Feasibility Study Report
Final—For Public Review (Revision 1)
Isaacson-Thompson Site
Tukwila, Washington

July 5, 2023

Prepared for

The Boeing Company

LANDAU ASSOCIATES

155 NE 100th St, Ste 302
Seattle, WA 98125
206.631.8680

Feasibility Study Report
Final – For Public Review (Revision 1)
Isaacson-Thompson Site
Tukwila, Washington

This document was prepared by, or under the direct supervision of, the technical professionals noted below.

Document prepared by: Kaila Anderson Kaila Anderson, PE
Senior Project Engineer

Document reviewed by: Piper M. Roelen, PE
Principal Engineer

Date: July 5, 2023
Project No.: 0025190.223
File path: \\edmdata01\projects\025\190\002\FileRm\R\FS\5_Public Review FS - Rev 1\Boeing_I-T_Landau_Final(PR) FS_Rev 1_07.05.2023.docx
Project Coordinator: tam/ljl

This page intentionally left blank.

TABLE OF CONTENTS

Page
1.0 INTRODUCTION 1-1
  1.1 Site Description 1-1
    1.1.1 Current Land Uses in the Vicinity of the Site 1-3
    1.1.2 Geologic Conditions 1-3
    1.1.3 Hydrogeologic Conditions 1-4
  1.2 Site History/Background 1-5
  1.3 Previous Site Investigations 1-6
  1.4 Previous Interim Actions/Remedial Actions 1-6
    1.4.1 1984 Soil Excavation 1-6
    1.4.2 1988 Soil Excavation 1-7
    1.4.3 1989/1990 Storm Drain Line Sampling/Excavation 1-7
    1.4.4 1991 Soil Excavation/Stabilization 1-7
    1.4.5 1993–1995 Hydraulic Test Pad Area Excavations 1-8
    1.4.6 2004 20,000-Gallon Boiler Fuel Tank Closure/Excavation 1-8
    1.4.7 2006 Sump Removal 1-8
    1.4.8 2008 Removal of Stabilized Soil Mound 1-9
    1.4.9 2011 Removal of Former Washdown System and Aqueous Degreaser 1-9
    1.4.10 Former Paint Storage Area and Sumps 1-10
    1.4.11 Former Diesel and Gasoline Tanks Area 1-10
  1.5 Future Land Uses 1-11
2.0 PROPOSED CLEANUP STANDARDS 2-1
  2.1 Development of Proposed Cleanup Levels 2-1
  2.2 Proposed Cleanup Levels—Groundwater 2-1
  2.3 Groundwater Background Levels 2-2
  2.4 Proposed Cleanup Level—Soil 2-3
  2.5 Points of Compliance 2-4
    2.5.1 Point of Compliance—Groundwater 2-4
    2.5.2 Point of Compliance—Soil 2-4
    2.5.3 Elimination of COCs 2-5
  2.6 Other Regulatory Requirements 2-6
  2.7 Applicable or Relevant and Appropriate Requirements 2-6
3.0 NATURE AND EXTENT OF CONTAMINATION/CONCEPTUAL SITE MODEL 3-1
  3.1 Groundwater Quality 3-1
    3.1.1 Upland Area Groundwater 3-2
    3.1.2 Shoreline Area/Western Site Boundary Groundwater 3-3
    3.1.3 Groundwater Exposure Pathways 3-4
  3.2 Soil Quality 3-5
    3.2.1 North of Former Slip 5 Area 3-5

3.2.2 Former Slip 5 Area 3-6
3.2.3 South of the Former Slip 5 Area 3-7
3.2.4 Soil Exposure Pathways 3-7
3.3 Identification of Areas or Volumes of Media that Require Remedial Action 3-8
3.3.1 Groundwater 3-8
3.3.2 Soil 3-9
3.4 Supplemental Data Collection 3-10
4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES 4-1
4.1 Screening of Technologies 4-1
4.1.1 Institutional Controls 4-1
4.1.2 Containment 4-2
4.1.2.1 Engineered Cap 4-2
4.1.2.2 Engineered Vertical Barriers 4-2
4.1.2.3 Hydraulic Containment 4-4
4.1.3 Removal (Excavation) 4-4
4.1.4 *In Situ* Treatment 4-5
4.1.4.1 Soil Stabilization 4-5
4.1.4.2 Permeable Reactive Barrier 4-6
4.1.4.3 Reductant Injection 4-6
4.1.4.4 pH/Redox Modification 4-7
4.1.5 *Ex Situ* Treatment 4-8
4.1.5.1 Precipitation/Co-precipitation 4-8
4.1.5.2 Adsorption 4-8
4.1.5.3 Filtration 4-9
4.2 Treatability Study 4-9
5.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES 5-1
5.1 Remedial Action Objectives 5-1
5.2 Summary of Remedial Alternatives 5-2
5.2.1 Alternative 1: Containment and Hydraulic Capture via Capping and Groundwater Extraction 5-2
5.2.2 Alternative 2: Containment and Hydraulic Control via Capping and Vertical Barrier 5-5
5.2.3 Alternative 3: *In Situ* Groundwater Treatment, Shoreline Excavation, and Containment 5-7
5.2.4 Alternative 4: Focused Excavation and Containment, and *In Situ* Groundwater Treatment 5-10
5.2.5 Alternative 5: Site-Wide Excavation of Contaminated Soil 5-12
5.3 Lower Duwamish Waterway Source Control 5-14
5.4 Shoreline Management Act Compliance 5-15
5.5 Climate Change 5-17

6.0 DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES 6-1
  6.1 Evaluation Criteria 6-1
    6.1.1 Threshold Requirements 6-1
    6.1.2 Requirements for a Permanent Solution to the Maximum Extent Practicable...6-1
    6.1.3 Requirements for a Reasonable Restoration Time Frame 6-2
    6.1.4 Requirement for Consideration of Public Concerns 6-3
  6.2 Evaluation and Comparison of Alternatives 6-3
    6.2.1 Threshold Requirements 6-3
    6.2.2 Permanent Solutions to the Maximum Extent Practicable (i.e., Disproportionate Cost Analysis) 6-4
    6.2.3 Conclusion of Disproportionate Cost Analysis 6-6
    6.2.4 Restoration Time Frame 6-7
    6.2.5 Requirement for Consideration of Public Concerns 6-8
    6.2.6 Supplemental Remedial Alternative Evaluation and Disproportionate Cost Analysis 6-8
7.0 PREFERRED CLEANUP ACTION 7-1
8.0 USE OF THIS REPORT 8-1
9.0 REFERENCES 9-1

FIGURES

Figure	Title
1-1	Vicinity Map
1-2	Current Site Features
1-3	Current Storm Drain System
1-4	Pre-Remedial Investigation Soil Sampling Locations
1-5	Pre-Remedial Investigation Groundwater Monitoring Locations
1-6	RI Soil Sampling Locations
1-7	RI Groundwater Monitoring Locations
1-8	Previous Remediation Areas
3-1a	Conceptual Site Model
3-1b	Site Environmental Areas
3-1c	Groundwater Elevation Contours – December 5, 2011
3-2	Dissolved Copper Concentrations in Groundwater
3-3	Dissolved Nickel Concentrations in Groundwater
3-4	Dissolved Zinc Concentrations in Groundwater
3-5	Dissolved Mercury Concentrations in Groundwater
3-6	Dissolved Arsenic Concentrations in Groundwater
3-7	Total PCB Concentrations in Groundwater
3-8	Vinyl Chloride Concentrations in Groundwater
3-9	Arsenic Concentrations in Soil
3-10	Copper Concentrations in Soil
3-11	Mercury Concentrations in Soil
3-12	Zinc Concentrations in Soil

3-13 Extent of TPHs and cPAHs in Observed Tar-Like Substance Area Soil
3-14 Lead Concentrations in Soil
3-15 Nickel Concentrations in Soil
3-16 Total PCB Concentrations in Soil
3-17 Total cPAH Concentrations in Soil
3-18 GRO Concentrations in Soil
3-19 Barium Concentrations in Soil
3-20 Cadmium Concentrations in Soil
3-21 bis(2-ethylhexyl)phthalate Concentrations in Soil
3-22 Total Chromium Concentrations in Soil
3-23 Hexavalent Chromium Concentrations in Soil
3-24 RI Groundwater Monitoring Locations with DO, pH, and ORP Data
3-25 Extent of Metals Contamination in Groundwater
3-26 Extent of Organic Chemical Contamination in Groundwater
3-27 Extent of Metals Contamination in Soil
5-1 Alternative 1—Containment and Hydraulic Control via Capping and Groundwater Extraction
5-2 Alternative 2—Containment and Hydraulic Control via Capping and Vertical Barrier
5-3 Alternative 3—*In Situ* Groundwater Treatment, Shoreline Excavation, and Containment
5-4 Cross-Section Locations
5-5 Cross-Section B-B’ Alternative 3 Shoreline Excavation and PRB
5-6 Alternative 4—Focused Excavation and Containment, and *In Situ* Groundwater Treatment
5-7 Cross-Section C-C’ Alternative 4 Focused Excavation and PRB
5-8 Alternative 5—Site-Wide Excavation of Contaminated Soil
5-9 Cross-Section D-D’ Alternative 5 Site-Wide Excavation
6-1 Summary of MTCA Alternatives Relative Benefits Ranking

TABLES

Table Title

2-1a Proposed Cleanup Levels: Groundwater
2-1b Proposed Cleanup Levels: Soil
2-2 Groundwater Data and pCUL Exceedances
2-3a Soil Data and pCUL Exceedances: North of Former Slip 5 Area
2-3b Soil Data and pCUL Exceedances: Former Slip 5 Area
2-3c Soil Data and pCUL Exceedances: South of Former Slip 5 Area
2-4a Groundwater COC Elimination Criteria
2-4b Soil COC Elimination Criteria
2-5 Total Non-Carcinogenic Site Risk: Groundwater
2-6 Total Non-Carcinogenic Site Risk: Soil
2-7 Total Carcinogenic Site Risk: Soil and Groundwater
3-1 Summary of Soil Analytical Results for Detected Constituents, Boeing Thompson Property Wooden Bulkhead
5-1 Remedial Action Alternatives
5-2a Remedial Alternative 1 Detailed Cost Estimation
5-2b Remedial Alternative 2 Detailed Cost Estimation

5-2c	Remedial Alternative 3 Detailed Cost Estimation
5-2d	Remedial Alternative 4 Detailed Cost Estimation
5-2e	Remedial Alternative 5 Detailed Cost Estimation
6-1	Summary of Remedial Alternatives Compliance with MTCA Threshold Requirements
6-2	Disproportionate Cost Analysis Relative Benefits Ranking Considerations
6-3	Summary of MTCA Alternatives Relative Benefits Ranking

APPENDICES

Appendix	Title
A1	Port of Seattle Sliver Property Data Summary Report
A2	Port of Seattle Sliver Property 2012 Figure and Data Tables
B	LDW PCB Congeners Data from Boeing Isaacson-Thompson
C	8801 Site VC/TCE Plume
D	Treatability Study Work Plan
E	Treatability Study Results—Resolution Partners Lab Report
F	Numerical Model Documentation
G	Supplemental Remedial Alternative Evaluation and Disproportionate Cost Analysis

LIST OF ABBREVIATIONS AND ACRONYMS

°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	micrograms per liter
1,1-DCE	1,1-dichloroethene
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
BEHP	bis(2-ethylhexyl)phthalate
bgs	below ground surface
Boeing	The Boeing Company
CB	catch basin
CFR	Code of Federal Regulations
cis-DCE	cis-1,2-dichloroethene
City	City of Tukwila
CPOC	conditional point of compliance
COC	contaminant of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSM	conceptual site model
cVOC	chlorinated volatile organic compound
DAHP	Department of Archaeology and Historic Preservation
DCA	disproportionate cost analysis
DRO	diesel-range organics
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
ERD	enhanced reductive dichlorination
FS	feasibility study
ft	feet, foot
ft^2	square feet
GAC	granular activated carbon
gpm	gallons per minute
GRO	gasoline-range organics
IHS	indicator hazardous substances
ISGP	Industrial Stormwater General Permit
KC	King County
KCIA	King County International Airport
KCIW	King County Industrial Waste
LAI	Landau Associates, Inc.
LDW	Lower Duwamish Waterway
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MLLW	mean lower low water
MTCA	Washington State Model Toxics Control Act
NHPA	National Historic Preservation Act of 1966
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance

LIST OF ABBREVIATIONS AND ACRONYMS (continued)

OHWM	ordinary high water mark
ORC	oxygen release compound
Order	Agreed Order No. DE 7088
ORO	oil-range organics
ORP	oxidation reduction potential
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCUL	proposed cleanup level
Port	Port of Seattle
PQL	practical quantitation limit
PRB	permeable reactive barrier
PTI	PTI Environmental Services
RAO	remedial action objective
RCRA	Resource Conservation Recovery Act
RCW	Revised Code of Washington
RI	remedial investigation
SEPA	State Environmental Policy Act
Site	Boeing Isaacson-Thompson
SMA	Washington State Shoreline Management Act of 1971
SMP	Shoreline Master Program
SU	standard unit
SVOC	semivolatile organic compound
SWPPP	stormwater pollution prevention plan
TCE	trichloroethene
TCLP	Toxicity Characteristic Leachate Procedure
TEE	terrestrial ecological evaluation
TEQ	toxic equivalency quotient
TMC	Tukwila Municipal Code
TPH	total petroleum hydrocarbons
TSCA	Toxic Substances Control Act
UIC	underground injection control
USC	United States Code
UST	underground storage tank
VC	vinyl chloride
VI	vapor intrusion
VOC	volatile organic compound
Vortechs	CONTECH® Vortechs®
WAC	Washington Administrative Code
WDFW	Washington Department of Fish & Wildlife
ZVI	zero-valent iron

This page intentionally left blank.

1.0 INTRODUCTION

This document presents the results of a feasibility study (FS) conducted for The Boeing Company (Boeing) Isaacson-Thompson Site (Site) located in Tukwila, Washington (Site; Figure 1-1). The Site is composed of two parcels of land surrounded by a security fence, with limited access: the Isaacson property, located in the northern portion of the Site, purchased by Boeing from the Isaacson Corporation in 1984; and the Thompson property, located in the southern portion of the Site, most of which was purchased by Boeing from Charles Thompson in 1956. Boeing has conducted investigations at the Site to characterize soil and groundwater conditions as documented in the remedial investigation (RI) report (Landau Associates, Inc. [LAI] 2014). Investigation activities have been supplemented by the Washington State Department of Ecology (Ecology) investigation of the Port of Seattle (Port) property located adjacent to the west end of the Isaacson property (also known as the "Sliver property"), the results of which are documented in a report that is included in Appendix A1. At Ecology's request, the Port property is included as part of the Site for the purposes of this FS.

The RI report concludes that remedial action evaluation was warranted for impacted soil and groundwater at the Site. This FS develops and evaluates remedial action alternatives for the Site and identifies a preferred remedial alternative that will address the contamination at the Site as required by Washington Administrative Code (WAC) 173-340-360, under the Model Toxics Control Act (MTCA). This FS also develops proposed soil and groundwater cleanup levels and identifies proposed points of compliance. The RI and this FS are being implemented under Agreed Order No. DE 7088 (Order) between Boeing and Ecology. The Final RI was submitted to Ecology on April 21, 2014. Ecology determined the RI to be sufficient to proceed with the FS in a letter dated May 11, 2017 (Ecology 2017a).

1.1 Site Description

The Site (Figure 1-2) is comprised of two Boeing-owned parcels and one Port-owned parcel of land surrounded by a security fence, with limited access. The northern Boeing parcel is known as the Isaacson property and is a 9.84-acre parcel of land located near the east side of the Lower Duwamish Waterway (LDW), at approximately river miles 3.7 to 3.8, as measured from the southern tip of Harbor Island. The southern Boeing parcel is known as the Thompson property and is a 19.35-acre parcel of land located on the eastern bank of the LDW, directly south of the Isaacson property. Boeing occupies and operates on the Isaacson and Thompson properties only. The northwestern Port parcel is a 1/2-acre strip of land, approximately 60 feet (ft) wide and 400 ft long, located adjacent to the east of the LDW, to the west of the Isaacson property, and to the northwest of the Thompson property. For the purposes of this FS, these three parcels are referred to collectively as the Isaacson-Thompson Site. The total size of the Site is approximately 29.7 acres.

Except for pavement and catch basins (CBs) that collect stormwater runoff, the northern portion of the Site (Isaacson property) is undeveloped. This property is used by Boeing primarily for shipping container storage and parking.

The southern portion of the Site (Thompson property) is developed with several structures operated by Boeing to support the P-8 program that include a 316,000-square foot (ft^2) industrial building (Building 14-01) and several support structures including a boiler house (Building 14-02); two mechanical buildings (Buildings 14-03 and 14-14); a fire pump house (Building 14-13) and water tank; an electrical substation (Building 14-22); and a guard shack. Two pedestrian tunnels are located on the north side of Building 14-01. There are three storage tanks currently located on the Thompson property: a 20,000-gallon boiler fuel underground storage tank (UST; TS-01) located on the west side of Building 14-02, which was decommissioned in-place in 2003; a 500-gallon diesel aboveground storage tank (AST; TS-57); and a 200-gallon diesel AST (TSA-25). Each AST is located within secondary containment. Five sumps exist on the Site. One of the sumps is located in the southeast corner of Building 14-02 (this has not been assigned a numerical designation); it is approximately 3 ft^2 and is located in a 10-ft^2 by 6-ft-deep mechanical pit that houses underground utility pipes. The sump does not appear to be connected to the existing storm drain. The depth of the sump has not been determined. Sump BMA046 is in the northern portion of Building 14-01, in an area that has historically been used for office space. This sump is associated with a sanitary sewer lift station. The other three existing sumps are located outside Building 14-01. Two of these sumps are associated with tunnels located north of Building 14-01. These sumps are 2-ft by 2-ft and 3-ft deep concrete structures located 11 ft below ground surface (bgs) at the base of the stairs used to exit the tunnels. The sumps accumulate rainwater that collects at the base of the stairs. The third sump is located at the northeast corner of Building 14-01 at the base of the stairs that lead to a room housing piping and valves associated with the main water line. This sump also accumulates rainwater that collects at the base of the stairs. Construction details for this sump are not known but are likely similar to the sumps associated with the tunnels. Rainwater collected in each of these three sumps is discharged, as needed, to the Site storm drain system. There are no existing ASTs, USTs, or sumps on the Isaacson property actively in use. Details regarding decommissioning of historical sumps were presented in the RI report and are summarized in Section 1.4 of this report.

The northwestern Port parcel consists of a flat area with deteriorating asphalt paving with vegetation growing up through cracks and holes in the pavement. A chain-link fence separates the Port parcel from the Boeing parcels. The Port parcel is not currently used.

Stormwater from the Site is collected in two Boeing-owned storm drain systems (Figure 1-3) that discharge to the LDW via two outfalls (Outfalls A and B; shown on Figure 1-2).[1] The Isaacson

---

[1] Figure 1-3 shows manholes and catch basins currently unconnected to the main drain system. These manholes and catch basins were previously connected to the 48-inch KC storm drain line, which was abandoned and rerouted in 1990. The location of the historical KC storm drain line is shown on Figure 27 of the RI report. Rerouting details are presented in Section 1.4.3 of this report.

stormwater system includes two CONTECH® Vortechs® (Vortechs) treatment vaults that treat stormwater by allowing suspended solids to settle out prior to discharge to the LDW. Stormwater discharge from the facility is covered under Industrial Stormwater General Permit (ISGP) No. WAR000148. A 48-inch King County (KC) storm drain alignment runs through the Isaacson property and discharges to the LDW through the steel bulkhead, as shown on Figure 1-2. Stormwater from the Isaacson and Thompson properties does not enter the KC storm drain line.

A deteriorating wooden shoreline bulkhead runs from the southern end of the Thompson property approximately 340 ft north, where the bulkhead transitions to steel construction and runs an additional 160 ft to the southern end of the Port parcel (shown on Figure 1-2). Construction details of the Thompson wooden bulkhead are not known, but the bulkhead may have been present since at least 1936 based on historical photos. The steel bulkhead was constructed in the 1960s and consists of a sheet pile wall that extends 60 ft bgs (Alpha Engineers 1989). The sheet pile is supported with tiebacks and timber fender piles spaced on 9-ft centers. The tieback anchor rods are located about 6 ft bgs, extend 40 ft east behind the wall, and are supported by timber pile groups connected by a continuous concrete pile cap. A timber pile-supported concrete apron extends behind the bulkhead approximately 20 ft. A deteriorating wooden shoreline bulkhead runs along the southern and western sides of the Port parcel. Construction details for this bulkhead are not known, but it appears to have been constructed between the 1930s and 1960s during filling of the former Slip 5 (see Section 1.2).

1.1.1 Current Land Uses in the Vicinity of the Site

Current land uses in the vicinity of the Site include a former steel and aluminum forging and milling facility (Jorgensen site), a property that formerly stored damaged and wrecked vehicles and is being re-developed for industrial use and trailer storage (8801 site), and an airport (King County International Airport [KCIA]).

1.1.2 Geologic Conditions

The geology of the lower Duwamish River valley is characterized by the historic riverine depositional environment from the river and the anthropogenic changes made to the river that resulted in the current configuration of the LDW. Naturally occurring soils in the vicinity generally consist of low to moderately permeable alluvial deposits of interbedded silt, clay, silty sand, and sand. The Duwamish River historically meandered across the river valley floor but was channelized in the 1900s for shipping and commerce. The channel constructed resulted in the human movement and deposition of dredge fill and other large quantities of sand, silt, gravel, and other fill sources.

Observations during the RI indicated that subsurface soil conditions at the Site consist of approximately 2 to 19.5 ft of fill overlying river deposits with the thickest layers of fill occurring in the Former Slip 5 Area. The fill generally consists of silty sand to sandy gravel. Fill materials within the Former Slip 5 Area include bricks, wood debris, and slag material. The native deposits typically consist of fine sand and silty fine sand with silt lenses. The native surficial deposits are characterized by the presence of small in-place roots, wood fragments, and peat, which are indicators of the original ground surface elevation prior to filling. Underlying the silt and silty fine sand is a series of interbedded alluvial sand and silt layers that were deposited within the floodplain of the lower Duwamish River. Beneath the interbedded alluvial silt and fine sand is a layer of very dark to black, fine to medium sand. This naturally deposited sand is found throughout the lower Duwamish River valley and was likely deposited from flood waters.

1.1.3 Hydrogeologic Conditions

The near-surface groundwater regime within the lower Duwamish River valley is generally characterized as a shallow, single-aquifer system. The Site is located at and near the east bank of the LDW, at approximately 16.5 to 19.5 ft above mean lower low water (MLLW). Shallow groundwater is present throughout the area of the Site. River elevations adjacent to the Site and groundwater levels at the Site are tidally influenced proximate to the LDW. Depth to water at the Site measured during the RI (all collected during an intermediate tide) typically ranged from 11 ft to 17 ft bgs and on average was 13.5 ft bgs.

Groundwater at the Site generally flows to the west toward the LDW, except at some locations along the immediate shoreline where groundwater is tidally influenced and groundwater may flow north or south prior to discharge to the LDW. Groundwater flow directions near the shoreline may be also affected by the various existing bulkheads described in Section 1.1.

The LDW is comprised of both marine and fresh surface water. Following the initial dredging and realignment of the LDW, saltwater from Puget Sound extended back into the waterway and infiltrated the upland groundwater. As a result of the saltwater intrusion into the LDW, a saltwater wedge is present in the LDW. The saltwater also intruded from the LDW to groundwater at properties along its shoreline. The presence of brackish or saline water in the aquifer can affect groundwater flow because the less dense fresh groundwater tends to move above the higher density saline water. The density difference between the freshwater aquifer system and the saltwater of the LDW tends to concentrate the outflow of the surficial aquifer into the intertidal areas.

Tidal influences in upland groundwater monitoring wells are dependent on several factors including soil type, distance from the shoreline, and the presence of hydraulic barriers. These factors cause the magnitude of tidal influences in upland monitoring wells to be reduced, or altogether eliminated, in comparison to tidal fluctuations observed in water bodies like the LDW. In addition to attenuation of the magnitude of tidal influences, the timing of any observed tidal extremes (i.e., minimum or maximum groundwater elevation fluctuations caused by tidal influences) in upland monitoring wells typically lags behind the timing observed in the adjacent water body.

A tidal study during the RI showed that groundwater elevations at Site monitoring wells are influenced by tidal elevations by varying degrees. The amplitude of tidal fluctuations is dependent on the distance from the LDW (the amplitude decreases as distance increases) and the bulkhead material between the well and the LDW (the steel bulkhead appears to mute the amplitude more than the wooden bulkheads). The study indicated that tidal fluctuations generally do not occur more than 400 ft from the LDW. Lag times also generally increase with distance from the LDW.

1.2 Site History/Background

A description of Site development and historical uses is provided in Section 2.0 of the RI. The following provides a brief summary of the Site history.

Historically, meanders of the Duwamish River were present in the area of the Site including a segment of the river that flowed west to east through the approximate center of the Site. Between 1910 and 1917, extensive dredge and fill operations were conducted in the lower Duwamish River valley and the river was channelized and placed in its current location to the west of the Site. The river channel modifications resulted in the creation of Slip 5 through part of the Site. The approximate location of former Slip 5 is shown on Figure 1-2. The first known development of the Site began in 1917 and included a sawmill on the land south of former Slip 5 and, in 1920, another on the western portion of the Site. Slip 5 was filled in phases between 1936 and about 1966 to allow further development of the Site. A bulkhead oriented east to west at the southern edge of former Slip 5 is visible in historical aerial photos taken in 1956, 1961, and 1965; no other information regarding this bulkhead is available.

In 1943, the Isaacson property was purchased by the Isaacson Corporation and was developed between 1943 and 1966. The Isaacson property was used for various purposes associated with the Jorgensen Steel plant to the north, which included storage of scrap metal prior to it being melted down. Between 1943 and 1945, a galvanizing plant was constructed in the northeast corner of the Isaacson property; the plant was dismantled in 1967. The Mineralized Cell Wood Preserving Company operated on the northern side of former Slip 5 for an unknown period of time beginning prior to 1945. The operations of this company involved heating a solution of arsenic and sulfate salts of copper and zinc and applying the solution under pressure to the base of logs. Storage tanks associated with this operation were reportedly cleaned twice per day and sludge and remaining chemicals in the tanks were reportedly drained directly to the ground surface.

Boeing purchased the Isaacson property from the Isaacson Corporation in 1984. Boeing proposed to redevelop the Isaacson property by demolishing the Isaacson building (former Building 14-05 outline shown on Figure 1-4) and constructing a new building; however, although the Isaacson building was dismantled prior to 1990, the planned new building was not constructed. Boeing purchased most of the Thompson property in 1956; the southern portion of the Thompson property was developed beginning in 1966. Until 2011, the layout of the Thompson property had remained relatively unchanged. In 2011, Boeing re-occupied Building 14-01 and building modifications were made, including removal of a loading dock and an inactive 5,000-gallon wastewater AST (TSA-21) located west of Building 14-01, and removal of the aqueous degreaser formerly located in the western portion of Building 14-01. The sump associated with the aqueous degreaser was decommissioned in place when the aqueous degreaser was removed.

1.3 Previous Site Investigations

Environmental investigations at the Site to date have been conducted to characterize and evaluate the chemical quality and physical condition of soil, groundwater, sediment, and storm drain solids. Investigations have been conducted from 1983 to 2011, including formal RI investigation activities, at which point enough data had been collected to prepare the RI report. A full summary of previous investigations is provided in Section 3.0 of the RI report. Pre-RI soil and groundwater sampling locations are identified on Figures 1-4 and 1-5, respectively (also see Appendix A2 for data from the Port parcel), and RI soil and groundwater sampling locations are shown on Figures 1-6 and 1-7, respectively.

Since completion of the RI, Ecology commissioned an investigation on the Port parcel consisting of drilling and sampling 10 soil borings. Samples from the soil borings were analyzed for polycyclic aromatic hydrocarbons (PAHs), Resource Conservation and Recovery Act (RCRA) metals plus copper and zinc, and polychlorinated biphenyls (PCBs). Select samples were also analyzed for volatile organic compounds (VOCs) and oil- and diesel-range total petroleum hydrocarbons (TPH). The results of the investigation are included in a data summary report in Appendix A.

1.4 Previous Interim Actions/Remedial Actions

Several cleanup actions have previously been performed at the Site, the locations of which are shown on Figure 1-8. A full description of previous actions is provided in Section 3.0 of the RI report. The following sections provide a brief summary of these actions.

1.4.1 1984 Soil Excavation

In 1984, the Isaacson Corporation implemented a remedial action that consisted of excavating arsenic- and zinc-contaminated soil from three areas located in the northern portion of the Site. The extent of contamination identified, and excavation within each of these areas (identified as A, B, and C) are described below:

- The Area A excavation was located around well I-2(s) where elevated concentrations of arsenic were present in the soil and groundwater. Based on the analytical results for soil samples collected at this location, soil was excavated from an area about 13 ft by 25 ft, centered on this well. The excavation extended vertically to a depth of 11 ft bgs.
- The excavation at Area B occurred at the location of the former steam cleaning rack and a 5-ft deep sand and gravel sump where the previous investigations had identified elevated concentrations of arsenic and zinc in the soil. The excavation removed the sump and some soil surrounding the sump to a depth of 4.7 ft bgs.
- The excavation in Area C was conducted to address arsenic-contaminated soil at I-1(s) and boring #11. The excavation was about 23 ft by 23 ft and extended to a depth of 12 ft bgs.

1.4.2 1988 Soil Excavation

In 1988, prior to Boeing's planned removal of the Isaacson building and paving of the Isaacson property, Ecology requested that soil containing elevated arsenic concentrations be removed from Bay 13 and the courtyard between Bays 11, 12, and 14 of the former Isaacson building. In each area, soil was excavated to the groundwater table (approximately 10–12 ft bgs). Excavations were backfilled with pea gravel, imported fill, and excavated soil.

1.4.3 1989/1990 Storm Drain Line Sampling/Excavation

In late 1989 and early 1990, the former Isaacson building was demolished, and the KC storm drain line that crossed the Isaacson property near its southern parcel boundary was rerouted along the northern parcel boundary (to its current alignment) as part of the planned development of the Site by Boeing. To evaluate proper disposition of soil removed from the linear excavation along the alignment of the new storm drain (vertical extent approximately 11–13 ft bgs, at which depth groundwater was encountered), soil from each 10- to 12-ft length of the storm drain alignment was stockpiled and sampled. The stockpile samples were analyzed for arsenic. Soil stockpiles containing arsenic concentrations less than 500 milligrams per kilogram (mg/kg) were used as backfill for the new storm drain line. Soil stockpiles containing arsenic concentrations greater than or equal to 500 mg/kg were disposed of offsite. Additionally, if a stockpile contained arsenic at greater than 500 mg/kg, then sidewall samples were collected from the corresponding portion of trench from where the soil was removed. Based on the results of the sidewall samples, further excavation was conducted on both sides of the storm drain line in some areas (shown as "1990 excavation" on Figure 1-8).

1.4.4 1991 Soil Excavation/Stabilization

Due to elevated concentrations of arsenic in soil samples collected during 1989/1990 storm drain line sampling, an additional area was remediated. The selected remediation method consisted of excavation of soil within the area to the depth of the groundwater table (approximately 12 ft bgs) and chemical treatment and stabilization of the excavated soil using soluble silicate solutions and cementitious materials. Because previous sampling results indicated arsenic concentrations in shallow soil were below the remediation cleanup level of 200 mg/kg, most of the soil removed from the upper 2–3 ft of the excavation was not treated and was used as backfill. The remediation activities occurred between August and November 1991. Excavation continued until all sidewall sample arsenic concentrations were below 200 mg/kg, except along the northern boundary of the excavation. Additional excavation to the north was not feasible because of the King County storm drain line located approximately 15 ft north of the excavation. Following stabilization, the material was returned to the excavated area; however, the volume of treated material was greater than the volume of the excavation and a mound of treated soil was created. The stabilized material, including the mound, was covered with asphalt pavement.

1.4.5 1993–1995 Hydraulic Test Pad Area Excavations

In late 1993, approximately 10 ft of petroleum product was observed in a monitoring well near an oil/water separator located in the Former Hydraulic Test Pad Area east of Building 14-03. Based on this observation and subsequent drilling in this area at a nearby oil/water separator, an estimated 825 cubic yards of contaminated soil was excavated from this area. One report has been identified showing the proposed excavation area (GeoEngineers 1994), but documentation showing the final lateral and vertical extent of the excavation has not been identified.

In August 1995, the oil/water separator system was removed. According to an undated internal Boeing memorandum, approximately 900 tons of petroleum-contaminated soil was excavated from the area surrounding the oil/water separator and holding tank. The soil was transported to a treatment facility in Oregon operated by TPS Technologies. Documentation showing the final lateral and vertical extent of the excavation has not been identified.

1.4.6 2004 20,000-Gallon Boiler Fuel Tank Closure/Excavation

In 2004, a 20,000-gallon boiler fuel UST (TS-01) located on the west side of Building 14-02 was decommissioned in-place. A concrete pad (up to 4 ft thick) was situated on top of the UST as a counterweight to prevent the UST from floating in the shallow groundwater when not full. The bottom of the tank was estimated to be about 10 to 12 ft bgs. Due to the tank's location, it was abandoned in place rather than risking potential damage to a nearby 500-gallon diesel AST (TS-57) or Building 14-02. The overlying concrete slab and some of the soil surrounding the tank were removed prior to deciding to abandon the tank in place. The excavated soil was stockpiled nearby during abandonment of the tank. AST TS-57 was not excavated and is still actively used.

1.4.7 2006 Sump Removal

In November 2006, Boeing removed a sump located in the northeastern corner of the Site. The sump was a below-grade, open-to-the-surface 55-gallon drum that was discovered under a steel plate. Prior to removal of the sump, two samples of soil in the sump were collected and analyzed for diesel-range and motor oil-range petroleum hydrocarbons; VOCs; semivolatile organic compounds (SVOCs); and metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) to determine appropriate disposal of the sump and its contents. The excavation associated with the sump removal extended about 2 ft beyond the exterior of the sump and to about 5 ft in depth. One soil sample (IsaacEX-01-5) was collected from the base of the excavation (5 ft bgs) and two soil samples (IsaacEX-02-1.5 and IsaacEX-03-2) were collected from the excavation sidewalls at depths of 1.5 ft and 2 ft bgs. These samples were analyzed for diesel-range and motor oil-range petroleum hydrocarbons; VOCs; SVOCs; PCBs; and metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Diesel-range and motor oil-range petroleum hydrocarbons, acetone, PAHs, bis(2-ethylhexyl)phthalate (BEHP), and metals were detected in one or more of the samples collected from the excavation. PCB Aroclor 1260 was detected in one sidewall sample at a concentration of 0.041 mg/kg.

1.4.8 2008 Removal of Stabilized Soil Mound

In late 2008, an independent action was conducted to remove a portion of the mound within the Stabilized Soil Area in the northern portion of the Site (see Section 1.4.4 above). The independent action consisted of the removal and offsite disposal of the stabilized soil mound and non-stabilized surface soil surrounding the mound to reduce the grade, as necessary, to allow greater usability for driving and storage at the Isaacson property. After the mound of stabilized material and the surrounding non-stabilized surface soil were removed and graded for drainage, the area was recapped with asphalt. New stormwater treatment and conveyance system improvements (Vortechs vaults) were also installed as part of this action.

To determine the appropriate disposal options for the stabilized soil designated for removal, samples of the stabilized soil were collected from seven test pits completed within the mound. The samples, identified ISS-TP-1 through ISS-TP-7, were analyzed for total RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and zinc); Toxicity Characteristic Leachate Procedure (TCLP) RCRA metals; and gasoline-range, diesel-range, and oil-range petroleum hydrocarbons. Elevated concentrations of arsenic (up to 1,700 mg/kg) were detected in the samples, but the TCLP results were low (non-detect to 0.0017 milligrams per liter (mg/L); i.e., below the hazardous waste designation threshold of 5 mg/L). Barium, cadmium, chromium, and lead were also detected in the stabilized soil samples, but only barium was detected by TCLP. Barium concentrations ranged from 0.000051 mg/L to 0.00056 mg/L. Low concentrations (380 mg/kg or less) of diesel-range and motor oil-range petroleum hydrocarbons were also detected. To determine appropriate disposal options for the non-stabilized soil that was removed, 20 samples of the surface soil were collected and analyzed for total arsenic and TCLP arsenic. The samples were identified as ISC-A through ISC-T. Although total arsenic concentrations were elevated, TCLP arsenic results were all below 0.0017 mg/L.

1.4.9 2011 Removal of Former Washdown System and Aqueous Degreaser

A large area of the western portion of Building 14-01 was formerly used for washing and painting of airplane sections. An aqueous degreaser was also located in the southwest portion of Building 14-01. Workers in this area washed various airplane sections with a solution containing methyl isobutyl ketone to prepare the sections for painting. Wastewater and overspray were washed into one of three concrete trenches, which ran north to south through the painting area. The trenches conveyed the solution to three sumps (TS-67, TS-68, and TS-69) located on the exterior of the south side of Building 14-01. The wastewater from the painting and washing operations was pumped from the sumps to two ASTs located in the west yard of Building 14-01 (TSA-14 and TSA-15) via underground piping. A third 5,000-gallon AST (TSA-21), located in the western yard of Building 14-01, was originally used to contain waste copper plating solution. This tank was later used for overflow containment for the aqueous degreaser.

In 2011, Boeing re-occupied Building 14-01 and building modifications were made, including removal of a loading dock and an inactive 5,000-gallon wastewater AST (TSA-21) located west of Building

14-01. The aqueous degreaser was also removed in 2011, and sump associated with the aqueous degreaser (TS-26) was decommissioned in place. There were no indications of a release at any of the locations based on pre-RI soil sample results, RI soil and groundwater results, and construction-related soil sample results. The locations of the former ASTs and sumps are shown on Figure 4 of the RI Report (LAI 2014).

1.4.10 Former Paint Storage Area and Sumps

Two paint storage areas were previously located in the eastern portion of the Isaacson property, as shown on Figure 1-4. Three sumps were associated with the former paint storage area (identified as TS-09, TS-10, and TS-11 on Figure 4 of the RI Report). The sumps have since been removed. Analytical results for one soil sample collected in 1983 at 2.5 ft bgs indicated low concentrations of metals are present in the soil (e.g., arsenic and lead were detected at 8.7 mg/kg and 11 mg/kg, respectively).

Characterization of the soil and in former paint storage area was identified as a data gap in the RI/FS Work Plan. As a result, two monitoring wells (MW-15 and MW-16) were installed downgradient of the former paint storage areas. Three soil borings were also explored in the former paint storage area: one in each of the paint storage areas (SB-9 and SB-10) and one located where the former paint sludge sumps were located (SB-11). Soil and groundwater sample results were presented in Sections 8.2.2.1 and 8.2.2.2 of the RI Report, respectively. Soil samples from the three locations in the former paint storage area contained carcinogenic polycyclic aromatic hydrocarbons (cPAHs), PCBs, arsenic, and copper at concentrations exceeding the RI screening levels. Except for arsenic and copper, the exceedances only occurred in the unsaturated soil zone and generally occurred in the upper 3.5 ft of soil. Only arsenic was detected in the groundwater at concentrations exceeding the screening level.

1.4.11 Former Diesel and Gasoline Tanks Area

Four diesel and gasoline USTs were located in the eastern portion of the Isaacson property, as shown on Figure 1-4. The USTs are identified as TS-05, TS-06, TS-07, and TS-08 on Figure 4 of the RI Report. A soil sample was collected at a depth of 5.5 ft bgs in 1983 and analyzed for PCBs, metals, and total cyanide. PCBs, total cyanide, mercury, and silver were not detected. Concentrations of other metals detected in the soil sample were low (e.g., arsenic and lead were detected at 3.4 mg/kg and 1.3 mg/kg, respectively). Characterization of the soil and in former diesel and gasoline tanks area was identified as a data gap in the RI/FS Work Plan.

As a result, one test pit (TP-109) was excavated to determine if the tanks were still present and to collect soil samples for laboratory analysis. No monitoring wells were installed in this area. The test pit was approximately 6.5 ft by 10.5 ft and extended to a depth of 10 ft bgs. No visual signs of potential contamination were observed in the soil and no soil vapors were detected using the photoionization detector. No USTs were encountered. Based on the analytical results for the soil sample collected near the base of the test pit, no constituents are present at concentrations exceeding RI screening levels. Gasoline-range petroleum hydrocarbons (without associated benzene) were present at 17 mg/kg, well below the RI screening level of 100 mg/kg. Diesel-range and motor oil-range petroleum hydrocarbons were not detected. There was no indication of a release based on field screening and soil sample results at RI test pit TP-109.

1.5 Future Land Uses

Boeing has no current plans for significant changes to land use at the Isaacson or Thompson properties. The properties will continue to be used for aerospace manufacturing operations and storage. Future uses of the Port's Sliver Property are unknown.

The Boeing Isaacson-Thompson facility is proposing improvements to the Thompson shoreland infrastructure sometime in the next few years (no specific schedule or timeline has been determined). The proposed project entails installing a sheet pile wall upland of the existing wooden shoreline bulkhead. Ecology has indicated that it considers the sheet pile wall project to be an interim action. However, the proposed sheet pile wall project is not intended to be implemented as source control or containment. Based on soil data in this area of the Site that indicate there is no environmental erosion-to-sediment risk in this area, the project is not necessary for meeting remedial objectives. The purpose of the project is intended solely to provide protection to shoreline property and infrastructure. Therefore, the bulkhead project does not meet the definition or requirements of an interim action according to MTCA (WAC 173-340-430).

Boeing, however, acknowledges that the Order identifies shoreline stabilization as a potential interim action in Exhibit B Task 3. So, to move forward with both the FS and the proposed sheet pile wall project, Boeing will follow the interim action process established in the Order for the construction of the portion of the sheet pile wall project on the Thompson property, if and when it occurs. Potential impacts that the sheet pile wall might have on groundwater flow can be evaluated and incorporated into the design of the final remedy or addressed through modifications to the final remedy as necessary, depending on the timing of the project.

2.0 PROPOSED CLEANUP STANDARDS

Cleanup standards consist of cleanup levels for hazardous substances present at the Site; the location where the cleanup levels must be met (point of compliance), and other regulatory requirements that apply to the Site because of the type of action and/or location of the Site (applicable state and federal laws; WAC 173-340-700). The following sections describe the proposed cleanup standards for the Site.

2.1 Development of Proposed Cleanup Levels

Preliminary screening levels, developed in the RI for all constituents detected in soil and groundwater, were based on conservative values protective of human health and the environment. Development of these preliminary screening levels is discussed in Section 7.0 of the RI report. Proposed cleanup levels (pCULs)[2] are presented in this report only for contaminants of concern (COCs) identified in the RI. The pCULs are revised from the preliminary screening levels established in the RI to account for practical quantitation limits (PQLs), applicable exposure pathways, background values, total Site risk, and new or revised applicable or relevant and appropriate requirements (ARARs) as described below.

The pCULs used in this FS are presented in Tables 2-1a (groundwater) and 2-1b (soil). To determine the applicable Site COCs that require cleanup, Site sampling data from the RI was re-screened against the pCULs. The screening of RI sampling data for groundwater against the groundwater pCULs is presented in Table 2-2, and for soil data against the soil pCULs is presented in Tables 2-3a, 2-3b, and 2-3c. COCs identified in the RI were eliminated or maintained for consideration in the FS based on pCULs exceedances and statistical or empirical demonstrations where applicable, as presented on Tables 2-4a and 2-4b and discussed below. An evaluation of total carcinogenic and non-carcinogenic Site risks associated with these pCULs was also performed and the results presented in Tables 2-5, 2-6, and 2-7.

2.2 Proposed Cleanup Levels—Groundwater

Under MTCA (WAC 173-340-720), groundwater cleanup levels are to be based on estimates of the highest beneficial use and the reasonable maximum exposure expected to occur under both current and potential future Site use conditions. As described in the RI, groundwater at, or potentially affected by, the Site is not considered potable. Groundwater at the Site discharges into the LDW; therefore, the highest beneficial use of groundwater at the Site is protection of surface water beneficial uses in the LDW. The pCULs for the Site were developed using WAC 173-201A or 40 Code of Federal Regulation (CFR) 131.45 criteria considering the protection of human health and marine aquatic criteria, protection of sediment quality, background values, and PQLs, as appropriate. For VOCs, screening levels protective of indoor air were also considered. The Ecology LDW pCUL

---

[2] Note that screening levels used in the RI were referred to as "**preliminary** cleanup levels" or "pCULs;" the same acronym is used herein for "**proposed** cleanup levels."

workbook (Ecology 2018, 2019) for upland sites along the LDW was also utilized as a resource in pCUL development. The pCULs developed for the Site groundwater are provided in Table 2-1a.

The pCULs for acrylonitrile, BEHP; total cPAHs (expressed as total benzo[a]pyrene toxic equivalency); total PCBs; and thallium were adjusted up to the PQL. PQL values were based on reporting limits provided by Boeing's contracted laboratory(ies) for this Site. The PQL for total cPAHs represents a toxic equivalency (TEQ) value developed in accordance with Ecology Implementation Memo #11 (Ecology 2015).

The pCULs for trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), vinyl chloride (VC), antimony, barium, trivalent chromium (Chromium [III] or Cr[III]) or total chromium, hexavalent chromium (Chromium [VI] or Cr[VI]), copper, lead, mercury, nickel, selenium, and zinc are based on the marine surface water criteria found in WAC 173-201A or 40 CFR 131.45 ARARs (including new human health criteria that were promulgated by Ecology and US Environmental Protection Agency [EPA] in November 2016). The pCULs for beryllium and cadmium are based on the protection of sediment criteria from the Ecology LDW pCUL workbook.

The pCULs for TPHs, including diesel-, oil-, and gasoline-range organics, are based on MTCA Method A criteria. The pCUL for arsenic is based on background concentrations (see Section 2.3). Based on screening of the RI groundwater data against the pCULs, only VC, PCBs, arsenic, copper, mercury, nickel, and zinc were identified as Site COCs, as indicated on Table 2-1a.

2.3 Groundwater Background Levels

The background level for arsenic in groundwater is based on a study performed for the Boeing Plant 2 site (EPI et al. 2006), located proximate to the north of the Isaacson-Thompson site. The study utilized statistical analyses to determine background values for arsenic, copper, and manganese in groundwater in a localized area. The goal of this study was to develop background values that are as close to natural background as possible, because it was determined that there are no locations between the Duwamish Waterway and the eastern valley wall that could be unambiguously identified as un-impacted by human activities. Additionally, existing datasets of un-impacted aquifers in KC consist of data from glacial aquifers, which are not representative of the geochemical conditions found in the alluvial Lower Duwamish River Valley. Therefore, background levels were developed by compiling data from groundwater wells located on the east shore of the LDW between Slips 4 and 6 (specifically, Plant 2, Jorgensen Forge, Isaacson-Thompson, and Rhone Poulenc sites). From these data, statistical data distributions were identified and truncated from the larger set to include only lower-range concentrations. Copper and arsenic data fit a log-normal distribution and were truncated based on concentration values, which were too high to be considered background. Background values from these datasets were established at 4 times the 50th percentile, which were determined, in sensitivity analyses, to be a more robust value than the 90th percentile.

These background values are considered representative of natural background in groundwater at Isaacson-Thompson because of the physical proximity of Plant 2, Jorgensen Forge, and Rhone Poulenc, and groundwater geochemical similarities to the Isaacson-Thompson Site. The Isaacson-Thompson Site is less than 1 mile south of Plant 2, several hundred feet north of the Rhone Poulenc site, and adjacent to Jorgensen Forge; and soil at each site contains alluvial deposits and dredged spoils from historic Duwamish River channelization. The sites are located within the same aquifer, and groundwater conditions between the sites are very similar. Shallow groundwater at each site discharges to the Duwamish Waterway at elevations generally above -5 ft MLLW and is influenced by marine intrusion, evidenced by higher salinity observed in wells near the shoreline. Given the similarities in aquifer soils and groundwater conditions, the deposition of naturally occurring metals into groundwater should also be similar within areas unaffected by hazardous substance releases. Therefore, the background values developed for Plant 2 are considered representative for Isaacson-Thompson.

The natural background value developed by the Boeing Plant 2 evaluation of 8 micrograms per liter (µg/L) agrees with the most recently published natural background level for arsenic in Puget Sound published by Ecology in 2021 (Ecology 2021). This provides a second line of evidence to support the proposed natural background cleanup level of 8 µg/L arsenic.

2.4 Proposed Cleanup Level—Soil

The most stringent cleanup levels identified as potentially applicable at this Site are values for soil protective of surface water via the groundwater leaching pathway. Therefore, pCULs were set at values protective of surface water (via the groundwater leaching pathway) and adjusted up to the PQL or natural background, if applicable.

In accordance with MTCA, a Terrestrial Ecological Evaluation (TEE) was considered for this Site during the RI. Terrestrial ecological receptors are not considered to be potential receptors for contaminants in soil at the Site based on an exposure analysis per WAC 173-340-7491, as documented in Appendix J of the RI. Therefore, the Site is excluded from further TEE evaluation and consideration of ecologic-based cleanup values is unnecessary for development of pCULs for the Site.

The basis for the pCULs for Site soil is described below and included in Table 2-1b:

- Soil pCULs were selected for TCE, 1,1-DCE, antimony, barium, cadmium, chromium (VI), and lead based on protection of surface water via the groundwater leaching pathway. For TCE and barium, because no exceedances of the groundwater pCULs have been identified in groundwater (i.e., TCE and barium in saturated soils have not resulted in groundwater exceedances), the vadose zone pCULs were considered applicable as noted in Table 2-1b.
- The pCUL for VC, BEHP, total cPAH TEQ, total PCBs, selenium, and thallium were set at laboratory PQLs, because the applicable criteria (soil values protective of groundwater/surface water) are less than the PQL.

- The pCULs for arsenic, cadmium, chromium III (total chromium), copper, mercury, nickel, and zinc were set at their respective natural background levels, because the applicable criteria (soil values protective of groundwater/surface water) are less than background concentrations. Background values are based on the Ecology LDW CUL Workbook (Ecology 2018, 2019).
- The pCULs for TPHs, including diesel-, oil-, and gasoline-range organics, were set at MTCA Method A values.
- The pCUL for beryllium was based on protection of sediment based on the LDW pCUL workbook developed by Ecology.

2.5 Points of Compliance

This section discusses points of compliance where the pCULs must be met. Standard points of compliance or conditional points of compliance (CPOCs) may both need to be included under various remedial alternatives and are discussed in this section.

2.5.1 Point of Compliance—Groundwater

The standard point of compliance for groundwater is throughout groundwater at the Site. A CPOC is a location downgradient of, but as close to the source as reasonably possible. A CPOC may be used for a site (in accordance with WAC 173-340-720[8][c,d]) if it can be demonstrated that it is not practicable to meet the cleanup levels throughout the site in a reasonable restoration time frame and that all practicable methods of treatment are to be used in the site cleanup. Because it has been determined that it is not practicable to achieve a reasonable restoration time frame at the standard point of compliance at the Site (see Sections 6.2.2 and 6.2.4), the proposed CPOC for groundwater at the Site, for protection of surface water beneficial uses, is between the LDW and as close as practicable to the contaminant source(s)—i.e., the former industrial areas where the COCs were likely used and released, the Stabilized Soil Area, and fill in the Former Slip 5 Area. Because of the broad and extensive nature of the contaminant sources at the Site, the most practicable location(s) for the points of compliance will likely be near the LDW shoreline to ensure that remediation will effectively achieve the pCULs in groundwater prior to discharge to the LDW.

2.5.2 Point of Compliance—Soil

The standard point of compliance where soil cleanup levels protective of direct human contact must be met is throughout a site from the ground surface to 15 ft bgs, in accordance with WAC 173-340-740(6)(d). The standard point of compliance where soil cleanup levels protective of groundwater must be met is throughout a site, in accordance with WAC 173-340-740(6)(b). For the Site, because it appears that certain constituents in groundwater are the result of leaching from Site soil in contact with groundwater, the proposed soil point of compliance will be throughout the Site.

2.5.3 Elimination of COCs

The groundwater and soil pCULs established for the Site (see Tables 2-1a and 2-1b) were used to characterize the extent of contamination and to identify COCs to be targeted by remedial actions. As a consequence of using the new pCULs, some of the COCs identified in the RI report have now been eliminated. Elimination criteria for groundwater and soil constituents are presented in Tables 2-4a and 2-4b. Details on COC elimination are also presented below, and in Section 3.0 on the nature and extent of contamination in groundwater and soil.

Screening of the RI groundwater data against the pCULs (set at PQLs) for acrylonitrile, BEHP, cPAHs, and thallium resulted in elimination of these constituents as groundwater COCs because Site concentrations do not exceed their respective PQLs (except for one anomalous detection of cPAHs at sampling location SEEP-1 during one quarter of monitoring and anomalous detections of thallium at sampling location MW-23 during two quarters of monitoring).

Screening of the RI groundwater data against the pCULs for 1,1-DCE, antimony, barium, chromium (III) and chromium (VI), lead, and selenium resulted in elimination of these constituents as groundwater COCs because Site concentrations do not exceed their respective surface water criteria (except for an anomalous detection of barium at sampling location PZ-7 during one quarter of monitoring and anomalous detections of chromium (III) at sampling locations MW-23 and MW-24 during two quarters of monitoring). TCE was eliminated as a COC because screening of the RI TCE groundwater data against the pCUL identified no exceedances of the pCUL except at monitoring locations MW-5 and MW-7, which are located in the 8801 site groundwater chlorinated volatile organic compound (cVOC) plume (see Section 3.1)

Screening of the RI groundwater data against the pCULs for TPHs resulted in elimination as groundwater COCs because Site concentrations of TPHs do not exceed their respective Method A values (except for an anomalous detection of total diesel-range organics (DRO) and oil-range organics (ORO) at sampling location MW-24 during one quarter of monitoring).

Screening of the RI groundwater data against the pCULs for beryllium and cadmium resulted in elimination as groundwater COCs because Site concentrations do not exceed their respective criteria based on the protection of LDW sediment.

Screening of the RI soil data against the pCULs (set at the PQLs) for VC, selenium, and thallium resulted in elimination of these soil COCs because Site concentrations do not exceed their respective PQLs (except VC detections in the soil boring for MW-6, which is located in the 8801 site cVOC plume—see Section 3.1).

Screening of RI soil data against the pCUL (for protection of surface water) for TCE resulted in its elimination as a soil COC because Site concentrations outside the 8801 TCE plume area do not exceed the pCUL, except for one detection of 0.0021 mg/kg collected from the saturated zone while installing well MW-24 (groundwater samples from this well were non-detect for TCE during all four RI sampling events). This detection is less than twice the pCUL (of 0.002 mg/kg in saturated soils). Based on these factors, the single exceedance is considered statistically insignificant.

Screening of the RI soil data against the pCULs for 1,1-DCE, antimony and beryllium, resulted in elimination of these constituents as soil COCs because Site concentrations do not exceed their respective surface water or protection of sediment criteria.

2.6 Other Regulatory Requirements

For cleanup actions that use containment for some or all of the remedy such that soil cleanup levels will not be met at the standard point of compliance, institutional controls must be put in place that prohibit or limit activities that could interfere with the long-term integrity of the containment system and ensure that the remedy continues to effectively protect applicable receptors. Based on the evaluation of remedial alternatives found in Section 6.0, it is not practicable to treat or remove soil to the standard point of compliance. Therefore, institutional controls will be a required element of the final remedy. Associated compliance monitoring and periodic reviews to ensure the long-term integrity of the containment system will also be required.

Other state and federal laws applicable to the cleanup standards and cleanup actions at the Site are summarized in Section 2.7 below.

2.7 Applicable or Relevant and Appropriate Requirements

In accordance with MTCA, all cleanup actions must comply with applicable state and federal laws (WAC 173-340-710[1]). MTCA defines applicable state and federal laws to include legally applicable requirements and those requirements that are relevant and appropriate. Collectively, these requirements are referred to as ARARs. This section provides a brief overview of potential ARARs for the Site cleanup. The primary ARAR is the MTCA cleanup regulation (WAC 173-340), which outlines requirements for the development of cleanup standards and procedures for development and implementation of a cleanup under MTCA. The requirements of this ARAR and other associated ARARs (e.g., Washington Water Quality Standards—WAC 173-201A; National Toxics Rule—40 CFR 131.45) were followed and used in developing the cleanup standards in this FS and in identifying, evaluating, and recommending a cleanup action alternative as documented in Sections 4.0, 5.0, and 6.0 of this FS. The other ARARs that may be applicable to the cleanup action include the following:

- **Washington Hazardous Waste Management Act (Revised Code of Washington [RCW] 70.105) and its implementing regulations: Dangerous Waste Regulations (WAC 173-303).** These regulations establish a comprehensive statewide framework for the planning, regulation, control, and management of dangerous waste. The regulations designate those solid wastes that are dangerous or extremely hazardous to human health and the environment. The management of excavated contaminated soil from the Site would be conducted in accordance with these regulations to the extent that any dangerous wastes are discovered or generated during the cleanup action.

- **Washington Solid Waste Management Act (RCW 70.95) and its implementing regulation: Criteria for Municipal Solid Waste Landfills (Chapter 173-351 WAC).** These regulations establish a comprehensive statewide program for solid waste management including proper handling and disposal. The management of any contaminated soil removed from the Site would be conducted in accordance with these regulations to the extent that this soil could be managed as solid waste instead of dangerous waste.
- **Hazardous Waste Operations (WAC 296-843).** Establishes safety requirements for workers conducting investigation and cleanup operations at sites containing hazardous materials. These requirements would be applicable to onsite cleanup activities and would be addressed in a site health and safety plan prepared specifically for these activities.
- **Clean Water Act, Section 404—Dredge or Fill Requirements Regulations, 33 United States Code (USC) 1344(a)–(d); 33 CFR Parts 320–330; 40 CFR Part 230.** These requirements are applicable to cleanup action alternatives in or near navigable waters and establish requirements that limit the discharge of dredged or fill material to these waters. EPA guidelines for discharge of dredged or fill materials in 40 CFR 230 specify consideration of alternatives that have less adverse impacts; prohibit discharges that would result in exceedance of surface water quality standards, exceedance of toxic effluent standards, and jeopardy of threatened or endangered species; and provide for evaluation and testing of fill materials before placement.
- **Federal Clean Water Act National Pollutant Discharge Elimination System (NPDES) Permit and State Construction Stormwater General Permit.** Construction activities that disturb one or more acres of land typically need to obtain an NPDES Construction Stormwater General Permit from Ecology. A substantive requirement would be to prepare a stormwater pollution prevention plan (SWPPP) prior to earthwork activities. The SWPPP would document planned procedures designed to prevent stormwater pollution by controlling erosion of exposed soil and by containing soil stockpiles and other materials that could contribute pollutants to stormwater.
- **Clean Water Act, Section 401, Water Quality Certification, 33 USC 1340; WAC 173-225-010.** Section 401 of the Federal Water Pollution Control Act provides that applicants for a license or permit from the federal government relating to any activity that may result in any discharge into the navigable waters shall obtain a certification from the state that the water quality standards will be met. Ecology's Water Quality Section would review any Nationwide Permit No. 38 issued by the US Army Corps of Engineers. Ecology would also review any associated draft and final design of the chosen cleanup action alternative to document substantive compliance with the Washington State Water Pollution Control Act requirements.
- **Toxic Substances Control Act, 15 USC 2601.** The TSCA of 1976 provides EPA with authority to require reporting, record-keeping and testing requirements, and restrictions relating to production, use, and disposal of certain chemical substances and/or mixtures such as PCBs. TSCA is the only ARAR used for development of soil pCULs; there are no other soil criteria for cleanup standards established under applicable federal laws.
- **Washington Hydraulics Project Approval (RCW 75.20.100; WAC 220-110).** This regulation requires Washington Department of Fish & Wildlife (WDFW) approval for projects that will use, divert, obstruct, or change the natural flow or bed of waters of the state, such as LDW. WDFW, in conjunction with the US Army Corps of Engineers, the National Marine Fisheries

Service, and the US Fish & Wildlife Service, authorizes allowable periods for work in state and/or federal waters through this code.

- **State Environmental Policy Act (SEPA), RCW 43.21.036, WAC 197-11-250 through 268.** Under the SEPA rules, MTCA and SEPA processes are to be combined to reduce duplication and improve public participation (WAC 97-11-250). Ecology is the lead agency for implementing the substantive requirements of SEPA as described in WAC 197-11-253. Ecology is likely to determine that it will act as the lead agency for implementing the requirements of SEPA for cleanup actions at the Site. A SEPA checklist will be completed and attached to the draft Cleanup Action Plan. It is expected that a determination of non-significance will be issued, as the alternatives evaluated in this FS are unlikely to have a significant adverse environmental impact.
- **Washington Minimum Standards for Construction and Decommissioning Wells (WAC 173-160-381).** Under WAC 173-160-381, Ecology or its delegated authority establishes requirements for the installation and decommissioning of monitoring wells.
- **Underground Injection Control Program (WAC 173-218).** Under WAC 173-160, underground injection control (UIC) registration would be required for the injection of any materials below ground surface for the purposes of groundwater cleanup. This would include injection of reducing agents such as zero valent iron, electron donor substrates for bioremediation, oxidants for chemical oxidation, or other chemical activation agents or catalysts; or reinjection of treated groundwater.
- **National Historic Preservation Act of 1966 (NHPA); Indian Graves and Records (RCW 27.44); Archaeological Sites and Resources (RCW 27.53); Archaeological Excavation and Removal Permit (WAC 25-48).** In the event that archaeological artifacts or resources or human remains are encountered or disturbed by construction or excavation activities, or as otherwise determined through the SEPA review process, the requirements of the NHPA, RCW 27.44 and 27.53, and WAC 25-48 must be adhered to in order to ensure these resources are appropriately protected. When working in areas where archaeological resources may be present, as a best management practice, Contractors should consider preparing a Cultural Resources/Inadvertent Discovery Plan to follow when performing subgrade excavation and construction activities near historical native landforms. At a minimum, if archaeological resources are discovered during construction, work will be stopped immediately and Client and their respective contractors and agents, Ecology, the Department of Archaeology and Historic Preservation (DAHP), and the cultural resources department or any applicable tribal government will be notified by the close of business on the day of discovery. A licensed archaeologist should also be retained to inspect the Site and document the discovery, provide a professionally documented site form, and report to the aforementioned parties. In the event of an inadvertent discovery of human remains, work will be immediately halted in the discovery area, the remains will be covered and secured against further disturbance, and the Police Department and City or County Medical Examiner will be immediately contacted, along with the DAHP Physical Anthropologist and authorized tribal representatives. A treatment plan by a licensed archaeologist would then be developed in consultation with the above-listed parties consistent with RCW 27.44 and RCW 27.53 and implemented according to Chapter 25-48 WAC.
- **Washington State Shoreline Management Act of 1971 (SMA).** The SMA (RCW 90.58) considers the basic policy areas: shoreline use, environmental protection, and public access. It

establishes the concept of preferred shoreline uses that are consistent with controlling pollution, preventing damage to the natural environment, and promoting water-dependent industrial and commercial developments, ports, developments that provide public access opportunities, recreational uses, and single-family residences. The SMA is intended to ensure the development of shorelines in a manner that will promote and enhance the public interest and that will protect shorelines of the state, including the land, vegetation, wildlife, and aquatic habitats, against adverse environmental effects. All allowed uses are required to minimize adverse environmental impacts as much as possible. The City of Tukwila (City) complies with the SMA through its Shoreline Master Program (SMP), which establishes goals and policies consistent with the SMA that are implemented through use regulations set forth in Tukwila Municipal Code (TMC). The final design of the selected remedy will comply with applicable substantive requirements of the City's SMP.

3.0 NATURE AND EXTENT OF CONTAMINATION/CONCEPTUAL SITE MODEL

The nature and extent of contamination were characterized during the RI and are described in detail in Section 9.0 of the RI report. For reference, the soil and groundwater investigation locations are shown on Figures 1-4 through 1-7. This section provides a summary of the general extent of contamination for soil and groundwater as compared against Site pCULs (identified in Section 2.0). COCs discussed in this section were identified by re-screening RI groundwater and soil sampling data against pCULs (see Tables 2-2 [groundwater] and 2-3a, 2-3b, and 2-3c [soil]). This section also identifies indicator hazardous substances (IHS) as determined under WAC 183-340-703; i.e., the primary subset of COCs used for characterizing the Site and/or establishing cleanup requirements for that Site (excludes COCS that only contribute a small percentage of the overall threat to human health and the environment).

The following sections describe the locations, extent, estimated quantities, and potential or actual exposure pathways for contaminants at the Site for each media of concern that contributes to the conceptual site model (CSM). Figure 3-1a presents a conceptual site model diagram summarizing the site conditions, contaminant migration pathways, and exposure pathways. The nature and extent of contamination at the Site is discussed in the RI report and in this FS report by area based on the operational history of the Site and media. These areas are defined as: 1) North of Former Slip 5 Area, 2) Former Slip 5 Area, and 3) South of Former Slip 5 area. The approximate extents of each of these areas are identified on Figure 3-1b.

3.1 Groundwater Quality

Based on rescreening of RI data, the following COCs have been identified for Site groundwater: VC, PCBs, arsenic, copper, mercury, nickel, and zinc. However, compared to the minimal prevalence of other COCs, IHS for Site groundwater are limited to PCBs, arsenic, copper, nickel, and zinc. Areas of IHS exceedances are widespread and generally include areas where the non-IHS COCs are also found above pCULs. Therefore, the use of IHS in the development of remedial alternatives will be adequately protective of human health and the environment. Note that, while chlorinated VOCs such as TCE and VC have been detected above pCULs in groundwater at the southern end of the Site, they are attributed to an offsite source (8801 site). Therefore, while VC is considered a COC for the Site, it is assumed that the presence of these contaminants at the south end of the Site will be treated via enhanced reductive dichlorination (ERD) injections as part of the cleanup of the 8801 site (Ecology Facility Site ID #2072; Cleanup Site ID #5056) as indicated in the associated interim action work plan (Shannon & Wilson 2019). Boeing is working with the owners and consultants for the 8801 site to ensure cleanup work can be appropriately conducted on the Site as planned. VC contamination on

Boeing property not associated with the 8801 site will be addressed by Boeing.[3] Also note that groundwater concentrations of TCE and/or VC have been detected at concentrations above groundwater screening levels for protection of the vapor intrusion (VI) pathway at four different monitoring wells along the southern end of the Site; however, sub-slab soil gas sampling inside Building 14-01 in 2011 identified no exceedances of any VI screening levels for soil gas (including but not limited to TCE, VCE, and 1,1-DCE), which is a more direct measure of potential VI risks.

Groundwater at the Site is encountered at approximately 11–17 ft bgs and generally flows west to the LDW. A groundwater contour map from the RI is provided on Figure 3-1c. Groundwater quality is evaluated below for the upland area of the Site (representative of general Site groundwater) and the shoreline area along the western boundary of the Site (representative of groundwater that may discharge to the LDW). The IHS are also discussed below by area.

3.1.1 Upland Area Groundwater

The upland area (i.e., area of the Site excluding the shoreline area along the western boundary of the Site) IHS in groundwater are PCBs and dissolved metals (arsenic, copper, nickel, and zinc). Copper, nickel, and zinc exceed pCULs primarily at monitoring wells located in the North of Former Slip 5 Area (Figures 3-2, 3-3, and 3-4), where historical operations occurred such as the former sawmills, wood preserving facility, and steel forging and galvanizing plant. Dissolved mercury also exceeded the pCUL in the North of Former Slip 5 area (Figure 3-5), but only at locations with IHS exceedances; therefore, mercury is not considered an IHS. Dissolved arsenic exceedances occurred in groundwater throughout the property (Figure 3-6), with the highest exceedances occurring in the North of Former Slip 5 Area and mostly within and downgradient of the Stabilized Soil Area (see Figure 3-1b for locations of these areas). PCBs exceed the pCUL at a total of four upland monitoring well locations, the majority of which are located within the Former Slip 5 Area (Figure 3-7). Debris and contaminants present in the material used to fill the former slip may be a source of contaminants within the North of Former Slip 5 and Former Slip 5 Areas.

The Site was included in a 2017 source evaluation study conducted by Ecology at sites adjacent to or near the LDW. As part of this study, PCB congener groundwater samples were collected from three Isaacson-Thompson wells (MW-25, MW-13, and MW-10). Relevant data from Isaacson-Thompson wells are excerpted from the study and provided in Appendix B. Total PCB congeners were estimated and ranged from 0.000546 µg/L to 0.00266 µg/L among the three wells (including a duplicate sample from MW-10), and total PCB aroclors were not detected at or above a reporting limit of 0.010 µg/L.

Arsenic, copper, nickel, and zinc all exceeded pCULs in groundwater at the North of Former Slip 5 Area in wells located within and downgradient of the Stabilized Soil Area. The Stabilized Soil Area consists

---

[3] TCE has only been detected above the pCUL in two monitoring wells along the southern Site boundary bordering the 8801 site. VC has been detected above pCULs in wells along the southern Site boundary as well but has also been detected above the pCUL in other areas of the Site; it is considered a Site COC to be addressed by Boeing.

of arsenic-contaminated soil that was treated with soluble silicate solutions and stabilized with cementitious material to prevent leaching of arsenic to groundwater. Measurements of pH from wells within the Stabilized Soil Area frequently indicate highly alkaline conditions, including pH measurements ranging as high as 13.7 standard units (SU) at MW-24. This alkaline groundwater environment is a likely cause of higher concentrations of dissolved metals in groundwater. Although, under moderately alkaline conditions (e.g., pH 8–10 SU) many metals precipitate as (or with) metal oxides/hydroxides and metal sulfides, higher pH conditions (generally pH greater than 9) can result in increased solubility of hydroxides/sulfides (EPA 1980) or desorption from oxides (Smedley and Kinniburgh 2002) and, therefore, increase mobility of some metals, including arsenic, copper, nickel, and zinc. Elevated arsenic concentrations were also identified at concentrations over an order of magnitude above the pCULs within the Former Slip 5 Area (at piezometer PZ-6) and within the South of Former Slip 5 Area (at well I-206), see Figure 3-6. These well locations are collocated with isolated areas of arsenic contamination in soil, see Figures 3-6 and 3-9.

Dissolved arsenic concentrations in groundwater below and immediately west of the Stabilized Soil Area range from 3,290 µg/L to 285,000 µg/L. Dissolved arsenic concentrations at PZ-6 and I-206 range from 437 µg/L to 8,010 µg/L and 190 µg/L to 464 µg/L, respectively. Other IHS dissolved metals exceedances occurred at monitoring wells within or adjacent to the Stabilized Soil Area. Dissolved copper exceedances range from 3.3 µg/L to 2,050 µg/L. Dissolved nickel exceedances range from 8.8 µg/L to 297 µg/L. Dissolved zinc exceedances range from 58 µg/L to 477 µg/L. PCB exceedances range from 0.011 µg/L to 0.024 µg/L.

TCE and its breakdown products were detected above the preliminary screening level in a few groundwater wells on the Site. TCE exceedances occurred exclusively in groundwater near the southern Site boundary. The source of TCE is attributed to the 8801 site (see Appendix C), based on investigations completed during the RI and additional data collected in January 2019 as part of the 8801 baseline sampling event. During the RI, data was collected within Building 14-01 and the investigation results indicated that Building 14-01 was not a source of TCE found at the southern property boundary. Tetrachloroethene and the TCE breakdown products (cis-DCE and 1,1-DCE) have not exceeded the pCULs; therefore, are not COCs for the Site. VC exceedances are also coincidental with TCE at the southern Site boundary and are attributed to the 8801 site contamination (to be addressed by separate cleanup of that site). However, VC exceedances are also found in the North of Former Slip 5 Area (Figure 3-8) and, therefore, VC is still considered a Site COC.

3.1.2 Shoreline Area/Western Site Boundary Groundwater

The single seep, wells and piezometers located in the shoreline area along the western Site boundary are the groundwater monitoring locations nearest the LDW, which provide the best information regarding what constituents may be discharging to the LDW surface water and sediment via groundwater. As shown on Figure 1-7, seven groundwater monitoring wells (MW-7, MW-9, MW-10, MW-19, MW-20, I-104[s], and I-205[s]); two piezometers (PZ-7, PZ-8); and one seep (SEEP-1) are located near the western Site boundary, near the LDW shoreline. Except for single exceedances of nickel at MW-9 (Figure 3-3) and PCBs at SEEP-1 (Figure 3-7) as well as three low-level exceedances of copper at MW-20 and MW-19 (Figure 3-2), the only IHS with consistent pCUL exceedances in groundwater at these western-most monitoring locations is dissolved arsenic (Figure 3-6).

Dissolved arsenic exceedances occurred in around half of the samples collected from the near-shoreline monitoring locations and primarily in those wells and piezometers located north of MW-9. The highest arsenic concentrations in the shoreline area occurred at wells MW-19, MW-20, and I-104(s), which are located downgradient of the Stabilized Soil Area. Dissolved arsenic concentrations range from 25.9 µg/L (well MW-19) to 2,460 µg/L (well I-104[s]). Although wells I-104(s) and MW-20 are located immediately adjacent to each other, dissolved arsenic concentrations are typically an order of magnitude higher at I-104(s), indicating the spatial variability of groundwater concentrations—i.e., monitoring well I-104(s) is screened at a deeper depth (15–25 ft bgs) than well MW-20 (screened at 8–18 ft bgs). As stated in Section 3.1.1, the high pH of groundwater within the Stabilized Soil Area (pH up to 13.8 SU) likely results in arsenic contamination becoming more mobile downgradient and in groundwater in the Shoreline Area of the Site. The variability of pH in shoreline wells (pH ranging from approximately 5 to 10 SU) likely contributes to the variability in dissolved arsenic concentrations observed in these wells. Although arsenic concentrations in some of the shoreline wells is above pCULs, it is not known whether dissolved arsenic is discharging to the LDW at concentrations above the pCULs.[4]

3.1.3 Groundwater Exposure Pathways

Exposure pathways for contaminants in groundwater are identified in the CSM (see Figure 3-1a). Contaminants in groundwater can potentially migrate into the LDW because of groundwater flow into the LDW (above -5 ft MLLW), and LDW surface water may intrude and mix with groundwater contamination because of tidal influences that periodically reverse water gradients near the western Site boundary. However, it should be noted that based on the results of a tidal study performed during the RI (see RI Section 8.1.2.3), groundwater at most Site wells is typically higher than water elevations in the LDW including high tides. This is especially true east of the steel bulkhead running along the central portion of the western Site boundary where tidal influences are marginal. Tidal fluctuations are more evident at near-shoreline wells east of the wooden bulkheads on the north and south ends of the Site boundary. There are various potential exposure receptors including humans, terrestrial ecological receptors, and aquatic species. These receptors have the potential for exposure through direct contact with surface water and/or sediment, direct or indirect uptake of surface water and/or sediment through consumption, or indirect uptake through consumption of aquatic organisms. These exposure pathways are considered in the evaluation of cleanup alternatives.

---

[4] Dissolved arsenic concentrations in samples collected from SEEP-1 during the RI were all below the pCUL (i.e., were at concentrations protective of surface water beneficial uses).

3.2 Soil Quality

Based on the findings from the RI, the following COCs have been identified for Site soil at concentrations exceeding the pCULs: TPH, PCBs, cPAHs, BEHP, arsenic, barium, cadmium, chromium (total), chromium VI, copper, lead, mercury, nickel, and zinc. Concentrations of soil COCs are presented in Figures 3-9 through 3-23. These figures present the maximum concentrations detected within three different depth intervals for sample locations with pCUL exceedances. Concentrations less than or equal to the pCUL are not shown but are color-coded green. Each sample location is given an iso-concentration contour based on linear interpolation between itself and the nearest locational data. The blue contours, which represent pCUL exceedances are used to generally identify the extent of contamination present for each COC.

IHS for Site soil are PCBs, cPAHs, arsenic, copper, lead, mercury, nickel, and zinc. Exceedances of other COC metals (barium, cadmium, chromium, and chromium VI) occur only in areas where IHS metals have been identified and will be addressed in the same manner as IHS metals. Because of the limited number or magnitude of detections, TPH and BEHP were not included as IHS. Other than in the Observed Tar-like Substance Area (see Section 3.2.1), TPH (total DRO and ORO) exceeded the cleanup in only one soil sample at the Site. BEHP exceeded the pCUL in only seven of the 238 samples collected and analyzed for the compound. The locations are disparate and do not indicate a specific source area. Areas of IHS exceedances are widespread and include areas where the non-IHS COCs are also found above pCULs. Therefore, the use of IHS in the development of remedial alternatives will be adequately protective of human health and the environment.

The extent of soil contamination presented is based on the analytical results for soil samples collected during and prior to the RI (and on the Port parcel after the RI—see Appendix A1; also see Appendix A2, including data from a 2012 Port parcel-specific investigation) that are representative of soil that remains at the Site following completion of the interim actions previously completed at the Site. The nature and extent of contamination at the Site is discussed in the RI report and in this FS report by area based on the operational history of the Site and media. The areas of concern for soil are: 1) North of Former Slip 5 Area; 2) Former Slip 5 Area, and 3) South of Former Slip 5 Area (see Figure 3-1b). The COCs in each of these areas are discussed below.

3.2.1 North of Former Slip 5 Area

The North of Former Slip 5 Area can be characterized by elevated concentrations of arsenic observed in soil and groundwater samples from the Stabilized Soil Area (Figure 3-9). Other contaminant source areas include the area of observed tar-like substance (Observed Tar-Like Substance Area) and fill material used to fill the former river meander. The potential sources for the contaminants found in soil and groundwater are discussed in section 10.4.1.1 of the RI. IHS identified in soil for this area are arsenic, copper, mercury, nickel, zinc, and cPAHs. Barium, cadmium, chromium (total and VI), lead, and PCBs are not considered IHS because minimal exceedances occurred in this area and, where present, exceedances are located in areas already identified by other IHS.

The vertical extent of the exceedances is generally limited to the unsaturated zone (above 11 ft bgs), but arsenic, copper, mercury, and zinc exceedances extend into the saturated soil zone (below the groundwater table) at several locations (Figures 3-9, 3-10, 3-11, and 3-12). Primarily, the highest concentrations of arsenic occur at depths between 5 and 11 ft bgs at locations west and north of the Stabilized Soil Area. Another area with elevated concentrations of arsenic at this depth is a small section of soil that was not stabilized adjacent to the east of the Stabilized Soil Area.

The Observed Tar-Like Substance Area is generally characterized by TPH and cPAH exceedances and visual observations of tar-like substance (Figure 3-13). Although petroleum hydrocarbons are non-IHS compounds, diesel-range, oil-range, and gasoline-range petroleum hydrocarbons exceedances also occurred in soil samples from this Area. These exceedances, as well other exceedances in this area (cPAHs, arsenic, and copper), appear to be associated with the tar-like substance encountered at a depth interval between 1 and 2 ft bgs. No constituents were detected at concentrations exceeding the pCULs in samples collected below the tar-like substance (2–3 ft bgs). The tar-like substance did not appear to extend farther west than TP-107, because there was no observation of the substance on the west sidewall of TP-107. Although the extent of the tar-like substance was not specifically defined in the other directions, it is known to be contained within a relatively small and isolated area of the Site.

3.2.2 Former Slip 5 Area

The Former Slip 5 Area and the Port parcel can be characterized by dispersed contaminants present in soil and groundwater with no specific source area. Historical operations along the former slip and fill material may have contributed to contamination and are discussed in section 10.4.1.1 of the RI. The IHS in soil for this area are arsenic, copper, mercury, zinc, lead, nickel, PCBs, and cPAHs (Figures 3-9, 3-10, 3-11, 3-12, 3-14, 3-15, 3-16, and 3-17). There were only five isolated gasoline-range organics (GRO) exceedances in this area, and therefore, GRO is not considered an IHS (Figure 3-18). As discussed in sections 2.2 and 8.1.5.2 of the RI, filling of the slip was conducted in phases between 1936 and 1966. The majority of the pCULs exceedances occurred above and below the groundwater table in the fill materials in the central and northern portion of the former slip.

Arsenic, copper, nickel, and zinc exceeded pCULs in samples collected from depths above and below the water table in areas near MW-17 and I-202(s). The presence of industrial debris is a likely source of most of the contamination at these locations.

Exceedances of copper, mercury, and nickel occurred above and below the groundwater table in the area of MW-12, MW-13, and MW-13B. No visual signs of potential contamination were observed at MW-12, but slag material was observed at MW-13 and MW 13B at depths of 10–14 ft bgs and 9.5–11 ft bgs, respectively.

The Ecology Port property investigation also identified concentrations of one or more of arsenic, copper, mercury, or zinc exceeding the pCULs in 9 of the 10 soil borings (all except boring SDP-06). Although petroleum hydrocarbons are not IHS for this area, heavy-oil-range petroleum hydrocarbons were detected in exceedance of the pCUL at the Port property at Ecology boring SDP-02 at a depth of around 16 ft bgs.

A total of 17 boring locations had exceedances of PCBs in the Former Slip 5 Area: MW-13B, IT-SB-3, IT-SB-4, IT-SB-5, IT-SB-12, Boring 22 (4) from 1983, Boring 19 (3.5) from 1983, Boring 15 (2) from 1983, Boring 7-1 (2.5) from 1983, Boring 6-3 (2) from 1983, Boring 5 (2.5) from 1983, IT-MW-10 MW-17, I-202(s), I-203(i), MW-12, and MW-10. PCBs exceeded the pCUL in saturated soils (below 11 ft bgs) at MW-17, I-202(s), MW-12, and MW-10.

3.2.3 South of the Former Slip 5 Area

The South of Former Slip 5 Area can be characterized by shallow soil contamination and limited groundwater contamination. Identified sources of contamination are fill material and migration of contaminants from the southern Site boundary as discussed in section 10.4.1.1 of the RI. The IHS in soil for this area are arsenic, copper, lead, mercury, and zinc (Figures 3-9, 3-10, 3-11, 3-12, and 3-14). The highest arsenic concentrations were detected in samples from the western portion of the Site at locations MW-7, HP-3, and I-206(s) and from intervals above and below the groundwater table. The majority of copper exceedances were detected above the groundwater table and in the vicinity of the former washdown area and near the eastern Site boundary. Lead exceedances occurred only in the unsaturated zone in a few locations south and west of the Thompson Building. While the highest concentrations of zinc occurred in soil north of the South of Former Slip 5 Area, zinc concentrations in shallow soils along the eastern Site boundary of the South of Former Slip 5 area exceed the pCUL. Elevated mercury concentrations in soil were also detected in the southeastern portion of the Site.

Soil samples were collected from the upland side of the wooden bulkhead on the Thompson property to evaluate the potential for soil erosion through the bulkhead as a source of contaminants in offshore sediment. The results were compared to the soil pCULs protective of LDW sediment because soil erosion to sediments is the pathway of concern. As shown in Table 3-1, when compared to the LDW sediment pCULs, sampling results indicate an arsenic detection, in a single sample (out of three samples analyzed for arsenic in this area), at a concentration (7.6 mg/kg) slightly above the pCUL, which is at the level for arsenic natural background concentrations (7.0 mg/kg).

Although VOCs are not considered a COC for this area, TCE exceedances were detected in soil near the southern Site boundary. As discussed above, the source of these exceedances is likely migration from the neighboring 8801 site and is expected to be addressed by the cleanup of that site. Each of the TCE exceedances occurred at depth (near or below the groundwater table), except at the construction-related excavation where the exceedance occurred at 4 ft bgs.

3.2.4 Soil Exposure Pathways

Exposure pathways for contaminants in soil are identified in the CSM (see Figure 3-1a). Contaminants in soil have the potential to leach into groundwater and migrate to adjacent surface water, which is discussed in Section 3.1 of this FS. Another migration pathway to the LDW potentially occurs from soil erosion at gaps in the wooden bulkhead located at the southern portion of the Thompson property and the wooden bulkhead located along the Port property.

Other than potential leaching pathways and erosion, contaminants in soil are mostly contained at the Site by buildings and pavement. These structures also prevent plants or wildlife from being exposed to soil contamination. Only humans have been identified as potential receptors for Site contaminants in soil. Exposure for humans could occur during construction or maintenance activities that involve earthwork. Therefore, direct contact exposure pathways are considered in the evaluation of cleanup alternatives and development of pCULs.

3.3 Identification of Areas or Volumes of Media that Require Remedial Action

As discussed in Section 3.1 and 3.2, the Site contains areas where the constituent concentrations detected in soil and groundwater are greater than the pCULs. As discussed in the RI and below, the analytical data indicate that much of the extent of impacts to groundwater is primarily related to high pH conditions (resultant from cement/soil matrix in the Stabilized Soil Area), contact with and/or leaching from contaminated soil on the Isaacson property (North of Former Slip 5 Area), or contact with/leaching from contaminated fill in the Former Slip 5 Area. Soil contamination at the Site is widespread, but most prevalent north of and in the northern portion of the Former Slip 5. Cleanup action alternatives developed in this FS focus on groundwater with contaminant concentrations greater than the pCULs that may discharge to the LDW, and on soil that is potentially impacting groundwater and that represents a potential direct contact pathway risk for humans.

The cleanup action alternatives were developed in the context of the nature and extent of the groundwater and soil contamination as it relates to the conceptual model of the subsurface at the Site. As discussed in the RI and in Section 4.0 of this FS, much of the Site consists of heterogeneous fill that was placed in the former river channel (Former Slip 5 Area) to allow development of the area in the vicinity of various industrial properties.

3.3.1 Groundwater

As described in the RI report and summarized above, much of the extent of impacts to groundwater is primarily related to pH and reduction-oxidation (redox) conditions in the aquifer (see Figure 3-24):

- Dissolution caused by high pH[5] resultant from the Stabilized Soil Area,
- contact with/leaching from contaminated soil, and/or
- contact with/leaching from contaminated fill.

---

[5] As discussed in Section 3.1.1, at greater than pH ≈ 9, metal hydroxide solubilities generally tend to increase.

The most frequent occurrence and highest magnitude of groundwater contamination occurs directly beneath or proximate to the Stabilized Soil Area on the Isaacson property (Figure 3-25). Arsenic, copper, nickel, and zinc are all found at concentrations above the pCULs beneath or immediately adjacent to the Stabilized Soil Area, including arsenic at concentrations over 100 times the pCUL. Slightly elevated arsenic concentrations (only slightly above the pCUL) are also found in a wider area extending south into the Former Slip 5 Area, with sporadic areas of contamination in the South of Former Slip 5 Area. Moderately elevated arsenic concentrations are also found near the shoreline at monitoring wells MW-10, I-205, and I-206. In addition to metals, organic chemical contamination (Figure 3-26), is mostly sporadic and occurs in areas north of and in the Former Slip 5 areas, with the exception of TCE and VC, which is attributed to the offsite 8801 plume. The total area of groundwater contamination is estimated to encompass approximately half the total area of the Site.

Because much of the metals contamination in groundwater appears to be related to high pH caused by the Stabilized Soil Area, unless the Stabilized Soil Area, along with other contaminated soil and fill, is removed from the Site, it may be infeasible to restore Site-wide groundwater quality to below the pCULs. Therefore, in addition to excavation-based alternatives, a number of the groundwater remedial action alternatives to prevent discharge of groundwater with concentrations that could impact surface water beneficial uses in the LDW were evaluated in this FS and include containment/hydraulic control and/or passive treatment near the shoreline.

3.3.2 Soil

To estimate the volume of soil with constituent concentrations greater than the pCULs that requires remedial action, the extent of contamination in and north of the Former Slip 5 Area was considered, along with a shallow zone of copper and zinc contamination in the southeastern side of the Site, and the other limited areas of arsenic contamination near and west of the southwest corner of Building 14-01 (see Figure 3-27). The extent of organic chemical contamination in soil (PCBs and cPAHs) is generally characterized by single soil sample locations with pCUL exceedances but have or come from no known or identifiable source, origin, or historical release. The areas for soil remedial action have been defined based on levels of arsenic, copper, mercury, nickel, and zinc in soil above natural background levels (which define the pCULs for these metals—see Section 2.1).

The impacted area of soil in the Stabilized Soil Area (approximately 171,000 ft^2) and adjacent impacted soil areas north of Slip 5 (approximately 133,000 ft^2) to be addressed by the cleanup action is approximately 304,000 ft^2. The volume of impacted soil from ground surface to the water table (assuming a depth of approximately 15 ft bgs) would result in a total volume of approximately 170,000 cubic yards (measured as in-place cubic yards).

The impacted area of soil in the Former Slip 5 Area (defined based on the extent of fill material in the former slip) to be addressed by the cleanup action is approximately 290,000 ft^2 (including approximately 22,500 ft^2 on the Port property). The volume of impacted soil from ground surface to an average depth of approximately 25 ft bgs (the average depth of the native river sediment layer), would be approximately 270,000 cubic yards.

The area of contaminated soil in the southeastern and southwestern areas of the Site (South of Slip 5) to be addressed by the cleanup action is approximately 80,000 ft^2. The volume of impacted soil to the depth of contamination in the southeastern area (generally 5 ft bgs) and to the depth of groundwater in the southwestern area (approximately 15 ft bgs), would be approximately 22,000 cubic yards.

If the contaminated soil in the Observed Tar-like Substance Area (TPH and cPAHs above pCULs) were completely removed, the area requiring removal would be approximately 2,000 ft^2. If soil were removed to about 5 ft bgs (contamination is generally less than 3 ft bgs), then the amount of soil excavated for offsite disposal would be approximately 370 cubic yards.

3.4 Supplemental Data Collection

Depending on the selected final remedy, supplemental collection of certain data may be needed to obtain sufficient information to complete the design and implementation of the final remedy. These data needs may include:

- Determining the depth of groundwater and soil contamination near portions of the shoreline where contamination has been identified to the maximum depth of prior investigations (previous investigations were generally limited to 25 ft bgs or less);
- Evaluating the lateral extent and hydraulic characteristics of the marine/river meander silty sediment layer encountered in borings (e.g., PZ-6, PZ-7, MW-9, MW-11, MW-12, I-203, I-205) at depths of approximately 21–24 ft bgs within the former Slip 5 area;
- Further evaluating soil in the southwest corner of the Site, particularly metals concentrations in potentially erodible soil along the shoreline that, if contaminated, could impact nearshore sediments; and/or
- Better understanding the influence of the three different shoreline bulkheads on groundwater and better defining the groundwater gradients and flow directions near the shoreline and approaching the LDW.

Depending on the selected final remedy and as needed for design, Boeing will conduct a pre-remedial design investigation to address these supplemental data needs and incorporate the findings into the final remedial design as applicable.

4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Per WAC 173-340-350(8)(b), an initial screening of remedial technologies and alternatives may be performed to reduce the number of alternatives for the final detailed evaluation of remedial alternatives. In this section, applicable remedial technologies are identified and screened on the basis of general effectiveness for the COCs and media of concern, technical implementability, and cost.

4.1 Screening of Technologies

Potential general response actions and remedial technologies were identified based on the known Site conditions, media impacted, contaminant types, and best professional judgment of applicable remedial technologies. The identified remedial technologies are screened in this section of the FS on the basis of effectiveness, implementability, and cost. Remedial technologies not screened out are included in the cleanup action alternatives and are further evaluated in Section 5.0.

4.1.1 Institutional Controls

Institutional controls are legal or administrative measures to restrict or prohibit activities that could result in exposure to contaminants that are above acceptable health risk levels or interfere with the integrity of a cleanup action. Institutional controls are commonly used at sites where contaminants are expected to remain at concentrations above cleanup levels for an extended period of time. A restrictive covenant is a common type of institutional control that restricts the use of a property and is binding for all current and future owners of the property. Restrictive covenants can be used to limit or restrict intrusive activities at a property that might pose a risk to worker health and safety. Another common institutional control is a local ordinance or state regulation that limits installation of groundwater wells or requires special permits before excavating or drilling in contaminated soil. Requirements for long-term monitoring (for example, periodic groundwater monitoring or inspections of engineering controls) are another form of institutional control and can be used to verify that protection of human health and the environment is maintained.

Institutional controls would not likely be an acceptable cleanup action alternative on their own because they are considered unlikely to achieve the Site remedial action objectives (RAOs) without additional engineering controls. However, environmental covenants are effective and implementable in combination with engineering and other institutional controls where the covenant requires maintenance of the protective barriers that keep humans and ecological receptors from contacting contaminated soil. If contaminated soil is left in place at a depth less than 15 ft (per WAC 173-340-740[6][d], this depth “represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities”), then a restrictive covenant could be employed to require special procedures for future subgrade work. Similarly, a restrictive covenant could be employed prohibiting the installation of water production wells. Institutional controls would require long-term monitoring to ensure that the Site conditions remain as required to achieve the RAOs. Institutional controls are retained for further evaluation.

4.1.2 Containment

Containment as a general response action typically involves an engineered control that can be designed to keep contaminated media from migrating offsite, prevent human or ecological contact with the contaminated media, provide physical separation of contaminated areas of the site from uncontaminated soil and groundwater, provide hydraulic containment or capture of contaminated groundwater, prevent the migration of volatile contaminants into indoor air, and/or prevent the infiltration of precipitation and leaching of contaminants into groundwater or surface water. Examples of containment technologies that may be applicable at the Site are summarized in the following subsections.

4.1.2.1 Engineered Cap

An engineered surface cap is the most common containment method for contaminated soil. A cleanup action alternative that employs a cap or physical barrier typically includes institutional controls that would provide long-term monitoring of the physical condition of the cap, would place restrictions on construction activities that would compromise the integrity of the cap or barrier, and would require that any necessary repairs of the cap or barrier are conducted.

Capping would consist of placing a layer, or multiple layers, of material over the contaminated soil in locations where human contact is anticipated. If the cap is made of or contains an impermeable material, then it would act to prevent infiltration of rainwater that could contact the contaminated soil and potentially result in leaching of contaminants to groundwater. The use of an impermeable layer would require that additional drainage features be incorporated into the Cleanup Action Plan design.

The installation of a cap for the Site is considered to be an effective cleanup action technology that will help achieve the RAOs. The presence of groundwater contamination necessitates supplemental treatment in addition to a cap because, although it does prevent infiltration and leaching, a cap does not prevent groundwater flow from upgradient recharge areas through an area of contamination. A cap requires long-term institutional controls and monitoring, and the associated costs need to be considered in project planning. The buildings and pavement that already exist on most of the Site will provide a barrier to contact with the underlying soil; therefore, a cap for contaminant containment could cost-effectively be integrated into the final remedy. The cap would require an ongoing level of effort for periodic inspection and repair. Because of the potential effectiveness, the ability to be implemented at the Site, and the reasonable projected costs, use of a cap is retained for further evaluation as a potential option for portions of the Site.

4.1.2.2 Engineered Vertical Barriers

This technology involves construction of a low-permeability physical barrier to prevent groundwater flow through a cross-sectional area of an aquifer or to isolate a contamination zone from mixing with clean areas of the aquifer. Common physical barriers are slurry walls and sheet pile walls (described below). To prevent underflow of contamination, physical barriers are typically “keyed in” at the bottom of the barrier to a low-permeability soil or rock formation; or extraction wells are installed to maintain a hydraulic gradient that prevents groundwater from moving around the barrier. Contaminated groundwater that is pumped out for hydraulic control would require above-ground treatment. An impermeable cap may also be required to prevent rainwater from infiltrating into the area enclosed by the barrier.

An advantage of using vertical containment barriers at this Site is the ability to isolate the Stabilized Soil Area, thereby reducing the transport of dissolved metals and highly alkaline groundwater to downgradient areas. Because the Site does not have an impermeable layer for barriers to key into, extraction wells would be required to maintain hydraulic control inside the barrier. Extracted water would require treatment, which would increase the cost of these control technologies. However, the addition of a groundwater extraction and treatment system would provide some source zone mass removal, which is an advantage over engineered vertical barriers alone.

Because engineered vertical barriers can reduce contaminant mass flux to the LDW and treatment of extracted groundwater will result in permanent removal of contaminant mass from the site, engineered vertical barriers are retained for further evaluation. In this case, a slurry wall was chosen over a sheet pile wall because of the increased cost of a sheet pile wall and the potential for the highly alkaline water within the Stabilized Soil Area to corrode the steel sheet piles. A brief description of the sheet pile wall and slurry wall is provided below.

Sheet Pile Wall

Sheet pile walls consist of individual interlocking panels that are driven/vibrated to depth to create a continuous wall. Sheet piles come in various configurations and in materials such as steel and plastic. Creation of an impermeable wall requires sealing of the joints; typical sealants are bituminous or water-swelling filler. The lifetime of steel sheet pile materials could be limited by corrosion, which could be a concern if used in the Stabilized Soil Area where groundwater can be very alkaline. Sheet pile is relatively expensive, but can be rapidly installed without soil excavation, which can reduce costs for handling and disposing contaminated soil.

Slurry Wall

Slurry wall construction involves modification or replacement of aquifer materials with low-permeability clay to create a barrier wall. A typical type of slurry wall material is bentonite clay, which expands when wet to create a strong seal in saturated aquifer conditions. Cement may also be added to bentonite to make the slurry wall structurally stronger. There are various technologies for slurry wall construction including trenchless excavation, trench box excavation, slurry trench excavation, vibrating beam or mandrel, and deep soil mixing/cutter soil mixing.

Slurry walls are generally less expensive to install than sheet pile walls; however, they are less easily removed. A potential disadvantage of using a slurry wall is its longevity and effectiveness; slurry walls are not impermeable and, thus, provide containment over a finite period. However, the rate of contaminant transport through the slurry wall is assumed to be negligible compared to areas outside of containment.

4.1.2.3 Hydraulic Containment

A groundwater extraction and treatment system for hydraulic control and groundwater treatment is a potential containment and treatment option. This would involve installing numerous extraction wells at the Site and pumping groundwater for subsequent treatment (see 4.1.5 *Ex Situ* Treatment). Because a groundwater extraction and treatment system could reduce contaminant mass flux to the LDW and treatment of extracted groundwater would result in permanent removal of contaminant mass from the Site, it is retained for further evaluation.

Extraction wells could be installed toward the western edge of the Site to intercept contaminated groundwater prior to discharging into the Duwamish River. Initial capital costs would be moderate, but the long-term operation and maintenance (O&M) costs would be considerable due to large volumes of groundwater requiring treatment.

Alternatively, extraction wells could be installed throughout the Site in conjunction with a physical barrier to contain the areal extent of the contaminated groundwater and soil, thereby minimizing upgradient offsite groundwater entering the treatment system. This second option would likely require higher capital costs but would result in less long-term O&M costs due to smaller volumes of groundwater requiring treatment.

4.1.3 Removal (Excavation)

Removal of soil by excavation is considered to be an effective technology to permanently eliminate the risk of exposure to contaminants at the Site. Excavation is implementable, especially considering that a large portion of contaminated soil at the Site is above the depth of groundwater (about 11–17 ft below grade) at the Site. Excavation can also be completed below the groundwater table, but typically requires dewatering and shoring in conjunction with excavation activities.

Excavation would consist of excavating contaminated soil and transporting the soil to an appropriate, licensed, offsite disposal facility. Excavation would prevent long-term human contact with contaminated soil and prevent future leaching of contaminants to groundwater through removal of the material.

Excavation is considered to be very effective because it includes removal of contaminated soil from the Site and disposal at a controlled facility. Excavation would be readily implementable at the Site because there are available qualified local contractors, and licensed offsite solid waste (Subtitle D) and hazardous waste (Subtitle C) disposal facilities in the region. While excavation can have a high initial (capital) cost, especially where dewatering and extensive shoring is needed, the resulting source removal will reduce the future annual effort and expense associated with engineering and institutional controls. Because of the effectiveness in achieving the RAOs, the ability to remove contamination that may be impacting Site groundwater, and the potential elimination of long-term environmental management and associated costs, excavation is retained for further evaluation.

It should be noted; however, that remedial excavation is evaluated for only two types of scenarios: 1) focus areas where discrete and definable areas of soil contamination have been identified (e.g., where visual evidence or specific limits of soil contamination can be identified such as the Observed Tar-Like Substance Area); and 2) larger areas of the Site where the cumulative effects of soil contamination from historical Site activities are apparently impacting similarly large areas of groundwater (such as soil within the Stabilized Soil Area). Excavation is not considered practicable or cost-effective in areas where random soil boring, test pit locations, single soil sample locations identified elevated COC concentrations in soil, but have no identifiable source, origin, or historical release. Excavation of these individual areas would have a negligible impact on environmental quality or restoration of Site groundwater and are therefore not evaluated as part of any remedial alternatives.

4.1.4 *In Situ* Treatment

General response actions for *in situ* treatment of soil and groundwater at the Site can include soil stabilization, permeable reactive barriers (PRBs), chemical and biological treatment, and redox and pH adjustment. Treatment consists of the biological or chemical destruction of contaminants or transformation of contaminants to less toxic or non-toxic forms, the removal of contaminants, or the stabilization of contaminants through physical (other than excavation; e.g., cementation) or physically driven processes such as volatilization and/or thermal desorption.

4.1.4.1 Soil Stabilization

Soil and contaminant stabilization could be an effective treatment option for numerous areas of the Site. Soil stabilization has already been used in the North of Former Slip 5 Area in 1991 by mixing contaminated soil with cementitious material but resulted in other issues related to alkalinity (see Section 3.1.1). Soil stabilization can be performed using large soil mixing augers that would inject a concrete slurry mix into the soil at the depth identified for treatment.

The Site has a substantial amount of heterogeneous fill material with debris and current and historic Site infrastructure, which could limit the effect and/or accessibility of a larger effort at soil stabilization. The widespread nature of soil and groundwater contamination at the Site makes soil stabilization an obviously disproportionately costly option. Additionally, the previous soil stabilization does not appear to have prevented arsenic (and may have exacerbated) contamination of groundwater. Based on these considerations, soil stabilization is removed from further consideration.

4.1.4.2 Permeable Reactive Barrier

Installation of a PRB is an applicable treatment option for treatment of cPAHs, halogenated SVOCs, and metals (e.g., arsenic). A PRB could be installed *in situ* and up-gradient of the point of compliance to prevent contaminated groundwater from leaving the property or discharge to surface water. A PRB typically functions to allow the passage of water while prohibiting contaminants from flowing through due to interactions with reactive media (such as zero-valent metals), with sorbents (such as zeolite), and/or with biologically mediated environments which modulate geochemical conditions and enhance dissolution/precipitation processes.

A PRB with zero-valent iron (ZVI) may be an effective means to reduce groundwater concentrations for many of the COCs at the Site through reductive chemical processes. PRBs can also be configured to contain different media mixes in series to treat for different contaminants. Another benefit of PRBs is they often last for more than a decade and require little upkeep and maintenance.

Installation of a ZVI PRB is a potential treatment technology at the Site because it can sequester all IHS, can be strategically located immediately upgradient of the shoreline and perpendicular to the path of contaminant migration, has flexibility with regards to media mixes, has a relatively wide range of contaminants for which it could target, and has relatively low maintenance costs. Considerations that require further investigation are the effect of high pH on the effectiveness of a PRB, as well as how seawater intrusion impacts performance. PRBs are retained for additional evaluation. Evaluation of the applicability and efficacy of ZVI and other PRB amendments was further evaluated through a Site-specific treatability study (see Section 4.2).

4.1.4.3 Reductant Injection

Similar to a PRB, other iron-based compounds, such as ferrous sulfate and ferric chloride, can be injected to induce reductive chemical reactions that reduce COC concentrations through direct precipitation, co-precipitation, or adsorption. Injection points would be installed in a row or overlapping rows perpendicular to groundwater flow so that contaminated water would flow through the area influenced by the reductant. Ferrous sulfate and ferric chloride react quickly in groundwater and generally form precipitates such as iron oxyhydroxide and iron sulfides, which provide adsorption sites similar to that in a ZVI PRB.

An additional advantage of ferrous sulfate and ferric chloride over ZVI is pH adjustment. Ferrous sulfate and ferric chloride are acidic solutions, while ZVI may slightly increase the pH of groundwater. Reducing pH in highly alkaline groundwater areas will generally result in reducing the solubility of the metal COCs at the Site. Given the history of high pH measurements in groundwater within and downgradient of the Stabilized Soil Area, acidic solutions may be more effective at reducing dissolved concentrations of COC metals. Reductant injections could also be used to provide pH adjustment and pretreatment to groundwater before or after traveling through a ZVI PRB. Another potential advantage of injectable reductants over a PRB is the lower cost of installation. The primary disadvantages of injectable reductants compared to a PRB are uneven distribution in the aquifer and shorter longevity. Heterogeneities in the aquifer will result in a less even distribution of injected material compared to a PRB, which can be installed in a uniform trench intersecting groundwater flow. Additionally, the anticipated period of treatment from injectable reductants is anticipated to be significantly shorter because of the limited mass of reactant that can be injected. The longevity and cost of repeated injections compared to replacement of spent ZVI materials would have to be evaluated during design.

Use of reductant injections is a potential treatment technology at the Site because of its potential to reduce pH in groundwater, flexibility to use as a pre- or post-treatment step with a PRB, and relatively low cost. Considerations that require further investigation are the frequency with which injections would need to be conducted in order to maintain effective treatment.

Evaluation of injectable ferrous sulfate and ferric chloride amendments was further evaluated through a Site-specific treatability study (see Section 4.2).

4.1.4.4 pH/Redox Modification

Modifying groundwater pH or redox conditions to drive oxidation of arsenite (As[III]) to arsenate (As[V]) is a potential treatment strategy. Arsenate is generally a less soluble and less mobile arsenic species than arsenite, so this strategy would involve changing the oxidation state of arsenic. Because the redox conditions at the Site are generally reducing and the pH is generally alkaline, the dominant arsenic species in Site groundwater is assumed to be arsenite. Arsenite could be driven to arsenate by altering Site groundwater pH and/or redox conditions by: 1) oxygenating the groundwater to change it to an aerobic state and/or decreasing the pH to a more neutral state where the predominant oxidation state of arsenic is generally As(V), or 2) by injecting an oxidant into the groundwater to oxidize the arsenite species. Redox modification could be accomplished through injection of air, oxygen, or oxygen releasing compounds (ORCs). Areas of high pH groundwater could be neutralized by injection of acid or acidic compounds. Chlorine and permanganate are feasible options for oxidant injections.

This strategy is theoretically possible, but Site conditions preclude serious consideration of *in situ* pH/redox modification as standalone alternatives. An analysis of dissolved arsenic concentrations at different oxidation reducing potential (ORP) and pH values reveals concentrations in excess of the pCULs even under the most ideal conditions (i.e., a neutral pH and aerobic groundwater environment). Additionally, the Stabilized Soil Area extends to a depth near the water table, so the addition of an acid to decrease the pH would likely be only temporarily effective because of the permanent presence of the alkaline Stabilized Soil Area. Additionally, the solubility of other metals (e.g., copper, nickel, and zinc) increases or decreases at different pH conditions; therefore, it is likely infeasible to effectively balance the pH at the Site to prevent mobilization of all the COC metals. Although this technology is screened from further consideration in an *in situ* context, *ex situ* groundwater treatment may require reduction of arsenite to arsenate as a pre-treatment step for remedial alternatives that include groundwater extraction.

4.1.5 *Ex Situ* Treatment

In addition to *in situ* methods to treat groundwater at the Site, numerous *ex situ* alternatives and process options exist. This strategy would involve groundwater extraction via pumping and subsequent treatment prior to discharge either into groundwater, surface water, or sanitary sewer. Chemical precipitation is the most common application, but other options such as adsorption and filtration may also be applicable.

4.1.5.1 Precipitation/Co-precipitation

Precipitation/co-precipitation is an applicable *ex situ* treatment option for the treatment of arsenic (and other metals) in groundwater and would typically consist of oxidizing arsenite to arsenate followed by pH adjustment. Then, a polymer would be added for flocculation that would settle out in a clarifier followed by sludge thickening, dewatering, and solids disposal. This technology would likely be part of a hydraulic containment remedy.

This process is not very susceptible to effects from other contaminants and is cost effective at a large scale. If this technology is utilized at the Site, then it would likely be implemented as part of a treatment train because it is less effective for SVOCs, which are also present at the Site. A skilled operator would be required for this process, which would increase long-term O&M costs. Sludge disposal of thickened solids would also be part of a long-term O&M plan. Because of the ability to treat arsenic and other metals in groundwater, this technology is retained for further evaluation.

4.1.5.2 Adsorption

Adsorption presents a potential means for groundwater treatment at the Site. This technology consists of passing contaminated water through a fixed bed of media on which contaminants would adsorb. For the treatment of arsenic (and other metals), media such as activated alumina, activated carbon, granular ferric hydroxide, ferric hydroxide-coated newspaper pulp, iron oxide coated sand, iron filings mixed with sand, greensand, surfactant-modified zeolite, and any number of proprietary mixes may be used. Activated alumina is the most common media used for the treatment of arsenic. Media must be either regenerated or disposed of when exhausted. Regeneration involves backwashing, regeneration, neutralization, and rinsing.

Adsorption could be used at the Site, but the varied nature of contamination would likely result in the need for frequent regeneration due to competition for adsorption sites. Adsorption media may be susceptible to fouling for groundwater at the Site. Because of these issues, adsorption would likely be most effective as a polishing step for a treatment train. This technology is retained for further evaluation.

4.1.5.3 Filtration

Membrane filtration is a potential means for groundwater treatment at the Site. Reverse osmosis, which is a high-pressure filtration process, has successfully been used to treat arsenic in groundwater, albeit typically at sites with much lower concentrations of dissolved arsenic. The most common application of membrane filtration of groundwater is in drinking water applications or as a polishing step for precipitation processes.

While technically feasible, membrane filtration would likely be cost prohibitive because its effectiveness is sensitive to the extent of groundwater contamination. Additionally, a large volume of residuals would need to be managed on a regular basis further increasing costs. The presence of VOCs in the groundwater could also increase membrane fouling, which would require replacement further increasing costs. This technology could work as part of a treatment train as a polishing step, but the costs would likely be prohibitive and is, therefore, screened from further evaluation.

4.2 Treatability Study

A treatability study was conducted to evaluate the overall efficacy of and relative effectiveness between three solid iron-based materials (Ferox PRB® ZVI from Hepure Technologies, Inc.; customized formulations of Metafix® from PeroxyChem LLC; and ZVI from PeroxyChem LLC) and two injectable reductants (ferrous sulfate and ferric chloride) in treating groundwater IHS metals. The treatability study was performed in accordance with the Treatability Study Work Plan (Appendix D). Treatment effectiveness was determined by multiple batch reactions of groundwater collected from the Site (at various locations as described further below), combined with varying doses of treatment media. Batches were allowed to react under anaerobic conditions for time periods ranging from 5 to 15 days. Results of the study indicate that best treatment results were achieved with Ferox PRB® at a 10 percent dose by weight, and a mixture of Ferox PRB® at a 5 percent dose and ferrous sulfate (at 1 percent or 2 percent solutions). The complete treatability study results are documented in a report from ReSolution Partners, LLC (Appendix E). Based on the treatability study results, Ferox PRB® was retained for inclusion into remedial alternatives because of its treatment effectiveness, longevity, and cost. Use of ferrous sulfate will also be retained as an option for enhancing treatment within the ZVI PRB and/or pretreatment of groundwater upgradient of the PRB.

During the treatment study, tests were conducted on groundwater collected from three different locations to be representative of a range of different conditions within the contaminated groundwater zone. Groundwater was collected from existing wells I-104(s), I-205(s), and MW-23. Samples from I-104(s) and I-205(s) represent conditions along the shoreline, where a PRB would likely be located. Well I-104(s) contained the highest concentrations of arsenic of any of the shoreline wells as measured during the RI. Well I-205(s) contained arsenic concentrations that were generally an order of magnitude lower than at I-104(s). The pH of groundwater at I-205(s) was much lower than other shoreline wells, ranging from 5.4 to 6.9 SU, while the pH at I-104(s) ranged from 5.4 to 9.0 SU during the RI sampling. The third representative location, MW-23, is located inside the Stabilized Soil Area.

Measurements of pH at MW-23 ranged up to 11.9 SU and dissolved arsenic concentrations were one to three orders of magnitude greater than at the shoreline wells. This location represents the worst-case scenario for treatment requirements for a PRB placed downgradient of the Stabilized Soil Area.

Initial analytical results of untreated groundwater samples indicate that dissolved metals concentrations in the I-205(s) sample were all below detection limits, except zinc. Due to these low concentrations, data from initial batch tests were not illustrative of treatment effectiveness. Additional batch tests were not conducted with this water. However, the initial batch tests were useful for understanding the effect of the treatment technologies on pH at I-205s. The pH of untreated groundwater was 6.38 SU and increased during each of the treatment batch tests. Ferox PRB® increased pH only slightly, regardless of dose. Both Metafix® formulations increased pH significantly with positive correlations between Metafix® dose and pH. Doses of 5 percent Metafix® resulted in pH measuring about 11 SU. It was apparent from these results that Metafix® would not be suitable for areas of the Site with lower pH and IHS concentrations, because of its strong effect on pH conditions.

None of the treatment methods achieved remediation goals in water from MW-23, which contained the highest pH and dissolved metals concentrations from the representative wells. However, ferrous sulfate, ferric chloride, and Metafix® formula I-6AF2 were much more effective at reducing arsenic and copper concentrations than ZVI and other Metafix® formulas, because the injectable reductants and Metafix® I-6AF2 decreased groundwater pH significantly. When pH remained high, there was almost no observable treatment of IHSs. These results indicate that treatment of metals in groundwater with high pH cannot be accomplished with solid iron media, unless pH is adjusted first or simultaneously. The test results indicate the most effective treatment occurred between a pH of 6.9 and 7.9 SU. Once pH dropped below this range, concentrations of dissolved nickel and zinc increased.

Results from tests with groundwater from I-104 were more promising. Initial batch tests showed increasing treatment of arsenic with increasing doses of Ferox PRB® and Metafix® products; however, none of the initial doses and reaction times resulted in arsenic levels below the pCUL. Concentrations of copper, nickel, and zinc were all below respective pCULs at the end of the initial batch tests with Ferox PRB® and Metafix® formulations. Initial batch tests using ferrous sulfate and ferric chloride did show treatment of arsenic to levels below the pCUL; however, concentrations of copper, nickel, and zinc were not consistently below respective pCULs. In fact, concentrations of copper and nickel increased during the test runs when treatment of arsenic was the most effective. These results indicate that treatment of groundwater and soil from I-104 with injectable reductants was not effective alone, because it increased the concentrations of metals other than arsenic (likely due to the effects of pH changes on the solubility of the other metals).

After initial batch test results were analyzed, further testing with I-104(s) groundwater was conducted to determine the most effective treatment media. Selected media included: Ferox PRB® at a 10 percent dose, ZVI from PeroxyChem LLC, and a mixture of ferrous sulfate and Ferox PRB®. Metafix®

was not selected because its cost per pound is more expensive than the ZVI materials and did not appear to outperform ZVI during initial batch tests.

The second set of batch tests was conducted to evaluate the effect of different reaction times on treatment effectiveness. The tests were run between 5 and 15 days to simulate shorter and longer treatment durations. Based on initial PRB designs, the residence time of groundwater in the PRB was estimated to be about 10 days (used for the initial round of batch tests). However, heterogeneities in the groundwater aquifer will likely cause actual residence times to vary. Results of the reaction time batch tests did not appear to indicate any correlation between reaction time and treatment effectiveness for any of the treatment materials. Variability in final arsenic concentrations appeared to be unrelated to the duration of the test.

The 15-day I-104(s) test results indicate that pCULs can be achieved for all IHS metals using 10 percent Ferox PRB® or a mixture of 5 percent Ferox PRB® with 1–2 percent ferrous sulfate solution. These represent the best alternatives for use in a PRB at the Site. The longevity of ferrous sulfate is still undetermined but is likely much shorter than ZVI because it is soluble and will, therefore, be moved through the aquifer and diluted with groundwater flow, while ZVI PRBs typically have a lifespan of 10 or more years. For this reason, a higher percentage mix of Ferox PRB® was determined to be a preferable reactant over injectable reductants as the primary component of a PRB mixture for the Site. However, ferrous sulfate will be retained for consideration as a way to enhance areas of the ZVI PRB that may require pH adjustment to achieve sufficient treatment of IHS metals.

5.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

The following sections identify the objectives that each remedial action alternative must meet in order to be in compliance with MTCA, a summary of each of the remedial action alternatives developed for evaluation under this FS, and a summary of source control elements that will be addressed by each of the remedial alternatives.

5.1 Remedial Action Objectives

RAOs define the goals of the cleanup that must be achieved to adequately protect human health and the environment. Except for potential construction worker direct-contact exposure to shallow groundwater during intrusive activities,[6] the current conditions at the Site do not present a risk to Site users because contaminated soil is capped by the existing asphalt pavement and groundwater at the Site is not used for drinking water or other activities. However, migration of contaminated groundwater from the Site to the LDW represents a potential risk to surface water beneficial uses and LDW sediment. For cleanup of the Site, the RAOs must address all affected media, and a cleanup alternative must achieve all RAOs to be considered a viable cleanup action.

RAOs can be either action-specific or media-specific. Action-specific RAOs are based on actions required for environmental protection that are not intended to achieve specific chemical criteria. Media-specific RAOs incorporate the cleanup standards developed in Section 3. Based on the characterization of Site conditions presented in Section 3.0 and the pCULs developed in Section 2.0, the action-specific and media-specific RAOs identified for the Site consist of:

- RAO-1: Prevent direct human contact with soil containing contaminants from the Site at concentrations greater than the direct contact soil pCULs. RAO-1 applies to soil contamination between 0 to 15 ft bgs.
- RAO-2: Prevent groundwater containing contaminants from the Site at concentrations greater than the groundwater pCULs (protective of sediment and/or surface water beneficial uses) from migrating to surface water. RAO-2 is applicable at the CPOC.

RAO-1 can be achieved by removing or treating contaminated soil or by preventing exposure to the contaminated soil through containment, monitoring, and institutional controls. RAO-2 can be achieved through containment, treatment, and/or removal of the contaminated media (soil and groundwater). Each of the cleanup action alternatives identified in Section 5.2 achieve these two RAOs and meet all of the MTCA threshold requirements (described in Section 6.1.1); each alternative is, therefore, a viable cleanup alternative for the Site under MTCA. The degree to which each cleanup action alternative meets the threshold requirements and other requirements listed in WAC 173-340-

---

[6] Note that Boeing administrative protocols are in place so that any planned intrusive activities at the Site are evaluated to determine if potential contamination is present in proposed work areas, workers are notified of the presence of contamination and required to address potential exposures through appropriate health and safety procedures, any special management and disposal requirements are determined, and Ecology is notified of the proposed work actions.

360(2) will be determined by applying the specific evaluation criteria identified in MTCA (Sections 6.1 and 6.2).

5.2 Summary of Remedial Alternatives

Five alternatives that meet regulatory requirements and achieve the RAOs are evaluated in this FS to address contaminated media at the Site. The five alternatives incorporate the most viable cleanup action technologies within the general response action categories of containment, source removal (i.e., excavation), treatment, and institutional controls. The five alternatives are:

- Alternative 1: Containment and Hydraulic Control via Capping and Groundwater Extraction
- Alternative 2: Containment and Hydraulic Control via Capping and Vertical Barrier
- Alternative 3: *In Situ* Groundwater Treatment, Shoreline Excavation, and Containment
- Alternative 4: Focused Excavation and Containment, and *In Situ* Groundwater Treatment
- Alternative 5: Site-Wide Excavation of Contaminated Soil.

A summary of each remedial alternative is included in Table 5-1. A detailed description of each alternative is presented below.

5.2.1 Alternative 1: Containment and Hydraulic Capture via Capping and Groundwater Extraction

Alternative 1 consists of containment of contaminated soil and groundwater, including a surface cap and groundwater hydraulic control and capture via groundwater extraction wells, and institutional controls.

Soil Capping

Containment of contaminated soil at the Site will primarily consist of the existing Site cover features including Site buildings and asphalt and concrete paving. Cracks or seams in the pavement will be sealed to minimize infiltration of stormwater. Areas where pavement is in disrepair will be repaved. The Port property would be remediated and rehabilitated as identified in Section 7.0 including excavation of contaminated soil and potentially replacement of the dilapidated wooden bulkhead with a steel bulkhead, removal of the existing damaged and dilapidated paving, filling subsurface void spaces with clean structural fill, and repaving. The replacement bulkhead, or other shoreline protection, will provide a competent barrier against soil erosion from the Port property and adjacent Isaacson property into the LDW, as well as provide additional control of shallow groundwater flow to the LDW (see “Groundwater Hydraulic Capture” section below).

The purpose of the cap will be to prevent human contact with contaminated soil and groundwater (all COCs). The cap would also limit surface water infiltration and, thereby, limit potential contaminant leaching and migration.

Groundwater Hydraulic Capture

The primary component of the groundwater remedy under Alternative 1 will include installation and operation of a network of groundwater extraction wells along the western edge of the Site that will be designed to intercept or otherwise divert contaminated groundwater flow paths (see Figure 3-1c) from discharging to the LDW. The network will include approximately nine extraction wells, with an estimated combined total extraction rate of approximately 25 gallons per minute (gpm). As determined by a groundwater model developed for the Site (Appendix F) and used to evaluate spacing and pumping needed for adequate groundwater containment, the extraction wells would be located and designed to capture contaminated groundwater from the Former Slip 5 Area and the North of Former Slip 5 Area flowing toward the LDW, thereby minimizing flux of all dissolved phase COCs into the LDW. Extracted groundwater will be treated via an aboveground treatment system designed to remove total and dissolved metals and PCBs (likely a combination of pH adjustment/precipitation with resin adsorptions/filtration media) and other organic contaminants (e.g., cVOCs, cPAHs) as necessary (depending on the adsorption media selected for metals, granular activated carbon [GAC] may also be added to the treatment train). Treated groundwater could be handled in one of three ways: discharged to the sanitary sewer system under a King County Industrial Waste (KCIW) discharge permit, discharged to the LDW under an NPDES permit, or reinjected into the Site aquifer under a UIC permit. For the purposes of the FS, it is assumed that treated water would be reinjected using three injection wells located along the eastern Site boundary (shown on Figure 5-1). If reinjected, the treated groundwater could be used for beneficial/supplemental groundwater control and/or to enhance precipitation of dissolved metals through pH or redox adjustment (i.e., COC metals at the Site tend to be least soluble near neutral pH and/or aerobic conditions).

Under Alternative 1, this groundwater hydraulic capture system will be used to prevent contaminated groundwater discharge to surface water by achieving pCULs at the CPOC (in monitoring wells along the shoreline of the LDW). Without removal of the Stabilized Soil Area and fill soil in the Former Slip 5 Area, this alternative is not intended to restore groundwater quality throughout the Site (at the standard point of compliance). If monitoring indicates discharge to the LDW of dissolved-phase metals and PCBs (or other site COCs) at concentrations above the pCULs is still occurring, then additional contingent extraction wells will be installed to provide additional capture of residual contaminated groundwater (not included in cost estimate).

Because Alternative 1 will involve the long-term onsite containment of contaminated groundwater, long-term groundwater monitoring will be a component of this remedy. After an initial 2 years of quarterly sampling to demonstrate that the extraction system is resulting in compliance with groundwater cleanup levels at the CPOC, it is assumed that groundwater monitoring frequency will be reduced to annual monitoring, unless results indicate the need for more frequent monitoring. Costs also assume Site-wide monitoring every 5 years in conjunction with 5-year reviews. For purposes of estimating costs, it is assumed that groundwater monitoring will be performed for 50 years.[7]

Institutional Controls

Institutional controls will be an important component of Alternative 1 to prevent/control human contact with subsurface soil (RAO-1) and prevent use of Site groundwater for drinking water or any other activity. Institutional controls will include a restrictive covenant on the property deed recorded with King County, in accordance with the Uniform Environmental Covenants Act. This covenant will be binding on the owner's successors and assignees. The covenant will place restrictions on any future excavation work within the capped Site and prohibit use of groundwater. An excavation procedures work plan will be prepared that will provide specific details about how any future utility installation or other subgrade work will need to be performed to ensure that the cap integrity is maintained and that any soil that is generated is handled and disposed of appropriately. The excavation procedures work plan will include a default health and safety plan for contractors to adopt or modify for their work. Institutional controls will require that proper safety measures and soil management practices be implemented as part of any project involving disturbance of impacted soil at the Site (in accordance with WAC 173-340-440). The institutional controls will also include a requirement for periodic (e.g., annual) inspection of the cap, with cap repair to be conducted, as necessary, if damage is sustained from Site activity or from natural events. Because the Site cap includes buildings and pavement, inspection and maintenance will be incorporated into the property maintenance plan(s). Even though the City of Seattle requires connection to the City water system, an institutional control to prohibit use of Site groundwater for potable water supply will also be included as part of this alternative. Long-term source monitoring is anticipated to be addressed under monitoring associated with periodic Site reviews.

Focused Remedial Excavation

Although capping and institutional controls would effectively limit potential exposure to shallow cPAH and TPH contamination in the Observed Tar-Like Substance Area, this alternative includes excavation and offsite disposal of contaminated soil from this discrete and relatively small and easily accessible area of Site contamination. The extent of excavation will initially be determined in the field by visual observation of tar-like contamination but will be continued until confirmation sampling indicates that cPAH and TPH pCULs are met at the excavation base and sidewalls. Based on RI sampling results, the excavation will likely extend to a depth of about 5 ft bgs. Approximately 370 cubic yards of soil (in-place) is assumed to the excavated for the purposes of estimating cost. Figures 5-1 and 3-13 show the location of the Observed Tar-Like Substance Area and cross sections through this area showing the estimated excavation limits, respectively.

---

[7] Using present value analysis in the cost estimates, long-term operations, maintenance, and monitoring costs beyond around 30 to 50 years become negligible; therefore, providing estimates beyond 50 years is not warranted and are accounted for within the range of cost uncertainty for an FS. This is applicable for Alternatives 1–4.

Alternative 1 will include soil excavation of the Port property. The extent of the Port property excavation is estimated to cover the entire area of the Port property parcel to a depth of approximately 18 ft bgs (based on prior investigation results on this parcel) and will include the removal and offsite disposal (at a solid waste landfill) of 15,000 cubic yards (in-place). This excavation does not include excavation of river sediment from the LDW waterway; however, it is anticipated that coordination of this alternative with the LDW sediment cleanup work will be necessary. For cost-estimating purposes for all alternatives, it has been assumed that excavated soil is non-hazardous and will be disposed of at a permitted, offsite Subtitle D landfill. However, prior to disposal all waste will be analyzed for TCLP criteria as well as Washington State Dangerous Waste requirements.

Sufficient quantities of clean fill and other supporting materials will be placed, as necessary, to fill the excavated area to an elevation above the high water line and to protect the exposed areas of shoreline from erosion. The dilapidated wooden bulkhead on the Port property will be removed in conjunction with the excavation activities and will either be replaced with a steel bulkhead, or the shoreline will be otherwise stabilized and armored.

Cost Estimate

For cost-estimating purposes, the conceptual number and location of extraction and injection wells and lateral limits of the excavation at the Site for Alternative 1 are as shown on Figure 5-1. The specific items anticipated to be included in Alternative 1 are listed in Table 5-2a along with their estimated costs. As detailed in Table 5-2a, the total estimated present-worth cost of Alternative 1 is approximately $29,200,000. This is an FS-level estimate and the actual costs may be as much as 30 percent less or 50 percent greater than the estimate.

The cost estimate for Alternative 1 includes contingency line items for construction and operations, maintenance, and monitoring. Contingency actions for Alternative 1, in the event of full or partial remedy failure may include the installation of additional extraction wells and/or higher flow rate extraction pumps to provide greater hydraulic control and capture of contaminated groundwater and greater protection for the groundwater to surface water pathway.

5.2.2 Alternative 2: Containment and Hydraulic Control via Capping and Vertical Barrier

Alternative 2 is similar to Alternative 1 except that instead of solely using extraction wells to capture contaminated groundwater prior to discharge to LDW, Alternative 2 uses a continuous slurry wall in combination with extraction wells for containment of contaminated and highly alkaline groundwater in the Stabilized Soil Area, which appears to be the source and/or cause of the majority of contaminated groundwater at the Site.

Soil Capping

Containment of contaminated soil at the Site will be provided in the same manner as described under Alternative 1.

Groundwater Hydraulic Control

The primary component of the groundwater remedy under Alternative 2 will include installation of a slurry wall containment cell that will encircle the entire Stabilized Soil Area and much of the adjacent non-stabilized area where groundwater monitoring wells indicate that dissolved arsenic concentrations are over 100 times the groundwater pCUL (i.e., more than 800 µg/L), as well as the estimated extents of the copper, nickel, and zinc plumes over their respective pCULs.

It is assumed that the slurry wall will be installed to a depth of approximately 25 ft bgs, to the approximate elevation of where the historic silty marine/river meander sediment layer has been observed. In conjunction with the low-permeability cap, a network of five relatively low-flow extraction wells will be installed and operated within the cell to minimize diffusive or advective transport of contaminated/alkaline groundwater from the containment cell. Two additional extraction wells will be installed near the shoreline near the center of Former Slip 5 to capture groundwater contaminated by other contaminants (e.g., PCBs, cPAHs) not directly connected to/influenced by the alkaline conditions of the stabilized soil area. The combined network of approximately seven extraction wells, with an estimated combined total extraction rate of approximately 14 gpm, located and designed to provide sufficient extraction of groundwater to induce an upward gradient of groundwater flow into the cell. With removal of the source of alkaline water to the rest of the Site groundwater, it is assumed that natural groundwater redox conditions will be restored and result in significantly lower concentrations of dissolved metals in groundwater throughout the rest of the Site. If post-implementation monitoring indicates discharge to the LDW of site COCs at concentrations above the pCULs is still occurring in other areas of the Site, then additional contingent extraction wells will be installed to capture residual contaminated groundwater prior to discharge to the LDW (not included in cost estimate).

Similar to Alternative 1, extracted groundwater will be treated via an aboveground treatment system designed to remove total and dissolved metals, PCBs, and organic contaminants as necessary. Treated groundwater will be discharged to the sanitary sewer or the LDW, or reinjected into Site groundwater. For the purposes of the FS, it is assumed that treated water would be reinjected using one injection well located along the eastern Site boundary (shown on Figure 5-2).

Also similar to Alternative 1, this groundwater hydraulic control cell/system will be used to achieve groundwater cleanup levels at a CPOC (in monitoring wells along the shoreline of the LDW). It will also require long-term (assumed 50 years) groundwater monitoring and assumes 2 years of quarterly sampling to demonstrate effectiveness, followed by annual monitoring, unless results indicate the need for more frequent monitoring. Costs also assume Site-wide monitoring every 5 years in conjunction with 5-year reviews.

Institutional Controls

Institutional controls will be implemented under Alternative 2 in the same manner as for Alternative 1.

Focused Remedial Excavation

Excavation of contaminated soil at the Observed Tar-Like Substances Area of the Site and the Port property will be provided in the same manner as described under Alternative 1.

Cost Estimate

For cost-estimating purposes, the conceptual location of the slurry wall barrier, the number and location of extraction wells, and lateral limits of the excavation at the Site for Alternative 2 are as shown on Figure 5-2. The specific items anticipated to be included in Alternative 2 are listed in Table 5-2b along with their estimated costs. As detailed in Table 5-2b, the total estimated present-worth cost of Alternative 2 is approximately $34,500000. This is an FS-level estimate and the actual cost may be as much as 30 percent less or 50 percent greater than the estimate.

The cost estimate for Alternative 2 includes contingency line items for construction and operations, maintenance, and monitoring. Similar to Alternative 1, contingency actions for Alternative 2, in the event of full or partial remedy failure may include the installation of additional extraction wells and/or higher flow rate extraction pumps to provide greater hydraulic control and capture of contaminated groundwater within the slurry wall containment area or along the shoreline to provide greater protection for the groundwater to surface water pathway.

5.2.3 Alternative 3: *In Situ* Groundwater Treatment, Shoreline Excavation, and Containment

Alternative 3 consists of *in situ* treatment of contaminated groundwater with a PRB located upgradient of the shoreline monitoring wells likely to be used to demonstrate compliance at the groundwater CPOC, excavation of contaminated soil located downgradient of the CPOC and in the Observed Tar-Like Substance Area, containment of contaminated soil through a surface cap, and institutional controls.

Groundwater Treatment

The primary component of the groundwater remedy under Alternative 3 will include installation of a PRB extending from the northern Site boundary (and west of the Stabilized Soil Area) parallel to the shoreline to near the southern edge of the Former Slip 5 Area (Figure 5-3). The PRB will utilize reactive backfill containing ZVI and GAC for *in situ* treatment of contaminated groundwater flowing through the PRB. As demonstrated in the treatability study (see Section 4.2), the ZVI reactive fill has the ability to effectively remove dissolved metals (arsenic, copper, nickel, and zinc) present in Site groundwater. Although RI site data indicate that vinyl chloride are not discharging to surface water, it should be noted that ZVI also effectively treats vinyl chloride through reductive dechlorination. An appropriate proportion of GAC will also be added to the PRB fill material to treat low-level PCBs passing through the barrier. Depending on the actual performance and longevity of the PRB, ferrous sulfate injections may be used to supplement or enhance the performance of the PRB and/or provide pretreatment upgradient of the PRB.

The actual design parameters for the PRB (i.e., wall thickness, depth, and length, and reactant mix) will be determined during the design phase. However, for costing purposes, the PRB is assumed to be 5 ft thick, 25 ft deep, and 700 ft long, and use a mix of 30 percent ZVI,[8] 1 percent GAC,[9] and sand for the remainder (appropriately graded to provide necessary *in situ* hydraulic properties). The PRB will be set back from the shoreline/western Boeing property line approximately 50–100 ft to allow space to evaluate the performance of the PRB in treating groundwater contamination and confirming compliance with the pCULs prior to groundwater discharge to the LDW.

As part of the PRB design process, further evaluation and consideration will be needed for near-shoreline hydrogeology, aquifer chemistry/geochemistry, geotechnical conditions, and additional bench-scale and pilot study testing will be needed to determine PRB design specifications and evaluate performance and longevity. This pilot study testing may include column studies to evaluate treatment capacity/longevity of various PRB media (e.g., ZVI products) and installation of a short length of a PRB (e.g., 50 to 100 ft) to evaluate treatment effectiveness and design optimization in the area of the proposed PRB where groundwater pH and arsenic concentrations are highest (i.e., downgradient of the stabilized soil mass).

For purposes of estimating costs, it is assumed that the PRB will be designed for a treatment duration of at least 10 years based on PRB width and proportion of ZVI in the PRB media (i.e., costs assume complete excavation and replacement of the PRB every 10 years). To determine when PRB media replacement is required, intra-PRB and downgradient groundwater monitoring will be used to evaluate performance within and downgradient of the PRB (i.e., groundwater will be monitored and sampled at monitoring wells placed near the center of the PRB thickness and near the downgradient edge of the PRB). Data from within the PRB will be used to estimate time to breakthrough, and downgradient monitoring will determine if/when breakthrough is beginning to occur and/or when concentrations begin to increase/trend toward potential exceedance of the CULs. Costs also assume long-term groundwater compliance monitoring will be performed for 50 years and assumes 2 years of quarterly sampling to demonstrate effectiveness, followed by annual monitoring at CPOC wells, unless

---

[8] Note that, although the treatability study indicated a 10 percent ZVI mix yielded adequate treatment results, it is assumed that a higher ratio of ZVI will be necessary to achieve hydraulic contact with the reactive ZVI particles and adequate longevity of the PRB (actual ratio will be determined during the design phase and pilot testing).

[9] Based on vendor recommendations, 1 percent should provide adequate treatment; however, up to 10 percent may be necessary to achieve adequate hydraulic contact (actual ratio will be determined during the design phase and pilot testing).

results indicate the need for more frequent monitoring (e.g., to ensure compliance is maintained toward the end of the PRB design treatment life). Costs also assume Site-wide monitoring every 5 years in conjunction with 5-year reviews.

Remedial Excavations

Alternative 3 will include two areas of remedial excavation, including the Port property and contaminated soil extending east to the downgradient edge of the PRB (see above), and the Observed Tar-Like Substance Area. The Observed Tar-Like Substance Area excavation will be implemented in Alternative 3 in the same manner as Alternative 1.

The Port property excavation will include soil removal between the proposed PRB location and the Port property shoreline. Because there is metals-contaminated soil (as well as relatively small discrete areas of PCB contamination) between the Port property and the proposed PRB location that may itself be impacting groundwater quality, this soil in this area will be excavated to prevent recontamination of PRB-treated groundwater prior to discharge to the LDW. The extent of the Port property excavation is estimated to cover the entire area of the Port property parcel to a depth of approximately 18 ft bgs (based on prior investigation results on this parcel) and will include the removal and offsite disposal (at a solid waste landfill) of 15,000 cubic yards (in-place). An additional estimated 10,500 cubic yards of soil will be removed between the Port property and the PRB (excavation extending to approximately 15 ft bgs across a roughly 380 ft by 50 ft area immediately adjacent to the east of the Port property). Figures 5-4 and 5-5 present a cross section through this area showing the estimated excavation limits with respect to the existing shoreline. This excavation does not include excavation of river sediment from the LDW waterway; however, it is anticipated that coordination of this alternative with the LDW sediment cleanup work will be necessary.

Sufficient quantities of clean fill and other supporting materials will be placed, as necessary, to fill the excavated area to an elevation above the high water line and to protect the exposed areas of shoreline from erosion. The dilapidated wooden bulkhead on the Port property will be removed in conjunction with the excavation activities and will either be replaced with a steel bulkhead or the shoreline will be otherwise stabilized and armored.

Soil Capping

Containment of contaminated soil remaining at the Site under Alternative 3 will be provided in the same manner as described under Alternative 1, with the exception of the Port Property remedy.

Institutional Controls

Institutional controls would be implemented under Alternative 3 in the same manner as for Alternative 1.

Cost Estimate

For cost-estimating purposes, the anticipated location of the PRB and lateral limits of the excavation at the Site for Alternative 3 are as shown on Figure 5-3. The specific items anticipated to be included in Alternative 3 are listed in Table 5-2c along with their estimated costs. As detailed in Table 5-2c, the total estimated present-worth cost of Alternative 3 is approximately $30,100,000. This is an FS-level estimate and the actual costs may be as much as 30 percent less or 50 percent greater than the estimate.

The cost estimate for Alternative 3 includes contingency line items for construction and operations, maintenance, and monitoring. Contingency actions for Alternative 3, in the event the remedy does not meet or stops meeting RAOs over time may include enhancement or optimization of the remedy, such as more frequent replacement of the PRB media; increasing the width of specific sections of the PRB where breakthrough occurs more rapidly than the rest of the PRB; modifying the PRB media mixture to provide greater contaminant adsorptive capacity, pH adjustment, or other applicable capabilities. Injections of liquid iron substrates, such as ferrous sulfate or ferric chloride, may be performed upgradient of the PRB to provide pH adjustment and pre-treatment of groundwater to enhance the effectiveness and/or longevity of specific areas of the PRB.

Although metals contamination in soil is present downgradient of the conceptual PRB alignment, it is not practical to extend the excavation for the Port property to the area directly south along the existing Steel Bulkhead on the Thompson property. Soil removal along the shoreline adjacent to this bulkhead will not be practicable because of the presence of anchor rods, piles, and pile-caps associated with the structural support of the bulkhead. If, after installation of the PRB and equilibrium conditions are established, elevated dissolved metal concentrations in groundwater adjacent to the LDW persist in areas of the Site where shoreline soil removal is not practicable (i.e., at or downgradient of the PRB and CPOC), contingent injection of ferrous sulfate or other injectable ZVI products (e.g., micro-scale ZVI) into discrete areas closer to the shoreline may be conducted to provide *in situ* treatment.

5.2.4 Alternative 4: Focused Excavation and Containment, and *In Situ* Groundwater Treatment

Alternative 4 is similar to Alternative 3 with *in situ* treatment of contaminated groundwater with a PRB located upgradient of a groundwater CPOC; however, the PRB is more limited (shorter in length), and excavation of contaminated soil is expanded to include removal of the contaminated soil in the Stabilized Soil Area and in the Observed Tar-Like Substance Area to remove as much of the apparent source of groundwater contamination as possible (i.e., areas of highest metals concentrations in soil and cementitious materials in soil resulting in high alkalinity in groundwater and the tar-like substance). Alternative 4 also includes containment of remaining contaminated soil through a surface cap and institutional controls.

Remedial Excavation

Similar to Alternative 3, Alternative 4 includes excavation of contaminated soil located near the shoreline and within most of the Port property. Alternative 4 also includes removal and offsite disposal of soil in and adjacent to the Stabilized Soil Area north of the Former Slip 5 Area (Figure 5-6). The removal of most of the areas of soil with the highest concentrations of metals contamination (primarily arsenic) will eliminate a significant portion of the leachable metals from the Site (as well as relatively small discrete areas of - PCB-contaminated soil). Additionally, with the removal of the cementitious materials that are the source of alkaline water (that is, apparently the primary cause of elevated dissolved metals concentrations in Site groundwater), natural groundwater redox conditions are likely to be restored and result in significantly lower concentrations of dissolved metals in groundwater throughout the rest of the Site. This should also increase the performance and longevity of the PRB in the Slip 5 Area (see following subsection). The extent of the Port property excavation is estimated to cover the entire area of the Port property parcel (22,500 ft^2) to a depth of approximately 18 ft bgs (based on prior investigation results on this parcel). Excavation of the soil in and adjacent to the Stabilized Soil Area (206,700 ft^2) will extend to a depth of approximately 15 ft bgs. The Alternative 4 excavation is estimated to include the removal and offsite disposal (at a solid waste landfill) of 130,000 cubic yards (in-place). Figure 5-7 presents a cross section through these areas showing the estimated excavation limits with respect to the existing shoreline and Stabilized Soil Area.

This remedial excavation also includes removal of the Observed Tar-Like Substance Area in the same manner as described in Alternative 1.

As with Alternative 3, the dilapidated wooden bulkhead along the Port property will be removed and the shoreline along the Port property and western end of the Isaacson property will either be protected with a replacement steel bulkhead or otherwise stabilized and armored.

Groundwater Treatment

Because the remedial excavation is assumed to significantly reduce groundwater contamination at the Site, additional groundwater treatment will be dependent upon post-excavation monitoring results. Assuming that the excavation does not result in restoration of all groundwater discharging to the LDW, Alternative 4 includes installation of a shorter PRB, relative to Alternative 3, that is assumed to be located adjacent the shoreline in the southern half of the Former Slip 5 Area (south of the KC storm drain line) and parallel to the shoreline. The same as Alternative 3, it is assumed that the PRB will be installed to a depth of approximately 25 ft bgs, with a width of 5 ft, but will only be approximately 300–350 ft long. The PRB will also utilize ZVI reactive backfill for *in situ* treatment of metals- (and vinyl chloride, if present) contaminated groundwater flowing through the PRB and GAC for additional treatment for low-level PCBs.

Also similar to Alternative 3, the PRB will be designed for a treatment duration of at least 10 years, and intra-PRB and downgradient groundwater monitoring will be used to evaluate PRB performance and to determine when PRB media replacement is necessary. Cost estimates assume complete excavation and replacement of the PRB every 10 years. Alternative 4 will also require long-term (assumed 50 years) groundwater monitoring and assumes 2 years of quarterly sampling to demonstrate effectiveness, followed by annual monitoring, unless results indicate the need for more frequent monitoring (e.g., to ensure compliance is maintained toward the end of the PRB design treatment life). Costs also assume Site-wide monitoring every 5 years in conjunction with 5-year reviews.

Soil Capping

Containment of contaminated soil remaining at the Site under Alternative 4 will be provided in the same manner as described under Alternative 1, with the exception of the Port Property remedy.

Institutional Controls

Institutional controls will be implemented under Alternative 4 in the same manner as for Alternative 1.

Cost Estimate

For cost-estimating purposes, the anticipated lateral limits of the excavation and location of the PRB at the Site for Alternative 4 are as shown on Figure 5-6. The specific items anticipated to be included in Alternative 4 are listed in Table 5-2d along with their estimated costs. As detailed in Table 5-2d, the total estimated present-worth cost of Alternative 4 is approximately $83,200,000. This is an FS-level estimate and the actual costs may be as much as 30 percent less or 50 percent greater than the estimate.

The cost estimate for Alternative 4 includes contingency line items for construction and operations, maintenance, and monitoring. Similar to Alternative 3, contingency actions for Alternative 4 in the event of full or partial remedy failure, may include more frequent replacement of the PRB media or increasing the width of specific sections of the PRB where breakthrough occurs more rapidly than the rest of the PRB; modifying the PRB media mixture to provide greater contaminant adsorptive capacity, pH adjustment, or other applicable capabilities. Also like Alternative 3, contingent injection of ferrous sulfate or other injectable ZVI products into discrete areas closer to the shoreline may be conducted to provide *in situ* treatment. Contingency actions may also include additional focused remedial excavation of known areas of soil contamination within the former Slip 5 area.

5.2.5 Alternative 5: Site-Wide Excavation of Contaminated Soil

Alternative 5 includes complete excavation and offsite disposal of known and accessible metals- and organic COC-contaminated soil and fill material at the Site (Figure 5-8). This includes removal of the contaminated soil to the extent reasonably practicable in and adjacent to the Stabilized Soil Area (including the Observed Tar-Like Substance Area), removal of contaminated fill in the Former Slip 5 Area (including the Port property), removal of shallow contaminated soil in the southeastern portion of the Site, and removal of contaminated soil in the southwestern portion of the Site. Removal of this soil is assumed to result in restoration of both soil and groundwater at the Site at the standard point of compliance; therefore, this alternative does not include any other groundwater remedial actions, soil capping/containment, or institutional controls.

Remedial Excavation

Alternative 5 includes excavation and offsite disposal of contaminated soil across much of the Site including the following areas:

- Soil in and adjacent to the Stabilized Soil Area, north of the Former Slip 5 Area including the Observed Tar-Like Substance Area, to a depth of approximately 15 ft bgs.
- Fill soil in the Former Slip 5 Area, including most of the Port property, to the contact with the native marine/river meander sediments layer at approximately 25 ft bgs. Figure 5-9 presents a cross section through the Former Slip 5 Area showing the associated estimated excavation limits.
- Shallow soil in the southeastern portion of the Site to a depth of approximately 5 ft bgs.
- Pockets of deeper soil in the southwestern portion of the Site to a depth of approximately 15 ft bgs.

In total, the Alternative 5 excavation is estimated to include the removal and offsite disposal (at a solid waste landfill) of 462,000 cubic yards (in-place). Remedial excavation will not be performed beneath buildings or other critical infrastructure and utilities (e.g., tunnels, utility ducts and mains, KC storm drain line, and operable ASTs/USTs). Soil excavation will also not be performed near the shoreline adjacent to the existing Thompson property Steel Bulkhead where anchor rods, piles, pile-caps, and other subsurface components associated with the bulkhead are present.

Under this remedy, the dilapidated wooden bulkhead on the Port property will be removed and replaced with a new steel sheet pile bulkhead or otherwise stabilized and armored. All excavated soil will be replaced with clean structural fill to final grade.

The removal of known and accessible contaminated soil should eliminate the majority of sources of groundwater contamination at the Site, including the source of alkaline water that is apparently the primary cause of elevated dissolved metals concentrations in Site groundwater. It will not be possible to remove all contaminated soil from the Site due to its location proximate or beneath buildings or other subsurface infrastructure or features. Consequently, contingent *in situ* groundwater treatment may also be necessary. However, for the purposes of this FS and the cost estimate, this alternative is assumed to result in restoration of soil and groundwater quality to below pCULs at the Site at the standard point of compliance. Therefore, no capping/containment, or institutional controls are assumed for this alternative. Cost estimates assume that quarterly groundwater sampling will be conducted at Site monitoring wells for 4 years for post-remedial excavation performance monitoring and to demonstrate compliance with cleanup standards.

Cost Estimate

For cost-estimating purposes, the anticipated lateral limits of the excavation across the Site for Alternative 5 are as shown on Figure 5-8. The specific items anticipated to be included in Alternative 5 are listed in Table 5-2e along with their estimated costs. As detailed in Table 5-2e, the total estimated present-worth cost of the excavation alternative is approximately $196,000,000. This is an FS-level estimate and the actual costs may be as much as 30 percent less or 50 percent greater than the estimate.

The cost estimate for Alternative 5 includes contingency line items for construction and monitoring. Contingency actions for Alternative 5, in the event of full or partial remedy failure, may include remedial excavation of additional soil if post-excavation monitoring identifies specific areas where groundwater contamination persists. Contingent actions may also include longer-term monitoring to evaluate whether contaminant attenuation is occurring to evaluate whether additional actions are needed.

5.3 Lower Duwamish Waterway Source Control

The overall strategy for cleanup of the LDW superfund site includes early identification of contaminated sites in the LDW area and controlling sources of contamination ("source control") to the LDW (EPA 2014). This strategy includes specific action items for the Site identified by Ecology for the LDW cleanup (Ecology 2020—Table B-2). While the MTCA cleanup of this Site does not include direct requirements for source control, there are elements of, or related to, source control that are inherently resultant from each of the cleanup alternatives evaluated in this FS. Specifically, there are three primary pathways of concern for potential contaminant "sources" from the Isaacson-Thompson Site to migrate to the LDW sediments:

1) Contaminated groundwater flow from the Site to the LDW that can potentially sorb to and contaminate LDW sediments ("groundwater-to-sediment" pathway).
2) Migration of contaminated soils through the gaps in the bulkheads at the Site directly into the LDW channel and deposition as contaminated sediment ("bank erosion-to-sediment" pathway).
3) Contaminated stormwater or stormwater solids collected by the Site stormwater management system discharging to the LDW ("stormwater-to-sediment" pathway).

A summary of how the MTCA cleanup at the Site will address LDW source control as it pertains to these three pathways is provided below:

- **<u>Groundwater-to-sediment pathway</u>**: Each remedial alternative described in this FS will achieve cleanup of groundwater to the pCULs for Site COCs/IHS identified in Section 2.2, the development of which considered groundwater concentrations protective of LDW sediment. The method by which groundwater COCs/IHS will be captured/controlled or treated for each alternative is described in Section 5.2. By achieving the groundwater pCULs at the CPOC (point or points where groundwater flows into the LDW [Alternatives 1 through 4]) or throughout the Site (Alternative 5), the cleanup will achieve the Site-specific source control action item of "controlling groundwater contaminant sources that pose a risk of sediment recontamination" (paraphrased; Ecology 2020). Groundwater pCULs are anticipated to be reached within 3–6 years of initiation of cleanup action (subject to long-term maintenance and monitoring for Alternatives 1 through 4) and is anticipated to adequately address groundwater-to-sediment source control.

- **Bank erosion-to-sediment pathway**: Each remedial alternative described in this FS will either remove (through remedial excavation) or prevent/control migration and erosion of contaminated soil to the LDW (through replacing dilapidated bulkhead structures), as described in Section 5.2. Through these remedial actions, the cleanup will achieve the Site-specific source control action item of "controlling soil contaminant sources that pose a risk of sediment recontamination" (paraphrased; Ecology 2020). Soil removal or containment are anticipated to be completed within 1–3 years of initiation of cleanup action, which is anticipated to adequately address bank erosion-to-sediment source control.
- **Stormwater-to-sediment pathway**: Each remedial alternative described in this FS includes sealing, repairing, and maintaining the existing pavement at the Site and institutional controls to prevent removal of the pavement. The existing pavement prevents stormwater from contacting soils that may contain contaminants. As described in Sections 1.1.1 and 1.4.8, the stormwater collection/conveyance and treatment system at the Site was upgraded in 2008 after the removal of the stabilized soil mound. Stormwater from the Site is currently collected in two Boeing-owned storm drain systems (Figure 1-3) that discharge to the LDW via two outfalls (Outfalls A and B; see Figure 1-2). The Isaacson property stormwater system includes two Vortechs treatment vaults that treat stormwater by allowing suspended solids to settle out prior to discharge to the LDW. Treatment vaults are maintained and stormwater solids removed on a regular basis. Stormwater discharge from the Thompson property is covered under the ISGP (Permit No. WAR000148). The ISGP requires monitoring for standard benchmark pollutants and cleaning of the stormwater system during each permit period. The ISGP includes benchmarks for certain pollutants (benchmarks are pollutant level thresholds above which additional stormwater control measures must be implemented). Maintenance of the pavement and compliance with the ISGP are anticipated to adequately address stormwater-to-sediment source control.

  Note that stormwater from the Isaacson and Thompson properties does not enter the 48-inch KC storm drain line that discharges to the LDW through the steel bulkhead (Figure 1-2).

5.4 Shoreline Management Act Compliance

As noted in Section 2.7, the SMA is as an ARAR, the requirements of which are provided under the City's SMP and as codified in the TMC. These ARARs are considered for each of the remedial alternatives described in this FS, and none of the alternatives preclude the ability to achieve compliance with the SMA.

This section provides a general overview of SMA compliance as it relates to the cleanup alternatives considered in the FS. However, it should be noted that due to the conceptual nature of the cleanup alternatives, as is typical for the FS stage of cleanup action development and determination, it is not possible at this time to specifically identify the elements of SMA/TMC compliance for each alternative.

The specific means and methods by which SMA/TMC compliance will be addressed will be determined during the engineering design phase of the cleanup and will be based on the final remedy determined by Ecology in the cleanup action plan and further consultation with the City. Boeing has had meetings with the City and/or Ecology on December 3, 2020 and March 9, 2022 where the implications of the Site cleanup and associated requirements for compliance with SMA/TMC were discussed. During these meetings it was stated by the City and Ecology that Site cleanup did not trigger shoreline redevelopment requirements, and it was agreed that SMA/TMC compliance would be provided during the design process. Boeing is committed to continuing to work with both Ecology and the City to ensure the final design will be fully compliant with SMA/TMC requirements.

With regard to the nature of the cleanup alternatives considered, each of the alternatives include elements of capping (Alternatives 1–4) and excavation of contaminated material (Alternatives 1–5) within the 100-ft shoreline buffer for the Site.[10] Title 18 in the TMC specifically allows for certain activities within the shoreline buffer, including shoreline fill intended for capping contamination as part of a remediation plan. Landscaping and vegetation management plans would need to be developed for any alternative that is selected, in discussion with the City, to meet the intent of the SMP in the shoreline buffer.

Shoreline protection installed in conjunction with or after capping and remedial soil excavation activities are also included in all of the remedial alternatives. The specific method of shoreline protection (e.g., replacing existing bulkheads, rock armoring, or vegetated soft-scape) have yet to be determined by Boeing or the Port. Considerations for the impact to final remedy implementation resulting from bulkhead replacement would be evaluated during the remedial design phase of cleanup. If the bulkhead is replaced prior to remedial design, a hydraulic investigation will be conducted to evaluate changes to Site groundwater flow at the shoreline and applicable impacts to remedial design (and appropriate modifications to the remedial design will be made). However, it should be noted that the City also allows for new or replacement shoreline stabilization (TMC §18.44.050[F]) and support facilities for belowground pollution control (TMC §18.44.050[D]) within the buffer (Ord. 2627, 2020). The SMA, SMP, and TMC also have specific provisions that recognize the value and importance of onsite remediation and associated facility development alternatives that were considered in the FS. The SMA states that preferred uses for the shoreline include uses that "are consistent with control of pollution and prevention of damage to the natural environment" (RCW 90.58.020). Thus, the construction elements included in all of the FS alternatives, including the method of shoreline protection, would be permitted within the 100-ft-wide shoreline buffer.

Due to the flexibility of the SMA and TMC and some of the specific provisions summarized above, there is nothing in the SMA/TMC that would preclude implementation of any of the remedial

---

[10] Although the shoreline jurisdiction may extend 200 ft upland of the ordinary high water mark (OHWM) in some areas of the City, Tukwila Shoreline Environments that are zoned High-Intensity (i.e., the Duwamish Waterway downstream of the Turning Basin, which includes this Site) are managed using a reduced upland buffer width of 100 ft from the OHWM (TMC. §18.44.040 and .050[C][1][d]).

alternatives described in the FS or compliance and consistency with the SMA. Specifics of how the final selected cleanup alternative will comply with substantive requirements of the City's SMP will be provided after site development and construction details are further developed during remedial design.

As indicated above, Boeing is committed to continue to work with the City and Ecology to confirm interpretation and intent of the SMP and ensuring that remedial designs are fully compliant with the requirements. This commitment is reflected, in part, by the inclusion of costs specifically identified for coordination, planning, design, and final implementation of each cleanup alternative (e.g., implementation of landscaping/vegetation management plan) discussed in this FS in cooperation with the City and Ecology (see Tables 5-2a through 5-2e).

5.5 Climate Change

Ecology takes into consideration climate change as part of remedy selection (Ecology 2017b). Potential climate change effects (sea level rise and increased flooding) and associated impacts on the selected remedy are described below (note that Alternative 5 is not included in this evaluation because of the short-term duration of that alternative).

- **Sea level rise** of 1–4 ft by 2100 (Ecology 2017b) would result in average higher groundwater elevations near the shoreline (e.g., within approximately 400 ft—see Section 1.1.3), particularly during high tide events. Sea level rise would also result in greater sea water intrusion (increased thickness of saltwater wedge) in the LDW and possibly to groundwater at the Site. For alternatives that include groundwater pumping (i.e., Alternatives 1 and 2), these impacts would potentially result in the need to pump higher volumes of water in the future to provide complete hydraulic control and capture. Because the PRBs under Alternatives 3 and 4 will be replaced periodically, if sea level rise were to cause projected groundwater elevations to overtop the PRB, the height of the PRB could be increased by adding additional media in the trench beneath the backfill. Shoreline erosion from higher river elevations is not anticipated due to current or planned shoreline hardscapes adjacent to the Site along the LDW shoreline that are included in the remedial alternatives. The potential exception to this is along the Thompson property wooden bulkhead, which will be addressed, as necessary, by the proposed facility sheet pile wall installation project (Section 1.5); and potential contaminated erosion to sediment will be evaluated during pre-remedial design investigation activities (Section 3.4) and addressed as needed during remedy design.
- **Increased flooding** (from increased intensity of rainfall events and/or sea level rise) should not significantly affect the remedy. The Site is mostly paved with asphalt, and the shoreline protected with hard scape, so precipitation would primarily continue to run off the Site by sheet flow and through the stormwater management system.
- **Air temperature increase** of 4.2 to 5.5 degrees Fahrenheit (°F) average by the 2050s (Ecology 2017b) would result in commensurate increases in average soil and groundwater temperatures. Current groundwater temperatures in the Puget Sound region generally fall between 50 and 55°F (10 and 15 degrees Celsius [°C]), and subsurface soil temperatures generally fall between 40 and 70°F (between 4 and 20°C). Microbial activity typically doubles for every 10°C (45°F) rise in temperature (EPA 1995). For Alternatives 1 and 2, this could

increase the rate of bacterial fouling of extraction wells, injection wells, and/or a groundwater treatment system. This would have negligible impact on excavation and PRB-based remedies (Alternatives 3 and 4).

Based on the location and setting of the Site, other climate change issues such as landslide, erosion, wildfire, and drought do not appear to be vulnerabilities for the Site cleanup. Based on these factors, additional vulnerability assessment or planning/design for remedy resilience at the Site to account for climate change does not appear to be necessary.

6.0 DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES

The five remedial alternatives for cleanup of the Site are evaluated in this section, using applicable MTCA evaluation criteria. A preferred alternative is selected based on the evaluation and comparison of the alternatives.

6.1 Evaluation Criteria

MTCA requires that cleanup alternatives meet certain minimum requirements and be compared to or against each other with a number of criteria to evaluate the adequacy of each alternative in achieving the intent of the regulations, and as a basis for comparing the relative merits of each of the cleanup action alternatives. Consistent with MTCA, the alternatives were evaluated with respect to compliance with threshold requirements, using permanent solutions to the maximum extent practicable, restoration time frame, and consideration of public concerns. The following sections briefly summarize the MTCA threshold and other requirements that the remedial alternatives under consideration must meet.

6.1.1 Threshold Requirements

As specified in WAC 173-340-360(2), all cleanup actions are required to meet the following threshold requirements:

- Protect human health and the environment.
- Comply with cleanup standards.
- Comply with applicable state and federal laws.
- Provide for compliance monitoring.

Evaluation of whether each remedial alternative meets the threshold requirements is provided in Section 6.2.1 and Table 6-1.

6.1.2 Requirements for a Permanent Solution to the Maximum Extent Practicable

WAC 173-340-200 defines a permanent solution as one in which cleanup standards can be met without further action being required at the site being cleaned up or any other site involved with the cleanup action, other than the approved disposal site of any residue from the treatment of hazardous substances. Ecology recognizes that permanent solutions may not be practicable for all sites and provides a procedure referred to as a disproportionate cost analysis (DCA; WAC 173-340-360[3][e]) to determine whether a cleanup action is permanent to the maximum extent practicable.

The purpose of the DCA is to determine if the incremental increase in costs of a cleanup alternative over that of a lower cost alternative is justified by providing a corresponding incremental increase in human health and environmental benefits. The relative benefits of a cleanup alternative are based on a series of evaluation criteria. These criteria are evaluated in Table 6-1 and include:

- ***Protectiveness.*** Overall protectiveness of human health and the environment, including the degree to which site risks are reduced, time required to reduce risk at the facility and attain cleanup standards, risks during implementation, and improvement of overall environmental quality.
- ***Permanence.*** The degree of reduction in toxicity, mobility, and volume of hazardous substances, including the reduction or elimination of hazardous substance releases and sources of releases.
- ***Cost.*** The cost to implement the remedy including capital costs and O&M costs.
- ***Effectiveness over the long term.*** Long-term effectiveness, including the degree of certainty that the alternative will be successful, long-term reliability, the magnitude of residual risk, and the effectiveness of controls required to manage treatment residues and remaining waste. The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: Reuse or recycling; destruction or detoxification; immobilization or solidification; onsite or offsite disposal in an engineered, lined, and monitored facility; onsite isolation or containment with attendant engineering controls; and institutional controls and monitoring.
- ***Management of short-term risks***. The risk to human health and the environment during construction and implementation, and the effectiveness of measures to manage the risk.
- ***Technical and administrative implementability.*** Implementability, including consideration of whether the alternative is technically possible; the availability of necessary offsite facilities, services, and materials; administrative and regulatory requirements; scheduling, size, and complexity of construction; monitoring requirements; access for construction, operations, and monitoring; and integration with existing facility operations.
- ***Consideration of public concerns.*** Whether the community has concerns and the extent to which those concerns are addressed.

If the incremental increase in costs is determined to be disproportionate to the benefits, the more expensive alternative is considered impracticable and the lower cost alternative is determined to be permanent to the maximum extent practicable. This process provides a mechanism for balancing the permanence of the cleanup action with its costs, while ensuring that human health and the environment are adequately protected. Evaluation of the remedial alternatives through the DCA process is provided in Section 6.2.

6.1.3 Requirements for a Reasonable Restoration Time Frame

WAC 173-340-360(4)(b) specifies that the following factors be considered when determining whether a cleanup action provides for a reasonable restoration time frame:

- Potential risks to human health and the environment.
- Practicability of achieving a shorter restoration time frame.

- Current and potential future use of the Site, surrounding areas, and associated resources that are, or may be, affected by releases from the Site.
- Availability of alternative water supplies.
- Likely effectiveness and reliability of institutional controls.
- Ability to control and monitor migration of hazardous substances from the Site.
- Toxicity of the hazardous substances at the Site.
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the Site or under similar Site conditions.

Evaluation of restoration time frames for the remedial alternatives is provided in Section 6.2.4.

6.1.4 Requirement for Consideration of Public Concerns

Consideration of public concerns is an inherent part of the cleanup process under MTCA (see WAC 173-340-600). Prior to implementation of a cleanup action, Ecology will issue a Cleanup Action Plan for public comment as specified in WAC 173-340-380. Under this process, the RI and FS reports, and the Cleanup Action Plan will be available for public review as part of the 30-day comment period for the agreed order under the Ecology formal program.

6.2 Evaluation and Comparison of Alternatives

This section evaluates and compares the adequacy of each alternative relative to the criteria discussed in Section 6.1. The comparative analysis of the alternatives is organized by criteria and is presented in the following sections.

6.2.1 Threshold Requirements

For an alternative to achieve the threshold requirements, it must adequately protect human health and the environment, comply with cleanup standards, comply with state and federal laws, and provide for compliance monitoring. Threshold requirements are evaluated for each remedial alternative in Table 6-1 and summarized below:

- Protection of human health and the environment: Each of the remedial alternatives is protective of human health and the environment by meeting the RAOs, reducing site risks, addressing exposure pathways, protecting human and ecological receptors, and improving overall environmental quality.
- Compliance with cleanup standards: Each of the remedial alternatives complies with the cleanup standards. Alternatives 1 through 4 comply with applicable cleanup standards by meeting the criteria in WAC 173-340-740(6)(f) through containment and Institutional Controls (per WAC 173-340-440), and comply with groundwater standards at a CPOC and by meeting the criteria in WAC 173-340-720(8)(c). Alternative 5 complies with cleanup standards at the standard point of compliance by near-complete removal of contaminated soil that will restore groundwater quality at the Site.

- Compliance with applicable state and federal laws: Each of the remedial alternatives will comply with applicable state and federal laws as described in Section 2.7 or as otherwise applicable through proper development of cleanup levels (Section 2.0).
- Provisions for compliance monitoring: Alternatives 1 through 5 include compliance monitoring (protection monitoring, performance monitoring, and conformational monitoring) as required under WAC 173-340-410 and compliance monitoring required by the cleanup standards (WAC 173-340-720 through -760).

As demonstrated, each of the cleanup action alternatives meets all of the MTCA threshold requirements. Each alternative also meets the two RAOs presented in Section 5.1 and, therefore, are viable and appropriate cleanup alternatives under MTCA.

6.2.2 Permanent Solutions to the Maximum Extent Practicable (i.e., Disproportionate Cost Analysis)

As described in Section 6.1.2, a DCA is performed to determine whether a cleanup alternative is permanent to the maximum extent practicable. The purpose of the DCA is to determine if the costs of a cleanup alternative are disproportionate to the human health and environmental benefits achieved by the cleanup action, thus rendering the alternative impracticable. Each of the remedial alternatives are evaluated, using the DCA criteria, in Tables 6-2 and 6-3 and Figure 6-1. Alternative 5 is considered the most permanent solution and, as such, is the baseline cleanup action alternative against which the other cleanup action alternatives are compared. A summary of quantitative benefit scores (and weighting factors) assigned for each DCA criteria are summarized below from highest to lowest for each:

- Protectiveness (30 percent):
  - Alternative 5 (Site-Wide Excavation): 9
  - Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): 8
  - Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): 7
  - Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): 5
  - Alternative 2 (Capping, Vertical Barrier, and Shoreline Excavation): 4
- Permanence (20 percent):
  - Alternative 5 (Site-Wide Excavation): 10
  - Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): 8
  - Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): 5
  - Alternative 2 (Capping, Vertical Barrier, and Shoreline Excavation): 3
  - Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): 3
- Cost (no weighting factor; compared against total benefit scores for each alternative):
  - Alternative 5 (Site-Wide Excavation): $196,000,000
  - Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): $83,200,000

  - Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): $30,100,000
  - Alternative 2 (Capping, Vertical Barrier, and Shoreline Excavation): $34,500,000
  - Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): $29,200,000

  A breakdown of these costs is presented in Tables 5-2a through 5-2e. The cost for Alternative 5 is approximately 2.5 to 10 times higher than the cost for each of the other four alternatives. These costs are further evaluated against the relative environmental benefit described in Section 6.2.3.

- Effectiveness over the long term (20 percent):
  - Alternative 5 (Site-Wide Excavation): 10
  - Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): 8
  - Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): 7
  - Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): 3
  - Alternative 2 (Capping, Vertical Barrier, and Shoreline Excavation): 3
- Management of short-term risks (10 percent):
  - Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): 7
  - Alternative 2 (Capping, Vertical Barrier, and Shoreline Excavation): 7
  - Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): 7
  - Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): 4
  - Alternative 5 (Site-Wide Excavation): 2
- Technical and administrative implementability (10 percent):
  - Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): 6
  - Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): 6
  - Alternative 2 (Capping, Vertical Barrier, and Shoreline Excavation): 5
  - Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): 4
  - Alternative 5 (Site-Wide Excavation): 2
- Consideration of public concerns (10 percent):
  - Alternative 5 (Site-Wide Excavation): 8
  - Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): 7
  - Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): 6
  - Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): 4
  - Alternative 2 (Capping, Vertical Barrier, and Shoreline Excavation): 3

  Each alternative will consider public concerns in the same manner by responding to comments received during the required public comment period for the RI/FS (and possibly Cleanup Action Plan) as part of the cleanup process under MTCA.

Based on these benefit rankings for each criteria and the assigned weighting factors, the overall weighted benefit score for each alternative is as follows (from highest to lowest):

- Alternative 5 (Site-Wide Excavation): 7.9
- Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): 7.1
- Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): 6.4
- Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): 4.4
- Alternative 2 (Capping and Vertical Barrier): 4.0

6.2.3 Conclusion of Disproportionate Cost Analysis

Alternative 5 is considered the most permanent alternative developed in this FS per WAC 173-340-360(3)(e)(ii)(B) and is also the most expensive alternative. Alternative 5 consists of excavation of contaminated soil down to the native marine/river meander sediment layer and would remove nearly all contaminated soil at the Site, but the DCA shows that the cost of Alternative 5 is significantly disproportionate to the benefit. The complete DCA analysis is presented in Table 6-3 and the rankings and associated rationale for the various rankings are presented in Table 6-2. A relative cost and relative benefit analysis was also performed as part of the DCA. The results of the relative cost and benefit analysis are provided in graphical format on Figure 6-1, which compares the costs and benefits of each alternative.

To provide a direct quantitative metrics for comparison of the costs and benefits of each alternative, a benefit-to-cost ratio was calculated. The overall benefit score for each alternative was divided by the overall cost, then multiplied by the cost of the lowest cost alternative to normalize and scale the data to fit on the chart. The benefit-to-cost ratio for each of the alternatives was calculated to be:

- Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): 4.4
- Alternative 2 (Capping, Vertical Barrier, and Shoreline Excavation): 3.4
- Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): 6.2
- Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): 2.5
- Alternative 5 (Site-Wide Excavation): 1.2

Alternative 3 has the highest cost-to-benefit ratio over both higher and lower cost alternatives (as illustrated on Figure 6-1 that shows a peak in the benefit-to-cost ratio at Alternative 3). This indicates that more expensive alternatives are disproportionately costly to their incremental increase in benefits, and less costly alternatives have lower benefits that cannot be justified by the decrease in cost. Therefore, based on the DCA, Alternative 3, which includes *in situ* groundwater treatment with a PRB and excavation of contaminated soil along the shoreline, and containment of remaining contaminated soil with a cap and institutional controls, is permanent to the maximum extent practicable.

6.2.4 Restoration Time Frame

This section evaluates and compares the restoration time frame associated with each of the remedial alternatives. The restoration time frame is defined in MTCA as “the period of time needed to achieve the required cleanup levels at the points of compliance established for the site” (WAC 173-340-200). Per WAC 173-340-360(4)(b), the selected alternative must meet the cleanup levels within a reasonable time frame based on the eight factors for consideration identified in Section 6.1.3 to determine if the alternatives provide for a reasonable restoration time frame. A summary of the estimated restoration time frames for each remedial alternative and how each of the associated factors relates to “reasonableness” is summarized in Table 6-1. The estimated restoration time frame for each alternative is estimated to be as follows:

- Alternative 1 (Capping, Groundwater Extraction, and Shoreline Excavation): 3 years (assumes approximately 1 year for design/permitting/institutional controls, 1 year for construction and startup, and 1 year for groundwater downgradient of the CPOC to reach equilibrium below the pCULs). This alternative will also require long-term (assumed 50 years) groundwater monitoring.
- Alternative 2 (Capping and Vertical Barrier): 3 years (assumes approximately 1 year for design/permitting/institutional controls, 1 year for construction and startup, and 1 year for groundwater downgradient of the CPOC to reach equilibrium below the pCULs). This alternative will also require long-term (assumed 50 years) groundwater monitoring.
- Alternative 3 (*In Situ* Groundwater Treatment and Shoreline Excavation): 4 years (assumes approximately 1.5 years for design/permitting/institutional controls, 1.5 years for construction/excavation and site restoration, and 1 year for groundwater downgradient of the CPOC to reach equilibrium below the pCULs). This alternative will also require long-term (assumed 50 years) groundwater monitoring.
- Alternative 4 (Focused Excavation and *In Situ* Groundwater Treatment): 5 years (assumes approximately 1.5 years for design/permitting/institutional controls, 1.5 years for construction/excavation and site restoration, and 2 years for groundwater downgradient of the CPOC to reach equilibrium below the pCULs). This alternative will also require long-term (assumed 50 years) groundwater monitoring.
- Alternative 5 (Site-Wide Excavation): 6 years (assumes approximately 1.5 years for design/permitting, 2 years for construction/excavation and site restoration, and 2.5 years for groundwater at the standard POC to reach equilibrium below the pCULs).

For each of the alternatives, it is assumed that the remedy described in Section 5.2 will be successful in achieving the RAOs as planned/designed and that contingent actions are not required. Restoration time frames also do not include short- or long-term O&M, confirmation monitoring, or periodic reviews.

As indicated, each of the remedial alternatives would achieve the pCULs at the proposed points of compliance shortly after implementation of the alternative. Achievement of the cleanup standards for each alternative is considered to be within a reasonable restoration time frame. Note, however, that the restoration time frames for Alternatives 1 through 4 are only reasonable if a CPOC for groundwater is provided along the shoreline. If the groundwater pCUL for these alternatives were required to be met at the standard point of compliance (Site-wide), the restoration time frames would be indeterminately long due to the presence of the Stabilized Soil Area and contaminants in the former Slip 5 fill, which represent infinite sources of contaminants for all intents and purposes.

6.2.5 Requirement for Consideration of Public Concerns

As previously indicated, consideration of public concerns is an inherent part of the cleanup process under MTCA (see WAC 173-340-600). Prior to implementation of a cleanup action, Ecology will issue a Cleanup Action Plan for public comment as specified in WAC 173-340-380. Under this process, the RI and FS reports, and the Cleanup Action Plan will be available for public review as part of the comment period for the agreed order under the Ecology formal program.

6.2.6 Supplemental Remedial Alternative Evaluation and Disproportionate Cost Analysis

In addition to the remedial alternatives evaluation discussed in the previous sections, Ecology also required Boeing to evaluate one additional remedial alternative (Ecology 2023) not included in previous drafts of this FS, that is similar to Alternative 1 but includes a slurry wall hydraulic barrier along the LDW shoreline for enhanced containment (designated Alternative 1B) and compare it against Alternative 3. Discussion and results of this focused evaluation and comparison, including a supplemental DCA, are included in Appendix G. As discussed in Appendix G, the results of the supplemental evaluation and DCA confirmed that Alternative 3 is permanent to the maximum extent practicable when compared to Alternative 1B (as well as the other Alternatives evaluated in this FS as discussed in Sections 6.2.3 and 7.0).

7.0 PREFERRED CLEANUP ACTION

Based on this FS, including the DCA discussed in Section 6.2.3, the preferred remedial action alternative for the Site is Alternative 3, which consists of excavation of contaminated soil from the northwestern portion of the Site downgradient of the CPOC (including the Port Property) and the Observed Tar-Like Substance Area, *in situ* groundwater treatment upgradient of the shoreline CPOC using a ZVI PRB, a low-permeability cap over remaining soil contamination, institutional controls, and groundwater monitoring.

Alternative 3 physically removes some of the Site soil contamination; however, the majority of the contaminated soil (including the Stabilized Soil Area and most of the Former Slip 5 fill material) will remain in place. Alternative 3 relies on *in situ* treatment processes that will take place via groundwater flow through the PRB to protect the groundwater to surface water pathway, and site capping and institutional controls to protect humans from direct contact exposures.

Selection of this alternative over Alternatives 1, 2, 4, and 5 is primarily based on the following:

- Alternative 3 achieves each of the two RAOs and each of the threshold requirements, uses permanent solutions to the maximum extent practicable as described in Section 6.2.3, and provides for a reasonable restoration time frame as described in Section 6.2.4.
- Focused excavation of soil along the shoreline permanently removes contaminated soil along the Site's shoreline and protects sediments from migration of contaminated soil.
- Installation of a PRB (containing a mix of ZVI and GAC) upgradient of the CPOC provides long-term groundwater treatment for Site IHS and reduces the risk of contaminant migration from Site groundwater to the Duwamish Waterway.
- Maintaining and repairing Site pavement will provide a cap over remaining contamination and prevent human contact with contaminated soil and groundwater. The cap will also limit surface water infiltration and, thereby, limit potential contaminant leaching and migration.
- As discussed in Section 6.2.3, the DCA, Alternative 3 is proportionate to its benefits and is permanent to the maximum extent practicable.

8.0 USE OF THIS REPORT

This Feasibility Study has been prepared for the exclusive use of The Boeing Company and applicable regulatory agencies for specific application to the Isaacson-Thompson Site. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

9.0 REFERENCES

Alpha Engineers. 1989. Final Report, Thompson-Isaacson Seawall, Boeing Advanced Systems, Tukwila, Washington. December 29.

Ecology. 2015. "Dioxins, Furans, and Dioxin-Like PCB Congeners: Addressing Non-Detects and Establishing PQLs for Ecological Risk Assessments in Upland Soil, Implementation Memorandum #11, Publication No. 15-09-048 (July 2015)." Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/documents/1509048.pdf.

Ecology. 2017a. Letter: Ecology Request to Proceed with the Feasibility Study for Boeing Isaacson-Thompson Site, Agreed Order No. DE 7088. Washington State Department of Ecology. May 11.

Ecology. 2017b. Adaptation Strategies for Resilient Cleanup Remedies: A Guide for Cleanup Project Managers to Increase the Resilience of Toxic Cleanup Sites to the Impacts from Climate Change. Publication No. 17-09-05. Washington State Department of Ecology. November.

Ecology. 2018. Lower Duwamish Waterway Preliminary Cleanup Level Workbook Supplemental Information. Washington State Department of Ecology. December.

Ecology. 2019. Lower Duwamish Waterway Preliminary Cleanup Level Workbook. Washington State Department of Ecology. April.

Ecology. 2020. Lower Duwamish Waterway Source Control Status Report 2018. Publication No. 20-09-172. Washington State Department of Ecology. June.

Ecology. 2021. Draft, Natural Background Arsenic Concentrations in Washington State. Washington State Department of Ecology. https://ecology.wa.gov/Events/TCP/Program-and-Policy/Study-Results-of-Natural-Background-Groundwater-Ar. July.

Ecology. 2023. Letter: Ecology Comments on the Feasibility Study Report Final – For Public Review, Isaacson-Thompson Site, Tukwila, Washington, Agreed Order No. DE-7088, dated August 5, 2022. From David Butler, Washington State Department of Ecology, to Joe Flaherty, The Boeing Company. January 31.

EPA. 1980. Sulfide Precipitation of Heavy Metals, EPA-600/2-80-139. US Environmental Protection Agency. June

EPA. 1995. Manual: Bioventing Principles and Practice. Volume I: Bioventing Principles. EPA/540/R-95/534a. US Environmental Protection Agency. September.

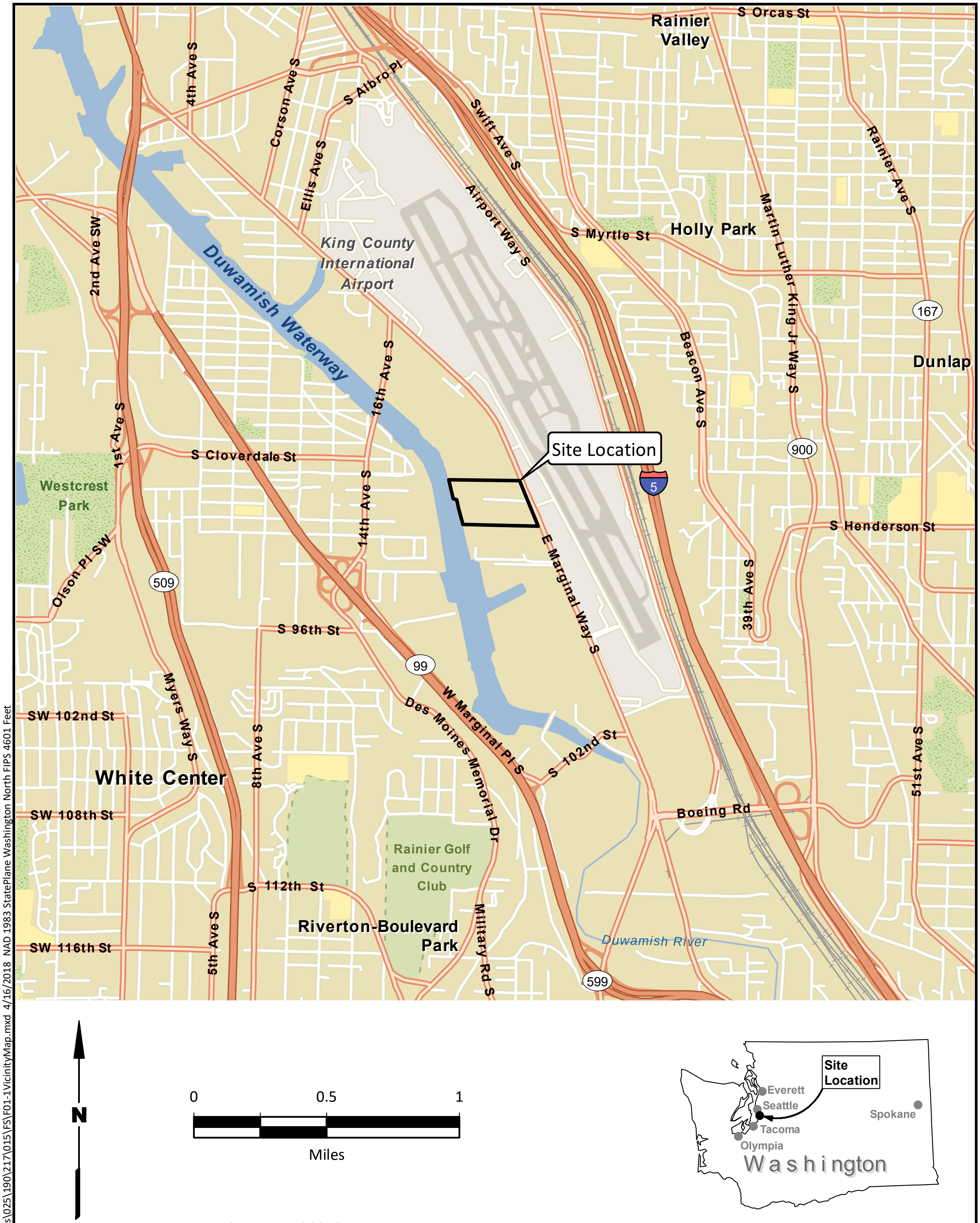
EPI, Floyd-Snyder, and Golder Associates. 2006. Technical Memorandum: Development and Use of Background Values, Boeing Plant 2, Seattle/Tukwila, Washington. Environmental Partners, Inc. (EPI), Floyd-Snyder, and Golder Associates, Inc. March 30.

GeoEngineers. 1994. Report: Report of Geotechnical Services, Subsurface Investigation, Oil/Water Separator Area, Building 14-03, Thompson-Isaacson Facility, Seattle, Washington. March 13.

LAI. 2014. Final Remedial Investigation Report, Boeing Isaacson-Thompson Site, Tukwila, Washington (Volumes 1 and 2). Landau Associates, Inc. April 21.

Shannon & Wilson. 2019. Public Review Draft Interim Action Work Plan, 8801 East Marginal Way S., Tukwila, Washington, Agreed Order No. 6069. Shannon & Wilson, Inc. June 7.

Smedley, P.L. and D.G. Kinniburgh. 2002. "A Review of the Source, Behaviour and Distribution of Arsenic in Natural Waters." Applied Geochemistry, vol. 17, pp 417-568.



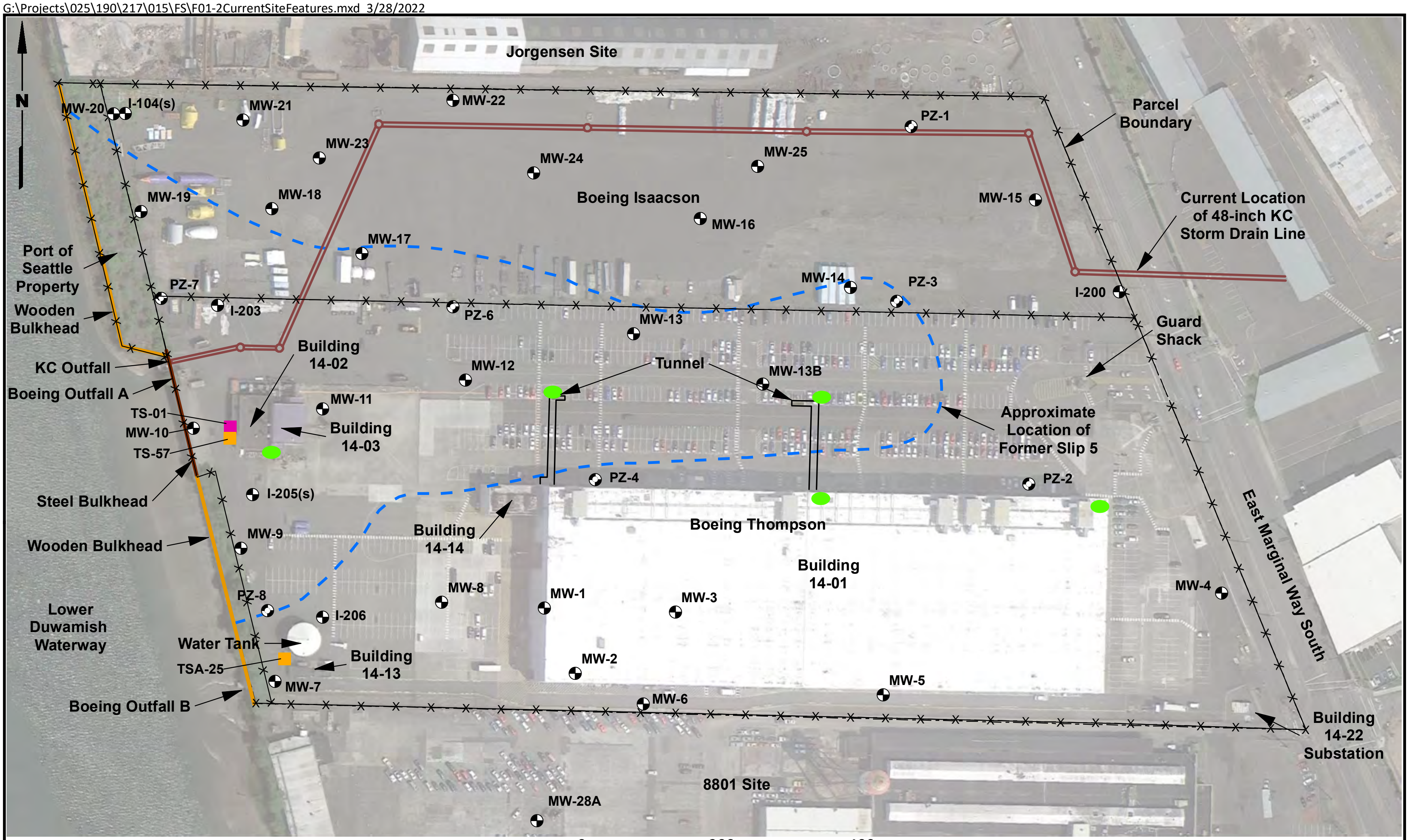
Data Source: Esri 2012

G:\Projects\025\190\217\015\FS\F01-1VicinityMap.mxd 4/16/2018 NAD 1983 StatePlane Washington North FIPS 4601 Feet

Landau Associates

Boeing Isaacson-Thompson Site Tukwila, Washington	**Vicinity Map**	Figure 1-1

G:\Projects\025\190\217\015\FS\F01-2CurrentSiteFeatures.mxd 3/28/2022



0 200 400

Scale in Feet

Data Sources: Google Earth Pro 2012; King County Parcel Data.

Legend

- ● Monitoring Well
- ◐ Piezometer
- ×—× Fence
- 🟧 Aboveground Storage Tank
- 🟪 Underground Storage Tank
- 🟢 Sump

Note

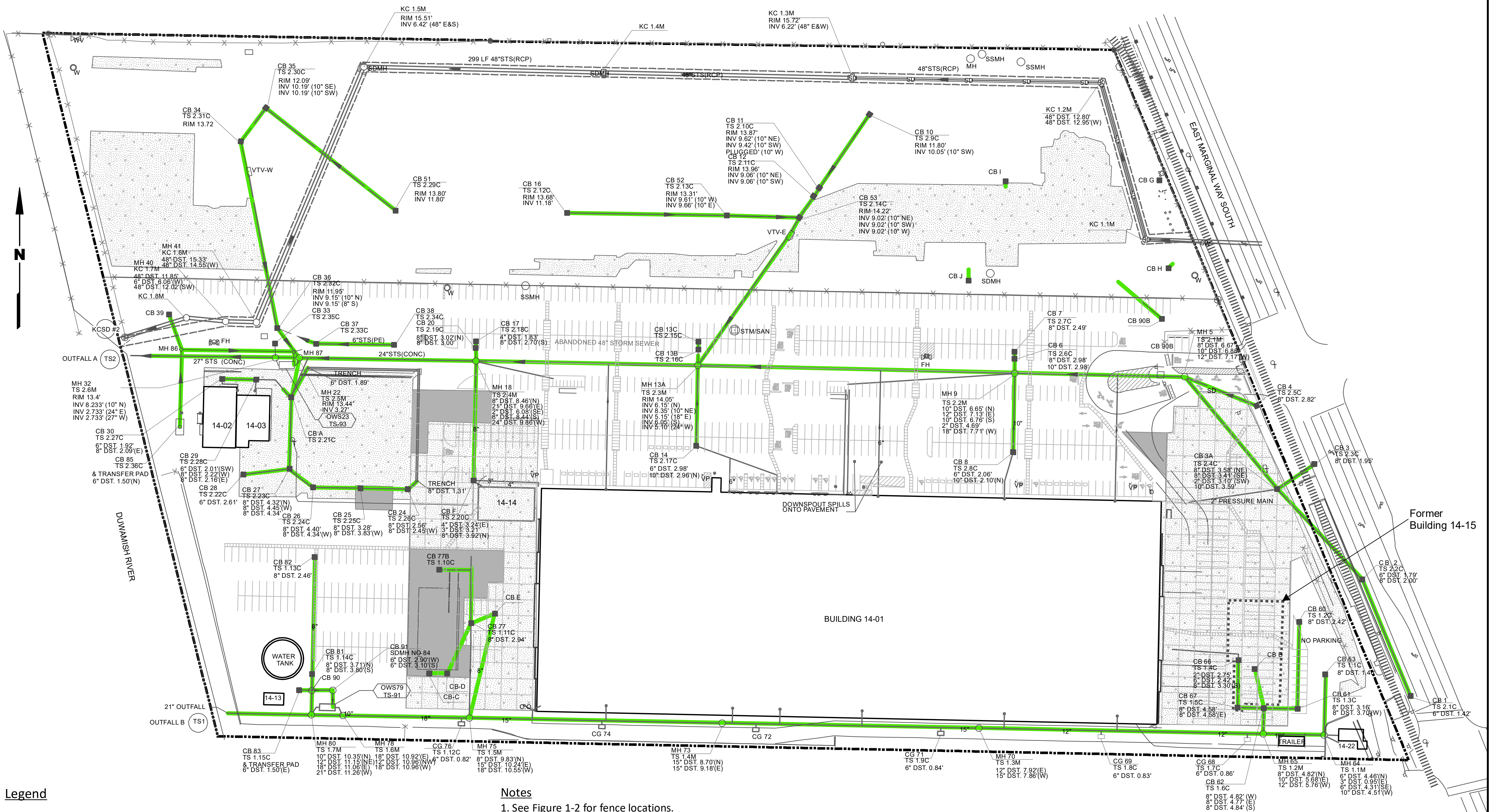
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Current Site Features

Figure
1-2



Legend

■ Existing Catch Basin
▬ Existing Storm Drain Line
-··- Boeing Property Boundary
▩ New Concrete (Replaced 2011)
▒ Concrete Area
⬚ Former Building

Notes

1. See Figure 1-2 for fence locations.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 120 240
Scale in Feet

Data Source: Boeing 2012

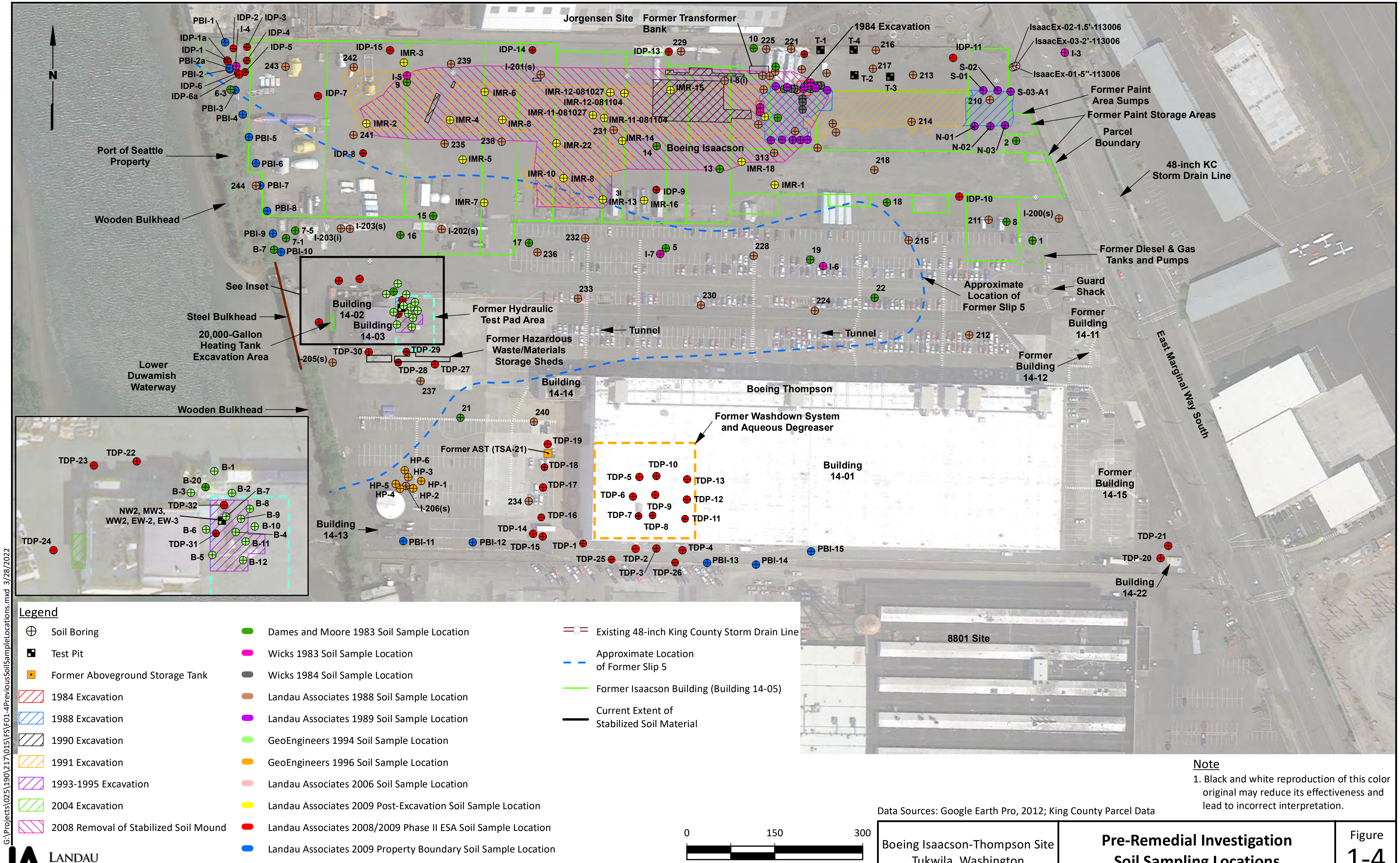
Boeing Isaacson-Thompson Site
Tukwila, Washington

Current Storm Drain System

Figure
1-3

LANDAU ASSOCIATES

G:\Projects\025\190\217\015\FS\F01-3CurrentStormDrainSystem.mxd 4/14/2018



G:\Projects\025\190\217\015\FS\F01-4PreviousSoilSampleLocations.mxd 3/28/2022

Data Sources: Google Earth Pro, 2012; King County Parcel Data

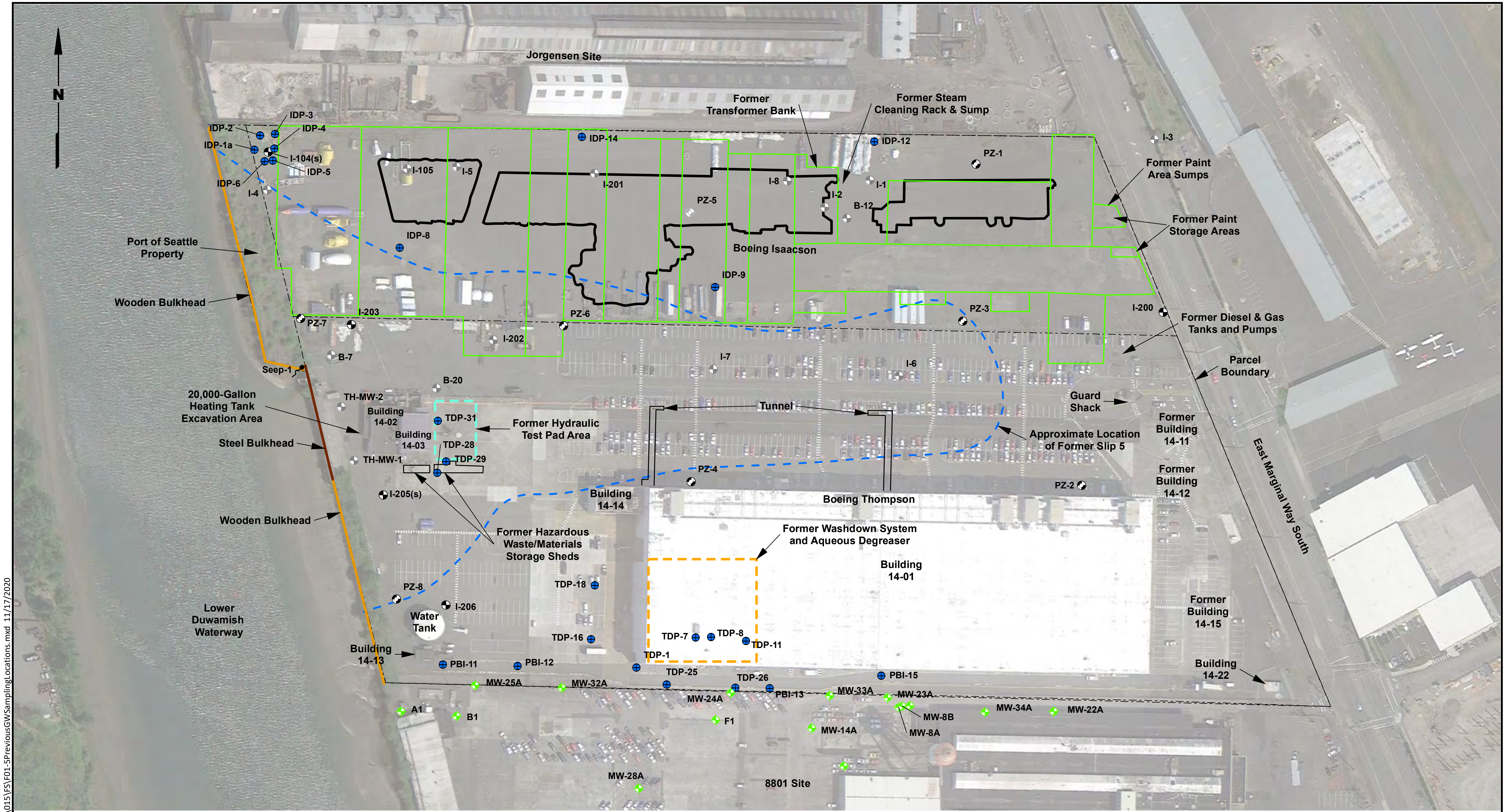
Note
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Landau Associates

Boeing Isaacson-Thompson Site
Tukwila, Washington

Pre-Remedial Investigation
Soil Sampling Locations

Figure
1-4



Legend

● Direct-Push Groundwater Sample Location

● Existing Monitoring Well Location

● Existing Piezometer Location

● Decommissioned or Destroyed Monitoring Well

● 8801 Site Groundwater Sampling Locations

Seep

- - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

— Former Isaacson Building/Building 14-05

0 150 300
Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

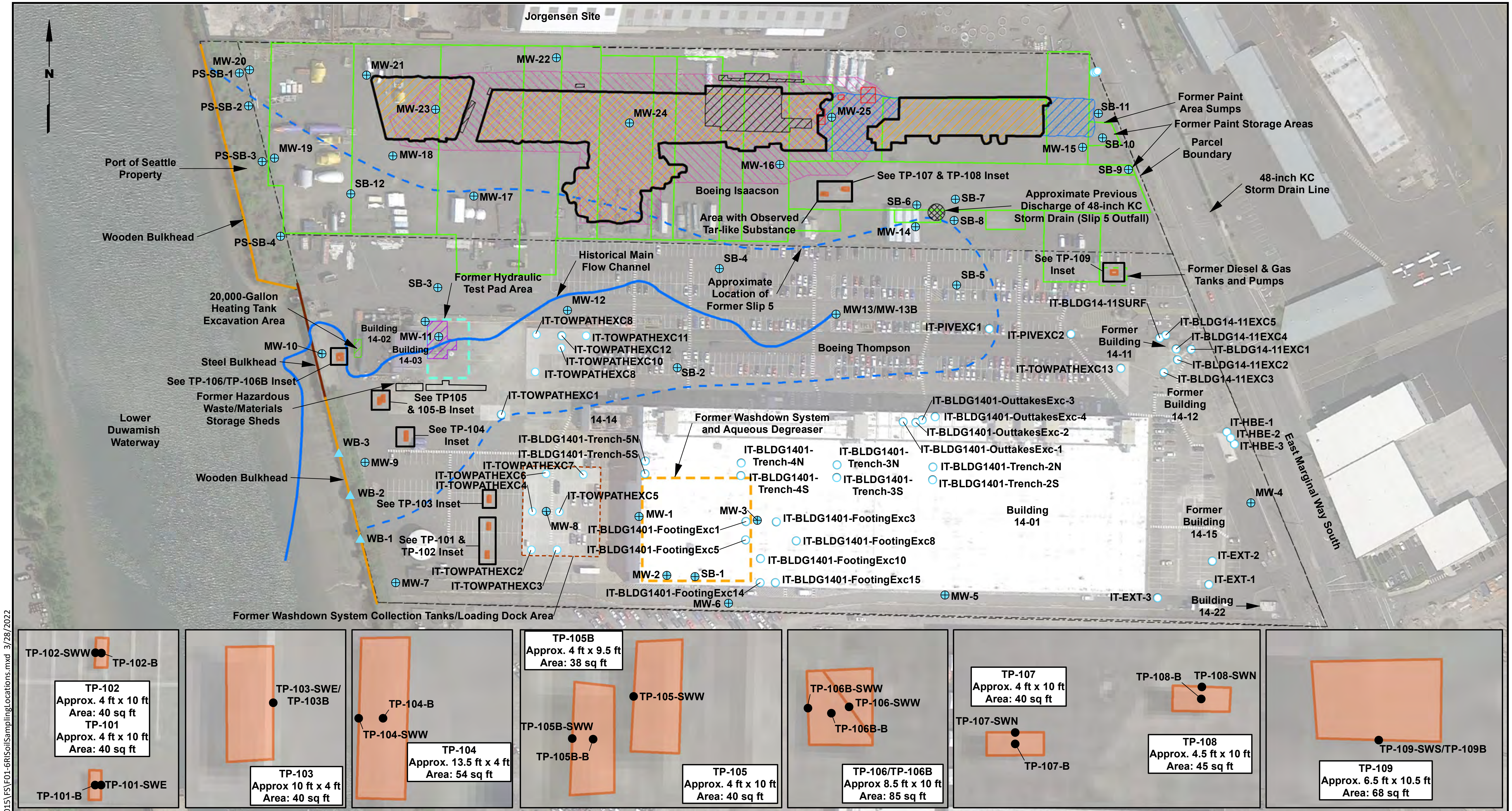
LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Pre-Remedial Investigation Groundwater Monitoring Locations

Figure
1-5

G:\Projects\025\190\217\015\FS\F01-5PreviousGWSamplingLocations.mxd 11/17/2020



G:\Projects\025\190\217\015\FS\F01-6RISoilSamplingLocations.mxd 3/28/2022

Legend

- ⊕ RI Soil Boring Sample Location
- 🟧 RI Test Pit Soil Sampling Location
- ○ RI Construction-Related Soil Sample Location
- ▲ RI Wooden Bulkhead Sample Location
- ▨ 1984 Excavation
- ▨ 1988 Excavation
- ▨ 1990 Excavation
- ▨ 1991 Excavation
- ▨ 1993-1995 Excavation
- ▨ 2004 Excavation
- ▨ 2008 Removal of Stabilized Soil Mound
- — Former Isaacson Building/ Building 14-05
- — Current Extent of Stabilized Soil Material
- - - Approximate Location of Former Slip 5

0 150 300

Scale in Feet

Notes

1. MW-13/MW-13B borings were advanced, but no wells were installed at these locations because of an obstruction. The actual monitoring well MW-13 was installed near boring location SB-4.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

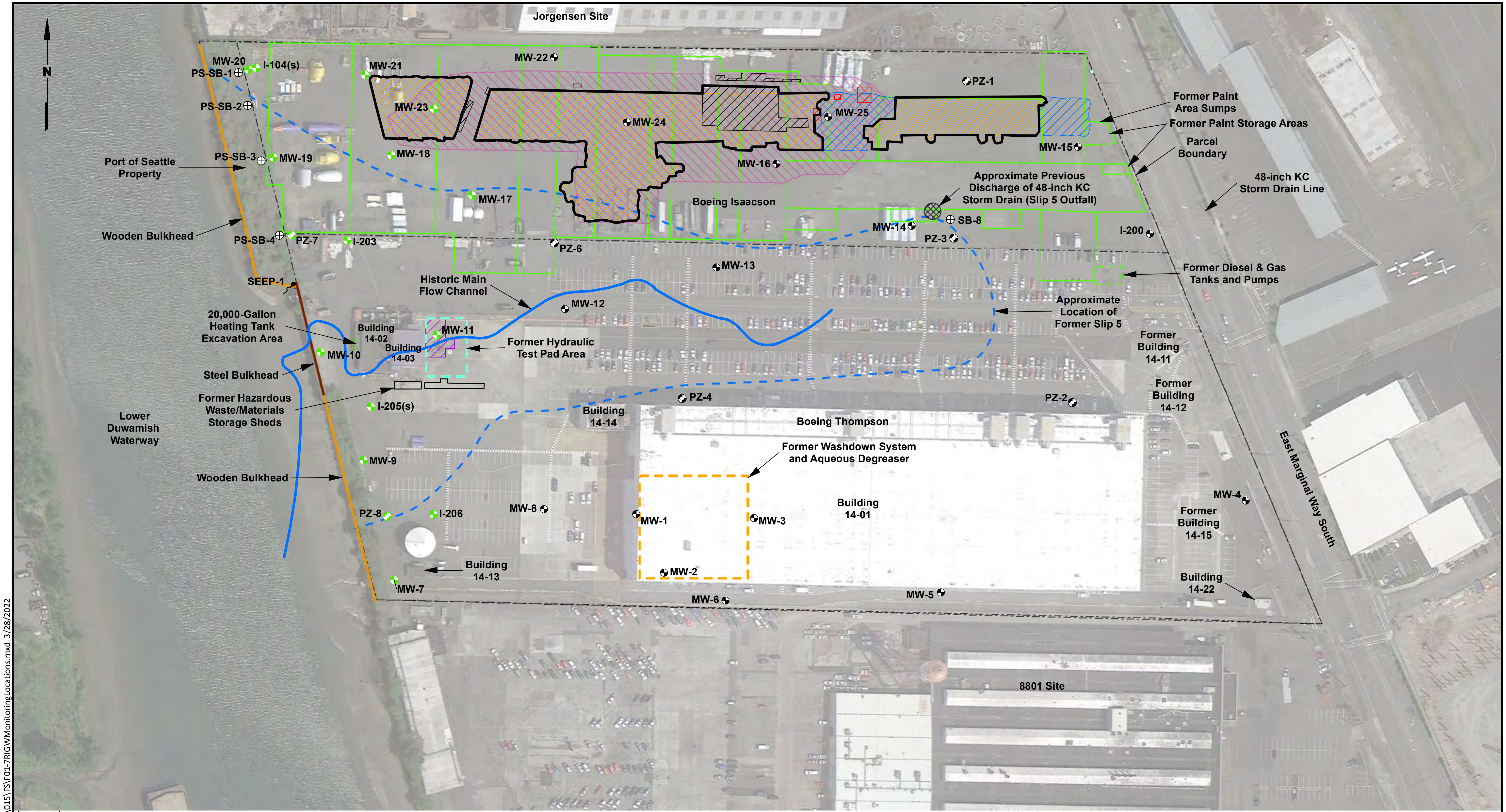
LANDAU ASSOCIATES

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Boeing Isaacson-Thompson Site
Tukwila, Washington

RI Soil Sampling Locations

Figure
1-6



Legend

MW-22 Monitoring Well Location

MW-10 Monitoring Well Location Where Groundwater Sampling Occured 1 Hour Before Low Tide and 1 Hour After a 0.0 Tide

PZ-1 Piezometer Location

PZ-7 Piezometer Location Where Groundwater Sampling Occured 1 Hour Before Low Tide and 1 Hour After a 0.0 Tide

SB-8 Direct-Push Boring Groundwater Sample Location

SEEP-1 Seep

▨ 1984 Excavation

▨ 1988 Excavation

▨ 1990 Excavation

▨ 1991 Excavation

▨ 1993-1995 Excavation

▨ 2004 Excavation

🟩 2008 Removal of Stabilized Soil Mound

Current Extent of Stabilized Soil Material

Former Isaacson Building (Building 14-05)

Approximate Location of Former Slip 5

0 150 300

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

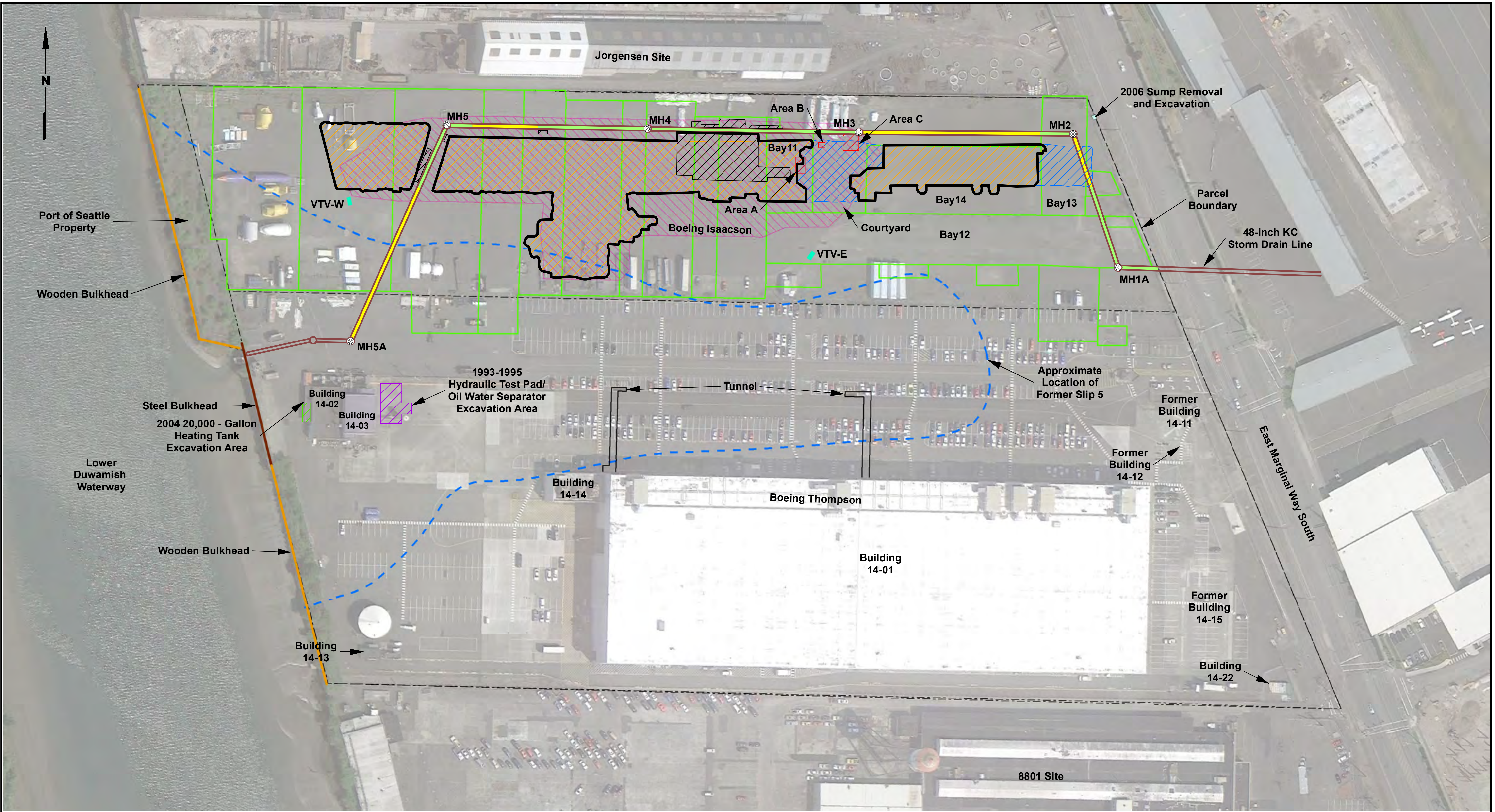
LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

RI Groundwater Monitoring Locations

Figure
1-7

G:\Projects\025\190\217\015\FS\F01-7RIGWMonitoringLocations.mxd 3/28/2022



Legend

- ▨ 1984 Excavation
- ▨ 1988 Excavation
- ▨ 1990 Excavation
- ▨ 1991 Excavation
- ▨ 1993-1995 Excavation
- ▨ 2004 Excavation
- ▨ 2008 Removal of Stabilized Soil Mound
- ■ Vortechs Treatment System Vaults
- - - Approximate Location of Former Slip 5
- — Former Isaacson Building/ Building 14-05
- 🟩 Backfilled with Imported Soil
- 🟨 Backfilled with Site Excavated Soil < 500 ppm Arsenic
- — Current Extent of Stabilized Soil Material

0 130 260

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

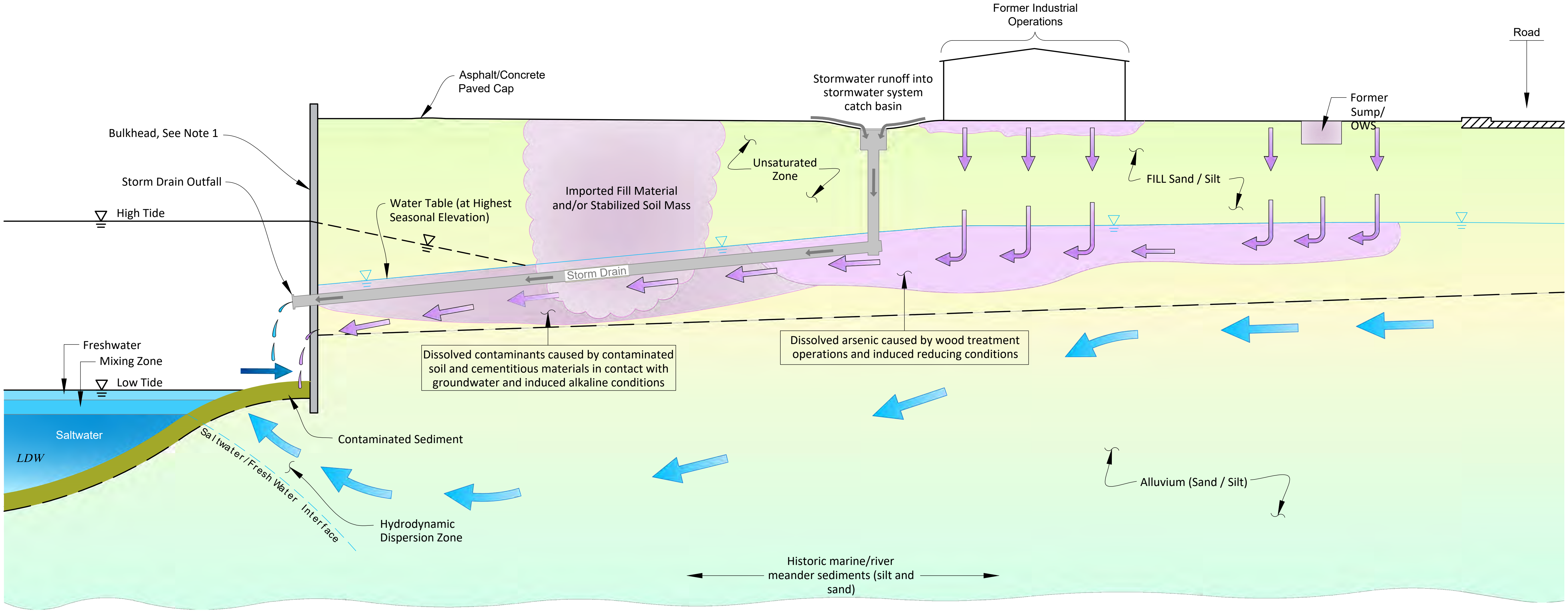
G:\Projects\025\190\217\015\FS\F01-8PreviousRemediationAreas.mxd 3/28/2022

LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Previous Remediation Areas

Figure
1-8



Legend

- ▽ Water Table
- ▽ Tidally Influenced Water Level
- — — Conceptual Boundary Between Stratigraphic Units
- ⬅ Potential Transport of Dissolved Contaminants
- ⬅ Potential Transport of Dissolved Contaminants
- ➡ LDW Water Intrusion

Notes

1. Gaps in portions of the wooden bulkhead (which is not a solid structure) that may allow groundwater seepage through holes.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Summary of Potential Receptors and Exposure Pathways

Contaminated Media	Potential Receptors			Potential Exposure Pathways		
	Human	Terrestrial Ecological	Aquatic Ecological	Direct Contact	Ingestion	Inhalation
Soil	✓			✓(a)		
Ground Water	✓			✓(b)	○	
Surface Water	✓	✓	✓	✓	✓(d)	
Sediment (c)	✓	✓	✓	✓	✓(d)	
Soil Gas/Air	✓					○

Abbreviations and Acronyms:

✓ = potential receptor/complete exposure pathway

○ = incomplete exposure pathway

Blank = no applicable receptors or exposure pathways

Notes

(a) Site soil covered with asphalt/concrete cap or buildings, exposure risk only for utility workers during intrusive activities.

(b) (b) Shallow groundwater exposure risk for construction workers is present during intrusive activities

(c) Note that while stormwater/stormwater solids from the onsite stormwater management system and sediments adjacent to the Site were investigated during the remedial investigation (RI), any necessary source control and/or cleanup thereof will be addressed under the requirements of the site Industrial Stormwater General Permit (ISGP) or Lower Duwamish Waterway (LDW) sediment cleanup.

(d) Direct uptake or consumption of aquatic organisms.

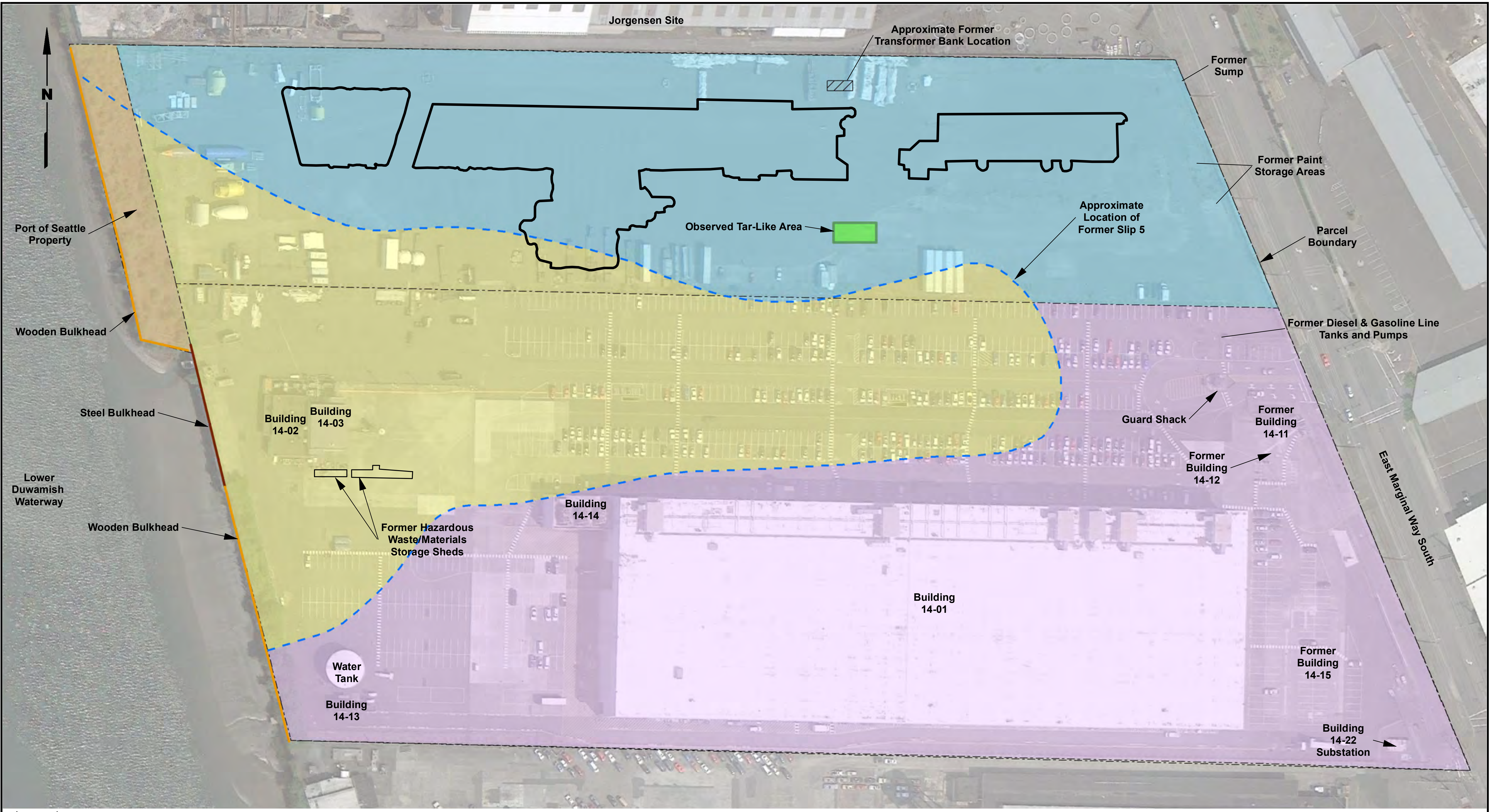
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Conceptual Site Model

Figure
3-1a

LANDAU ASSOCIATES, INC. | G:\Projects\025\190\218\015\F03-1a CSM.dwg | 11/19/20



Legend

🟨 Former Slip 5 Area

🟦 North of Former Slip 5 Area

🟧 Port of Seattle Property

🟪 South of Former Slip 5 Area

🟩 Observed Tar-Like Area

— Current Extent of Stabilized Soil Material

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Source: Google Earth Pro, 2012; King County Parcel Data

0 120 240

Scale in Feet

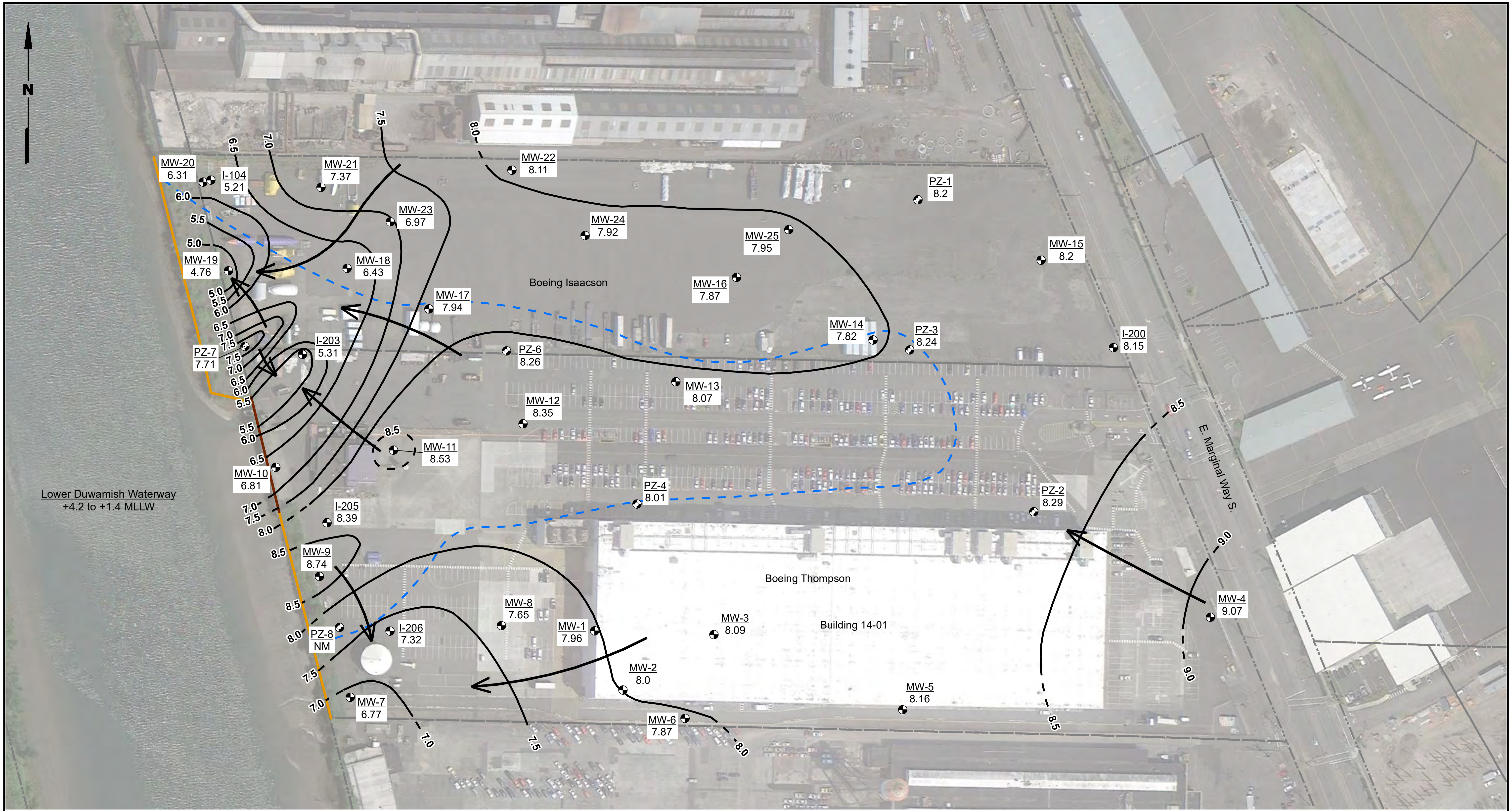
LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Site Environmental Areas

Figure
3-1b

G:\Projects\025\190\218\015\F03-1bSiteEnvironmentalAreas.mxd 9/18/2019



Legend

●	MW-10 6.81	Monitoring Well Location and Groundwater Elevation (ft, MLLW)
●	PZ-1 8.2	Piezometer Location and Groundwater Elevation (ft, MLLW)

—— Groundwater Contours (FT, MLLW)

→ Estimated Direction of Groundwater Flow

King County Parcels

Approximate Location of Former Slip 5

Wooden Bulkhead

Steel Bulkhead

Notes

1. Groundwater levels were measured on 12/5/11 between 17:25 and 19:20. Estimated surface water levels ranged from +4.2 to +1.4 ft, MLLW between 17:25 and 19:20 on 12/5/11.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 150 300

Scale in Feet

Data Sources: Boeing, 2012; King County GIS, 2010; Google Earth Pro, 2012.

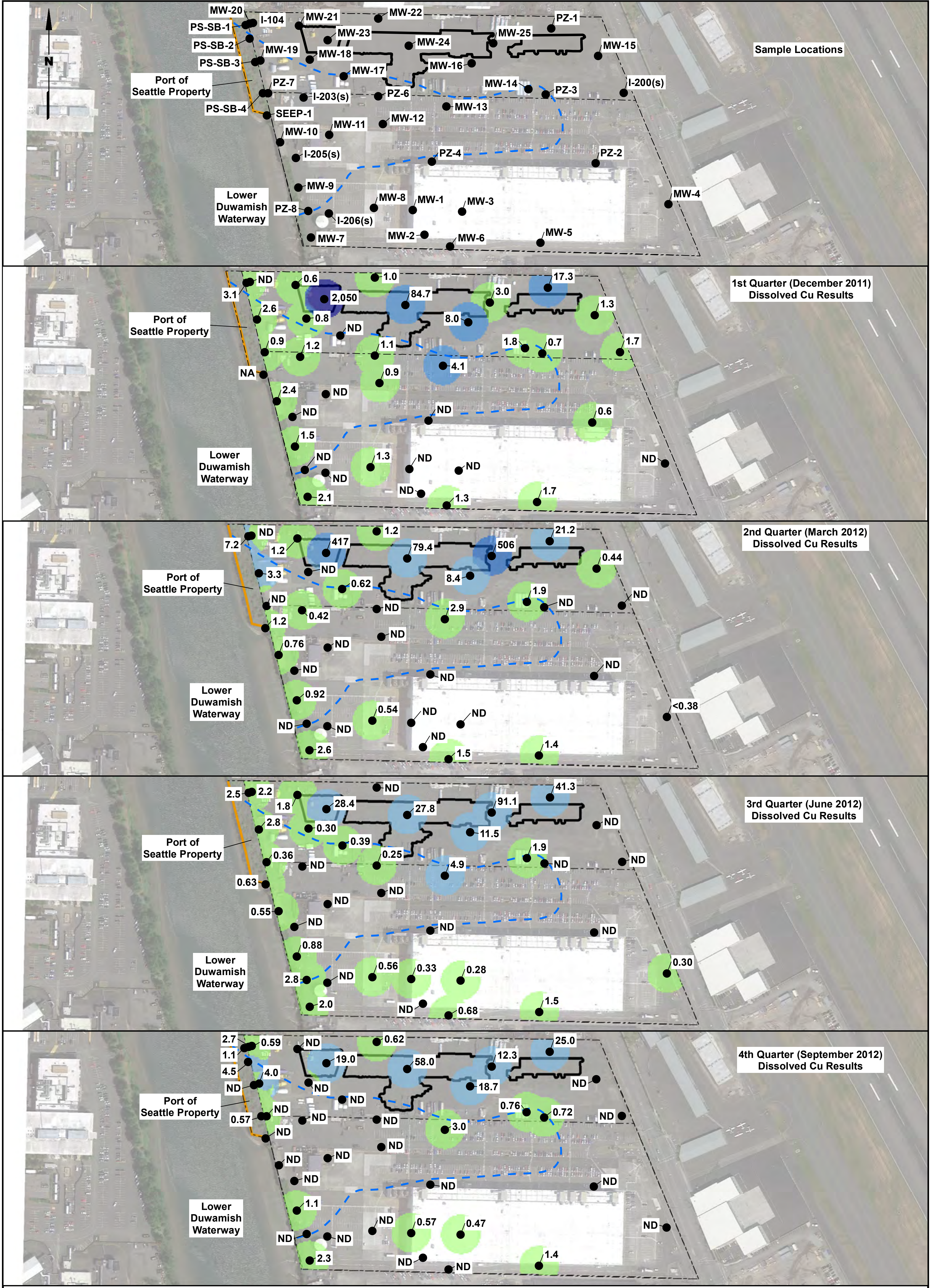
LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Groundwater Elevation Contours
December 5, 2011

Figure
3-1c

G:\Projects\025\190\218\015\F03-2DissolvedCuConcentrations.mxd 4/9/2022



Legend

● Groundwater Sampling Locations

- - - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentrations (µg/L)

🟩 ≤3.1 (pCUL)

🟦 3.1-100

🟦 100-500

🟦 500-1,000

🟪 1,000+

Notes

1. All results shown are reported in µg/L.
2. The preliminary cleanup level (pCUL) for copper in groundwater is 3.1 µg/L.
3. Groundwater samples from direct push borings were collected on the Port Property on 8/27/2013.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 350 700

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

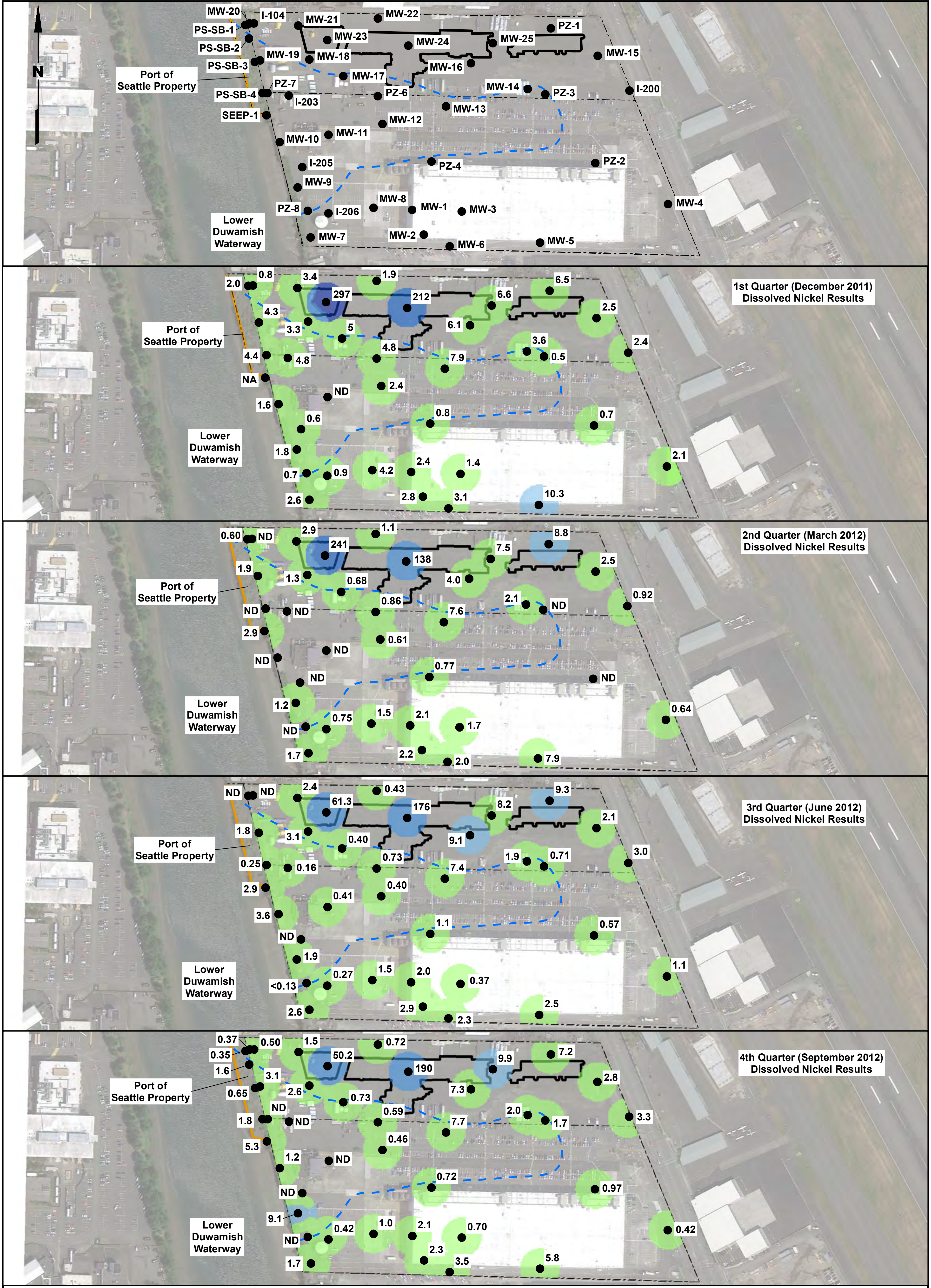
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Dissolved Copper Concentrations in Groundwater

Figure
3-2

G:\Projects\025\190\218\015\F03-3DissolvedNiConcentrations.mxd 9/17/2019



Legend

- ● Groundwater Sampling Locations
- - - Approximate Location of Former Slip 5
- ▬ Current Extent of Stabilized Soil Material

Detected Concentrations (µg/L)

- 🟩 ≤8.2 (pCUL)
- ▨ 8.2-15
- ▨ 15-200
- ▨ 200-275
- ▨ 275+

Notes

1. All results shown are reported in µg/L.
2. The preliminary cleanup level for nickel in groundwater is 8.2 µg/L.
3. Groundwater samples from direct push borings were collected on the Port Property on 8/27/2013.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 350 700

Scale in Feet

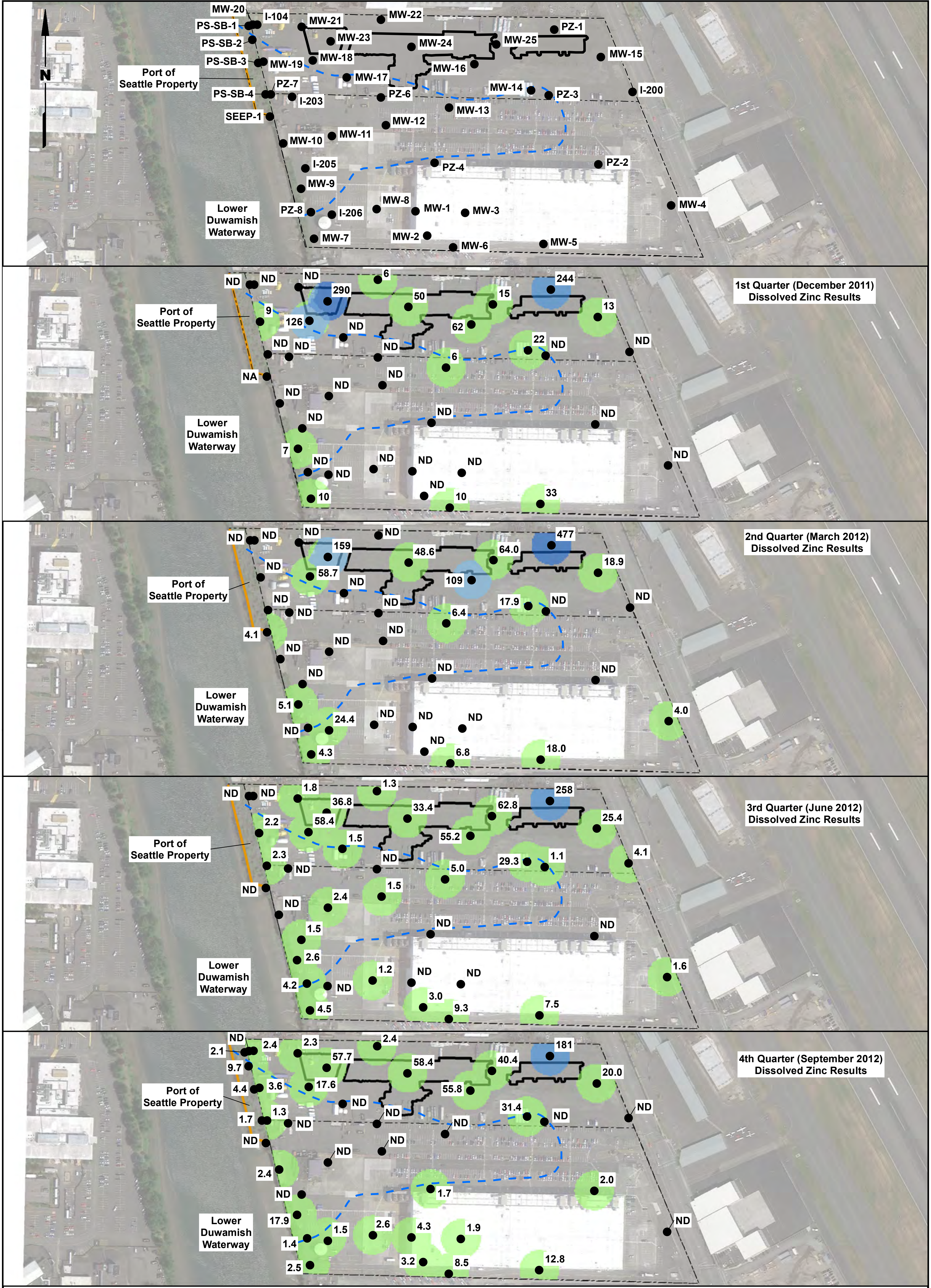
Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final RI Boeing I-T (April 2014)

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Dissolved Nickel Concentrations in Groundwater

Figure
3-3



Legend

●	Groundwater Sampling Locations
– –	Approximate Location of Former Slip 5
—	Current Extent of Stabilized Soil Material

Detected Concentrations (µg/L)

🟩	≤81 (pCUL)
🟦	81-165
🟦	165-265
🟦	265-365
🟦	365+

Notes

1. All results shown are reported in µg/L.
2. The preliminary cleanup level for zinc in groundwater is 81 µg/L.
3. Groundwater samples from direct push borings were collected on the Port Property on 8/27/2013.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 350 700
Scale in Feet

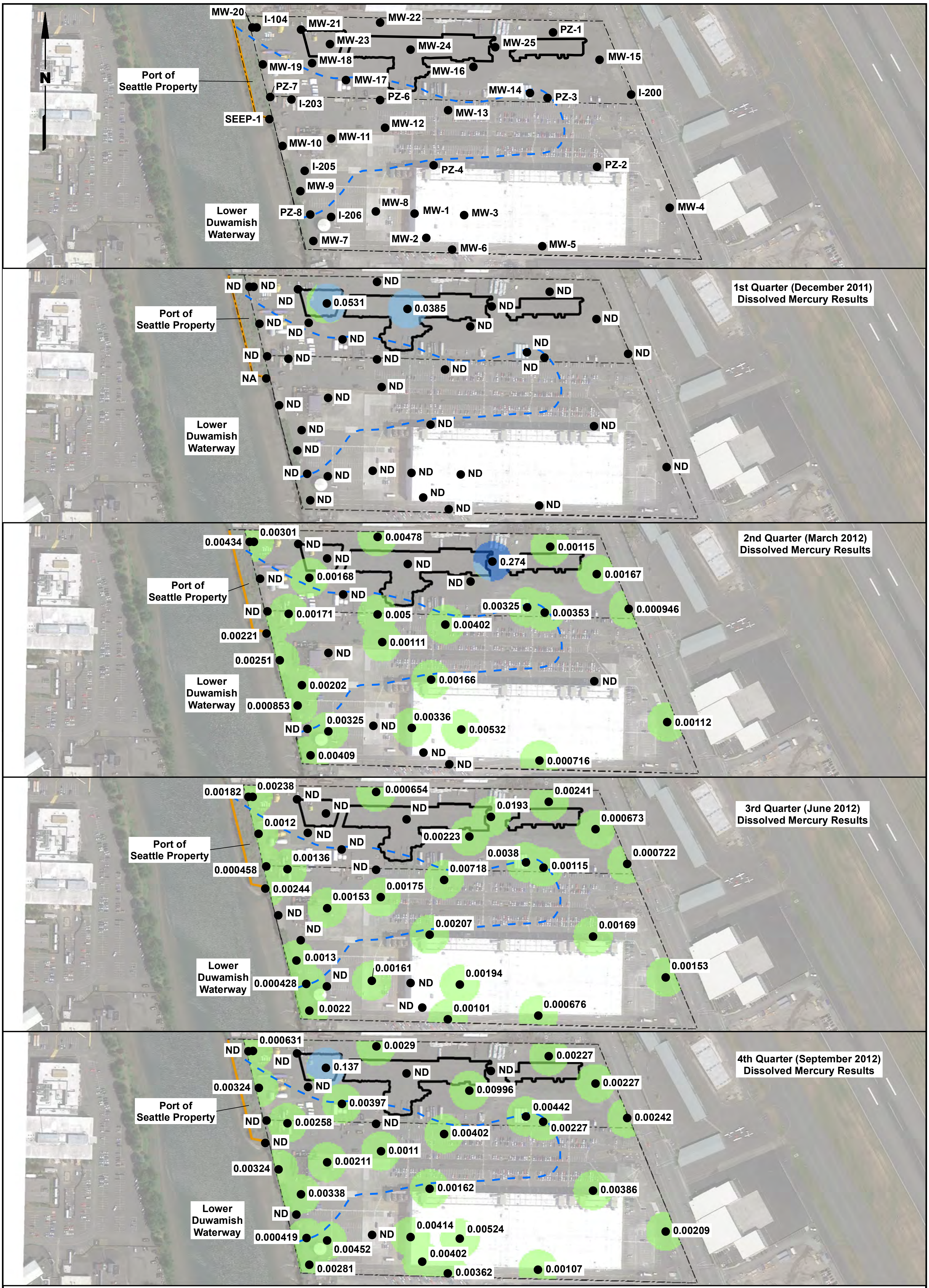
Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final RI Boeing I-T (April 2014)

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Dissolved Zinc Concentrations in Groundwater

Figure
3-4



Legend

● Groundwater Sampling Locations

Approximate Location of Former Slip 5

Current Extent of Stabilized Soil Material

Detected Concentrations (µg/L)

🟩 ≤0.025

🟦 0.025-0.25

🟦 0.25+

Notes

1. All results shown are reported in µg/L.
2. The preliminary cleanup level for mercury in groundwater is 0.025 µg/L.
3. Groundwater samples from direct push borings were collected on the Port Property on 8/27/2013.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 350 700

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

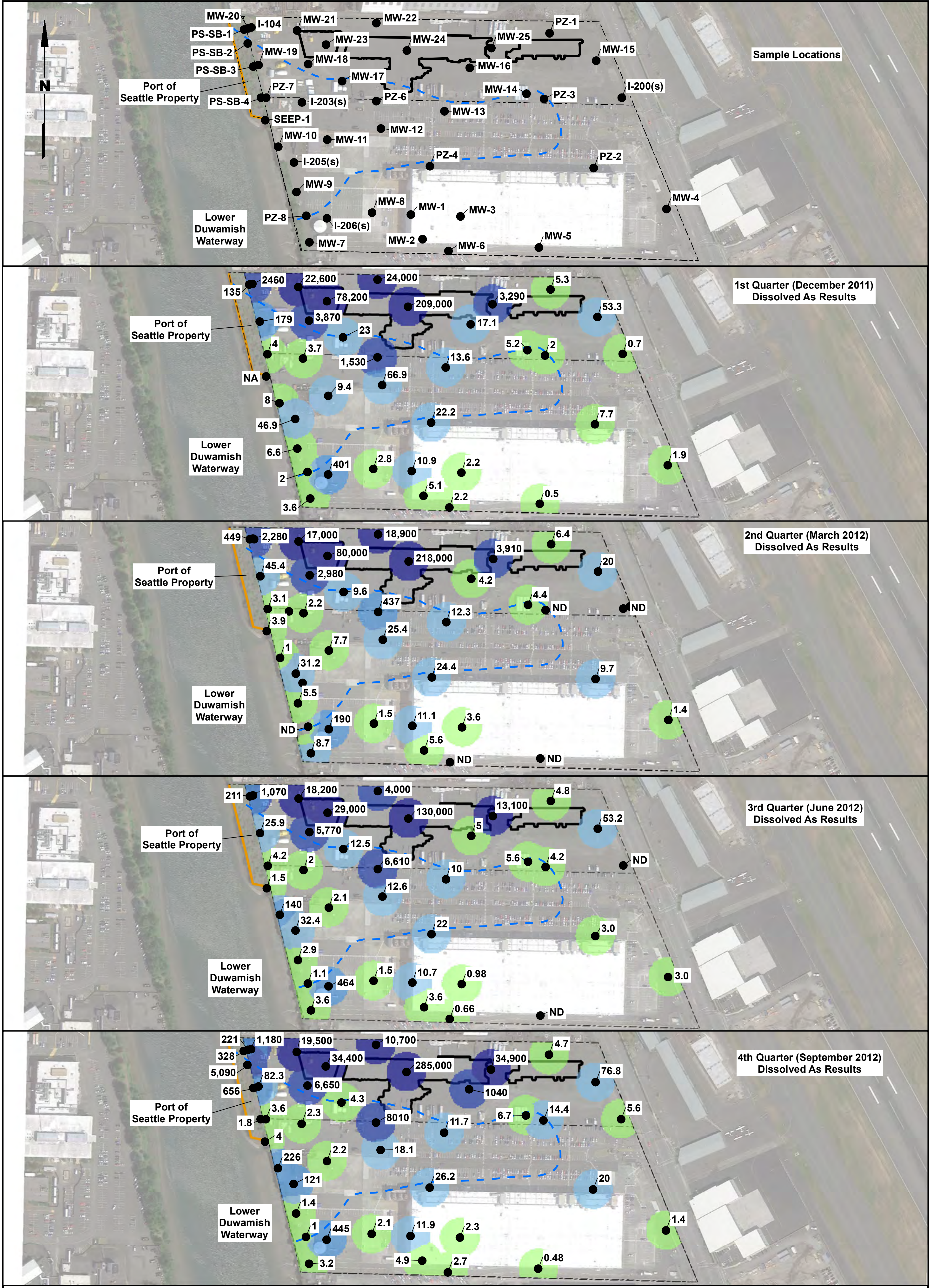
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Dissolved Mercury Concentrations in Groundwater

Figure
3-5

G:\Projects\025\190\218\015\F03-6DissolvedAsConcentrations.mxd 9/17/2019



Legend

● Groundwater Sampling Locations

- - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentrations (µg/L)

🟩 ≤8 µg/L (pCUL)

🟦 8-100 µg/L

🟦 100-500 µg/L

🟦 500-1,000 µg/L

🟦 1000-10,000 µg/L

🟦 10,000+ µg/L

Notes

1. All results shown are reported in µg/L.
2. The preliminary cleanup level for arsenic in groundwater is 8 µg/L.
3. Groundwater samples from direct push borings were collected on the Port Property on 8/27/2013.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 350 700

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final RI Boeing I-T (April 2014)

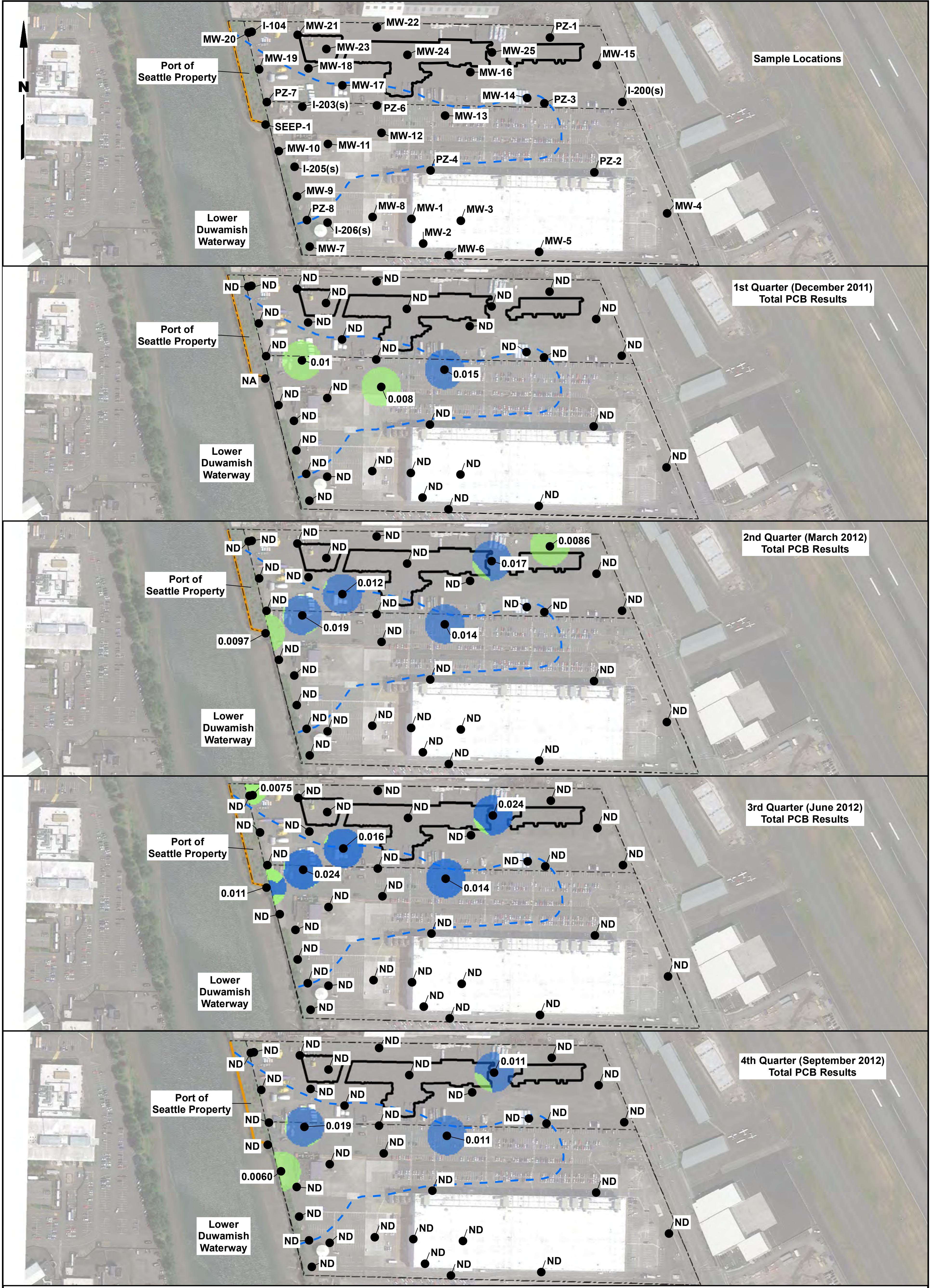
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Dissolved Arsenic Concentrations in Groundwater

Figure
3-6

G:\Projects\025\190\218\015\F03-7GWPCBConcentrations.mxd 9/17/2019



Legend

● Groundwater Sampling Locations

- - - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentrations (µg/L)

🟩 ≤0.01 µg/L (pCUL)

🟦 0.01+

Notes

1. All results shown are reported in µg/L.
2. The preliminary cleanup level for total PCBs in groundwater is 0.01 µg/L.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final RI Boeing I-T (April 2014)

0 350 700

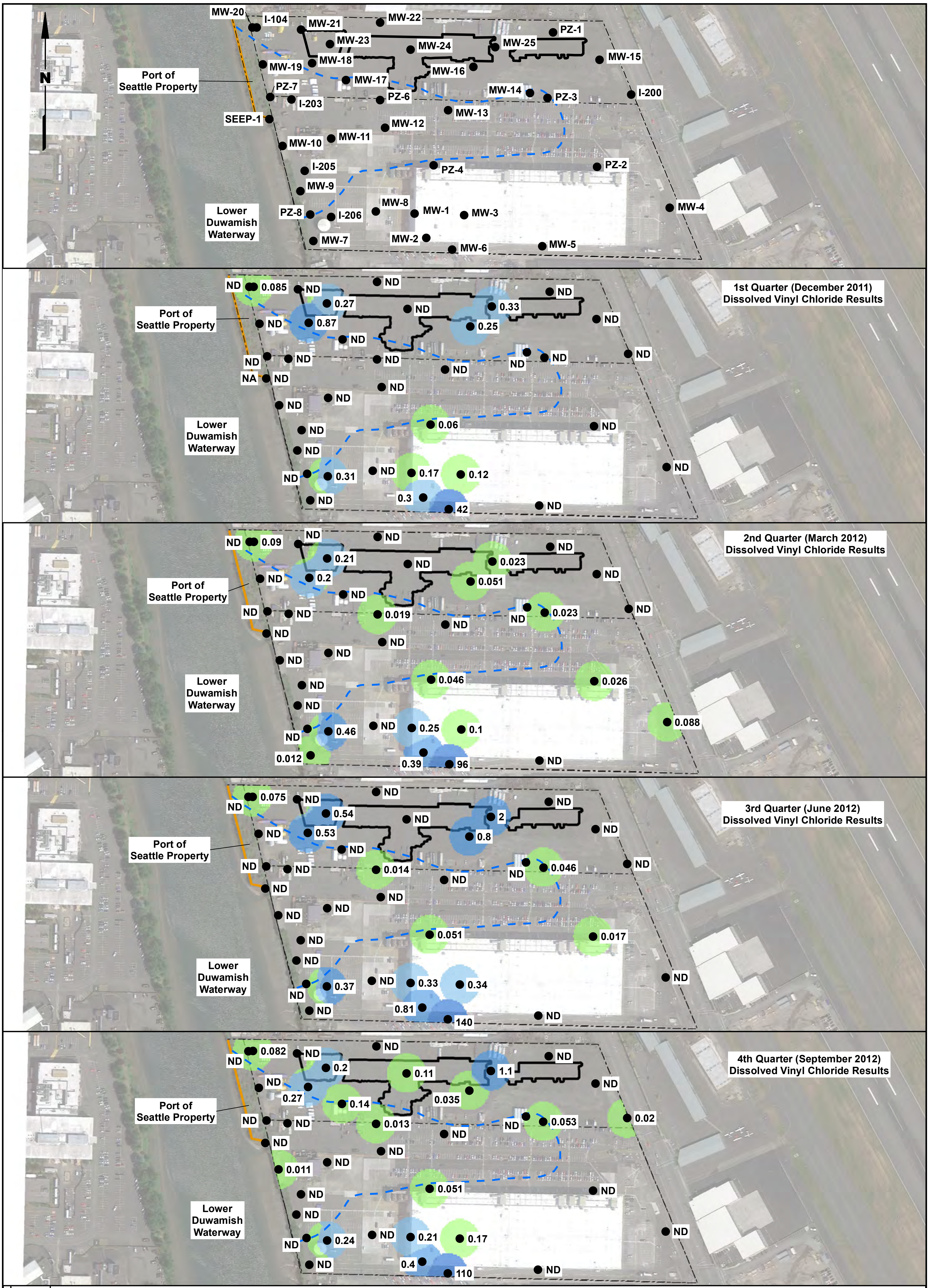
Scale in Feet

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Total PCB Concentrations in Groundwater

Figure
3-7



Legend

● Groundwater Sampling Locations

Approximate Location of Former Slip 5

Current Extent of Stabilized Soil Material

Detected Concentrations (µg/L)

🟩 ≤0.18

🟦 0.18-0.35

🟦 0.35-10

🟦 10+

Notes

1. All results shown are reported in µg/L.
2. The preliminary cleanup level for vinyl chloride in groundwater is 0.18 µg/L.
3. Groundwater samples from direct push borings were collected on the Port Property on 8/27/2013.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 350 700

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

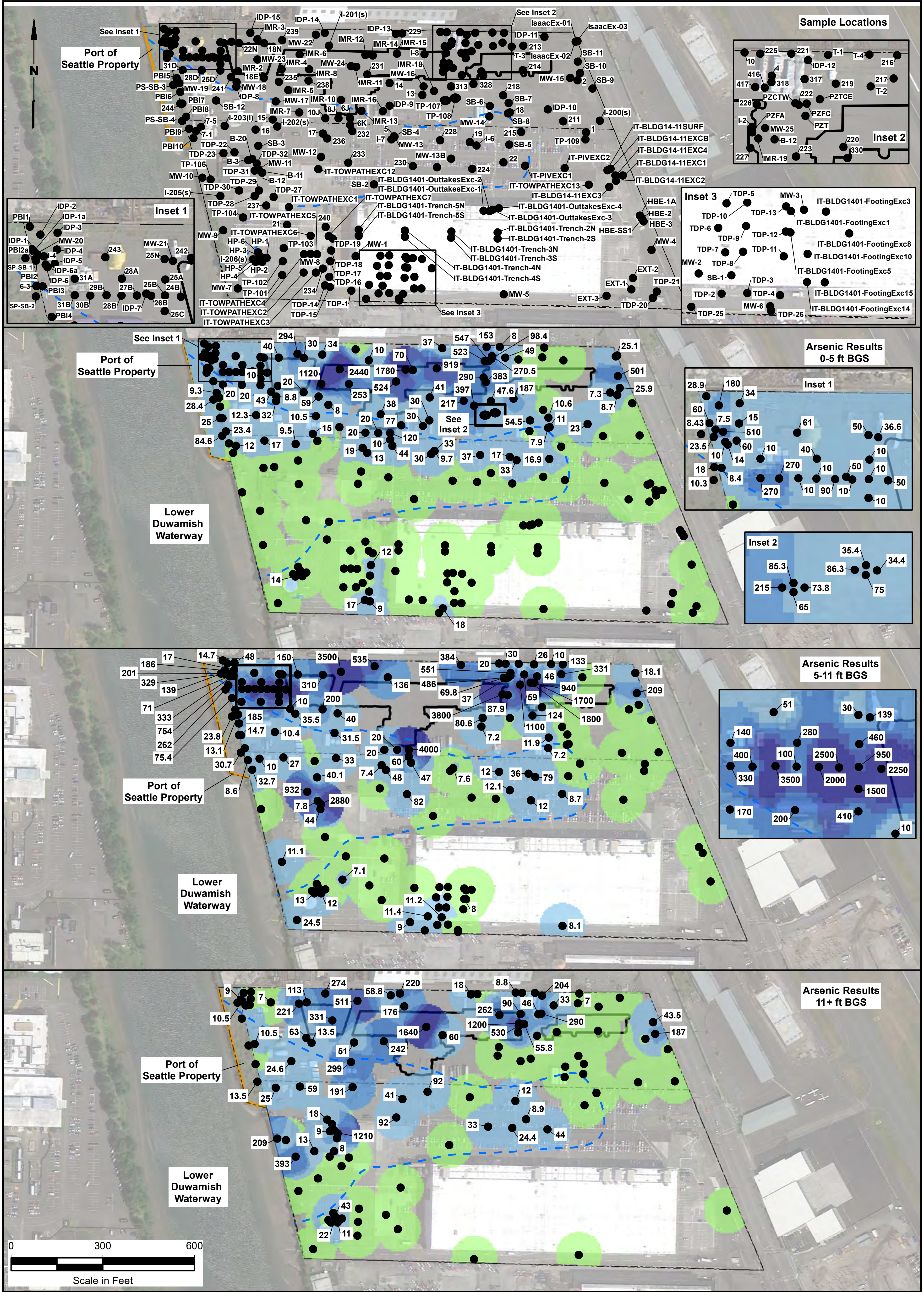
Landau Associates

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Vinyl Chloride Concentrations in Groundwater

Figure
3-8

G:\Projects\025\190\218\015\F03-9AsSoilConcentrations.mxd 8/1/2022



Legend

● Soil Sampling Locations

- - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

🟩 ≤7 (pCUL)

▨ 7-100

▨ 100-200

▨ 200-500

▨ 500-1,000

▨ 1,000+

Notes

1. All results shown are reported in mg/kg.
2. Concentration values less than or equal to the preliminary cleanup level (7 mg/kg) are not presented.
3. The preliminary cleanup level for arsenic in soil is 7 mg/kg.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Post-RI samples that were collected from the Port Sliver Property are not shown on this figure, but are included in Appendix A of the FS Report.
6. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final RI Boeing I-T (April 2014)

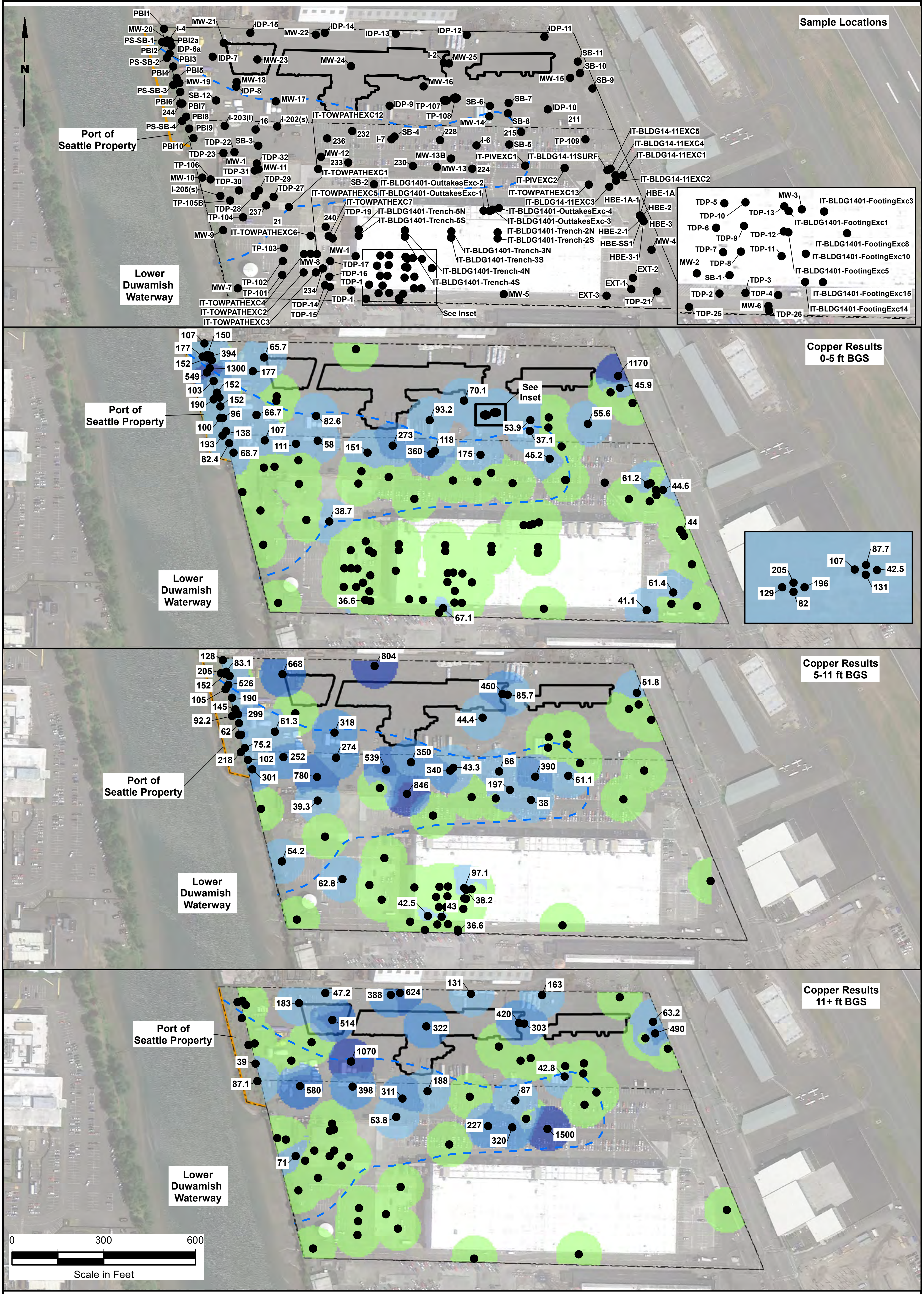
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Arsenic Concentrations in Soil

Figure
3-9

G:\Projects\025\190\218\015\F03-10CuSoilConcentrations.mxd 8/1/2022



Legend

● Soil Sampling Locations

- - - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

🟩 ≤36 (pCUL)

🟦 36-200

🟦 200-500

🟦 500-800

🟦 800-3,200

🟦 3,200+

Notes
1. All results shown are reported in mg/kg.
2. Concentration values less than or equal to the preliminary cleanup level (36 mg/kg) are not presented.
3. Inverse Distance Weighting calculated using the following inputs:
Power = 4
Search Radius = Variable
Number of Points = 8
Maximum Distance = 75
4. Post-RI samples that were collected from the Port Sliver Property are not shown on this figure, but are included in Appendix A of the FS Report.
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final RI Boeing I-T (April 2014)

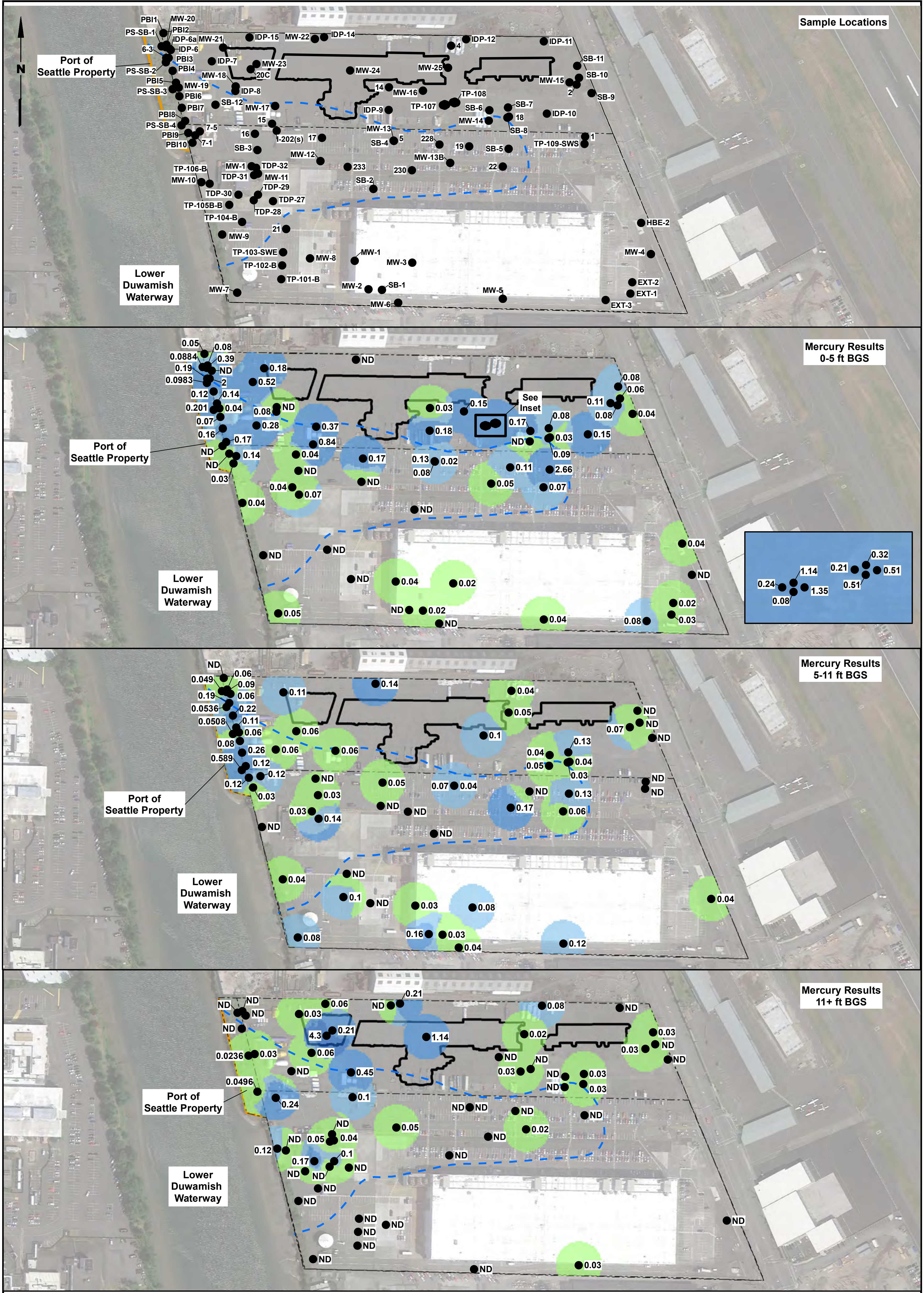
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Copper Concentrations in Soil

Figure
3-10

G:\Projects\025\190\218\015\F03-11HgSoilConcentrations.mxd 8/1/2022



Legend

● Soil Sampling Locations

- - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

🟩 ≤0.07

🟦 0.07-0.14

🟦 0.14-24

🟦 24+

Notes

1. All results shown are reported in mg/kg.
2. The preliminary cleanup level for Mercury in soil is 0.07 mg/kg.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Post-RI samples that were collected from the Port Sliver Property are not shown on this figure, but are included in Appendix A of the FS Report.
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data

0 300 600

Scale in Feet

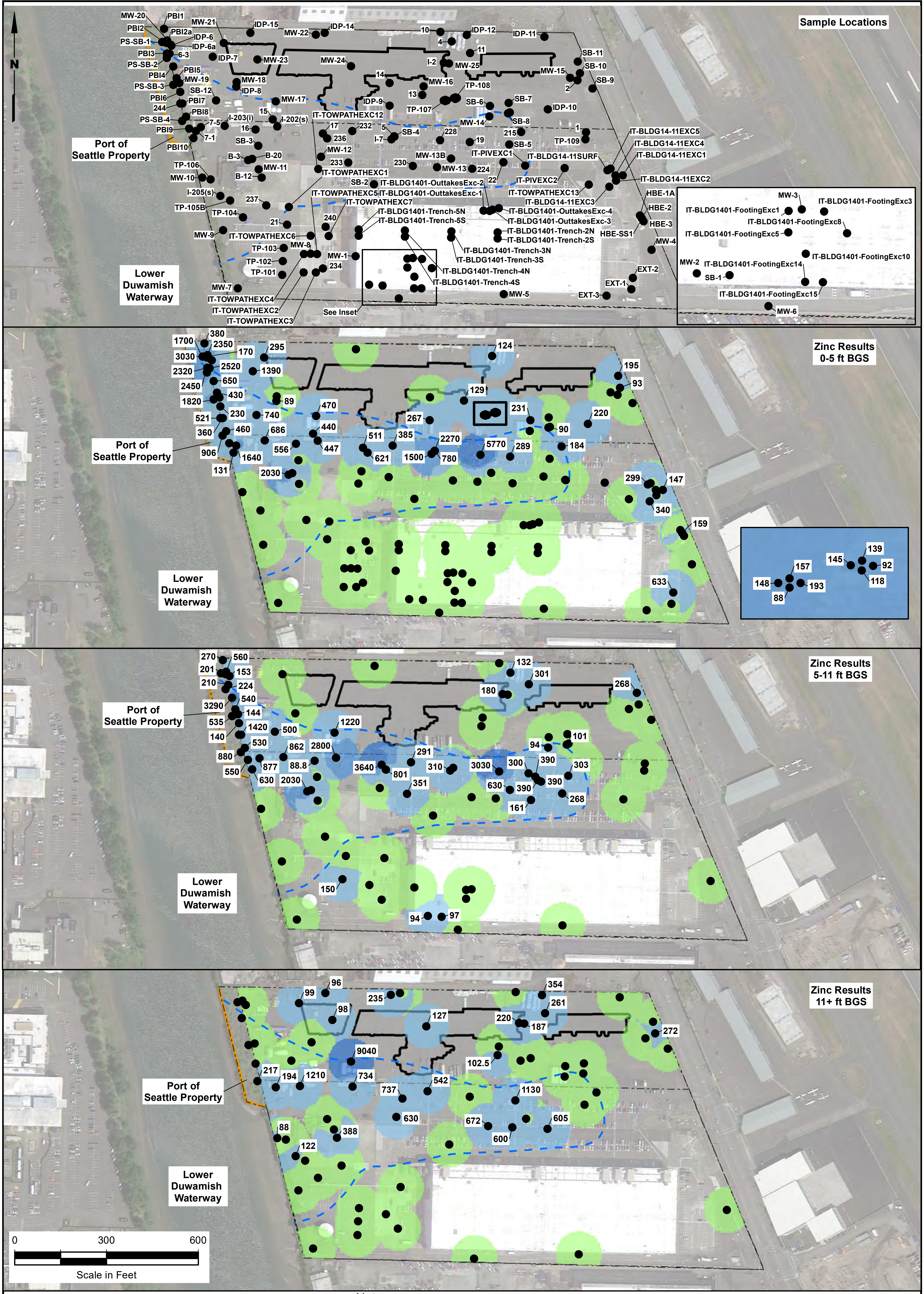
Landau Associates

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Mercury Concentrations in Soil

Figure
3-11

G:\Projects\025\190\218\015\F03-12ZnSoilConcentrations.mxd 8/1/2022



Legend

- ● Soil Sampling Locations
- ┄ Approximate Location of Former Slip 5
- ― Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

- 🟩 ≤85 (pCUL)
- 🟦 85-1,400
- 🟦 1,400-3,000
- 🟦 3,000-24,000
- 🟦 24,000+

Notes

1. All results shown are reported in mg/kg.
2. Concentration values less than or equal to the preliminary cleanup level (85 mg/kg) are not presented.
3. Soil samples from direct push borings were collected on the Port Property on 8/27/2013.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Post-RI samples that were collected from the Port Sliver Property are not shown on this figure, but are included in Appendix A of the FS Report.
6. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final Boeing I-T (April 2014).

LANDAU ASSOCIATES

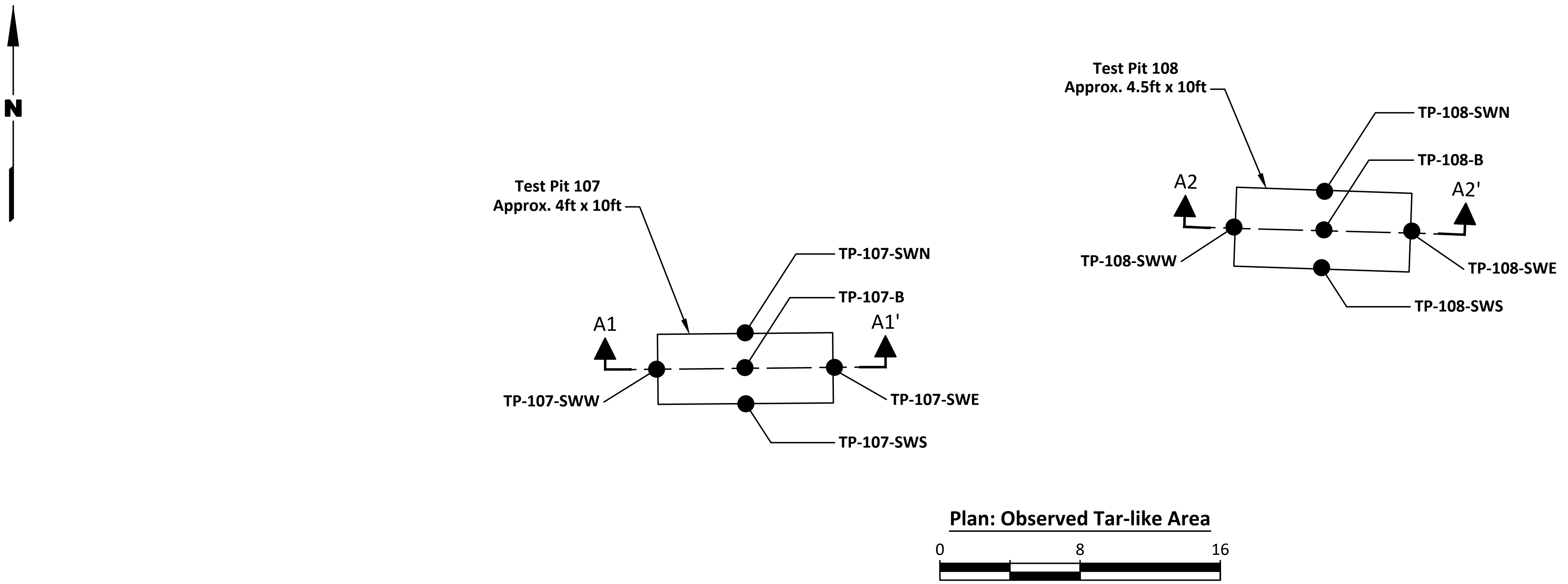
Boeing
Isaacson-Thompson Site
Tukwila, Washington

Zinc Concentrations in Soil

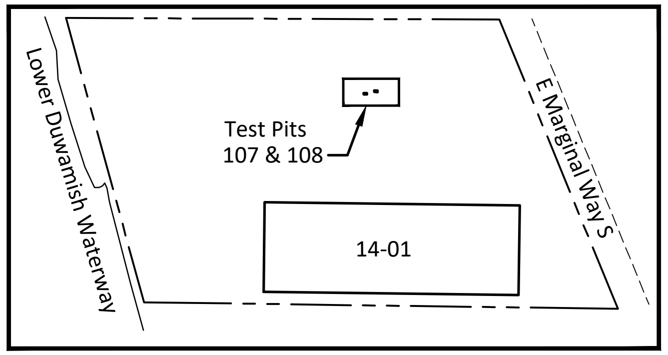
Figure
3-12

Legend

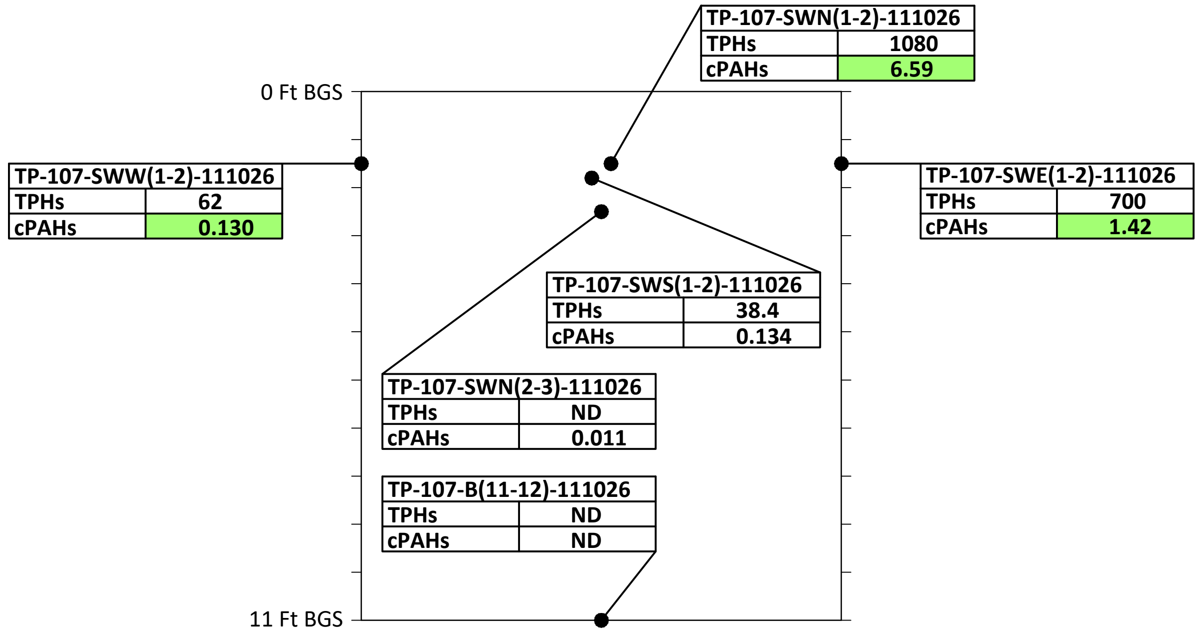
TP-107 ● Test Pit Sample Location and Designation



Plan: Observed Tar-like Area



Site-wide Plan 1"=600'



TP-107-SWN(1-2)-111026	
TPHs	1080
cPAHs	6.59

TP-107-SWW(1-2)-111026	
TPHs	62
cPAHs	0.130

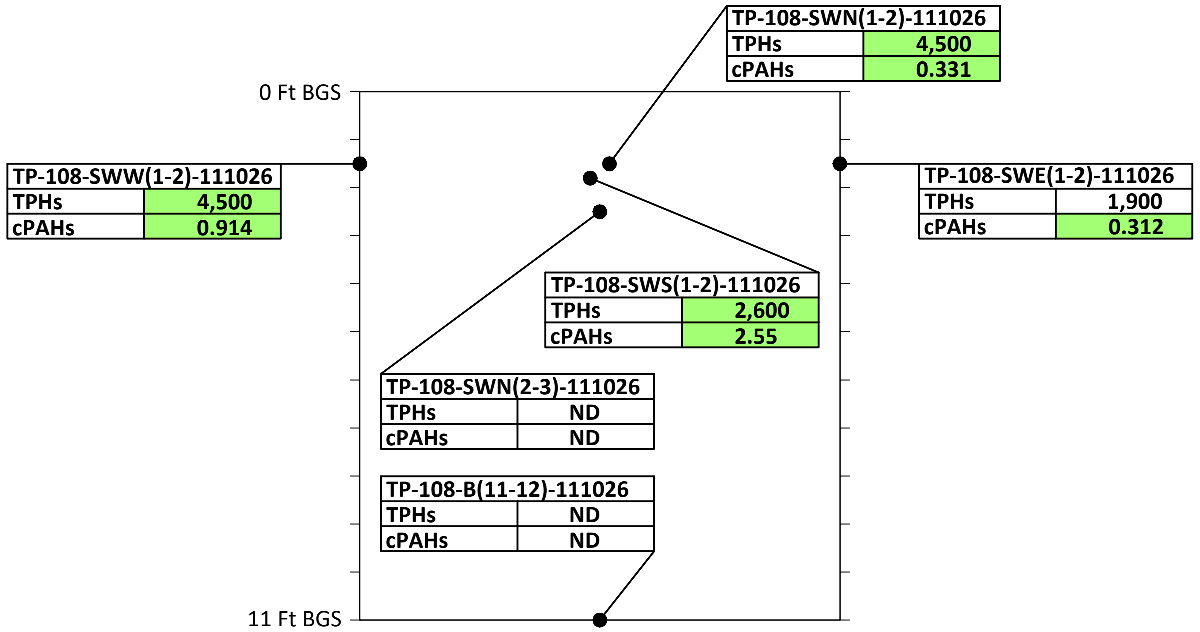
TP-107-SWE(1-2)-111026	
TPHs	700
cPAHs	1.42

TP-107-SWS(1-2)-111026	
TPHs	38.4
cPAHs	0.134

TP-107-SWN(2-3)-111026	
TPHs	ND
cPAHs	0.011

TP-107-B(11-12)-111026	
TPHs	ND
cPAHs	ND

Cross-Section A1-A1'



TP-108-SWN(1-2)-111026	
TPHs	4,500
cPAHs	0.331

TP-108-SWW(1-2)-111026	
TPHs	4,500
cPAHs	0.914

TP-108-SWE(1-2)-111026	
TPHs	1,900
cPAHs	0.312

TP-108-SWS(1-2)-111026	
TPHs	2,600
cPAHs	2.55

TP-108-SWN(2-3)-111026	
TPHs	ND
cPAHs	ND

TP-108-B(11-12)-111026	
TPHs	ND
cPAHs	ND

Cross-Section A2-A2'

0 4 8

Scale in Feet

1x Vertical Exaggeration

Notes

1. Concentrations of TPHs include the sum of diesel range organics (DRO) and oil range organics (ORO) in mg/kg.
2. Concentrations of cPAHs are total cPAH TEQs in mg/kg.
3. Detected concentrations exceeding preliminary cleanup levels (pCULs) are highlighted green.
4. The pCUL is 2,000 mg/kg for the sum of DRO and ORO; the pCUL is 0.0076 mg/kg for total cPAH TEQs.
5. ND = Non-detect; concentrations were not detected above laboratory reporting limits.
6. All samples collected on October 26, 2011 during Remedial Investigation.
7. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Landau Associates

Boeing Isaacson-Thompson Site
Tukwila, Washington

Extent of TPHs and cPAHs in Observed Tar-Like Substance Area Soil

Figure
3-13

G:\Projects\025\190\218\015\F03-14PbSoilConcentrations.mxd 8/1/2022

Legend

● Soil Sampling Locations

Approximate Location of Former Slip 5

Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

🟩 ≤81 (pCUL)

🟦 81-250

🟪 250+

0 300 600
Scale in Feet

Notes
1. All results shown are reported in mg/kg.
2. Concentration values less than or equal to the preliminary cleanup level (81 mg/kg) are not presented.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Groundwater samples from direct push borings were collected on the Port Property on 8/27/2013.
5. Post-RI samples that were collected from the Port Sliver Property are not shown on this figure, but are included in Appendix A of the FS Report.

Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final RI Boeing I-T (April 2014)

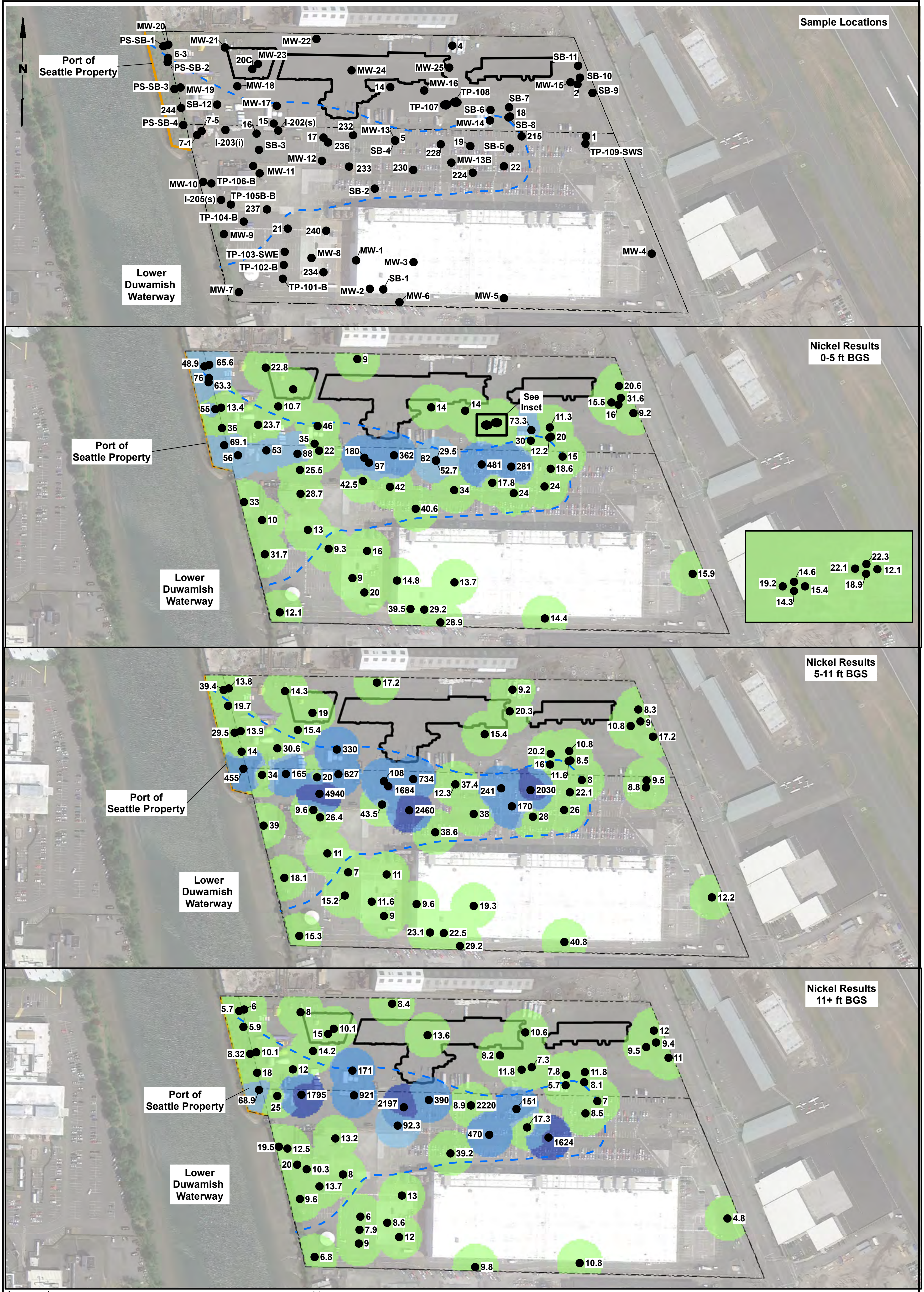
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Lead Concentrations in Soil

Figure
3-14

G:\Projects\025\190\218\015\F03-15NiSoilConcentrations.mxd 8/1/2022



Legend

● Soil Sampling Locations

- - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

🟩 ≤48

▨ 48-96

▨ 96-1,600

▨ 1,600+

Notes

1. All results shown are reported in mg/kg.
2. The preliminary cleanup level for Nickel in soil is 48 mg/kg.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 300 600

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

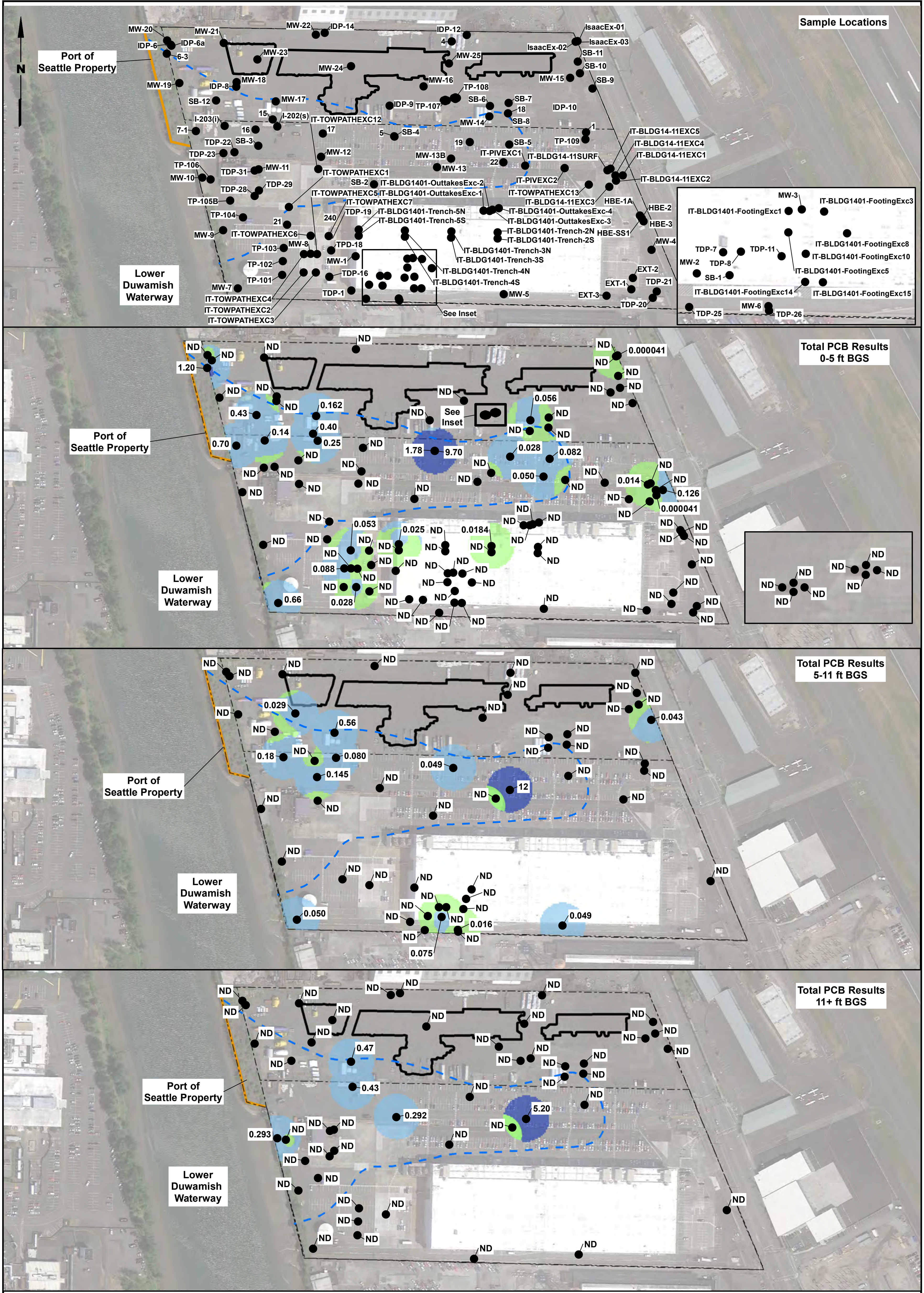
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Nickel Concentrations in Soil

Figure
3-15

G:\Projects\025\190\218\015\F03-16PCBSoilConcentrations.mxd 8/1/2022



Legend

● Soil Sampling Locations

- - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

🟩 ≤0.02 (pCUL)

🟦 0.02-1.00

■ 1.00+

0 300 600

Scale in Feet

Notes

1. All results shown are reported in mg/kg.
2. The preliminary cleanup level (pCUL) for Total PCBs is 0.02 mg/kg.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Post-RI samples that were collected from the Port Sliver Property are not shown on this figure, but are included in Appendix A of the FS Report.
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final RI Boeing I-T (April 2014)

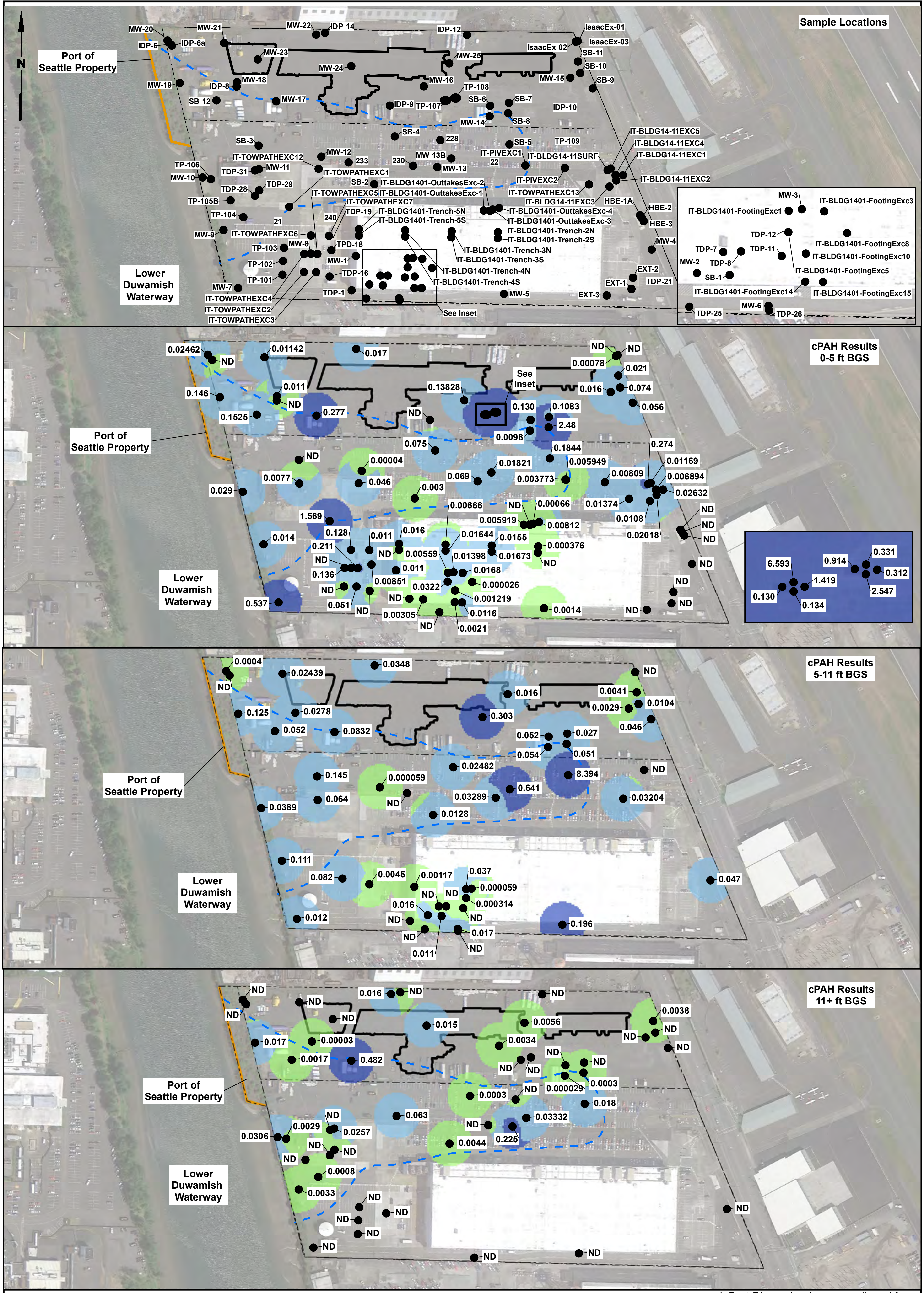
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Total PCB Concentrations in Soil

Figure
3-16

G:\Projects\025\190\218\015\F03-17cPAHSoilConcentrations.mxd 8/1/2022



Legend

● Soil Sampling Locations

- - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentration (mg/kg)

🟩 ≤ 0.0076 (pCUL)

🟦 0.0076 - 0.19

▨ 0.19+

0 300 600

Scale in Feet

Notes

1. All results shown are reported in mg/kg.
2. The preliminary cleanup level for total cPAHs in soil is 0.0076 mg/kg.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Post-RI samples that were collected from the Port Sliver Property are not shown on this figure, but are included in Appendix A of the FS Report.
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

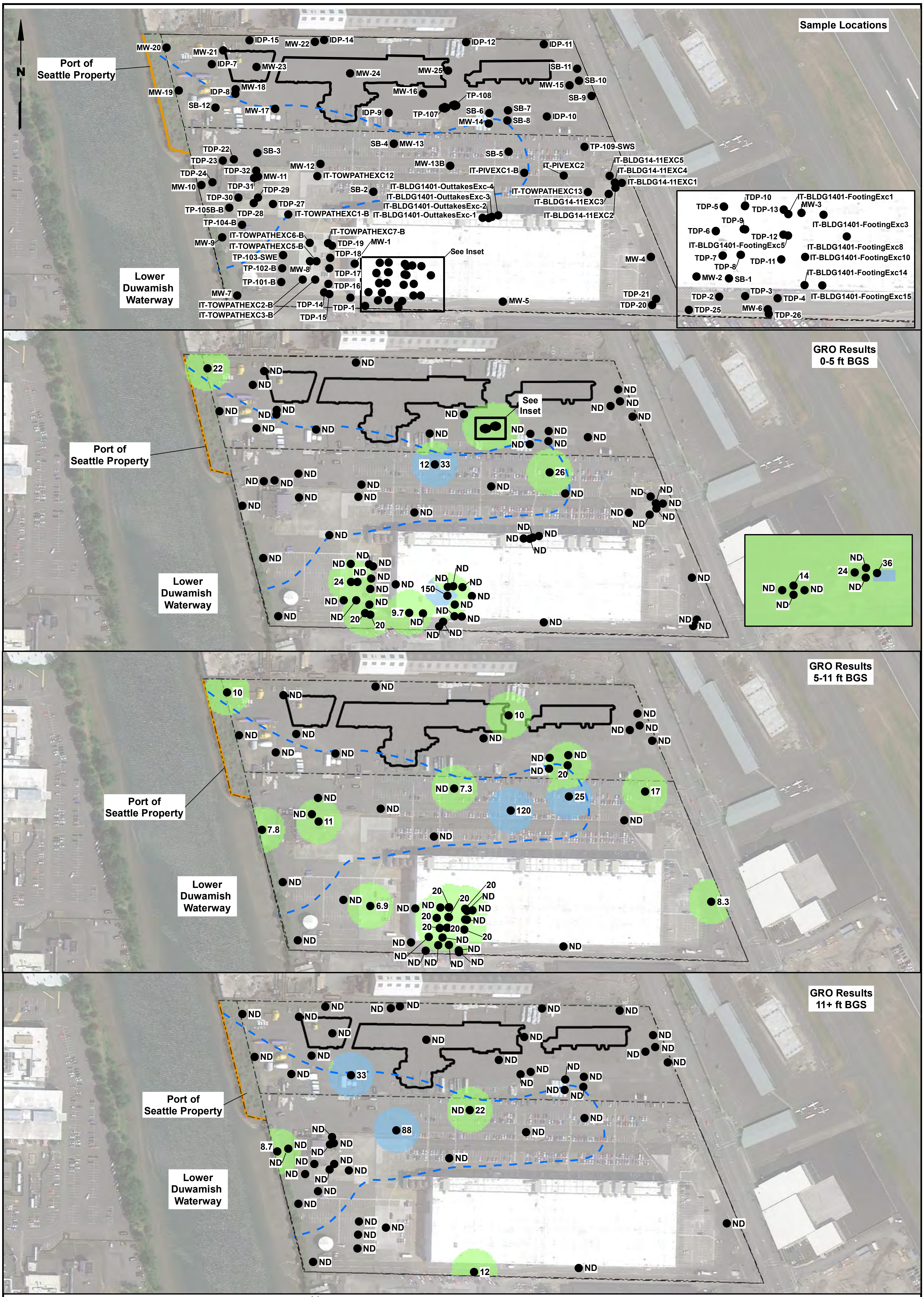
Data Sources: Google Earth Pro, 2012; King County Parcel Data; Final RI Boeing I-T (April 2014)

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Total cPAH Concentrations in Soil

Figure
3-17



Legend

- ● Soil Sampling Locations
- Approximate Location of Former Slip 5
- Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

- 🟩 ≤30 (pCUL)
- 30-1,500
- 1,500+

Notes
1. All results shown are reported in mg/kg.
2. The preliminary cleanup level for GRO in soil is 30 mg/kg.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 300 600

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

GRO Concentrations in Soil

Figure
3-18

Legend

● Soil Sampling Locations

Approximate Location of Former Slip 5

Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

🟩 ≤160

🟦 160+

0 300 600

Scale in Feet

Notes

1. All results shown are reported in mg/kg.
2. Concentration values less than or eqaul to the preliminary screening level (160 mg/kg) are not presented.
3. The preliminary cleanup level for barium in soil is 160 mg/kg.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Post-RI samples that were collected from the Port Sliver Property are not shown on this figure, but are included in Appendix A of the FS Report.
6. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

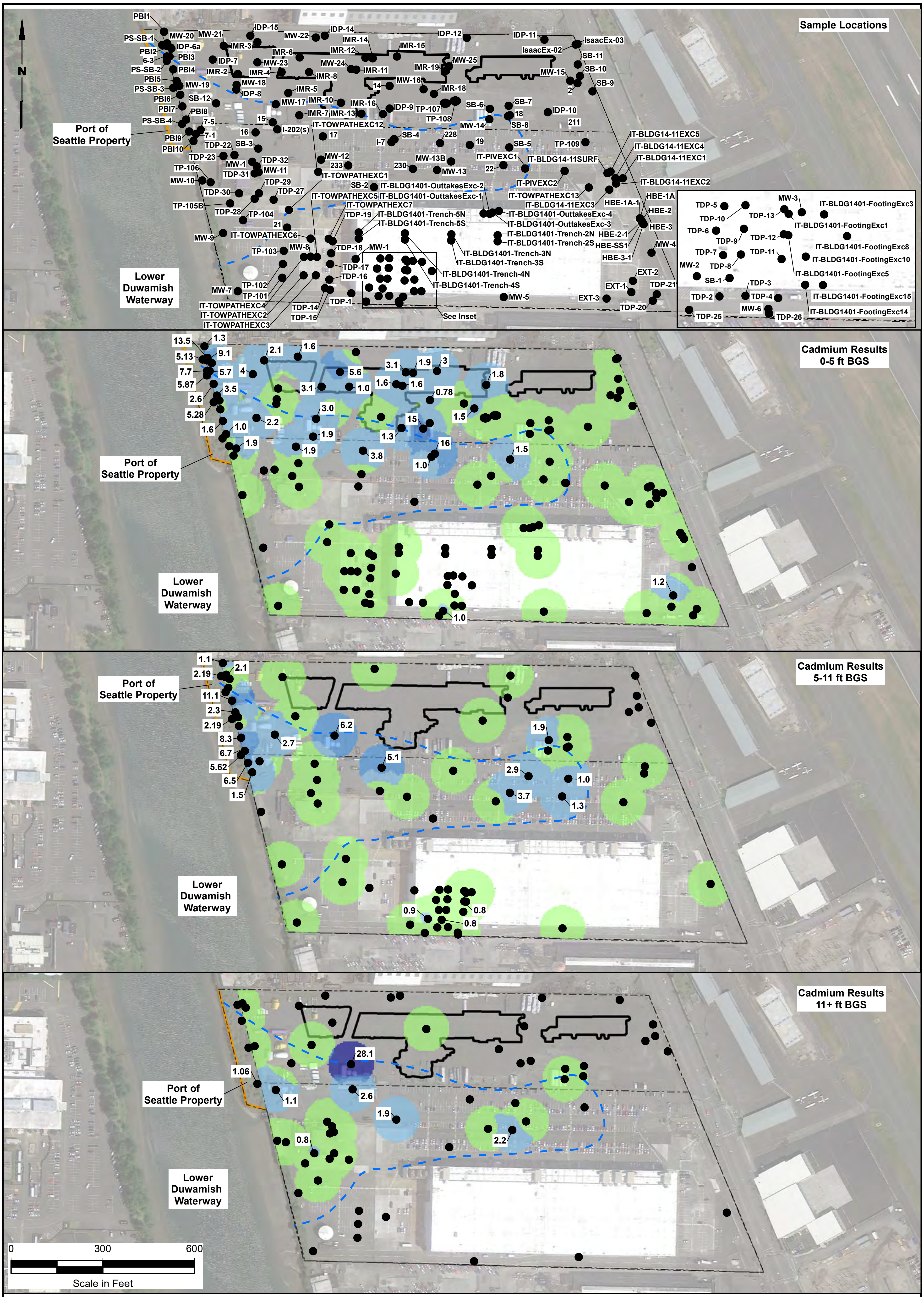
Data Sources: Google Earth Pro, 2012; King County Parcel Data

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Barium Concentrations in Soil

Figure
3-19



Legend

● Soil Sampling Locations

- - - Approximate Location of Former Slip 5

Detected Concentrations (mg/kg)

🟩 ≤0.77

🟦 0.77-5

🟦 5-10

🟦 10-15

🟦 15-20

🟦 20+

Notes

1. All results shown are reported in mg/kg.
2. Concentration values less than or equal to the preliminary cleanup level (1.3 mg/kg) are not presented.
3. The preliminary cleanup level for cadmium in soil is 1.3 mg/kg.
4. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
5. Post-RI samples that were collected from the Port Sliver Property are not shown on this figure, but are included in Appendix A of the FS Report.
6. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data

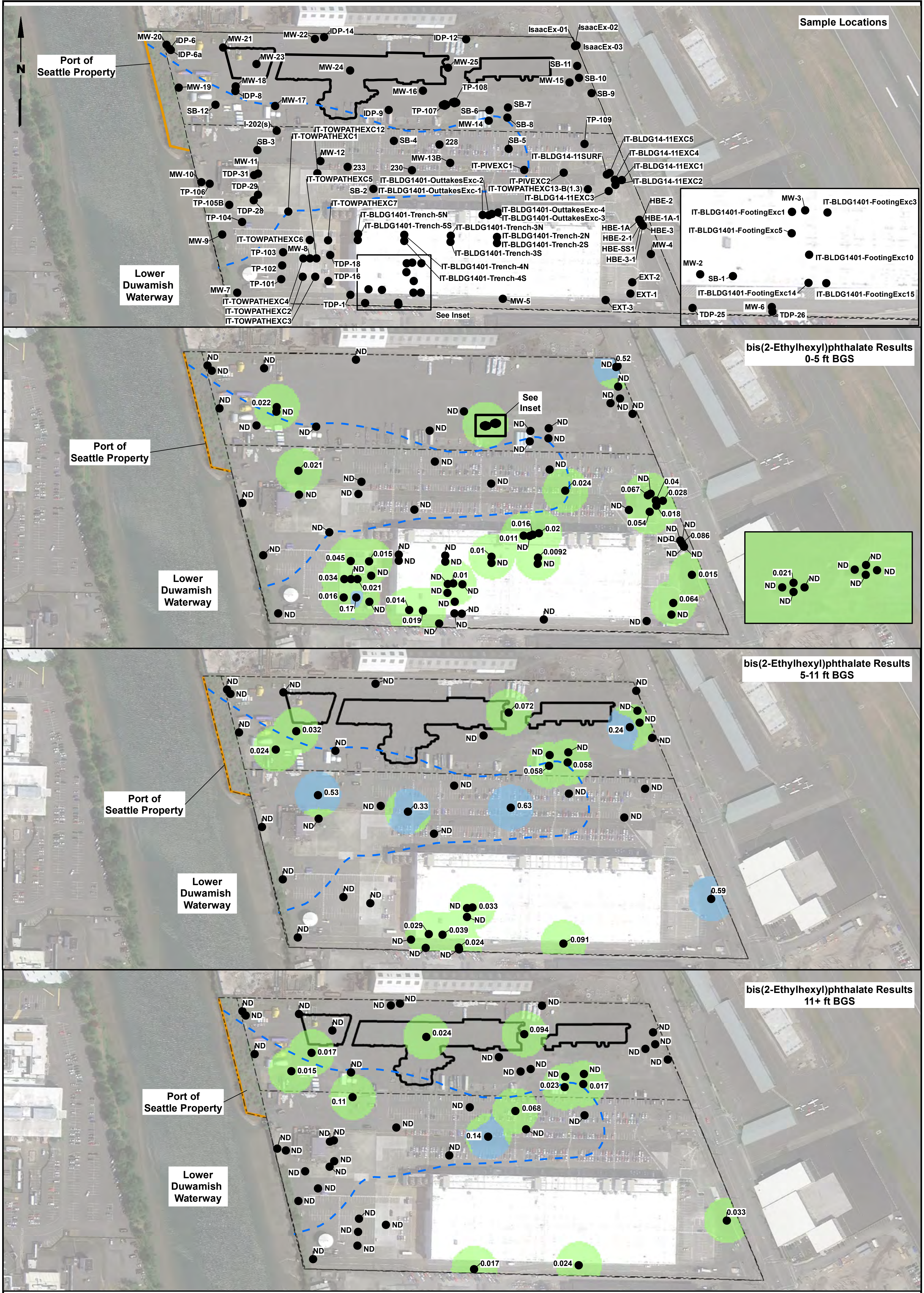
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Cadmium Concentrations in Soil

Figure
3-20

G:\Projects\025\190\218\015\F03-21BisEthylSoilConcentrations.mxd 8/2/2022



Legend

- ● Soil Sampling Locations
- Approximate Location of Former Slip 5
- Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

- 🟩 ≤0.12
- 🟦 0.12-1.3
- 🟦 1.3-71
- 🟦 71+

Notes

1. All results shown are reported in mg/kg.
2. The preliminary cleanup level for bis(2-Ethylhexyl)phthalate in soil is 0.12 mg/kg.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data

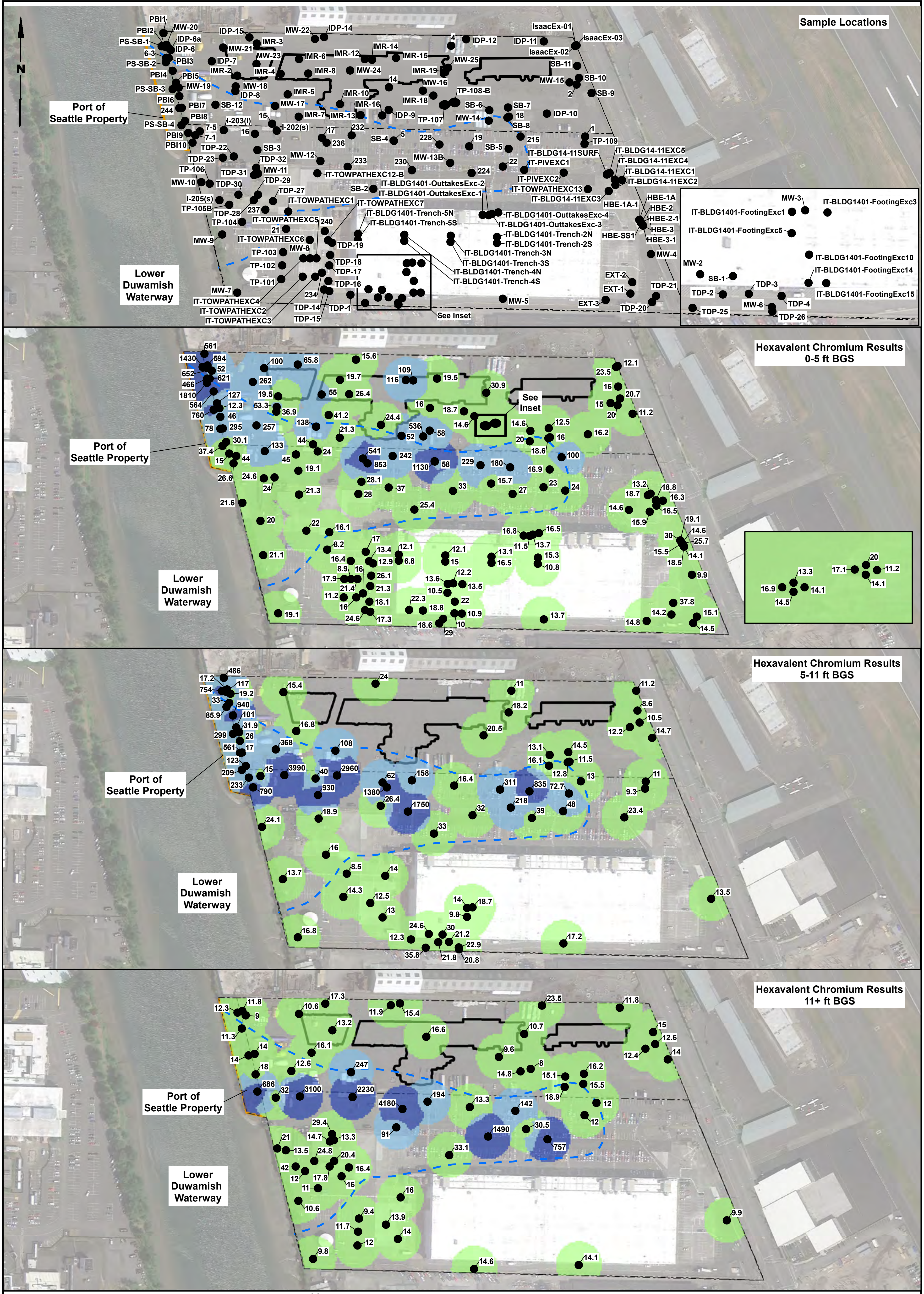
Landau Associates

Boeing
Isaacson-Thompson Site
Tukwila, Washington

bis(2-ethylhexyl)phthalate Concentrations in Soil

Figure
3-21

G:\Projects\025\190\218\015\F03-22TotalChromiumSoilConcentrations.mxd 8/2/2022



Legend

● Soil Sampling Locations

- - Approximate Location of Former Slip 5

— Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

🟩 ≤48 (pCUL)

🟦 48-550

🟦 >550

Notes

1. All results shown are reported in mg/kg.
2. The preliminary cleanup level for Total Chromium in soil is 48 mg/kg.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 300 600

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

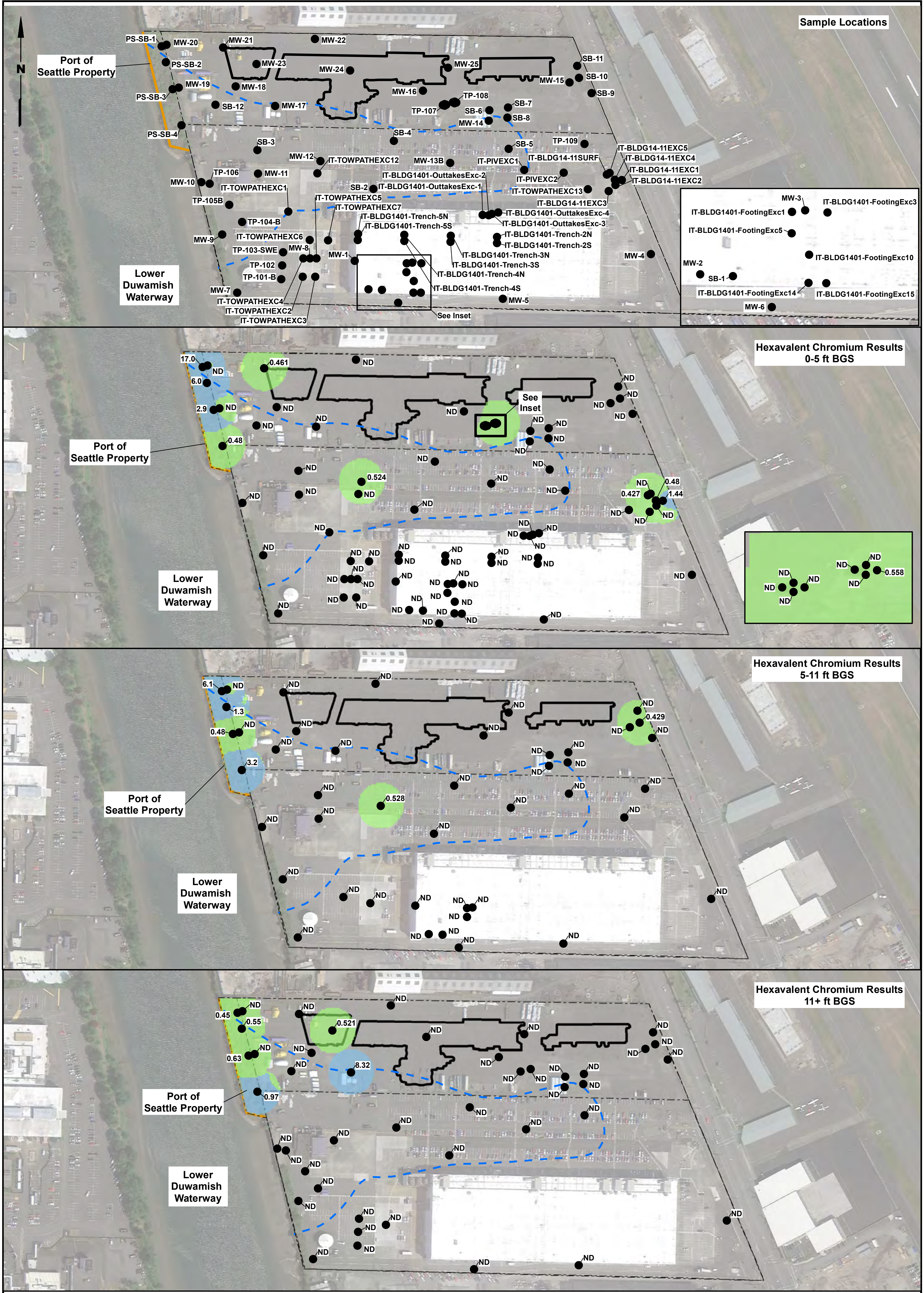
LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Total Chromium Concentrations in Soil

Figure
3-22

G:\Projects\025\190\218\015\F03-23ChromiumVISoilConcentrations.mxd 8/2/2022



Legend

- ● Soil Sampling Locations
- Approximate Location of Former Slip 5
- Current Extent of Stabilized Soil Material

Detected Concentrations (mg/kg)

- 🟩 ≤0.96
- 🟦 0.96-240
- 🟦 >240

Notes

1. All results shown are reported in mg/kg.
2. The preliminary cleanup level for Hexavalent Chromium in soil is 0.96 mg/kg.
3. Inverse Distance Weighting calculated using the following inputs:
   Power = 4
   Search Radius = Variable
   Number of Points = 8
   Maximum Distance = 75
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 300 600

Scale in Feet

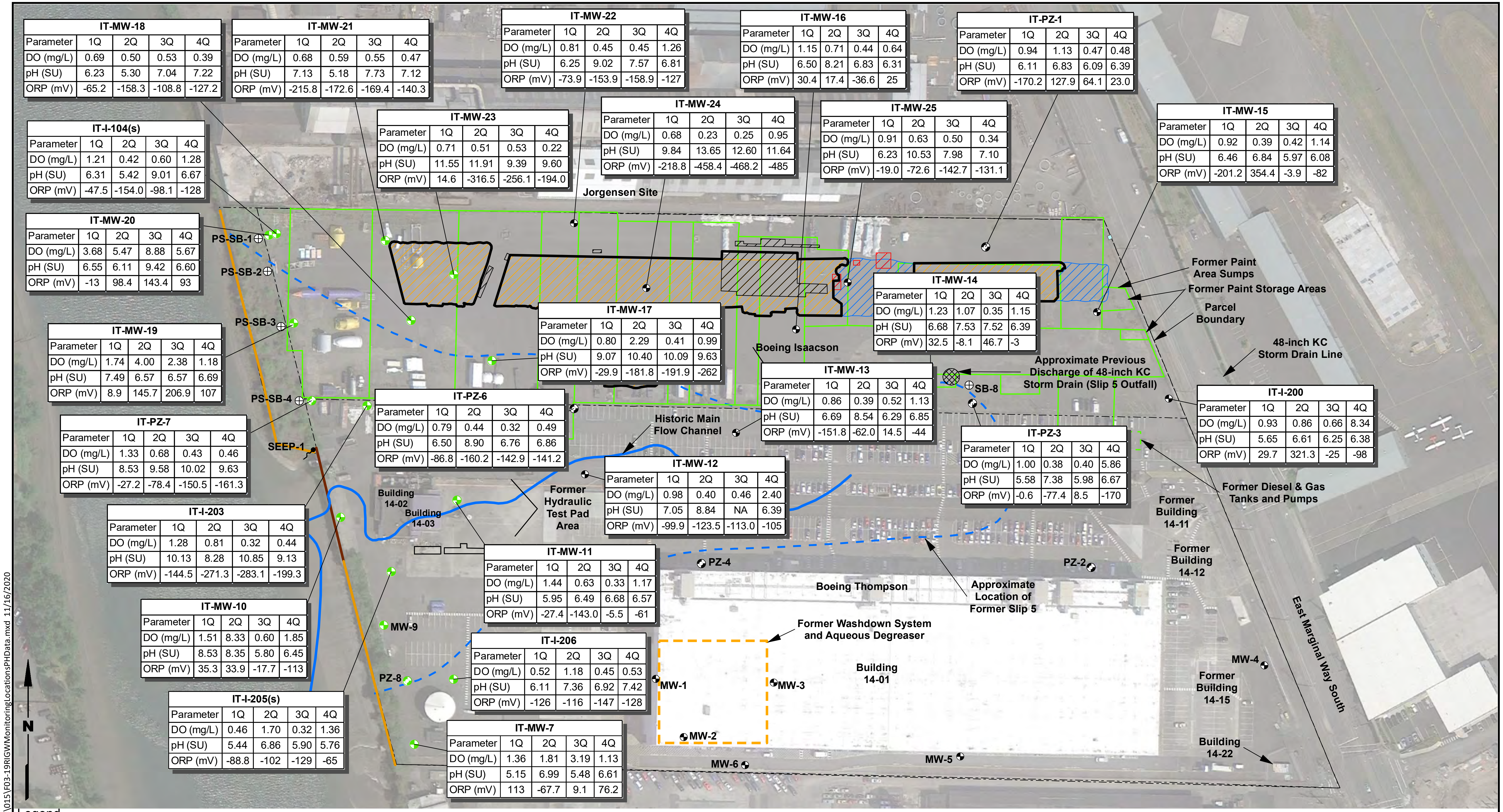
Data Sources: Google Earth Pro, 2012; King County Parcel Data

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Hexavalent Chromium Concentrations in Soil

Figure
3-23



IT-MW-18

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.69	0.50	0.53	0.39
pH (SU)	6.23	5.30	7.04	7.22
ORP (mV)	-65.2	-158.3	-108.8	-127.2

IT-MW-21

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.68	0.59	0.55	0.47
pH (SU)	7.13	5.18	7.73	7.12
ORP (mV)	-215.8	-172.6	-169.4	-140.3

IT-MW-22

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.81	0.45	0.45	1.26
pH (SU)	6.25	9.02	7.57	6.81
ORP (mV)	-73.9	-153.9	-158.9	-127

IT-MW-16

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.15	0.71	0.44	0.64
pH (SU)	6.50	8.21	6.83	6.31
ORP (mV)	30.4	17.4	-36.6	25

IT-PZ-1

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.94	1.13	0.47	0.48
pH (SU)	6.11	6.83	6.09	6.39
ORP (mV)	-170.2	127.9	64.1	23.0

IT-I-104(s)

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.21	0.42	0.60	1.28
pH (SU)	6.31	5.42	9.01	6.67
ORP (mV)	-47.5	-154.0	-98.1	-128

IT-MW-23

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.71	0.51	0.53	0.22
pH (SU)	11.55	11.91	9.39	9.60
ORP (mV)	14.6	-316.5	-256.1	-194.0

IT-MW-24

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.68	0.23	0.25	0.95
pH (SU)	9.84	13.65	12.60	11.64
ORP (mV)	-218.8	-458.4	-468.2	-485

IT-MW-25

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.91	0.63	0.50	0.34
pH (SU)	6.23	10.53	7.98	7.10
ORP (mV)	-19.0	-72.6	-142.7	-131.1

IT-MW-15

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.92	0.39	0.42	1.14
pH (SU)	6.46	6.84	5.97	6.08
ORP (mV)	-201.2	354.4	-3.9	-82

IT-MW-20

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	3.68	5.47	8.88	5.67
pH (SU)	6.55	6.11	9.42	6.60
ORP (mV)	-13	98.4	143.4	93

IT-MW-14

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.23	1.07	0.35	1.15
pH (SU)	6.68	7.53	7.52	6.39
ORP (mV)	32.5	-8.1	46.7	-3

IT-MW-17

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.80	2.29	0.41	0.99
pH (SU)	9.07	10.40	10.09	9.63
ORP (mV)	-29.9	-181.8	-191.9	-262

IT-MW-19

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.74	4.00	2.38	1.18
pH (SU)	7.49	6.57	6.57	6.69
ORP (mV)	8.9	145.7	206.9	107

IT-MW-13

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.86	0.39	0.52	1.13
pH (SU)	6.69	8.54	6.29	6.85
ORP (mV)	-151.8	-62.0	14.5	-44

IT-I-200

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.93	0.86	0.66	8.34
pH (SU)	5.65	6.61	6.25	6.38
ORP (mV)	29.7	321.3	-25	-98

IT-PZ-6

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.79	0.44	0.32	0.49
pH (SU)	6.50	8.90	6.76	6.86
ORP (mV)	-86.8	-160.2	-142.9	-141.2

IT-PZ-7

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.33	0.68	0.43	0.46
pH (SU)	8.53	9.58	10.02	9.63
ORP (mV)	-27.2	-78.4	-150.5	-161.3

IT-PZ-3

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.00	0.38	0.40	5.86
pH (SU)	5.58	7.38	5.98	6.67
ORP (mV)	-0.6	-77.4	8.5	-170

IT-MW-12

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.98	0.40	0.46	2.40
pH (SU)	7.05	8.84	NA	6.39
ORP (mV)	-99.9	-123.5	-113.0	-105

IT-I-203

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.28	0.81	0.32	0.44
pH (SU)	10.13	8.28	10.85	9.13
ORP (mV)	-144.5	-271.3	-283.1	-199.3

IT-MW-11

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.44	0.63	0.33	1.17
pH (SU)	5.95	6.49	6.68	6.57
ORP (mV)	-27.4	-143.0	-5.5	-61

IT-MW-10

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.51	8.33	0.60	1.85
pH (SU)	8.53	8.35	5.80	6.45
ORP (mV)	35.3	33.9	-17.7	-113

IT-I-206

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.52	1.18	0.45	0.53
pH (SU)	6.11	7.36	6.92	7.42
ORP (mV)	-126	-116	-147	-128

IT-I-205(s)

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	0.46	1.70	0.32	1.36
pH (SU)	5.44	6.86	5.90	5.76
ORP (mV)	-88.8	-102	-129	-65

IT-MW-7

Parameter	1Q	2Q	3Q	4Q
DO (mg/L)	1.36	1.81	3.19	1.13
pH (SU)	5.15	6.99	5.48	6.61
ORP (mV)	113	-67.7	9.1	76.2

Legend

● MW-22	Monitoring Well Location
● MW-10	Monitoring Well Location Where Groundwater Sampling Occured 1 Hour Before Low Tide and 1 Hour After a 0.0 Tide
● PZ-1	Piezometer Location
● PZ-7	Piezometer Location Where Groundwater Sampling Occured 1 Hour Before Low Tide and 1 Hour After a 0.0 Tide
⊕ SB-8	Direct-Push Boring Groundwater Sample Location
SEEP-1	Seep
▨	1984 Excavation
▨	1988 Excavation
▨	1990 Excavation
▨	1991 Excavation
―	Current Extent of Stabilized Soil Material
―	Former Isaacson Building (Building 14-05)
- -	Approximate Location of Former Slip 5

0 150 300

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

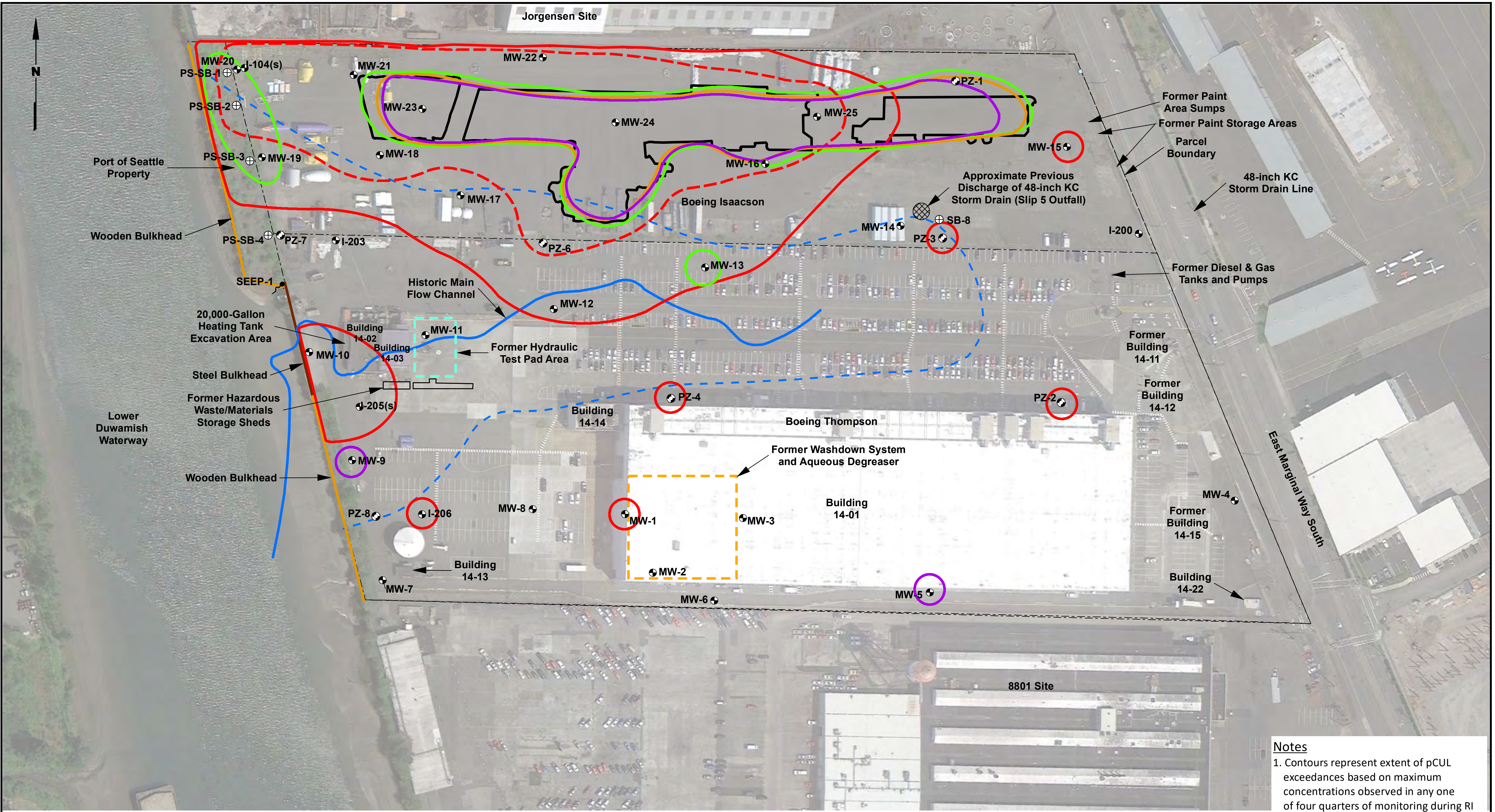
G:\Projects\025\190\218\015\F03-19RIGWMonitoringLocationsPHData.mxd 11/16/2020

LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

RI Groundwater Monitoring Locations with DO, pH, and ORP Data

Figure
3-24



Notes
1. Contours represent extent of pCUL exceedances based on maximum concentrations observed in any one of four quarters of monitoring during RI (December 2011 - September 2012).
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

⊕ SB-8 Direct-Push Boring Groundwater Sample Location

● MW-22 Monitoring Well Location

● PZ-1 Piezometer Location

SEEP-1 Seep Location

Current Extent of Stabilized Soil Material

Groundwater Contamination

As > 100X pCUL (800 µg/L)

As > pCUL (8 µg/L)

Cu > pCUL (3.1 µg/L)

Ni > pCUL (8.2 µg/L)

Zn > pCUL (81 µg/L)

0 150 300

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

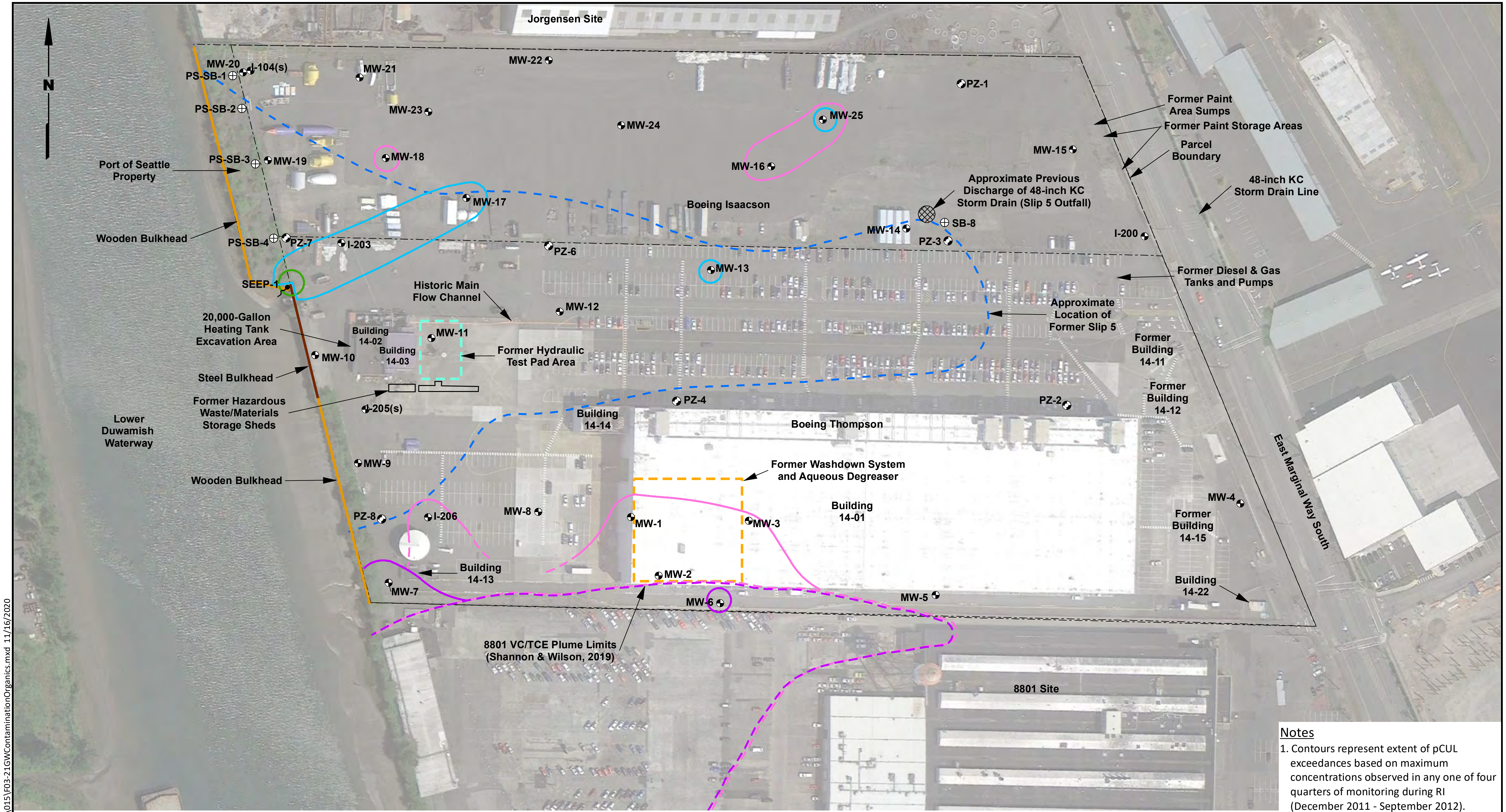
Landau Associates

Boeing Isaacson-Thompson Site
Tukwila, Washington

Extent of Metals Contamination in Groundwater

Figure
3-25

G:\Projects\025\190\218\015\F03-20GWContaminationMetals.mxd 7/7/2022



Notes

1. Contours represent extent of pCUL exceedances based on maximum concentrations observed in any one of four quarters of monitoring during RI (December 2011 - September 2012).
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- MW-22 Monitoring Well Location
- PZ-1 Piezometer Location
- ⊕ SB-8 Direct-Push Boring Groundwater Sample Location
- SEEP-1 Seep Location
- Current Extent of Stabilized Soil Material
- Approximate Location of Former Slip 5

Groundwater Contamination

- PCBs > pCUL (0.01 µg/L)
- cPAH (TEQ) > pCUL (0.048 µg/L)
- TCE > pCUL (0.7 µg/L)
- VC > pCUL (0.18 µg/L)

0 150 300
Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data; Shannon & Wilson, 2019

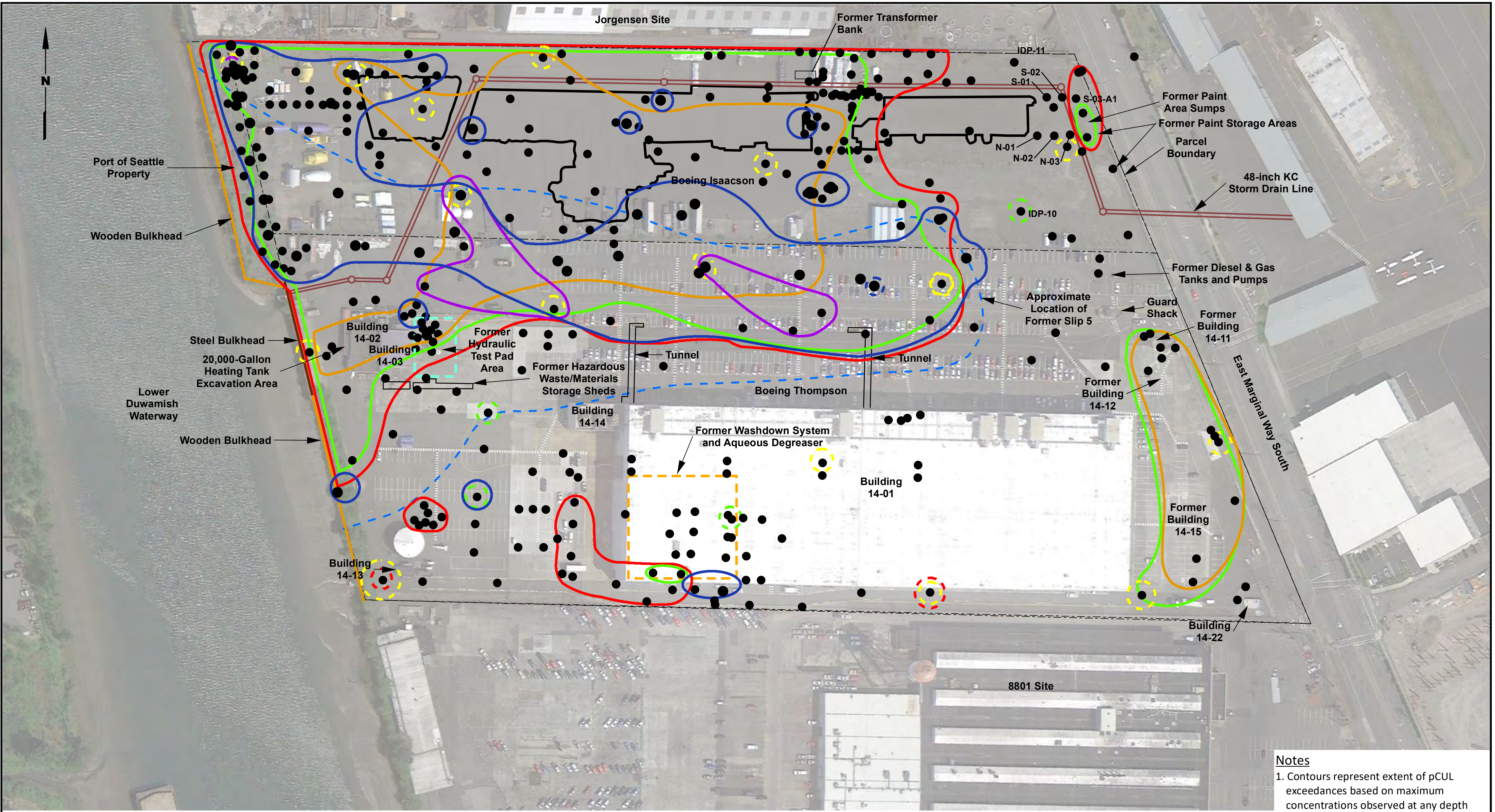
LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Extent of Organic Chemical Contamination in Groundwater

Figure
3-26

G:\Projects\025\190\218\015\F03-21GWContaminationOrganics.mxd 11/16/2020



Notes
1. Contours represent extent of pCUL exceedances based on maximum concentrations observed at any depth interval at the tiven exploration location.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

G:\Projects\025\190\218\015\F03-22SoilContaminationMetals.mxd 7/7/2022

Legend

● Soil Boring

Existing 48" King County Storm Drain Line

Approximate Location of Former Slip 5

Current Extent of Stabilized Soil Material

Soil Contamination

As > pCUL (7 mg/kg)

Cu > pCUL (36 mg/kg)

Hg > pCUL (0.07 mg/kg)

Ni > pCUL (48 mg/kg)

Pb > pCUL (81 mg/kg)

Zn > pCUL (85 mg/kg)

*Dashed Lines = Isolated Sampling Results, Extent not Defined

0 150 300

Scale in Feet

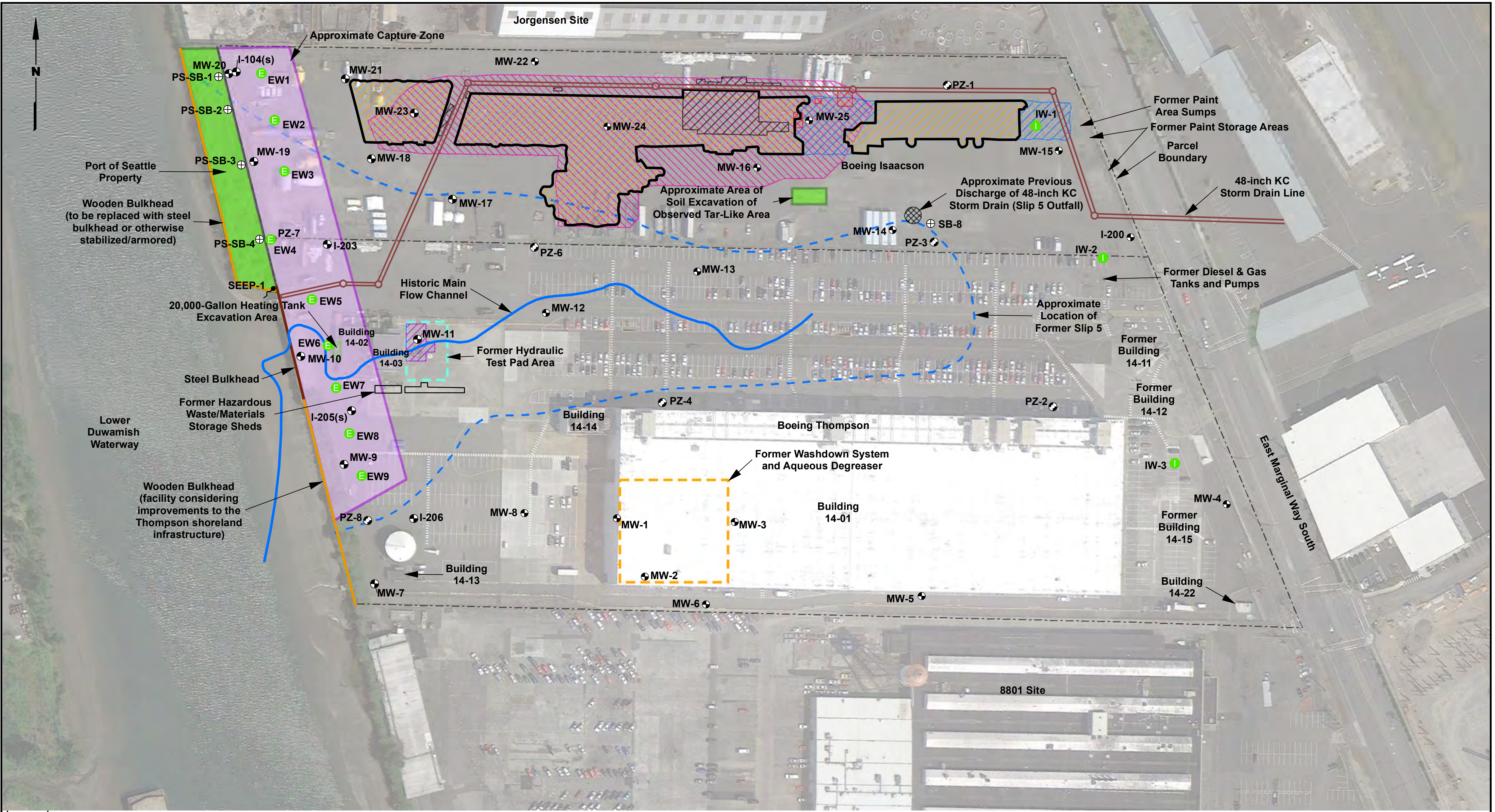
Data Sources: Google Earth Pro, 2012; King County Parcel Data

Landau Associates

Boeing Isaacson-Thompson Site
Tukwila, Washington

Extent of Metals Contamination in Soil

Figure
3-27



Legend

◑ MW-22	Monitoring Well Location	⊕ SB-8	Direct-Push Boring Groundwater Sample Location
Ⓔ EW-1	Extraction Well Location	↗ SEEP-1	Seep
Ⓘ IW-1	Injection Well Location		
◑ PZ-1	Piezometer Location		

▨ 1984 Excavation
▨ 1988 Excavation
▨ 1990 Excavation
▨ 1991 Excavation
▨ 1993-1995 Excavation
▨ 2004 Excavation
▨ 2008 Removal of Stabilized Soil Mound
— Current Extent of Stabilized Soil Material
- - Approximate Location of Former Slip 5
🟪 Approximate Capture Zone
🟩 Approximate Area of Soil Excavation

0 150 300
Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

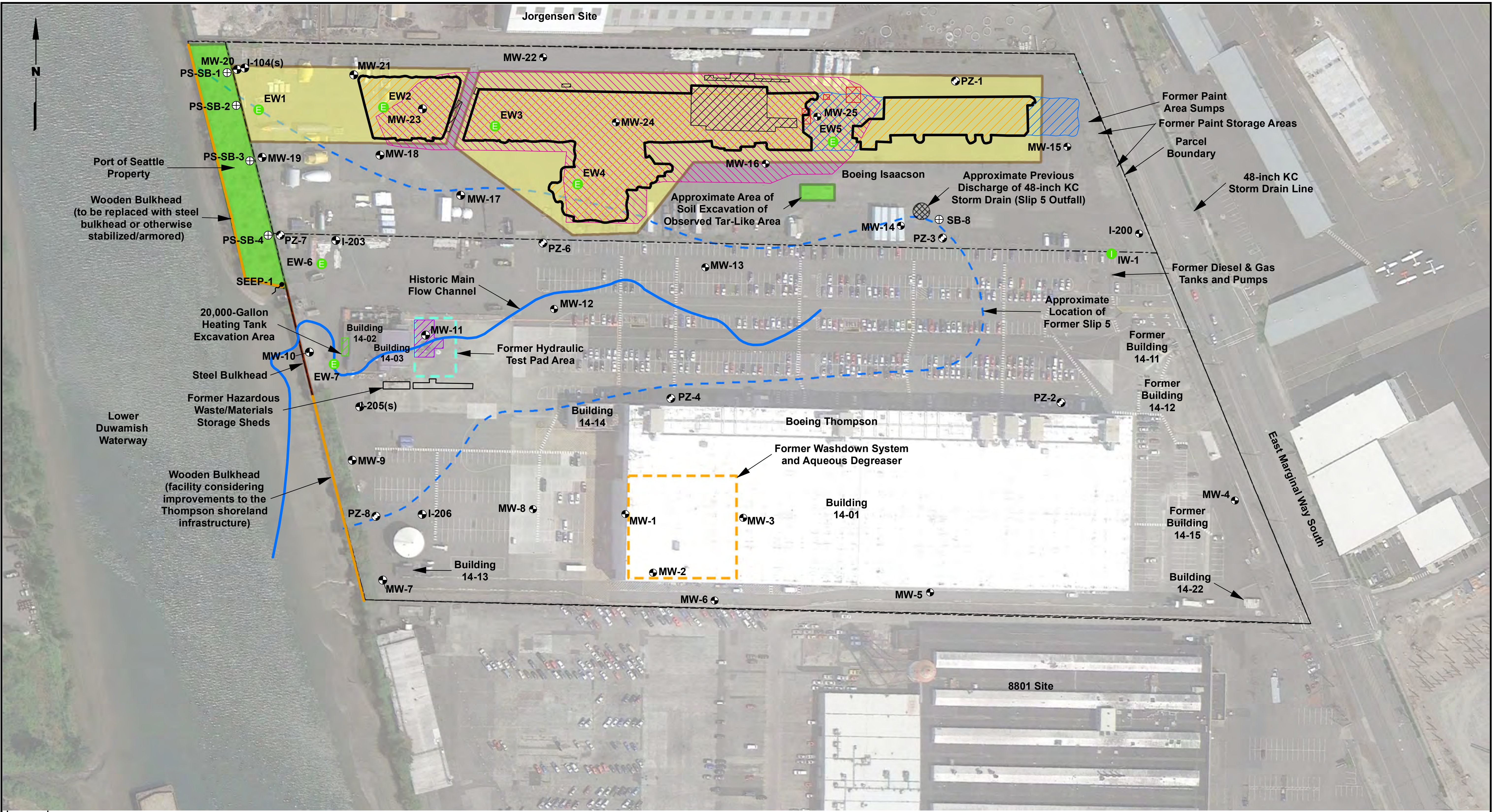
LANDAU ASSOCIATES

G:\Projects\025\190\218\015\F05-1RIAlt1.mxd 5/15/2023

Boeing Isaacson-Thompson Site
Tukwila, Washington

Alternative 1 - Containment and Hydraulic Control via Capping and Groundwater Extraction

Figure
5-1



Legend

MW-22	Monitoring Well Location	SB-8	Direct-Push Boring Groundwater Sample Location
EW-1	Extraction Well Location	SEEP-1	Seep
IW-1	Injection Well Location		
PZ-1	Piezometer Location		

- ▨ 1984 Excavation
- ▨ 1988 Excavation
- ▨ 1990 Excavation
- ▨ 1991 Excavation
- ▨ 1993-1995 Excavation
- ▨ 2004 Excavation
- ▨ 2008 Removal of Stabilized Soil Mound
- — Current Extent of Stabilized Soil Material
- - - Approximate Location of Former Slip 5
- 🟨 Approximate Area of Slurry Wall Containment Cell and Hydraulic Control
- 🟩 Approximate Area of Soil Excavation

0 150 300

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

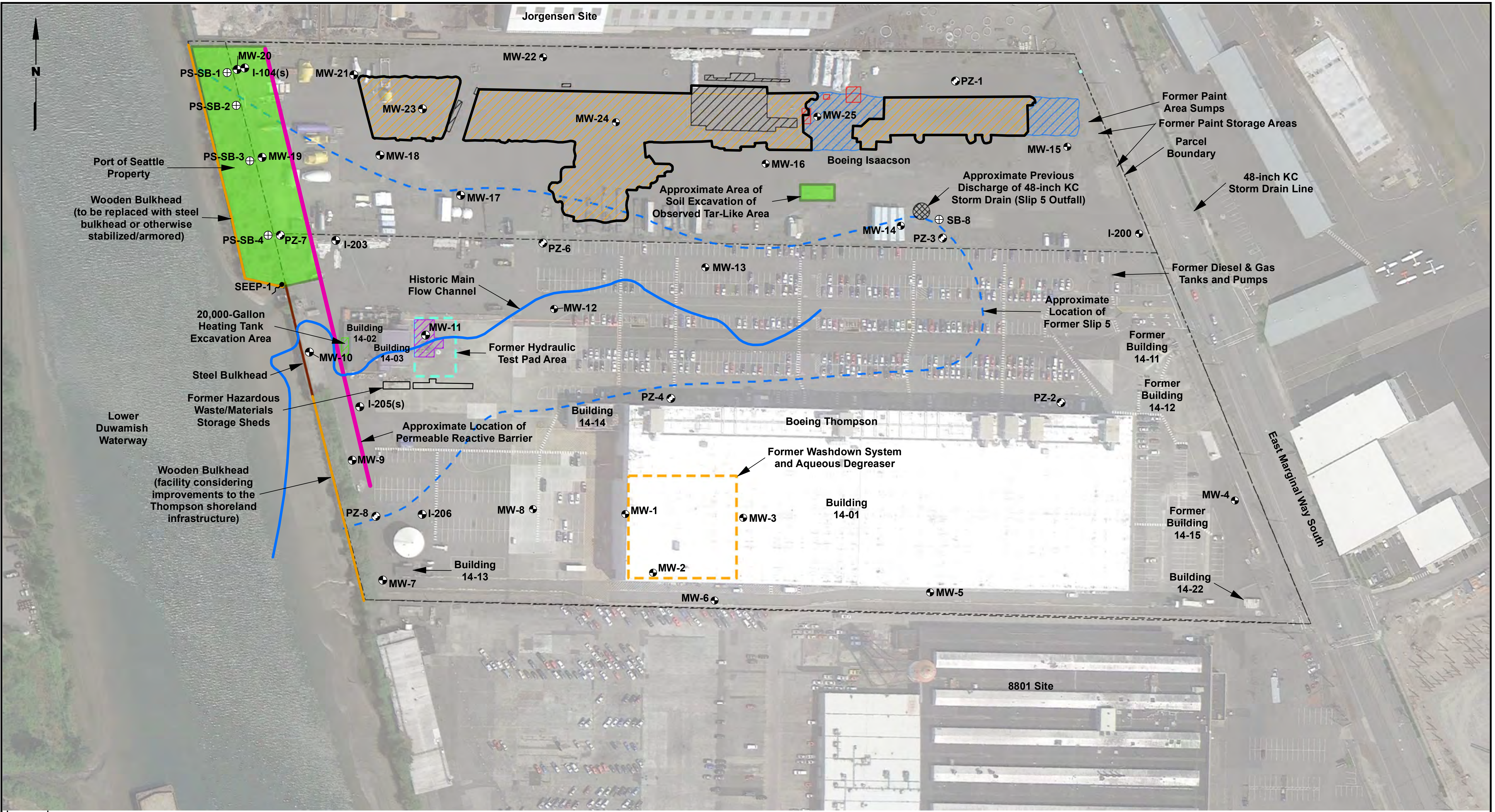
G:\Projects\025\190\218\015\F05-2RIAlt2.mxd 5/15/2023

LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Alternative 2 -
Containment and Hydraulic Control via Capping and Vertical Barrier

Figure
5-2



Legend

MW-22	Monitoring Well Location
PZ-1	Piezometer Location
SB-8	Direct-Push Boring Groundwater Sample Location
SEEP-1	Seep
▨	1984 Excavation
▨	1988 Excavation
▨	1990 Excavation
▨	1991 Excavation
▨	1993-1995 Excavation
▨	2004 Excavation
▨	2008 Removal of Stabilized Soil Mound
—	Current Extent of Stabilized Soil Material
- -	Approximate Location of Former Slip 5
—	Approximate Location of Permeable Reactive Barrier
🟩	Approximate Area of Soil Excavation

Scale in Feet: 0, 150, 300

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data

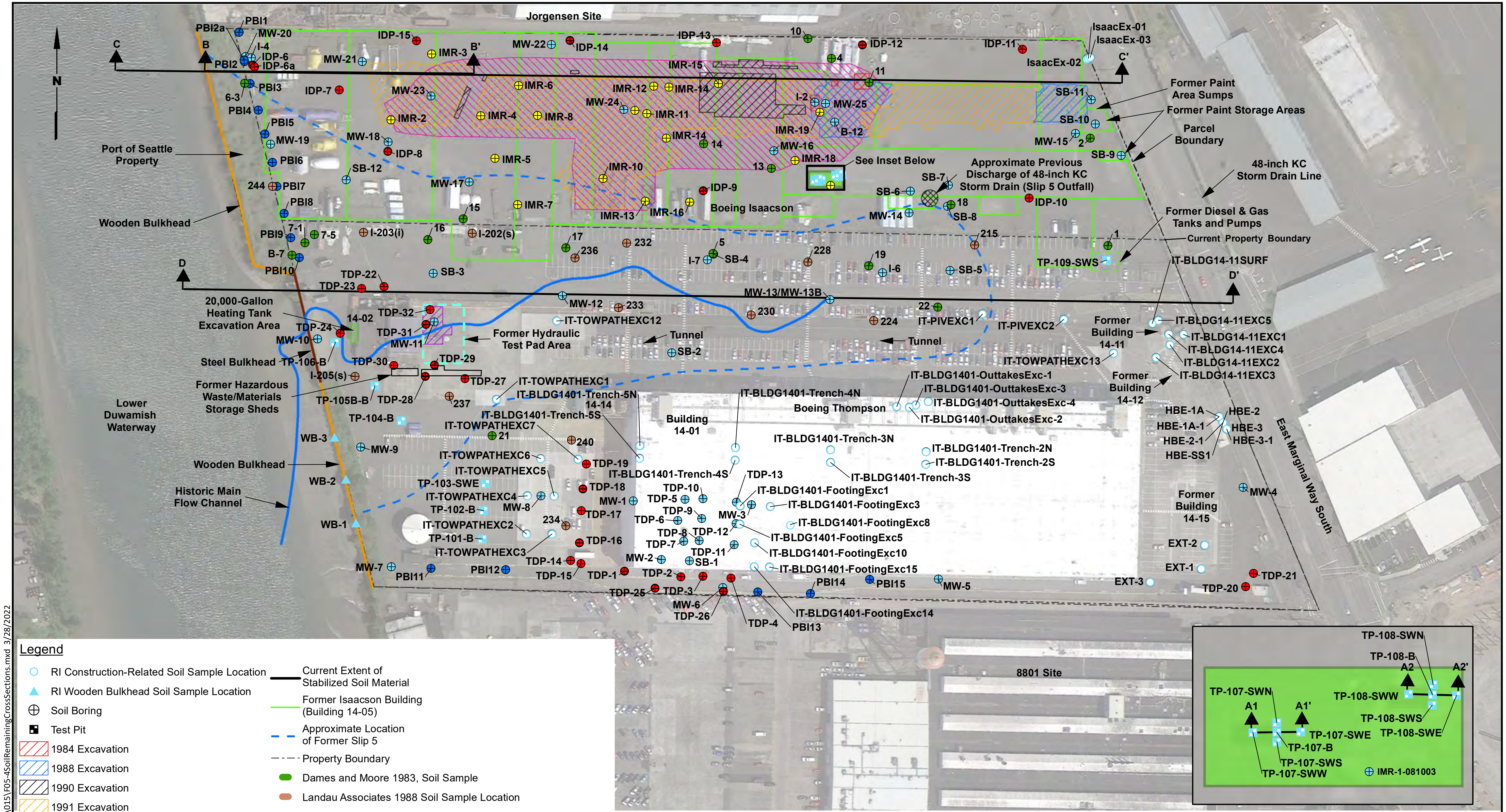
G:\Projects\025\190\218\015\F05-3RIAlt3.mxd 6/8/2023

LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Alternative 3 -
In Situ Groundwater Treatment,
Shoreline Excavation, and Containment

Figure
5-3



Legend

○ RI Construction-Related Soil Sample Location

▲ RI Wooden Bulkhead Soil Sample Location

⊕ Soil Boring

■ Test Pit

▨ 1984 Excavation

▨ 1988 Excavation

▨ 1990 Excavation

▨ 1991 Excavation

▨ 1993-1995 Excavation

▨ 2004 Excavation

▨ 2008 Removal of Stabilized Soil Mound

🟩 Approximate Area of Soil Excavation of Observed Tar-Like Area

— Current Extent of Stabilized Soil Material

— Former Isaacson Building (Building 14-05)

- - Approximate Location of Former Slip 5

-·- Property Boundary

● Dames and Moore 1983, Soil Sample

● Landau Associates 1988 Soil Sample Location

● Landau Associates 2009 Post-Excavation Soil Sample Location

● Landau Associates 2008/2009 Phase II ESA Soil Sample Location

● Landau Associates 2009 Property Boundary Soil Sample Location

● Landau Associates RI Soil Sample Location

▲▲ Cross Section Location

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Google Earth Pro, 2012; King County Parcel Data

0 150 300

Scale in Feet

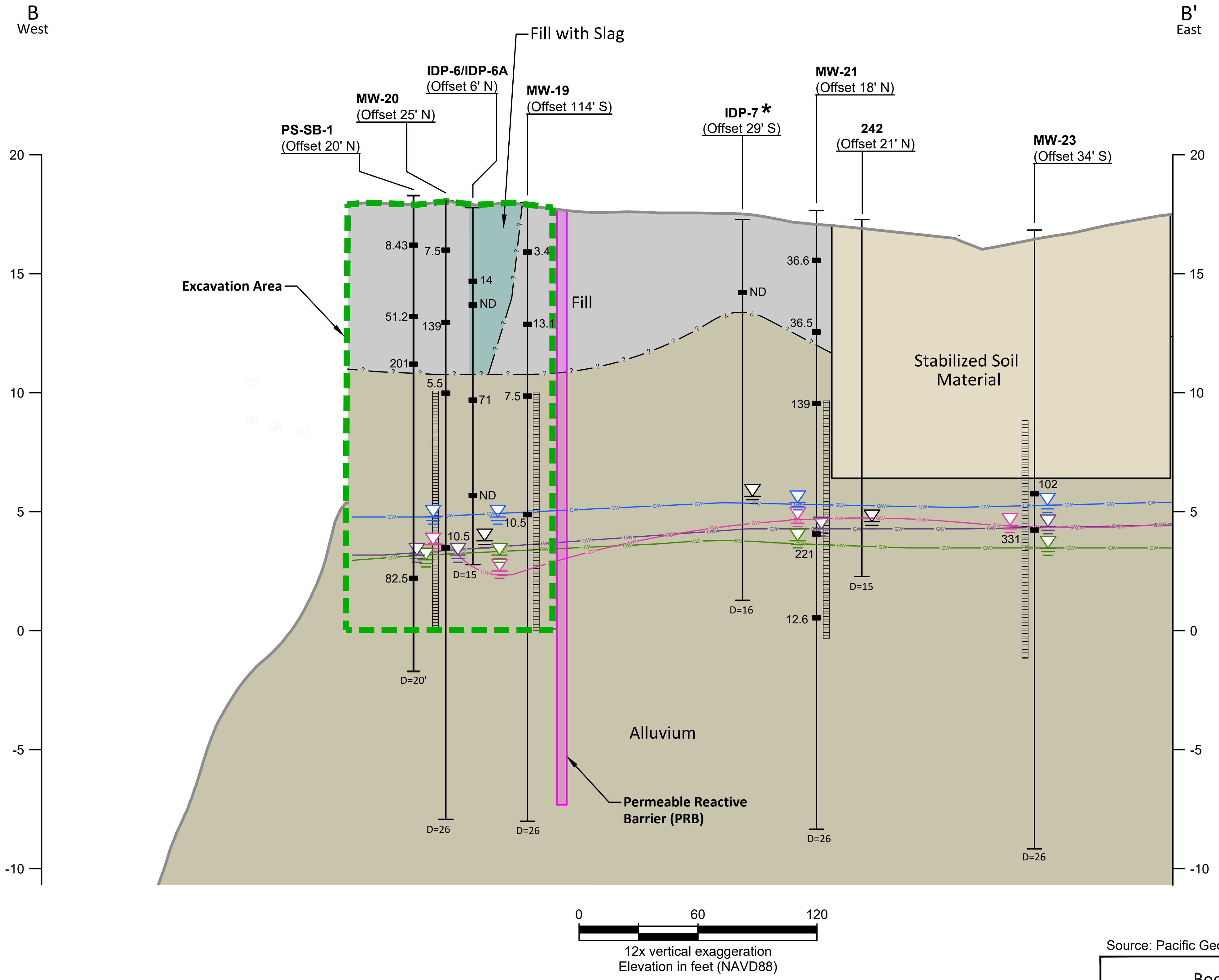
G:\Projects\025\190\218\015\F05-4SoilRemainingCrossSections.mxd 3/28/2022

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Cross-Section Locations

Figure
5-4



Legend

XX — Project Exploration Designation
(Offset 16' W) — Offset Distance in Feet and Direction
Top of Exploration
Soil Sample Location
ND — Arsenic not detected above laboratory reporting limits
36.3 — Arsenic concentration in mg/kg
Groundwater Level (at time of drilling)
Inferred Geologic Contact
Well Screen Interval (if installed)
Bottom of Exploration
D=14 — Depth of Exploration (BGS)

Groundwater Elevation (12/05/12; Q1)
Groundwater Elevation (03/06/12; Q2)
Groundwater Elevation (06/13/12; Q3)
Groundwater Elevation (09/10/12; Q4)

Fill: Brown to light gray fine to coarse sand, silty sand, sandy gravel, and debris (brick, concrete, glass, crushed rock)

Fill with Slag: Brown to light gray fine to coarse sand, silty sand, sandy gravel, and debris with slag, brick, and wood debris

Stabilized Soil Material: Soil mixed with cementitious material

Alluvium: Brown to dark gray silty fine to medium sand, sandy silt, with occasional gravel and organic material

Notes

1. Soil descriptions are generalized, based on interpretation of field and laboratory data. Stratigraphic contacts are interpolated between borings and based on topographic features; actual conditions may vary.
2. For cross-section profile location, see Figure 5-4.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

* 2010 ground surface elevation used as top of boring locations where elevation was missing or could not be resolved.

Source: Pacific Geomatic Services, Inc. 2008, Puget Sound Lidar Consortium 2005

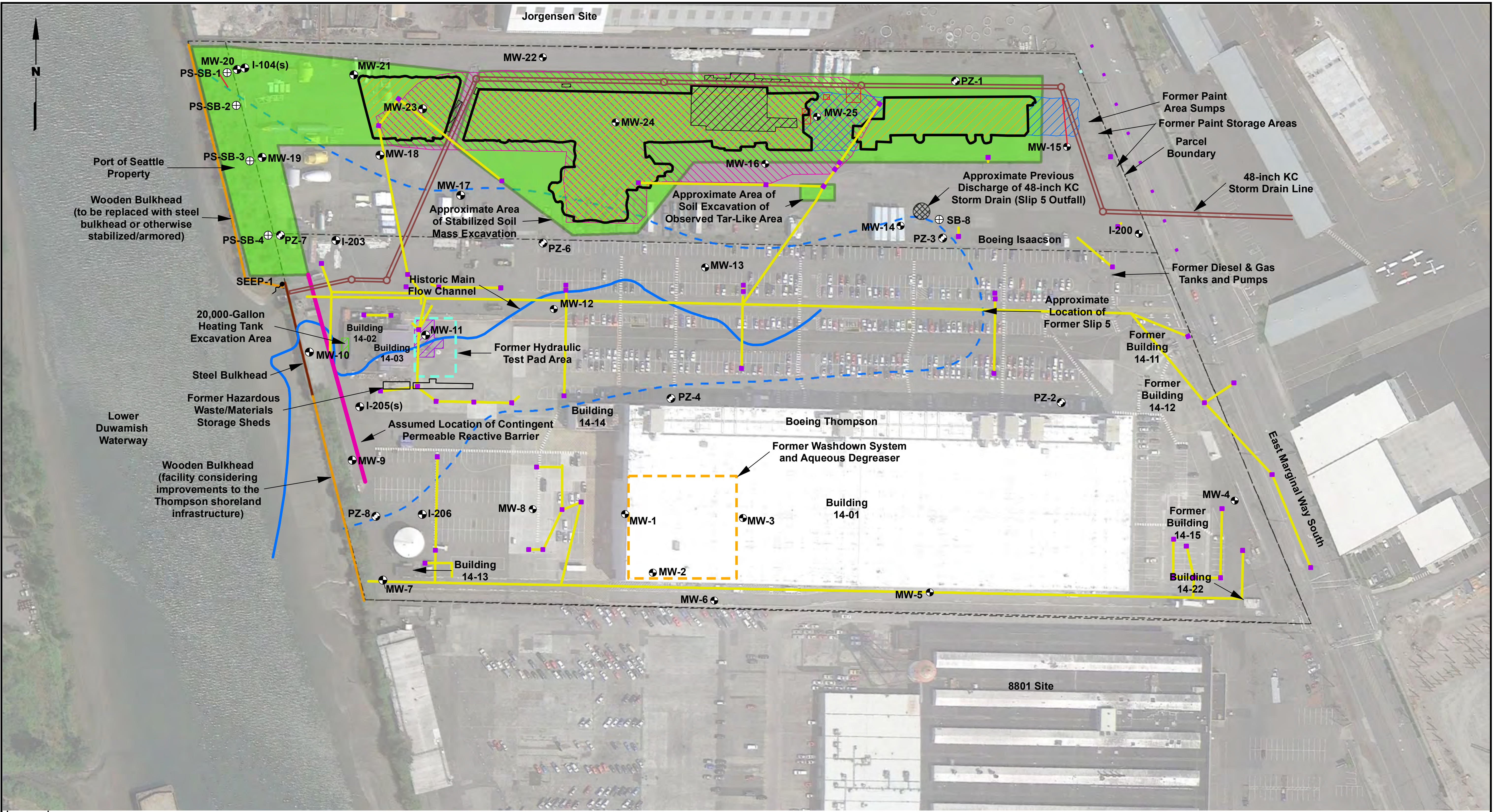
Landau Associates | G:\Projects\025\190\218\015\F05-05 Alt3CrossSectionBB.dwg | 12/21/2020 9:04 AM | EZICK

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Cross-Section B-B'
Alternative 3
Shoreline Excavation and PRB

Figure
5-5



Legend

● MW-22	Monitoring Well Location
● PZ-1	Piezometer Location
⊕ SB-8	Direct-Push Boring Groundwater Sample Location
↗ SEEP-1	Seep
■	Catch Basin Location
—	Existing Storm Drain Line
—	Current Extent of Stabilized Soil Material
- -	Approximate Location of Former Slip 5
—	Approximate Location of Contingent Permeable Reactive Barrier
▨	1984 Excavation
▨	1988 Excavation
▨	1990 Excavation
▨	1991 Excavation
▨	1993-1995 Excavation
▨	2004 Excavation
▨	2008 Removal of Stabilized Soil Mound
🟩	Approximate Area of Soil Excavation

0 150 300

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

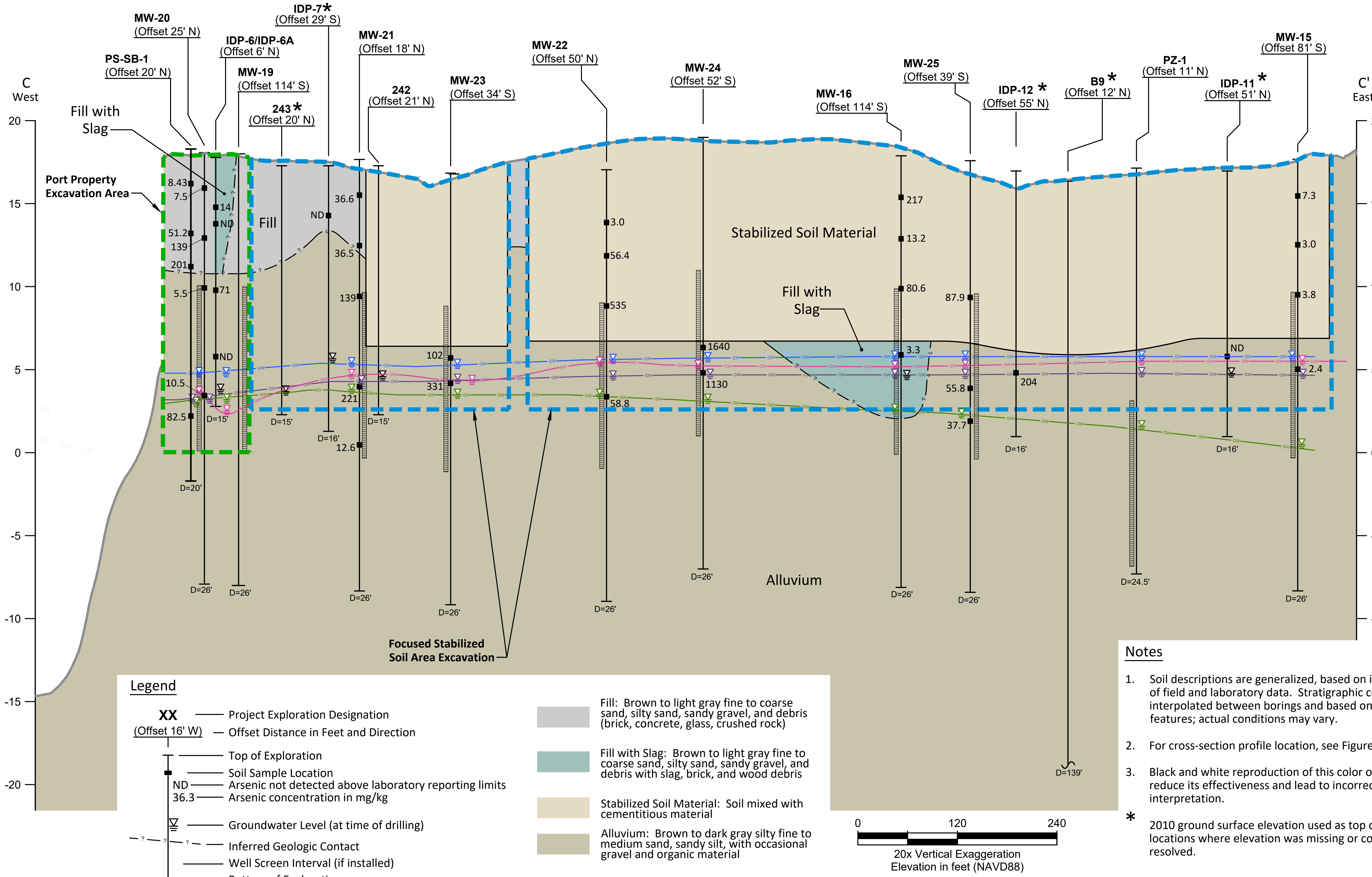
LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

**Alternative 4 -
Focused Excavation and Containment,
and In Situ Groundwater Treatment**

Figure
5-6

G:\Projects\025\190\218\015\F05-6RIAlt4.mxd 3/28/2022



Legend

XX — Project Exploration Designation
(Offset 16' W) — Offset Distance in Feet and Direction
Top of Exploration
Soil Sample Location
ND — Arsenic not detected above laboratory reporting limits
36.3 — Arsenic concentration in mg/kg
Groundwater Level (at time of drilling)
Inferred Geologic Contact
Well Screen Interval (if installed)
Bottom of Exploration
D=14 — Depth of Exploration (BGS)

Fill: Brown to light gray fine to coarse sand, silty sand, sandy gravel, and debris (brick, concrete, glass, crushed rock)
Fill with Slag: Brown to light gray fine to coarse sand, silty sand, sandy gravel, and debris with slag, brick, and wood debris
Stabilized Soil Material: Soil mixed with cementitious material
Alluvium: Brown to dark gray silty fine to medium sand, sandy silt, with occasional gravel and organic material

Groundwater Elevation (12/05/12; Q1)
Groundwater Elevation (03/06/12; Q2)
Groundwater Elevation (06/13/12; Q3)
Groundwater Elevation (09/10/12; Q4)

Notes

1. Soil descriptions are generalized, based on interpretation of field and laboratory data. Stratigraphic contacts are interpolated between borings and based on topographic features; actual conditions may vary.
2. For cross-section profile location, see Figure 5-4.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

* 2010 ground surface elevation used as top of boring locations where elevation was missing or could not be resolved.

Source: Pacific Geomatic Services, Inc. 2008, Puget Sound Lidar Consortium 2005,

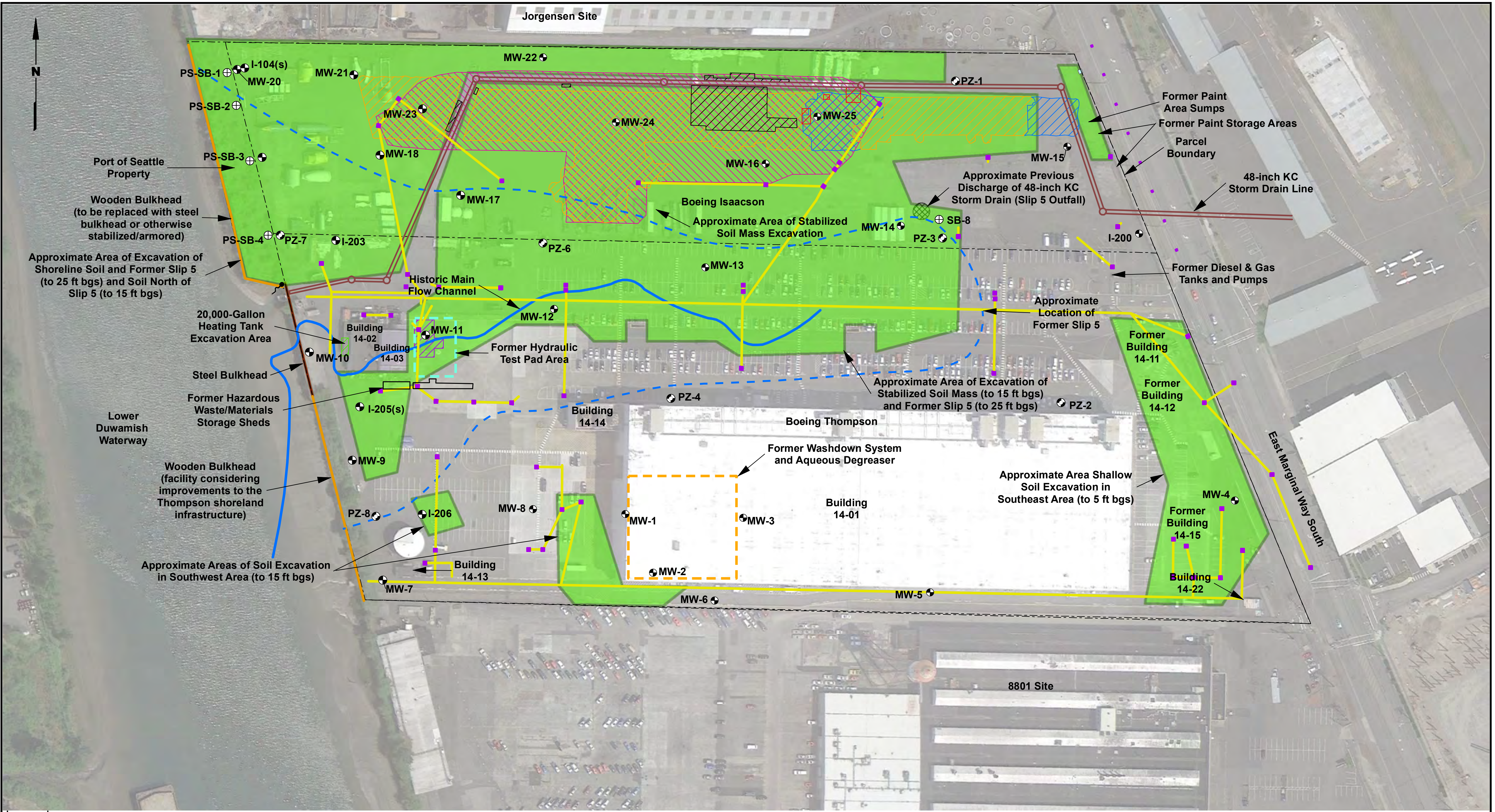
Landau Associates | G:\Projects\025\190\218\015\F05-07 Alt4CrossSectionCC.dwg | 12/20/2020 9:59 PM | EZICK

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Cross-Section C-C'
Alternative 4
Focused Excavation and PRB

Figure
5-7



Legend
MW-22 Monitoring Well Location
PZ-1 Piezometer Location
SB-8 Direct-Push Boring Groundwater Sample Location
SEEP-1 Seep
■ Catch Basin Location
Existing Storm Drain Line
Current Extent of Stabilized Soil Material
Approximate Location of Former Slip 5
▨ 1984 Excavation
▨ 1988 Excavation
▨ 1990 Excavation
▨ 1991 Excavation
▨ 1993-1995 Excavation
▨ 2004 Excavation
▨ 2008 Removal of Stabilized Soil Mound
🟩 Approximate Area of Soil Excavation

0 150 300
Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

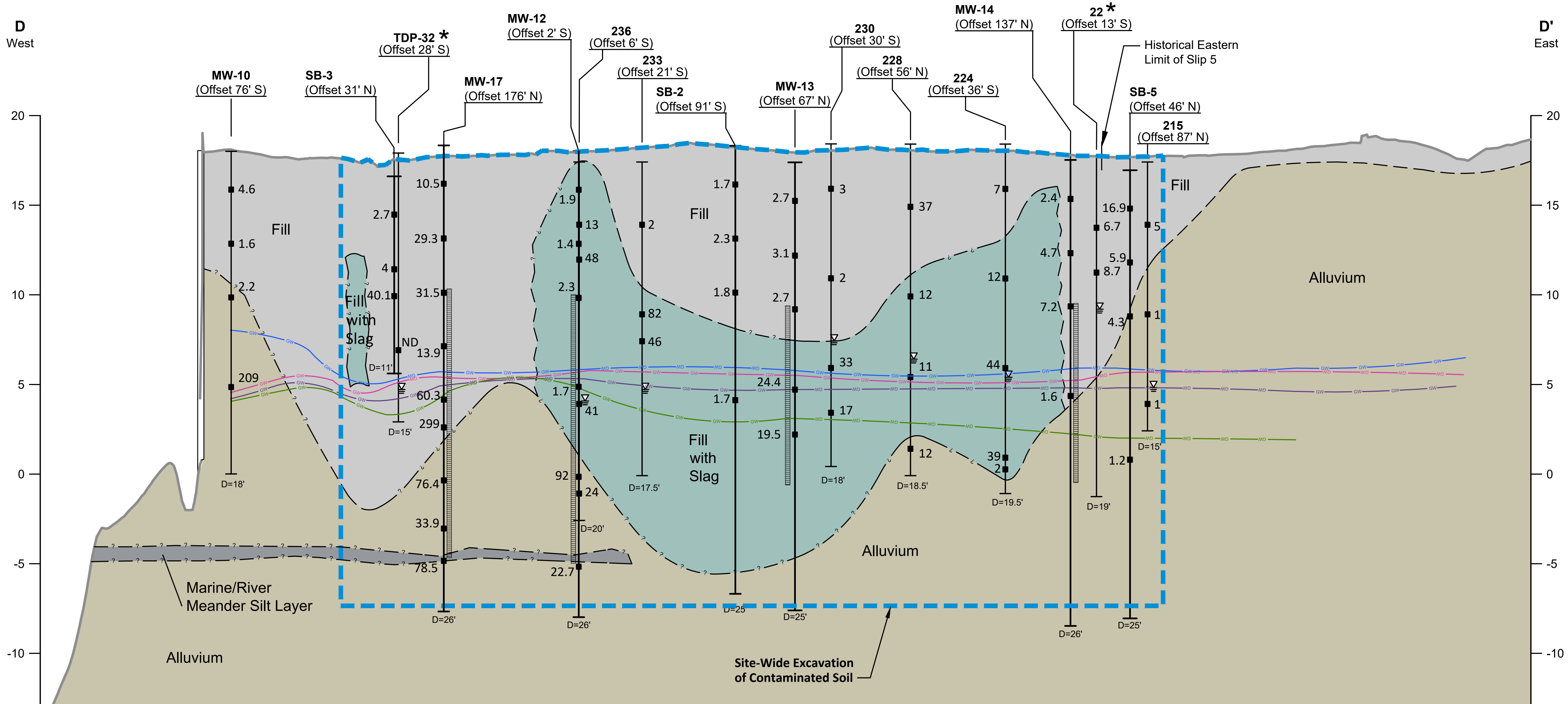
G:\Projects\025\190\218\015\F05-8RIAlt5.mxd 6/8/2023

LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Alternative 5 -
Site-Wide Excavation
of Contaminated Soil

Figure
5-8



Notes

1. Soil descriptions are generalized, based on interpretation of field and laboratory data. Stratigraphic contacts are interpolated between borings and based on topographic features; actual conditions may vary.
2. For cross-section profile location, see Figure 5-4.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

* 2010 ground surface elevation used as top of boring locations where elevation was missing or could not be resolved.

Legend

XX — Project Exploration Designation
(Offset 16' W) — Offset Distance in Feet and Direction
— Top of Exploration
■ — Soil Sample Location
ND — Arsenic not detected above laboratory reporting limits
36.3 — Arsenic concentration in mg/kg
▽ — Groundwater Level (at time of drilling)
— ? — ? — Inferred Geologic Contact
— Well Screen Interval (if installed)
— Bottom of Exploration
D=14 — Depth of Exploration (BGS)

▨ Fill: Brown to light gray fine to coarse sand, silty sand, sandy gravel, and debris (brick, concrete, glass, crushed rock)

▨ Fill with Slag: Brown to light gray fine to coarse sand, silty sand, sandy gravel, and debris with slag, brick, and wood debris

▨ Alluvium: Brown to dark gray silty fine to medium sand, sandy silt, with occasional gravel and organic material

GW ▽ — Groundwater Elevation (12/05/12; Q1)
GW ▽ — Groundwater Elevation (03/06/12; Q2)
GW ▽ — Groundwater Elevation (06/13/12; Q3)
GW ▽ — Groundwater Elevation (09/10/12; Q4)

Source: Pacific Geomatic Services, Inc. 2008, Puget Sound Lidar Consortium 2005,

0 120 240
20x Vertical Exaggeration
Elevation in feet (NAVD88)

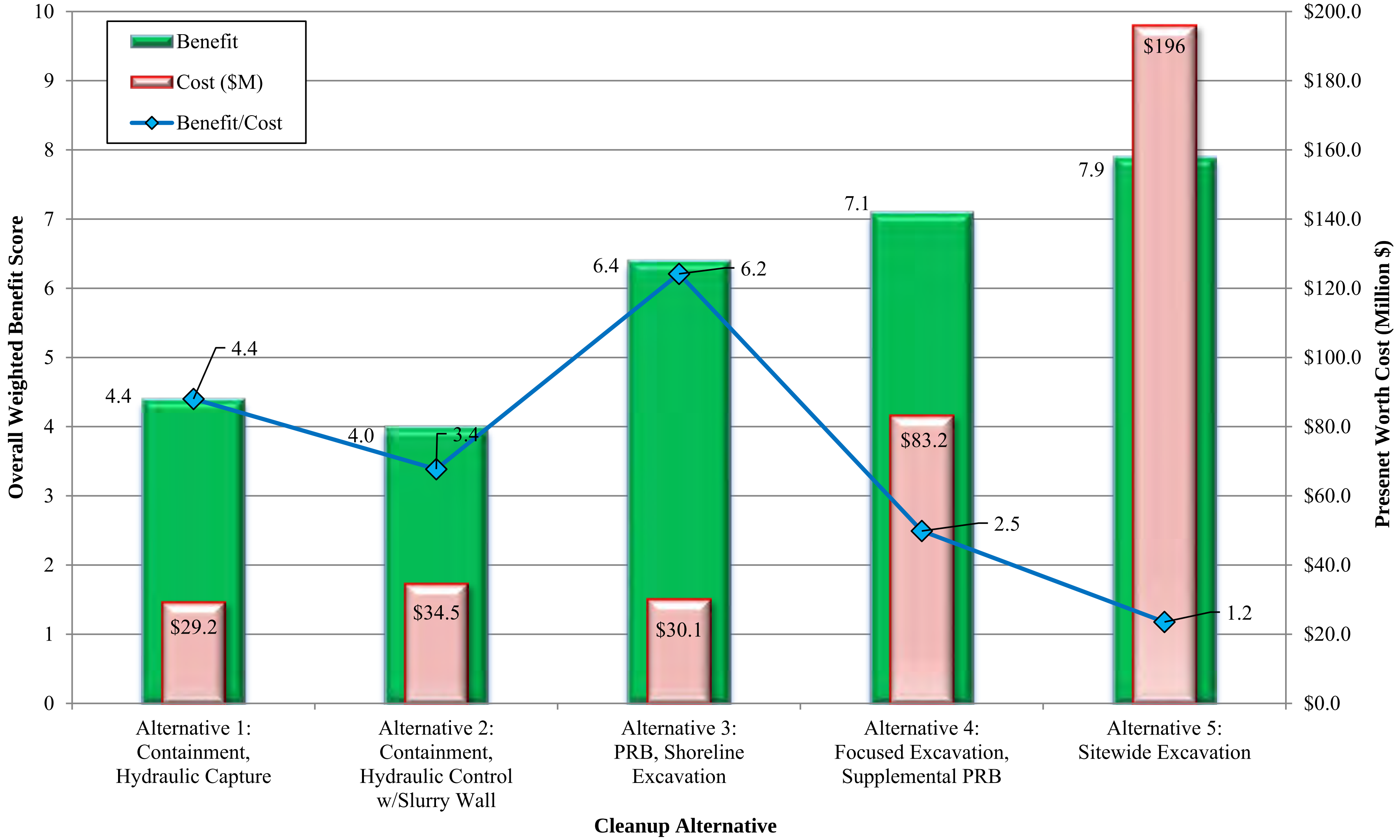
Landau Associates | G:\Projects\025\190\218\015\F05-09 Alt5CrossSectionDD.dwg | 6/8/2023 1:20 PM | EZICK

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Cross-Section D-D'
Alternative 5
Site-Wide Excavation

Figure
5-9



LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Summary of MTCA Alternatives Relative Benefits Ranking

Figure
6-1

Table 2-1a
Proposed Cleanup Levels: Groundwater
Boeing Isaacson-Thompson
Feasibility Study

GROUNDWATER	I-T RI Groundwater Preliminary CUL (µg/L)	Human Health Criteria for Consumption of Organisms; WAC 173-201A or 40 CFR 131.45 (µg/L)	Marine Aquatic Criteria (lowest of ARARs) (µg/L)	Protection of Surface Water (Ecology 2018/2019) (µg/L)	Protection of Sediment (Ecology 2018/2019) (µg/L)	Groundwater Screening Level Protective of Indoor Air (Ecology 2018/2019) (µg/L)	PQLs (µg/L)	Background (µg/L)	Revised Groundwater pCUL (µg/L)	Basis
VOLATILES										
Acrylonitrile	0.057	0.028	0.028	0.028	--	--	0.6*	--	0.6	Method 8260 PQL. Eliminated as COC because no detections above 0.6 µg/L pCUL (PQL).
Trichloroethene	1.4	0.7	0.7	0.7	--	1.5	0.02*	--	0.7	Protection of Surface Water (40 CFR 131.45). Eliminated as COC because only exceedances of pCUL occurred at MW-6 and MW-7, which are located within the 8801 VOC plume footprint and are not a result of I-T operations.
1,1-Dichloroethene	3.2	4,000	4,000	4,000	--	130	0.05*	--	4,000	Protection of Surface Water (40 CFR 131.45). Eliminated as COC because no detections above 4,000 µg/L pCUL (or above 130 µg/L VI screening level).
cis-1,2-Dichloroethene	130	--	--	--	--	--	0.1*	--	--	No applicable CULs (groundwater not potable).
Vinyl Chloride	0.53	0.18	0.18	0.18	--	0.35	0.05*	--	0.18	Protection of Surface Water (40 CFR 131.45).
SEMIVOLATILES										
bis(2-ethylhexyl)phthalate	1.2	0.046	0.046	0.046	0.62	--	5	--	5	Method 8270E PQL based on Ecology's recommended PQL from comment letter December 29, 2021. Eliminated as COC for groundwater because the maximum detected concentration (3.7 µg/L) is less than the pCUL.
Total cPAH TEQ	0.00018	--	--	0.000016	0.005	--	0.048 (a)*	--	0.048	Method 8270 SIM PQL. Eliminated as COC for groundwater - only one detection above 0.048 µg/L pCUL (TEQ PQL) at one location (Seep-1) during one of four quarterly sampling events.
PCBs										
Total PCBs	0.000023	0.000007	0.000007	0.000007	0.022	--	0.01 **	--	0.01	Method 8082 PQL = 0.01 µg/L (**ARI)
TOTAL PETROLEUM HYDROCARBONS										
Diesel-Range Organics	500	--	--	--	--	--	100*	--	500	Method A. Eliminated as COC because no detections above 500 µg/L pCUL in groundwater. Only one detection of total DRO + ORO above 500 µg/L at one location (MW-24) during one of four quarterly sampling events.
Oil-Range Organics	500	--	--	--	--	--	300*	--		
Gasoline-Range Organics	1,000/800	--	--	--	--	--	200*	--	1,000	Method A. Eliminated as COC because no detections above 1,000 µg/L pCUL in groundwater.
METALS										
Antimony	150	90	90	90	--	--	0.3*	--	90	Protection of Surface Water (40 CFR 131.45). Eliminated as COC because no detections above 90 µg/L pCUL in groundwater.
Arsenic	8	0.14	0.098	0.14	220	--	0.4*	8	8	Background (b)
Barium	770	--	--	200	830,000	--	0.4*	--	200	Protection of surface water (Marine Aquatic Criteria). Eliminated as COC because only one detection above 200 µg/L pCUL (PZ-7) during one of four quarterly sampling events.
Beryllium	12	--	270	76	4.4	--	0.1*	--	4.4	Protection of Sediment. Eliminated as COC because no detections above 4.4 µg/L pCUL in groundwater.

Table 2-1a
Proposed Cleanup Levels: Groundwater
Boeing Isaacson-Thompson
Feasibility Study

GROUNDWATER	I-T RI Groundwater Preliminary CUL (µg/L)	Human Health Criteria for Consumption of Organisms; WAC 173-201A or 40 CFR 131.45 (µg/L)	Marine Aquatic Criteria (lowest of ARARs) (µg/L)	Protection of Surface Water (Ecology 2018/2019) (µg/L)	Protection of Sediment (Ecology 2018/2019) (µg/L)	Groundwater Screening Level Protective of Indoor Air (Ecology 2018/2019) (µg/L)	PQLs (µg/L)	Background (µg/L)	Revised Groundwater pCUL (µg/L)	Basis
Cadmium	0.25	--	7.9	7.9	1.2	--	0.3*	--	1.2	Protection of Sediment. Eliminated as COC because no detections above 1.2 µg/L pCUL in groundwater.
Chromium III or Total Chromium	74	--	240,000	27	76	--	0.3*	--	27	Protection of Surface Water (Marine Aquatic Criteria). Eliminated as COC because maximum detection is less than 2x the pCUL and number of exceedances is less than 10% (see Table 2-4a).
Chromium VI	0.58	--	0.13	50	45,000	--	25*	--	50	Protection of Surface Water (Aquatic Life, Chronic). Eliminated as COC because no detections above 50 µg/L pCUL in groundwater.
Copper	8	--	3.1	3.1	14	--	1.5*	--	3.1	Protection of Surface Water
Lead	2.5	--	8.1	8.1	19	--	0.6*	--	8.1	Protection of Surface Water. Eliminated as COC because no detections above 8.1 µg/L pCUL in groundwater.
Mercury	0.012	N/A (c)	0.025	0.025	2	--	0.00045*	--	0.025	Protection of Surface Water (Aquatic Life, Chronic)
Nickel	8.2	100	8.2	8.2	2,300	--	0.3*	--	8.2	Protection of Surface Water (Aquatic Life, Chronic)
Selenium	5	200	71	71	390,000	--	6*	--	71	Protection of Surface Water (Aquatic Life, Chronic). Eliminated as COC because no detection above 71 µg/L pCUL in groundwater.
Thallium	0.47	0.27	0.22	0.062	23	--	0.2*	--	0.2	Method 200.8 PQL. Eliminated as COC because only detection above 0.2 µg/L pCUL (PQL) at one location (MW-23) during two of four quarterly sampling events.
Zinc	56	1,000	81	81	770	--	4*	---	81	Protection of Surface Water (Aquatic Life, Chronic)

Table 2-1a
Proposed Cleanup Levels: Groundwater
Boeing Isaacson-Thompson
Feasibility Study

Abbreviations and Acronyms:

-- = not available
μg/L = micrograms per liter
ARAR = applicable or relevant and appropriate requirement
ARI = Analytical Resources, Inc.
CFR = Code of Federal Regulations
COC = contaminant of concern
cPAHs = carcinogenic polycyclic aromatic hydrocarbons
CUL = cleanup level
DRO = diesel-range organics
Ecology = Washington State Department of Ecology
EPA = US Environmental Protection Agency
IHS = indicator hazardous substance
I-T = Isaacson-Thompson
LDW = Lower Duwamish Waterway
mg/kg = milligrams per kilogram
MTCA = Model Toxics Control Act
N/A = not applicable
ORO = oil-range organics
PCBs = polychlorinated biphenyls
pCUL = proposed cleanup level
PQL = practical quantitation limit
RI = remedial investigation
SIM = selected ion monitoring
TCE = trichloroethene
TEF = total equivalency factor
TEQ = total equivalency quotient
VI = vapor intrusion
VOC = volatile organic compound
WAC = Washington Administrative Code

Notes:

(a) TEQ PQL value developed based on Ecology Implementation Memo # 11 (Ecology 2015; i.e., sum of individual cPAH PQLs x TEFs) using Ecology Representative PQLs.
(b) Based on EPI et al. 2006, and Ecology's draft Natural Background Arsenic Concentrations in Washington State (July 2021).
(c) Only mercury criterion is for methylmercury expressed as the fish tissue concentration of methylmercury (mg methylmercury/kg fish). See Water Quality Criterion for the Protection of Human Health: Methylmercury (EPA 2001) for how this value is calculated using the criterion equation in EPA's 2000 Human Health Methodology rearranged to solve for a protective concentration in fish tissue rather than in water.
(d) Soil preliminary CULs are based on direct human contact and protection of groundwater.
(e) Benzene is detected in soil on Site (lower GRO value of 100/30 mg/kg selected).
*PQL from Test America Laboratory in Tacoma, Washington (Boeing's contract laboratory).
**PQL from Analytical Resources, Inc. Laboratory in Tukwila, Washington (used for PCBs to get low-level reporting limits).
***MTCA Method A values.
CULs protective of surface water standards will be met at the conditional point of compliance, as described in the feasibility study.

Blue = compound identified as an IHS in Feasibility Study.
Gray = contaminant eliminated as a COC in media identified (pCULs not applicable for media; darker grey indicates value that would have been pCUL).
Yellow = value used for basis of pCUL.

Reference Reports:

Ecology. 2021. Draft, Natural Background Arsenic Concentrations in Washington State. Washington State Department of Ecology. https://ecology.wa.gov/Events/TCP/Program-and-Policy/Study-Results-of-Natural-Background-Groundwater-Ar. July.
Ecology. 2018. DRAFT: Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action. Washington State Department of Ecology. April.
Ecology. 2018/2019. Lower Duwamish Waterway Preliminary Cleanup Level Workbook Supplemental Information/LDW PCUL Workbook. Washington State Department of Ecology. December 2018/April 2019.
Ecology. 2015. "Dioxins, Furans, and Dioxin-Like PCB Congeners: Addressing Non-Detects and Establishing PQLs for Ecological Risk Assessments in Upland Soil, Implementation Memorandum #11, Publication No. 15-09-048 (July 2015)." Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/documents/1509048.pdf.
EPA. 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury. Final. EPA-823-R-01-001. US Environmental Protection Agency. January 3.
EPI, Floyd-Snyder, and Golder Associates. 2006. Technical Memorandum: Development and Use of Background Values, Boeing Plant 2, Seattle/Tukwila, Washington. Environmental Partners, Inc. (EPI), Floyd-Snyder, and Golder Associates, Inc. March 30.

Table 2-1b
Proposed Cleanup Levels: Soil
Boeing Isaacson-Thompson
Feasibility Study

SOIL	I-T RI Soil pCUL (d) (mg/kg)	Soil Protective of Surface Water via Groundwater - Vadose (Ecology 2018/2019) (mg/kg)	Soil Protective of Surface Water via Groundwater - Saturated (Ecology 2018/2019) (mg/kg)	Protection of Sediment (Ecology 2018/2019) (mg/kg)	MTCA Method B Soil - Direct Contact (mg/kg)	PQLs (mg/kg)	Natural Background (Ecology 2018/2019)	Revised Soil pCUL (mg/kg)	Basis
VOLATILES									
Trichloroethene	51	0.0044	0.00027	--	12	0.002	--	0.004 unsaturated / 0.002 saturated	Protection of Surface Water. Eliminated as COC only one detect north of the 8801 TCE plume that exceeds the saturated or unsaturated protection of surface water criteria, so statistically insignificant (saturated exceedance concentration = 0.0021 mg/kg).
1,1-Dichloroethene	81	25	1.4	--	4000	0.003*	--	1.4	Protection of Surface Water. Eliminated as COC because no detections in soil.
Vinyl Chloride	7.4	0.001	0.000055	--	0.67	0.002*	--	0.002	Method 8260D PQL. Eliminated as COC because no detections above 0.002 mg/kg pCUL, except at MW-6, which is part of the 8801 VOC plume and due to migration from off-site source.
SEMIVOLATILES									
bis(2-ethylhexyl)phthalate	56.6	0.1	0.0051	1.3	71	0.12	--	0.12	Method 8270E PQL based on Ecology's recommended PQL from comment letter December 29, 2021.
Total cPAH TEQ	0.015	0.00031	0.000016	0.59	0.19	0.0076 (a)*	--	0.0076	Method 8270E SIM PQL.
PCBs									
Total PCBs	0.0018	0.000043	0.0000022	0.002	1***	0.02*	--	0.020	Method 8082A PQL.
TOTAL PETROLEUM HYDROCARBONS									
Diesel-Range Organics	2,000	--	--	--	2,000***	30*	--	2,000	MTCA Method A. CUL is sum of DRO and ORO if from unknown source and/or no distinct product releases have been identified. Other than three detections in test pit TP-108 (tar-like substance area), only one detection total DRO + ORO above 2,000 mg/kg in MW-17 boring (15.5-17 feet; 2,700 mg/kg).
Oil-Range Organics	2,000	--	--	--	2,000***	30*	--		
Gasoline-Range Organics	100/30	--	--	--	30***	4.6*	--	30 (e)	MTCA Method A
METALS									
Antimony	5	81	4.1	97	32	0.3*	--	4.1	Protection of Surface Water. Eliminated as COC, because no detections above 4.1 mg/kg pCUL (max antimony detection of 3.9 mg/kg on Isaacson-Thompson property and max detection of 19.2 mg/kg on Port Property, see Appendix A1 and A2).
Arsenic	7	0.082	0.0041	7.0	0.67	0.4*	7	7	Natural background.
Barium	640	165	8.3	48,667	16,000	0.4*	--	160	Protection of Surface Water (through the groundwater leaching pathway) for saturated soils is not applicable for barium at this site, because barium is not impacting groundwater, even though all of the samples collected in saturated zone soil exceeded the protection of surface water for saturated soils value (8.3 mg/kg). Therefore, only the Protection of Surface Water for vadose zone soils should be applicable.

Table 2-1b
Proposed Cleanup Levels: Soil
Boeing Isaacson-Thompson
Feasibility Study

SOIL	I-T RI Soil pCUL (d) (mg/kg)	Soil Protective of Surface Water via Groundwater - Vadose (Ecology 2018/2019) (mg/kg)	Soil Protective of Surface Water via Groundwater - Saturated (Ecology 2018/2019) (mg/kg)	Protection of Sediment (Ecology 2018/2019) (mg/kg)	MTCA Method B Soil - Direct Contact (mg/kg)	PQLs (mg/kg)	Natural Background (Ecology 2018/2019)	Revised Soil pCUL (mg/kg)	Basis
Beryllium	160	1200	60	487	160	0.3*	0.6	3.5	Protection of Sediment. Eliminated as COC because no detections above 0.8 mg/kg.
Cadmium	1.3	1.1	0.055	5.1	80	0.2*	0.77	0.77	Natural background.
Chromium (III or total)	1,480	550	27	260	120,000	0.25*	48	48	Natural background.
Chromium (VI)	3.8	19	0.96	1.1	0.38	1.0*	--	0.96	Protection of Surface Water.
Copper	36	1.4	0.069	390	3,200	0.60*	36	36	Background
Lead	250	1600	81	450	250***	0.19*	24	81	Protection of Surface Water
Mercury	1.5	0.026	0.0013	0.41	2***	0.0008*	0.07	0.07	Natural background.
Nickel	210	11	0.54	4,867	1,600	0.50*	48	48	Natural background.
Selenium	1	7.4	0.38	1,217	400	3	--	3	Method 6010D PQL based on Ecology's recommended PQL from comment letter December 29, 2021. Eliminated as COC because no detections above 0.96 mg/kg.
Thallium	0.67	0.088	0.0044	2.4	0.8	2	--	2	Method 6010D PQL based on Ecology's recommended PQL from comment letter December 29, 2021. Eliminated as COC because no detections above 1.1 mg/kg.
Zinc	1,400	100	5	410	24,000	5.0*	85	85	Background

Table 2-1b
Proposed Cleanup Levels: Soil
Boeing Isaacson-Thompson
Feasibility Study

Abbreviations and Acronyms:

-- = not available
μg/L = micrograms per liter
ARAR = applicable or relevant and appropriate requirement
ARI = Analytical Resources, Inc.
CFR = Code of Federal Regulations
COC = contaminant of concern
cPAHs = carcinogenic polycyclic aromatic hydrocarbons
CUL = cleanup level
DRO = diesel-range organics
Ecology = Washington State Department of Ecology
EPA = US Environmental Protection Agency
IHS = indicator hazardous substance
I-T = Isaacson-Thompson
LDW = Lower Duwamish Waterway
mg/kg = milligrams per kilogram
MTCA = Model Toxics Control Act
N/A = not applicable
ORO = oil-range organics
PCBs = polychlorinated biphenyls
pCUL = proposed cleanup level
PQL = practical quantitation limit
RI = remedial investigation
SIM = selected ion monitoring
TCE = trichloroethene
TEF = total equivalency factor
TEQ = total equivalency quotient
VI = vapor intrusion
VOC = volatile organic compound
WAC = Washington Administrative Code

Notes:

(a) TEQ PQL value developed based on Ecology Implementation Memo # 11 (Ecology 2015; i.e., sum of individual cPAH PQLs x TEFs) using Ecology Representative PQLs.
(b) Based on EPI et al. 2006, and Ecology's draft Natural Background Arsenic Concentrations in Washington State (July 2021).
(c) Only mercury criterion is for methylmercury expressed as the fish tissue concentration of methylmercury (mg methylmercury/kg fish). See Water Quality Criterion for the Protection of Human Health: Methylmercury (EPA 2001) for how this value is calculated using the criterion equation in EPA's 2000 Human Health Methodology rearranged to solve for a protective concentration in fish tissue rather than in water.
(d) Soil preliminary CULs are based on direct human contact and protection of groundwater.
(e) Benzene is detected in soil on Site (lower GRO value of 100/30 mg/kg selected).
*PQL from Test America Laboratory in Tacoma, Washington (Boeing's contract laboratory).
**PQL from Analytical Resources, Inc. Laboratory in Tukwila, Washington (used for PCBs to get low-level reporting limits).
***MTCA Method A values.
CULs protective of surface water standards will be met at the conditional point of compliance, as described in the feasibility study.

Blue = compound identified as an IHS in Feasibility Study.
Gray = contaminant eliminated as a COC in media identified (pCULs not applicable for media; darker grey indicates value that would have been pCUL).
Yellow = value used for basis of pCUL.

Reference Reports:

Ecology. 2021. Draft, Natural Background Arsenic Concentrations in Washington State. Washington State Department of Ecology. https://ecology.wa.gov/Events/TCP/Program-and-Policy/Study-Results-of-Natural-Background-Groundwater-Ar. July.
Ecology. 2018. DRAFT: Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action. Washington State Department of Ecology. April.
Ecology. 2018/2019. Lower Duwamish Waterway Preliminary Cleanup Level Workbook Supplemental Information/LDW PCUL Workbook. Washington State Department of Ecology. December 2018/April 2019.
Ecology. 2015. "Dioxins, Furans, and Dioxin-Like PCB Congeners: Addressing Non-Detects and Establishing PQLs for Ecological Risk Assessments in Upland Soil, Implementation Memorandum #11, Publication No. 15-09-048 (July 2015)." Washington State Department of Ecology. https://fortress.wa.gov/ecy/publications/documents/1509048.pdf.
EPA. 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury. Final. EPA-823-R-01-001. US Environmental Protection Agency. January 3.
EPI, Floyd-Snyder, and Golder Associates. 2006. Technical Memorandum: Development and Use of Background Values, Boeing Plant 2, Seattle/Tukwila, Washington. Environmental Partners, Inc. (EPI), Floyd-Snyder, and Golder Associates, Inc. March 30.

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Groundwater Proposed Cleanup Levels	Sample Location, Lab SDG, Sample Date														
		IT-I-104 UA54/UA55/ UB47 12/08/2011	IT-I-104 1295418/ UM31 3/13/2012	Dup of IT-I-104 IT-DUP-2 1295418/ UM31 3/13/2012	IT-I-104 1316071/ UY55 6/14/2012	Dup of IT-I-104 IT-DUP-1 1316071/ UY55 6/14/2012	IT-I-104 1335483/ VJ32 9/12/2012	Dup of IT-I-104 IT-DUP-1 1335483/ VJ32 9/12/2012	IT-I-200 UA86/ UA87 12/12/2011	IT-I-200 1293530/ UK92 03/06/2012	IT-I-200 1315688/ UY34 6/13/2012	IT-I-200 1335480/ VJ03 9/11/2012	IT-I-203 UA44/UA45/ UB46 12/07/2011	IT-I-203 1296009/ UM84 3/15/2012	IT-I-203 1316296/ UZ00 6/15/2012	IT-I-203 1335688/ VJ53 9/13/2012
Volatiles (µg/L; SW-846 8260C)																
1,1-Dichloroethene	4,000	0.2 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Acrylonitrile	0.6	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	0.7	0.2 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Vinyl Chloride	0.18	0.2 U	0.1 U	0.1 U	0.1 U	**0.1 J1**	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Volatiles (µg/L; SW-846 8260C-SIM)																
Acrylonitrile	0.6	0.050 U	--	--	--	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--
Vinyl Chloride	0.18	**0.085**	**0.090 J**	**0.085**	**0.075**	**0.084**	**0.082**	**0.091**	0.020 U	0.010 U	0.010 U	**0.020**	0.020 U	0.010 U	0.010 U	0.010 U
Semivolatiles (µg/L; SW-846 8270D)																
bis(2-Ethylhexyl)phthalate	5	1.0 U	2 U	2 U	2 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U
Polycyclic Aromatic Hydrocarbons (µg/L; SW-846 8270D-SIM)																
cPAH TEQ	0.048	ND	ND	ND	ND	ND	ND	**0.0005 J**	ND	ND	ND	ND	ND	**0.001 J**	ND	**0.0005 J**
Polychlorinated Biphenyls (µg/L; SW-846 8082)																
Total PCBs	0.01	ND	ND	ND	ND	**0.0075 J**	ND	ND	ND	ND	ND	ND	**0.010**	**0.019**	**0.024**	**0.019**
Total Petroleum Hydrocarbons (µg/L; NWTPH-Dx/-Gx)																
Gasoline-Range Organics	1,000	250 U	50 U	50 U	50 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U
Diesel-Range Organics	500	100 U	73 U	67 U	29 U	25 U	29 U	29 U	100 U	67 U	**41 J1**	29 U	100 U	70 U	29 U	28 U
Oil-Range Organics		200 U	1000 U	950 U	68 U	66 U	68 U	67 U	200 U	950 U	74 U	68 U	200 U	1000 U	67 U	66 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	**41 J1**	ND	ND	ND	ND	ND
Total Metals (µg/L; EPA 200.8)																
Antimony	90	0.2 U	0.42 U	0.42 U	0.42 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.42 U	0.33 U	0.2 U	**0.77 J1**	0.33 U	0.33 U
Arsenic	8	**2,310**	**2,900 J**	**2,140 J**	**1,140**	**988**	**1,080**	**1,210**	**1.1**	0.95 U	**1.8 J1**	**6.2**	**3**	**2.4**	**1.5 J1**	**2.3**
Barium	200	**6.7**	**7.7**	**8.3**	**5.4**	**5.4**	**6.9**	**5.8**	**2.4**	**1.4 J1**	**11.3**	**14.2 J**	**76.5**	**41.2**	**31.6**	**152**
Beryllium	4.4	0.2 U	0.13 U	0.13 U	0.13 U	0.13 U	**0.067 J1**	**0.073 J1**	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	0.025 U	0.025 U
Cadmium	1.2	0.1 U	0.20 U	0.20 U	0.20 U	0.20 U	0.082 U	0.082 U	0.1 U	0.20 U	0.20 U	0.082 U	0.1 U	**0.28 J1**	0.048 U	0.082 U
Chromium	27	**2.6**	**4.4 J**	**5.5 J**	**3.4**	**3.8**	**2.0**	**2.7**	0.5 U	0.60 U	0.60 U	0.50 U	1 U	0.60 U	0.10 U	0.50 U
Copper	3.1	**18.5**	**5.4 J**	**6.7 J**	**10.7**	**11.9**	**4.0 J**	**6.1 J**	0.5 U	0.38 U	0.38 U	**0.52 J1**	1 U	**1.4 J1**	0.15 U	**0.60 J1**
Lead	8.1	**0.5**	**1.5 J**	**1.9 J**	**1.0**	**0.98 J1**	**0.39 J1**	**0.64 J1**	0.1 U	0.080 U	0.080 U	0.034 U	0.1 U	**0.87 J1**	0.034 U	**0.076 J1**
Nickel	8.2	**0.9**	**0.80 J1**	**0.91 J1**	0.50 U	0.50 U	**0.36 J1**	**0.38 J1**	**2.5**	**0.93 J1**	**3.2**	**2.7**	**4.2**	**0.81 J1**	**0.16 J1**	0.35 U
Selenium	71	0.5 U	0.27 U	0.27 U	0.27 U	0.27 U	0.50 U	0.50 U	0.5 U	0.27 U	0.27 U	0.50 U	**5**	0.27 U	0.18 U	0.50 U
Thallium	0.2	0.2 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	**8**	**12.3 J, J1**	**16.5 J**	**12.3 J1**	**14.8 J1**	4.7 UJ2	**7.4 J1**	4 U	4.0 U	4.0 U	2.4 UJ2	4 U	**23.9**	1.1 U	**2.1 J1**
Total Metals (µg/L; SW-846 7196A)																
Chromium VI	50	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 UJ	10.0 U	10.0 U	10.0 U	10.0 U
Total Metals (µg/L; SW-846 7470A/EPA 1631E)																
Mercury	0.025	0.020 U	0.002 UJ	**0.008 J, J1**	**0.013**	**0.011**	**0.005**	**0.009**	0.020 U	**0.002 J1**	**0.001**	0.002 U	0.020 U	**0.002 J1**	**0.000 J1**	0.002 U
Dissolved Metals (µg/L; EPA 200.8)																
Antimony	90	0.2 U	0.42 U	0.42 U	0.42 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.42 U	0.33 U	0.2 U	**0.86 J1**	0.33 U	0.33 U
Arsenic	8	**2,460**	**2,180**	**2,280**	**844 J**	**1,070 J**	**1,110**	**1,180**	**0.7**	0.95 U	0.95 U	**5.6**	**3.7**	**2.2**	**2.0 J1**	**2.3**
Barium	200	**3.9**	**3.6**	**3.3**	**2.9**	**3.3**	**3.7**	**3.6**	**2.0**	**1.5 J1**	**9.3**	**13.0**	**81.6**	**38.4**	**31.2**	**147**
Beryllium	4.4	0.2 U	0.13 U	0.13 U	0.13 U	0.13 U	**0.036 J1**	**0.043 J1**	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	0.025 U	0.025 U
Cadmium	1.2	0.1 U	0.20 U	0.20 U	0.20 U	0.20 U	0.082 U	0.082 U	0.1 U	0.2 U	0.20 U	0.082 U	0.1 U	0.20 U	0.048 U	**0.084 J1**
Chromium	27	**3**	**3.4**	**3.2**	**3.1**	**3.0**	**2.0**	**2.0 J1**	**0.9**	0.60 U	0.60 U	0.50 U	**0.7**	0.60 U	0.10 U	0.50 U
Copper	3.1	0.5 U	0.38 U	0.38 U	0.38 U	**2.2**	0.40 U	**0.59 J1**	**1.7**	0.38 U	0.38 U	0.40 U	**1.2**	**0.42 J1**	0.15 U	0.40 U
Lead	8.1	0.1 U	0.080 U	0.080 U	**0.66 J1**	**0.15 J1**	0.034 U	0.034 U	0.1 U	0.080 U	**0.088 J1**	0.034 U	0.1 U	0.080 U	0.034 U	0.034 U
Nickel	8.2	**0.8**	0.50 U	0.50 U	0.50 U	0.50 U	**0.35** J1	**0.50 J1**	**2.4**	**0.92** J1	**3.0**	**3.3**	**4.8**	0.50 U	**0.16 J1**	0.35 U
Selenium	71	0.5 U	0.27 U	0.27 U	0.27 U	0.27 U	0.50 U	0.50 U	0.5 U	0.27 U	0.27 U	0.50 U	5 U	0.27 U	0.18 U	0.50 U
Thallium	0.2	0.2 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	4 U	4.0 U	4.0 U	4.0 U	4.0 U	1.1 U	**2.4 J1**	4 U	4.0 U	**4.1 J1**	3.9 UJ2	4 U	4.0 U	1.1 U	1.1 U
Dissolved Metals (µg/L; SW-846 7470A/EPA 1631E)																
Mercury	0.025	0.020 U	**0.003 J1**	0.002 U	**0.002**	**0.003 J1**	**0.001**	0.002 U	0.020 U	**0.001**	**0.001**	**0.002 J1**	0.020 U	**0.002 J1**	**0.001**	**0.003 J1**

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Groundwater Proposed Cleanup Levels	Sample Location, Lab SDG, Sample Date															
		IT-I-205 UA27/UA28/ UB45 12/06/2011	IT-I-205 1296009/ UM84 3/15/2012	IT-I-205 1316296/ UZ00 6/15/2012	IT-I-205 1335688/ VJ53 9/13/2012	IT-I-206 UA27/UA28/ UB45 12/06/2011	IT-I-206 1295065/ UM00 03/12/2012	IT-I-206 1317022/ UZ37 6/19/2012	IT-I-206 1335985/ VJ63 9/14/2012	IT-MW-1 UA27/UA28/ UB45 12/06/2011	IT-MW-1 1294477/ UL60 03/09/2012	IT-MW-1 1317686/ UZ66 6/21/2012	IT-MW-1 1335985/ VJ63 9/14/2012	IT-MW-2 UA27/UA28/ UB45 12/06/2011	IT-MW-2 1294477/ UL60 03/09/2012	IT-MW-2 1317686/ UZ66 6/21/2012	IT-MW-2 1335985/ VJ63 9/14/2012
Volatiles (µg/L; SW-846 8260C)																	
1,1-Dichloroethene	4,000	0.2 U	0.1 U	0.1 U	0.1 U	**0.1 J1**	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.5 U	0.5 U
Acrylonitrile	0.6	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	5.0 U	5.0 U
Trichloroethene	0.7	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.5 U	0.5 U
Vinyl Chloride	0.18	0.2 U	0.1 U	0.1 U	0.1 U	**0.4**	**0.5**	**0.4**	**0.3**	**0.2**	**0.3**	**0.3**	**0.2**	**0.3**	**0.4**	**0.7 J1**	0.5 U
Volatiles (µg/L; SW-846 8260C-SIM)																	
Acrylonitrile	0.6	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--
Vinyl Chloride	0.18	0.020 U	0.010 U	0.010 U	0.010 U	**0.31**	**0.46**	**0.37**	**0.24**	**0.17**	**0.25**	**0.33**	**0.21**	**0.30**	**0.39**	**0.81**	**0.40**
Semivolatiles (µg/L; SW-846 8270D)																	
bis(2-Ethylhexyl)phthalate	5	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U
Polycyclic Aromatic Hydrocarbons (µg/L; SW-846 82																	
cPAH TEQ	0.048	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Polychlorinated Biphenyls (µg/L; SW-846 8082)																	
Total PCBs	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (µg/L; NWTPH-Dx/-																	
Gasoline-Range Organics	1,000	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	**83 J1**	50 U
Diesel-Range Organics	500	100 U	70 U	30 U	28 U	100 U	75 U	31 U	33 U	100 U	73 U	**37 J1**	29 U	100 U	70 U	**41 J1**	28 U
Oil-Range Organics		200 U	1000 U	70 U	66 U	200 U	1100 U	72 U	78 U	200 U	1000 U	67 U	68 U	200 U	1000 U	69 U	66 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**37 J1**	ND	ND	ND	**41 J1**	ND
Total Metals (µg/L; EPA 200.8)																	
Antimony	90	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U
Arsenic	8	**49.3**	**31.6**	**33.7**	**132**	**398**	**207**	**461**	**453**	**10.8**	**10.6**	**10.8**	**12.1**	**5.4**	**4.8**	**1.8 J1**	**5.1**
Barium	200	**5.1**	**2.4**	**3.3**	**4.2**	**22.8**	**22.1**	**24.7**	**23.1**	**35.6**	**39.7**	**52.1**	**60.0**	**35.7**	**38.9**	**29.3 J**	**73.1**
Beryllium	4.4	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.025 U	**0.035 J1**	0.2 U	0.13 U	**0.056 J1**	**0.054 J1**	0.2 U	0.13 U	**0.059 J1**	**0.16 J1**
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U
Chromium	27	**0.6**	**0.83 J1**	**0.49 J1**	0.50 U	**1.1**	**0.97 J1**	**1.5 J1**	**1.4 J1**	**1.7**	**2.6**	**2.3**	**2.8**	**10**	**9.1**	**3.7**	**9.9**
Copper	3.1	**1.1**	0.38 U	0.15 U	0.40 U	**0.6**	**1.1 J1**	0.15 U	0.40 U	**1.0**	0.38 U	0.15 U	0.40 U	**0.8**	0.38 U	0.15 U	0.40 U
Lead	8.1	0.1 U	0.080 U	0.034 U	**0.048 J1**	0.1 U	**0.31 J1**	0.034 U	**0.37 J1**	0.1 U	0.080 U	0.034 U	**0.085 J1**	**0.2**	0.080 U	0.034 U	**0.067 J1**
Nickel	8.2	**0.5**	0.50 U	**0.15 J1**	0.35 U	**1.4**	**0.55 J1**	**0.30 J1**	**0.42 J1**	**2.4**	**2.0**	**1.8 J1**	**1.9 J1**	**3.0**	**2.4**	**1.6 J1**	**2.9**
Selenium	71	0.5 U	0.27 U	0.18 U	0.50 U	**0.8**	0.27 U	**0.24 J1**	0.50 U	**0.7**	0.27 U	**0.18 J1**	0.50 U	**0.8**	0.27 U	**0.21 J1**	0.50 U
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	4 U	4.0 U	1.1 U	1.1 U	4 U	**20.1**	1.1 U	1.1 U	**4**	4 U	4.4 UJ2	**5.1 J1**	4 U	4.0 U	2.1 UJ2	**2.1 J1**
Total Metals (µg/L; SW-846 7196A)																	
Chromium VI	50	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	**10.0**	10.0 U	10.0 U	**19.0 J**	**15.0 J**	10.0 U	10.0 UJ
Total Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	0.002 U	0.000 U	**0.000 J1**	0.020 U	**0.003 J1**	0.002 U	**0.003 J1**	0.020 U	0.002 U	0.002 U	0.002 U	0.020 U	0.003 U	0.003 U	0.003 U
Dissolved Metals (µg/L; EPA 200.8)																	
Antimony	90	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U
Arsenic	8	**46.9**	**31.2**	**32.4**	**121**	**401**	**190**	**464**	**445**	**10.9**	**11.1**	**10.7**	**11.9**	**5.1**	**5.6**	**3.6**	**4.9**
Barium	200	**4.7**	**2.2**	**2.8**	**4.6**	**21.4**	**16.0**	**23.3**	**26.6**	**33.6**	**40.2**	**54.0**	**60.2**	**33.2**	**40.5**	**59.3**	**76.4**
Beryllium	4.4	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.025 U	**0.027 J1**	0.2 U	0.13 U	**0.062 J1**	**0.052 J1**	0.2 U	0.13 U	**0.11 J1**	**0.17 J1**
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U
Chromium	27	0.5 U	**0.84 J1**	**0.38 J1**	0.50 U	**0.9**	**0.79 J1**	**1.4 J1**	**1.1 J1**	**1.5**	**2.5**	**2.4**	**2.9**	**6.4**	**9.1**	**7.2**	**10.8**
Copper	3.1	0.5 U	0.38 U	0.15 U	0.40 U	0.5 U	0.38 U	0.15 U	0.40 U	0.5 U	0.38 U	**0.33 J1**	**0.57 J1**	0.5 U	0.38 U	0.15 U	0.40 U
Lead	8.1	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	**0.035 J1**	0.034 U	0.1 U	**0.086 J1**	**0.059 J1**	**0.034 J1**
Nickel	8.2	**0.6**	0.50 U	0.13 U	0.35 U	**0.9**	**0.75 J1**	**0.27 J1**	**0.42 J1**	**2.4**	**2.1**	**2.0**	**2.1**	**2.8**	**2.2**	**2.9**	**2.3**
Selenium	71	0.5 U	0.27 U	0.18 U	0.50 U	**0.8**	0.27 U	0.18 U	0.50 U	**0.6**	0.27 U	**0.20 J1**	0.50 U	**0.8**	**0.31 J1**	**0.35 J1**	0.50 U
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	**0.032 J1**	0.15 U
Zinc	81	4 U	4.0 U	**1.5 J1**	1.1 U	4 U	**24.4**	1.1 U	**1.5 J1**	4 U	4.0 U	5.0 UJ2	**4.3 J1**	4 U	4.0 U	**3.0 J1**	**3.2 J1**
Dissolved Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.002 J1**	0.000 U	**0.003 J1**	0.020 U	**0.003 J1**	0.002 U	**0.005 J1**	0.020 U	**0.003 J1**	0.002 U	**0.004 J1**	0.020 U	0.003 U	0.003 U	**0.004 J1**

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

		Sample Location, Lab SDG, Sample Date															
															Dup of IT-MW-6		Dup of IT-MW-6
Analyte	**Revised Groundwater Proposed Cleanup Levels**	IT-MW-3 UA27/UA28/UB45 12/06/2011	IT-MW-3 1294477/UL60 03/09/2012	IT-MW-3 1317686/UZ66 6/21/2012	IT-MW-3 1335985/VJ63 9/14/2012	IT-MW-4 UB28/UB29/UD90 12/14/2011	IT-MW-4 1294218/UL36 03/08/2012	IT-MW-4 1316786/UZ18 6/18/2012	IT-MW-4 1335985/VJ63 9/14/2012	IT-MW-5 UB08/UB09/UD89 12/13/2011	IT-MW-5 1294218/UL36 03/08/2012	IT-MW-5 1317333/UZ55 6/20/2012	IT-MW-5 1335688/VJ53 9/13/2012	IT-MW-6 UA44/UA45/UB46 12/07/2011	IT-DUP-1 UA44/UA45/UB46 12/07/2011	IT-MW-6 1294218/UL36 03/08/2012	IT-DUP-1 1294218/UL36 03/08/2012
Volatiles (µg/L; SW-846 8260C)																	
1,1-Dichloroethene	4,000	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	**0.6**	**0.6**	**0.7**	**0.7**
Acrylonitrile	0.6	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2.0 U	2.0 U
Trichloroethene	0.7	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	**71**	**76**	**110**	**120**
Vinyl Chloride	0.18	**0.1 J1**	**0.1 J1**	**0.3**	**0.2 J1**	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	**94**	**100**	**110**	**110**
Volatiles (µg/L; SW-846 8260C-SIM)																	
Acrylonitrile	0.6	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--	**0.16 J**	**0.16 J**	--	--
Vinyl Chloride	0.18	**0.12**	**0.10**	**0.34**	**0.17**	0.020 U	**0.088**	0.010 U	0.010 U	0.020 U	0.010 U	0.010 U	0.010 U	**42 ES**	**43 ES**	**96**	**94**
Semivolatiles (µg/L; SW-846 8270D)																	
bis(2-Ethylhexyl)phthalate	5	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	2.0 U	1.0 U	2 U	2 U
Polycyclic Aromatic Hydrocarbons (µg/L; SW-846 82																	
cPAH TEQ	0.048	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0007 J**	ND	ND	ND	ND	ND	ND
Polychlorinated Biphenyls (µg/L; SW-846 8082)																	
Total PCBs	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (µg/L; NWTPH-Dx/-																	
Gasoline-Range Organics	1,000	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	250 U	50 U	50 U
Diesel-Range Organics	500	100 U	72 U	29 U	29 U	100 U	67 U	28 U	30 U	100 U	67 U	29 U	29 U	100 U	100 U	68 U	67 U
Oil-Range Organics		200 U	1000 U	67 U	68 U	200 U	950 U	66 U	70 U	200 U	950 U	68 U	68 U	200 U	200 U	970 U	950 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Metals (µg/L; EPA 200.8)																	
Antimony	90	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.42 U	0.33 U	0.2 U	0.2 U	0.42 U	0.42 U
Arsenic	8	**2.0**	**3.3**	**1.2 J1**	**2.0 J1**	.1U/1.8*	**1.1 J1**	**4.6**	**2.0 J1**	.6U/0.4*	0.95 U	0.95 U	**0.52 J1**	**2.2**	**2.1**	0.95 U	0.95 U
Barium	200	**64.7**	**110**	**49.7**	**73.3**	**7.7**	**4.6**	**2.8**	**2.9**	**130**	**80.3**	**40.7**	**53.7**	**91.3**	**92.0**	**80.6**	**80.5**
Beryllium	4.4	0.2 U	0.13 U	**0.045 J1**	**0.052 J1**	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.13 U	**0.043 J1**	0.2 U	0.2 U	0.13 U	0.13 U
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.20 U	0.082 U	0.1 U	0.1 U	0.20 U	0.20 U
Chromium	27	**1.6**	**3.2**	**1.9 J1**	**2.5**	**1.2**	**0.84 J1**	**2.1**	**1.8 J1**	0.5 U	0.60 U	0.60 U	0.50 U	**0.5**	**0.5**	0.60 U	**0.61 J1**
Copper	3.1	0.5 U	0.38 U	**0.29 J1**	0.40 U	0.5 U	0.38 U	**0.34 J1**	0.40 U	**1.8**	**1.1 J1**	**1.3 J1**	**1.2 J1**	**0.9**	0.5 U	**1.5 J1**	**1.6 J1**
Lead	8.1	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	0.080 U	0.034 U	0.1 U	0.1 U	0.080 U	0.080 U
Nickel	8.2	**1.4**	**1.5 J1**	**0.33 J1**	**0.87 J1**	**1.9**	**0.75 J1**	**1.4 J1**	**0.81 J1**	**10.2**	**6.9**	**2.6**	**5.6**	**2.5 J**	**3.1 J**	**1.8 J1**	**1.7 J1**
Selenium	71	**0.7**	**0.36 J1**	0.18 U	0.50 U	0.5 U	0.27 U	0.18 U	0.50 U	**0.6**	**0.53 J1**	0.27 U	0.50 U	**0.6**	**0.8**	0.27 U	0.27 U
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.2 U	0.15 U	0.15 U
Zinc	81	4 U	4.0 U	2.4 UJ2	1.1 U	4 U	4.0 U	**1.2 J1**	**1.4 J1**	**31**	**14.8 J1**	**7.4 J1**	**14.3 J1**	**10**	**10**	**5.4 J1**	**6.1 J1**
Total Metals (µg/L; SW-846 7196A)																	
Chromium VI	50	10.0 U	**15.0**	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Total Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	0.002 U	0.002 U	0.002 U	0.020 U	**0.001**	**0.002**	**0.001**	0.020 U	**0.000 J1**	**0.001**	**0.001**	0.020 U	0.020 U	**0.010 J, J1**	**0.037 J**
Dissolved Metals (µg/L; EPA 200.8)																	
Antimony	90	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.42 U	0.33 U	0.2 U	0.2 U	0.42 U	0.42 U
Arsenic	8	**2.2**	**3.6**	**0.98 J1**	**2.3**	**1.9**	**1.4 J1**	**3.0**	**1.4 J1**	**0.5**	0.95 U	0.95 U	**0.48 J1**	**2.1**	**2.2**	0.95 U	0.95 U
Barium	200	**64.8**	**112**	**50.3**	**75.5**	**7.6**	**5.0**	**3.2**	**2.9**	**137**	**83.7**	**40.3**	**55.3**	**89.9**	**89.2**	**84.9**	**92.4**
Beryllium	4.4	0.2 U	0.13 U	**0.037 J1**	**0.055 J1**	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.13 U	**0.030 J1**	0.2 U	0.2 U	0.13 U	0.13 U
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.20 U	**0.11 J1**	0.1 U	0.1 U	0.20 U	0.20 U
Chromium	27	**1.8**	**3.4**	**2.0 J1**	**2.2**	**0.8**	**0.93 J1**	**2.0**	**2.0**	0.5 U	0.60 U	0.60 U	0.50 U	**1**	1 U	**0.61 J1**	0.60 U
Copper	3.1	0.5 U	0.38 U	**0.28 J1**	**0.47 J1**	0.5 U	0.38 U	**0.30 J1**	0.40 U	**1.7**	**1.4 J1**	**1.5 J1**	**1.4 J1**	**1.3**	**0.7**	**1.5 J, J1**	0.38 UJ
Lead	8.1	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	0.080 U	0.034 U	0.1 U	0.1 U	0.080 U	0.080 U
Nickel	8.2	**1.4**	**1.7 J1**	**0.37 J1**	**0.70 J1**	**2.1**	**0.64 J1**	**1.1 J1**	**0.42 J1**	**10.3**	**7.9**	**2.5**	**5.8**	**3.1**	**2.9**	**2.0 J**	0.50 UJ
Selenium	71	**0.7**	**0.30 J1**	0.18 U	0.50 U	0.5 U	0.27 U	**0.20 J1**	0.50 U	**0.7**	**0.57 J1**	0.27 U	**0.55 J1**	**0.6**	**0.7**	0.27 U	0.27 U
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.2 U	0.15 U	0.15 U
Zinc	81	4 U	4.0 U	5.3 UJ2	**1.9 J1**	4 U	**4.0 J1**	**1.6 J1**	1.1 U	**33**	**18.0**	**7.5 J1**	**12.8 J1**	**10**	**10**	**6.8 J1**	4.0 U
Dissolved Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.005 J1**	**0.002 J1**	**0.005**	0.020 U	**0.001**	**0.002**	**0.002**	0.020 U	**0.001**	**0.001**	**0.001**	0.020 U	0.020 U	0.002 U	0.002 U

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

		Sample Location, Lab SDG, Sample Date															
			Dup of IT-MW-6		Dup of IT-MW-6												
Analyte	**Revised Groundwater Proposed Cleanup Levels**	IT-MW-6 1317686/ UZ66 6/21/2012	IT-DUP-2 1317686/ UZ66 6/21/2012	IT-MW-6 1335688/ VJ53 9/13/2012	IT-DUP-2 1335688/ VJ53 9/13/2012	IT-MW-7 TZ99/UA00/ UB44 12/05/2011	IT-MW-7 1295065/ UM00 03/12/2012	IT-MW-7 1317022/ UZ37 6/19/2012	IT-MW-7 1335985/ VJ63 9/14/2012	IT-MW-8 UA54/UA55/ UB47 12/08/2011	IT-MW-8 1294218/ UL36 03/08/2012	IT-MW-8 1316296/ UZ00 6/15/2012	IT-MW-8 1335483/ VJ32 9/12/2012	IT-MW-9 UA27/UA28/ UB45 12/06/2011	IT-MW-9 1295065/ UM00 03/12/2012	IT-MW-9 1316296/ UZ00 6/15/2012	IT-MW-9 1335688/ VJ53 9/13/2012
Volatiles (µg/L; SW-846 8260C)																	
1,1-Dichloroethene	4,000	**4.3**	**4.0**	**1.6**	**1.6**	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Acrylonitrile	0.6	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	0.7	**150**	**150**	**150**	**150**	**1.8**	**1.4**	**1.4**	**1.3**	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Vinyl Chloride	0.18	**120**	**130**	**97**	**100**	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Volatiles (µg/L; SW-846 8260C-SIM)																	
Acrylonitrile	0.6	--	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--
Vinyl Chloride	0.18	**140**	**140**	**110**	**110**	0.020 U	**0.012 J1**	0.010 U	0.010 U	0.020 U	0.010 U	0.010 U	0.010 U	0.020 U	0.010 U	0.010 U	0.010 U
Semivolatiles (µg/L; SW-846 8270D)																	
bis(2-Ethylhexyl)phthalate	5	2 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U
Polycyclic Aromatic Hydrocarbons (µg/L; SW-846 82																	
cPAH TEQ	0.048	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Polychlorinated Biphenyls (µg/L; SW-846 8082)																	
Total PCBs	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (µg/L; NWTPH-Dx/-																	
Gasoline-Range Organics	1,000	**57 J1**	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U
Diesel-Range Organics	500	31 U	30 U	28 U	29 U	100 U	68 U	30 U	30 U	100 U	70 U	29 U	29 U	100 U	67 U	29 U	29 U
Oil-Range Organics		73 U	71 U	66 U	68 U	200 U	970 U	70 U	71 U	200 U	1000 U	68 U	68 U	200 U	950 U	67 U	69 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Metals (µg/L; EPA 200.8)																	
Antimony	90	0.33 U	0.33 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.42 U	0.33 U	**0.2**	0.42 U	0.33 U	0.33 U
Arsenic	8	**0.68 J1**	**0.99 J1**	**1.0 J1**	**0.68 J1**	**3.5**	**9.0**	**3.1**	**4.7**	**88.5**	**1.6 J1**	**1.9 J1**	**3.0**	**7.6**	**6.8**	**3.7**	**5.7**
Barium	200	**45.0**	**44.4**	**52.6**	**56.0**	**30.0**	**9.1**	**13.6**	**10.6**	**37.4**	**44.1**	**30.0**	**32.7**	**37.0**	**18.4**	**7.7**	**59.7**
Beryllium	4.4	**0.029 J1**	**0.035 J1**	**0.027 J1**	**0.031 J1**	0.2 U	0.13 U	**0.026 J1**	**0.027 J1**	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	0.025 U	**0.031 J1**
Cadmium	1.2	0.048 U	0.048 U	0.082 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.20 U	0.082 U	0.1 U	0.20 U	0.048 U	**0.45 J1**
Chromium	27	**0.54 J1**	**0.52 J1**	**0.62 J1**	**0.73 J1**	0.5 U	0.60 U	0.50 U	0.50 U	0.5 U	0.60 U	0.60 U	0.50 U	0.5 U	0.60 U	**0.20 J1**	0.50 U
Copper	3.1	**0.98 J1**	**1.1 J1**	**0.45 J1**	**0.46 J1**	**2.0**	**2.4**	**1.5 J1**	**2.2**	**0.7**	**0.57 J1**	**0.56 J1**	**0.50 J1**	**1.2**	**1.1 J1**	**1.2 J1**	**1.7 J1**
Lead	8.1	0.034 U	0.034 U	0.034 U	**0.035 J1**	0.1 U	**0.094 J1**	**0.042 J1**	0.034 U	0.1 U	0.080 U	0.080 U	0.034 U	0.1 U	0.080 U	**0.099 J1**	**0.035 J1**
Nickel	8.2	**2.6**	**2.4**	**2.6**	**3.9**	**2.9**	**1.9 J1**	**2.6**	**1.7 J1**	**4.4**	**1.2 J1**	**1.2 J1**	**0.82 J1**	**1.8**	**1.1 J1**	**1.7 J1**	**9.9**
Selenium	71	0.18 U	**0.21 J1**	0.50 U	0.50 U	**0.5**	**0.42 J1**	**0.75 J1**	**0.63 J1**	**0.7**	0.27 U	0.27 U	0.50 U	**4**	0.27 U	0.18 U	0.50 U
Thallium	0.2	0.029 U	0.029 U	0.15 U	0.15 U	0.2 U	0.15 U	**0.050 J1**	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	**6.9 J1**	**7.2 J1**	**8.6 J1**	**9.4 J1**	**4**	4.0 U	**2.1 J1**	**1.5 J1**	4 U	4.0 U	4.0 U	1.4 UJ2	**6**	4.0 U	**2.0 J1**	**18.5**
Total Metals (µg/L; SW-846 7196A)																	
Chromium VI	50	10.0 U	10.0 U	10.0 U	10.0 U	10.0 UJ	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 UJ	10.0 UJ	10.0 U	10.0 U	10.0 U	10.0 U
Total Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	**0.001**	**0.001**	**0.001**	0.002 U	0.020 U	**0.004**	**0.002**	**0.002**	0.020 U	**0.002 J1**	0.002 U	0.002 U	0.020 U	**0.001**	**0.002**	0.002 U
Dissolved Metals (µg/L; EPA 200.8)																	
Antimony	90	0.33 U	0.33 U	0.33 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	**0.10 J1**	0.33 U	**0.2**	0.42 U	0.33 U	0.33 U
Arsenic	8	**0.66 J1**	**0.64 J1**	**2.7**	**0.74 J1**	**3.6**	**8.7**	**3.6**	**3.2**	**2.8**	**1.5 J1**	**1.5 J1**	**2.1**	**6.6**	**5.5**	**2.9**	**1.4 J1**
Barium	200	**46.6**	**46.4**	**50.8**	**56.1**	**29.0**	**8.6**	**12.2**	**10.8**	**36.9**	**44.8**	**31.7**	**32.8**	**35.0**	**18.2**	**7.1**	**64.7**
Beryllium	4.4	0.025 U	0.025 U	**0.027 J1**	**0.044 J1**	0.2 U	0.13 U	**0.027 J1**	0.025 U	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.025 U	**0.040 J1**
Cadmium	1.2	0.048 U	0.048 U	0.082 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	**0.47 J1**
Chromium	27	**0.60 J1**	**0.57 J1**	**0.65 J1**	**0.59 J1**	0.5 U	0.60 U	0.50 U	0.50 U	1 U	0.60 U	**0.70 J1**	0.50 U	**0.6**	0.60 U	**0.20 J1**	0.50 U
Copper	3.1	**0.54 J1**	**0.68 J1**	0.40 U	0.40 U	**2.1 J**	**2.6**	**2.0**	**2.3**	**1.3**	**0.54 J1**	**0.56 J1**	0.44 UJ2	**1.5**	**0.92 J1**	**0.88 J1**	**1.1 J1**
Lead	8.1	0.034 U	0.034 U	0.034 U	**0.17 J1**	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	0.034 U	0.034 U
Nickel	8.2	**2.1**	**2.3**	**3.1**	**3.5**	**2.6**	**1.7 J1**	**2.6**	**1.7 J1**	**4.2**	**1.5 J1**	**1.5 J1**	**1.0 J1**	**1.8**	**1.2 J1**	**1.9 J1**	**9.1**
Selenium	71	0.18 U	0.18 U	0.50 U	0.50 U	0.5 U	**0.43 J1**	**0.69 J1**	**1.0 J1**	0.5 U	0.27 U	**0.19 J1**	0.50 U	**3**	0.27 U	0.18 U	0.50 U
Thallium	0.2	0.029 U	0.029 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	**8.3 J1**	**9.3 J1**	**8.5 J1**	**8.1 J1**	**10**	**4.3 J1**	**4.5 J1**	**2.5 J1**	4 U	4.0 U	**1.2 J1**	**2.6 J1**	**7**	**5.1 J1**	**2.6 J1**	**17.9**
Dissolved Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	**0.001**	**0.001**	**0.004 J1**	**0.002 J1**	0.020 U	**0.004**	**0.002**	**0.003**	0.020 U	0.002 U	**0.002 J1**	0.002 U	0.020 U	**0.001**	**0.001**	0.002 U

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

		Sample Location, Lab SDG, Sample Date																
										Dup of IT-MW-12								
Analyte	Revised Groundwater Proposed Cleanup Levels	IT-MW-10 UA27/UA28/ UB45 12/06/2011	IT-MW-10 1296009/ UM84 3/15/2012	IT-MW-10 1316071/ UY55 6/14/2012	IT-MW-10 1335688/ VJ53 9/13/2012	IT-MW-11 UA44/UA45/ UB46 12/07/2011	IT-MW-11 1296009/ UM84 3/15/2012	IT-MW-11 1317022/ UZ37 6/19/2012	IT-MW-11 1335688/ VJ53 9/13/2012	IT-MW-12 UA86/ UA87 12/12/2011	IT-DUP-2 UA86/ UA87 12/12/2011	IT-MW-12 1293989/ UL18 03/07/2012	IT-MW-12 1316296/ UZ00 6/15/2012	IT-MW-12 1335483/ VJ32 9/12/2012	IT-MW-13 UB08/ UB09 12/13/2011	IT-MW-13 1293989/ UL18 03/07/2012	IT-MW-13 1316071/ UY55 6/14/2012	IT-MW-13 1335483/ VJ32 9/12/2012
Volatiles (µg/L; SW-846 8260C)																		
1,1-Dichloroethene	4,000	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Acrylonitrile	0.6	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	0.7	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Vinyl Chloride	0.18	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Volatiles (µg/L; SW-846 8260C-SIM)																		
Acrylonitrile	0.6	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	0.050 U	--	--	--	0.050 U	--	--	--
Vinyl Chloride	0.18	0.020 U	0.010 U	0.010 U	**0.011 J1**	0.020 U	0.010 U	0.010 U	0.010 U	0.020 U	0.020 U	0.010 U	0.010 U	0.010 U	0.020 U	0.010 U	0.010 U	0.010 U
Semivolatiles (µg/L; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	5	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	**1.5**	1.0 U	2 U	2 U	2 U	**3.3**	2 U	2 U	2 U
Polycyclic Aromatic Hydrocarbons (µg/L; SW-846 82																		
cPAH TEQ	0.048	ND	**0.0131 J**	ND	**0.0005 J**	ND	ND	ND	ND	ND	ND	ND	**0.0016 J**	ND	ND	ND	ND	ND
Polychlorinated Biphenyls (µg/L; SW-846 8082)																		
Total PCBs	0.01	ND	ND	ND	**0.0060 J**	ND	ND	ND	ND	**0.0080 J**	**0.0080 J**	ND	ND	ND	**0.015**	**0.014**	**0.014**	**0.011**
Total Petroleum Hydrocarbons (µg/L; NWTPH-Dx/-																		
Gasoline-Range Organics	1,000	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U
Diesel-Range Organics	500	100 U	70 U	29 U	31 U	100 U	70 U	29 U	29 U	100 U	100 U	68 U	28 U	29 U	100 U	73 U	29 U	29 U
Oil-Range Organics		200 U	1000 U	68 U	73 U	200 U	1000 U	67 U	67 U	200 U	200 U	970 U	66 U	67 U	200 U	1000 U	68 U	68 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Metals (µg/L; EPA 200.8)																		
Antimony	90	**0.4**	**0.45 J1**	0.42 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	**0.21 J1**	0.33 U
Arsenic	8	**8.6**	0.95 U	**169**	**272**	**7.6**	**7.2**	**2.0**	**2.4**	**66.1**	**66.3**	**27.9**	**13.7**	**16.8**	**14.5**	**11.2**	**10.2**	**12.4**
Barium	200	**4.0**	**2.7**	**12.4**	**23.5**	**8.0**	**5.0**	**4.3**	**3.6**	**169**	**162**	**42.4**	**15.6**	**20.6**	**18.3**	**15.0**	**13.8**	**14.2**
Beryllium	4.4	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.2 U	0.13 U	0.025 U	**0.039 J1**	0.2 U	0.13 U	0.025 U	0.025 U
Cadmium	1.2	0.1 U	0.20 U	**0.28 J1**	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.1 U	0.20 U	**0.051 J1**	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U
Chromium	27	0.5 U	**1.7 J1**	**1.8 J1**	**2.5**	0.5 U	0.60 U	0.50 U	0.50 U	**0.8**	**0.9**	0.60 U	**0.16 J1**	0.50 U	**0.8**	**1.5 J1**	**1.6 J1**	**1.3 J1**
Copper	3.1	**1.7**	**1.0 J1**	**1.3 J1**	**0.78 J1**	**0.6**	0.38 U	0.39 UJ2	0.40 U	**1.2**	**1.3**	0.38 U	0.15 U	0.40 U	**4.8**	**3.2**	**5.1**	**2.6**
Lead	8.1	**0.2**	**0.26 J1**	**0.66 J1**	**0.18 J1**	**0.2**	**0.12 J1**	0.034 U	**0.14 J1**	**0.3**	**0.2**	0.080 U	**0.093 J1**	0.034 U	**0.3**	**0.093 J1**	**0.35 J1**	0.034 U
Nickel	8.2	**1.4**	**0.63 J1**	**4.1**	**1.5 J1**	**0.7**	0.50 U	**0.20 J1**	0.35 U	**2.9 J**	**3.6 J**	**0.70 J1**	**0.64 J1**	0.35 U	**8**	**7.5**	**8.5**	**7.2**
Selenium	71	0.5 U	0.27 U	0.27 U	0.50 U	0.5 U	0.27 U	0.18 U	0.50 U	**2**	2 U	0.27 U	0.18 U	0.50 U	**2.2**	**0.87 J1**	**0.76 J1**	**0.62 J1**
Thallium	0.2	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	4 U	4.0 U	4.0 U	**1.7 J1**	4 U	**5.5 J1**	**1.5 J1**	**2.1 J1**	4 U	4 U	4.0 U	1.1 U	1.1 U	**6**	4.0 U	**5.8 J1**	2.5 UJ2
Total Metals (µg/L; SW-846 7196A)																		
Chromium VI	50	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 UJ	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Total Metals (µg/L; SW-846 7470A/EPA 1631E)																		
Mercury	0.025	0.020 U	**0.007**	0.004	**0.003 J1**	0.020 U	**0.001**	0.002 U	**0.001**	0.020 U	0.020 U	0.002 U	**0.000 J1**	**0.000 J1**	0.020 U	**0.005 J1**	**0.004 J1**	**0.004 J1**
Dissolved Metals (µg/L; EPA 200.8)																		
Antimony	90	**0.4**	0.42 U	0.42 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	**0.33 J1**	0.33 U
Arsenic	8	**8.0**	**1.0 J1**	**140**	**226**	**9.4**	**7.7**	**2.1**	**2.2**	**65.8**	**66.9**	**25.4**	**12.6**	**18.1**	**13.6**	**12.3**	**10**	**11.7**
Barium	200	**3.6**	**1.6 J1**	**12.7**	**19.5**	**7.9**	**5.3**	**5.3**	**3.9**	**171**	**175**	**43.8**	**17.9**	**21.5**	**17.8**	**14.9**	**15.1**	**16.0**
Beryllium	4.4	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.025 U	**0.029 J1**
Cadmium	1.2	0.1 U	0.20 U	0.20 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.1 U	0.20 U	**0.13 J1**	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U
Chromium	27	**0.7**	**1.4 J1**	**1.7 J1**	**2.0 J1**	1 U	0.60 U	0.50 U	0.50 U	0.5 U	0.5 U	0.60 U	**0.13 J1**	0.50 U	**1.0**	**1.5 J1**	**1.3 J1**	**1.4 J1**
Copper	3.1	**2.4**	**0.76 J1**	**0.55 J1**	0.40 U	0.5 U	0.38 U	0.46 UJ2	0.40 U	**0.6**	**0.9**	0.38 U	0.15 U	0.40 U	**4.1**	**2.9**	**4.9**	**3.0**
Lead	8.1	**0.1**	0.080 U	0.080 U	0.034 U	0.1 U	0.080 U	**0.25 J1**	0.034 U	0.1 U	0.1 U	0.080 U	**0.19 J1**	0.034 U	0.1 U	0.080 U	**0.045 J1**	0.034 U
Nickel	8.2	**1.6**	0.50 U	**3.6**	**1.2 J1**	0.5 U	0.50 U	**0.41 J1**	0.35 U	**2.4**	**2.4**	**0.61 J1**	**0.40 J1**	**0.46 J1**	**7.9**	**7.6**	**7.4**	**7.7**
Selenium	71	0.5 U	0.27 U	0.27 U	0.50 U	0.5 U	0.27 U	0.18 U	0.50 U	**2**	**2**	0.27 U	0.18 U	0.50 U	**2.1**	**0.75 J1**	**0.80 J1**	**0.83 J1**
Thallium	0.2	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	4 U	4.0 U	4.0 U	**2.4 J1**	4 U	4.0 U	**2.4 J1**	1.1 U	4 U	4 U	4.0 U	**1.5 J1**	1.1 U	**6**	**6.4 J1**	**5.0 J1**	2.3 UJ2
Dissolved Metals (µg/L; SW-846 7470A/EPA 1631E)																		
Mercury	0.025	0.020 U	**0.003**	0.003 U	**0.003 J1**	0.020 U	0.002 U	**0.002**	**0.002 J1**	0.020 U	0.020 U	**0.001**	**0.002**	**0.001**	0.020 U	**0.004 J1**	**0.007 J1**	**0.004 J1**

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Groundwater Proposed Cleanup Levels	Sample Location, Lab SDG, Sample Date															
		IT-MW-14 UB08/ UB09 12/13/2011	IT-MW-14 1293989/ UL18 03/07/2012	IT-MW-14 1317686/ UZ66 6/21/2012	IT-MW-14 1335480/ VJ03 9/11/2012	IT-MW-15 UB28/ UB29 12/14/2011	IT-MW-15 1293530/ UK92 03/06/2012	IT-MW-15 1315688/ UY34 6/13/2012	IT-MW-15 1335480/ VJ03 9/11/2012	IT-MW-16 UB08/ UB09 12/13/2011	IT-MW-16 1293989/ UL18 03/07/2012	IT-MW-16 1316786/ UZ18 6/18/2012	IT-MW-16 1335480/ VJ03 9/11/2012	IT-MW-17 UA90/ UA91 12/12/2011	IT-MW-17 1295735/ UM54 3/14/2012	IT-MW-17 1316786/ UZ18 6/18/2012	IT-MW-17 1335483/ VJ32 9/12/2012
Volatiles (µg/L; SW-846 8260C)																	
1,1-Dichloroethene	4,000	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	**0.1 J1**	0.1 U	0.2 UJ	0.1 U	0.1 U	0.1 U
Acrylonitrile	0.6	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U
Trichloroethene	0.7	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	**0.2**	**0.2 J1**	**0.2**	**0.2**	0.2 UJ	0.1 U	0.1 U	0.1 U
Vinyl Chloride	0.18	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	**0.3**	0.1 U	**0.8**	0.1 U	0.2 UJ	0.1 U	0.1 U	0.1 U
Volatiles (µg/L; SW-846 8260C-SIM)																	
Acrylonitrile	0.6	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--	0.050 UJ	--	--	--
Vinyl Chloride	0.18	0.020 U	0.010 U	0.010 U	0.010 U	0.020 U	0.010 U	0.010 U	0.010 U	**0.25**	**0.051**	**0.80**	**0.035**	0.020 UJ	0.010 U	0.010 U	**0.14**
Semivolatiles (µg/L; SW-846 8270D)																	
bis(2-Ethylhexyl)phthalate	5	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	**3.7**	2 U	2 U	2 U
Polycyclic Aromatic Hydrocarbons (µg/L; SW-846 82																	
cPAH TEQ	0.048	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0008 J**	**0.0006 J**
Polychlorinated Biphenyls (µg/L; SW-846 8082)																	
Total PCBs	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.012**	**0.016**	ND
Total Petroleum Hydrocarbons (µg/L; NWTPH-Dx/-																	
Gasoline-Range Organics	1,000	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U
Diesel-Range Organics	500	100 U	67 U	29 U	28 U	100 U	66 U	29 U	28 U	100 U	72 U	31 U	29 U	100 U	70 U	29 U	29 U
Oil-Range Organics		200 U	950 U	68 U	66 U	200 U	940 U	67 U	66 U	200 U	1000 U	72 U	68 U	200 U	1000 U	67 U	68 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Metals (µg/L; EPA 200.8)																	
Antimony	90	**1.1**	**1.1**	**0.49 J1**	**0.85 J1**	0.2 U	0.42 U	0.42 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	1 U	**0.73 J1**	**1.4**	0.33 U
Arsenic	8	**5.3**	**4.2**	**4.8**	**15.3**	**43.3**	**17.9**	**52.2**	**47.4**	**17.7**	**5.1**	**2.3**	**1,070**	**16**	**9.2**	**63.1**	**5.5 J1**
Barium	200	**9.5**	**10.6**	**21.3**	**22.1**	**19.0**	**14.4**	**15.4**	**24.8**	**59.3**	**57.7**	**43.1**	**18.6**	**77**	**34.3**	**75.7**	**104**
Beryllium	4.4	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	0.025 U	**0.042 J1**	1 U	0.13 U	0.025 U	0.025 U
Cadmium	1.2	**0.4**	**0.44 J1**	**0.20 J1**	**0.31 J1**	0.1 U	0.20 U	0.20 U	0.082 U	0.1 U	0.20 U	**0.11 J1**	**0.12 J1**	0.5 U	0.20 U	0.048 U	0.082 U
Chromium	27	1 U	**1.2 J1**	**0.72 J1**	**0.65 J1**	1 U	0.60 U	**1.2 J1**	0.50 U	0.5 U	0.60 U	**0.70 J1**	**1.2 J1**	2 U	**1.5 J1**	**0.50 J1**	0.50 U
Copper	3.1	**1.7**	**2.1**	**1.2 J1**	**0.81 J1**	**1.0**	**0.64 J1**	**0.50 J1**	**1.1 J1**	**7.6**	**8.4**	**7.5**	**21.8**	2 U	1.6 UJ2	**6.2**	**0.68 J1**
Lead	8.1	**0.1**	0.080 U	0.034 U	**0.052 J1**	0.1 U	0.080 U	0.080 U	0.13 UJ2	0.1 U	0.080 U	0.034 U	0.049 UJ2	0.5 U	**0.59 J1**	**2.9**	**0.12 J1**
Nickel	8.2	**3.6**	**2.2**	**1.6 J1**	**2.4**	**3.7**	**2.3**	**1.8 J1**	**5.1**	**6.1**	**4.1**	**7.7**	**7.3**	**5**	**1.0 J1**	**2.0**	**0.63 J1**
Selenium	71	0.5 U	0.27 U	**0.19 J1**	0.50 UJ	0.5 U	0.27 U	0.27 U	0.50 U	**0.6**	0.27 U	**0.20 J1**	0.50 U	10 U	0.27 UJ	**0.69 J1**	**0.66 J1**
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	1 U	0.15 U	0.029 U	0.15 U
Zinc	81	**22**	**18.2**	**24.5**	**34.5**	**15**	**15.5**	**24.8**	**16.8**	**62**	**107**	**48.8**	**56.4**	20 U	4.0 U	**12.8 J1**	1.1 U
Total Metals (µg/L; SW-846 7196A)																	
Chromium VI	50	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 UJ	10.0 U	10.0 UJ	10.0 U
Total Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.002**	**0.003 J1**	0.002 U	0.020 U	**0.002**	**0.001**	**0.003**	0.020 U	**0.006 J1**	**0.002 J1**	**0.023**	0.020 U	0.002 U	**0.003 J1**	0.003 U
Dissolved Metals (µg/L; EPA 200.8)																	
Antimony	90	**1.1**	**0.92 J1**	**0.44 J1**	**0.77 J1**	0.2 U	0.42 U	0.42 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	1 U	**0.61 J1**	**0.97 J1**	0.33 U
Arsenic	8	**5.2**	**4.4**	**5.6**	**6.7**	**53.3**	**20.0**	**53.2**	**76.8**	**17.1**	**4.2**	**5.0**	**1,040**	**23**	**9.6**	**12.5**	**4.3 J1**
Barium	200	**9.4**	**10.8**	**19.5**	**22.1**	**17.5**	**16.1**	**15.7**	**19.1**	**59.1**	**60.8**	**38.9**	**18.2**	**76**	**34.8**	**56.3**	**112**
Beryllium	4.4	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	**0.038 J1**	0.025 U	1 U	0.13 U	0.025 U	0.025 U
Cadmium	1.2	**0.4**	**0.34 J1**	**0.24 J1**	**0.36 J1**	0.1 U	0.20 U	0.20 U	0.082 U	0.1 U	0.20 U	**0.11 J1**	0.082 U	0.5 U	0.20 U	0.048 U	0.082 U
Chromium	27	**0.6**	**1.0 J1**	**0.64 J1**	**0.76 J1**	**0.6**	0.60 U	**1.1 J1**	0.50 U	0.5 U	0.60 U	**1.4 J1**	**1.2 J1**	2 U	**0.80 J1**	**0.15 J1**	0.50 U
Copper	3.1	**1.8**	**1.9 J1**	**1.9 J1**	**0.76 J1**	**1.3**	**0.44 J1**	0.38 U	0.40 U	**8.0**	**8.4**	**11.5**	**18.7**	2 U	**0.62 J1**	**0.39 J1**	0.40 U
Lead	8.1	0.1 U	0.080 U	0.034 U	**0.089 J1**	0.1 U	**0.11 J1**	0.080 U	0.034 U	0.1 U	0.080 U	0.034 U	0.038 UJ2	0.5 U	0.080 U	0.034 U	0.034 U
Nickel	8.2	**3.6**	**2.1**	**1.9 J1**	**2.0 J1**	**2.5**	**2.5**	**2.1**	**2.8**	**6.1**	**4.0**	**9.1**	**7.3**	**5**	**0.68 J1**	**0.40 J1**	**0.73 J1**
Selenium	71	0.5 U	0.27 U	0.18 U	0.50 UJ	0.5 U	0.27 U	0.27 U	0.50 U	**0.6**	0.27 U	**0.23 J1**	0.50 U	10 U	0.27 UJ	**0.69 J1**	**0.82 J1**
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	1 U	0.15 U	0.029 U	0.15 U
Zinc	81	**22**	**17.9**	**29.3**	**31.4**	**13**	**18.9**	**25.4**	**20.0**	**62**	**109**	**55.2**	**55.8**	20 U	4.0 U	**1.5 J1**	1.1 U
Dissolved Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.003 J1**	**0.004 J1**	**0.004 J1**	0.020 U	**0.002**	**0.001**	**0.002**	0.020 U	0.003 U	**0.000**	**0.010**	0.020 U	0.002 U	0.002 U	**0.004 J1**

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Groundwater Proposed Cleanup Levels	Sample Location, Lab SDG, Sample Date															
		IT-MW-18 UA45/UA55/ UB47 12/08/2011	IT-MW-18 1295735/ UM54 3/14/2012	IT-MW-18 1316786/ UZ18 6/18/2012	IT-MW-18 1335483/ VJ32 9/12/2012	IT-MW-19 UA44/UA45/ UB46 12/07/2011	IT-MW-19 1295418/ UM31 3/13/2012	IT-MW-19 1316071/ UY55 6/14/2012	IT-MW-19 1335483/ VJ32 9/12/2012	IT-MW-20 UA54/UA55/ UB47 12/08/2011	IT-MW-20 1295418/ UM31 3/13/2012	IT-MW-20 1316071/ UY55 6/14/2012	IT-MW-20 1335483/ VJ32 9/12/2012	IT-MW-21 UA54/UA55/ UB47 12/08/2011	IT-MW-21 1295735/ UM54 3/14/2012	IT-MW-21 1316786/ UZ18 6/18/2012	IT-MW-21 1335483/ VJ32 9/12/2012
Volatiles (µg/L; SW-846 8260C)																	
1,1-Dichloroethene	4,000	0.2 U	0.1 U	0.5 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.5 U	0.1 U
Acrylonitrile	0.6	1.0 U	1.0 U	5.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	5.0 U	1.0 U
Trichloroethene	0.7	0.2 U	0.1 U	0.5 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.5 U	0.1 U
Vinyl Chloride	0.18	**0.8**	**0.3**	**0.5 J1**	**0.2**	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.5 U	0.1 U
Volatiles (µg/L; SW-846 8260C-SIM)																	
Acrylonitrile	0.6	**0.059**	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--
Vinyl Chloride	0.18	**0.87**	**0.20**	**0.53**	**0.27**	0.020 U	0.010 U	0.010 U	0.010 U	0.020 U	0.010 U	0.010 U	0.010 U	0.020 U	0.010 U	0.010 U	0.010 U
Semivolatiles (µg/L; SW-846 8270D)																	
bis(2-Ethylhexyl)phthalate	5	**1.8**	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U
Polycyclic Aromatic Hydrocarbons (µg/L; SW-846 82																	
cPAH TEQ	0.048	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Polychlorinated Biphenyls (µg/L; SW-846 8082)																	
Total PCBs	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (µg/L; NWTPH-Dx/-																	
Gasoline-Range Organics	1,000	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U
Diesel-Range Organics	500	100 U	69 U	28 U	29 U	100 U	67 U	29 U	29 U	100 U	66 U	29 U	28 U	100 U	75 U	30 U	29 U
Oil-Range Organics		200 U	990 U	66 U	67 U	200 U	960 U	68 U	69 U	200 U	950 U	68 U	66 U	200 U	1100 U	70 U	67 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Metals (µg/L; EPA 200.8)																	
Antimony	90	0.2 U	0.42 U	0.33 U	0.33 U	**0.8**	0.42 U	0.42 U	0.33 U	**0.3**	**0.45 J1**	0.42 U	0.33 U	**0.4**	0.42 U	0.33 U	0.33 U
Arsenic	8	**3,600**	**2,490**	**4,890**	**6,610**	**154**	**49.1**	**23.3**	**82.9**	**143**	**518**	**212**	**219**	**21,300**	**19,000**	**20,500**	**19,200**
Barium	200	**12.9**	**14.4**	**14.0**	**11.0**	**18.4**	**15.1**	**10.7**	**17.6**	**16.2**	**5.0**	**5.8**	**7.9**	**17.2**	**16.1**	**16.2**	**17.9**
Beryllium	4.4	0.2 U	0.13 U	**0.11 J1**	**0.15 J1**	0.2 U	0.13 U	0.13 U	**0.031 J1**	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	**0.068 J1**	**0.042 J1**
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.20 U	0.082 U	0.1 U	0.20 U	0.20 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U
Chromium	27	**2.1**	**4.4**	**6.8**	**7.1**	0.5 U	0.60 U	0.60 U	**0.90 J1**	**0.5**	**1.0 J1**	**2.2**	0.50 U	**2.4**	**2.7**	**3.0**	**2.1**
Copper	3.1	**8.2**	**6.4**	**6.2**	**13.0**	**3.0**	**3.5**	**2.3**	**4.6**	**3.0**	**8.0**	**2.6**	**3.1**	**69.7**	**7.5**	**13.1**	**20.8**
Lead	8.1	**0.2**	**0.64 J1**	**0.56 J1**	**0.78 J1**	0.1 U	0.080 U	0.080 U	0.034 U	0.1 U	**0.14 J1**	0.080 U	0.034 U	**0.3**	**0.19 J1**	**0.20 J1**	**0.21 J1**
Nickel	8.2	**3.4**	**1.7 J1**	**3.0**	**2.8**	**3.8**	**2.2 J**	**1.1 J1**	**3.0**	**2.1**	**0.69 J1**	0.50 U	**0.42 J1**	**4.0**	**3.1**	**2.4**	**1.9 J1**
Selenium	71	0.5 U	0.27 U	**0.23 J1**	0.50 U	**0.6**	0.27 U	0.27 U	0.50 U	**2**	**0.97 J1**	**0.46 J1**	**0.62 J1**	0.5 U	0.27 U	**0.30 J1**	0.50 U
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	**122**	**75.0**	**56.4**	**31.3**	**8**	4.0 U	4.0 U	**4.3 J1**	4 U	4.0 U	4.0 U	1.1 U	**10**	**6.1 J1**	**6.0 J1**	**6.4 J1**
Total Metals (µg/L; SW-846 7196A)																	
Chromium VI	50	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	**10.0**	10.0 U	10.0 U
Total Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.006**	**0.009 J1**	**0.011**	0.020 U	0.002 U	**0.001**	**0.003**	0.020 U	**0.008**	**0.003 J1**	**0.001**	0.020 U	0.003 U	**0.010 J1**	**0.004 J1**
Dissolved Metals (µg/L; EPA 200.8)																	
Antimony	90	0.2 U	0.42 U	0.33 U	0.33 U	**0.8**	**0.43 J1**	**0.39 J1**	0.33 U	**0.2**	**0.55 J1**	0.42 U	0.33 U	**0.4**	0.42 U	0.33 U	0.33 U
Arsenic	8	**3,870**	**2,980**	**5,770**	**6,650**	**179**	**45.4**	**25.9**	**82.3**	**135**	**449**	**211**	**221**	**22,600**	**17,000**	**18,200**	**19,500**
Barium	200	**12.2**	**9.9**	**12.7**	**12.4**	**17.8**	**15.7**	**12.4**	**18.4**	**14.2**	**1.4 J1**	**5.4**	**6.3**	**13.7**	**12.6**	**12.9**	**14.9**
Beryllium	4.4	0.2 U	0.13 U	**0.079 J1**	**0.10 J1**	0.2 U	0.13 U	**0.027 J1**	**0.034 J1**	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	**0.054 J1**	**0.036 J1**
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.20 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U
Chromium	27	**2**	**3.6**	**7.0**	**6.7**	**0.8**	0.60 U	**0.21 J1**	**0.72 J1**	0.5 U	**0.94 J1**	**2.3**	0.50 U	**2**	**2.8**	**3.3**	**2.1**
Copper	3.1	**0.8**	0.38 U	**0.30 J1**	0.91 UJ2	**2.6**	**3.3**	**2.8**	**4.0**	**3.1**	**7.2**	**2.5**	**2.7**	**0.6**	**1.2 J1**	**1.8 J1**	0.74 UJ2
Lead	8.1	0.1 U	0.080 U	**0.038 J1**	**0.080 J1**	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	0.080 U	**0.041 J1**	0.1 U	0.080 U	**0.084 J1**	0.034 U
Nickel	8.2	**3.3**	**1.3** J1	**3.1**	**2.6**	**4.3**	**1.9 J, J1**	**1.8 J1**	**3.1**	**2.0**	**0.60 J1**	0.50 U	**0.37 J1**	**3.4**	**2.9**	**2.4**	**1.5 J1**
Selenium	71	0.5 U	0.27 U	**0.19 J1**	0.50 U	0.5 U	0.27 U	**0.19 J1**	0.50 U	**2.6**	**1.0 J1**	**0.41 J1**	**0.53 J1**	0.5 U	**0.27 J1**	**0.28 J1**	0.50 U
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	**126**	**58.7**	**58.4**	**17.6**	**9**	4.0 U	**2.2 J1**	**3.6 J1**	4 U	4.0 U	4.0 U	2.9 UJ2	4 U	4.0 U	**1.8 J1**	**2.3 J1**
Dissolved Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.002 J1**	0.003 U	0.003 U	0.020 U	0.003 U	**0.001**	**0.003 J1**	0.020 U	**0.004**	**0.002 J1**	0.002 U	0.020 U	0.003 U	0.003 U	0.003 U

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

		Sample Location, Lab SDG, Sample Date															
Analyte	**Revised Groundwater Proposed Cleanup Levels**	IT-MW-22 UA54/UA55/ UB47 12/08/2011	IT-MW-22 1293989/ UL18 03/07/2012	IT-MW-22 1316786/ UZ18 6/18/2012	IT-MW-22 1335688/ VJ53 9/13/2012	IT-MW-23 UA90/ UA91 12/12/2011	IT-MW-23 1295735/ UM54 3/14/2012	IT-MW-23 1316786/ UZ18 6/18/2012	IT-MW-23 1335688/ VJ53 9/13/2012	IT-MW-24 UA54/UA55/ UB47 12/08/2011	IT-MW-24 1293989/ UL18 03/07/2012	IT-MW-24 1316786/ UZ18 6/18/2012	IT-MW-24 1335480/ VJ03 9/11/2012	IT-MW-25 UB08/ UB09 12/13/2011	IT-MW-25 1293989/ UL18 03/07/2012	IT-MW-25 1315688/ UY34 6/13/2012	IT-MW-25 1335480/ VJ03 9/11/2012
Volatiles (µg/L; SW-846 8260C)																	
1,1-Dichloroethene	4,000	0.2 U	0.1 U	0.1 U	0.1 U	2.0 U	0.5 U	1.0 U	0.5 U	2.0 U	5.0 U	2.0 UJ	1.0 UJ	0.2 U	0.1 U	1.0 U	0.2 U
Acrylonitrile	0.6	1.0 U	1.0 U	1.0 U	1.0 U	10 U	5.0 U	10 U	5.0 U	10 U	50 U	20 UJ	10 UJ	1.0 U	1.0 U	10 U	2.0 U
Trichloroethene	0.7	0.2 U	0.1 U	0.1 U	0.1 U	2.0 U	0.5 U	1.0 U	0.5 U	2.0 U	5.0 U	2.0 UJ	1.0 UJ	0.2 U	**0.3**	1.0 U	**0.3 J1**
Vinyl Chloride	0.18	0.2 U	0.1 U	0.1 U	0.1 U	2.0 U	0.5 U	1.0 U	0.5 U	2.0 U	5.0 U	2.0 UJ	1.0 UJ	**0.4**	0.1 U	**1.6 J1**	**0.9 J**
Volatiles (µg/L; SW-846 8260C-SIM)																	
Acrylonitrile	0.6	0.050 U	--	--	--	0.50 U	--	--	--	1.0 U	--	--	--	0.050 U	--	--	--
Vinyl Chloride	0.18	0.020 U	0.010 U	0.010 U	0.010 U	**0.27**	**0.21**	**0.54**	**0.20**	0.40 U	0.50 UJ	0.10 U	**0.11 J1**	**0.33**	**0.023**	**2.0**	**1.1**
Semivolatiles (µg/L; SW-846 8270D)																	
bis(2-Ethylhexyl)phthalate	5	1.0 U	2 U	2 U	2 U	1.0 U	10 U	20 U	2 U	1.1 U	2 U	20 U	2 U	1.0 U	2 U	2 U	2 U
Polycyclic Aromatic Hydrocarbons (µg/L; SW-846 82																	
cPAH TEQ	0.048	ND	ND	ND	ND	ND	**0.008 J**	ND	**0.0025 J**	ND	**0.00736 J**	**0.02**	**0.002 J**	ND	**0.0007 J**	**0.0008 J**	**0.0016 J**
Polychlorinated Biphenyls (µg/L; SW-846 8082)																	
Total PCBs	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.017**	**0.024**	**0.011**
Total Petroleum Hydrocarbons (µg/L; NWTPH-Dx/-																	
Gasoline-Range Organics	1,000	250 U	50 U	50 U	50 U	1200 U	50 U	50 U	50 U	250 U	50 U	250 U	250 U	250 U	50 U	50 U	50 U
Diesel-Range Organics	500	100 U	69 U	29 U	30 U	100 U	76 U	**200**	**100**	100 UJ	70 U	**210**	**180**	100 U	67 U	28 U	31 U
Oil-Range Organics		200 U	990 U	68 U	69 U	200 U	1100 U	**82 J1**	**76 J1**	200 UJ	1000 U	**300**	**260**	200 U	950 U	66 U	73 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	**282 J1**	**176 J1**	ND	ND	**510**	**440**	ND	ND	ND	ND
Total Metals (µg/L; EPA 200.8)																	
Antimony	90	**0.3**	0.42 U	0.33 U	0.33 U	**9.5**	**6.0**	**0.99 J1**	**1.9**	**19.4**	**55.9**	**18.1**	**9.0**	**0.5**	**12.0**	**0.80 J1**	**0.61 J1**
Arsenic	8	**21,900**	**21,000**	**3,810**	**11,500**	**77,100**	**76,800**	**34,200**	**36,100**	**212,000**	**227,000**	**125,000**	**274,000**	**3,300**	**3,680**	**11,400**	**38,700**
Barium	200	**16.9**	**18.6**	**12.5**	**16.7**	**133**	**116**	**56.3**	**43.3**	**215**	**200**	**87.5**	**109**	**25.2**	**23.9**	**22.1**	**37.9**
Beryllium	4.4	0.2 U	0.13 U	0.025 U	**0.051 J1**	1 U	3.3 U	**0.50**	**0.61**	**2.2**	**1.8**	**0.93 J1**	**1.1**	0.2 U	**0.25 J1**	**0.27 J1**	**0.31 J1**
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	**1.1**	**0.52**	**0.20 J1**	0.082 U	**2.0**	**0.28 J1**	0.24 U	**0.14 J1**	**0.1**	**0.51**	**0.40 J1**	**0.79**
Chromium	27	**3**	**4.6**	**1.1 J1**	**2.1**	**38**	**39.1**	**25.3**	**20.2**	**36**	**30.6**	**9.4 J1**	**25.8**	**1.5**	**3.7**	**18.1**	**13.4**
Copper	3.1	**27**	**98.5**	**2.3**	**10.7**	**1,790**	**837**	**1,600**	**34.0**	**1,230**	**288**	**45.6**	**481**	**19.3**	**1160**	**327**	**449**
Lead	8.1	**0.3**	**0.55 J1**	**0.041 J1**	**0.063 J1**	**2.8**	**1.8**	**2.0**	**0.22 J1**	**33.8**	**11.3**	**2.3 J1**	**9.9**	**0.1**	**3.8**	**2.9**	**9.2**
Nickel	8.2	**1.8**	**1.3 J1**	**0.39 J1**	**0.75 J1**	**303**	**253**	**88.1**	**53.8**	**309**	**180**	**219**	**225**	**7.4**	**8.2**	**7.7**	**11.3**
Selenium	71	0.5 U	0.27 U	0.18 U	0.50 U	**8.7**	**4.5**	**0.80 J1**	**1.1 J1**	**18**	**11.2**	**12.6**	**8.7**	**0.9**	**1.9 J1**	**0.56 J1**	**0.69 J, J1**
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	**0.7**	**0.77**	**0.40 J1**	0.15 U	**0.3**	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.15 U	**0.26 J1**
Zinc	81	**7**	**6.6 J1**	**1.6 J1**	**2.7 J1**	**390**	**225**	**195**	**123**	**610**	**266**	**213**	**187**	**17**	**217**	**90.6**	**199**
Total Metals (µg/L; SW-846 7196A)																	
Chromium VI	50	10.0 U	10.0 U	10.0 U	10.0 U	**37.0**	**18.0**	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Total Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.009**	**0.001**	**0.003 J1**	**0.052**	0.008 U	0.003 U	**0.245**	**1.750**	0.008 U	0.003 U	0.003 U	0.020 U	**0.748**	**0.090**	0.003 U
Dissolved Metals (µg/L; EPA 200.8)																	
Antimony	90	**0.3**	0.42 U	0.33 U	0.33 U	**10.2**	**6.6**	**0.44 J1**	**2.1**	**19.8**	**55.2**	**17.6**	**8.6**	**0.6**	**12.3**	**0.77 J1**	0.33 U
Arsenic	8	**24,000**	**18,900**	**4,000**	**10,700**	**78,200**	**80,000**	**29,000**	**34,400**	**209,000**	**218,000**	**130,000**	**285,000**	**3,290**	**3,910**	**13,100**	**34,900**
Barium	200	**14.6**	**13.5**	**11.5**	**15.2**	**119**	**103**	**23.9**	**28.4**	**157**	**158**	**59.4**	**94.4**	**25.3**	**14.6**	**19.6**	**17.6**
Beryllium	4.4	0.2 U	0.13 U	0.025 U	**0.028 J1**	1 U	3.3 U	**0.25 J1**	**0.48 J1**	**1.6**	**1.5**	**0.62**	**0.97**	0.2 U	**0.19 J1**	**0.29 J1**	**0.21 J1**
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	**0.8**	0.20 U	**0.056 J1**	0.082 U	**0.8**	0.20 U	**0.065 J1**	**0.091 J1**	0.1 U	0.20 U	0.20 U	0.082 U
Chromium	27	**3**	**3.1**	**1.1 J1**	**2.1**	**39**	**39.9**	**20.0**	**18.7**	**34**	**27.7**	**7.7**	**18.5**	**1.3**	**3.1**	**21.0**	**14.2**
Copper	3.1	**1.0**	**1.2 J1**	0.42 UJ2	**0.62 J1**	**2,050**	**417**	**28.4**	**19.0**	**84.7**	**79.4**	**27.8**	**58.0**	**3.0**	**506**	**91.1**	**12.3**
Lead	8.1	0.1 U	0.080 U	0.034 U	0.034 U	**2.2**	**1.9**	**0.21 J1**	**0.17 J1**	**2.9**	**5.5**	**1.6**	**3.9**	0.1 U	**1.4**	**0.76 J1**	**0.26 J1**
Nickel	8.2	**1.9**	**1.1 J1**	**0.43 J1**	**0.72 J1**	**297**	**241**	**61.3**	**50.2**	**212**	**138**	**176**	**190**	**6.6**	**7.5**	**8.2**	**9.9**
Selenium	71	**0.8**	0.27 U	0.18 U	0.50 U	**9.9**	**4.9**	**0.67 J1**	**1.2 J1**	**13.4**	**10.2**	**10.4**	**9.7**	**0.8**	**2.1**	**0.89 J1**	**0.66 J, J1**
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	**0.5**	**0.25 J1**	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.15 U	0.15 U
Zinc	81	**6**	4.0 U	**1.3 J1**	**2.4 J1**	**290**	**159**	**36.8**	**57.7**	**50**	**48.6**	**33.4**	**58.4**	**15**	**64.0**	**62.8**	**40.4**
Dissolved Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.000 J1**	**0.001**	**0.003 J1**	**0.053**	0.008 U	0.003 U	**0.137**	**0.039**	0.008 U	0.003 U	0.003 U	0.020 U	**0.274**	**0.019**	0.003 U

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Groundwater Proposed Cleanup Levels	Sample Location, Lab SDG, Sample Date															
		IT-PZ-1 UB28/ UB29 12/14/2011	IT-PZ-1 1293989/ UL18 03/07/2012	IT-PZ-1 1315688/ UY34 6/13/2012	IT-PZ-1 1335480/ VJ03 9/11/2012	IT-PZ-2 UB28/ UB29 12/14/2011	IT-PZ-2 1294218/ UL36 03/08/2012	IT-PZ-2 1317022/ UZ37 6/19/2012	IT-PZ-2 1335985/ VJ63 9/14/2012	IT-PZ-3 UB28/UB29/ UD90 12/14/2011	IT-PZ-3 1293530/ UK92 03/06/2012	IT-PZ-3 1316071/ UY55 6/14/2012	IT-PZ-3 1335480/ VJ03 9/11/2012	IT-PZ-4 UA44/UA45/ UB46 12/07/2011	IT-PZ-4 1294477/ UL60 03/09/2012	IT-PZ-4 1317022/ UZ37 6/19/2012	IT-PZ-4 1335483/ VJ32 9/12/2012
Volatiles (μg/L; SW-846 8260C)																	
1,1-Dichloroethene	4,000	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Acrylonitrile	0.6	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	0.7	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Vinyl Chloride	0.18	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
Volatiles (μg/L; SW-846 8260C-SIM)																	
Acrylonitrile	0.6	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--
Vinyl Chloride	0.18	0.020 U	0.010 U	0.010 U	0.010 U	0.020 U	**0.026**	**0.017 J1**	0.010 U	0.020 U	**0.023**	**0.046**	**0.053**	**0.060**	**0.046**	**0.051**	**0.051**
Semivolatiles (μg/L; SW-846 8270D)																	
bis(2-Ethylhexyl)phthalate	5	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	7.8 U	2 U	2 U	2 U
Polycyclic Aromatic Hydrocarbons (μg/L; SW-846 82																	
cPAH TEQ	0.048	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Polychlorinated Biphenyls (μg/L; SW-846 8082)																	
Total PCBs	0.01	ND	**0.0086 J**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (μg/L; NWTPH-Dx/-																	
Gasoline-Range Organics	1,000	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U
Diesel-Range Organics	500	100 U	68 U	29 U	29 U	100 U	68 U	29 U	31 U	100 U	69 U	29 U	30 U	100 U	69 U	29 U	32 U
Oil-Range Organics		200 U	970 U	68 U	68 U	200 U	980 U	69 U	73 U	200 U	990 U	67 U	69 U	200 U	990 U	67 U	75 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Metals (μg/L; EPA 200.8)																	
Antimony	90	0.2 U	0.42 U	0.42 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.10 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U
Arsenic	8	**6.7**	**7.5**	**6.6**	**5.2**	**8.8**	**8.9**	**3.8**	**20.2**	2.4U/**2.5***	0.95 U	**4.6**	**16.2**	**24.4**	**23.6**	**24.2**	**27.7**
Barium	200	**9.4**	**11.2**	**14.3**	**10.2**	**14.1**	**11.2**	**11.9**	**18.9**	**6.4**	**5.3**	**7.5**	**10.7**	**40.9**	**32.2**	**35.8**	**37.0**
Beryllium	4.4	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	**0.074 J1**	**0.080 J1**	0.2 U	0.13 U	0.025 U	**0.031 J1**	0.2 U	0.13 U	0.025 U	0.025 U
Cadmium	1.2	**0.4**	**0.61**	**0.48 J1**	**0.27 J1**	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U
Chromium	27	0.5 U	0.60 U	0.60 U	0.50 U	2 U	**2.3**	**2.8**	**3.5**	**0.7**	0.60 U	**0.69 J1**	**1.4 J1**	2 U	**0.82 J1**	**0.74 J1**	**0.86 J1**
Copper	3.1	**21.9**	**23.5**	**44.3**	**26.2**	**1.4**	0.38 U	0.42 UJ2	**1.4 J1**	**1.2**	**0.70 J1**	**0.35 J1**	**0.58 J1**	0.5 U	0.38 U	0.15 U	0.40 U
Lead	8.1	0.1 U	0.080 U	**0.080 J1**	0.034 U	**0.2**	0.080 U	**0.14 J1**	0.034 U	**0.3**	**0.16 J1**	**0.052 J1**	0.12 UJ2	0.1 U	0.080 U	0.034 U	0.034 U
Nickel	8.2	**6.0**	**8.9**	**9.6**	**7.6**	**0.8**	0.50 U	**0.55 J1**	**1.1 J1**	**0.6**	0.50 U	**0.80 J1**	**1.1 J1**	**1.0**	**0.61 J1**	**1.2 J1**	**1.1 J1**
Selenium	71	0.5 U	0.27 U	0.27 U	0.50 UJ	**0.7**	0.27 U	**0.20 J1**	0.50 U	0.5 U	0.27 U	0.18 U	0.50 U	0.5 U	0.27 U	0.18 U	0.50 U
Thallium	0.2	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	**262**	**490**	**264**	**185**	4 U	4.0 U	**1.4 J1**	1.1 U	**12**	**6.0 J1**	**4.6 J1**	**8.3 J1**	4 U	4.0 U	1.1 U	1.1 U
Total Metals (μg/L; SW-846 7196A)																	
Chromium VI	50	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Total Metals (μg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.001**	**0.003**	**0.002**	0.020 U	0.003 U	0.002 U	**0.003 J1**	0.020 U	**0.005 J1**	**0.001**	**0.002 J1**	0.020 U	0.002 U	**0.000 J1**	**0.001**
Dissolved Metals (μg/L; EPA 200.8)																	
Antimony	90	0.2 U	0.42 U	0.42 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U	0.2 U	0.42 U	0.10 U	0.33 U	0.2 U	0.42 U	0.33 U	0.33 U
Arsenic	8	**5.3**	**6.4**	**4.8**	**4.7**	**7.7**	**9.7**	**3.0**	**20.0**	**2.0**	0.95 U	**4.2**	**14.4**	**22.2**	**24.4**	**22.0**	**26.2**
Barium	200	**9.0**	**11.2**	**14.6**	**9.8**	**11.6**	**12.2**	**10.8**	**20.5**	**5.3**	**4.7**	**7.1**	**10.8**	**39.6**	**34.0**	**35.8**	**35.6**
Beryllium	4.4	0.2 U	0.13 U	0.13 U	0.025 U	0.2 U	0.13 U	**0.072 J1**	**0.046 J1**	0.2 U	0.13 U	0.025 U	**0.041 J1**	0.2 U	0.13 U	0.025 U	0.025 U
Cadmium	1.2	**0.3**	**0.57**	**0.56**	**0.38 J1**	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U
Chromium	27	0.5 U	0.60 U	0.60 U	0.50 U	2 U	**2.4**	**2.6**	**3.1**	**0.8**	0.60 U	**0.60 J1**	**1.6 J1**	1 U	**0.89 J1**	**0.79 J1**	**1.0 J1**
Copper	3.1	**17.3**	**21.2**	**41.3**	**25.0**	**0.6**	0.38 U	0.35 UJ2	0.40 U	**0.7**	0.38 U	0.15 U	**0.72 J1**	0.5 U	0.38 U	0.15 U	0.40 U
Lead	8.1	0.1 U	0.080 U	**0.14 J1**	0.034 U	0.1 U	0.080 U	0.034 U	0.034 U	0.1 U	0.080 U	0.034 U	0.044 UJ2	0.1 U	0.080 U	0.034 U	0.034 U
Nickel	8.2	**6.5**	**8.8**	**9.3**	**7.2**	**0.7**	0.50 U	**0.57 J1**	**0.97 J1**	**0.5**	0.50 U	**0.71 J1**	**1.7 J1**	**0.8**	**0.77 J1**	**1.1 J1**	**0.72 J1**
Selenium	71	0.5 U	0.27 U	0.27 U	0.50 UJ	**0.7**	0.27 U	**0.37 J1**	0.50 U	0.5 U	0.27 U	0.18 U	0.50 U	0.5 U	0.27 U	0.18 U	0.50 U
Thallium	0.2	0.2 U	0.15 U	0.15 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U
Zinc	81	**244**	**477**	**258**	**181**	4 U	4.0 U	1.1 U	**2.0 J1**	4 U	4.0 U	**1.1 J1**	3.4 UJ2	4 U	4.0 U	1.1 U	**1.7 J1**
Dissolved Metals (μg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.001**	**0.002**	**0.002**	0.020 U	0.002 U	**0.002 J1**	**0.004 J1**	0.020 U	**0.004 J1**	**0.001**	**0.002 J1**	0.020 U	**0.002 J1**	**0.002 J1**	**0.002 J1**

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Groundwater Proposed Cleanup Levels	Sample Location, Lab SDG, Sample Date															
		IT-PZ-6 UA54/UA55/ UB47 12/08/2011	IT-PZ-6 1293989/ UL18 03/07/2012	IT-PZ-6 1316071/ UY55 6/14/2012	IT-PZ-6 1335480/ VJ03 9/11/2012	IT-PZ-7 UA44/UA45/ UB46 12/07/2011	IT-PZ-7 1295418/ UM31 3/13/2012	IT-PZ-7 1316071/ UY55 6/14/2012	IT-PZ-7 1335483/ VJ32 9/12/2012	IT-PZ-8 TZ99/UA00/ UB44 12/05/2011	IT-PZ-8 1295065/ UM00 03/12/2012	IT-PZ-8 1316296/ UZ00 6/15/2012	IT-PZ-8 1335688/ VJ53 9/13/2012	IT-Seep-1 1296010/ UM85 3/15/2012	IT-Seep-1 1317333/ UZ55 6/20/2012	IT-Seep-1 1338005/ VK67 9/25/2012	IT-SB-8 TW99/TX06/TX0 11/14/2011
Volatiles (µg/L; SW-846 8260C)																	
1,1-Dichloroethene	4,000	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U
Acrylonitrile	0.6	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	0.7	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U
Vinyl Chloride	0.18	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U
Volatiles (µg/L; SW-846 8260C-SIM)																	
Acrylonitrile	0.6	0.050 U	--	--	--	0.050 U	--	--	--	0.050 U	--	--	--	--	--	--	0.050 U
Vinyl Chloride	0.18	0.020 U	**0.019 J1**	**0.014 J1**	**0.013 J1**	0.020 U	0.010 U	0.010 U	0.010 U	0.020 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.020 U
Semivolatiles (µg/L; SW-846 8270D)																	
bis(2-Ethylhexyl)phthalate	5	1.2 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	1.0 U	2 U	2 U	2 U	2 U	2 U	2 U	1.0 U
Polycyclic Aromatic Hydrocarbons (µg/L; SW-846 82																	
cPAH TEQ	0.048	ND	ND	ND	ND	**0.0001 J**	**0.0005 J**	**0.0007 J**	**0.0116 J**	ND	ND	ND	ND	**0.0072 J**	**0.0012 J**	**0.152**	ND
Polychlorinated Biphenyls (µg/L; SW-846 8082)																	
Total PCBs	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0097**	**0.011**	ND	ND
Total Petroleum Hydrocarbons (µg/L; NWTPH-Dx/-																	
Gasoline-Range Organics	1,000	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	250 U	50 U	50 U	50 U	50 U	50 U	50 U	250 U
Diesel-Range Organics	500	100 U	69 U	29 U	30 U	100 U	66 U	30 U	28 U	100 U	69 U	30 U	29 U	70 U	29 U	29 U	110 U
Oil-Range Organics		200 U	990 U	68 U	70 U	200 U	950 U	71 U	66 U	200 U	980 U	69 U	67 U	1000 U	67 U	67 U	220 U
Combined DRO/ORO	500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Metals (µg/L; EPA 200.8)																	
Antimony	90	0.5 U	0.42 U	**0.43 J1**	**0.46 J1**	0.9	**1.3**	**1.0 J1**	**0.68 J1**	0.2 U	0.42 U	0.33 U	0.33 U	**0.49 J1**	**0.43 J1**	3.3 U	**0.2**
Arsenic	8	**1,560**	**462**	**7,870**	**7,280**	**3**	**3.5**	**6.7**	**4.0**	**1.2**	0.95 U	**0.94 J1**	**0.90 J1**	**4.5**	**2.2**	**5.9**	**1.0**
Barium	200	**163**	**177**	**152**	**191**	**93.4**	**28.7**	**20.8**	**235**	**11.6**	**34.9**	**21.9**	**10.1**	**6.8**	**8.5**	**28.8**	**11.3**
Beryllium	4.4	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.025 U	0.025 U	0.13 U	0.13 U	0.025 U	0.2 U
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.20 U	0.20 U	**0.14 J1**	**0.3**
Chromium	27	1 U	**1.1 J1**	**0.83 J1**	**1.2 J1**	**0.5**	**14.5**	**1.5 J1**	0.50 U	**1.1**	0.60 U	**0.49 J1**	**1.0 J1**	**2.1**	**2.3**	**5.0**	0.5 U
Copper	3.1	1 U	**0.57 J1**	**0.29 J1**	**0.78 J1**	**0.8**	**6.7**	**0.95 J1**	0.40 U	0.5 U	0.38 U	**0.28 J1**	0.40 U	**1.4 J1**	**2.0 J1**	4.0 U	**7.8**
Lead	8.1	0.1 U	**0.17 J1**	0.034 U	0.034 U	0.1 U	**4.2**	**0.30 J1**	**0.10 J1**	0.1 U	0.080 U	0.034 U	**0.047 J1**	**0.74 J1**	**2.7**	**0.95 J1**	**0.2**
Nickel	8.2	**4.5**	**1.4 J1**	**0.68 J1**	**0.69 J1**	**4.2**	**2.5**	**0.41 J1**	0.35 U	**0.6**	0.50 U	0.13 U	0.35 U	**3.0**	**3.1**	**7.9 J1**	**3.4**
Selenium	71	5 U	**0.29 J1**	**1.1 J1**	**0.59 J, J1**	5 U	0.27 U	**0.27 J1**	0.50 U	**2**	0.27 U	**0.23 J1**	0.50 U	0.27 U	0.27 U	**0.75 J1**	**0.6**
Thallium	0.2	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.15 U	0.15 U	1.5 U	0.2 U
Zinc	81	4 U	4.0 U	1.1 U	**8.4 J1**	4 U	**8.2 J1**	1.1 U	1.1 U	4 U	4.0 U	1.1 U	1.1 U	4.0 U	**4.9 J, J1**	**7.1 J1**	**24**
Total Metals (µg/L; SW-846 7196A)																	
Chromium VI	50	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Total Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	0.003 U	0.003 U	0.003 U	0.020 U	0.002 U	**0.001**	0.002 U	0.020 U	0.002 U	0.000 U	**0.000** J1	**0.003 J1**	**0.001**	0.006 U	0.020 U
Dissolved Metals (µg/L; EPA 200.8)																	
Antimony	90	0.5 U	0.42 U	**0.31 J1**	0.33 U	**0.8**	**0.79 J1**	**0.84 J1**	**0.67 J1**	0.2 U	0.42 U	0.33 U	0.33 U	**0.56 J1**	0.42 U	1.7 U	**0.2**
Arsenic	8	**1,530**	**437**	**6,610**	**8,010**	**4**	**3.1**	**4.2**	**3.6**	**2.0**	0.95 U	**1.1 J1**	**1.0 J1**	**3.9**	**1.5 J1**	**4.0 J1**	**1.0**
Barium	200	**163**	**176**	**157**	**184**	**99.4**	**31.1**	**20.1**	**249**	**12.3**	**33.2**	**21.1**	**9.5**	**6.6**	**8.2**	**30.3**	**9.9**
Beryllium	4.4	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.025 U	0.025 U	0.2 U	0.13 U	0.025 U	0.025 U	0.13 U	0.13 U	0.025 U	0.2 U
Cadmium	1.2	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.1 U	0.20 U	0.048 U	0.082 U	0.20 U	0.20 U	0.41 U	**0.3**
Chromium	27	**1.4**	**1.1 J1**	**0.89 J1**	**0.98 J1**	**0.7**	0.60 U	**0.14 J1**	0.50 U	**1.0**	0.60 U	**0.39 J1**	**1.0 J1**	**1.9 J1**	**2.1**	**4.3 J1**	0.5 U
Copper	3.1	**1.1**	0.38 U	**0.25 J1**	0.40 U	**0.9**	0.38 U	**0.36 J1**	0.40 U	0.5 U	0.38 U	**2.8**	0.40 U	**1.2 J1**	**0.63 J1**	2.0 U	**7.2**
Lead	8.1	0.1 U	0.080 U	0.34 U	0.034 U	0.1 U	0.080 U	**0.037 J1**	**0.086 J1**	0.1 U	0.080 U	**0.097 J1**	0.034 U	0.080 U	0.080 U	0.17 U	0.1 U
Nickel	8.2	**4.8**	**0.86 J1**	**0.73 J1**	**0.59 J1**	**4.4**	0.50 U	**0.25 J1**	0.35 U	**0.7**	0.50 U	0.13 U	0.35 U	**2.9**	**2.9**	**5.3 J1**	**3.3**
Selenium	71	**5**	**0.38 J1**	**1.4 J1**	0.50 UJ	5 U	0.27 U	**0.22 J1**	0.50 U	**3.8**	0.27 U	**0.22 J1**	0.50 U	0.27 U	0.27 U	2.5 U	**0.7**
Thallium	0.2	0.2 U	0.15 U	0.29 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.2 U	0.15 U	0.029 U	0.15 U	0.15 U	0.15 U	0.75 U	0.2 U
Zinc	81	4 U	4.0 U	1.1 U	1.7 UJ2	4 U	4.0 U	**2.3 J1**	**1.3 J1**	4 U	4.0 U	**4.2 J1**	**1.4 J1**	**4.1 J1**	4.0 UJ	5.5 U	**23**
Dissolved Metals (µg/L; SW-846 7470A/EPA 1631E)																	
Mercury	0.025	0.020 U	**0.005 J1**	0.003 U	0.003 U	0.020 U	0.002 U	**0.000 J1**	0.003 U	0.020 U	0.002 U	**0.000 J1**	**0.000 J1**	**0.002 J1**	**0.002 J1**	0.006 U	0.020 U

Table 2-2
Groundwater Data and pCUL Exceedances
Boeing Isaacson-Thompson
Feasibility Study

Notes:

U = Indicates the compound was not detected at or above the reporting limit.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J1 = Laboratory flag indicating the analyte was positively identified; the associated concentration is approximate and less than the reporting limit, but equal to or greater than the detection limit.
UJ2 = The analyte was not detected in the sample at or above the numerical value shown; the numerical value is below the reporting limit, but greater than the detection limit.
E = Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.
S = Indicates an analyte response that has saturated the detector. The calculated concentration is not valid; a dilution is required to obtain valid quantification of the analyte.
*Sample results include original digest and analysis and re-digest and analysis.
Bold = Detection **Green Shading** = Reported concentration is greater than the proposed cleanup level.

Abbreviations and Acronyms:

-- = not analyzed
µg/L = micrograms per liter
cPAH = carcinogenic polycyclic aromatic hydrocarbon
DRO = diesel-range organics
EPA = US Environmental Protection Agency
Lab = laboratory
mg/L = milligrams per liter
ng/L = nanograms per liter
NWTPH = Northwest Total Petroleum Hydrocarbon
ND = not detected
ORO = oil-range organics
PCB = polychlorinated biphenyl
SDG = sample delivery group
SIM = select ion monitoring
TEQ = toxicity equivalency quotient

Table 2-3a
Soil Data and pCUL Exceedances: North of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		Northern Property Boundary																
		4 (2.5) 8/1/1983	4 (6.5) 8/1/1983	4 (10.5) 8/1/1983	10 (6) 8/1/1983	10 (11) 8/1/1983	Dup of 10 10-Dup (11) 8/1/1983	10 (13.5) 8/1/1983	IMR-3 OA02A 11/13/2008	IDP-11 (11) OL03E 2/3/2009	IDP-12 (12) OL03F 2/3/2009	IDP-13 (12) OL03G 2/3/2009	IDP-14 (11) OL03H 2/3/2009	IDP-15 (12) OL03I 2/3/2009	IT-MW-22 (2-3.5) TW89I 11/11/2011	IT-MW-22 (5-6.5) TW89J 11/11/2011	IT-MW-22 (8-9.5) TW89K 11/11/2011	IT-MW-22 (13.5-15) TW89L 11/11/2011
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	--	--	--	--	--	--	--	--	0.0008 U	0.0006 U	0.0008 U	0.0009 U	0.0006 U	0.0013 U	0.0013 U	0.0015 U	0.0010 U
Acrylonitrile	240	--	--	--	--	--	--	--	--	0.0040 U	0.0030 U	0.0038 U	0.0043 U	0.0032 U	0.0065 U	0.0065 U	0.0073 U	0.0050 U
Trichloroethene	0.002/0.004 (a)	--	--	--	--	--	--	--	--	0.0008 U	0.0006 U	0.0008 U	0.0009 U	0.0006 U	**0.0015**	**0.0009 J1**	**0.0017**	0.0010 U
Vinyl Chloride	0.002	--	--	--	--	--	--	--	--	0.0008 U	0.0006 U	0.0008 U	0.0000 U	0.0006 U	0.0013 U	0.0013 U	0.0015 U	0.0010 U
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	--	--	--	--	0.0640 U	--	0.0580 U	--	0.0340 U	0.0260 U	0.0300 U	0.0300 U
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	ND	--	ND	--	**0.0170 J**	**0.0055**	**0.0013 J**	ND
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.0138**	**0.0348**	**0.0158**	**0.0160**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	--	0.2000 U	--	--	--	--	--	--	--	ND	--	ND	--	ND	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (b)	--	--	--	--	--	--	--	--	--	--	--	--	--	7.6 U	9.4 U	8.0 U	6.9 U
Diesel-Range Organics	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	**64 J**	**13 J**	**10 J**	5.9 U
Oil-Range Organics		--	--	--	--	--	--	--	--	--	--	--	--	--	**220**	**25**	**22**	12 U
Combined DRO/ORO	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	**284 J**	**38 J**	**32 J**	ND
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2 U	0.3 U	0.3 U	0.2 U
Arsenic	7	**270.5**	**551**	**15**	**20**	**4.7**	**8.8**	**7.1**	**294**	6 U	**204**	**18**	**220**	**274**	**3.0**	**56.4**	**535**	**58.8**
Barium	160	--	**33**	--	--	--	--	--	**95.5**	--	--	--	--	--	**26.6**	**67.3**	**67.6**	**39.0**
Beryllium	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2 U	**0.4**	**0.3**	0.2 U
Cadmium	0.77	--	**0.06**	--	--	--	--	--	**1.6**	0.2 U	0.3 U	0.3 U	0.2 U	0.3 U	0.1 U	**0.7**	**0.3**	0.1 U
Chromium	48	--	**11**	--	--	--	--	--	**65.8**	**11.8**	**16.3**	**23.5**	**15.4**	**17.3**	**15.6**	**24**	**15.1**	**11.9**
Chromium VI	0.96	--	--	--	--	--	--	--	--	--	--	--	--	--	0.438 U	0.547 U	0.526 U	0.512 U
Copper	36	--	--	--	--	--	--	--	--	**13.5**	**163**	**131**	**624**	**47.2**	**14.3**	**28.8**	**804**	**388**
Lead	81	--	**2.4**	--	--	--	--	--	**126**	2 U	**4**	**4**	**6**	**5**	**4.1**	**12.2**	**6.8**	**1.8**
Mercury	0.07	--	**0.04**	--	--	--	--	--	**1.44**	0.05 U	**0.06**	**0.08**	**0.21**	**0.06**	0.02 U	**0.14**	**0.10**	0.03 U
Nickel	48	--	**9.2**	--	--	--	--	--	--	--	--	--	--	--	**9.0**	**17.2**	**13.2**	**8.4**
Selenium	3	--	--	--	--	--	--	--	6 U	--	--	--	--	--	0.5 U	0.7 U	0.6 U	0.6 U
Thallium	2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2 U	0.3 U	**0.8**	0.2 U
Zinc	85	**124**	**40**	**132**	**59.5**	**31.8**	**31.8**	**27.2**	--	**35**	**354**	**97**	**77**	**96**	**26**	**62**	**66**	**235**

Table 2-3a
Soil Data and pCUL Exceedances: North of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																	
		Western Property Boundary (West of Stabilized Soil Area)																	
		I-4 (3) 10/20/1983	PBI-1 (2) PI24A 7/27/2009	PBI-1 (5) PI24B 7/27/2009	PBI-1 (8) PI24C 7/27/2009	PBI-2 (2) PI24D 7/27/2009	PBI-2A (5) PI24E 7/27/2009	PBI-2A (8) PI24F 7/27/2009	IDP-6 (4) OK85 2/2/2009	IDP-6 (8) OK85AB 2/2/2009	IDP-6 (12) OK85AC 2/2/2009	IDP-6A (3) OL03J 2/3/2009	IDP-7 (3) OL03A 2/3/2009	IT-MW-20 (2-3.5) TW35G 11/09/2011	IT-MW-20 (5-6.5) TW35H 11/09/2011	IT-MW-20 (8-9.5) TW35I 11/09/2011	IT-MW-20 (14.5-16) TW35J 11/09/2011	IT-MW-21 (2-3.5) TW89D 11/11/2011	IT-MW-21 (5-6.5) TW89E 11/11/2011
Volatiles (mg/kg; SW-846 8260C)																			
1,1-Dichloroethene	1.4	--	--	--	--	--	--	--	--	--	--	--	0.0011 U	0.0011 U	0.0011 U	0.0014 U	0.0011 U	0.0012 U	0.0013 U
Acrylonitrile	240	--	--	--	--	--	--	--	--	--	--	--	0.0057 U	0.0053 U	0.0056 U	0.0071 U	0.0054 U	0.0058 U	0.0065 U
Trichloroethene	0.002/0.004 (a)	--	--	--	--	--	--	--	--	--	--	--	**0.0016**	0.0011 U	0.0011 U	0.0014 U	0.0011 U	**0.0014**	0.0013 U
Vinyl Chloride	0.002	--	--	--	--	--	--	--	--	--	--	--	0.0011 U	0.0011 U	0.0011 U	0.0014 U	0.0011 U	0.0012 U	0.0013 U
Semivolatiles (mg/kg; SW-846 8270D)																			
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	--	--	--	0.0610 U	0.0650 U	0.0580 U	--	0.0250 U	0.0240 U	0.0240 U	0.0240 U	0.0240 U	0.0230 U
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	ND	ND	ND	--	**0.0116 J**	ND	ND	ND	**0.0014 J**	**0.0163 J**
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																			
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	**0.0246**	**0.0004 J**	ND	ND	**0.0114 J**	**0.0244 J**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																			
Total PCBs	0.020	--	--	--	--	--	--	--	--	ND	ND	ND	--	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																			
Gasoline-Range Organics	30 (b)	--	--	--	--	--	--	--	--	--	--	--	--	**22**	**10**	11 U	7.5 U	7.7 U	8.2 U
Diesel-Range Organics	2,000	--	--	--	--	--	--	--	--	--	--	--	--	**1,400**	6.2 U	6.8 U	6.4 U	**21 J**	**18 J**
Oil-Range Organics		--	--	--	--	--	--	--	--	--	--	--	--	**190**	12 U	14 U	13 U	**100**	**41**
Combined DRO/ORO	2,000	--	--	--	--	--	--	--	--	--	--	--	--	**1,590**	ND	ND	ND	**121 J**	**59 J**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																			
Antimony	4.1	--	--	--	--	--	--	--	--	--	--	--	--	**0.6**	0.2 U	0.3 U	0.2 U	**0.6**	0.2 U
Arsenic	7	**510**	**28.9 J**	**5.8**	**14.7**	**23.5**	**329**	**58.2**	10 U	**71**	5.0 U	**14**	50 U	**7.5**	**139**	**5.5**	**10.5**	**36.6**	**36.5**
Barium	160	--	--	--	--	--	--	--	--	--	--	--	--	**324**	**60.5**	**67.1**	**31.7**	**67.3**	**52.0**
Beryllium	3.5	--	--	--	--	--	--	--	--	--	--	--	--	**0.3**	**0.3**	**0.3**	0.2 U	0.2 U	**0.3**
Cadmium	0.77	--	**1.3**	**0.7**	**1.1**	**9.1**	**0.8**	**2.1**	--	0.3 U	0.2 U	0.2 U	**4**	**13.5**	0.1 U	0.1 U	0.1 U	**2.1**	**0.3**
Chromium	48	**16**	**561 J**	**299**	**486**	**652**	**54**	**117**	--	**19.2**	**9**	**52**	**262**	**594**	**17.2**	**17.1**	**11.8**	**100**	**15.1**
Chromium VI	0.96	--	--	--	--	--	--	--	--	--	--	--	--	0.462 U	0.491 U	0.528 U	0.486 U	**0.461**	0.458 U
Copper	36	**280**	**107 J**	**46**	**128**	**394**	**152**	**136**	--	**26.9**	**9.1**	**20.8**	**177 J**	**150**	**83.1**	**22.3**	**12.8**	**65.7**	**21.8**
Lead	81	**150**	**141**	**86**	**113**	**1,200**	**29**	**164**	--	**3**	2 U	**27**	**420**	**684**	**5.2**	**5.2**	**3.9**	**112**	**14.4**
Mercury	0.07	--	**0.05**	0.02 U	0.02 U	**0.39**	**0.07**	**0.09**	--	**0.06**	0.05 U	0.05 U	**0.52 J**	**0.08**	**0.05**	**0.06**	0.02 U	**0.18**	**0.11**
Nickel	48	--	--	--	--	--	--	--	--	--	--	--	--	**65.6**	**12.9**	**13.8**	**6.0**	**22.8**	**11.3**
Selenium	3	--	--	--	--	--	--	--	--	--	--	--	--	0.6 U	0.6 U	0.7 U	0.6 U	0.5 U	0.6 U
Thallium	2	--	--	--	--	--	--	--	--	--	--	--	--	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U
Zinc	85	**430**	**380 J**	**190**	**270**	**3,030**	**170**	**560**	--	**153**	**20**	**68**	**1,390 J**	**2,350**	**78**	**37**	**26**	**295**	**58**

Table 2-3a
Soil Data and pCUL Exceedances: North of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

		Sample Area, Sample ID, Lab Sample ID, Sample Date																	
		Western Prop. Boundary (West of Stabilized Soil)				South of Stabilized Soil Area													
Analyte	Revised Soil Proposed Cleanup Level	IT-MW-21 (8-9.5) TW89F 11/11/2011	IT-MW-21 (13.5-15) TW89G 11/11/2011	IT-MW-21 (17-18.5) TW89H 11/11/2011	IT-MW-21 (24.5-26) TW89M 11/11/2011	13 (9) 8/1/1983	13 (13.5) 8/1/1983	14 (2) 8/1/1983	S-02-A1 (BAY13) 5/18/1989	E-01-C1 (BAY13) 5/24/1989	IMR-5 NV07C 10/17/2008	IMR-7 NW45A 10/27/2008	IMR-13 NY11D 11/4/2008	IMR-14 NY11E 11/4/2008	IMR-16 NY11G 11/4/2008	IMR-18 OA02B 11/13/2008	IDP-8 (3) OL03B 2/3/2009	IDP-9 (3) OL03C 2/3/2009	IDP-10 (2) OL03D 2/3/2009
Volatiles (mg/kg; SW-846 8260C)																			
1,1-Dichloroethene	1.4	0.0016 U	0.0014 U	0.0012 U	0.0013 U	--	--	--	--	--	--	--	--	--	--	--	0.0006 U	0.0013 U	0.0008 U
Acrylonitrile	240	0.0078 U	0.0070 U	0.0059 U	0.0063 U	--	--	--	--	--	--	--	--	--	--	--	0.0032 U	0.0066 U	0.0039 U
Trichloroethene	0.002/0.004 (a)	**0.0008 J1**	**0.0010 J1**	**0.0010 J1**	**0.0014**	--	--	--	--	--	--	--	--	--	--	--	0.0006 U	0.0013 U	0.0008 U
Vinyl Chloride	0.002	0.0016 U	0.0014 U	0.0012 U	0.0013 U	--	--	--	--	--	--	--	--	--	--	--	0.0006 U	0.0013 U	0.0008 U
Semivolatiles (mg/kg; SW-846 8270D)																			
bis(2-Ethylhexyl)phthalate	0.12	0.0210 UJ2	0.0420 U	0.0260 U	--	--	--	--	--	--	--	--	--	--	--	--	0.0640 U	0.0610 U	--
cPAH TEQ	0.0076	**0.0185 J**	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	ND	ND	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																			
cPAH TEQ	0.0076	**0.0080 J**	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																			
Total PCBs	0.020	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	ND	ND	--
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																			
Gasoline-Range Organics	30 (b)	8.2 U	7.6 U	6.4 U	8.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diesel-Range Organics	2,000	6.4 U	5.8 U	5.6 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil-Range Organics		13 U	12 U	11 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Combined DRO/ORO	2,000	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																			
Antimony	4.1	0.3 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	7	**139**	**221**	**12.6**	--	**7.2**	**4.5**	**41**	**180**	**250**	**8**	--	**77**	**70**	**30**	**397**	**32**	**30**	**23**
Barium	160	**66.3**	**28.7**	**23.3**	--	--	--	**33**	--	--	**61.5**	**31.4**	**75.1**	**157**	**253**	**40.8**	--	--	--
Beryllium	3.5	0.3 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.77	**0.2**	0.1 U	0.1 U	--	--	--	**0.78**	--	--	**0.6**	0.2 U	**1.3**	**1.9**	**15**	**1.5**	**0.4**	**0.6**	**0.6**
Chromium	48	**15.4**	**10.2**	**10.6**	--	--	--	**16**	--	--	**41.2**	**21.3**	**52**	**109**	**536**	**14.6**	**36.9**	**58**	**16.2**
Chromium VI	0.96	0.517 U	0.490 U	0.500 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	36	**668**	**183**	**11.4**	--	--	--	--	--	--	--	--	--	--	--	--	**27.4**	**93.2**	**55.6**
Lead	81	**9.1**	**2.3**	**1.0**	--	--	--	**69**	--	--	**56**	2 U	**86**	**273**	**1,210**	**24**	**27**	**112**	**59**
Mercury	0.07	**0.07**	**0.03**	0.03 U	--	--	--	**0.03**	--	--	**0.1**	0.05 U	**0.21**	**0.33**	**0.06**	**0.16**	**0.08**	**0.18**	**0.15**
Nickel	48	**14.3**	**8.0**	**7.1**	--	--	--	**14**	--	--	--	--	--	--	--	--	--	--	--
Selenium	3	0.6 U	0.6 U	0.6 U	--	--	--	0.2 U	--	--	5 U	5 U	6 U	10 U	30 U	6 U	--	--	--
Thallium	2	0.3 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	85	**63**	**99**	**26**	--	**25**	**102.5**	**73.9**	--	--	--	--	--	--	--	--	**89**	**267**	**220**

Table 2-3a
Soil Data and pCUL Exceedances: North of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		South of Stabilized Soil Area												Stabilized Soil Area				
		IT-MW-15 (2-3.5) TX21A 11/15/2011	IT-MW-15 (5-6.5) TX21B 11/15/2011	IT-MW-15 (8-9.5) TX21C 11/15/2011	IT-MW-15 (12.5-14) TX21D 11/15/2011	IT-MW-16 (2-3.5) TW45L 11/10/2011	IT-MW-16 (5-6.5) TW45M 11/10/2011	IT-MW-16 (8-9.5) TW45N 11/10/2011	IT-MW-16 (12-13.5) TW45O 11/10/2011	IT-MW-18 (2-3.5) TW27A 11/08/2011	IT-MW-18 (5-6.5) TW27B 11/08/2011	IT-MW-18 (8-9.5) TW27D 11/08/2011	IT-MW-18 (11.5-13) TW27C 11/08/2011	IMR-2 NV07A 10/17/2008	IMR-4 NV07B 10/17/2008	IMR-6 NV07D 10/17/2008	IMR-8 NV07E 10/17/2008	IMR-10 NY11A 11/4/2008
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	0.0013 U	0.0014 U	0.0014 U	0.0014 U	0.0013 U	0.0011 U	0.0013 U	0.0013 U	0.0012 U	0.0014 U	0.0014 U	0.0012 U	--	--	--	--	--
Acrylonitrile	240	0.0064 U	0.0070 U	0.0071 U	0.0071 U	0.0063 U	0.0053 U	0.0065 U	0.0065 U	0.0062 U	0.0069 U	0.0068 U	0.0061 U	--	--	--	--	--
Trichloroethene	0.002/0.004 (a)	**0.0009 J1**	**0.0018**	**0.0016**	**0.0012 J1**	0.0013 U	0.0011 U	0.0013 U	0.0013 U	0.0012 U	0.0014 U	0.0014 U	0.0012 U	--	--	--	--	--
Vinyl Chloride	0.002	0.0013 U	0.0014 U	0.0014 U	0.0014 U	0.0013 U	0.0011 U	0.0013 U	0.0013 U	0.0012 U	0.0014 U	0.0014 U	0.0012 U	--	--	--	--	--
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	0.1300 U	**0.2400**	0.1800 U	0.0230 U	0.0340 U	0.0320 U	0.0670 U	0.0430 U	**0.0220 J1**	**0.0290**	**0.0320**	**0.0170 J1**	--	--	--	--	--
cPAH TEQ	0.0076	ND	ND	ND	ND	**0.1383 J**	ND	**0.0318 J**	ND	**0.0020 J**	**0.0058**	**0.0048 J**	ND	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	**0.0159**	**0.0029 J**	ND	ND	**0.0654**	**0.3031**	**0.0422 J**	**0.0034 J**	**0.0110 J**	**0.0278**	**0.0157**	**0.0000 J**	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0290 J**	ND	--	--	--	--	--
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (b)	8.1 U	7.0 U	7.4 U	8.7 U	7.5 U	7.6 U	6.9 U	7.9 U	6.4 U	9.2 U	8.7 U	8.5 U	--	--	--	--	--
Diesel-Range Organics	2,000	6.0 U	6.4 U	5.3 U	6.6 U	**12**	5.3 U	**14**	6.1 U	**26**	**27**	**32**	6.8 U	--	--	**17**	--	--
Oil-Range Organics		12 U	13 U	11 U	13 U	**47**	**12**	**57**	12 U	**110**	**34**	**41**	**20**	--	--	**61**	--	--
Combined DRO/ORO	2,000	ND	ND	ND	ND	**59**	**12**	**71**	ND	**136**	**61**	**73**	**20**	--	--	**78**	--	--
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	0.2 UJ	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 UJ	0.2 U	0.3 U	0.3 U	--	--	--	--	--
Arsenic	7	**7.3**	**3.0**	**3.8**	**2.4**	**217**	**13.2**	**80.6**	**3.3**	**8.8**	**35.5**	**18.9**	**13.5**	5 U	**1,120**	**2,440**	**253**	**38**
Barium	160	**51.0**	**44.2**	**33.6**	**50.9**	**55.0**	**34.9**	**43.7**	**27.6**	**44.3 J**	**52.8**	**59.7**	**70.7**	**48**	**153**	**78.6**	**57.8**	**30.1**
Beryllium	3.5	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.4**	**0.3**	**0.3**	--	--	--	--	--
Cadmium	0.77	0.1 U	0.1 U	0.1 U	0.1 U	**0.2**	0.1 U	**0.2**	0.1 U	0.1 U	**0.4**	**0.5**	**0.2**	0.2 U	**3.1**	**5.6**	**1**	**0.3**
Chromium	48	**15.0**	**12.2**	**8.6**	**12.4**	**18.7**	**12.1**	**20.5**	**9.6**	**53.3 J**	**15.3**	**16.8**	**16.1**	**19.5**	**55**	**19.7**	**26.4**	**24.4**
Chromium VI	0.96	0.475 U	0.500 U	0.423 U	0.533 U	0.458 U	0.457 U	0.463 U	0.482 U	0.419 UJ	0.528 U	0.520 U	0.543 U	--	--	--	--	--
Copper	36	**15.7**	**17.2**	**11.0**	**20.2**	**70.1**	**21.2**	**44.4**	**11.9**	**15.7 J**	**20.9**	**30.8**	**25.9**	--	--	--	--	--
Lead	81	**17.1 J**	**3.4**	**17.4**	**2.5**	**33.3**	**7.7**	**33.5**	**1.4**	**7.6**	**6.4**	**7.6**	**4.9**	2 U	**136**	**26**	**44**	2 U
Mercury	0.07	**0.11**	**0.07**	0.02 U	**0.03**	**0.15**	0.03 U	**0.10**	0.03 U	0.02 U	**0.06**	**0.06**	**0.06**	0.04 U	**0.46**	**0.68**	**0.81**	0.04 U
Nickel	48	**15.5**	**10.8**	**7.9**	**9.5**	**14.0**	**9.4**	**15.4**	**8.2**	**10.7**	**14.6**	**15.4**	**14.2**	--	--	--	--	--
Selenium	3	0.6 U	0.6 U	0.5 U	0.7 U	0.5 U	0.6 U	0.6 U	0.6 U	0.5 U	0.6 U	0.6 U	0.7 U	5 U	20 U	6 U	5 U	5 U
Thallium	2	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.3 U	--	--	--	--	--
Zinc	85	**51**	**27**	**29**	**27**	**129**	**31**	**75**	**45**	**41**	**46**	**57**	**37**	--	--	--	--	--

Table 2-3a
Soil Data and pCUL Exceedances: North of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		Stabilized Soil Area									Former Sump/NE Property Corner			Former Paint Storage Area				
		IMR-11 NW45B 10/27/2008	IMR-11 NY11B 11/4/2008	IMR-12 NW45C 10/27/2008	IMR-12 NY11C 11/4/2008	IMR-15 NY11F 11/4/2008	IT-MW-23 (11-12.5) TW35A 11/09/2011	IT-MW-23 (12.5-14) TW35B 11/09/2011	IT-MW-24 (12.5-14) TX01D 11/14/2011	IT-MW-24 (14-15.5) TX01E 11/14/2011	IssacEx-01 (5) KH07A 11/30/2006	IssacEx-02 (1.5) KH07B 11/30/2006	IssacEx-03 (2) KH07C 11/30/2006	2 (2.5) 8/1/1983	IT-SB-9 (2-3.5) TX02E 11/14/2011	IT-SB-9 (5-6.5) TX02F 11/14/2011	IT-SB-9 (8-8.5) TX02G 11/14/2011	IT-SB-9 (14-15.5) TX02H 11/14/2011
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	--	--	--	--	--	0.0012 U	0.0012 U	0.0012 U	0.0015 U	0.0008 U	0.0006 U	0.0006 U	--	0.0013 U	0.0013 U	0.0013 U	0.0015 U
Acrylonitrile	240	--	--	--	--	--	0.0061 U	0.0061 U	0.0061 U	0.0073 U	0.0040 U	0.0030 U	0.0032 U	--	0.0064 U	0.0065 U	0.0064 U	0.0073 U
Trichloroethene	0.002/0.004 (a)	--	--	--	--	--	0.0012 U	0.0012 U	**0.0021**	**0.0017**	0.0008 U	0.0006 U	0.0006 U	--	**0.0006 J1**	**0.0013**	**0.0021**	**0.0015**
Vinyl Chloride	0.002	--	--	--	--	--	0.0012 U	0.0012 U	0.0012 U	0.0015 U	0.0008 U	0.0006 U	0.0006 U	--	0.0013 U	0.0013 U	0.0013 U	0.0015 U
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	0.0230 U	0.0370 U	**0.0170 J1**	**0.0240**	0.0650 U	**0.5200**	0.0630 U	--	0.0290 U	0.0840 U	0.0360 U	0.0570 U
cPAH TEQ	0.0076	--	--	--	--	--	ND	ND	ND	ND	ND	**0.0008**	ND	--	**0.0326 J**	**0.0133**	ND	ND
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	--	--	--	--	--	ND	ND	**0.0149 J**	**0.0051 J**	--	--	--	--	**0.0555**	**0.0463**	ND	ND
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	--	--	--	--	--	ND	ND	ND	ND	ND	**0.0410**	ND	--	ND	**0.0430**	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (b)	--	--	--	--	--	8.3 U	7.6 U	7.5 U	8.1 U	--	--	--	--	6.9 U	6.7 U	7.1 U	8.3 U
Diesel-Range Organics	2,000	--	--	--	--	--	6.6 U	6.2 U	**30**	6.0 U	6.2 U	**7.3**	5.7 U	--	5.7 U	5.6 U	5.2 U	6.2 U
Oil-Range Organics		--	--	--	--	--	13 U	**15**	**45**	12 U	12 U	**65**	**11**	--	11 U	11 U	10 U	**13**
Combined DRO/ORO	2,000	--	--	--	--	--	ND	**15**	**75**	ND	ND	**72.3**	**11**	--	ND	ND	ND	**13**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	--	--	--	--	--	0.2 UJ	0.3 U	**0.3**	0.2 U	--	--	--	--	0.2 U	0.2 U	0.2 U	0.3 U
Arsenic	7	**524**	**439**	**1,780**	**485**	**919**	**102 J**	**331**	**1,640**	**1,130**	**18.1**	**25.1**	**6.6**	**8.7**	**3.7**	**3.4**	**2.0**	**2.2**
Barium	160	**85**	**46.6**	**93**	**61.4**	**84.2**	**50.7 J**	**27.9**	**56.5**	**39.1**	**46.1**	**51.4**	**61.6**	**44**	**47.8**	**48.6**	**25.8**	**45.1**
Beryllium	3.5	--	--	--	--	--	0.2 U	0.3 U	**0.3**	0.2 U	--	--	--	--	0.2 U	0.2 U	0.2 U	0.3 U
Cadmium	0.77	**1.4**	**1.6**	**3.1**	**1.6**	**3**	0.1 U	0.1 U	**0.3**	0.1 U	0.2 U	**0.4**	**0.3**	**0.12**	0.1 U	0.1 U	0.1 U	0.1 U
Chromium	48	**38.6**	**22.9**	**116**	**25.1**	**19.5**	**13.2**	**11.6**	**16.6**	**9.9**	**11.2**	**23.5**	**12.1**	**20**	**11.2**	**14.7**	**9.0**	**14.0**
Chromium VI	0.96	--	--	--	--	--	**0.521**	0.517 U	0.511 U	0.484 U	--	--	--	--	0.443 U	0.447 U	0.421 U	0.536 U
Copper	36	--	--	--	--	--	**180**	**514**	**226**	**322**	--	--	--	--	**16.8**	**18.0**	**10.6**	**17.9**
Lead	81	**114**	**40**	**46**	**36**	**51**	**2.2 J**	**2.2**	**18.0**	**3.6**	**4**	**85**	**27**	**11**	**11.8**	**19.7**	**1.3**	**2.1**
Mercury	0.07	**1.82**	**1.12**	**0.7**	**0.12**	**0.8**	**0.21 J**	**0.15**	**1.14**	**0.54**	0.04 U	0.05 U	**0.05**	**0.08**	**0.04**	0.03 U	0.02 U	0.03 U
Nickel	48	--	--	--	--	--	**10.1**	**8.3**	**13.6**	**8.8**	--	--	--	**16**	**9.2**	**17.2**	**8.0**	**11.0**
Selenium	3	6 U	6 U	20 U	6 U	7 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.5 U	--	0.6 U	0.6 U	0.5 U	0.7 U
Thallium	2	--	--	--	--	--	0.2 U	**0.3**	**0.7**	0.2 U	--	--	--	--	0.2 U	0.2 U	0.2 U	0.3 U
Zinc	85	--	--	--	--	--	**44**	**98**	**127**	**95**	--	--	--	**37**	**40**	**55**	**20**	**32**

Table 2-3a
Soil Data and pCUL Exceedances: North of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		Former Paint Storage Area								Former Diesel/Gas Tank		Vicinity of Former Steam Cleaning Rack and Sump and Boiler Tank Areas						
		IT-SB-10 (2-3.5) TU90P 11/01/2011	IT-SB-10 (5-6.5) TU90Q 11/01/2011	IT-SB-10 (8-9.5) TU90T 11/01/2011	IT-SB-10 (13.5-15) TU90S 11/01/2011	IT-SB-11 (2-3.5) TX02A 11/14/2011	IT-SB-11 (5-6.5) TX02B 11/14/2011	IT-SB-11 (8-9) TX02C 11/14/2011	IT-SB-11 (14-15.5) TX02D 11/14/2011	1 (5.5) 8/1/1983	IT-TP-109-SWS(9-10) TT67A 10/25/2011	B-12 (14) 1983	I-2 (14.5) 10/14/1983	PZT-20' 9/24/1984	IMR-19 OA02C 11/13/2008	IT-MW-25 (8-9.5) TX01A 11/14/2011	IT-MW-25 (13.5-15) TX01B 11/14/2011	IT-MW-25 (15.5-17) TX01C 11/14/2011
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	0.0014 U	0.0011 U	0.0015 U	0.0016 U	0.0011 U	0.0012 U	0.0012 U	0.0012 U	--	0.0013 U	--	--	--	--	0.0012 U	0.0012 UJ	0.0013 U
Acrylonitrile	240	0.0072 U	0.0055 U	0.0073 U	0.0080 U	0.0055 U	0.0061 U	0.0062 U	0.0059 U	--	0.0064 U	--	--	--	--	0.0059 U	0.0060 U	0.0067 U
Trichloroethene	0.002/0.004 (a)	0.0014 U	0.0011 U	0.0015 U	0.0016 U	**0.0010 J1**	**0.0015**	**0.0019**	**0.0012**	--	0.0013 U	--	--	--	--	0.0012 U	**0.0018**	0.0013 U
Vinyl Chloride	0.002	0.0014 U	0.0011 U	0.0015 U	0.0016 U	0.0011 U	0.0012 U	0.0012 U	0.0012 U	--	0.0013 U	--	--	--	--	0.0012 U	0.0012 U	0.0013 U
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	0.1400 U	0.0230 U	0.0240 U	0.0230 U	0.0260 U	0.0380 U	0.0240 U	0.0330 U	--	0.0240 U	--	--	--	--	**0.0720**	**0.0940**	**0.0860**
cPAH TEQ	0.0076	**0.0735 J**	**0.0002**	ND	ND	**0.0030 J**	ND	ND	ND	--	ND	--	--	--	--	**0.0157 J**	ND	ND
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	**0.0606**	**0.0104 J**	ND	ND	**0.0205 J**	**0.0041 J**	ND	**0.0038 J**	--	ND	--	--	--	--	**0.0152 J**	**0.0056 J**	**0.0000 J**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	ND	ND	ND	ND	ND	ND	ND	ND	0.2000 U	ND	--	--	--	--	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (b)	6.1 U	5.6 U	8.4 U	9.3 U	8.2 U	7.0 U	6.6 U	7.4 U	--	**17**	--	--	--	--	**10**	7.0 U	8.4 U
Diesel-Range Organics	2,000	**400**	**7.5**	5.7 U	6.7 U	5.8 U	5.4 U	5.4 U	6.0 U	--	5.2 U	--	--	--	--	**24**	**51**	**6.8**
Oil-Range Organics		**770**	**47**	11 U	13 U	12 U	**30**	11 U	**26**	--	10 U	--	--	--	--	**100**	**53**	**18**
Combined DRO/ORO	2,000	**1,170**	**55**	ND	ND	ND	**30**	ND	**26**	--	ND	--	--	--	--	**124**	**104**	**25**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	0.2 U	0.2 U	0.2 U	0.3 U	0.2 UJ	0.2 U	0.2 U	0.3 U	--	0.2 UJ	--	--	--	--	0.2 U	0.2 UJ	0.2 U
Arsenic	7	**25.9**	**2.7**	**2.1**	**187**	**501**	**209**	**15.4**	**43.5**	**3.4**	**2.3**	**23**	**1,200**	**1,700**	**383**	**87.9**	**55.8**	**37.7**
Barium	160	**150**	**35.0**	**36.1**	**47.0**	**58.2 J**	**28.4**	**30.7**	**55.3**	**26**	**21.3 J**	--	--	--	**78.5**	**62.2**	**30.0 J**	**28.6**
Beryllium	3.5	**0.3**	0.2 U	0.2 U	0.3 U	**0.2**	0.2 U	0.2 U	0.3 U	--	0.2 U	--	--	--	--	**0.2**	0.2 U	0.2 U
Cadmium	0.77	**0.1**	0.1 U	0.1 U	0.1 U	**0.3**	0.1 U	0.1 U	0.1 U	**0.03**	0.1 U	--	--	--	**1.8**	0.1 U	0.1 U	0.1 U
Chromium	48	**20.7**	**9.3**	**10.5**	**12.6**	**16.0**	**8.6**	**8.6**	**15.0**	**11**	**9.3**	--	**9.3**	--	**30.9**	**18.2**	**10.7**	**8.7**
Chromium VI	0.96	0.445 U	**0.429**	0.436 U	0.536 U	0.464 UJ	0.427 U	0.429 U	0.499 U	--	0.414 U	--	--	--	--	0.449 UJ	0.496 U	0.477 U
Copper	36	**45.9**	**12.9**	**14.8**	**490**	**1,170**	**51.8**	**11.1**	**63.2**	--	**10.5**	--	**420**	--	--	**85.7**	**303**	**224**
Lead	81	**29.3**	**1.9**	**1.6**	**2.3**	**14.4**	**1.6**	**1.4**	**3.7**	**1.3**	**1.4**	--	**4.5**	--	**87**	**8.4**	**2.8**	**1.4**
Mercury	0.07	**0.06**	0.03 U	0.02 U	0.03 U	**0.08 J**	0.02 U	0.02 U	**0.03**	0.03 U	0.02 U	--	--	--	**0.69**	**0.05**	**0.02**	0.02 U
Nickel	48	**31.6**	**8.5**	**9.0**	**9.4**	**20.6**	**8.3**	**7.6**	**12.0**	**9.5**	**8.8**	--	--	--	--	**20.3**	**10.6**	**9.0**
Selenium	3	0.5 U	0.5 U	0.5 U	0.7 U	0.6 U	0.5 U	0.5 U	0.6 U	--	0.5 U	--	--	--	6 U	0.5 U	0.6 U	0.6 U
Thallium	2	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.3 U	--	0.2 U	--	--	--	--	0.2 U	0.2 U	0.2 U
Zinc	85	**93**	**24**	**23**	**272**	**195**	**268**	**81**	**62**	**21**	**25**	**388**	**220**	--	--	**71**	**135**	**187**

Table 2-3a
Soil Data and pCUL Exceedances: North of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date												
		Observed Tar-Like Substance Area												
		IMR-1 NS65A 10/3/2008	IT-TP-107-B (11-12) TU01F 10/26/2011	IT-TP-107-SWN(1-2) TU01A 10/26/2011	IT-TP-107-SWN(2-3) TU01E 10/26/2011	IT-TP-107-SWS(1-2) TU01C 10/26/2011	IT-TP-107-SWE(1-2) TU01B 10/26/2011	IT-TP-107-SWW(1-2) TU01D 10/26/2011	IT-TP-108-B (11-12) TU01L 10/26/2011	IT-TP-108-SWN(1-2) TU01G 10/26/2011	IT-TP-108-SWN(2-3) TU01K 10/26/2011	IT-TP-108-SWS(1-2) TU01H 10/26/2011	IT-TP-108-SWE(1-2) TU01I 10/26/2011	IT-TP-108-SWW(1-2) TU01J 10/26/2011
Volatiles (mg/kg; SW-846 8260C)														
1,1-Dichloroethene	1.4	0.0012 U	0.0013 U	0.0012 U	0.0013 U	0.0011 U	0.0017 U	0.0010 U	0.0014 U	0.0014 U	0.0013 U	0.0012 U	0.0015 U	0.0018 U
Acrylonitrile	240	0.0060 U	0.0066 U	0.0059 U	0.0066 U	0.0055 U	0.0086 U	0.0051 U	0.0068 U	0.0072 U	0.0066 U	0.0060 U	0.0074 U	0.0090 U
Trichloroethene	0.002/0.004 (a)	0.0012 U	0.0013 U	0.0012 U	0.0013 U	0.0011 U	0.0017 U	0.0010 U	0.0014 U	0.0014 U	0.0013 U	0.0012 U	0.0015 U	0.0018 U
Vinyl Chloride	0.002	0.0012 U	0.0013 U	0.0012 U	0.0013 U	0.0011 U	0.0017 U	0.0010 U	0.0014 U	0.0014 U	0.0013 U	0.0012 U	0.0015 U	0.0018 U
Semivolatiles (mg/kg; SW-846 8270D)														
bis(2-Ethylhexyl)phthalate	0.12	1.2000 U	0.0240 U	0.3600 U	**0.0210 J1**	0.0250 U	0.1200 U	0.0230 U	0.0240 U	0.1600 U	0.0240 U	0.1200 U	0.1200 U	0.3500 U
cPAH TEQ	0.0076	**2.7480**	ND	**1.2430**	**0.0016 J**	**0.1338 J**	**1.4190**	**0.1298**	ND	**0.3299**	ND	**2.5470**	**0.2288**	**0.7320 J**
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)														
cPAH TEQ	0.0076	--	ND	**6.5930**	**0.0114**	**0.0138**	**1.2390**	**0.0647**	ND	**0.3306**	ND	**2.0830**	**0.3120**	**0.9140**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)														
Total PCBs	0.020	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)														
Gasoline-Range Organics	30 (b)	--	8.3 U	**14**	7.9 U	7.1 U	13 U	7.1 U	8.0 U	8.0 U	7.7 U	7.0 U	**36**	**24**
Diesel-Range Organics	2,000	**7,400**	6.8 U	**280**	5.4 U	**6.4**	**200**	**11**	6.1 U	**2,500**	5.2 U	**1,100**	**500**	**1,400**
Oil-Range Organics		**25,000**	14 U	**800**	11 U	**32**	**500**	**51**	12 U	**2,000**	10 U	**1,500**	**1,400**	**3,100**
Combined DRO/ORO	2,000	**32,400**	ND	**1,080**	ND	**38**	**700**	**62**	ND	**4,500**	ND	**2,600**	**1,900**	**4,500**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)														
Antimony	4.1	--	0.3 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Arsenic	7	--	**4.5**	**85.3 J**	**7.0**	**65.0**	**73.8**	**215**	**1.9**	**35.4**	**1.5**	**75.0**	**34.4**	**86.3**
Barium	160	--	**71.9**	**169**	**38.9**	**70.3**	**153**	**57.1**	**30.7**	**165**	**22.7**	**79.6**	**77.7**	**71.4**
Beryllium	3.5	--	0.3 U	0.2 U	0.2 U	**0.2**	0.2 U	0.2 U	0.2 U	**0.3**	0.2 U	0.2 U	0.2 U	**0.3**
Cadmium	0.77	--	0.1 U	**0.3**	0.1 U	**0.2**	**0.3**	**0.2**	0.1 U	**0.3**	0.1 U	**0.3**	**0.3**	**0.2**
Chromium	48	--	**14.8**	**13.3**	**12**	**14.5**	**14.1**	**16.9**	**8.0**	**20**	**6.7**	**14.1**	**11.2**	**17.1**
Chromium VI	0.96	--	0.534 U	0.469 UJ	0.434 U	0.423 U	0.481 U	0.439 U	0.484 U	0.444 U	0.417 U	0.471 U	**0.558**	0.478 U
Copper	36	--	**20.9**	**205**	**17.5**	**82.0**	**196**	**129**	**10.9**	**87.7**	**8.8**	**131**	**42.5**	**107**
Lead	81	--	**2.8**	**81.4 J**	**7.7**	**20.0**	**82.3**	**26.6**	**1.5**	**91.3**	**1.2**	**52.8**	**43.6**	**52.1**
Mercury	0.07	--	**0.03**	**1.14**	**0.02**	**0.08**	**1.35**	**0.24**	0.02 U	**0.32**	0.02 U	**0.51**	**0.51**	**0.21**
Nickel	48	--	**11.8**	**14.6**	**10.6**	**14.3**	**15.4**	**19.2**	**7.3**	**22.3**	**6.3**	**18.9**	**12.1**	**22.1**
Selenium	3	--	0.6 U	0.6 U	0.5 U	0.5 U	0.6 U	0.5 U	0.6 U	0.6 U	0.5 U	0.6 U	0.6 U	0.6 U
Thallium	2	--	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	85	--	**82**	**157**	**59**	**88**	**193**	**148**	**21**	**139**	**18**	**118**	**92**	**145**

Table 2-3a
Soil Data and pCUL Exceedances: North of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

		Sample Area, Sample ID, Lab Sample ID, Sample Date													
		Former Slip 5 Outfall Area													
Analyte	Revised Soil Proposed Cleanup Level	18 (2) 8/1/1983	18 (6.5) 8/1/1983	IT-SB-6 (2-3.5) TU90H 11/01/2011	IT-SB-6 (5-6.5) TU90I 11/01/2011	IT-SB-6 (8-9.5) TU90J 11/01/2011	IT-SB-6 (13.5-15) TU90K 11/01/2011	IT-SB-7 (2-3.5) TU90L 11/01/2011	IT-SB-7 (5-6.5) TU90M 11/01/2011	IT-SB-7 (8-9.5) TU90N 11/01/2011	IT-SB-7 (13-14.5) TU90O 11/01/2011	IT-SB-8 (2-3.5) TX01F 11/14/2011	IT-SB-8 (5-6.5) TX01G 11/14/2011	IT-SB-8 (8-9.5) TX01H 11/14/2011	IT-SB-8 (14-15.5) TX01I 11/14/2011
Volatiles (mg/kg; SW-846 8260C)															
1,1-Dichloroethene	1.4	--	--	0.0012 U	0.0012 U	0.0015 U	0.0011 U	0.0013 U	0.0010 U	0.0016 U	0.0012 U	0.0014 U	0.0013 U	0.0012 U	0.0013 U
Acrylonitrile	240	--	--	0.0059 U	0.0062 U	0.0073 U	0.0055 U	0.0065 U	0.0051 U	0.0078 U	0.0059 U	0.0072 U	0.0064 U	0.0059 U	0.0066 U
Trichloroethene	0.002/0.004 (a)	--	--	0.0012 U	0.0012 U	0.0015 U	0.0011 U	0.0013 U	0.0010 U	0.0016 U	0.0012 U	**0.0010 J1**	0.0013 U	**0.0012 J1**	**0.0020**
Vinyl Chloride	0.002	--	--	0.0012 U	0.0012 U	0.0015 U	0.0011 U	0.0013 U	0.0010 U	0.0016 U	0.0012 U	0.0014 U	0.0013 U	0.0012 U	0.0013 U
Semivolatiles (mg/kg; SW-846 8270D)															
bis(2-Ethylhexyl)phthalate	0.12	--	--	0.0330 U	0.0330 U	0.0230 U	0.0260 U	0.0230 U	0.0240 U	0.0240 U	0.0240 U	0.0240 U	**0.0150 J1**	**0.0580**	**0.0170 J1**
cPAH TEQ	0.0076	--	--	**0.1143 J**	**0.0397**	ND	ND	**0.0451**	**0.0271 J**	ND	ND	**0.1306**	**0.0202 J**	**0.0009 J**	ND
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)															
cPAH TEQ	0.0076	--	--	**0.1305**	**0.0519**	ND	ND	**0.1083**	**0.0226**	ND	ND	**2.4800**	**0.0505**	ND	**0.0003 J**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)															
Total PCBs	0.020	--	--	**0.0560 P**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)															
Gasoline-Range Organics	30 (b)	--	--	7.3 U	7.4 U	8.6 U	7.4 U	7.0 U	6.0 U	7.6 U	8.5 U	7.2 U	**20**	6.7 U	8.0 U
Diesel-Range Organics	2,000	--	--	**35**	**10**	5.8 U	6.2 U	**21**	**6.7**	5.8 U	6.6 U	**13**	**23**	5.7 U	6.4 U
Oil-Range Organics		--	--	**90**	**29**	12 U	12 U	**41**	**14**	12 U	13 U	**34**	**170**	12 U	13 U
Combined DRO/ORO	2,000	--	--	**125**	**39**	ND	ND	**62**	**21**	ND	ND	**47**	**193**	ND	ND
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)															
Antimony	4.1	--	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U
Arsenic	7	**11**	**4.2**	**54.5**	**11.9**	**2.6**	**2.6**	**10.6**	**4.1**	**1.8**	**4.0**	**7.9**	**3.9**	**3.1**	**2.4**
Barium	160	**30**	**25**	**54.3**	**40.1**	**48.7**	**32.1**	**54.2**	**46.6**	**34.0**	**60.7**	**104**	**46.1**	**41.6**	**46.5**
Beryllium	3.5	--	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	**0.2**	0.2 U	0.2 U	0.2 U
Cadmium	0.77	**0.6**	**0.31**	**0.4**	**1.9**	0.1 U	0.1 U	0.1 U	**0.2**	0.1 U	0.1 U	**0.3**	0.1 U	0.1 U	0.1 U
Chromium	48	**16**	**11.5**	**14.6**	**13.1**	**11.9**	**15.1**	**12.5**	**14.5**	**10.0**	**16.2**	**18.6**	**12.8**	**12.7**	**15.5**
Chromium VI	0.96	--	--	0.461 U	0.444 U	0.457 U	0.513 U	0.447 U	0.444 U	0.449 U	0.530 U	0.467 U	0.448 U	0.449 U	0.501 U
Copper	36	--	--	**53.9**	**23.2**	**17.7**	**9.6**	**29.7**	**19.4**	**12.0**	**17.5**	**30.0**	**17.4**	**12.1**	**16.7**
Lead	81	**73**	**5.5**	**53.9**	**15.3**	**2.1**	**12.0**	**16.7**	**14.7**	**1.5**	**2.7**	**153**	**5.1**	**6.2**	**2.1**
Mercury	0.07	**0.03**	**0.04**	**0.17**	**0.04**	**0.02**	0.03 U	**0.08**	**0.13**	0.02 U	**0.03**	**0.09**	**0.03**	0.02 U	**0.03**
Nickel	48	**20**	**8.5**	**73.3**	**20.2**	**9.6**	**7.8**	**11.3**	**10.8**	**8.2**	**11.8**	**12.2**	**11.6**	**9.3**	**8.1**
Selenium	3	0.2 U	0.2 U	0.6 U	0.5 U	0.6 U	0.6 U	0.5 U	0.5 U	0.5 U	0.7 U	0.6 U	0.5 U	0.6 U	0.6 U
Thallium	2	--		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	85	**81**	**33.7**	**231**	**57**	**52**	**73**	**59**	**61**	**22**	**52**	**90**	**45**	**101**	**48**

Table 2-3a
Soil Data and pCUL Exceedances: North of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Notes:

U = Indicates the compound was not detected at or above the reporting limit.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J1 = Laboratory flag indicating the analyte was positively identified; the associated concentration is approximate and less than the reporting limit, but equal to or greater than the detection limit.
UJ2 = The analyte was not detected in the sample at or above the numerical value shown; the numerical value is below the reporting limit, but greater than the detection limit.
P = The analyte was detected on both chromatographic columns but the quantified values differ by 40 percent relative percent difference with no obvious chromatographic interference. The higher of the two values is reported by the laboratory.
(a) Cleanup levels for saturated zone soil (>11 feet below ground surface) and vadose zone soil (<11 feet below ground surface), respectively.
(b) Assumes benzene is detected in sample (lower value of 100/30 mg/kg selected).
Bold = Detection **Green Shading** = Reported concentration is greater than the proposed cleanup level.

Abbreviations and Acronyms:

-- = not analyzed
µg/kg = micrograms per kilogram
cPAH = carcinogenic polycyclic aromatic hydrocarbon
DRO = diesel-range organics
EPA = US Environmental Protection Agency
ID = identification
Lab = laboratory
mg/kg = milligrams per kilogram
ND = not detected
NWTPH = Northwest Total Petroleum Hydrocarbon
ORO = oil-range organics
PCB = polychlorinated biphenyl
SIM = select ion monitoring
TEQ = toxicity equivalency quotient

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL A: 1900-1946 Random Fill Consisting of Gravel, Sand, Slag, Demolition Waste, and Crushed Rocks							**FILL B: 1946-1960 Random Fill Material**									
		215 (3.5-4) 1/15/1988	215 (8.5-9) 1/15/1988	215 (13.5-14) 1/15/1988	IT-MW-14 (2-3.5) TW27J 11/08/2011	IT-MW-14 (5-6.5) TW27K 11/08/2011	IT-MW-14 (8-9.5) TW27L 11/08/2011	IT-MW-14 (13-14.5) TW27M 11/08/2011	I-205s (2.5) 1/19/1988	I-205s (12.5) 1/19/1988	Dup of I-205s I-205s-Dup (12.5) 1/19/1988	I-205s (17.5) 1/19/1988	I-205s (27.5) 1/19/1988	IT-MW-9 (2-3.5) TU65P 10/31/2011	IT-MW-9 (5-6.5) TU65C 10/31/2011	IT-MW-9 (8-9.5) TV85C 11/04/2011	IT-MW-9 (13-14.5) TV85D 11/04/2011	IT-MW-10 (2-3.5) TU65D 10/31/2011
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	--	--	--	0.001 U	0.001 U	0.001 U	0.002 U	--	--	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Acrylonitrile	240	--	--	--	0.005 U	0.006 U	0.006 U	0.007 U	--	--	--	--	--	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U
Trichloroethene	0.002/0.004 (b)	--	--	--	0.001 U	0.001 U	0.001 U	0.002 U	--	--	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Vinyl Chloride	0.002	--	--	--	0.001 U	0.001 U	0.001 U	0.002 U	--	--	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	0.071 U	**0.058 J1**	**0.056 J1**	**0.023 J1**	--	--	--	--	--	0.018 UJ2	0.029 U	0.040 U	0.022 UJ2	0.023 UJ2
cPAH TEQ	0.0076	--	--	--	**0.001**	**0.054 J**	**0.008 J**	ND	--	--	--	--	--	**0.003 J**	**0.087 J**	**0.012 J**	ND	**0.029 J**
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	--	--	--	**0.010**	**0.038**	**0.019**	**0.000**	--	--	--	--	--	**0.014 J**	**0.111**	**0.013 J**	**0.003 J**	**0.021 J**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	--	--	--	ND	ND	ND	ND	--	--	--	--	--	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	--	--	--	5.7 U	7.0 U	8.0 U	9.0 U	--	--	--	--	--	5.7 U	6.4 U	6.7 U	6.8 U	6.8 U
Diesel-Range Organics	2,000	--	--	--	**38**	**76**	**52**	6.2 U	--	--	--	--	--	**9.4**	**18**	**12**	5.5 U	**6.1**
Oil-Range Organics		--	--	--	**290**	**460**	**250**	12 U	--	--	--	--	--	**15**	**77**	**43**	11 U	**19**
Combined DRO/ORO	2,000	--	--	--	**328**	**536**	**302**	ND	--	--	--	--	--	**24.4**	**95**	**55**	ND	**25.1**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	--	--	--	0.2 U	0.2 U	0.2 U	0.3 U	--	--	--	--	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Arsenic	7	**5**	**1**	**1**	**2.4**	**4.7**	**7.2**	**1.6**	**3**	**9**	**3**	**6**	**393**	**2.5**	**6.2**	**11.1**	**2.5**	**4.6**
Barium	160	--	--	--	**42.3**	**50.6**	**60.5**	**26.4**	--	--	--	--	--	**38.7**	**46.1**	**50.8**	**26.3**	**53.6**
Beryllium	3.5	--	--	--	0.2 U	0.2 U	0.2 U	0.3 U	--	--	--	--	--	0.2 U	**0.2**	0.2 U	0.2 U	**0.2**
Cadmium	0.77	--	--	--	**0.1**	**0.2**	**0.1**	**0.7**	--	--	--	--	--	0.1 U	**0.5**	**0.2**	0.1 U	**0.1**
Chromium	48	**100**	**13**	**12**	**20.0**	**14.7**	**16.1**	**18.9**	**20**	**25**	**18**	**23**	**42**	**21.1**	**13.2**	**13.7**	**10.6**	**21.6**
Chromium VI	0.96	--	--	--	0.445 U	0.489 U	0.488 U	0.520 U	--	--	--	--	--	0.453 U	0.448 U	0.467 U	0.482 U	0.45 U
Copper	36	**27**	**9**	**7**	**37.1**	**23.7**	**29.0**	**42.8**	**19**	**15**	**10**	**18**	**71**	**14**	**54.2**	**17.9**	**14.3**	**25.8**
Lead	81	**94**	3 U	3 U	**7.3**	**11.6**	**23.6**	**8.5**	**6**	4 U	4 U	**6**	**49**	**3.7**	**14.7**	**5.3**	**4.8**	**23.4**
Mercury	0.07	--	--	--	0.02 U	**0.05**	**0.05**	0.02 U	--	--	--	--	--	0.03 U	**0.03**	**0.04**	0.03 U	**0.04**
Nickel	48	**15**	**8**	**7**	**30.0**	**16.0**	**13.6**	**5.7**	**10**	**13**	**10**	**15**	**20**	**31.7**	**18.1**	**14.6**	**9.6**	**33.0**
Selenium	3	--	--	--	0.6 U	0.6 U	0.6 U	0.6 U	--	--	--	--	--	0.6 U	0.5 U	0.6 U	0.6 U	0.5 U
Thallium	2	--	--	--	0.2 U	0.2 U	0.2 U	0.3 U	--	--	--	--	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	85	**184**	**24.7**	**20.9**	**48**	**59**	**94**	**80**	**33.2**	**47.8**	**34.9**	**53**	**122**	**33**	**63**	**56**	**35**	**46**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL B: 1946-1960 Random Fill Material																
					Vicinity of I-205(s)			Hazardous Material Storage Sheds Paint Storage Area								Hydraulic Test Pad Area		
		IT-MW-10 (5-6.5) TU65E 10/31/2011	IT-MW-10 (8-9.5) TV99G 11/07/2011	IT-MW-10 (13.5-15) TV99H 11/07/2011	IT-TP-104-B (12-13) TU13A 10/27/2011	IT-TP-105B-B(11-12) TU13B 10/27/2011	IT-TP-106B (11-12) TU48J 10/28/2011	IT-TOWPATH EXC1-B(.8) TE27A 07/15/2011	237 (3.5) 1/21/1988	237 (8.5) 1/29/1988	237 (15) 1/29/1988	TDP27 (11) NY64B 11/6/2008	TDP28 (11) NY64C 11/6/2008	TDP29 (11) NY64D 11/6/2008	TDP30 (11) NY64E 11/6/2008	IT-MW-11 (2-3.5) TU65F 10/31/2011	IT-MW-11 (5-6.5) TU65G 10/31/2011	IT-MW-11 (8-9.5) TV99D 11/07/2011
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 UJ	0.001 U	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 UJ
Acrylonitrile	240	0.006 U	0.006 U	0.007 U	0.006 U	0.007 U	0.007 U	0.005 U	--	--	--	--	--	--	--	0.005 U	0.006 U	0.005 U
Trichloroethene	0.002/0.004 (b)	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 UJ
Vinyl Chloride	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	0.015 UJ2	0.025 U	0.058 U	0.024 U	0.024 U	0.023 U	0.023 U	--	--	--	--	0.061 U	0.060 U	--	0.021 UJ2	0.028 U	0.025 U
cPAH TEQ	0.0076	ND	**0.036**	**0.028**	ND	ND	**0.001 J**	**1.569**	--	--	--	--	ND	ND	--	**0.001 J**	ND	**0.064**
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	ND	**0.039**	**0.031 J**	**0.001 J**	ND	**0.003 J**	**0.013**	--	--	--	--	--	--	--	**0.008 J**	ND	**0.050**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	ND	ND	**0.293**	ND	ND	ND	ND	--	--	--	--	ND	ND	--	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	6.2 U	**7.8**	**8.7**	7.6 U	8 U	8.2 U	5.8 U	--	--	--	--	--	--	--	5.5 U	5.1 U	**11**
Diesel-Range Organics	2,000	5 U	5.5 U	**35**	5.8 U	5.8 U	**9.4**	**6.2**	--	--	--	--	--	--	--	**6.2**	5.2 U	**14**
Oil-Range Organics		10 U	11 U	**56**	12 U	12 U	12 U	**18**	--	--	--	--	--	--	--	**17**	10 U	**42**
Combined DRO/ORO	2,000	ND	ND	**91**	ND	ND	**9.4**	**24.2**	--	--	--	--	--	--	--	**23.2**	ND	**56**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	0.2 U	0.2 U	0.3 U	0.2 UJ	0.2 U	0.2 UJ	0.2 U	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U
Arsenic	7	**1.6**	**2.2**	**209**	**2.0**	**2.3**	**4.2**	**3.6**	**5**	**4**	**3**	**6**	**6**	**8**	**13**	**6.6**	**2.9**	**7.8**
Barium	160	**38.4**	**38.7**	**71.4**	**35.6 J**	**27.6**	**43.5**	**43.5**	--	--	--	--	--	--	--	**52.5**	**51.4**	**51.4**
Beryllium	3.5	0.2 U	0.2 U	**0.4**	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	**0.2**	**0.2**	**0.2**
Cadmium	0.77	0.1 U	0.1 U	**0.6**	**0.1**	0.1 U	**0.2**	0.1 U	--	--	--	0.2 U	**0.3**	**0.7**	**0.8**	**0.1**	0.1 U	**0.2**
Chromium	48	**24.1**	**22.2**	**21**	**11**	**12**	**13.5**	**16.1**	**22**	**16**	**16**	**16.4**	**17.8**	**20.4**	**24.8**	**21.3**	**18.9**	**17.3**
Chromium VI	0.96	0.415 U	0.426 U	0.564 U	0.498 U	0.47 U	0.494 U	0.45 UJ	--	--	--	--	--	--	--	0.412 U	0.431 U	0.432 UJ
Copper	36	**10.5**	**14.1**	**32.7**	**11.9**	**9.9**	**14.5**	**38.7**	**29**	**15**	**10**	**13.7**	**20.5**	**26.2**	**35.9**	**22.5**	**15.2**	**39.3**
Lead	81	**1.9**	**5.1**	**30.5**	**2.9**	**2.1**	**4.1 J**	**6.1**	**4**	4 U	5 U	2 U	**4**	**7**	**15**	**7.5**	**2.5**	**11.4**
Mercury	0.07	0.02 U	0.02 U	**0.12**	0.02 U	0.03 U	0.02 UJ	**0.04**	--	--	--	0.05 U	0.06 U	**0.1**	**0.17**	**0.07**	0.02 U	**0.14**
Nickel	48	**39.0**	**32.0**	**19.5**	**13.7**	**10.3**	**12.5**	**18.0**	**13**	**11**	**8**	--	--	--	--	**28.7**	**26.4**	**24.0**
Selenium	3	0.5 U	0.5 U	0.7 U	0.6 U	0.6 U	0.6 U	0.5 U	--	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U
Thallium	2	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U
Zinc	85	**28**	**32**	**88**	**37**	**31**	**38**	**43**	**40.3**	**30.1**	**27.6**	--	--	--	--	**45**	**34**	**63**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL B: 1946-1960 Random Fill Material			FILL C: 1946-1960 Some Random Fill Along with Fill From Off-Site Sources													
		Hydraulic Test Pad Area											Dup of 15					Dup of 17
		IT-MW-11 (13.5-15)	TDP31 (12)	TDP32 (11) (a)	5 (2.5)	6-3 (1)	6-3 (2)	7-1 (2.5)	7-5 (8.5)	7-5 (13.5)	7-5 (18.5)	15 (2)	15-Dup (2)	15 (2.5)	16 (2.5)	16 (6.5)	17 (2.5)	17-Dup (2.5)
		TV99E	NY64F	NY64G														
		11/07/2011	11/6/2008	11/6/2008	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983	8/1/1983
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	0.001 U	0.001 U	0.001 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acrylonitrile	240	0.005 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	0.002/0.004 (b)	0.001 U	0.001 U	0.001 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl Chloride	0.002	0.001 U	0.001 U	0.001 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	0.100 U	0.064 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cPAH TEQ	0.0076	**0.022 J**	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	**0.026 J**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	ND	ND	--	**9.700**	--	**1.200**	**0.700**	--	0.200 U	--	**0.400**	**0.130**	--	0.100 U	--	--	0.100 U
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	7.3 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diesel-Range Organics	2,000	**13**	**58**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil-Range Organics		**26**	**400**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Combined DRO/ORO	2,000	**39**	**458**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	7	**3.7**	**9**	--	**33**	**18**	--	**12**	**10**	**7**	**25**	--	**11**	**15**	**9.5**	**5.3**	**16**	**19**
Barium	160	**47.6**	--	--	**650**	**520**	--	**59**	**42**	**51**	**60**	--	**135**	**200**	**83**	**24**	**70**	**70**
Beryllium	3.5	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.77	**0.2**	0.2 U	0.2 U	**16**	**7.7**	--	**1.9**	**0.76**	**0.26**	**1.1**	--	**1.9**	**1.6**	**1.9**	**0.69**	**2.4**	**3.8**
Chromium	48	**13.3**	**14.7**	**29.4**	**1,130**	**466**	--	**44**	**15**	**21**	**32**	--	**33**	**44**	**45**	**40**	**270**	**541**
Chromium VI	0.96	0.493 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	36	**17.6**	**15.9**	**20.5**	--	--	--	--	--	--	--	--	--	--	**111**	--	--	--
Lead	81	**4.2**	**2**	2 U	**1,170**	**580**	--	**230**	**100**	**49**	**24**	--	**200**	**490**	**170**	**36**	**280**	**230**
Mercury	0.07	**0.04**	**0.05**	0.05 U	**0.13**	**0.19**	--	**0.14**	**0.12**	**0.05**	**0.24**	--	**0.18**	**0.84**	**0.04**	0.03 U	0.05 U	**0.17**
Nickel	48	**13.2**	--	--	**82**	**76**	--	**56**	**34**	**17**	**25**	--	**21**	**35**	**88**	**20**	**180**	**146**
Selenium	3	0.6 U	--	--	--	--	--	--	**0.73**	--	0.2 U	--	**0.24**	**0.6**	**0.68**	0.2 U	**0.6**	**0.22**
Thallium	2	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	85	**39**	--	--	**2,270**	**2,320**	--	**1,640**	**877**	**77**	**194**	--	**272**	**440**	**556**	**88.8**	**390**	**511**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL C: 1946-1960 Some Random Fill Along with Fill From Off-Site Sources																
		17 (6.5)	19 (1.5)	19 (3.5)	19 (9)	I-6 (10)	I-7 (3)	I-7 (5)	228 (3.5-4)	228 (8.5-9)	228 (13-13.5)	228 (17-17.5)	232 (3.5-4)	232 (8.5)	232 (13.5)	236 (3.5)	236 (8.5)	236 (13.5)
		8/1/1983	8/1/1983	8/1/1983	8/1/1983	10/19/1983	10/20/1983	10/20/1983	1/19/1988	1/19/1988	1/19/1988	1/19/1988	1/19/1988	1/19/1988	1/19/1988	1/20/1988	1/20/1988	1/20/1988
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acrylonitrile	240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	0.002/0.004 (b)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl Chloride	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	--	0.100 U	**0.280**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diesel-Range Organics	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil-Range Organics		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Combined DRO/ORO	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	7	**7.4**	**8.9**	**17**	**36**	**79**	**30**	**2.3**	**37**	**12**	**11**	**12**	**44**	**47**	**92**	**13**	**48**	**41**
Barium	160	**149**	**49**	**75**	**63**	--	**89**	--	--	--	--	--	--	--	--	--	--	--
Beryllium	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.77	**5.1**	**0.61**	**1.5**	**2.9**	--	**1**	--	--	--	--	0.5 U	--	--	--	--	--	--
Chromium	48	**62**	**19**	**180**	**835**	**540**	**580**	**740**	**229**	**311**	**142**	**13**	**242**	**158**	**194**	**853**	**1,380**	**4,180**
Chromium VI	0.96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	36	--	--	--	--	**390**	**360**	**340**	**175**	**66**	**87**	**11**	**273**	**350**	**188**	**151**	**539**	**311**
Lead	81	**396**	**14**	**323**	**220**	**150**	**3,900**	**630**	**362**	**152**	**392**	**5**	**552**	**103**	**109**	**953**	**1,690**	**462**
Mercury	0.07	**0.05**	**0.11**	**0.03**	0.03 U	--	--	--	--	--	--	0.01 U	--	--	--	--	--	--
Nickel	48	**108**	**22**	**281**	**2,030**	--	--	--	**481**	**241**	**151**	**10**	**362**	**734**	**390**	**97**	**1,684**	**2,197**
Selenium	3	**0.96**	0.2 U	**0.28**	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	85	**3,640**	**32.6**	**289**	**300**	**390**	**1,500**	**310**	**5,770**	**3,030**	**1,130**	**44.1**	**385**	**291**	**542**	**621**	**801**	**737**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL C: 1946-1960 Some Random Fill Along with Fill From Off-Site Sources																
		236 (18.5)	244 (3.5)	244 (8.5)	244 (13.5)	I-202s (2.5)	I-202s (7.5)	I-202s (12.5)	I-202s (17.5)	I-202s (27.5)	I-203i (2.5)	I-203i (7.5)	I-203i (10)	I-203i (12.5)	I-203i (15)	I-203i (18)	I-203i (23)	I-203i (33)
		1/20/1988	1/21/1988	1/21/1988	1/21/1988	1/14/1988	1/14/1988	1/14/1988	1/14/1988	1/14/1988	1/15/1988	1/15/1988	1/28/1988	1/15/1988	1/28/1988	1/28/1988	1/28/1988	1/28/1988
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	ND
Acrylonitrile	240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	0.002/0.004 (b)	--	--	--	--	--	--	ND	--	--	--	--	--	--	--	--	--	ND
Vinyl Chloride	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	--	**0.110**	--	--	--	--	--	--	--	--	--	--
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	--	--	--	--	**0.250**	**0.080**	**0.320**	**0.085**	**0.430**	**0.140**	**0.180**	--	--	--	--	--	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diesel-Range Organics	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil-Range Organics		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Combined DRO/ORO	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	7	**24**	**25**	**4**	**5**	**5**	**33**	**54**	**191**	**27**	**17**	**26**	**27**	**22**	**47**	**10**	**59**	**11**
Barium	160	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.77	--	--	--	--	--	--	**2.6**	--	--	--	--	--	--	--	--	--	--
Chromium	48	**49**	**78**	**17**	**18**	**24**	**2,960**	**2,230**	**47**	**899**	**133**	**3,990**	**760**	**2,460**	**3,100**	**27**	**23**	**18**
Chromium VI	0.96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	36	**49**	**100**	**22**	**39**	**58**	**274**	**398**	**58**	**23**	**107**	**252**	**188**	**174**	**580**	**29**	**26**	**18**
Lead	81	**20**	**234**	5 U	**25**	**44**	**503**	**191**	**36**	**301**	**284**	**250**	**349**	**349**	**36**	**11**	**7**	6 U
Mercury	0.07	--	--	--	--	--	--	**0.1**	--	--	--	--	--	--	--	--	--	--
Nickel	48	**24**	**36**	**14**	**18**	**22**	**627**	**921**	**19**	**19**	**53**	**149**	**165**	**101**	**1,795**	**18**	**17**	**10**
Selenium	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	85	**138**	**521**	**46.8**	**84.2**	**447**	**2,800**	**734**	**445**	**325**	**686**	**579**	**862**	**1,210**	**138**	**75.3**	**40.8**	**25.7**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL C: 1946-1960 Some Random Fill Along with Fill From Off-Site Sources																
		I-203i (43) 1/28/1988	I-203i (48) 1/28/1988	IMR-7 NW45A 10/27/2008	PBI-3 (2) PI24G 7/27/2009	PBI-3 (5) PI24H 7/27/2009	PBI-3 (8) PI24I 7/27/2009	PBI-4 (2) PI24J 7/27/2009	PBI-4 (5) PI24K 7/27/2009	PBI-4 (8) PI24L 7/27/2009	PBI-5 (2) PI24M 7/27/2009	PBI-5 (5) PI24N 7/27/2009	PBI-5 (8) PI24O 7/27/2009	PBI-6 (2) PI24P 7/27/2009	PBI-6 (5) PI24Q 7/27/2009	PBI-6 (8) PI24R 7/27/2009	PBI-7 (2) PI24S 7/27/2009	PBI-7 (5) PI24T 7/27/2009
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acrylonitrile	240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	0.002/0.004 (b)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl Chloride	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diesel-Range Organics	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oil-Range Organics		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Combined DRO/ORO	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	7	**2**	**2**	5 U	**8.4**	**754**	**4.8**	**6.2**	**6.9**	**75.4**	**9.3**	**6.4**	**6.7**	**2.7**	**185**	**74**	**6.2**	**14.7**
Barium	160	--	--	**31.4**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.77	--	--	0.2 U	**5.7**	0.6 U	0.6 U	**2.6**	**11.1**	**1.4**	**3.5**	**1.9**	**2.3**	**0.6**	0.6 U	**0.6**	**1.6**	**5.4**
Chromium	48	**13**	**11**	**21.3**	**621**	**16**	**33**	**564**	**940**	**359**	**127**	**101**	**47**	**46**	**14**	**26**	**295**	**361**
Chromium VI	0.96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	36	**19**	**12**	--	**1,300**	**526**	**21**	**103**	**190**	**60**	**152**	**145**	**56**	**152**	**60**	**62**	**96**	**118**
Lead	81	6 U	5 U	2 U	**768**	**37**	**29**	**209**	**796**	**114**	**138**	**166**	**59**	**55**	**7**	**32**	**200**	**400**
Mercury	0.07	--	--	0.05 U	**2**	**0.19**	**0.07**	**0.12**	**0.22**	**0.06**	**0.14**	**0.11**	**0.04**	**0.07**	**0.08**	**0.07**	**0.16**	**0.26**
Nickel	48	**10**	**8**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	3	--	--	5 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	85	**26.4**	**20.7**	--	**2,520**	**210**	**120**	**650**	**3,290**	**500**	**430**	**540**	**190**	**230**	**120**	**140**	**360**	**890**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL C: 1946-1960 Some Random Fill Along with Fill From Off-Site Sources																
		PBI-7 (8) PI25A 7/27/2009	PBI-8 (2) PI25B 7/27/2009	PBI-8 (5) PI25C 7/27/2009	PBI-8 (8) PI25D 7/27/2009	PBI-9 (2) PI25E 7/27/2009	PBI-9 (5) PI25F 7/27/2009	PBI-9 (8) PI25G 7/27/2009	PBI-10 (2) PI25H 7/27/2009	PBI-10 (5) PI25I 7/27/2009	PBI-10 (8) PI25J 7/27/2009	IT-MW-17 (2-3.5) TW45A 11/10/2011	IT-MW-17 (5-6.5) TW45B 11/10/2011	IT-MW-17 (8-9.5) TW45C 11/10/2011	IT-MW-17 (11-12.5) TW45D 11/10/2011	IT-MW-17 (14-15.5) TW45E 11/10/2011	IT-MW-17 (15.5-17) TW45F 11/10/2011	IT-MW-17 (18.5-19.75) TW45G 11/10/2011
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	--	--	--	--	--	--	--	--	--	--	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U	0.004 U	0.002 U
Acrylonitrile	240	--	--	--	--	--	--	--	--	--	--	0.006 U	0.007 U	0.006 U	0.009 U	0.007 U	0.018 U	0.010 U
Trichloroethene	0.002/0.004 (b)	--	--	--	--	--	--	--	--	--	--	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U	0.004 U	0.002 U
Vinyl Chloride	0.002	--	--	--	--	--	--	--	--	--	--	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U	0.004 U	0.002 U
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	--	--	--	--	--	0.062 U	0.055 U	0.033 U	0.023 U	0.048 U	0.084 U	0.035 U
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	0.213	0.072 J	0.000	0.043	0.482	0.162	0.017 J
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	0.277	0.083	0.016	0.084	0.301	0.180	0.030
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	--	--	--	--	--	--	--	--	--	--	0.162	0.510	0.560	0.099	0.420	0.470	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	--	--	--	--	--	--	--	--	--	--	7.0 U	9.2 U	6.1 U	10 U	9.9	33	9.5 U
Diesel-Range Organics	2,000	--	--	--	--	--	--	--	--	--	--	160	23	5.2 U	51 J	240	900	9.5
Oil-Range Organics		--	--	--	--	--	--	--	--	--	--	380	72	10 U	77 J	580	1,800	15
Combined DRO/ORO	2,000	--	--	--	--	--	--	--	--	--	--	540	95	ND	128 J	820	2,700	24.5
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	--	--	--	--	--	--	--	--	--	--	0.3	0.3	0.2 U	3.9	0.6	0.4	0.4
Arsenic	7	0.5 J	23.4	4.8	7	1.4	8.6	6.3	4.7	6.3	32.7	10.5	29.3	31.5	13.9	60.3	299	76.4
Barium	160	--	--	--	--	--	--	--	--	--	--	165	71.1	37.6	83.6	645	295	71.0
Beryllium	3.5	--	--	--	--	--	--	--	--	--	--	0.3	0.2	0.2 U	0.3 U	0.3	0.3 U	0.3 U
Cadmium	0.77	8.3 J	1	1.2	6.7	0.2 U	6.5	0.6	0.3	0.3	1.5	3.0	6.2	0.1	28.1	15.3	2.5	0.1 U
Chromium	48	561 J	30.1	57.2	123	15	52.2	233	26.6	51.9	790	138	108	31.2	247	238	58.4	11.3
Chromium VI	0.96	--	--	--	--	--	--	--	--	--	--	0.429 U	0.459 U	0.424 U	1.79	0.585 U	8.32	0.564 U
Copper	36	281	138	75.2	47.9	82.4	102	62.5	68.7	78.6	301	82.6	318	41.8	279	353	1,070	27.3
Lead	81	660	205	698	460	3	212	189	65	175	4,200	210	467	9.3	2,160	1,120	338	16.3
Mercury	0.07	0.14	0.17	0.12	0.02 U	0.02 U	0.12	0.03	0.03	0.03	0.02 U	0.37	0.06	0.03	0.10	0.10	0.45	0.03 U
Nickel	48	--	--	--	--	--	--	--	--	--	--	46.0	330	37.5	164	171	33.7	10.9
Selenium	3	--	--	--	--	--	--	--	--	--	--	0.6 U	0.6 U	0.5 U	0.7 U	0.7 U	0.9 U	0.7 U
Thallium	2	--	--	--	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U	0.3 U	0.3 U	1.1	0.3 U
Zinc	85	1,420	460	249	530	56	550	180	131	194	630	470	1,220	78	5,780	9,040	1,400	60

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL C: 1946-1960 Some Random Fill Along with Fill From Off-Site Sources																
		IT-MW-17 (21.25-21.5) TW45H 11/10/2011	IT-MW-17 (21.5-23) TW45I 11/10/2011	IT-MW-19 (2-3.5) TW35C 11/09/2011	IT-MW-19 (5-6.5) TW35D 11/09/2011	IT-MW-19 (8-9.5) TW35E 11/09/2011	IT-MW-19 (13-14.5) TW35F 11/09/2011	IT-SB-3 (2-3.5) TW27E 11/08/2011	IT-SB-3 (5-5.5) TX02I 11/14/2011	IT-SB-3 (6.5-7) TX02J 11/14/2011	IT-SB-4 (2-3.5) TU90E 11/01/2011	IT-SB-4 (5-6.5) TU90R 11/01/2011	IT-SB-4 (8-9) TU90F 11/01/2011	IT-SB-4 (11.5-13) TU90G 11/01/2011	IT-SB-12 (2-3.5) TX02K 11/14/2011	IT-SB-12 (5-6.5) TX01J 11/14/2011	IT-SB-12 (8-9.5) TX01K 11/14/2011	IT-SB-12 (14-15.5) TX01L 11/14/2011
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U
Acrylonitrile	240	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.006 U	0.001 U	0.001 U	0.001 U	0.006 U	0.007 U	0.007 U	0.006 U	0.006 U	0.007 U	0.007 U	0.006 U
Trichloroethene	0.002/0.004 (b)	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.006 U	0.006 U	0.003 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.001 J1**	**0.001 J1**	**0.002**	**0.001 J1**
Vinyl Chloride	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	0.053 U	0.048 U	0.025 U	0.056 U	0.033 U	0.032 U	**0.021 J1**	**0.530**	0.025 U	0.058 U	0.045 U	0.024 U	0.023 U	0.046 U	**0.024**	**0.015 J1**	**0.015 J1**
cPAH TEQ	0.0076	ND	ND	**0.117 J**	**0.125**	**0.036 J**	**0.001 J**	ND	**0.012 J**	**0.014 J**	**0.060 J**	**0.017 J**	ND	ND	**0.130**	**0.045**	**0.001 J**	ND
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	**0.006 J**	**0.020 J**	**0.146**	**0.064**	**0.032**	**0.017 J**	ND	**0.026**	**0.011 J**	**0.075**	**0.025**	ND	**0.000 J**	**0.153**	**0.052**	**0.009 J**	**0.002 J**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	ND	ND	ND	ND	ND	ND	ND	**0.145 J**	**0.082**	**1.780**	**0.049**	ND	ND	**0.430**	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	8.2 U	6.7 U	6.4 U	6.7 U	6.3 U	7.7 U	5.5 U	5.6 U	4.1 U	**12**	9.2 U	7.4 U	7.9 U	5.7 U	8.2 U	9.6 U	7.2 U
Diesel-Range Organics	2,000	6.2 U	5.8 U	**18**	5.6 U	**6.6**	**11**	5.3 U	**23**	**24**	**69**	**28**	5.6 U	6.5 U	**31 J**	**26**	**12**	**10**
Oil-Range Organics		12 U	12 U	**170**	**12**	**15**	13 U	11 U	**100**	**65**	**220**	**71**	11 U	13 U	**62**	**38**	**14**	**17**
Combined DRO/ORO	2,000	ND	ND	**188**	**12**	**21.6**	**11**	ND	**123**	**89**	**289**	**99**	ND	ND	**93 J**	**64**	**26**	**27**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.7**	0.2 U	0.2 U	0.2 U	0.3 U	**0.3**	0.2 U	0.2 U	0.2 U
Arsenic	7	**33.9**	**78.5**	**3.4**	**13.1**	**7.5**	**10.5**	**2.7**	**4.0**	**40.1**	**9.7**	**7.6**	**4.8**	**1.9**	**12.3**	**10.4**	**9.2**	**24.6**
Barium	160	**57.3**	**35.5**	**47.9**	**46.2**	**28.1**	**45.5**	**38.8**	**60.3**	**30.1**	**154**	**58.8**	**37.9**	**41.7**	**257**	**206**	**130**	**47.3**
Beryllium	3.5	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.2**	0.2 U	**0.4**	0.2 U	0.2 U	0.3 U	**0.2**	**0.8**	**0.4**	0.2 U
Cadmium	0.77	0.1 U	**1.1**	**0.2**	**0.5**	**0.2**	0.1 U	0.1 U	**0.2**	**0.3**	**0.9**	**0.2**	0.1 U	0.1 U	**2.2**	**2.4**	**2.7**	0.1 U
Chromium	48	**15.1**	**25.6**	**12.3**	**31.9**	**15.5**	**14.0**	**19.1**	**39.5**	**930**	**58**	**16.4**	**11.8**	**13.3**	**257**	**368**	**158**	**12.6**
Chromium VI	0.96	**0.587**	0.489 U	0.434 U	0.439 U	0.442 U	0.505 U	0.411 U	0.429 U	0.426 U	0.454 U	0.499 U	0.478 U	0.599 U	0.441 U	0.457 U	0.456 U	0.518 U
Copper	36	**18.7**	**47.3**	**34.5**	**299**	**25.3**	**17.5**	**17.5**	**43.5**	**780**	**118**	**43.3**	**18.6**	**17.9**	**66.7**	**61.3**	**47.1**	**21.8**
Lead	81	**10.9**	**81.0**	**47.1**	**46.1**	**17.4**	**4.2**	**2.7**	**39.6**	**31.3**	**287**	**40.6**	**2.2**	**2.0**	**261**	**222**	**219**	**35.5**
Mercury	0.07	**0.08**	0.02 U	**0.04**	**0.06**	**0.03**	**0.03**	0.02 U	**0.03**	0.02 U	**0.08**	**0.07**	0.03 U	0.03 U	**0.28**	**0.06**	**0.03**	0.03 U
Nickel	48	**9.8**	**39.4**	**13.4**	**13.9**	**12.7**	**10.1**	**25.5**	**67.4**	**4,940**	**52.7**	**12.3**	**9.7**	**8.9**	**23.7**	**30.6**	**21.8**	**12.0**
Selenium	3	0.6 U	0.6 U	0.5 U	0.5 U	0.5 U	0.6 U	0.5 U	0.5 U	0.5 U	0.5 U	0.6 U	0.6 U	0.7 U	0.6 U	0.5 U	0.6 U	0.6 U
Thallium	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	85	**38**	**224**	**72**	**144**	**66**	**30**	**38**	**66**	**39**	**780**	**77**	**30**	**27**	**740**	**500**	**333**	**48**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL D: 1960-1965 Slag, Construction, Demolition Debris, and Imported Soil							FILL E: 1965-1966 Imported Construction-Quality Sand Fill Material									
		22 (4) 8/1/1983	22 (6.5) 8/1/1983	IT-PIVEXC1-B(4.2) TH64A 8/8/2011	IT-SB-5 (2-3.5) TU65L 10/31/2011	IT-SB-5 (5-6.5) TU65M 10/31/2011	IT-SB-5 (8-9.5) TU65N 10/31/2011	IT-SB-5 (16-17.5) TU65O 10/31/2011	224 (2.5-3) 1/20/1988	224 (7.5-8) 1/20/1988	224 (12.5-13) 1/20/1988	224 (17.5-18) 1/20/1988	224 (18-18.5) 1/20/1988	230 (2.5-3) 1/21/1988	230 (7.5-8) 1/21/1988	230 (12.5-13) 1/21/1988	230 (15-15.5) 1/21/1988	233 (3.5-4) 1/21/1988
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	--	--	0.001 U	0.001 U	0.001 UJ	0.002 U	0.001 U	--	--	--	--	--	--	--	--	--	--
Acrylonitrile	240	--	--	0.004 U	0.005 U	0.005 UJ	0.008 U	0.006 U	--	--	--	--	--	--	--	--	--	--
Trichloroethene	0.002/0.004 (b)	--	--	0.001 U	0.001 U	0.001 UJ	0.002 U	0.001 U	--	--	--	--	--	--	--	--	--	--
Vinyl Chloride	0.002	--	--	0.001 U	0.001 U	0.001 UJ	0.002 U	0.001 U	--	--	--	--	--	--	--	--	--	--
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	--	--	**0.024**	0.017 UJ2	0.049 U	0.023 U	0.023 U	--	--	--	--	--	--	--	--	--	--
cPAH TEQ	0.0076	--	--	ND	**0.184**	**0.077 J**	**1.607**	**0.000 J**	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	--	--	**0.004**	**0.164**	**0.098**	**8.394**	**0.018 J**	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	**0.050**	--	ND	**0.082**	ND	ND	ND	--	--	--	--	--	--	--	--	--	--
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	--	--	5.5 U	**26**	**25**	**22**	6.6 U	--	--	--	--	--	--	--	--	--	--
Diesel-Range Organics	2,000	--	--	5.5 U	**86**	**140**	**130**	**16**	--	--	--	--	--	--	--	--	--	--
Oil-Range Organics		--	--	**12**	**210**	**340**	**220**	**14**	--	--	--	--	--	--	--	--	--	--
Combined DRO/ORO	2,000	--	--	**12**	**296**	**480**	**350**	**30**	--	--	--	--	--	--	--	--	--	--
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	--	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--
Arsenic	7	**6.7**	**8.7**	**2.5**	**16.9**	**5.9**	**4.3**	**1.2**	**7**	**12**	**44**	**39**	**2**	**3**	**2**	**33**	**17**	**2**
Barium	160	**50**	**60**	**44.4**	**89.7**	**69.0**	**70.4**	**17.7**	--	--	--	--	--	--	--	--	--	--
Beryllium	3.5	--	--	0.2 U	**0.3**	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--
Cadmium	0.77	**0.57**	**1.3**	0.1 U	**0.3**	**1.0**	**0.9**	0.1 U	--	--	--	--	--	--	--	--	**0.6**	--
Chromium	48	**23**	**48**	**24**	**16.9**	**27.9**	**72.7**	**12.0**	**27**	**39**	**757**	**120**	**9**	**33**	**32**	**81**	**1,490**	**37**
Chromium VI	0.96	--	--	0.448 U	0.464 U	0.432 U	0.456 U	0.489 U	--	--	--	--	--	--	--	--	--	--
Copper	36	--	--	**30**	**45.2**	**44.8**	**61.1**	**9.5**	**22**	**38**	**1,500**	**113**	**17**	**14**	**11**	**227**	**108**	**11**
Lead	81	**13**	**110**	**4.7**	**52.1**	**76.7**	**82.0**	**3.2**	**8**	**34**	**370**	**149**	4 U	4 U	4 U	**239**	**274**	4 U
Mercury	0.07	**0.07**	**0.06**	0.03 U	**2.66**	**0.13**	**0.02**	0.03 U	--	--	--	--	--	--	--	--	0.01 U	--
Nickel	48	**27**	**26**	**37.7**	**18.6**	**22.1**	**19.8**	**8.5**	**24**	**28**	**1,624**	**350**	**13**	**34**	**38**	**125**	**470**	**42**
Selenium	3	**0.27**	**0.26**	0.5 U	0.6 U	0.5 U	0.6 U	0.6 U	--	--	--	--	--	--	--	--	--	--
Thallium	2	--	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--
Zinc	85	**70.2**	**268**	**47**	**76**	**116**	**303**	**27**	**46.1**	**161**	**332**	**605**	**25.9**	**34.2**	**31.3**	**672**	**154**	**32.2**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																
		FILL E: 1965-1966 Imported Construction-Quality Sand Fill Material																
		233 (8.5-9) 1/21/1988	233 (10-10.5) 1/28/1988	B-20 (4) 1983	B-20 (10.5) 1983	B-20 (14) 1983	TDP22 (3) NY44G 11/5/2008	TDP23 (3) NY44H 11/5/2008	TDP32 (11) NY64G 11/6/2008	IT-SB-2 (2-3.5) TU65H 10/31/2011	IT-SB-2 (5-6.5) TU65I 10/31/2011	IT-SB-2 (8-9.5) TU65J 10/31/2011	IT-SB-2 (14-15.5) TU65K 10/31/2011	IT-MW-12 (2-3.5) TV61A 11/03/2011	IT-MW-12 (5-6.5) TV61K 11/03/2011	IT-MW-12 (8-9.5) TV61B 11/03/2011	IT-MW-12 (13-14.5) TV61C 11/03/2011	IT-MW-12 (18-19.5) TV61D 11/03/2011
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	--	--	--	--	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Acrylonitrile	240	--	--	--	--	--	--	--	--	0.005 U	0.005 U	0.006 U	0.005 U	0.006 U	0.006 U	0.005 U	0.007 U	0.006 U
Trichloroethene	0.002/0.004 (b)	--	--	--	--	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Vinyl Chloride	0.002	--	--	--	--	--	--	--	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	--	--	--	0.033 U	0.038 U	0.022 U	0.023 U	0.026 U	0.023 U	0.027 U	0.023 U	0.039 U
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	ND	**0.004 J**	ND	ND	ND	**0.000 J**	ND	ND	**0.063**
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	**0.000 J**	**0.013**	ND	**0.004 J**	**0.000 J**	**0.000 J**	**0.000**	ND	**0.048**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	--	--	0.100 U	--	--	ND	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	**0.292**
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (c)	--	--	--	--	--	--	--	--	6.5 U	5.4 U	6.9 U	6.2 U	6.1 U	6.8 U	5.4 U	6.9 U	**88**
Diesel-Range Organics	2,000	--	--	--	--	--	--	--	--	5.4 U	**32**	5.1 U	5.5 U	5.4 U	5.2 U	5.6 U	5.9 U	**180**
Oil-Range Organics		--	--	--	--	--	--	--	--	11 U	**290**	10 U	11 U	**19**	10 U	**39**	12 U	**400**
Combined DRO/ORO	2,000	--	--	--	--	--	--	--	--	ND	**322**	ND	ND	**19**	ND	**39**	ND	**580**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	--	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Arsenic	7	**82**	**46**	**5.3**	**9.2**	**18.0**	5 U	5 U	5 U	**1.7**	**2.3**	**1.8**	**1.7**	**1.9**	**1.4**	**2.3**	**1.7**	**92**
Barium	160	--	--	**28**	**49**	**71**	--	--	--	**47.4**	**46.4**	**44.3**	**47.9**	**47.1**	**38.6**	**63.7**	**45**	**87.8**
Beryllium	3.5	--	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U	**0.2**	**0.2**	0.2 U	**0.2**	0.2 U	**0.3**
Cadmium	0.77	**0.4**	--	**0.40**	**0.45**	**0.68**	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	**1.9**
Chromium	48	**1,750**	**591**	**19**	**15**	**19**	**24**	**24.6**	**29.4**	**25.4**	**33**	**24.4**	**33.1**	**28.1**	**23.1**	**26.4**	**25**	**91**
Chromium VI	0.96	--	--	--	--	--	--	--	--	0.426 U	0.427 U	0.438 U	0.432 U	**0.524**	0.413 U	**0.528**	0.475 U	0.513 U
Copper	36	**846**	**591**	--	--	--	**15.6**	**17.7**	**20.5**	**12.4**	**17.8**	**11.4**	**13.7**	**13.1**	**10.2**	**14.5**	**10.9**	**53.8**
Lead	81	**1,110**	**55**	**8**	**9**	**93**	**4**	**11**	2 U	**2.4**	**4.3**	**2.0**	**2.2**	**4.2**	**1.7**	**2.3**	**1.9**	**169**
Mercury	0.07	0.01 U	--	0.03 U	0.03 U	**4.3**	0.04 U	**0.11**	0.05 U	0.03 U	0.02 U	0.03 U	0.03 U	0.02 U	0.02 U	0.02 U	0.02 U	**0.22**
Nickel	48	**1,427**	**2,460**	**28**	**19**	**15**	--	--	--	**40.6**	**34.1**	**38.6**	**39.2**	**42.5**	**40.9**	**43.5**	**39.4**	**92.3**
Selenium	3	--	--	**0.40**	**0.75**	**0.31**	--	--	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.6 U	0.6 U
Thallium	2	--	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	85	**351**	**42.6**	**26.8**	**30.7**	**52.9**	--	--	--	**31**	**33**	**29**	**30**	**35**	**28**	**36**	**29**	**630**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date											
		FILL E: 1965-1966 Imported Construction-Quality Sand Fill Material											
		IT-MW-12 (23-24.5) TV61E 11/03/2011	IT-MW-13 (2-3.5) TV61F 11/03/2011	IT-MW-13 (5-6.5) TV61G 11/03/2011	IT-MW-13 (8-9.5) TV61H 11/03/2011	IT-MW-13 (12.5-14) TV61I 11/03/2011	IT-MW-13 (15-16.5) TV61J 11/03/2011	IT-MW-13B (2-3.5) TW45J 11/10/2011	IT-MW-13B (5-6.5) TW45K 11/10/2011	IT-MW-13B (6.5-8) TW89A 11/11/2011	IT-MW-13B (8-9.5) TW89B 11/11/2011	IT-MW-13B (12.5-13.5) TW89C 11/11/2011	IT-TOWPATH-EXC12-B(2.7) TF71A 07/26/2011
Volatiles (mg/kg; SW-846 8260C)													
1,1-Dichloroethene	1.4	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U	0.001 U
Acrylonitrile	240	0.006 U	0.007 U	0.005 U	0.005 U	0.007 U	0.005 U	0.006 U	0.006 U	0.006 U	0.008 U	0.005 U	0.004 U
Trichloroethene	0.002/0.004 (b)	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U	0.001 U
Vinyl Chloride	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 U	0.001 U	0.001 U
Semivolatiles (mg/kg; SW-846 8270D)													
bis(2-Ethylhexyl)phthalate	0.12	0.026 U	0.047 U	0.030 U	0.085 U	0.036 U	0.024 U	0.037 U	0.037 U	**0.630**	0.086 U	0.044 U	0.024 U
cPAH TEQ	0.0076	**0.005**	**0.069**	**0.000 J**	**0.020 J**	**0.225**	**0.064**	**0.002**	ND	**0.641**	**0.163 J**	**0.024 J**	**0.046**
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)													
cPAH TEQ	0.0076	**0.021**	**0.020**	**0.008 J**	**0.033 J**	**0.136**	**0.082**	**0.018 J**	**0.021 J**	**0.302**	**0.170**	**0.033**	ND
Polychlorinated Biphenyls (mg/kg; SW-846 8082)													
Total PCBs	0.020	**0.040**	ND	ND	ND	ND	ND	ND	ND	**12.000**	**3.420**	**5.200**	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)													
Gasoline-Range Organics	30 (c)	10 U	**33**	5.9 U	**7.3**	**22**	**19**	6.5 U	6.6 U	**120**	6.5 U	6.5 U	6.9 U
Diesel-Range Organics	2,000	**37**	**55**	**8.4**	**32**	**130**	**48**	**9.8**	**38**	**380 J**	**220 J**	**28 J**	5.4 U
Oil-Range Organics		**66**	**200**	**50**	**87**	**380**	**140**	**32**	**50**	**650**	**830**	**140**	11 U
Combined DRO/ORO	2,000	**103**	**255**	**58.4**	**119**	**510**	**188**	**41.8**	**88**	**1,030 J**	**1,050 J**	**168 J**	ND
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)													
Antimony	4.1	0.2 U	0.2 U	0.2 U	0.2 U	**0.3**	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U
Arsenic	7	**22.7**	**2.7**	**3.1**	**2.7**	**24.4**	**19.5**	**3.8**	**2.5**	**7.2 J**	**12.1**	**8.9**	**2.2**
Barium	160	**45.7**	**46.4**	**45.3**	**119**	**143**	**145**	**50.8**	**43.6**	**69.8 J**	**197**	**59**	**49.1**
Beryllium	3.5	**0.3**	**0.2**	**0.2**	**0.3**	**0.3**	0.2 U	**0.2**	0.2 U	**0.3**	**0.3**	0.2 U	0.2 U
Cadmium	0.77	**0.3**	**0.1**	**0.1**	**0.1**	**2.2**	**1**	0.1 U	0.1 U	**0.6**	**3.7**	**0.2**	0.1 U
Chromium	48	**16.4**	**22**	**28**	**171**	**3,430**	**1,640**	**15.7**	**20.8**	**25.2**	**218**	**30.5**	**28**
Chromium VI	0.96	0.509 U	0.449 U	**0.431**	0.465 U	0.459 U	**0.456**	0.453 U	0.452 U	0.463 U	0.439 U	0.465 U	0.421 U
Copper	36	**20**	**19.9**	**17.8**	**34.9**	**320**	**209**	**23.6**	**15.3**	**53.6 J**	**197**	**28.1**	**12.1**
Lead	81	**9.7**	**6**	**4.5**	**8.7**	**570**	**421**	**7.5**	**5.5**	**51.8**	**348**	**17.3**	**2.5**
Mercury	0.07	**0.05**	**0.02**	**0.04**	**0.02**	0.03 U	0.02 U	**0.05**	0.03 U	**0.17**	**0.11**	**0.02**	0.02 U
Nickel	48	**15.9**	**29.5**	**34.6**	**37.4**	**2,220**	**869**	**17.8**	**28.9**	**30.9 J**	**170**	**17.3**	**34.4**
Selenium	3	0.6 U	0.5 U	0.5 U	0.5 U	0.6 U	0.6 U	0.6 U	0.5 U	0.6 U	0.6 U	0.6 U	0.5 U
Thallium	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	85	**67**	**46**	**35**	**44**	**600**	**252**	**42**	**44**	**390 J**	**630**	**72**	**31**

Table 2-3b
Soil Data and pCUL Exceedances: Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Notes:

U = Indicates the compound was not detected at or above the reporting limit.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J1 = Laboratory flag indicating the analyte was positively identified; the associated concentration is approximate and less than the reporting limit, but equal to or greater than the detection limit.
UJ2 = The analyte was not detected in the sample at or above the numerical value shown; the numerical value is below the reporting limit, but greater than the detection limit.
(a) Sample TDP32 (11) has been categorized with the hydraulic test pad area samples (Fill B) even though the sample was collected within Fill E.
(b) Cleanup levels for saturated zone soil (>11 feet below ground surface) and vadose zone soil (<11 feet below ground surface), respectively.
(c) Assumes benzene is detected in sample (lower value of 100/30 mg/kg selected).
Bold = Detection **Green Shading** = Reported concentration is greater than the proposed cleanup level.

Abbreviations and Acronyms:
-- = not analyzed
µg/kg = micrograms per kilogram
cPAH = carcinogenic polycyclic aromatic hydrocarbon
DRO = diesel-range organics
EPA = US Environmental Protection Agency
ID = identification
Lab = laboratory
mg/kg = milligrams per kilogram
ND = not detected
NWTPH = Northwest Total Petroleum Hydrocarbon
ORO = oil-range organics
PCB = polychlorinated biphenyl
SIM = select ion monitoring
TEQ = toxicity equivalency quotient

Table 2-3c
Soil Data and pCUL Exceedances: South of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

		Sample Area, Sample ID, Lab Sample ID, Sample Date																	
		Western Property Boundary				Southern Property Boundary/Former Washdown System Collection Sumps													
Analyte	Revised Soil Proposed Cleanup Level	IT-MW-7 (2-3.5) TU65A 10/31/2011	IT-MW-7 (5-6.5) TU65B 10/31/2011	IT-MW-7 (8-9.5) TV85A 11/04/2011	IT-MW-7 (13.5-15) TV85B 11/04/2011	TDP1 (9) NX93A 11/3/2008	TDP2 (5) NX93B 11/3/2008	TDP3 (5) NX93C 11/3/2008	TDP4 (4) NX93D 11/3/2008	TDP25 (9) NY44J 11/5/2008	TDP26 (8) NY64A 11/6/2008	PBI-11 (2) PI42A 7/28/2009	PBI-11 (5) PI42B 7/28/2009	PBI-11 (8) PI42C 7/28/2009	PBI-12 (2) PI42D 7/28/2009	PBI-12 (5) PI42E 7/28/2009	PBI-12 (8) PI42F 7/28/2009	PBI-13 (2) PI42G 7/28/2009	PBI-13 (5) PI42H 7/28/2009
Volatiles (mg/kg; SW-846 8260C)																			
1,1-Dichloroethene	1.4	0.0013 U	0.0014 U	0.0012 U	0.0012 U	0.0012 U	0.0008 U	0.0010 U	0.0010 U	0.0007 U	0.0007 U	0.0006 U	0.0010 U	0.0009 U	0.0010 U	0.0009 U	0.0011 U	0.0009 U	0.0009 U
Acrylonitrile	240	0.0064 U	0.0068 U	0.0061 U	0.0060 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	0.002/0.004 (c)	**0.0460**	**0.0220**	0.0012 U	**0.0014**	**0.0062**	0.0008 U	0.0010 U	0.0010 U	**0.0062**	**0.0660**	**0.0021**	**0.0110**	**0.0070**	**0.0037**	**0.0083**	0.0011 U	**0.0200**	**0.0280**
Vinyl Chloride	0.002	0.0013 U	0.0014 U	0.0012 U	0.0012 U	0.0012 U	0.0008 U	0.0010 U	0.0010 U	0.0007 U	0.0007 U	0.0006 U	0.0010 U	0.0009 U	0.0010 U	0.0009 U	0.0011 U	0.0009 U	0.0009 U
Semivolatiles (mg/kg; SW-846 8270D)																			
bis(2-Ethylhexyl)phthalate	0.12	0.0220 UJ2	0.0160 UJ2	0.0360 U	0.0840 U	0.0620 U	--	--	--	0.0640 U	0.0590 U	--	--	--	--	--	--	--	--
cPAH TEQ	0.0076	**0.0026 J**	**0.0018 J**	ND	ND	ND	--	--	--	ND	ND	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																			
cPAH TEQ	0.0076	**0.5370**	**0.0120**	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																			
Total PCBs	0.020	**0.6600**	**0.0500**	ND	ND	ND	--	--	--	ND	ND	--	--	--	--	--	--	--	--
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																			
Gasoline-Range Organics	30 (d)	7.2 U	7.9 U	7.2 U	8.3 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diesel-Range Organics	2,000	**18**	**6.8**	5.5 U	6.0 U	**16**	**19**	**110**	**78**	**61**	**6.5**	--	--	--	--	--	--	--	--
Oil-Range Organics		**27**	**28**	11 U	12 U	**99**	**95**	**740**	**640**	**340**	**24**	--	--	--	--	--	--	--	--
Combined DRO/ORO	2,000	**45**	**34.8**	ND	ND	**115**	**114**	**850**	**718**	**401**	**30.5**	--	--	--	--	--	--	--	--
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																			
Antimony	4.1	0.2 U	0.2 U	0.2 UJ	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	7	**5.6**	**24.5**	**3.0**	**0.9**	**9**	--	**6**	**18**	5 U	**7**	--	--	--	--	--	--	--	--
Barium	160	**51.3**	**62.1**	**44.9**	**20.8**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	3.5	0.2 U	**0.3**	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.77	**0.3**	**0.4**	0.1 U	0.1 U	**0.4**	0.2 U	**0.2**	**1**	0.2 U	**0.4**	--	--	--	--	--	--	--	--
Chromium, Total	48	**19.1**	**16.8**	**11.2**	**9.8**	**12.3**	**21.8**	**21.2**	**29**	**35.8**	**20.8**	--	--	--	--	--	--	--	--
Chromium VI	0.96	0.462 U	0.472 U	0.468 U	0.524 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	36	**25.2**	**26.1**	**19.2**	**10.3**	**31.6**	**23.2**	**24.8**	**67.1**	**14.3**	**36.6**	--	--	--	--	--	--	--	--
Lead	81	**36.6**	**22.0**	**2.5**	**1.8**	**17**	**2**	**139**	**106**	**2**	**12**	--	--	--	--	--	--	--	--
Mercury	0.07	**0.05**	**0.08**	0.03 U	0.02 U	**0.06**	0.05 U	**0.06**	**0.2**	0.04 U	0.06 U	--	--	--	--	--	--	--	--
Nickel	48	**12.1**	**15.3**	**10.4**	**6.8**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	3	0.6 U	0.6 U	0.6 U	0.6 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	2	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	85	**47**	**70**	**25**	**21**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

Table 2-3c
Soil Data and pCUL Exceedances: South of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date															
		Southern Property Boundary/Former Washdown System Collection Sumps															
		PBI-13 (8) PI42I 7/28/2009	PBI-14 (2)	PBI-14 (5)	PBI-15 (2) PI42L 7/28/2009	PBI-15 (5) PI42M 7/28/2009	PBI-15 (8) PI42N 7/28/2009	IT-MW-5 (2-3.5) TU90A 11/01/2011	IT-MW-5 (5-6.5) TU90B 11/01/2011	IT-MW-5 (8-9) TV16A 11/02/2011	IT-MW-5 (14-15.5) TV16B 11/02/2011	IT-MW-6 (2-3.5) TU90C 11/01/2011	IT-MW-6 (5-6.5) TU90D 11/01/2011	IT-MW-6 (8-9.5) TV16C 11/02/2011	IT-MW-6 (14-15.5) TV16D 11/02/2011	IT-MW-6 (20-21.5) TV16E 11/02/2011	IT-MW-6 (23-24.5) TV16F 11/02/2011
Volatiles (mg/kg; SW-846 8260C)																	
1,1-Dichloroethene	1.4	0.0010 U	0.0009 U	0.0008 U	0.0009 U	0.0010 U	0.0008 U	0.0012 UJ	0.0014 U	0.0013 U	0.0016 U	0.0012 U	0.0012 U	0.0014 U	0.0012 U	0.0011 U	0.0012 U
Acrylonitrile	240	--	--	--	--	--	--	0.0061 UJ	0.0068 U	0.0064 U	0.0079 U	0.0062 U	0.0062 U	0.0070 U	0.0062 U	0.0057 U	0.0060 U
Trichloroethene	0.002/0.004 (c)	**0.0350**	0.0009 U	**0.0015**	0.0009 U	0.0010 U	0.0008 U	**0.0013 J**	**0.0010 J1**	0.0013 U	0.0016 U	**0.0077**	**0.0084**	**0.2700**	**0.2200**	**0.0043**	**0.0022**
Vinyl Chloride	0.002	0.0010 U	0.0009 U	0.0008 U	0.0009 U	0.0010 U	0.0009 U	0.0012 U	0.0014 U	0.0013 U	0.0016 U	0.0012 U	0.0012 U	0.0014 U	**0.0022**	**0.0072**	**0.0010 J1**
Semivolatiles (mg/kg; SW-846 8270D)																	
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	--	0.0240 U	0.0340 U	**0.0910**	**0.0240**	0.0230 U	0.0230 U	**0.0240**	0.0250 U	**0.0170 J1**	**0.0140 J1**
cPAH TEQ	0.0076	--	--	--	--	--	--	ND	**0.0334**	**0.0621**	ND	ND	ND	**0.0165 J**	ND	ND	ND
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																	
cPAH TEQ	0.0076	--	--	--	--	--	--	**0.0014 J**	**0.1960**	**0.0180 J**	ND	ND	**0.1300**	**0.0150 J**	ND	ND	ND
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																	
Total PCBs	0.020	--	--	--	--	--	--	ND	ND	**0.0490**	ND	ND	ND	**0.0160 J**	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																	
Gasoline-Range Organics	30 (d)	--	--	--	--	--	--	6.9 U	8.4 U	8.6 U	8.5 U	6.6 U	6.4 U	8.3 U	7.8 U	**12**	7.8 U
Diesel-Range Organics	2,000	--	--	--	--	--	--	**99 J**	**17**	**18**	6.6 U	5.0 U	5.2 U	**14**	6.4 U	**12**	6.2 U
Oil-Range Organics		--	--	--	--	--	--	**22**	**42**	**77**	13 U	10 U	10 U	**56**	13 U	**46**	12 U
Combined DRO/ORO	2,000	--	--	--	--	--	--	**121**	**59**	**95**	ND	ND	ND	**70**	ND	**58**	ND
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																	
Antimony	4.1	--	--	--	--	--	--	0.2 UJ	0.2 U	0.2 UJ	0.3 U	0.2 U	0.2 U	0.2 U	0.3 U	0.3 U	0.2 U
Arsenic	7	--	--	--	--	--	--	**4.3**	**8.1**	**4.6**	**2.1**	**2.2**	**2.3**	**7.0**	**1.1**	**1.3**	**1.0**
Barium	160	--	--	--	--	--	--	**82.1 J**	**75.5**	**60.8**	**57.2**	**37.8**	**36.0**	**76.3**	**41.6**	**22.4**	**23.4**
Beryllium	3.5	--	--	--	--	--	--	**0.3**	**0.3**	**0.3**	0.3 U	0.2 U	**0.2**	**0.4**	0.3 U	0.3 U	0.2 U
Cadmium	0.77	--	--	--	--	--	--	**0.1**	**0.3**	**0.1**	0.1 U	0.1 U	0.1 U	**0.2**	0.1 U	0.1 U	0.1 U
Chromium, Total	48	--	--	--	--	--	--	**13.7**	**16.1**	**17.2**	**14.1**	**18.6**	**22.9**	**22.5**	**14.6**	**9.2**	**10.9**
Chromium VI	0.96	--	--	--	--	--	--	0.480 UJ	0.501 U	0.493 U	0.539 U	0.408 U	0.403 U	0.514 U	0.532 U	0.511 U	0.491 U
Copper	36	--	--	--	--	--	--	**24.7**	**29.4**	**26.4**	**21.5**	**11.0**	**11.6**	**34.0**	**18.8**	**11.4**	**9.7**
Lead	81	--	--	--	--	--	--	**5.8**	**30.7**	**28.6 J**	**2.8**	**1.6**	**1.6**	**30.4**	**2.3**	**1.1**	**1.1**
Mercury	0.07	--	--	--	--	--	--	**0.04**	**0.12**	**0.03**	**0.03**	0.02 U	0.02 U	**0.04**	0.03 U	0.02 U	0.03 U
Nickel	48	--	--	--	--	--	--	**14.4**	**16.9**	**40.8 J**	**10.8**	**28.9**	**29.2**	**23.1**	**9.8**	**7.9**	**7.7**
Selenium	3	--	--	--	--	--	--	0.6 U	0.6 U	0.6 U	0.6 U	0.5 U	0.5 U	0.6 U	0.7 U	0.6 U	0.6 U
Thallium	2	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.3 U	0.3 U	0.2 U
Zinc	85	--	--	--	--	--	--	**44**	**65**	**60**	**31**	**27**	**27**	**72**	**25**	**20**	**22**

Table 2-3c
Soil Data and pCUL Exceedances: South of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

		Sample Area, Sample ID, Lab Sample ID, Sample Date																	
		Eastern Property Boundary																	
Analyte	**Revised Soil Proposed Cleanup Level**	TDP20 (3) NY44E 11/5/2008	TDP21 (3) NY44F 11/5/2008	IT-HBE-1A-1 RL72A 09/03/2010	IT-HBE-1A (4.5-5.5) RL72C 09/03/2010	IT-HBE-2-1 RL63B 09/02/2010	IT-HBE-2 (4.0-4.5) RL87A 09/07/2010	IT-HBE-3-1 RL72B 09/03/2010	IT-HBE-3 (4.5-5.5) RL87B 09/07/2010	IT-HBE-SS1 RL72D 09/03/2010	IT-EXT1 (0-1) RM87A 09/15/2010	IT-EXT1 (4-5) RM87B 09/15/2010	IT-EXT2 (0-1) RM87C 09/15/2010	IT-EXT2 (3-4) RM87D 09/15/2010	IT-EXT3 (0-1) RM87E 09/15/2010	IT-EXT3 (3-4) RM87F 09/15/2010	IT-Bldg-14-11Exc1-B(2.1) TG02B 7/28/2011	IT-Bldg-14-11Exc2-B(2.5) TG02C 7/28/2011	IT-Bldg-14-11Exc3-B(3.0) TG02D 7/28/2011
Volatiles (mg/kg; SW-846 8260C)																			
1,1-Dichloroethene	1.4	--	--	0.0009 U	0.0010 U	0.0012 U	0.0012 U	0.0010 U	0.0013 U	0.0011 U	0.0007 U	0.0006 U	0.0004 U	0.0005 U	0.0005 U	0.0005 U	0.0012 U	0.0012 U	0.0012 U
Acrylonitrile	240	--	--	0.0047 U	0.0049 U	0.0059 U	0.0060 U	0.0052 U	0.0066 U	0.0054 U	0.0035 U	0.0029 U	0.0022 U	0.0024 U	0.0025 U	0.0027 U	0.0062 U	0.0058 U	0.0060 U
Trichloroethene	0.002/0.004 (c)	--	--	0.0009 U	0.0010 U	0.0012 U	0.0012 U	0.0010 U	0.0013 U	0.0011 U	0.0007 U	0.0006 U	0.0004 U	0.0005 U	0.0005 U	0.0005 U	0.0012 U	0.0012 U	0.0012 U
Vinyl Chloride	0.002	--	--	0.0009 U	0.0010 U	0.0012 U	0.0012 U	0.0010 U	0.0013 U	0.0011 U	0.0007 U	0.0006 U	0.0004 U	0.0005 U	0.0005 U	0.0005 U	0.0012 U	0.0012 U	0.0012 U
Semivolatiles (mg/kg; SW-846 8270D)																			
bis(2-Ethylhexyl)phthalate	0.12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.0280**	**0.0180 J**	**0.0540 J**
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.0263 J**	**0.0202 J**	ND
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																			
cPAH TEQ	0.0076	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.0175 J**	**0.0168 J**	**0.0108 J**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																			
Total PCBs	0.020	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.1260**	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																			
Gasoline-Range Organics	30 (d)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6 U	6.3 U	6.8 U
Diesel-Range Organics	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**21**	**9.4**	**11**
Oil-Range Organics		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**50**	**18**	**48**
Combined DRO/ORO	2,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**71**	**27.4**	**59**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																			
Antimony	4.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U
Arsenic	7	6 U	5 U	10 U	6 U	5 U	6 U	5 U	6 U	6 U	5 U	5 U	5 U	6 U	5 U	6 U	**6.8**	**4**	**3.6**
Barium	160	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**63.7**	**57.6**	**51.4**
Beryllium	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.2**	0.2 U	**0.2**
Cadmium	0.77	0.3 U	**0.3**	0.5 U	**0.3**	**0.4**	**0.4**	**0.3**	**0.3**	**0.5**	**0.3**	**0.3**	**1.2**	**0.8**	**0.4**	**0.3**	**0.5**	**0.2**	**0.3**
Chromium, Total	48	**14.5**	**15.1**	**30**	**19.1**	**15.5**	**14.6**	**18.5**	**14.1**	**25.7**	**14.2**	**11.0**	**25.4**	**37.8**	**14.8**	**14.3**	**16.3**	**16.5**	**15.9**
Chromium VI	0.96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.44 J**	0.444 U	0.454 U
Copper	36	--	**13.3**	**35.7**	**19.1**	**12.6**	**15.3**	**13.8**	**21.8**	**44.0**	**15.2**	**11.2**	**61.4**	**52.7**	**20.1**	**41.1**	**44.6**	**24.2**	**16.9**
Lead	81	**3**	2 U	5 U	**14**	**4**	**4**	**12**	**4**	**14**	**5**	**3**	**9**	**23**	**10**	**19**	**80.8**	**22.1**	**6.1**
Mercury	0.07	0.05 U	0.05 U	0.02 U	**0.03**	**0.06**	**0.04**	0.03 U	**0.04**	**0.14**	**0.03**	0.02 U	0.03 U	**0.02**	**0.08**	**0.08**	**0.05**	**0.03**	**0.03**
Nickel	48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**22.1**	**22.4**	**15.3**
Selenium	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6 U	0.5 U	0.5 U
Thallium	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U
Zinc	85	--	--	**49**	**39**	**37**	**36**	**43**	**29**	**159**	**36**	**32**	**633**	**396**	**47**	**38**	**147**	**51**	**340**

Table 2-3c
Soil Data and pCUL Exceedances: South of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

		Sample Area, Sample ID, Lab Sample ID, Sample Date																
		Eastern Property Boundary										Northern Portion of 14-01 Building						
Analyte	**Revised Soil Proposed Cleanup Level**	IT-Bldg-14-11Exc4-B(2.4) TG02E 7/28/2011	IT-BLDG 14-11-SURF TJ06B 8/18/2011	IT-BUILDING 14-11EXC 5-B(.5) TJ06A 8/18/2011	IT-PIVExc2-B (5.0) TH74A 8/9/2011	IT-PIVExc2-SW (2.5) TH74B 8/9/2011	IT-Towpath Exc13-(1.3) TG72A 8/2/2011	IT-MW-4 (2-3.5) TW27F 11/08/2011	IT-MW-4 (5-6.5) TW27G 11/08/2011	IT-MW-4 (8-9.5) TW27H 11/08/2011	IT-MW-4 (13.5-15) TW27I 11/08/2011	IT-BLDG1401-TRENCH-2N SU96A/SW32A 5/2/2011	IT-BLDG1401-TRENCH-2S SU96B/SW32B 5/2/2011	IT-BLDG1401-TRENCH-3N SV05A/SW32C 5/3/2011	IT-BLDG1401-TRENCH-3S SV05B/SW32D 5/3/2011	IT-BLDG1401-TRENCH-4N SW63A 5/12/2011	IT-BLDG1401-TRENCH-4S (a) SW63B 5/12/2011	IT-BLDG1401-TRENCH-5N (b) SW79A 5/13/2011
Volatiles (mg/kg; SW-846 8260C)																		
1,1-Dichloroethene	1.4	0.0009 U	0.0009 U	0.0010 U	0.0012 U	0.0012 U	0.0010 U	0.0013 U	0.0013 U	0.0011 U	0.0012 U	0.0009 U	0.0012 U	0.0011 U	0.0011 U	0.0013 U	0.0012 U	0.0013 U
Acrylonitrile	240	0.0047 U	0.0044 U	0.0048 U	0.0058 U	0.0059 U	0.0051 U	0.0063 U	0.0066 U	0.0056 U	0.0058 U	0.0045 U	0.0062 U	0.0053 U	0.0055 U	0.0065 U	0.0060 U	0.0066 U
Trichloroethene	0.002/0.004 (c)	0.0009 U	0.0009 U	0.0010 U	0.0012 U	0.0012 U	0.0010 U	0.0013 U	0.0013 U	0.0011 U	0.0012 U	0.0009 U	0.0012 U	0.0011 U	0.0011 U	0.0013 U	0.0012 U	0.0013 U
Vinyl Chloride	0.002	0.0009 U	0.0009 U	0.0010 U	0.0012 U	0.0012 U	0.0010 U	0.0013 U	0.0013 U	0.0011 U	0.0012 U	0.0009 U	0.0012 U	0.0011 U	0.0011 U	0.0013 U	0.0012 U	0.0013 U
Semivolatiles (mg/kg; SW-846 8270D)																		
bis(2-Ethylhexyl)phthalate	0.12	**0.0400**	**0.0670**	0.0230 U	0.0230 U	0.0230 U	0.0230 U	**0.0150 J1**	0.0240 U	**0.5900**	**0.0330**	**0.0092 J**	0.0180 U	**0.0100 J**	0.0180 U	0.0190 U	0.0180 U	0.0190 U
cPAH TEQ	0.0076	**0.0023 J**	**0.2740**	**0.0012 J**	**0.0159 J**	**0.0017 J**	**0.0137 J**	ND	**0.0475 J**	**0.0147 J**	ND	ND	ND	**0.0155 J**	**0.0132 J**	**0.0027 J**	**0.0017 J**	**0.0159 J**
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																		
cPAH TEQ	0.0076	**0.0069 J**	**0.0424**	**0.0117**	**0.0320**	**0.0081 J**	**0.0107 J**	ND	**0.0047 J**	**0.0092**	ND	**0.0004**	ND	**0.0126**	**0.0167**	**0.0067**	**0.0164**	**0.0077**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																		
Total PCBs	0.020	ND	**0.0140 J**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0184 J**	ND	ND	ND	**0.0250 J**
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																		
Gasoline-Range Organics	30 (d)	5.9 U	5.3 U	5 U	6.4 U	5.9 U	5.7 U	6.8 U	8.5 U	**8.3**	6.6 U	5.9 U	6.3 U	6.7 U	6.8 U	**12**	7.7 U	8.0 U
Diesel-Range Organics	2,000	**12**	**10**	**10**	**11**	**15**	**27**	5.2 U	6.0 U	**23**	5.9 U	5.0 U	5.0 U	**10**	**100**	**9.0**	**6.5**	**17**
Oil-Range Organics		**25**	**74**	**24**	**33**	**45**	**150**	10 U	12 U	**120**	12 U	**5.1 J**	10 U	**59**	**200**	**21**	**32**	**170**
Combined DRO/ORO	2,000	**37**	**84**	**34**	**44**	**60**	**177**	ND	ND	**143**	ND	**5.1 J**	ND	**69**	**300**	**30**	**38.5**	**187**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																		
Antimony	4.1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Arsenic	7	**3.6**	**2.9**	**3.3**	**3.3**	**2.4**	**3.4**	**4.1**	**4.1**	**3.0**	**1.9**	**2.9**	**2.7**	**2.3**	**4.0**	**3.1**	**4.5**	**5.3**
Barium	160	**45.2**	**57.1**	**60.8**	**60.1**	**55.9**	**53.6**	**57.5**	**49.0**	**48.0**	**18.0**	**32.4**	**39.8**	**36.5**	**62.5**	**40.4**	**47.9**	**43.4**
Beryllium	3.5	**0.2**	0.2 U	0.2 U	**0.2**	**0.2**	**0.3**	**0.2**	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.2**	0.2 U	**0.2**	0.2 U
Cadmium	0.77	**0.1**	**0.3**	0.1 U	**0.4**	**0.2**	**0.1**	0.1 U	**0.2**	0.1 U	0.1 U	**0.1**	**0.10**	0.1 U	0.1 U	0.1 U	0.1 U	**0.3**
Chromium, Total	48	**18.8**	**18.7**	**13.2**	**21.4**	**23.4**	**14.6**	**9.9**	**13.1**	**13.5**	**9.9**	**13.5**	**10.3**	**12.3**	**16.5**	**12.1**	**15.0**	**12.1**
Chromium VI	0.96	**0.48**	**0.427**	0.411 U	0.443 U	0.443 U	0.445 U	0.402 U	0.481 U	0.466 U	0.481 U	0.414 U	0.402 U	0.425 UJ	0.445 U	0.461 UJ	0.446 U	0.460 U
Copper	36	**24.6**	**61.2**	**22.5**	**27.4**	**23.9**	**23.1**	**26.0**	**14.1**	**21.5**	**6.3**	**13.9**	**10.6**	**20.6**	**24.4**	**22.8**	**19.6**	**23.6**
Lead	81	**15.8**	**18.7**	**10.5**	**42.4**	**17**	**8.5**	**4.0**	**4.1**	**3.4**	**1.1**	**2.5**	**2.59**	**5.4**	**5.6**	**3.5**	**6.4**	**11.6**
Mercury	0.07	**0.02**	0.02 U	0.02 U	**0.03**	**0.03**	**0.03**	0.02 U	**0.04**	0.02 U	0.03 U	0.02 U	0.02 U	**0.09**	**0.04**	**0.02**	**0.03**	**0.03**
Nickel	48	**26.6**	**25.5**	**17.5**	**25.6**	**32.5**	**16.5**	**15.9**	**12.2**	**10.9**	**4.8**	**12.5**	**11.2**	**14.1**	**13.8**	**10.0**	**16.9**	**11.9**
Selenium	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.6 U	0.5 U	0.6 U	0.6 U	0.6 U	0.5 U	0.5 U	0.5 U	0.5 U	0.6 U	0.5 U	0.6 U
Thallium	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	85	**46**	**299**	**44**	**68**	**50**	**39**	**38**	**42**	**33**	**20**	**32**	**31**	**35**	**34**	**29**	**35**	**36**

Table 2-3c
Soil Data and pCUL Exceedances: South of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date														
		Northern Portion of 14-01 Building					Former Washdown/Aqueous Degreaser Area									
		IT-BLDG1401-TRENCH-5S SW79B 5/13/2011	IT-Bldg1401-Outtakes Exc-1 (3.5) SX84A 5/20/2011	IT-Bldg1401-Outtakes Exc-2 (3.7) SX84B 5/20/2011	IT-Bldg1401-Outtakes Exc-3 (2.9) SY11A 5/23/2011	IT-Bldg1401-Outtakes Exc-4 (3.05) SY11B 5/23/2011	TDP5 (5) NX93E 11/3/2008	TDP6 (8) NY07A 11/4/2008	TDP7 (8) NY07B 11/4/2008	TDP8 (8) NY07C 11/4/2008	TDP9 (8) NY07D 11/4/2008	TDP10 (7) NY07P 11/4/2008	TDP10 (8) NY07E 11/4/2008	TDP11 (7) NY07F 11/4/2008	TDP11 (9) NY07G 11/4/2008	TDP12 (7) NY07H 11/4/2008
Volatiles (mg/kg; SW-846 8260C)																
1,1-Dichloroethene	1.4	0.0012 U	0.0011 U	0.0011 U	0.0013 U	0.0012 U	0.0011 U	0.0014 U	0.0008 U	0.0011 U	0.0006 U	0.0012 U	0.0007 U	0.0008 U	0.0006 U	0.0012 U
Acrylonitrile	240	0.0060 U	0.0055 U	0.0054 U	0.0064 U	0.0059 U	--	--	--	--	--	--	--	--	--	--
Trichloroethene	0.002/0.004 (c)	0.0012 U	0.0011 U	0.0011 U	0.0013 U	0.0012 U	0.0011 U	0.0014 U	0.0008 U	0.0011 U	0.0006 U	0.0012 U	0.0007 U	0.0009 U	0.0006 U	0.0012 U
Vinyl Chloride	0.002	0.0012 U	0.0011 U	0.0011 U	0.0013 U	0.0012 U	0.0011 U	0.0014 U	0.0008 U	0.0011 U	0.0006 U	0.0012 U	0.0007 U	0.0009 U	0.0006 U	0.0012 U
Semivolatiles (mg/kg; SW-846 8270D)																
bis(2-Ethylhexyl)phthalate	0.12	0.0180 U	**0.0110 J**	0.0580 U	**0.0160 J**	**0.0200**	--	--	0.0630 U	0.0610 U	--	--	--	--	0.0600 U	--
cPAH TEQ	0.0076	ND	**0.0015 J**	ND	**0.0013 J**	**0.0013 J**	--	--	ND	ND	--	--	--	--	ND	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																
cPAH TEQ	0.0076	ND	**0.0059**	ND	**0.0007**	**0.0081**	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																
Total PCBs	0.020	ND	ND	ND	ND	ND	--	--	ND	ND	--	--	--	--	ND	--
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																
Gasoline-Range Organics	30 (d)	6.2 U	5.7 U	6.1 U	7.9 U	5.8 U	--	--	--	--	--	--	--	--	--	--
Diesel-Range Organics	2,000	5.1 U	5.4 U	**23**	**5.6**	**5.6**	--	--	--	--	--	--	--	--	**20**	**140**
Oil-Range Organics		10 U	**11**	**300**	**15**	**16**	--	--	--	--	--	--	--	--	**130**	**990**
Combined DRO/ORO	2,000	ND	**11**	**323**	**20.6**	**21.6**	--	--	--	--	--	--	--	--	**150**	**1,130**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																
Antimony	4.1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--
Arsenic	7	**2.3**	**3.2**	**3.6**	**2.9**	**3.4**	5 U	--	6 U	6 U	6 U	--	6 U	--	5 U	**8**
Barium	160	**19.5**	**47.4**	**52.5**	**40.0**	**47.6**	--	--	--	--	--	--	--	--	--	--
Beryllium	3.5	0.2 U	0.2 U	0.2 U	**0.2**	0.2 U	--	--	--	--	--	--	--	--	--	--
Cadmium	0.77	0.1 U	**0.1**	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.2 U	**0.2**	0.2 U	--	0.2 U	--	0.2 U	**0.8**
Chromium, Total	48	**6.8**	**16.8**	**11.5**	**13.7**	**16.5**	**8.8**	**13.6**	**16.5**	**13.8**	**15.1**	--	**20.7**	--	**17.1**	**20**
Chromium VI	0.96	0.401 U	0.429 U	0.422 U	0.443 U	0.434 U	--	--	--	--	--	--	--	--	--	--
Copper	36	**8.4**	**16.5**	**30.8**	**15.8**	**17.9**	**10.8**	**20.5 J**	**20.2**	**21.6**	**17.7**	--	**18.9**	--	**24.8**	**31.3**
Lead	81	**1.3**	**4.7**	**8.4**	**5.2**	**8.4**	2 U	2 U	**2**	**7**	2 U	--	2 U	--	**3**	**13**
Mercury	0.07	0.02 U	**0.04**	0.02 U	0.02 U	**0.07**	0.04 U	0.05 U	0.05 U	0.05 U	0.05 U	--	0.06 U	--	0.04 U	**0.19**
Nickel	48	**6.6**	**22.7**	**14.1**	**19.3**	**24.8**	--	--	--	--	--	--	--	--	--	--
Selenium	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	--	--	--	--	--	--	--	--	--	--
Thallium	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--
Zinc	85	**21**	**37**	**46**	**31**	**34**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

Table 2-3c
Soil Data and pCUL Exceedances: South of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

		Sample Area, Sample ID, Lab Sample ID, Sample Date																	
		Former Washdown/Aqueous Degreaser Area																	
Analyte	Revised Soil Proposed Cleanup Level	TDP13 (7) NY07J 11/4/2008	IT-MW-1 (3-4) ST77A 04/25/2011	IT-MW-1 (5-6) ST77B 04/25/2011	IT-MW-1 (8-9) ST77C 04/25/2011	IT-MW-2 (2-3) SU07A 04/26/2011	IT-MW-2 (5-6) SU07B 04/26/2011	IT-MW-2 (8-9) SU07C 04/26/2011	IT-MW-3 (2-3) SU07D 04/26/2011	IT-MW-3 (5-6) SU07E 04/26/2011	IT-MW-3 (9-10) SU07F 04/26/2011	IT-SB-1 (2-3) ST77D 04/25/2011	IT-SB-1 (5-6) ST77E 04/25/2011	IT-SB-1 (8-9) ST77F 04/25/2011	IT-Bldg1401-Footing Exc1-SW(4.0) TB91C 06/23/2011	IT-Bldg1401-Footing Exc1-B(6.0) TB91D 06/23/2011	IT-Bldg1401-Footing Exc1-B(7.5) TC25A 6/27/2011	IT-Bldg1401-Footing Exc3-B(4.0) TB68B 06/22/2011	IT-Bldg1401-Footing Exc5-SW(4.0) TB91B 06/23/2011
Volatiles (mg/kg; SW-846 8260C)																			
1,1-Dichloroethene	1.4	0.0011 U	0.0014 UJ	0.0014 UJ	0.0013 UJ	0.0011 U	0.0012 U	0.0019 U	0.0012 U	0.0011 U	0.0015 U	0.0010 UJ	0.0012 UJ	0.0019 UJ	0.0012 U	0.0015 U	0.0011 U	0.0012 U	0.0011 U
Acrylonitrile	240	--	0.0070 UJ	0.0068 UJ	0.0064 UJ	0.0053 U	0.0061 U	0.0094 U	0.0062 U	0.0054 U	0.0075 U	0.0049 UJ	0.0058 UJ	0.0093 UJ	0.0058 U	0.0073 U	0.0054 U	0.0061 U	0.0057 U
Trichloroethene	0.002/0.004 (c)	0.0011 U	0.0014 UJ	0.0014 UJ	0.0013 UJ	0.0011 U	0.0012 U	0.0019 U	0.0012 U	0.0011 U	0.0015 U	0.0010 UJ	0.0012 UJ	0.0019 UJ	0.0012 U	0.0015 U	0.0011 U	0.0012 U	0.0011 U
Vinyl Chloride	0.002	0.0011 U	0.0014 UJ	0.0014 UJ	0.0013 UJ	0.0011 U	0.0012 U	0.0019 U	0.0012 U	0.0011 U	0.0015 U	0.0010 UJ	0.0012 UJ	0.0019 UJ	0.0012 U	0.0015 U	0.0011 U	0.0012 U	0.0011 U
Semivolatiles (mg/kg; SW-846 8270D)																			
bis(2-Ethylhexyl)phthalate	0.12	--	**0.0140 J**	**0.0380**	**0.0260**	**0.0140 J**	**0.0140 J**	**0.0290**	**0.0100 J**	**0.0100 J**	**0.0330**	**0.0190**	**0.0150 J**	**0.0390**	0.0730 U	0.0230 U	0.0240 U	**0.0180 J**	0.0720 U
cPAH TEQ	0.0076	--	**0.0109**	**0.0012 J**	ND	ND	**0.0002 J**	**0.0165 J**	ND	ND	ND	**0.0014 J**	ND	**0.0110 J**	ND	ND	**0.0370 J**	**0.0133 J**	ND
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																			
cPAH TEQ	0.0076	--	**0.0072**	**0.0012**	ND	ND	**0.0053**	**0.0093**	**0.0140**	**0.0001**	**0.0000**	**0.0031**	**0.0000**	**0.0058**	**0.0056**	**0.0000**	**0.0279**	**0.0168**	**0.0322**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																			
Total PCBs	0.020	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0750**	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																			
Gasoline-Range Organics	30 (d)	--	8.8 U	6.1 U	6.9 U	**9.7**	6.0 U	13 U	7.4 U	6.1 U	10 U	6.1 U	7.2 U	11 U	7.0 U	7.4 U	7.8 U	6.6 U	**150**
Diesel-Range Organics	2,000	--	**13**	**5.9**	5.3 U	5.4 U	**22**	**15**	**15**	**6.0**	6.6 U	**8.1**	**4.4 J**	**51**	**27**	**7.2**	**38**	**42**	**29**
Oil-Range Organics		--	**34**	**27**	11 U	11 U	**230**	**40**	**150**	**42**	13 U	**80**	**9.7 J**	**130**	**110**	**18**	**60**	**92**	**95**
Combined DRO/ORO	2,000	--	**47**	**33**	ND	ND	**252**	**55**	**165**	**48**	ND	**88**	**14 J**	**181**	**137**	**25**	**98**	**134**	**124**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																			
Antimony	4.1	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Arsenic	7	10 U	**5.5**	**3.1**	**1.7**	**2.5**	**4.6**	**11.4**	**2.8**	**3.4**	**5.5**	**2.9**	**3.2**	**11.2**	**2.9**	**3.2**	**6.5**	**3.2**	**2.7**
Barium	160	--	**51.7**	**3.2**	**28.2**	**57.6**	**51.5**	**81.6**	**48.6**	**44.0**	**81.8**	**43.2**	**46.8**	**85.0**	**47.2**	**39.6**	**50.1**	**58.3**	**48.6**
Beryllium	3.5	--	**0.3**	0.2 U	0.2 U	0.2 U	0.2 U	**0.5**	0.2 U	0.2 U	**0.3**	0.2 U	0.2 U	**0.5**	0.2 U	0.2 U	**0.2**	0.2 U	0.2 U
Cadmium	0.77	0.6 U	**0.1**	0.1 U	0.1 U	0.1 U	0.1 U	**0.9**	0.1 U	**0.1**	**0.1**	0.1 U	0.1 U	**0.8**	0.1 U	**0.1**	**0.2**	0.1 U	0.1 U
Chromium, Total	48	**17**	**15.1**	**9.3**	**8.8**	**22.3**	**12.0**	**24.6**	**12.2**	**11.3**	**18.7**	**18.8**	**13.0**	**30**	**13.6**	**10.8**	**14**	**13.5**	**10.5**
Chromium VI	0.96	--	0.510 UJ	0.434 U	0.417 U	0.423 U	0.449 U	0.645 U	0.429 U	0.410 U	0.530 U	0.436 U	0.466 U	0.628 U	0.449 U	0.416 U	0.472 U	0.445 U	0.422 U
Copper	36	**97.1**	**34.2**	**15.7**	**12.5**	**15.7**	**16.4**	**42.5**	**21.1**	**14.9**	**28.3**	**18.1**	**19.6**	**43.0**	**17.7**	**12.6**	**38.2**	**20**	**22.6**
Lead	81	6 U	**7.9**	**4.7**	**1.5**	**5.8**	**3.8**	**15.3**	**6.7**	**3.5**	**5.0**	**4.0**	**5.6**	**16.7**	**5.9**	**4.2**	**12.6**	**5.8**	**5.6**
Mercury	0.07	0.06 U	**0.04**	**0.03**	0.02 U	0.02 U	**0.05**	**0.16**	**0.02**	**0.02**	**0.08**	**0.02**	**0.03**	**0.25**	**0.02**	**0.02**	**0.06**	**0.03**	0.02 U
Nickel	48	--	**14.8**	**9.6**	**8.1**	**39.5**	**13.7**	**23.1**	**13.7**	**14.6**	**19.3**	**29.2**	**14.2**	**22.5**	**17.5**	**11.0**	**14.2**	**17.1**	**11.4**
Selenium	3	--	0.6 U	0.5 U	0.5 U	0.5 U	0.5 U	0.8 U	0.5 U	0.5 U	0.6 U	0.5 U	0.5 U	0.7 U	0.5 U	0.5 U	0.6 U	0.5 U	0.5 U
Thallium	2	--	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	85	**--**	**55**	**33**	**22**	**35**	**38**	**94**	**36**	**40**	**69**	**34**	**41**	**97**	**33**	**35**	**49**	**36**	**33**

Table 2-3c
Soil Data and pCUL Exceedances: South of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

		Sample Area, Sample ID, Lab Sample ID, Sample Date																		
		Former Washdown/Aqueous Degreaser Area					Former Washdown System Collection Tanks/Loading Dock Area													
Analyte	Revised Soil Proposed Cleanup Level	IT-Bldg1401-Footing Exc5-B(6.0) TB91A 06/23/2011	IT-Bldg1401-Footing Exc8-B(2.5) TB68C 06/22/2011	IT-Bldg1401-Footing Exc10-B(1.5) TC19A 06/24/2011	IT-Bldg1401-Footing Exc14-B(4.0) TB68D 06/22/2011	IT-Bldg1401-Footing Exc15-B(4.0) TB68A 06/22/2011	234 (2.5) 1/22/1988	234 (7.5) 1/22/1988	234 (12.5) 1/22/1988	234 (17.5) 1/22/1988	TDP14 (4) NY07K 11/4/2008	TDP15 (4) NY07L 11/4/2008	TDP16 (3) NY44A 11/5/2008	TDP17 (4) NY44B 11/5/2008	TDP18 (4) NY44C 11/5/2008	TDP19 (4) NY44D 11/5/2008	IT-TOWPATH EXC2-B(.7) TE72A 07/19/2011	IT-TOWPATH EXC3-B(.7) TE72B 07/19/2011	IT-TOWPATH EXC4-B(.7) TE72C 07/19/2011
Volatiles (mg/kg; SW-846 8260C)																				
1,1-Dichloroethene	1.4	0.0014 U	0.0010 U	0.0012 U	0.0013 U	0.0012 U	--	--	--	--	0.0011 U	0.0008 U	0.0012 U	0.0010 U	0.0011 U	0.0010 U	0.0010 U	0.0010 U	0.0011 U
Acrylonitrile	240	0.0072 U	0.0051 U	0.0060 U	0.0063 U	0.0059 U	--	--	--	--	--	--	--	--	--	--	0.0048 U	0.0052 U	0.0055 U
Trichloroethene	0.002/0.004 (c)	0.0014 U	0.0010 U	0.0012 U	**0.0930**	**0.0240**	--	--	--	--	0.0011 U	0.0008 U	0.0012 U	0.0010 U	0.0011 U	0.0010 U	0.0010 U	0.0010 U	0.0011 U
Vinyl Chloride	0.002	0.0014 U	0.0010 U	0.0012 U	0.0013 U	0.0012 U	--	--	--	--	0.0011 U	0.0008 U	0.0012 U	0.0010 U	0.0011 U	0.0010 U	0.0010 U	0.0010 U	0.0011 U
Semivolatiles (mg/kg; SW-846 8270D)																				
bis(2-Ethylhexyl)phthalate	0.12	0.0240 U	0.0240 U	0.0240 U	0.0240 U	0.0240 U	--	--	--	--	--	--	0.0620 U	--	0.0620 U	--	**0.0160 J**	**0.1700**	**0.0340**
cPAH TEQ	0.0076	ND	ND	ND	ND	ND	--	--	--	--	--	--	ND	--	**0.0009**	--	ND	**0.0450 J**	**0.0649**
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																				
cPAH TEQ	0.0076	**0.0003**	**0.0000**	**0.0012**	**0.0021**	**0.0116**	--	--	--	--	--	--	--	--	--	--	ND	**0.0515**	**0.1364**
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																				
Total PCBs	0.020	ND	ND	ND	ND	ND	--	--	--	--	--	--	ND	--	ND	--	ND	**0.0280 J**	**0.0880**
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																				
Gasoline-Range Organics	30 (d)	7.3 U	5.7 U	5.5 U	7.0 U	6.1 U	--	--	--	--	--	--	--	--	--	--	5.5 U	6.1 U	5.6 U
Diesel-Range Organics	2,000	**5.6**	**6.0**	5.3 U	**10**	**6.9**	--	--	--	--	--	--	--	--	--	**23**	5.5 U	**24**	**53**
Oil-Range Organics		10 U	10 U	11 U	11 U	**12**	--	--	--	--	--	--	--	--	--	**110**	11 U	**150**	**300**
Combined DRO/ORO	2,000	**5.6**	**6.0**	ND	**10**	**19**	--	--	--	--	--	--	--	--	--	**133**	ND	**174**	**353**
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																				
Antimony	4.1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U
Arsenic	7	**2.5**	**1.7**	**1.6**	**3.2**	**2.8**	**5**	**2**	**3**	**2**	**17**	**9**	**7**	**7**	**12**	6 U	**2.2**	**5.8**	**5.7**
Barium	160	**34.7**	**42.0**	**38.0**	**35.7**	**33.0**	--	--	--	--	--	--	--	--	--	--	**33.3**	**52.0**	**55.0**
Beryllium	3.5	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--	0.2 U	**0.2**	**0.2**
Cadmium	0.77	**0.2**	0.1 U	0.1 U	0.1 U	0.1 U	--	--	--	--	**0.6**	0.2 U	0.3 U	0.3 U	**0.6**	0.3 U	0.1 U	**0.1**	**0.2**
Chromium, Total	48	**9.8**	**23.5**	**22**	**10.0**	**10.9**	**16**	**13**	**14**	**13**	**24.6**	**17.3**	**18.1**	**21.3**	**26.1**	**12.9**	**11.2**	**16.0**	**17.9**
Chromium VI	0.96	0.413 U	0.425 U	0.429 U	0.434 U	0.449 UJ	--	--	--	--	--	--	--	--	--	--	0.445 U	0.441 U	0.428 U
Copper	36	**10.3**	**12.9**	**14.4**	**13.3**	**13.7**	**20**	**13**	**11**	**13**	**36.6**	**25.7**	**28.8**	**34.3**	--	**16.4**	**13.9**	**22.8**	**24.6**
Lead	81	**2.8**	**2.2**	**2.0**	**3.2**	**3.8**	**13**	**4**	**7**	**9**	**18**	**3**	**4**	**5**	**28**	**30**	**2.1**	**9.8**	**12.8**
Mercury	0.07	0.02 U	0.03 U	0.02 U	0.03 U	0.02 U	--	--	--	--	**0.13**	0.06 U	**0.05**	**0.11**	**0.23**	**0.07**	0.02 U	**0.03**	**0.04**
Nickel	48	**10.4**	**40.4**	**39.7**	**10.0**	**9.0**	**20**	**9**	**12**	**12**	--	--	--	--	--	--	**13**	**24.2**	**27.5**
Selenium	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	--	--	--	--	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U
Thallium	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--	--	--	--	0.2 U	0.2 U	0.2 U
Zinc	85	**32**	**31**	**29**	**25**	**28**	**43.2**	**60.6**	**26.8**	**25.8**	**--**	**--**	**--**	**--**	**--**	**--**	**25**	**48**	**55**

Table 2-3c
Soil Data and pCUL Exceedances: South of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Analyte	Revised Soil Proposed Cleanup Level	Sample Area, Sample ID, Lab Sample ID, Sample Date																	
		Former Washdown System Collection Tanks/Loading Dock Area							Vicinity of I-206(s)					Other West of Building					
		IT-TOWPATH EXC5-B(.7) TE72D 07/19/2011	IT-TOWPATH EXC6-B(.7) TE72E 07/19/2011	IT-TOWPATH EXC7-B(.7) TE72F 07/19/2011	IT-MW-8 (2-3.5) TV99A 11/07/2011	IT-MW-8 (5-6.5) TV99B 11/07/2011	IT-MW-8 (8-9.5) TV99C 11/07/2011	IT-MW-8 (14-15.5) TV99F 11/07/2011	IT-TP-101-B (12-13) TT59A 10/24/2011	IT-TP-102-B (13-14) TT67B 10/25/2011	IT-TP-103-SWE (5-6) TT67C 10/25/2011	IT-TP-103-SWE (6-7) TT67D 10/25/2011	IT-TP-103-SWE (12-13) TT67E 10/25/2011	21 (1.5) 8/1/1983	21 (8.5) 8/1/1983	240 (2.5) 1/22/1988	240 (7.5) 1/22/1988	240 (12.5) 1/22/1988	240 (17.5) 1/22/1988
Volatiles (mg/kg; SW-846 8260C)																			
1,1-Dichloroethene	1.4	0.0009 U	0.0011 U	0.0010 U	0.0012 U	0.0014 U	0.0014 U	0.0014 U	0.0013 UJ	0.0013 U	0.0013 U	0.0014 U	0.0013 U	--	--	--	--	--	--
Acrylonitrile	240	0.0047 U	0.0056 U	0.0050 U	0.0061 U	0.0069 U	0.0068 U	0.0068 U	0.0066 U	0.0067 U	0.0065 U	0.0069 U	0.0066 U	--	--	--	--	--	--
Trichloroethene	0.002/0.004 (c)	0.0009 U	0.0011 U	0.0010 U	0.0012 U	0.0014 U	0.0014 U	0.0014 U	0.0013 UJ	0.0013 U	0.0013 U	0.0014 U	0.0013 U	--	--	--	--	--	--
Vinyl Chloride	0.002	0.0009 U	0.0011 U	0.0010 U	0.0012 U	0.0014 U	0.0014 U	0.0014 U	0.0013 U	0.0013 U	0.0013 U	0.0014 U	0.0013 U	--	--	--	--	--	--
Semivolatiles (mg/kg; SW-846 8270D)																			
bis(2-Ethylhexyl)phthalate	0.12	**0.0210 J**	**0.0450**	**0.0150 J**	0.0310 U	0.1400 U	0.0740 U	0.0220 UJ2	0.0240 U	0.0240 U	0.0230 U	0.0300 U	0.0350 U	--	--	--	--	--	--
cPAH TEQ	0.0076	**0.0251 J**	**0.1280**	**0.0112 J**	ND	**0.0014 J**	ND	ND	ND	ND	**0.0820 J**	**0.0343**	ND	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (mg/kg; SW-846 8270D-SIM)																			
cPAH TEQ	0.0076	**0.2110**	**0.1260**	**0.0099**	**0.0051 J**	**0.0045 J**	ND	ND	ND	ND	**0.0620**	**0.0520**	ND	--	--	--	--	--	--
Polychlorinated Biphenyls (mg/kg; SW-846 8082)																			
Total PCBs	0.020	ND	**0.0530**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1000 U	--	--	--	--	--
Total Petroleum Hydrocarbons (mg/kg; NWTPH-Dx/-Gx)																			
Gasoline-Range Organics	30 (d)	6.2 U	8.8 U	5.7 U	**24**	**6.9**	6.3 U	8.3 U	8.3 U	8.8 U	8.1 U	5.1 U	8.9 U	--	--	--	--	--	--
Diesel-Range Organics	2,000	**19**	**85**	**7.9**	5.2 U	5.4 U	5.7 U	6.0 U	6.5 U	6.8 U	**11**	**15**	6.8 U	--	--	--	--	--	--
Oil-Range Organics		**89**	**510**	**15**	**13**	**13**	11 U	12 U	13 U	14 U	**58**	**57**	14 U	--	--	--	--	--	--
Combined DRO/ORO	2,000	**108**	**595**	**23**	**13**	**13**	ND	ND	ND	ND	**69**	**72**	ND	--	--	--	--	--	--
Total Metals (mg/kg; EPA 200.8/SW-846 7471A/SW-846 7196A)																			
Antimony	4.1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.3 UJ	0.3 U	0.2 U	0.2 U	0.3 U	--	--	--	--	--	--
Arsenic	7	**3.9**	**6.1**	**3.8**	**3.2**	**3.8**	**2.9**	**2.0**	**2.4**	**1.2**	**7.1**	**5.1**	**1.5**	**6**	**5.2**	**4**	**4**	**3**	**2**
Barium	160	**62.0**	**63.7**	**45.2**	**26.8**	**45.8**	**41.4**	**36.6**	**37.4**	**31**	**202**	**158**	**27.0**	**31**	**18**	--	--	--	--
Beryllium	3.5	0.2 U	**0.2**	**0.3**	0.2 U	0.2 U	0.2 U	0.3 U	0.3 U	0.3 U	0.2 U	**0.3**	0.3 U	--	--	--	--	--	--
Cadmium	0.77	**0.2**	**0.2**	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	**0.4**	**0.2**	0.1 U	**0.41**	**0.3**	--	--	--	--
Chromium, Total	48	**21.4**	**16.4**	**13.4**	**8.9**	**12.5**	**11.8**	**13.9**	**12.0**	**11.7**	**14.3**	**13.3**	**9.4**	**8.2**	**8.5**	**17**	**14**	**16**	**15**
Chromium VI	0.96	0.450 U	0.436 U	0.456 U	0.419 U	0.438 U	0.467 U	0.524 U	0.550 U	0.540 U	0.480 U	0.473 U	0.531 U	--	--	--	--	--	--
Copper	36	**18.5**	**24.6**	**18.4**	**14.8**	**22.1**	**17.4**	**14.9**	**18.9**	**14.1**	**48.4**	**62.8**	**16.8**	--	--	**22**	**19**	**18**	**15**
Lead	81	**7.6**	**12.2**	**5.8**	**3.5**	**4.4**	**2.3**	**1.8**	**2.3**	**1.7**	**90.5**	**49.9**	**1.7**	**5.5**	**4**	**13**	**7**	**10**	**9**
Mercury	0.07	**0.03**	**0.03**	**0.04**	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.03 U	**0.05**	**0.10**	0.03 U	0.03 U	0.03 U	--	--	--	--
Nickel	48	**23.0**	**22.4**	**16.5**	**9.0**	**11.6**	**10.3**	**8.6**	**9.0**	**7.9**	**15.2**	**15.1**	**6.0**	**9.3**	**7**	**16**	**11**	**13**	**13**
Selenium	3	0.5 U	0.5 U	0.6 U	0.5 U	0.5 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.2 U	0.2 U	--	--	--	--
Thallium	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.3 U	0.3 U	0.2 U	0.2 U	0.3 U	--	--	--	--	--	--
Zinc	85	**44**	**58**	**32**	**26**	**36**	**70**	**27**	**25**	**25**	**150**	**99**	**22**	**18**	**12.5**	**36.6**	**29.6**	**33**	**29**

Table 2-3c
Soil Data and pCUL Exceedances: South of Former Slip 5 Area
Boeing Isaacson-Thompson
Feasibility Study

Notes:

U = Indicates the compound was not detected at or above the reporting limit.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J1 = Laboratory flag indicating the analyte was positively identified; the associated concentration is approximate and less than the reporting limit, but equal to or greater than the detection limit.
UJ2 = The analyte was not detected in the sample at or above the numerical value shown; the numerical value is below the reporting limit, but greater than the detection limit.
(a) The area limits for internal standards perylene-dl2 and di-n-octylphthalate were above the control limits for the original SVOC analysis of sample IT-Bldg1401-Trench-4S-110512. The sample was reanalyzed at a dilution with all internal standards in control. The original analysis results are reported.
(b) The area limit for laboratory internal standard perylene-dl2 was above the control limit for the original SVOC analysis of sample ITBldg1401-Trench5N-110513. The sample was reanalyzed at a dilution with all internal standards in control. The original analysis results are reported.
(c) Cleanup levels for saturated zone soil (>11 feet below ground surface) and vadose zone soil (<11 feet below ground surface), respectively.
(d) Assumes benzene is detected in sample (lower value of 100/30 mg/kg selected).
Bold = Detection **Green Shading** = Reported concentration is greater than the proposed cleanup level.

Abbreviations and Acronyms:

-- = not analyzed
µg/kg = micrograms per kilogram
cPAH = carcinogenic polycyclic aromatic hydrocarbon
DRO = diesel-range organics
EPA = US Environmental Protection Agency
ID = identification
Lab = laboratory
mg/kg = milligrams per kilogram
ND = not detected
NWTPH = Northwest Total Petroleum Hydrocarbon
ORO = oil-range organics
PCB = polychlorinated biphenyl
SIM = select ion monitoring
TEQ = toxicity equivalency quotient

Table 2-4a
Groundwater COC Elimination Criteria
Boeing Isaacson-Thompson
Feasibility Study

GROUNDWATER	Revised Groundwater pCUL (µg/L)	Sample Statistics							Elimination Criteria					Retained as COC?
		Sample Count	ND Count	Detect Count	Detect > pCUL Count	Percent of Sample Exceedances (%)	Maximum Detection (µg/L)	Sample Name of Maximum Detection	Not Detected	Maximum Detection < pCUL	Maximum Detection < 2X pCUL?	Percent of Exceedances < 10 %	Other	
VOLATILES (8260C)														
Acrylonitrile	0.6	160	160	0	0	0%	--	--	X					
Trichloroethene	0.7	160	142	18	12	8%	150	IT-MW-6-120913					X - 8801 Site (a)	
1,1-Dichloroethene	4,000	160	150	10	0	0%	4.3	IT-MW-6-120621		X				
Vinyl Chloride	0.18	160	127	33	30	19%	130	IT-DUP-2-120621 (Dup of IT-MW-6)						X
VOLATILES (8260C-SIM)														
Acrylonitrile		40	37	3	0	0%	0.16	IT-MW-6-120621		X				
Vinyl Chloride		160	95	65	33	21%	140	IT-MW-6-111207						X
SEMIVOLATILES														
Bis(2-ethylhexyl)phthalate	5	160	156	4	0	0%	3.7	IT-MW-17-111212		X				
Total cPAH TEQ	0.048	160	136	24	1	1%	0.152	IT-Seep-1-120925				X	X - Single sample exceedance at seep	
PCBs														
Total PCBs	0.01	160	140	20	13	8%	0.024	IT-I-203-120615 IT-MW-25-120613						X
TOTAL PETROLEUM HYDROCARBONS														
Diesel-Range Organics	500	160	153	7	1	1%	510	IT-MW-24-120618			X	X		
Oil-Range Organics		160	156	4										
Gasoline-Range Organics	1,000	160	158	2	0	0%	83	IT-MW-2-120621		X				
METALS, Dissolved														
Antimony	90	160	124	36	0	0%	55.2	IT-MW-24-120307		X				
Arsenic	8	160	8	152	84	53%	285,000	IT-MW-24-120911						X
Barium	200	160	0	160	1	1%	249	IT-PZ-7-120912			X	X		
Beryllium	4.4	160	125	35	0	0%	1.6	IT-MW-24-111208		X				
Cadmium	1.2	160	141	19	0	0%	0.8	IT-MW-23-111212 IT-MW-24-111208		X				
Chromium III or total	27	160	51	109	4	3%	39.9	IT-MW-23-120314			X	X		
Copper	3.1	160	66	94	25	16%	2,050	IT-MW-23-111212						X
Lead	8.1	160	127	33	0	0%	5.5	IT-MW-24-120312		X				
Mercury	0.025	160	75	85	4	3%	0.274	IT-MW-25-120307						X
Nickel	8.2	160	22	138	14	9%	297	IT-MW-23-111212						X
Selenium	71	160	101	59	0	0%	13.4	IT-MW-24-111208		X				
Thallium	0.2	160	157	3	2	1%	0.5	IT-MW-23-111212				X	X - Only two sample exceedances	
Zinc	81	160	72	88	8	5%	477	IT-PZ-1-120307						X
METALS, Total														
Chromium VI	50	160	153	7	0	0%	37	IT-MW-23-111212		X				

Abbreviations and Acronyms:

µg/L = micrograms per liter	ND = non-detect
% = percent	PCB = polychlorinated biphenyl
COC = contaminant of concern	pCUL = proposed cleanup level
cPAH = carcinogenic polycyclic aromatic hydrocarbon	TEQ = total equivalency quotient

Notes:

(a) Trichloroethene was eliminated as a COC because the only pCUL exceedances occurred at MW-6 and MW-7, which are located within the 8801 VOC plume footprint and are not a result of I-T operations.

Table 2-4b
Soil COC Elimination Criteria
Boeing Isaacson-Thompson
Feasibility Study

		Sample Statistics							Elimination Criteria					
SOIL	Revised Soil pCUL (mg/kg)	Sample Count	ND Count	Detect Count	Detect > pCUL Count	Percent of Sample Exceedances (%)	Maximum Detection (mg/kg)	Sample Name of Maximum Detection	Not Detected	Maximum Detection < pCUL	Maximum Detection < 2X pCUL?	Percent of Exceedances < 10 %	Other	Retained as COC?
VOLATILES														
Trichloroethene	0.002/0.004 (a)	288	232	56	20	6.9%	0.27	IT-MW-6 (8-9.5) - 111102				X	X - 8801 Source (b)	
1,1-Dichloroethene	1.4	288	288	0	0	0	--	--	X					
Vinyl Chloride	0.002	283	280	3	2	0.7%	0.007	IT-MW-6(20-21.5)-111102					X - 8801 Source (b)	
SEMIVOLATILES														
Bis(2-ethylhexyl)phthalate	0.12	238	175	63	6	3%	0.63	IT-MW-13B(6.5-8)-111111				X		X
Total cPAH TEQ	0.0076	452	161	291	205	45.4%	8.4	IT-SB-5(8-9.5)-111031						X
PCBs														
Total PCBs	0.020	276	228	48	45	16%	12	IT-MW-13B(6.5-8)-111111						X
TOTAL PETROLEUM HYDROCARBONS														
Diesel-Range Organics	2,000	230	89	141	5	2.2%	32,400	IMR-1 (in observed tar-like area)						X
Oil-Range Organics		230	79	151										
Gasoline-Range Organics	30	216	186	30	6	2.8%	150	IT-Bldg1401-FootingExc5-SW(4.0)-110623						X
METALS														
Antimony	4.1	215	203	12	0	0%	3.9	IT-MW-17(11-12.5)-111110		X				
Arsenic	7	427	33	394	199	76%	2,440	IMR-6-081017						X
Barium	160	267	0	267	14	5%	650	5(2.5)-830801			X			X
Beryllium	3.5	215	145	70	0	0%	0.80	IT-SB-12 (5-6.5)-111114		X				
Cadmium	0.77	358	151	207	76	21%	28	IT-MW-17 (11-12.5)-111110						X
Chromium (III or total)	48	418	0	418	84	20%	4,180	236 (13.5)-880120						X
Chromium (VI)	0.96	215	201	14	3	1%	8.3	IT-MW-17 (15.5-17)-110110				X		X
Copper	36	366	0	366	144	39%	1,500	224 (12.5-13)-880120						X
Lead	81	418	30	388	95	23%	4,200	PBI-10 (8)-090727						X
Mercury	0.07	357	135	222	104	29%	4.3	B-20 (14)-1983						X
Nickel	48	304	0	304	43	14%	4,940	IT-SB-3 (6.5-7)111114						X
Selenium	3	259	246	13	0	0%	1.0	17 (6.5)-930801		X				
Thallium	2	215	211	4	0	0%	1.1	IT-MW-17 (15.5-17)-110110		X				
Zinc	85	373	0	373	145	39%	9,040	IT-MW-17 (14-15.5)-111110						X

Abbreviations and Acronyms:

% = percent
COC = contaminant of concern
cPAH = carcinogenic polycyclic aromatic hydrocarbon
GW = groundwater
mg/kg = milligrams per kilogram
ND = non-detect
PCB = polychlorinated biphenyl
pCUL = proposed cleanup level
TCE = trichloroethene
TEQ = total equivalency quotient

Notes:

(a) Cleanup levels for saturated zone soil (>11 feet below ground surface) and vadose zone soil (<11 feet below ground surface), respectively.

(b) TCE and vinyl chloride are eliminated as COCs because there are no statistical significant pCUL exceedances, except at MW-6 and nearby sampling location on the southern property boundary which are part of the 8801 volatile organic compound plume and due to migration from off-site sources.

Table 2-5
Total Non-Carcinogenic Site Risk: Groundwater
Boeing Isaacson-Thompson
Feasibility Study

				Toxic Effects									
Analyte (a)	Cleanup Level	Constituent Concentration in Groundwater at HQ = 1 (b)	HQ at Cleanup Level (c)	Hepatotoxicity (Liver target organ): HQ Risk at CUL	Hematological Toxicity: HQ Risk at CUL	Dermal Toxicity: HQ Risk at CUL	Cardiovascular Toxicity: HQ Risk at CUL	Neurotoxicity: HQ Risk at CUL	Developmental Toxicity: HQ Risk at CUL	Gastrointestinal Toxicity: HQ Risk at CUL	Nervous System Toxicity: HQ Risk at CUL	Immunotoxicity: HQ Risk at CUL	Weight: HQ Risk at CUL
VOLATILES (µg/L)													
Vinyl Chloride	0.18	24	7.50E-03	7.50E-03									
PCBs (µg/L)													
Total PCBs (d)	0.01	0.1	1.00E-01			1.00E-01			1.00E-01			1.00E-01	
DISSOLVED METALS (µg/L)													
Arsenic	8	4.8	1.67E+00			--	--						
Copper	3.1	640	4.84E-03							4.84E-03			
Mercury (d)	0.025	2	1.25E-02					1.25E-02	1.25E-02		1.25E-02		
Nickel	8.2	320	2.56E-02										2.56E-02
Zinc	81	4,800	1.69E-02		1.69E-02							1.69E-02	
Total HI at Groundwater CUL				**7.50E-03**	**1.69E-02**	**1.00E-01**	**--**	**1.25E-02**	**1.25E-02**	**4.84E-03**	**1.25E-02**	**1.69E-02**	**2.56E-02**

Abbreviations and Acronyms:
µg/L = micrograms per liter
cPAH = carcinogenic polycyclic aromatic hydrocarbon
CUL = cleanup level
HI = hazard index
HQ = hazard quotient
PQL = practical quantitation limit
TEQ = total equivalency quotient

Notes:
(a) Non-carcinogenic analyte detected in groundwater.
(b) Constituent concentration in groundwater at HQ = 1 is equal to the standard Non-Cancer Method B groundwater cleanup level.
(c) HQ at Cleanup Level = groundwater cleanup level divided by the constituent concentration in groundwater at HQ = 1.
(d) No toxicity data available; Method A Unrestricted Groundwater Cleanup Level used.

Gray shaded cell = Cleanup level cannot be adjusted downward because already been adjusted up to PQL or natural background (not included in total site risk where HI > 1)

Acrylonitrile, chromium III, chromium VI, thallium, and total petroleum hydrocarbons have been left off from this table, because there are not enough reliable studies to determine non-cancer toxic effects via oral ingestion.

Table 2-6
Total Non-Carcinogenic Site Risk: Soil
Boeing Isaacson-Thompson
Feasibility Study

				Toxic Effects										
Analyte (a)	Cleanup Level	Constituent Concentration in Soil at HQ = 1 (b)	HQ at Adjusted Cleanup Level (c)	Hepatotoxicity (Liver target organ): HQ Risk at CUL	Hematological Toxicity: HQ Risk at CUL	Dermal Toxicity: HQ Risk at CUL	Cardiovascular Toxicity: HQ Risk at CUL	Neurotoxicity: HQ Risk at CUL	Developmental Toxicity: HQ Risk at CUL	Gastrointestinal Toxicity: HQ Risk at CUL	Nervous System Toxicity: HQ Risk at CUL	Immunotoxicity: HQ Risk at CUL	Reproductive Toxicity: HQ Risk at CUL	Weight: HQ Risk at CUL
VOCs (mg/kg)														
bis(2-ethylhexyl) phthalate	0.12	1,600	7.50E-05	7.50E-05										
PCBs (mg/kg)														
Total PCBs (d)	0.02	1	2.00E-02			2.00E-02			2.00E-02			2.00E-02		
PAHs (mg/kg)														
Total cPAH TEQ (f)	0.0076	24	3.17E-04						3.17E-04			3.17E-04	3.17E-04	
TOTAL METALS (mg/kg)														
Arsenic	7	24	2.92E-01			2.92E-01	2.92E-01							
Barium	160	16,000	1.00E-02											
Cadmium	0.77	80	9.63E-03											
Copper	36	3,200	1.13E-02							1.13E-02				
Lead (d)	81	250	3.24E-01					3.24E-01						
Mercury (d)	0.07	2	3.50E-02					3.50E-02	3.50E-02		3.50E-02			
Nickel	48	1,600	3.00E-02											3.00E-02
Zinc	85	24,000	3.54E-03		3.54E-03							3.54E-03		
Total HI at Soil CUL (e)				**7.50E-05**	**3.54E-03**	**3.12E-01**	**2.92E-01**	**3.59E-01**	**5.53E-02**	**1.13E-02**	**3.50E-02**	**2.39E-02**	**3.17E-04**	**3.00E-02**
TOTAL SITE RISK SUMMARY FOR SOIL AND GROUNDWATER														
Total HI at Soil CUL				0.00	0.00	0.31	0.29	0.36	0.06	0.01	0.04	0.02	0.000	0.03
Total HI at Groundwater CUL (g)				0.01	0.02	0.10	--	0.01	0.01	0.00	0.01	0.02	0.00	0.03
Total HI for Soil and Groundwater				**0.01**	**0.02**	**0.41**	**0.29**	**0.37**	**0.07**	**0.02**	**0.05**	**0.04**	**0.000**	**0.06**

Abbreviations and Acronyms:

cPAH = carcinogenic polycyclic aromatic hydrocarbon
CUL = cleanup level
HI = hazard index
HQ = hazard quotient
mg/kg = milligrams per kilogram
PQL = practical quantitation limit
TEQ = total equivalency quotient

Notes:

(a) Non-carcinogenic analyte detected in soil.
(b) Constituent concentration in soil at HQ = 1 is equal to standard Non-Cancer Method B soil cleanup level.
(c) HQ at Cleanup Level = soil cleanup level divided by the constituent concentration in soil at HQ = 1.
(d) No toxicity data available in CLARC; Method A Unrestricted Soil Cleanup Level was used.
(e) Chromium III, chromium VI, and total petroleum hydrocarbons have been left off from this table, because there are not enough reliable studies to determine non-cancer toxic effects via oral ingestion.
(f) MTCA Method B non cancer value for benzo(a)pyrene used for HQ = 1.
(g) Total HI for Groundwater CULs calculated in Table 2-5.

Gray shaded cell = Cleanup level cannot be adjusted downward because already been adjusted up to PQL or natural background.

Table 2-7
Total Carcinogenic Site Risk: Soil and Groundwater
Boeing Isaacson-Thompson
Feasibility Study

Media	Analyte (a)	Unadjusted Cleanup Level (b)	Adjusted Cleanup Level (b)	Concentration at Carcinogenic Risk = 1x10^{-6} (b)(c)	Carcinogenic Risk at Adjusted Cleanup Level (d)
SOIL	cPAHs (TEQ)	0.0076	0.0076	0.59	--
	Arsenic	7	7	0.67	--
	BEHP	0.12	0.12	71	--
	PCBs	0.02	0.02	0.5	--
GROUNDWATER	Vinyl Chloride	0.18	0.18	0.029	6.2E-06
	Arsenic	8	8	0.058	--
	PCBs	0.01	0.01	0.022	--
				TOTAL SITE RISK	**6.21E-06**

Abbreviations and Acronyms:

µg/L = micrograms per liter
BEHP = bis(2-ethylhexyl)phthalate
cPAH = carcinogenic polycyclic aromatic hydrocarbon
mg/kg = milligrams per kilogram
PCB = polychlorinated biphenyl
PQL = practical quantitation limit
TEQ = toxicity equivalency quotient

Notes:

(a) Carcinogenic analyte detected in soil or groundwater.
(b) Units for soil analytes are mg/kg ; units for groundwater analytes are µg/L.
(c) Concentration at carcinogenic risk = 1E-06 is equal to the direct contact cleanup level for a carcinogen.
(d) Carcinogenic risk at cleanup level = Cleanup level divided by the concentration at which the risk is 1E-06 x 1E-06.

Gray shade = Cleanup level cannot be adjusted downward because set at PQL or natural background (not included in total risk).

Table 3-1
Summary of Soil Analytical Results for Detected Constituents
Boeing Thompson Property Wooden Bulkhead
Boeing Isaacson-Thompson
Feasibility Study

	Screening Levels Protect LDW Sediment via Erosion (Ecology 2021/2022)	IT-WB-1 UM06A 03/12/2012	IT-WB-2 UM06B 03/12/2012	IT-WB-3 UM06C 03/12/2012
SEMIVOLATILES (mg/kg)				
Method SW8270D				
bis(2-Ethylhexyl)phthalate	1.3	**0.021** J1	0.024 U	**0.016** J1
PAHs (mg/kg)				
Method SW8270D-SIM				
Total cPAH TEQ	0.59	**0.057**	**0.0224** J	**0.032**
TOTAL PETROLEUM HYDROCARBONS (mg/kg)				
NWTPH-Dx				
Diesel-Range Organics	NA	**160**	6.2 U	7.3 U
Motor Oil-Range Organics	NA	**1,400**	**15**	**15**
NWTPH-G				
Gasoline-Range Organics	NA	5.2 U	5.3 U	7.2 U
TOTAL METALS (mg/kg)				
Methods 200.8/7471A/SW7196A				
Antimony	97	0.3 UJ	0.3 U	0.3 U
Arsenic	7	**5.6**	**5.5**	**7.6**
Barium	49,000	**31.1**	**33.1**	**40.7**
Beryllium	490	0.3 U	0.3 U	**0.3**
Cadmium	5.1	0.1 U	0.1 U	0.1 U
Chromium	260	**19**	**24.2**	**17.4**
Chromium VI	1.1	0.508 U	0.512 U	0.566 U
Copper	390	**26.7**	**25.2**	**19.8**
Lead	450	**32.3**	**82.7**	**11.6**
Mercury	0.41	**0.04**	**0.03**	**0.06**
Nickel	4,900	**21.7**	**19.1**	**14.7**
Selenium	1,200	0.6 U	0.6 U	0.7 U
Silver	6.1	0.3 U	0.3 U	0.3 U
Thallium	2.4	0.3 U	0.3 U	0.3 U
Zinc	410	**55**	**55**	**53**

Abbreviations and Acronyms:

cPAH = carcinogenic polycyclic aromatic hydrocarbon
mg/kg = milligrams per kilogram
NA = not applicable
SIM = selected ion monitoring
TEQ = total equivalency quotient
LDW = Lower Duwamish Waterway

Notes:

U = Indicates the compound was not detected at or above the reporting limit.
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J1 = Laboratory flag indicating the analyte was positively identified; the associated concentration is approximate and less than the reporting limit, but equal to or greater than the detection limit.
Bold = Detected compound.
Green Shading = Exceedance of cleanup level.

Reference Reports:

Ecology. 2021/2022. Lower Duwamish Waterway Preliminary Cleanup Level Workbook Supplemental Information/LDW PCUL Workbook. Washington State Department of Ecology. December 2021/February 2022.

Table 5-1
Remedial Action Alternatives
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5**
Alternative Name:	**Containment and Hydraulic Capture via Capping and Groundwater Extraction**	**Containment and Hydraulic Control via Capping and Vertical Barrier**	***In Situ* Groundwater Treatment, Shoreline Excavation, and Containment**	**Focused Excavation and Containment, and *In Situ* Groundwater Treatment**	**Site-Wide Excavation of Contaminated Soil**
Alternative Description:	Containment of soil and in-situ hydraulic capture including: • Excavation of contaminated soil to 15–18 feet below ground surface downgradient of groundwater conditional point of compliance (CPOC) where practicable including Port property). • Excavation of contaminated soil in Observed Tar-Like Area. • Backfill all excavation areas with clean fill. Replace wooden bulkhead on Port property with new steel bulkhead. • Containment of contaminated soil site-wide with low-permeability cap. • Hydraulic capture and containment of contaminated groundwater with extraction wells. • *Ex-situ* treatment of extracted groundwater. • Institutional controls. (1)	Containment of soil and in-situ hydraulic control via vertical barrier including: • Excavation of contaminated soil to 15–18 feet below ground surface downgradient of groundwater conditional point of compliance (CPOC) where practicable including Port property). • Excavation of contaminated soil in Observed Tar-Like Area. • Backfill all excavation areas with clean fill. Replace wooden bulkhead on Port property with new steel bulkhead. • Containment of contaminated soil site-wide with low-permeability cap. • Excavation of contaminated soil in Observed Tar-Like Area. • Hydraulic control of contaminated groundwater with vertical slurry wall containment cell and extraction wells to maintain upward gradient into containment cell. • *Ex-situ* treatment of extracted groundwater. • Institutional controls. (1)	Containment of soil and in-situ groundwater treatment including: • Excavation of contaminated soil to 15–18 feet below ground surface downgradient of groundwater conditional point of compliance (CPOC) where practicable including Port property). • Excavation of contaminated soil in Observed Tar-Like Area. • Backfill all excavation areas with clean fill. Replace wooden bulkhead on Port property with new steel bulkhead. • Contain remaining contaminated soil with low-permeability cap. • *In-situ* groundwater treatment along the CPOC with a permeable reactive barrier. • Institutional controls. (1)	Focused soil excavation, containment of soil, and in-situ groundwater treatment including: • Focused excavation of contaminated soil to 15 feet below ground surface in stabilized soil area (including Observed Tar-Like Area to 5 feet below ground surface) and downgradient of groundwater CPOC (including Port property) to 15 to 18 feet below ground surface. • Backfill all excavation areas with clean fill. Replace wooden bulkhead on Port property with new steel bulkhead. • Contain remaining contaminated soil in the Former Slip 5 and the area south of Former Slip 5 with low-permeability cap. • *In-situ* groundwater treatment along the CPOC (where remaining groundwater contamination is present) with a permeable reactive barrier. • Institutional controls. (1)	Excavation of contaminated soil above cleanup levels (excluding soil beneath buildings/critical infrastructure) including: • Excavation of stabilized soil mass and other adjacent contaminated soil (including Observed Tar-Like Area to 5 feet below ground surface) to approximately 15 feet below ground surface. • Excavation of fill material to approximately 25 feet below ground surface to the native marine silt layer in former Slip 5 Area, including Port property. • Excavation of contaminated shallow soil in southeast portion of Site to approximately 5 feet below ground surface. • Excavation of soil in southwest portion of Site to approximately 15 feet below ground surface. • Backfill all excavation areas with clean fill. Replace wooden bulkhead on Port property with new steel bulkhead.
Point of Compliance - Soil:	Standard; Site-Wide. Compliance will be addressed via containment (capping), partial excavation, and institutional controls.	Standard; Site-Wide. Compliance will be addressed via containment (capping), partial excavation, and institutional controls.	Standard; Site-Wide. Compliance will be addressed via containment (capping), partial excavation, and institutional controls.	Standard; Site-Wide. Compliance will be addressed via containment (capping), excavation of primary source area, and institutional controls.	Standard; Site-Wide. Compliance will be addressed via site-wide excavation.
Point of Compliance - Groundwater:	Conditional; Monitoring wells along western Site shoreline (between extraction wells and shoreline)	Conditional; Monitoring wells along western Site shoreline	Conditional; Monitoring wells along western Site shoreline	Conditional; Monitoring wells along western Site shoreline	Standard; Site-Wide

(1) Consists of an Environmental Covenant to limit activities that could result in exposure to soil and groundwater and that outlines the required maintenance for the cap. Also includes groundwater monitoring and contingency plan to address potential off-Site migration of contaminants.

Table 5-2a
Remedial Alternative 1 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 1: Containment and Hydraulic Capture via Capping and Groundwater Extraction
Assumptions: Install 9 extraction wells for hydraulic control at CPOC, install treatment system for extracted water, 3 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Work Plans/Design/Reporting/Other					
GET System Work plan	1	LS	$ 36,000	$ 36,000	
Institutional Controls/Restrictive Covenants	1	LS	$ 12,000	$ 12,000	Restrictive covenant on the property deed filed w/County
SMA/TMC Compliance Planning and Design	1	LS	$ 97,000	$ 97,000	Coordination and planning w/City of Tukwila and Ecology for remedial alternative design compliance w/SMA and TMC/Tukwila SMP, develop Landscaping/Vegetation Management Plan
Permitting	1	LS	$ 85,000	$ 85,000	Includes: UIC Permit, JARPA, HPA, Biological Assessment, Shoreline Permitting, and SEPA checklist
Access agreements	1	LS	$ 30,000	$ 30,000	If necessary for Port and Jorgensen properties
Bid Package/Procurement	1	LS	$ 18,000	$ 18,000	If needed by Boeing
Construction report	1	LS	$ 18,000	$ 18,000	Upon completion
Design Peer Review	0	LS	$ 12,000	$ -	
Engineering Design	8	%	$ 15,376,203	$ 1,230,096.22	Assume 8% of capital costs; engineering designs and specifications; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Construction Management/Oversight	6	%	$ 15,376,203	$ 922,572	Assume 6% of capital costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Project Management	5	%	$ 24,335,348	$ 1,216,767.38	Assume 5% of total costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Ecology Oversight	5	%	$ 24,335,348	$ 1,216,767.38	Assume 5% of total costs
Task Subtotal				*$ 4,882,203*	
Preconstruction Submittals and Tasks					
Health and Safety Plan	1	LS	$ 2,500	$ 2,500	
Schedule	1	LS	$ 625	$ 625	
Other submittals	1	LS	$ 625	$ 625	Equipment/materials list, manuals, instructions, certificates, etc.
TESC Plan	1	LS	$ 6,250	$ 6,250	SEPA-required TESC plan for work near Duwamish
Permit Applications	1	LS	$ 3,750	$ 3,750	Grading permit, construction permit, electrical permit, etc., as applicable.
Mobilization	1	LS	$ 25,000	$ 25,000	Mobilize equipment and materials to site
Task Subtotal				*$ 38,750*	
Extraction Wells and Injection Wells					
6" Extraction Wells (~25 deep)	9	LS	$ 15,000	$ 135,000	6" stainless-steel casing/screen (all drilling related costs)
Well vaults & installation	9	EA	$ 15,000	$ 135,000	Includes transducer, flow meter, cables, well seals, and installation
4" submersible pump w/controls	9	EA	$ 8,750	$ 78,750	Includes pumps, controls, transducer, cables, well seals, 1" stainless-steel riser, and installation
2" Injection Wells (~25' deep)	3	LS	$ 11,250	$ 33,750	2" steel casing, wire wrapped screen (all drilling related costs)
Well vaults & installation	3	EA	$ 7,500	$ 22,500	Includes transducer, flow meter, cables, well seals, 1" stainless-steel riser, and installation
Task Subtotal				*$ 405,000*	
Groundwater Extraction and Treatment System					
Site Preparation	1	LS	$ 12,500	$ 12,500	Erosion and sediment control, site prep for building/trenching
Treatment Building	1	LS	$ 25,000	$ 25,000	Prefab building - 26 gauge metal walls and roof, 30' x 20' with 14' eave height (from RSMeans)
Precipitation system and filter press (PCB treatment)	1	LS	$ 375,000	$ 375,000	Treatment to remove contaminants associated with suspended solids and pH adjustment. Cost assumes Evoqua Model CPS-10-2-SA and 250 mm J-Press or equivalent
Ion exchange resin tanks	2	LS	$ 3,125	$ 6,250	Two 35-cubic foot resin tanks plumbed in lead-lag formation for residual arsenic polishing
Ion exchange resin (initial purchase)	70	CF	$ 1,900	$ 133,000	Arsenic-specific ion exchange media
Redundant System	1	LS	$ 551,750	$ 551,750	ECY - Create redundant treatment system
Extraction Well Piping and Conduit					
Electric and water trenching, excavator	180	CY	$ 63	$ 11,250	Piping from extraction wells to treatment building (assume trench = 2'Wx2.5'Dx800'L)
Bedding Material, place, compact	80	CY	$ 44	$ 3,520	
Backfill, compact	100	CY	$ 25	$ 2,500	
HDPE 2" water line, installed, welded	800	LF	$ 120	$ 96,000	SDR 11, includes connection to existing conveyance system
Electrical conduit, assemble, install	800	LF	$ 40	$ 32,000	
Electrical cable	800	LF	$ 31	$ 25,000	
Communications conduit, assemble, install	800	LF	$ 40	$ 32,000	

Table 5-2a
Remedial Alternative 1 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 1: Containment and Hydraulic Capture via Capping and Groundwater Extraction
Assumptions: Install 9 extraction wells for hydraulic control at CPOC, install treatment system for extracted water, 3 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Communications cable	800	LF	$ 56	$ 45,000	
Injection Well Piping and Conduit					
Transfer tank and valving	1	LS	$ 12,500	$ 12,500	Influent collection tank for flow equalization
Booster pump w/controls	1	EA	$ 10,000	$ 10,000	includes pumps, controls, transducer, cables, and installation
Communications and water trenching, excavator	400	CY	$ 63	$ 25,000	Piping from injection wells to existing discharge piping (assume trench = 2'Wx2.5'Dx1800'L)
Bedding Material, place, compact	160	CY	$ 44	$ 7,040	
Backfill, compact	240	CY	$ 25	$ 6,000	
HDPE 2" water line, installed, welded	1,800	LF	$ 120	$ 216,000	SDR 11
Electrical conduit, assemble, install	50	LF	$ 25	$ 1,250	
Electrical cable	50	LF	$ 31	$ 1,563	
Communications conduit, assemble, install	1,800	LF	$ 25	$ 45,000	
Communications cable	1,800	LF	$ 56	$ 101,250	
Redundant System	1	LS	$ 22,500	$ 22,500	ECY - Create redundant treatment system
General					
Electrical Permit	1	LS	$ 6,250	$ 6,250	
New Transformer/Electrical Supply Upgrade	1	EA	$ 437,500	$ 437,500	Upgrade transformers, electrical cables and controls as needed for additional load and run lengths
Control panel enclosures/panels/other equipment	1	EA	$ 37,500	$ 37,500	Control shed; electrical panels; grounding, supports, other equipment
Electrical Labor	1	LS	$ 50,000	$ 50,000	
Instrumentation/Controls	1	LS	$ 375,000	$ 375,000	Well control panels & equipment, PLC programming; integration into existing control system
System startup and testing	1	LS	$ 25,000	$ 25,000	
Redundant System	1	LS	$ 925,000	$ 925,000	ECY - Create redundant treatment system
Task Subtotal				*$ 2,730,123*	
Observed Tar-Like Area Remedial Excavation					
Excavation and loading of contaminated soil	370	cy	$ 25	$ 9,259	Assume 2,000 SF excavation area with depth of 5 ft
Hauling	593	ton	$ 5.50	$ 3,259	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip / 30 tons/trip)
Disposal	593	ton	$ 70	$ 41,244	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Import backfill	370	cy	$ 15	$ 5,704	Assume structural fill from clean borrow source
Place, grade, and compact backfill	370	cy	$ 25	$ 9,259	Compacted in 6" lifts to 95% max density
Repaving	222	sy	$ 59	$ 13,067	4" HMA Asphalt
Task Subtotal				*$ 81,793*	
PoS Property Remedial Excavation and Bulkhead Replacement					
Site Preparation	1	LS	$ 12,500	$ 12,500	Grubbing and clearing; erosion and sediment control, general site prep
Coffer Dam	1	LS	$ 587,500	$ 587,500	Place on water side of project to protect LDW. Cost based on vendor quote.
Remove Existing PoS Bulkhead	450	LF	$ 169	$ 75,938	Assume derrick and crew @ $10,000 per day. Production of 75LF per day
Asphalt Paving Demo/Disposal	22,500	SF	$ 1.25	$ 28,125	
Excavation dewatering (Port property)	30	day	$ 14,400	$ 432,000	Includes dewatering, onsite water treatment, and discharge/disposal; assume 200 gpm dewatering for 30 days (avg. cost $0.03/gallon based on best judgement).
Excavation and loading of contaminated soil	15,000	CY	$ 25.00	$ 375,000	18' deep, soil contamination w/metals, PAH, PCB
Hauling	24,000	TN	$ 5.50	$ 132,000	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($125/hr x 1 hr/trip /30 tons/trip)
Disposal	24,000	TN	$ 68	$ 1,632,000	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Import backfill	15,000	cy	$ 15	$ 231,000	Assume structural fill from clean borrow source; include armoring of shoreline as needed.
Place, grade, and compact backfill	15,000	cy	$ 24	$ 360,000	Compacted in 6" lifts to 95% max density
Repaving	50	SY	$ 59	$ 2,940	4" HMA Asphalt . Based on cost from similar work in Washington
Install Steel Sheet Pile	1	LS	$ 1,814,875	$ 1,814,875	Includes materials, equipment and labor
Concrete Bulkhead Cap	150	CY	$ 1,417	$ 212,499	

Table 5-2a
Remedial Alternative 1 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 1: Containment and Hydraulic Capture via Capping and Groundwater Extraction
Assumptions: Install 9 extraction wells for hydraulic control at CPOC, install treatment system for extracted water, 3 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Sheetpile Wall Termination	2	ea	$ 25,000	$ 50,000	Allowance at each end of wall
Furnish and Install Cathodic Protection System	1	LS	$ 43,750	$ 43,750	
Implement Landscaping/Vegetation Mgmt Plan	1	LS	$ 125,000	$ 125,000	Assumed budget to address design elements necessary to comply with Tukwila SMP.
Task Subtotal				*$ 6,115,127*	
Construction Contingency	35%	pct	$ 9,370,792	*$ 3,279,777*	low/mid range of scope contingency for groundwater treatment (20%) plus mid range of bid contingency (15%); per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Contractor bond fee, overhead, and profit	20%	pct	$ 9,370,792	*$ 1,874,158*	
Sales Tax (commercial equipment/services)	9.5%	pct	$ 9,370,792	*$ 890,225*	WSST
Routine Operations, Maintenance, and Monitoring				Nominal Rate	
			Discount Rate	4.2%	December 12, 2022 OMB App. C Circular No. A-94 30-year nominal interest rate = 4.2% (Per Proposed MTCA Rulemaking Language: Discount future costs using the current U.S. Treasury nominal interest rate for bonds of comparable maturity to the period of analysis. If project costs exceed 30 years, use the current U.S. Treasury 30-year nominal interest rate.)
Groundwater Treatment System OM&M	50	yr	$ 55,000	$ 1,142,135	Annual estimated costs (includes utilities, permit fees) - Calculated from EPA Guidance: Arsenic Treatment Technologies for Soil, Waste, and Water (2002) adjusted for inflation
Extraction/Injection Well System O&M	50	yr	$ 12,000	$ 249,193	Annual estimated cost for well and well pump maintenance, cleaning, rehabilitation
Electrical Usage	50	yr	$ 2,570	$ 53,361	9 x 0.5 hp pumps (11 kw*hr/day/well x $0.07/kw/hr x 365 days/yr * 9 wells)
Ion Exchange Media Usage	50	events	$ 69,000	$ 1,432,860	Assume 1 lead vessel changeout per year at $69,000 per changeout for media ($64,000) and labor ($5,000). Will move lag vessel to lead position.
Filter Cake Disposal (Hazardous Waste)	50	yr	$ 3,100	$ 64,375	Assume approximately 1 ton/year filter cake disposed of as hazardous waste
Routine groundwater sampling and reporting CPOC	50	yr	$ 12,500	$ 259,576	Assume annual sampling of 10 CPOC monitoring wells for metals, PCBs, and vinyl chloride. Includes annual reporting.
Routine groundwater sampling and reporting On-Site	50	yr	$ 34,000	$ 706,047	Assume 5-yr sampling of 35 monitoring wells for metals and PCBs and reporting for 50 years
Non-routine OM&M and reporting	5	LS	$ 312,500	$ 535,515	Assume GET system major equipment replacement (pumps, controls, transducers, flow meters) costs at 10, 20, 30, 40, and 50 yrs
Annual Cap Inspections	50	yrs	$ 10,000	$ 17,136	Asphalt cap inspections, reporting, and average for periodic maintenance
OM&M Contingency	100%	pct	$ 4,460,197	*$ 4,460,197*	
Task Subtotal				*$ 8,920,395*	
			Total	**$ 29,200,000**	
Estimated Cost Range (-30% to +50%)			$ 20,440,000 to	$ 43,800,000	

Abbreviations and Acronyms:

CPOC = conditional point of compliance
CY = cubic yard
ea = each
EPA = US Environmental Protection Agency
FS = feasibility Study
ft = feet/foot
GET = groundwater extraction and treatment system
HDPE = high-density polyethylene
HMA = hot mix asphalt
HPA = hydraulic project approval
JARPA = Joint Aquatic Resource Permit Application
kw/hr = kilowatts per hour
LF = linear feet
LS = lump sum
mm = millimeter
O&M = operation and maintenance
OM&M = operation, maintenance, and monitoring
OMB = Office of Management and Budget
pct = percent
% = percent
PLC = programmable logic control
Port = Port of Seattle
PoS = Port of Seattle
SEPA = State Environmental Policy Act
SF = square foot
sy = square yard
TESC = temporary erosion and sediment control
UIC = underground injection control
WSST = Washington State Sales Tax
yr = year

Table 5-2b
Remedial Alternative 2 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 2: Containment and Hydraulic Control via Capping and Vertical Barrier
Assumptions: Install slurry wall containment cell and 5 extraction wells for hydraulic control of stabilized soil area, install treatment system for extracted water, 2 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Work Plans/Design/Reporting/Other					
GET System Work plan	1	LS	$ 36,000	$ 36,000	
Institutional Controls/Restrictive Covenants	1	LS	$ 12,000	$ 12,000	Restrictive covenant on the property deed filed w/County
SMA/TMC Compliance Planning and Design	1	LS	$ 97,000	$ 97,000	Coordination and planning w/City of Tukwila and Ecology for remedial alternative design compliance w/SMA and TMC/Tukwila SMP, develop Landscaping/Vegetation Management Plan
Permitting	1	LS	$ 85,000	$ 85,000	Includes: UIC Permit, JARPA, HPA, Biological Assessment, Shoreline Permitting, and SEPA checklist
Access agreements	1	LS	$ 30,000	$ 30,000	If necessary for Port and Jorgensen properties
Bid Package/Procurement	1	LS	$ 18,000	$ 18,000	If needed by Boeing
Construction report	1	LS	$ 18,000	$ 18,000	Upon completion
Design Peer Review	0	LS	$ 12,000	$ -	
Engineering Design	6	%	$ 22,479,317	$ 1,348,759	Assume 6% of capital costs; engineering designs and specifications; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Construction Management/Oversight	6	%	$ 22,479,317	$ 1,348,759	Assume 6% of capital costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Project Management	5	%	$ 26,195,499	$ 1,309,775	Assume 5% of total costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Ecology Oversight	5	%	$ 26,195,499	$ 1,309,775	Assume 5% of total costs
Task Subtotal				*$ 5,613,068*	
Preconstruction Submittals and Tasks					
Health and Safety Plan	1	LS	$ 2,500	$ 2,500	
Schedule	1	LS	$ 625	$ 625	
Other submittals	1	LS	$ 625	$ 625	Equipment/materials list, manuals, instructions, certificates, etc.
TESC Plan	1	LS	$ 6,250	$ 6,250	SEPA-required TESC plan for work near Duwamish
Permit Applications	1	LS	$ 3,750	$ 3,750	Grading permit, construction permit, electrical permit, etc., as applicable.
Mobilization	1	LS	$ 25,000	$ 25,000	Mobilize equipment and materials to site
Task Subtotal				*$ 38,750*	
Extraction Wells and Injection Wells					
6" Extraction Wells (~25 deep)	7	LS	$ 15,000	$ 105,000	6" stainless-steel casing/screen (all drilling related costs)
Well vaults & installation	7	EA	$ 15,000	$ 105,000	Includes transducer, flow meter, cables, well seals, and installation
4" submersible pump w/controls	7	EA	$ 8,750	$ 61,250	Includes pumps (Grundfos 5SQ05-90 - 5 GPM 1/2 HP or equivalent), controls, transducer, cables, well seals, 1" stainless-steel riser, and installation
2" Injection Wells (~25' deep)	2	LS	$ 11,250	$ 22,500	2" steel casing, wire wrapped screen (all drilling related costs)
Well vaults & installation	2	EA	$ 7,500	$ 15,000	Includes transducer, flow meter, cables, well seals, 1" stainless-steel riser, and installation
Task Subtotal				*$ 308,750*	
Slurry Wall					
Slurry wall construction	78,500	SF	$ 53	$ 4,121,250	Slurry wall linear horizontal linear footage ~ 915 ft, depth ~ 25 ft. Contractor quote of ~$53 (adj for infl)/vertical square foot
Spoils disposal	5,582	TN	$ 70	$ 388,523	2-ft thick wall - 5,815 CY spoils, 1.6 tons/CY. Disposal at Subtitle D facility.
Task Subtotal				*$ 4,509,773*	
Groundwater Extraction and Treatment System					
Site Preparation	1	LS	$ 12,500	$ 12,500	Erosion and sediment control, site prep for building/trenching
Treatment Building	1	LS	$ 25,000	$ 25,000	Prefab building - 26 gauge metal walls and roof, 30' x 20' with 14' eave height (from RSMeans)
Precipitation system and filter press (PCB treatment)	1	LS	$ 375,000	$ 375,000	Treatment to remove contaminants associated with suspended solids and pH adjustment. Cost assumes Evoqua Model CPS-10-2-SA and 250 mm J-Press or equivalent
Ion exchange resin tanks	2	LS	$ 1,875	$ 3,750	Two 11-cubic foot resin tanks plumbed in lead-lag formation for residual arsenic polishing
Ion exchange resin (initial purchase)	22	CF	$ 1,900	$ 41,800	Arsenic-specific ion exchange media
Redundant System	1	LS	$ 458,050	$ 458,050	ECY - Create redundant treatment system
Extraction Well Piping and Conduits					

Table 5-2b
Remedial Alternative 2 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 2: Containment and Hydraulic Control via Capping and Vertical Barrier
Assumptions: Install slurry wall containment cell and 5 extraction wells for hydraulic control of stabilized soil area, install treatment system for extracted water, 2 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Electric and water trenching, spider excavator	240	CY	$ 63	$ 15,000	Piping from extraction wells to treatment building (assume trench = 2'Wx2.5'Dx1100'L)
Bedding Material, place, compact	100	CY	$ 44	$ 4,400	
Backfill, compact	140	CY	$ 25	$ 3,500	
HDPE 2" water line, installed, welded	1100	LF	$ 120	$ 132,000	SDR 11, includes connection to existing conveyance system
Electrical conduit, assemble, install	1100	LF	$ 40	$ 44,000	
Electrical cable	1100	LF	$ 31	$ 34,375	
Communications conduit, assemble, install	1100	LF	$ 40	$ 44,000	
Communications cable	1100	LF	$ 56	$ 61,875	
Injection Well Piping and Conduits					
Transfer tank and valving	1	LS	$ 12,500	$ 12,500	Influent collection tank for flow equalization
Booster pump w/controls	1	EA	$ 10,000	$ 10,000	Includes pumps, controls, transducer, cables, and installation
Communications and water trenching, spider excavator	400	CY	$ 63	$ 25,000	Piping from injection wells to existing discharge piping (assume trench = 2'Wx2.5'Dx1800'L)
Bedding Material, place, compact	160	CY	$ 44	$ 7,040	
Backfill, compact	240	CY	$ 25	$ 6,000	
HDPE 2" water line, installed, welded	1,800	LF	$ 120	$ 216,000	SDR 11
Electrical conduit, assemble, install	50	LF	$ 25	$ 1,250	
Electrical cable	50	LF	$ 31	$ 1,563	
Communications conduit, assemble, install	1,800	LF	$ 25	$ 45,000	
Communications cable	1,800	LF	$ 56	$ 101,250	
Redundant System	1	LS	$ 22,500	$ 22,500	ECY - Create redundant treatment system
General					
Electrical Permit	1	LS	$ 6,250	$ 6,250	
New Transformer/Electrical Supply Upgrade	1	EA	$ 437,500	$ 437,500	Upgrade transformers, electrical cables and controls as needed for additional load and run lengths
Control panel enclosures/panels/other equipment	1	EA	$ 37,500	$ 37,500	Below ground vault for controls; electrical panels; grounding, supports, other equipment
Electrical Labor	1	LS	$ 50,000	$ 50,000	
Instrumentation/Controls	1	LS	$ 375,000	$ 375,000	Well control panels & equipment, and PLC programming
System startup and testing	1	LS	$ 25,000	$ 25,000	
Redundant System	1	LS	$ 925,000	$ 925,000	ECY - Create redundant treatment system
Task Subtotal				*$ 2,634,603*	
Observed Tar-Like Area Remedial Excavation					
Excavation and loading of contaminated soil	370	cy	$ 25	$ 9,259	Assume 2,000 SF excavation area with depth of 5 ft
Hauling	593	ton	$ 5.50	$ 3,259	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip / 30 tons/trip)
Disposal	593	ton	$ 70	$ 41,244	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Import backfill	370	cy	$ 15	$ 5,704	Assume structural fill from clean borrow source
Place, grade, and compact backfill	370	cy	$ 25	$ 9,259	Compacted in 6" lifts to 95% max density
Repaving	222	sy	$ 59	$ 13,067	4" HMA Asphalt
Task Subtotal				*$ 81,793*	
PoS Property Remedial Excavation and Bulkhead Replacement					
Site Preparation	1	LS	$ 12,500	$ 12,500	Grubbing and clearing; erosion and sediment control, general site prep
Coffer Dam	1	LS	$ 587,500	$ 587,500	Place on water side of project to protect LDW. Cost based on vendor quote.
Remove Existing PoS Bulkhead	450	LF	$ 169	$ 75,938	Assume derrick and crew @ $10,000 per day. Production of 75LF per day
Asphalt Paving Demo/Disposal	22,500	SF	$ 1.25	$ 28,125	
Excavation dewatering (Port property)	30	day	$ 14,400	$ 432,000	Includes dewatering, onsite water treatment, and discharge/disposal; assume 200 gpm dewatering for 30 days (avg. cost $0.03/gallon based on best judgement).
Excavation and loading of contaminated soil	15,000	CY	$ 25.00	$ 375,000	18' deep, soil contamination w/metals, PAH, PCB
Hauling	24,000	TN	$ 5.50	$ 132,000	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($125/hr x 1 hr/trip /30 tons/trip)
Disposal	24,000	TN	$ 68	$ 1,632,000	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste

Table 5-2b
Remedial Alternative 2 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 2: Containment and Hydraulic Control via Capping and Vertical Barrier
Assumptions: Install slurry wall containment cell and 5 extraction wells for hydraulic control of stabilized soil area, install treatment system for extracted water, 2 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Import backfill	15,000	cy	$ 15	$ 231,000	Assume structural fill from clean borrow source; include armoring of shoreline as needed.
Place, grade, and compact backfill	15,000	cy	$ 24	$ 360,000	Compacted in 6" lifts to 95% max density
Repaving	50	SY	$ 59	$ 2,940	4" HMA Asphalt . Based on cost from similar work in Washington
Install Steel Sheet Pile	1	LS	$ 1,814,875	$ 1,814,875	Includes materials, equipment and labor
Concrete Bulkhead Cap	150	CY	$ 1,417	$ 212,499	
Sheetpile Wall Termination	2	ea	$ 25,000	$ 50,000	Allowance at each end of wall
Furnish and Install Cathodic Protection System	1	LS	$ 43,750	$ 43,750	
Implement Landscaping/Vegetation Mgmt Plan	1	LS	$ 125,000	$ 125,000	Assumed budget to address design elements necessary to comply with Tukwila SMP.
Task Subtotal				*$ 6,115,127*	
Construction Contingency	35%	pct	$ 13,688,795	*$ 4,791,078*	low/mid range of scope contingency for groundwater treatment (20%) plus mid range of bid contingency (15%); per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Contractor bond fee, overhead, and profit	20%	pct	$ 13,688,795	*$ 2,737,759*	
Sales Tax (commercial equipment/services)	9.5%	pct	$ 13,688,795	*$ 1,300,435*	WSST
Routine Operations, Maintenance, and Monitoring					
			Discount Rate	4.2%	December 12, 2022 OMB App. C Circular No. A-94 30-year nominal interest rate = 4.2% (Per Proposed MTCA Rulemaking Language: Discount future costs using the current U.S. Treasury nominal interest rate for bonds of comparable maturity to the period of analysis. If project costs exceed 30 years, use the current U.S. Treasury 30-year nominal interest rate.)
Groundwater Treatment System OM&M	50	yr	$ 39,000	$ 809,877	Annual estimated costs (includes utilities, permit fees) - Calculated from EPA Guidance: Arsenic Treatment Technologies for Soil, Waste, and Water (2002) adjusted for inflation
Extraction/Injection Well System O&M	50	yr	$ 10,000	$ 207,661	Annual estimated cost for well and well pump maintenance, cleaning, rehabilitation
Electrical Usage	50	yr	$ 2,250	$ 46,724	7 x 0.5 hp pumps (11 kw*hr/day/well x $0.07/kw/hr x 365 days/yr * 7 wells)
Ion Exchange Media Usage	50	events	$ 27,000	$ 560,684	Assume 1 lead vessel changeout per year at $27,000 per changeout for media ($22,000) and labor ($5,000). Will move lag vessel to lead position.
Filter Cake Disposal	50	yr	$ 3,100	$ 64,375	Assume approximately 1 ton/year filter cake disposed of as hazardous waste
Routine groundwater sampling and reporting CPOC	50	yr	$ 12,500	$ 259,576	Assume annual sampling of 10 CPOC monitoring wells for metals, PCBs, and vinyl chloride. Includes annual reporting.
Routine groundwater sampling and reporting On-Site	50	yr	$ 34,000	$ 706,047	Assume 5-yr sampling of 35 monitoring wells for metals and PCBs and reporting for 50 years
Non-routine OM&M and reporting	5	LS	$ 312,500	$ 535,515	Assume GET system major equipment replacement (pumps, controls, transducers, flow meters) costs at 10, 20, 30, 40, and 50 yrs
Annual Cap Inspections	50	yrs	$ 10,000	$ 17,136	Asphalt cap inspections, reporting, and average for periodic maintenance
OM&M Contingency	100%	pct	$ 3,207,596	*$ 3,207,596*	
Task Subtotal				*$ 6,415,191*	
			Total	**$ 34,500,000**	
Estimated Cost Range (-30% to +50%)			$ 24,200,000 to	$ 51,800,000	

Abbreviations and Acronyms:

CY = cubic yard
ea = each
EPA = US Environmental Protection Agency
FS = feasibility Study
ft = feet/foot
GET = groundwater extraction and treatment system
GPM = gallons per minute
HDPE = high-density polyethylene
HMA = hot mix asphalt
HPA = hydraulic project approval
JARPA = Joint Aquatic Resource Permit Application
kw/hr = kilowatts per hour
LF = linear feet
LS = lump sum
mm = millimeter
O&M = operation and maintenance
OM&M = operation, maintenance, and monitoring
OMB = Office of Management and Budget
pct = percent
% = percent
PLC = programmable logic control
Port = Port of Seattle
PoS = Port of Seattle
SEPA = State Environmental Policy Act
sy = square yards
TESC = temporary erosion and sediment control
UIC = underground injection control
WSST = Washington State Sales Tax
yr = year

Table 5-2c
Remedial Alternative 3 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 3: *In Situ* Groundwater Treatment, Shoreline Excavation, and Containment
Assumptions: Install PRB, excavate and remove contaminated soil downgradient of groundwater CPOC, capping and containment of remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Work Plans/Design/Reporting/Other					
PRB and Shoreline Excavation Construction Work plan	1	LS	$ 36,000	$ 36,000	
PRB Pilot Study Installation	1	LS	$ 254,000	$ 254,000	70 ft section of PRB installed onsite with MWs up and down gradient and within PRB to track performance (assume 10% of PRB cost).
Institutional Controls/Restrictive Covenants	1	LS	$ 12,000	$ 12,000	Restrictive covenant on the property deed filed w/County
SMA/TMC Compliance Planning and Design	1	LS	$ 97,000	$ 97,000	Coordination and planning w/City of Tukwila and Ecology for remedial alternative design compliance w/SMA and TMC/Tukwila SMP, develop Landscaping/Vegetation Management Plan
Permitting	1	LS	$ 100,000	$ 100,000	Includes: JARPA, HPA, Biological Assessment, Shoreline Permitting, and SEPA checklist
Access agreements	1	LS	$ 30,000	$ 30,000	If necessary for Port and Jorgensen properties
Bid Package/Procurement	1	LS	$ 18,000	$ 18,000	If needed by Boeing
Construction report	1	LS	$ 18,000	$ 18,000	Upon completion
Design Peer Review	0	LS	$ 12,000	$ -	
Engineering Design	6	%	$ 17,078,805	$ 1,024,728	Assume 6% of capital costs; engineering designs and specifications; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Construction Management/Oversight	6	%	$ 17,078,805	$ 1,024,728	Assume 6% of capital costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Project Management	5	%	$ 22,956,909	$ 1,147,845	Assume 5% of total costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Ecology Oversight	5	%	$ 22,956,909	$ 1,147,845	Assume 5% of total costs
Task Subtotal				*$ 4,910,148*	
Preconstruction Submittals and Tasks					
Health and Safety Plan	1	LS	$ 2,500	$ 2,500	
Schedule	1	LS	$ 625	$ 625	
Other submittals	1	LS	$ 625	$ 625	Equipment/materials list, manuals, instructions, certificates, etc.
TESC Plan	1	LS	$ 6,250	$ 6,250	Plan for steep slope excavation work TESC and restoration
Permit Applications	1	LS	$ 3,750	$ 3,750	Grading permit, public works permit, electrical permit, etc., as applicable.
Mobilization	1	LS	$ 62,500	$ 62,500	Mobilize equipment and materials to site
Task Subtotal				*$ 76,250*	
Permeable Reactive Barrier					
Storm drain management	1	LS	$ 62,500	$ 62,500	Temporary removal and diversion of KC storm drain line for PRB installation, then replacing.
Shoring	1	LS	$ 62,500	$ 62,500	Shore trench using slide rail system. Cost based on vendor quote.
Excavation and stockpiling/loading	13796	CY	$ 13	$ 179,352	Excavate 380'x50'x15' for Being Property excavation plus 5'x25'x700' trench and move soil to a containment area for draining/drying of soil. Cost based on vendor quote.
ZVI material	1,260,000	Lbs	$ 1.10	$ 1,395,900	Based on vendor quote at $1.10/lb +shipping and handling (30% ZVI mix).
GAC material	57,000	Lbs	$ 2.11	$ 127,270	Based on vendor quote at $2.11/lb +shipping and handling (10% GAC mix) for PCB treatment.
Backfill sand material and mixing and placing in trench	2300	CY	$ 96	$ 220,800	Combined cost of 2300 CY of sand (70%), mixing with ZVI and GAC onsite, and placing in trench. Cost based on vendor quote, plus 10% for GAC handling
Repaving	389	SY	$ 59	$ 22,867	4" HMA Asphalt . Based on cost from similar work in Washington
Hauling	5,185	TN	$ 5.50	$ 28,519	5'x25'x700' excavation. Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip / 30 tons/trip)
Disposal	5,185	TN	$ 70	$ 360,889	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste (2022 rates)
Water treatment from stockpile drainage	1	mo	$ 75,000	$ 75,000	Treatment system rental and operation
Task Subtotal				*$ 2,535,596*	
PoS Property Remedial Excavation					
Site Preparation	1	LS	$ 12,500	$ 12,500	Fence removal, moving airplane parts, erosion and sediment control for the LDW, utility locates.
Coffer Dam	1	LS	$ 588,000	$ 588,000	Place on water side of project to protect LDW. Cost based on vendor quote.
Remove Existing PoS Bulkhead	450	LF	$ 169	$ 75,938	Assume derrick and crew @ $12,500 per day. Production of 75LF per day
Asphalt Paving Demo/Disposal	22,500	SF	$ 1.25	$ 28,125	
Excavation dewatering (Port property)	30	day	$ 15,000	$ 450,000	Includes dewatering, onsite water treatment, and discharge/disposal; assume 200 gpm dewatering for 30 days (avg. cost $0.05/gallon based on best judgement).

Table 5-2c
Remedial Alternative 3 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 3: *In Situ* Groundwater Treatment, Shoreline Excavation, and Containment
Assumptions: Install PRB, excavate and remove contaminated soil downgradient of groundwater CPOC, capping and containment of remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Excavation and loading of contaminated soil	15,000	CY	$ 25	$ 375,000	18' deep, soil contamination w/metals, PAH, PCB
Hauling	24,000	TN	$ 5.50	$ 132,000	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip /30 tons/trip)
Disposal	24,000	TN	$ 70	$ 1,670,400	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Import backfill	15,000	cy	$ 15	$ 231,000	Assume structural fill from clean borrow source; include armoring of shoreline as needed.
Place, grade, and compact backfill	15,000	cy	$ 24	$ 360,000	Compacted in 6" lifts to 95% max density
Repaving	2,111	SY	$ 59	$ 124,133	4" HMA Asphalt . Based on cost from similar work in Washington
Install Steel Sheet Pile	1	LS	$ 1,815,000	$ 1,815,000	Includes materials, equipment and labor
Concrete Bulkhead Cap	150	CY	$ 2,000	$ 300,000	
Sheetpile Wall Termination	2	ea	$ 25,000	$ 50,000	Allowance at each end of wall
Furnish and Install Cathodic Protection System	1	LS	$ 44,000	$ 44,000	
Implement Landscaping/Vegetation Mgmt Plan	1	LS	$ 125,000	$ 125,000	Assumed budget to address design elements necessary to comply with Tukwila SMP.
Task Subtotal				*$ 6,381,096*	
Observed Tar-Like Area Remedial Excavation					
Excavation and loading of contaminated soil	370	cy	$ 25	$ 9,259	Assume 2,000 SF excavation area with depth of 5 ft
Hauling	593	ton	$ 5.50	$ 3,259	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip / 30 tons/trip)
Disposal	593	ton	$ 70	$ 41,244	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Import backfill	370	cy	$ 15	$ 5,704	Assume structural fill from clean borrow source
Place, grade, and compact backfill	370	cy	$ 25	$ 9,259	Compacted in 6" lifts to 95% max density
Repaving	222	SY	$ 59	$ 13,067	4" HMA Asphalt . Based on cost from similar work in Washington
Task Subtotal				*$ 81,793*	
Boeing Property Soil Excavation to Accommodate PRB					
Asphalt Paving Demo/Disposal	19,000	SF	$ 1.25	$ 23,750	380' x 50' existing paving removal
Contaminated Soil Excavation and loading	10,556	CY	$ 25	$ 263,889	380' x 50' x 15' deep, soil contamination w/arsenic
Hauling	16,889	TN	$ 5.50	$ 92,889	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip / 30 tons/trip)
Disposal	16,889	TN	$ 70	$ 1,175,467	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Furnish clean fill	17,206	TN	$ 17	$ 283,892	Pit Run and Road Base (assume 1.63 ton/CY)
Place fill	10,556	CY	$ 5.00	$ 52,778	Place/compact/grade fill material
Repaving	2,111	SY	$ 59	$ 124,133	4" HMA Asphalt . Based on cost from similar work in Washington
Task Subtotal				*$ 2,016,797*	
Decommissioned and Replacement Monitoring Wells					
Well Decommissioning - Driller	4	each	$ 1,500	$ 6,000	
Well Decommissioning - Oversight	4	each	$ 1,800	$ 7,200	
2" Monitoring Wells (~25' deep)	4	LS	$ 5,250	$ 21,000	2" steel casing, wire wrapped screen (all drilling related costs); assume all monitoring wells removed during excavation must be replaced.
Task Subtotal				*$ 34,200*	
Construction Contingency	25%	pct	$ 11,125,732	*$ 2,781,433*	low end of scope contingency for soil excavation (10%) plus mid range of bid contingency (15%); per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Contractor bond fee, overhead, and profit	20%	pct	$ 11,125,732	*$ 2,225,146*	
Sales Tax (commercial equipment/services)	9.5%	pct	$ 11,125,732	*$ 1,056,944*	WSST
Routine Operations, Maintenance, and Monitoring				Nominal rate	
		Discount Rate		4.2%	December 12, 2022 OMB App. C Circular No. A-94 30-year nominal interest rate = 4.2% (Per Proposed MTCA Rulemaking Language: Discount future costs using the current U.S. Treasury nominal interest rate for bonds of comparable maturity to the period of analysis. If project costs exceed 30 years, use the current U.S. Treasury 30-year nominal interest rate.)

Table 5-2c
Remedial Alternative 3 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 3: ***In Situ*** **Groundwater Treatment, Shoreline Excavation, and Containment**
Assumptions: Install PRB, excavate and remove contaminated soil downgradient of groundwater CPOC, capping and containment of remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Pilot study monitoring and reporting	1	yrs	$ 59,500	$ 59,500	Includes metals and PCB monitoring upgradient and downgradient of pilot PRB
Quarterly Groundwater monitoring and annual reporting	2	yrs	$ 53,550	$ 107,100	Quarterly metals and PCB sampling upgradient and downgradient of PRB (20 wells) for 2 years after installation
Routine groundwater sampling and reporting CPOC	50	yr	$ 15,000	$ 311,000	Assume annual sampling of 4 performance (intra-PRB) and 10 CPOC monitoring wells for metals, VC, and PCBs and reporting for 50 years
Routine groundwater sampling and reporting On-Site	50	yr	$ 34,000	$ 130,000	Assume 5-yr sampling of 35 monitoring wells for metals, VC, and PCBs and reporting for 50 years
Recharge PRB with new material (every 10 yrs)	50	yrs	$ 3,283,597	$ 5,627,000	Assumes 10-year life-span of ZVI and GAC material; incl. Contractor Fees and Taxes).
Annual Cap Inspections	50	yrs	$ 9,000	$ 187,000	Annual inspections and periodic maintenance
OM&M Contingency	25%	pct	$ 6,421,600	$ 1,605,400	
Task Subtotal				*$ 8,027,000*	
			Total	**$ 30,100,000**	
Estimated Cost Range (-30% to +50%)			$ 21,070,000	to $ 45,150,000	

Abbreviations and Acronyms:

CPOC = conditional point of compliance
CY = cubic yard
EPA = US Environmental Protection Agency
FS = feasibility Study
ft = feet/foot
GAC = granular activated carbon
GET = groundwater extraction and treatment system
GPM = gallons per minute
HDPE = high-density polyethylene
HMA = hot mix asphalt
HPA = hydraulic project approval
JARPA = Joint Aquatic Resource Permit Application
kw/hr = kilowatts per hour
KC = King County
Lbs = pounds
LF = linear feet
LS = lump sum
mm = millimeter
mo = month
O&M = operation and maintenance
OM&M = operation, maintenance, and monitoring
OMB = Office of Management and Budget
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
pct = percent
% = percent
PLC = programmable logic control
PRB = permeable reactive barrier
PoS = Port of Seattle
SEPA = State Environmental Policy Act
SF = square foot
TESC = temporary erosion and sediment control
TN = ton
WSST = Washington State Sales Tax
yr = year
ZVI = zero-valent iron

Table 5-2d
Remedial Alternative 4 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 4: Focused Excavation and Containment, and *In Situ* Groundwater Treatment
Assumptions: Focused soil excavation, capping and containment of remaining contaminated soil, and *in situ* groundwater treatment with ZVI PRB.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Work Plans/Design/Reporting/Other					
Remedial Excavation Work Plan	1	LS	$ 36,000	$ 36,000	
Institutional Controls/Restrictive Covenants	1	LS	$ 12,000	$ 12,000	Restrictive covenant on the property deed filed w/County
SMA/TMC Compliance Planning and Design	1	LS	$ 97,000	$ 97,000	Coordination and planning w/City of Tukwila and Ecology for remedial alternative design compliance w/SMA and TMC/Tukwila SMP, develop Landscaping/Vegetation Management Plan
Permitting	1	LS	$ 85,000	$ 85,000	Includes: UIC Permit, JARPA, HPA, Biological Assessment, Shoreline Permitting, and SEPA checklist
Access agreements	1	LS	$ 30,000	$ 30,000	If necessary for Port and Jorgensen properties
Bid Package/Procurement	1	LS	$ 18,000	$ 18,000	If needed by Boeing
Construction report	1	LS	$ 18,000	$ 18,000	Upon completion
Design Peer Review	0	LS	$ 12,000	$ -	
Engineering Design	6	%	$ 61,690,027	$ 3,701,402	Assume 6% of capital costs; engineering designs and specifications; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Construction Management/Oversight	6	%	$ 61,690,027	$ 3,701,402	Assume 6% of capital costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Project Management	5	%	$ 68,612,077	$ 3,430,604	Assume 5% of total costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Ecology Oversight	5	%	$ 68,612,077	$ 3,430,604	Assume 5% of total costs
Task Subtotal				*$ 14,560,011*	
Preconstruction Submittals and Tasks					
Health and Safety Plan	1	LS	$ 2,500	$ 2,500	
Schedule	1	LS	$ 625	$ 625	
Other submittals	1	LS	$ 625	$ 625	Equipment/materials list, manuals, instructions, certificates, etc.
TESC Plan	1	LS	$ 6,250	$ 6,250	Waterfront and in water TESC and restoration plan
Permit Applications	1	LS	$ 3,750	$ 3,750	Grading permit, public works permit, electrical permit, etc., as applicable.
Mobilization	1	LS	$ 62,500	$ 62,500	Mobilize equipment and materials to site
Task Subtotal				*$ 76,250*	
Replacement Monitoring Wells					
2" Monitoring Wells (~25' deep)	22	LS	$ 5,250	$ 115,500	2" PVC casing and screen (all drilling related costs); assume all monitoring wells removed during excavation must be replaced
Task Subtotal				*$ 115,500*	
Remedial Excavation and Site Restoration					
Site Preparation					
Site Preparation	1	LS	$ 19,000	$ 19,000	Grubbing and clearing; erosion and sediment control, general site prep
Temporary Fencing	1	LS	$ 1,900	$ 1,900	Temporary fencing around excavations/soil stockpiles to prevent public entrance
Coffer Dam	1	LS	$ 587,500	$ 587,500	Place on water side of project to protect LDW. Cost based on vendor quote.
Source area excavation					Includes stabilized soil area and observed tar-like area
Utilities management	1	LS	$ 10,000	$ 10,000	Utility locate, protection measures as necessary
Erosion and sediment control	1	LS	$ 6,250	$ 6,250	Dust control (water trucks), street sweeping, erosion control measures
Temporary Shoring	285,000	SF	$ 20	$ 5,700,000	Sheetpile temporary shoring; assume 4,325 LF x 45-75 ft deep; $20/SF rental, install, removal
Excavation dewatering (Port property)	30	day	$ 15,000	$ 450,000	Includes dewatering, onsite water treatment, and discharge/disposal; assume 200 gpm dewatering for 30 days (avg. cost $0.05/gallon based on best judgement).
Excavation/mgmt. of overburden soil	0	cy	$ 19	$ -	Assume average no clean overburden to be excavated and stockpiled onsite
Excavation and loading of stabilized soil area	95,126	cy	$ 50	$ 4,756,316	Assume stabilized soil will require breaker and excavator, which will double cost to remove.
Excavation and loading of contaminated soil (other areas)	34,722	cy	$ 25	$ 868,056	Excavation volume based on areas shown on Figure 5-4 and depths of 15' or 25' depending on area
Hauling	207,758	ton	$ 5.50	$ 1,142,667	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip /30 tons/trip)
Disposal	207,758	ton	$ 70	$ 14,459,935	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Import backfill	129,849	cy	$ 15	$ 1,999,668	Assume structural fill from clean borrow source
Place, grade, and compact backfill	129,849	cy	$ 24	$ 3,116,365	Compacted in 6" lifts to 95% max density

Table 5-2d
Remedial Alternative 4 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 4: Focused Excavation and Containment, and *In Situ* Groundwater Treatment
Assumptions: Focused soil excavation, capping and containment of remaining contaminated soil, and *in situ* groundwater treatment with ZVI PRB.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Site repaving	25,470	SY	$ 59	$ 1,497,619	4" HMA Asphalt . Based on cost from similar work in Washington
Permeable Reactive Barrier					
Storm drain management	1	LS	$ 62,500	$ 62,500	Temporary removal and diversion of KC storm drain line for PRB installation, then replacing.
Shoring	1	LS	$ 57,000	$ 57,000	Shore trench using slide rail system. Cost based on vendor quote.
Excavation and stockpiling	3241	CY	$ 13	$ 42,130	Excavate 5'x25'x300' trench and move soil to a containment area for draining/drying of soil. Cost based on vendor quote.
ZVI material	540,000	Lbs	$ 1.10	$ 598,500	Based on vendor quote at $0.52/lb +shipping and handling (30% ZVI mix)
GAC material	25,000	Lbs	$ 2.11	$ 59,750	Based on vendor quote at $1.55/lb +shipping and handling (1% GAC mix) for PCB treatment.
Backfill sand material and mixing and placing in trench	1000	CY	$ 96	$ 96,000	Combined cost of 1000 CY of sand (70%), mixing with ZVI and GAC onsite, and placing in trench. Cost based on vendor quote, plus 10% for GAC handling
Repaving	167	SY	$ 59	$ 9,800	4" HMA Asphalt . Based on cost from similar work in Washington
Contaminated Soil Hauling	2,222	TN	$ 5.50	$ 12,222	5'x25'x300' excavation. Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip / 30 tons/trip)
Contaminated Soil Disposal	2,222	TN	$ 70	$ 154,667	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Water treatment from stockpile drainage	1	mo	$ 75,000	$ 37,500	Treatment system rental and operation.
Stormwater management replacement					
Site survey	1	LS	$ 12,000	$ 12,000	
Trenching	180	CY	$ 63	$ 11,227	Based on cost from similar work in Washington
Laying stormwater pipes	485	LF	$ 50	$ 24,250	Unit cost from RSMeans and adjusted for inflation and location.
Catch Basin (Type 1)/Manholes	7	each	$ 2,875	$ 20,125	Unit cost from WSDOT bid tabs. Assume removed CBs cannot be reused.
Pipe bedding gravel, place, compact	4	CY	$ 44	$ 198	Based on cost from similar work in Washington
Placing Backfill, compact	154	CY	$ 25	$ 3,857	Based on cost from similar work in Washington
Trench Boxes	1	month	$ 3,125	$ 3,125	Based on quote from United Rentals. Rental includes 1 trench boxes for 4 weeks. A section at a time
Reroute/Replace KC 48" Storm Drain Line	485	LF	$ 625	$ 303,125	Assume double cost per LF of other onsite stormwater replacement.
PoS Property Wooden Bulkhead Replacement					
Site Preparation	0	LS	$ 19,000	$ -	Included under bulk remedial excavation costs
Coffer Dam	0	LS	$ 587,500	$ -	Included under bulk remedial excavation costs
PoS Property Bulkhead Removal	450	LF	$ 169	$ 75,938	Assume derrick and crew @ $12,500 per day. Production of 75LF per day
Install Steel Sheet Pile	1	LS	$ 1,815,000	$ 1,815,000	Includes materials, equipment and labor
Concrete Bulkhead Cap	150	CY	$ 2,000	$ 300,000	
Sheetpile Wall Termination	2	ea	$ 25,000	$ 50,000	Allowance at each end of wall
Furnish and Install Cathodic Protection System	1	LS	$ 44,000	$ 44,000	
Implement Landscaping/Vegetation Mgmt Plan	1	LS	$ 125,000	$ 125,000	Assumed budget to address design elements necessary to comply with Tukwila SMP.
Task Subtotal				*$ 38,533,188*	
Construction Contingency	30%	pct	$ 38,724,938	*$ 11,617,482*	Mid range of scope contingency for soil excavation (15%) plus mid range of bid contingency (15%); per EPA Guide to FS Cost Estimates (EPA 540-R-00-002 July 2000)
Contractor bond fee, overhead, and profit	20%	pct	$ 38,724,938	$ 7,744,988	
Sales Tax (commercial equipment/services)	9.5%	pct	$ 38,724,938	*$ 3,678,869*	WSST

Table 5-2d
Remedial Alternative 4 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 4: Focused Excavation and Containment, and *In Situ* Groundwater Treatment
Assumptions: Focused soil excavation, capping and containment of remaining contaminated soil, and *in situ* groundwater treatment with ZVI PRB.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Routine Operations, Maintenance, and Monitoring					Not applicable
		Discount Rate	0.7%		Nov. 2016 OMB 30-year real discount rate = 0.7%
Pilot study monitoring and reporting	1	yrs	$ 47,600	$ 47,600	Includes metals and PCB monitoring upgradient and downgradient of pilot PRB
Quarterly Groundwater monitoring and annual reporting	2	yrs	$ 41,650	$ 83,300	Quarterly metals and PCB sampling upgradient and downgradient of PRB (10 wells) for 2 years after installation
Routine groundwater sampling and reporting	50	yrs	$ 15,000	*$ 631,000*	Assume annual sampling of 4 performance (intra-PRB) and 10 CPOC monitoring wells for metals, VC, and PCBs and reporting for 50 years
Routine groundwater sampling and reporting On-Site	50	yr	$ 24,286	$ -	Assume 5-yr sampling of 25 monitoring wells for metals, VC, and PCBs and reporting for 50 years
Recharge PRB with new material (every 10 yrs)	50	yrs	$ 1,067,569	$ 4,351,000	Assumes 10 year life-span of ZVI material.
Annual Cap Inspections	50	yrs	$ 8,330	$ 416,500	Annual inspections and periodic maintenance
OM&M Contingency	25%	pct	$ 5,481,800	*$ 1,364,000*	
Task Subtotal				*$ 6,845,800*	
			Total	**$ 83,200,000**	
Estimated Cost Range (-30% to +50%)			$ 58,200,000 to	$ 124,800,000	

Abbreviations and Acronyms:

CB = catch basin
CPOC = conditional point of compliance
CY = cubic yard
ea = each
EPA = US Environmental Protection Agency
FS = feasibility study
ft = feet/foot
GAC = granular activated carbon
GET = groundwater extraction and treatment system
gpm = gallons per minute
HDPE = high-density polyethylene
HMA = hot mix asphalt
HPA = hydraulic project approval
JARPA = Joint Aquatic Resource Permit Application
kw/hr = kilowatts per hour
Lbs = pounds
LF = linear feet
LS = lump sum
mo = month
O&M = operation and maintenance
OM&M = operation, maintenance, and monitoring
OMB = Office of Management and Budget
PCB = polychlorinated biphenyl
pct = percent
% = percent
PLC = programmable logic control
PoS = Port of Seattle
PRB = permeable reactive barrier
SEPA = State Environmental Policy Act
SF = square foot
SMP = Shoreline Master Program
SY = square yard
TESC = temporary erosion and sediment control
TN = ton
WSDOT = Washington State Department of Transportation
WSST = Washington State Sales Tax
yr = year
ZVI = zero-valent iron

Notes:

1. 0.7% discount rate applied to long-term O&M tasks; Nov. 2016 OMB 30-year real discount rate = 0.7%

Table 5-2e
Remedial Alternative 5 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 5: Site-Wide Excavation of Contaminated Soil
Assumptions: Excavation of contaminated soil above CULs (excluding soil beneath buildings/critical infrastructure)

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Work Plans/Design/Reporting/Other					
Remedial Excavation Work Plan	1	LS	$ 36,000	$ 36,000	
SMA/TMC Compliance Planning and Design	1	LS	$ 97,000	$ 97,000	Coordination and planning w/City of Tukwila and Ecology for remedial alternative design compliance w/SMA and TMC/Tukwila SMP, develop Landscaping/Vegetation Management Plan
Permitting	1	LS	$ 85,000	$ 85,000	Includes: JARPA, HPA, Biological Assessment, Shoreline Permitting, and SEPA checklist
Access agreements	1	LS	$ 30,000	$ 30,000	If necessary for Port and Jorgensen properties
Bid Package/Procurement	1	LS	$ 18,000	$ 18,000	If needed by Boeing
Construction report	1	LS	$ 18,000	$ 18,000	Upon completion
Design Peer Review	0	LS	$ 12,000	$ -	
Engineering Design	6	%	$ 160,436,643	$ 9,626,199	Assume 6% of capital costs; engineering designs and specifications; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Construction Management/Oversight	6	%	$ 160,436,643	$ 9,626,199	assume 6% of capital costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Project Management	5	%	$ 160,706,893	$ 8,035,345	Assume 5% of total costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Ecology Oversight	5	%	$ 160,706,893	$ 8,035,345	Assume 5% of total costs
Task Subtotal				*$ 35,607,086*	
Preconstruction Submittals and Tasks					
Health and Safety Plan	1	LS	$ 2,500	$ 2,500	
Schedule	1	LS	$ 625	$ 625	
Other submittals	1	LS	$ 625	$ 625	Equipment/materials list, manuals, instructions, certificates, etc.
TESC Plan	1	LS	$ 6,250	$ 6,250	Waterfront and in water TESC and restoration plan
Permit Applications	1	LS	$ 3,750	$ 3,750	Grading permit, public works permit, electrical permit, etc., as applicable.
Mobilization	1	LS	$ 94,000	$ 94,000	Mobilize equipment and materials to site
Task Subtotal				*$ 107,750*	
Replacement Monitoring Wells					
2" Monitoring Wells (~25' deep)	22	LS	$ 5,250	$ 115,500	2" PVC casing and screen (all drilling related costs); assume all monitoring wells removed during excavation must be replaced
Task Subtotal				*$ 115,500*	
Remedial Excavation and Site Restoration					
Site Preparation					
Site Preparation	1	LS	$ 25,000	$ 25,000	Grubbing and clearing; erosion and sediment control, general site prep
Temporary Fencing	1	LS	$ 4,000	$ 4,000	Temporary fencing around excavations/soil stockpiles to prevent public entrance
PoS Property Bulkhead Removal	450	LF	$ 169	$ 75,938	Assume derrick and crew @ $12,500 per day. Production of 75LF per day
Coffer Dam	1	LS	$ 587,500	$ 587,500	Place on water side of project to protect LDW. Cost based on vendor quote.
Source area excavation					
Utilities management	1	LS	$ 13,000	$ 13,000	Utility locate, protection measures as necessary
Erosion and sediment control	1	LS	$ 10,000	$ 10,000	Dust control (water trucks), street sweeping, erosion control measures
Temporary Shoring	300,000	SF	$ 20	$ 6,000,000	Sheetpile temporary shoring; assume 4,650 LF x 45-75 ft deep; $20/SF rental, install, removal
Excavation dewatering (Slip 5 and Port property)	90	day	$ 15,000	$ 1,350,000	Includes dewatering, onsite water treatment, and discharge/disposal; assume 200 gpm dewatering for 60 days (avg. cost $0.05/gallon based on best judgement).
Excavation/mgmt. of overburden soil	0	cy	$ 19	$ -	Assume average no clean overburden to be excavated and stockpiled onsite
Excavation and loading of stabilized soil area	95,126	cy	$ 50	$ 4,756,316	Assume stabilized soil will require breaker and excavator, which will double cost to remove.
Excavation and loading of contaminated soil (all other areas)	367,276	cy	$ 25	$ 9,181,898	Excavation volume based on areas shown on Figure 5-5 and depths of 5', 15', or 25' depending on area
Hauling	739,844	ton	$ 5.50	$ 4,069,140	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip /30 tons/trip)
Disposal	739,844	ton	$ 70	$ 51,493,115	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Import backfill	462,402	cy	$ 15	$ 7,120,995	Assume structural fill from clean borrow source
Place, grade, and compact backfill	462,402	cy	$ 24	$ 11,097,654	Compacted in 6" lifts to 95% max density

Table 5-2e
Remedial Alternative 5 Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 5: Site-Wide Excavation of Contaminated Soil
Assumptions: Excavation of contaminated soil above CULs (excluding soil beneath buildings/critical infrastructure)

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Site repaving	75,424	SY	$ 59	$ 4,434,940	4" HMA Asphalt . Based on cost from similar work in Washington
Stormwater management replacement					
Site survey	1	LS	$ 12,000	$ 12,000	
Trenching	1,333	CY	$ 63	$ 83,333	Based on cost from similar work in Washington
Laying stormwater pipes	2,500	LF	$ 50	$ 125,000	Unit cost from RSMeans and adjusted for inflation and location.
Catch Basin (Type 1)/Manholes	32	each	$ 2,875	$ 92,000	Unit cost from WSDOT bid tabs. Assume removed CBs cannot be reused.
Pipe bedding gravel, place, compact	100	CY	$ 44	$ 4,400	Based on cost from similar work in Washington
Placing Backfill, compact	1,087	CY	$ 25	$ 27,186	Based on cost from similar work in Washington
Trench Boxes	1	month	$ 3,125	$ 3,125	Based on quote from United Rentals. Rental includes 1 trench boxes for 4 weeks. A section at a time
Reroute/Replace KC 48" Storm Drain Line	1,140	LF	$ 625	$ 712,500	Assume double cost per LF of other onsite stormwater replacement.
PoS Property Wooden Bulkhead Replacement					
Site Preparation	0	LS	$ 19,000	$ -	Included under bulk remedial excavation costs
Coffer Dam	0	LS	$ 587,500	$ -	Included under bulk remedial excavation costs
Bulkhead Removal	450	LF	$ 169	$ 75,938	Assume derrick and crew @ $10,000 per day. Production of 75LF per day
Install Steel Sheet Pile	1	LS	$ 1,815,000	$ 1,815,000	Includes materials, equipment and labor
Concrete Bulkhead Cap	150	CY	$ 2,000	$ 300,000	
Sheetpile Wall Termination	2	ea	$ 25,000	$ 50,000	Allowance at each end of wall
Furnish and Install Cathodic Protection System	1	LS	$ 44,000	$ 44,000	
Implement Landscaping/Vegetation Mgmt Plan	1	LS	$ 125,000	$ 125,000	Assumed budget to address design elements necessary to comply with Tukwila SMP.
Task Subtotal				*$ 103,688,978*	
Construction Contingency	25%	pct	$ 103,912,228	*$ 25,978,057*	low end of scope contingency for soil excavation (10%) plus mid range of bid contingency (15%); per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Contractor bond fee, overhead, and profit	20%	pct	$ 103,912,228	$ 20,782,446	
Sales Tax (commercial equipment/services)	9.5%	pct	$ 103,912,228	*$ 9,871,662*	WSST
Routine Operations, Maintenance, and Monitoring					
Groundwater monitoring and reporting	4	yrs	$ 32,500	$ 130,000	Assume 4 years of quarterly groundwater monitoring at 34 wells for equilibrium and CULs to be met.
OM&M Contingency	25%	pct	$ 130,000	$ 32,500	
Task Subtotal				*$ 162,500*	
			Total	**$ 196,000,000**	
Estimated Cost Range (-30% to +50%)			$ 137,200,000 to	$ 294,000,000	

Abbreviations and Acronyms:

Avg = average
CB = catch basin
CUL = cleanup level
CY = cubic yard
ea = each
EPA = US Environmental Protection Agency
Est = estimate
FS = feasibility Study
ft = feet/foot
gpm = gallons per minute
hr = hour
HPA = hydraulic project approval
JARPA = Joint Aquatic Resource Permit Application
KC = King County
Lbs = pounds
LF = linear feet
LS = lump sum
Max = maximum
O&M = operation and maintenance
OM&M = operation, maintenance, and monitoring
OMB = Office of Management and Budget
pct = percent
% = percent
PoS = Port of Seattle
PVC = polyvinylchloride
SEPA = State Environmental Policy Act
SF = square foot
SW = stormwater
SY = square yard
TESC = temporary erosion and sediment control
TN = ton
WSDOT = Washington State Department of Transportation
WSST = Washington State Sales Tax
yr = year

Table 6-1
Summary of Remedial Alternatives Compliance with MTCA Threshold Requirements
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Description:	**Containment and Hydraulic Capture via Capping and Groundwater Extraction**	**Containment and Hydraulic Control via Capping and Vertical Barrier**	**In Situ Groundwater Treatment, Shoreline Excavation, and Containment**	**Focused Excavation and Containment, and In Situ Groundwater Treatment**	**Site-Wide Excavation of Contaminated Soil**
Compliance with Model Toxics Control Act (MTCA) Threshold Criteria (Washington Administrative Code [WAC] 173-340-360[2][a])					
- Protect human health and the environment.	**Yes** - Alternative will protect human health and the environment through containment of contaminated soil and groundwater.	**Yes** - Alternative will protect human health and the environment through containment of contaminated soil and groundwater.	**Yes** - Alternative will protect human health and the environment through containment and excavation of contaminated soil and treatment of contaminated groundwater.	**Yes** - Alternative will protect human health and the environment through containment and excavation of contaminated soil and treatment of contaminated groundwater.	**Yes** - Alternative will protect human health and the environment through excavation of nearly all contaminated soil and elimination of soil leaching to groundwater pathway.
- Comply with cleanup standards (WAC 173-360-700 through 760).	**Yes** - Containment and Institutional Controls (ICS) used for soil not complying with cleanup standards; groundwater complies with cleanup standards at conditional point of compliance (CPOC).	**Yes** - Containment and ICs used for soil not complying with cleanup standards; groundwater complies with cleanup standards at CPOC.	**Yes** - Containment and ICs used for soil not complying with cleanup standards; groundwater complies with cleanup standards at CPOC.	**Yes** - Containment and ICs used for soil not complying with cleanup standards; groundwater complies with cleanup standards at CPOC.	**Yes** - Soil and groundwater meet cleanup levels at standard point of compliance.
- Comply w/applicable state/federal laws (WAC 173-360-710).	**Yes** - Alternative complies with applicable laws (see report Section 3.0).	**Yes** - Alternative complies with applicable laws (see report Section 3.0).	**Yes** - Alternative complies with applicable laws (see report Section 3.0).	**Yes** - Alternative complies with applicable laws (see report Section 3.0).	**Yes** - Alternative complies with applicable laws (see report Section 3.0).
- Provide for compliance monitoring (WAC 173-360-410).	**Yes** - Alternative includes provisions for compliance monitoring (health and safety monitoring during construction/operation and maintenance (O&M), soil cap monitoring for ICs, long-term groundwater confirmation monitoring).	**Yes** - Alternative includes provisions for compliance monitoring (health and safety monitoring during construction/O&M, soil cap monitoring for ICs, long-term groundwater confirmation monitoring).	**Yes** - Alternative includes provisions for compliance monitoring (health and safety monitoring during construction/O&M, soil cap monitoring for ICs, long-term groundwater confirmation monitoring).	**Yes** - Alternative includes provisions for compliance monitoring (health and safety monitoring during construction/O&M, soil cap monitoring for ICs, long-term groundwater confirmation monitoring).	**Yes** - Alternative includes provisions for compliance monitoring (health and safety monitoring during excavation, soil performance sampling during excavation, soil and groundwater confirmation sampling after excavation.
Compliance with other requirements (WAC 173-340-360[2][b])					
Permanent Solutions to the Maximum Extent Practicable (WAC 173-340-360[3])					
- Permanent to the Maximum Extent Practicable.	**No** - See Disproportionate Cost Analysis (Table 6-2).	**No** - See Disproportionate Cost Analysis (Table 6-2).	**Yes** - See Disproportionate Cost Analysis (Table 6-2).	**No** - See Disproportionate Cost Analysis (Table 6-2).	**No** - See Disproportionate Cost Analysis (Table 6-2).
Reasonable Restoration Time Frame (WAC 173-340-360[4][b])					
- Provide for a reasonable restoration time frame.	**Yes** - Estimated restoration time frame is **3 years** for design, construction, implementation, and demonstration that groundwater CULs are being met at CPOC. ICs and long-term monitoring of groundwater and cap needed to ensure compliance. See factors below. *Note: If the groundwater pCUL is required to be met by this alternative at the standard point of compliance (Site-wide), the restoration time frames would be indeterminately long because of the presence of the Stabilized Soil Area and contaminants in the former Slip 5 fill, which represent infinite contaminant sources.*	**Yes** - Estimated restoration time frame is **3 years** for design, construction, implementation, and demonstration that groundwater CULs are being met at CPOC. ICs and long-term monitoring of groundwater and cap needed to ensure compliance. See factors below. *Note: If the groundwater pCUL is required to be met by this alternative at the standard point of compliance (Site-wide), the restoration time frames would be indeterminately long because of the presence of the Stabilized Soil Area and contaminants in the former Slip 5 fill, which represent infinite contaminant sources.*	**Yes** - Estimated restoration time frame is **4 years** for design, construction, excavation, and demonstration that groundwater CULs are being met at CPOC. ICs and long-term monitoring of groundwater and cap needed to ensure compliance. See factors below. *Note: If the groundwater pCUL is required to be met by this alternative at the standard point of compliance (Site-wide), the restoration time frames would be indeterminately long because of the presence of the Stabilized Soil Area and contaminants in the remainder of the former Slip 5 fill, which represent infinite contaminant sources.*	**Yes** - Estimated restoration time frame is **5 years** for design, construction, excavation, and demonstration that groundwater CULs are being met at CPOC. ICs and long-term monitoring of groundwater and cap needed to ensure compliance. See factors below. *Note: If the groundwater pCUL is required to be met by this alternative at the standard point of compliance (Site-wide), the restoration time frames would be indeterminately long because of the presence of contaminants in the remainder of the former Slip 5 fill, which represent infinite contaminant sources.*	**Yes** - Estimated restoration time frame is **6 years** for design, excavation, and demonstration that soil and groundwater CULs are being met throughout Site. See factors below.
- Potential risk to human health and environment (1).	Low - Capping of contaminated soil and capture of contaminated groundwater to minimize migration to the Lower Duwamish Waterway (LDW) protects human health and the environment.	Low - Capping of contaminated soil and capture of contaminated groundwater to minimize migration to the LDW protects human health and the environment.	Low - Capping and excavation of contaminated soil and treatment of contaminated groundwater to minimize migration to the LDW protects human health and the environment.	Low - Capping and excavation of contaminated soil and treatment of contaminated groundwater to minimize migration to the LDW protects human health and the environment.	Low - Excavation of nearly all contaminated soil protects human health and the environment.
- Practicability of achieving shorter restoration time.	See Disproportionate Cost Analysis (Table 6-2).	See Disproportionate Cost Analysis (Table 6-2).	See Disproportionate Cost Analysis (Table 6-2).	See Disproportionate Cost Analysis (Table 6-2).	See Disproportionate Cost Analysis (Table 6-2).
- Current use of Site, surrounding area, and associated resources that are, or may be affected by releases from the Site.	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses
- Potential future use of Site, surrounding area, and resources that are, or may be, affected by releases from the Site.	Onsite: Industrial. Surrounding areas: Industrial, LDW. Resources: Surface water beneficial uses.	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses
- Availability of alternative water supplies.	**Yes**. The Site is located within the Tukwila city limits, which is supplied by a municipal water supply.	**Yes**. The Site is located within the Tukwila city limits, which is supplied by a municipal water supply.	**Yes**. The Site is located within the Tukwila city limits, which is supplied by a municipal water supply.	**Yes**. The Site is located within the Tukwila city limits, which is supplied by a municipal water supply.	**Yes.** The Site is located within the Tukwila city limits, which is supplied by a municipal water supply.
- Likely effectiveness/reliability of institutional controls. (1)	High. Site is fenced and access controlled industrial site.	High. Site is fenced and access controlled industrial site.	High. Site is fenced and access controlled industrial Site.	High. Site is fenced and access controlled industrial Site.	Not Applicable. Institutional controls not required for this remedial alternative.

Table 6-1
Summary of Remedial Alternatives Compliance with MTCA Threshold Requirements
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Description:	**Containment and Hydraulic Capture via Capping and Groundwater Extraction**	**Containment and Hydraulic Control via Capping and Vertical Barrier**	**In Situ Groundwater Treatment, Shoreline Excavation, and Containment**	**Focused Excavation and Containment, and In Situ Groundwater Treatment**	**Site-Wide Excavation of Contaminated Soil**
- Ability to monitor migration of hazardous substances. (1)	High. Appropriate groundwater monitoring network present and will be supplemented, as necessary, to adequately monitor groundwater after implementation.	High. Appropriate groundwater monitoring network present and will be supplemented, as necessary, to adequately monitor groundwater after implementation.	High. Appropriate groundwater monitoring network present and will be supplemented, as necessary, to adequately monitor groundwater after implementation. Compliance soil sampling will be conducted after excavation.	High. Appropriate groundwater monitoring network present and will be supplemented, as necessary, to adequately monitor groundwater after implementation. Compliance soil sampling will be conducted after excavation.	High. Appropriate groundwater monitoring network present and will be supplemented, as necessary, to adequately monitor groundwater after excavation. Compliance soil sampling will be conducted after excavation.
- Toxicity of hazardous substances at the site. (1)	Contaminant and media dependent - Soil (dermal contact): low to moderate Water (surface water beneficial uses): low to high	Contaminant and media dependent - Soil (dermal contact): low to moderate Water (surface water beneficial uses): low to high	Contaminant and media dependent - Soil (dermal contact): low to moderate Water (surface water beneficial uses): low to high	Contaminant and media dependent - Soil (dermal contact): low to moderate Water (surface water beneficial uses): low to high	Contaminant and media dependent - Soil (dermal contact): low to moderate Water (surface water beneficial uses): low to high
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the Site or under similar conditions.	Negligible	Negligible	Negligible	Negligible	Negligible
Consider Public Concerns (WAC 173-340-600[13])					
- Consider public concerns.	**Yes** - Public notice and public comment period will be provided for review of the remedial investigation/feasibility study (RI/FS) (possibly combined with cleanup action plan [CAP]). No comments from public with concerns about Site cleanup alternatives have been received.	**Yes** - Public notice and public comment period will be provided for review of the RI/FS (possibly combined with CAP). No comments from public with concerns about Site cleanup alternatives have been received.	**Yes** - Public notice and public comment period will be provided for review of the RI/FS (possibly combined with CAP). No comments from public with concerns about Site cleanup alternatives have been received.	**Yes** - Public notice and public comment period will be provided for review of the RI/FS (possibly combined with CAP). No comments from public with concerns about Site cleanup alternatives have been received.	**Yes** - Public notice and public comment period will be provided for review of the RI/FS (possibly combined with CAP). No comments from public with concerns about Site cleanup alternatives have been received.

Notes:
(1) Ratings used: Low, Moderate, or High.

Table 6-2
Disproportionate Cost Analysis Relative Benefits Ranking Considerations
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:			Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5
Alternative Name:			Containment and Hydraulic Capture via Capping and Groundwater Extraction, Shoreline Excavation		Containment and Hydraulic Control via Capping and Vertical Barrier, Shoreline Excavation		*In Situ* Groundwater Treatment, Shoreline Excavation, and Containment		Focused Excavation and Containment, and *In Situ* Groundwater Treatment		Site-Wide Excavation of Contaminated Soil
Relative Benefits Ranking for DCA											
Evaluation Criteria: WAC 173-340-360(3)(f)	**Weighting Factor**	**Benefit Score**	**Ranking Considerations (1)**	**Benefit Score**	**Ranking Considerations (1)**	**Benefit Score**	**Ranking Considerations (1)**	**Benefit Score**	**Ranking Considerations (1)**	**Benefit Score**	**Ranking Considerations (1)**
- Overall Protectiveness	**30%**	**5**	**Good** • Focused removal of contaminated soil and fill along shoreline protects surface water and sediments. • Cap to mitigate risk of direct contact with contaminated media. • Groundwater extraction and treatment to prevent migration of contaminated groundwater to surface water/sediment and attain groundwater cleanup standards at conditional point of compliance (CPOC). • Bulkhead replacement on Port property to prevent migration of contaminated soil to sediment.	**4**	**Fair** • Focused removal of contaminated soil and fill along shoreline protects surface water and sediments. • Cap to mitigate risk of direct contact with contaminated media. • Groundwater extraction and treatment to restore pH of groundwater and prevent migration of contaminated groundwater to surface water/sediment and attain groundwater cleanup standards at CPOC. • Bulkhead replacement on Port property to prevent migration of contaminated soil to sediment.	**7**	**Excellent** • Focused removal of contaminated soil and fill along shoreline protects surface water and sediments. • Cap to mitigate risk of direct contact with contaminated media. • Permeable Reactive Barrier (PRB) provides long-term treatment of contaminated groundwater and protection of surface water and sediment.	**8**	**Excellent** • Removal of soil with highest concentration of arsenic and other metals protects groundwater surface water, and sediment quality. • Cap to mitigate risk of direct contact with remaining contaminated media. • PRB provides long-term treatment of remaining contaminated groundwater and protection of surface water and sediment.	**9**	**Superior** • Provides high level of protection of groundwater, surface water, and sediment through near-complete removal of contaminated soil and fill material.
- Permanence	**20%**	**3**	**Fair** • Focused removal of soil along shoreline permanently removes contaminated soil near surface water. • Contaminated soil left in place across much of Site. • Permanence of containment maintained through institutional controls. • Continuous and ongoing groundwater extraction relied upon for protection of surface water. • Containment and control/extraction of arsenic-contaminated groundwater to attain groundwater cleanup standards at CPOC.	**3**	**Fair** • Focused removal of soil along shoreline permanently removes contaminated soil near surface water. • Contaminated soil left in place across much of Site • Permanence of containment maintained through institutional controls . • Continuous and ongoing groundwater extraction relied upon for containment of source area and protection of surface water. • Containment and control/extraction of alkaline groundwater to attain groundwater cleanup standards at CPOC.	**5**	**Good** • Focused removal of soil along shoreline permanently removes contaminated soil near surface water. • Contaminated soil left in place across much of Site. • PRB provides long-term groundwater treatment, but periodic replacement of media required. • Permanence of containment maintained through institutional controls.	**8**	**Excellent** • Removal of stabilized soil mass and shoreline soil permanently removes substantial portion of contaminated soil and primary cause of groundwater contamination. • Contaminated soil left in place in several areas. • PRB provides long-term groundwater treatment residual groundwater contamination, but periodic for replacement of media required. • Permanence of containment maintained through institutional controls.	**10**	**Superior** • Provides high level of permanence through complete removal of contaminated soil and fill material Site-wide. • Some contaminated soil left in place below buildings, infrastructure, and bulkhead support structures.
- Long-Term Effectiveness	**20%**	**3**	**Fair** • Likely groundwater hydraulic control will successfully minimize migration of contaminated groundwater to surface water and sediment. • Long-term groundwater extraction and treatment (GET) system operations susceptible to periodic short- to long-term shutdowns due to equipment failures, power outages, control system failures, well/treatment system fouling and rehabilitation. • Exposure and risk is mitigated by cap. • Long-term effectiveness relies on monitoring and institutional controls.	**3**	**Fair** • Likely groundwater containment will successfully minimize alkalinity of groundwater; uncertain of restoration of groundwater and control of contaminated groundwater migration to surface water and sediment. • Long-term GET system operations susceptible to periodic short- to long-term shutdowns due to equipment failures, power outages, control system failures, well/treatment system fouling and rehabilitation. • Exposure and risk is mitigated by cap. • Long-term effectiveness relies on monitoring and institutional controls.	**7**	**Excellent** • Removal of soil along shoreline permanently reduces risk of contaminated soil migration to sediment and leaching to groundwater adjacent to surface water. • PRB provides continuous and ongoing protection, but relies on monitoring to determine when to replace media. • Risk of contact with remaining contaminated media is mitigated by cap. • Long-term effectiveness relies on monitoring and institutional controls. • Moderate quantities of contaminated soil moved to engineered landfill.	**8**	**Excellent** • Removal of stabilized soil mass and shoreline soil permanently reduces risks of contaminated soil migration to sediment, leaching to groundwater, and increasing pH of groundwater. • Risk of contact with remaining contaminated media is mitigated by cap. • PRB provides continuous and ongoing protection, but relies on monitoring to determine when to replace media. • Long-term effectiveness relies on monitoring and institutional controls. • Moderately high quantities of contaminated soil moved to engineered landfill.	**10**	**Superior** • Provides high long-term effectiveness through complete removal of contaminated soil and fill material Site-wide. • Large quantities of contaminated soil moved to engineered landfill.

Table 6-2
Disproportionate Cost Analysis Relative Benefits Ranking Considerations
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:			Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5
Alternative Name:			Containment and Hydraulic Capture via Capping and Groundwater Extraction, Shoreline Excavation		Containment and Hydraulic Control via Capping and Vertical Barrier, Shoreline Excavation		*In Situ* Groundwater Treatment, Shoreline Excavation, and Containment		Focused Excavation and Containment, and *In Situ* Groundwater Treatment		Site-Wide Excavation of Contaminated Soil
Relative Benefits Ranking for DCA											
- Manageability of Short-Term Risk	10%	7	**Excellent** • Minimal worker health risk from contact with contaminated media during drilling; will be completed by HAZWOPER-certified driller. • Minimal worker safety risk during drilling, GET system construction, replacement of Port property bulkhead/pavement; will be completed by qualified contractor. Long term operations and maintenance (O&M) of extraction/injection wells and treatment system present minor risks.	7	**Excellent** • Minimal worker health risk from contact with contaminated media during drilling and slurry wall installation; will be completed by HAZWOPER-certified drillers and contractors. • Minimal worker safety risk during drilling, slurry wall barrier installation, GET system construction, replacement of Port property bulkhead/pavement; will be completed by qualified contractor. Long-term O&M of extraction/injection wells and treatment system present minor risks.	7	**Excellent** • Moderate risk of contact with contaminated soil and groundwater during excavation of shoreline areas and installation of PRB; will be completed by HAZWOPER-certified drillers and contractors. • Moderate worker safety risk during excavation and hauling, backfilling, and PRB installation; will be completed by a qualified contractor.	4	**Fair** • Moderately high risk of contact with contaminated media during excavation of shoreline and stabilized soil mass areas and installation of PRB; will be completed by HAZWOPER-certified contractors. • Moderately high worker safety risk during excavation and hauling, backfilling, and PRB installation; will be completed by qualified contractor. • Excavation would present risks to 48-inch King County (KC) storm drain line.	2	**Poor** • High risk of contact with contaminated media during Site-wide excavation; will be completed by HAZWOPER-certified contractors. • High worker safety risk during excavation and hauling and replacement of Port property bulkhead/ pavement; will be completed by qualified contractor. • Extensive shoring and dewatering would be required to excavate below the groundwater table. • Extensive excavation would present risks to surrounding structures, 48-inch KC storm drain line, and other utilities.
- Implementability	10%	6	**Good** • Technical implementation provides some challenges; removal of shoreline bulkhead and contaminated soil, and construction of durable habitat bench/bank provide moderate technical challenges.; proper treatment of groundwater provide limited technical challenges. Long-term O&M of extraction/injection wells and treatment system may present challenges. • Administration implementation challenges include grading permit, stormwater pollution prevention plan (SWPPP) permit/plan; permitting for discharge of treated groundwater (industrial waste discharge permit, National Pollutant Discharge Elimination System [NPDES] permit, or Underground Injection Control [UIC] permit), permitting for in-water work (Joint Aquatic Resource Protection Act [JARPA]/ US Army Corps of Engineers [USACE]/Washington Department of Fish and Wildlife [WDFW] permit), and filing institutional controls.	5	**Good** • Technical implementation provides some challenges; installation of slurry wall, removal of shoreline bulkhead and contaminated soil, and construction of durable habitat bench/bank provide moderate technical challenges.; proper treatment of groundwater provide limited technical challenges. Long- term O&M of extraction/injection wells and treatment system may present challenges. • Administration implementation challenges include grading permit, SWPPP permit/plan; permitting for discharge of treated groundwater (industrial waste discharge permit, NPDES permit, or UIC permit), permitting for in-water work (JARPA/USACE/WDFW permit), and filing institutional controls.	6	**Good** • Technical implementation provides some challenges; installation of PRB, removal of shoreline bulkhead and contaminated soil, and construction of durable habitat bench/bank provide moderate technical challenges. • Administration implementation challenges include grading permit, SWPPP permit/plan; permitting for in-water work (JARPA/USACE/WDFW permit), and filing institutional controls.	4	**Fair** • Technical implementation somewhat complicated; installation of PRB, removal of shoreline bulkhead, excavation of stabilized soil mass and large volumes of contaminated soil, protection of KC storm drain line, and construction of durable habitat bench/bank provide technical challenges. • Administration implementation challenges include grading permit, SWPPP permit/plan; permitting for in-water work (JARPA/USACE/WDFW permit), and filing institutional controls.	2	**Poor** • Technical implementation very complicated; removal of shoreline bulkhead, excavation of stabilized soil mass and very large volumes of contaminated soil, dewatering and shoring for excavation below water table, protection of structures and utilities, and construction of durable habitat bench/bank provide significant technical challenges. • Administration implementation challenges include permitting for discharge of treated dewatering water (industrial waste discharge permit), grading permit, SWPPP permit/plan; and permitting for in-water work (JARPA/USACE/WDFW permit).
- Consideration of Public Concerns	10%	4	**Fair** • Provides fair level of overall protectiveness and long-term effectiveness. • Public comments/concerns will be addressed during RI/FS/CAP public comment period(s).	3	**Fair** • Provides fair level of overall protectiveness. • Public comments/concerns will be addressed during RI/FS/CAP public comment period(s).	6	**Good** • Provides excellent level of overall protectiveness and long-term effectiveness. • Public comments/concerns will be addressed during RI/FS/CAP public comment period(s).	7	**Excellent** • Provides excellent level of overall protectiveness, permanence, and long-term effectiveness. • Public comments/concerns will be addressed during RI/FS/CAP public comment period(s). • Results in large amount of truck traffic through neighborhood and large quantities of waste disposed in a landfill.	8	**Excellent** • Provides superior level of overall protectiveness, permanence, and long-term effectiveness. • Public comments/concerns will be addressed during RI/FS/CAP public comment period(s). • Results in very large amount of truck traffic through neighborhood and enormous quantities of waste disposed in a landfill.
Estimated Cost ($)		**$29,200,000**		**$34,500,000**		**$30,100,000**		**$83,200,000**		**$196,000,000**	
Overall Weighted Benefit Score		**4.4**	**Fair**	**4**	**Fair**	**6.4**	**Good/Excellent**	**7.1**	**Excellent**	**7.9**	**Excellent**
Comparative Overall Benefit/Cost (2)		**4.4**		**3.4**		**6.2**		**2.5**		**1.2**	

Notes:

(1) Ratings used: Poor (1-2), Fair (3-4), Good (5-6), Excellent (7-8), and Superior (9-10).

(2) Benefit/Cost Ratio scaled (divided) by lowest cost alternative score in order to compare ranges similar in scale to comparative overall benefit, as presented on Figure 6-1.

Table 6-3
Summary of Model Toxics Control Act (MTCA)
Alternatives Relative Benefits Ranking
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number and Name	**Alternative 1**				**Alternative 2**				**Alternative 3**				**Alternative 4**				**Alternative 5**			
	Containment and Hydraulic Capture via Capping and Groundwater Extraction, Shoreline Excavation				**Containment and Hydraulic Control via Capping and Vertical Barrier, Shoreline Excavation**				***In Situ* Groundwater Treatment, Shoreline Excavation, and Containment**				**Focused Excavation and Containment, and In Situ Groundwater Treatment**				**Site-Wide Excavation of Contaminated Soil**			
Relative Benefits Ranking for Disproportionate Cost Analysis [Washington Administrative Code [WAC] 173-340-360(2)(b)(i) and WAC 173-340-36093)(f)]																				
***Comparative Overall Benefit* (a)**		Score	Weighting Factor	Weighted Score		Score	Weighting Factor	Weighted Score		Score	Weighting Factor	Weighted Score		Score	Weighting Factor	Weighted Score		Score	Weighting Factor	Weighted Score
- Overall Protectiveness	Good	5	0.3	1.5	Fair	4	0.3	1.2	Excellent	7	0.3	2.1	Excellent	8	0.3	2.4	Superior	9	0.3	2.7
- Permanence	Fair	3	0.2	0.6	Fair	3	0.2	0.6	Good	5	0.2	1	Excellent	8	0.2	1.6	Superior	10	0.2	2
- Long-Term Effectiveness	Fair	3	0.2	0.6	Fair	3	0.2	0.6	Excellent	7	0.2	1.4	Excellent	8	0.2	1.6	Superior	10	0.2	2
- Manageability of Short-Term Risk	Excellent	7	0.1	0.7	Excellent	7	0.1	0.7	Excellent	7	0.1	0.7	Fair	4	0.1	0.4	Poor	2	0.1	0.2
- Implementability	Good	6	0.1	0.6	Good	5	0.1	0.5	Good	6	0.1	0.6	Fair	4	0.1	0.4	Poor	2	0.1	0.2
- Consideration of Public Concerns	Fair	4	0.1	0.4	Fair	4	0.1	0.4	Good	6	0.1	0.6	Excellent	7	0.1	0.7	Excellent	8	0.1	0.8
Overall Weighted Benefit Score				**4.4**				**4.0**				**6.4**				**7.1**				**7.9**

Disproportionate Cost Analysis - Quantitative Evaluation

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall Weighted Benefit Score	4.4	4.0	6.4	7.1	7.9
Estimated Remedy Cost	$29,200,000	$34,500,000	$30,100,000	$83,200,000	$196,000,000
Relative Benefit/Cost Ratio (b)	4.4	3.4	6.2	2.5	1.2
Most Permanent Solution	No	No	No	No	**Yes**
Lowest Cost Alternative	**Yes**	No	No	No	No
Costs Disproportionate to Incremental Benefits	Yes	Yes	No	Yes	Yes
Remedy Permanent to the Maximum Extent Practicable?	No	No	**Yes**	No	No
Preferred Alternative	**No**	**No**	**Yes**	**No**	**No**

Cost of Lowest Cost Alternative	**$29,200,000**
Benefit Score of Highest Ranked Alternative	**7.9**
Cost of Highest Ranked Alternative	**$196,000,000**

Notes:

(a) Ratings used: Poor (1-2), Fair (3-4), Good (5-6), Excellent (7-8), and Superior (9-10).

(b) Benefit/Cost Ratio scaled (multiplied) by lowest cost alternative score in order to compare ranges similar in scale to comparative overall benefit, as presented on Figure 6-1.

APPENDIX B

LDW PCB Congeners Data from Boeing Isaacson-Thompson

Source:

Leidos. 2017. Lower Duwamish Waterway, Groundwater Sampling for PCB Congeners and Aroclors, Data Report, Final. Leidos, Inc. July.

Lower Duwamish Waterway

Groundwater Sampling for PCB Congeners and Aroclors

Data Report

FINAL

Prepared for

DEPARTMENT OF
ECOLOGY
State of Washington

Toxics Cleanup Program
Northwest Regional Office
Washington State Department of Ecology
Bellevue, Washington

Prepared by

leidos

Leidos, Inc.
18912 North Creek Parkway, Suite 101
Bothell, WA 98011

July 2017

TABLES

Table 2-1. Groundwater and Surface Water Sampling and Analysis Information (continued)

Sample Location	Sample Identifier	Sample Date	Sample Time	Time of LDW Low Tide	Tidal Influence at Well	PCB Congeners and Aroclors	Conventional Analyses	IDW RCRA Metals
Duwamish Marine Center								
MW-10	DMC-MW-10-20170313	03/13/17	1640	1250	Yes	X	X	--
MW-8	DMC-MW-8-20170313		1530		Yes	X	X	--
MW-16	DMC-MW-16-20170313		1323		Yes	X	X	--
Surface Water	DMC-SW-1-20170313		1245		--	X	X	--
Waste Drum	DMC-IDW-20170313		1640		--	--	--	X
Crowley Marine Services								
EMW-1S	CMS-EMW-1S-20170316	03/16/17	1305	1436	No	X	X	--
DMW-6A	CMS-DMW-6A-20170316		1725		Yes	X	X	--
EMW-13S	CMS-EMW-13S-20170316		1505		Yes	X	X	--
EMW-13S	CMS-EMW-13S-20170316-F		1505		Yes	X	--	--
Surface Water	CMS-SW-1-20170316		1500		--	X	X	--
Surface Water	CMS-SW-1-20170316-D		1500		--	X	--	--
Waste Drum	CMS-IDW-20170316		1820		--	--	--	X
Jorgensen Forge								
MW-23	JF-MW-23-20170331	03/31/17	1205	1426	No	X	X	--
MW-48	JF-MW-48-20170331		1330		No	X	X	--
MW-51	JF-MW-51-20170331		1505		Yes	X	X	--
Waste Drum	JF-IDW-20170331		1530		--	--	--	X
Boeing Isaacson/Thompson								
MW-25	BIT-MW-25-20170315	03/15/17	1215	1359	No	X	X	--
MW-13	BIT-MW-13-20170315		1355		No	X	X	--
MW-10	BIT-MW-10-20170315		1555		Yes	X	X	--
MW-10	BIT-MW-10-20170315-D		1555		Yes	X	--	--
Waste Drum	BIT-IDW-20170315		1600		--	--	--	X
8801 Site/PACCAR								
MW-16A	8801-MW-16A-20170328	03/28/17	1115	1216	No	X	X	--
MW-16A	8801-MW-16A-20170328-F		1115		No	X	--	--
MW-42A	8801-MW-42A-20170328		1255		No	X	X	--
MW-30A	8801-MW-30A-20170328		1430		Yes	X	X	--
Waste Drum	8801-IDW-20170328		1510		--	--	--	X

Table 2-2. Tubing Present in Wells Before Sampling (continued)

Well Identifier	Status of Dedicated Tubing Identified in Well Prior to Sampling
Boeing Isaacson/Thompson	
MW-25	Polyethylene and silicone tubing in well, polyethylene and silicone tubing below water level; all tubing removed at time of sampling
MW-13	Polyethylene and silicone tubing in well, polyethylene and silicone tubing below water level; all tubing removed 12 days prior to sampling
MW-10	No tubing present in well
8801 Site/PACCAR	
MW-16A	No tubing present in well
MW-42A	No tubing present in well
MW-30A	No tubing present in well
LDW Inland Properties	
South Park Landfill	
MW-12	Bladder pump and all associated tubing remained in well while sample was collected
MW-32	Bladder pump and all associated tubing remained in well while sample was collected
MW-31	Bladder pump and all associated tubing remained in well while sample was collected
Whitehead Tyee	
WT-MW-110	No tubing present in well
WT-MW-108	No tubing present in well
WT-MW-06	Polyethylene and silicone tubing in well, polyethylene tubing below water level; all tubing removed at time of sampling
North Boeing Field	
NGW521	Polyethylene and silicone tubing in well, polyethylene tubing below water level; all tubing removed 21 days prior to sampling
NGW520	Polyethylene and silicone tubing in well, polyethylene tubing below water level; all tubing removed 21 days prior to sampling
NGW252	Polyethylene and silicone tubing in well, polyethylene tubing below water level; all tubing removed 21 days prior to sampling
Electronics Manufacturing Facility	
EMF-MW-7	Polyethylene and silicone tubing in well, polyethylene tubing below water level; all tubing removed 21 days prior to sampling
80 S Hudson Street	
MW-07	No tubing present in well
MW-02	No tubing present in well
Gray Line of Seattle	
MW-K01	No tubing present in well
WA DOT Spokane Street	
MW-2	No tubing present in well

LDW = Lower Duwamish Waterway
PCB = Polychlorinated biphenyl.
WA DOT = Washington State Department of Transportation.

Table 2-3. Monitoring Well Information and Final Purge Parameters (continued)

Well or Surface Water Sample	Well Screen Depth (feet bgs)	Tidal Influence at Well	Initial DTW (feet bgs)	Final DTW (feet bgs)	ORP (mV)	Temperature (degrees Celsius)	pH	Conductivity (mS/cm)	DO (mg/L)	Turbidity (NTU)
Crowley Marine Services										
EMW-1S	5 – 19.8	No	5.62	5.66	143.4	9.04	7.30	0.469	7.96	3.20
DMW-6A	5 – 20	Yes	12.43	11.95	-98.3	14.58	6.77	0.588	0.30	1.04
EMW-13S	5 – 19.8	Yes	10.96	11.98	174.5	8.13	8.33	5.302	8.33	9.42
Surface Water	NA	--	NA	NA	117.5	7.72	NM	0.360	12.66	46.0
Jorgensen Forge										
MW-23	6 – 15.8	No	9.79	9.82	-61.0	14.34	6.31	0.647	0.30	2.32
MW-48	5 – 17	No	10.10	10.10	-10.9	12.38	6.22	0.254	1.16	0.76
MW-51	23 – 27	Yes	15.29	15.45	-24.9	15.29	6.68	0.414	0.40	24.5
Boeing Isaacson/Thompson										
MW-25	8 – 18	No	9.27	9.27	170.7	11.84	7.16	2.095	0.71	3.31
MW-13	8 – 18	No	9.61	9.66	-61.3	15.50	6.63	3.077	0.32	3.31
MW-10	8 – 18	Yes	7.80	8.80	69.5	9.48	7.22	0.300	7.15	2.96
8801 Site/PACCAR										
MW-16A	2 – 17	No	3.96	4.00	133.4	9.96	6.43	0.186	11.14	2.15
MW-42A	5 – 20	No	5.83	5.89	-8.8	13.32	6.67	0.347	0.98	10.0
MW-30A	14 – 24	Yes	8.41	8.41	-53.3	12.55	7.23	2.792	0.39	1.23
LDW Inland Properties										
South Park Landfill										
MW-12	10 – 15	No	4.50	4.45	15.0	8.86	7.33	0.130	3.10	19.4
MW-32	19 – 24	No	8.90	8.87	-105.0	12.76	6.67	1.090	0.65	12.0
MW-31	18 – 23	No	9.05	9.02	-58.6	13.00	6.59	0.394	0.64	8.84
Whitehead Tyee										
WT-MW-110	6 – 16	No	9.15	9.18	58.5	12.50	6.24	0.411	1.11	0.63
WT-MW-108	6 – 16	No	9.29	9.38	-93.9	14.28	6.70	0.742	0.39	1.04
WT-MW-06	5 – 20	No	7.11	7.19	-12.5	12.76	5.99	0.366	0.71	4.85
North Boeing Field										
NGW521	5 – 15	No	1.51	1.52	1.0	9.73	7.02	0.802	1.66	0.90
NGW520	5 – 15	No	3.41	3.44	-27.6	13.26	6.65	0.450	0.37	4.22
NGW252	5 – 15	No	9.96	9.95	111.0	13.00	6.23	0.460	2.32	1.82

Table 3-1. Total PCB Congeners and Aroclors in Groundwater Samples

Site	Sample	Number of Congeners Detected	Total PCB Congeners (µg/L)	Total PCB Aroclors (µg/L)
LDW Adjacent Properties				
Duwamish Shipyard	DS-DSIP2-19	43	0.000139 J	0.010 U
	DS-DSI-PZ-01	14	0.0000343 J	0.010 U
	DS-DSI-MW-06	9	0.0000284 J	0.010 U
Glacier Northwest	GNW-MW-32S	9	0.0000158 J	0.010 U
	GNW-MW-4S	26	0.0000839 J	0.010 U
	GNW-MW-33S	83	0.00655 J	0.008 J
North Terminal 115	NT115-MW-20	82	0.00464 J	0.010 U
	NT115-MW-3	63	0.00119 J	0.010 U
	NT115-MW-10	74	0.00176 J	0.010 U
Douglas Management Dock	DMD-MW-11	54	0.00128 J	0.010 U
	DMD-MW-17	138	0.0421 J	0.063 J
	DMD-MW-17-F	87	0.00983 J	0.043 J
	DMD-MW-15	102	0.00309 J	0.010 U
Industrial Container Services	ICS-DOF-MW3	33	0.000167 J	0.010 U
	ICS-DOF-MW1	131	0.197 J	0.27 J
	ICS-DOF-MW1-F	99	0.0297 J	0.036 J
	ICS-SA-MW2	130	0.0698 J	0.091 J
Duwamish Marine Center	DMC-MW-10	29	0.000159 J	0.010 U
	DMC-MW-8	69	0.00112 J	0.010 U
	DMC-MW-16	110	0.0148 J	0.010 U
Crowley Marine Services	CMS-EMW-1S	29	0.000124 J	0.010 U
	CMS-DMW-6A	54	0.00104 J	0.010 U
	CMS-EMW-13S	117	0.0153 J	0.010 U
	CMS-EMW-13S-F	72	0.00134 J	0.010 U
Jorgensen Forge	JF-MW-23	45	0.0000681 J	0.010 U
	JF-MW-48	22	0.000028 J	0.010 U
	JF-MW-51	19	0.0000295 J	0.010 U
Boeing Isaacson/Thompson	BIT-MW-25	92	0.00184 J	0.010 U
	BIT-MW-13	76	0.00266 J	0.010 U
	BIT-MW-10	47	0.000546 J	0.010 U
	BIT-MW-10-D	49	0.000608 J	0.010 U
8801 Site/PACCAR	8801-MW-16A	102	0.0352 J	0.024
	8801-MW-16A-F	58	0.0185 J	0.023
	8801-MW-42A	80	0.00299 J	0.010 U
	8801-MW-30A	90	0.00367 J	0.010 U
LDW Inland Properties				
South Park Landfill	SPL-MW-12	18	0.0000403 J	0.010 U
	SPL-MW-32	7	0.0000152 J	0.010 U
	SPL-MW-32-F	0	0.00000743 U	0.010 U
	SPL-MW-31	11	0.0000294 J	0.010 U
Whitehead Tyee	WT-MW-110	113	0.00445 J	0.010 U
	WT-MW-110-D	50	0.000223 J	0.010 U
	WT-MW-108	27	0.0000667 J	0.010 U
	WT-MW-06	48	0.00016 J	0.010 U

FIGURES

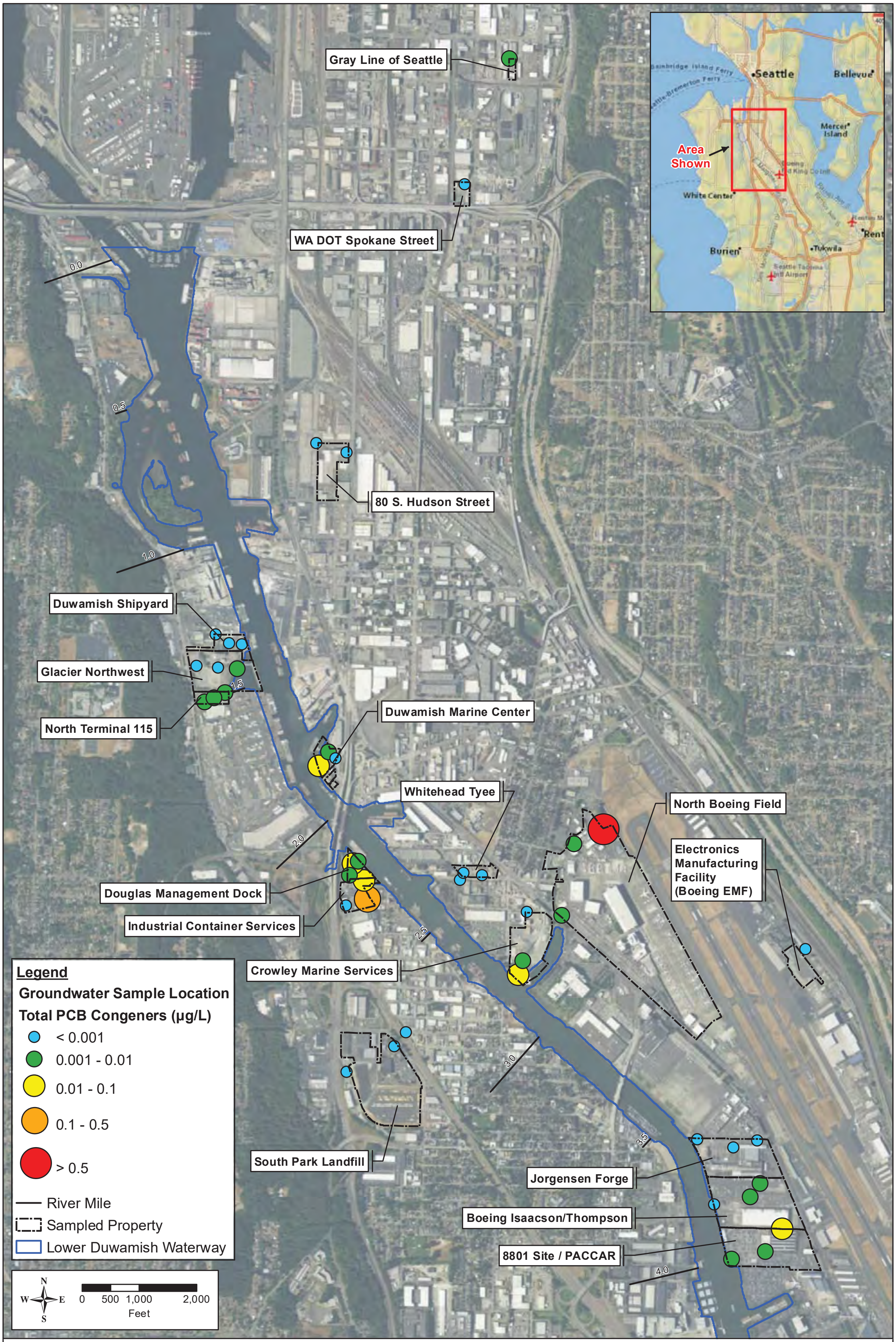
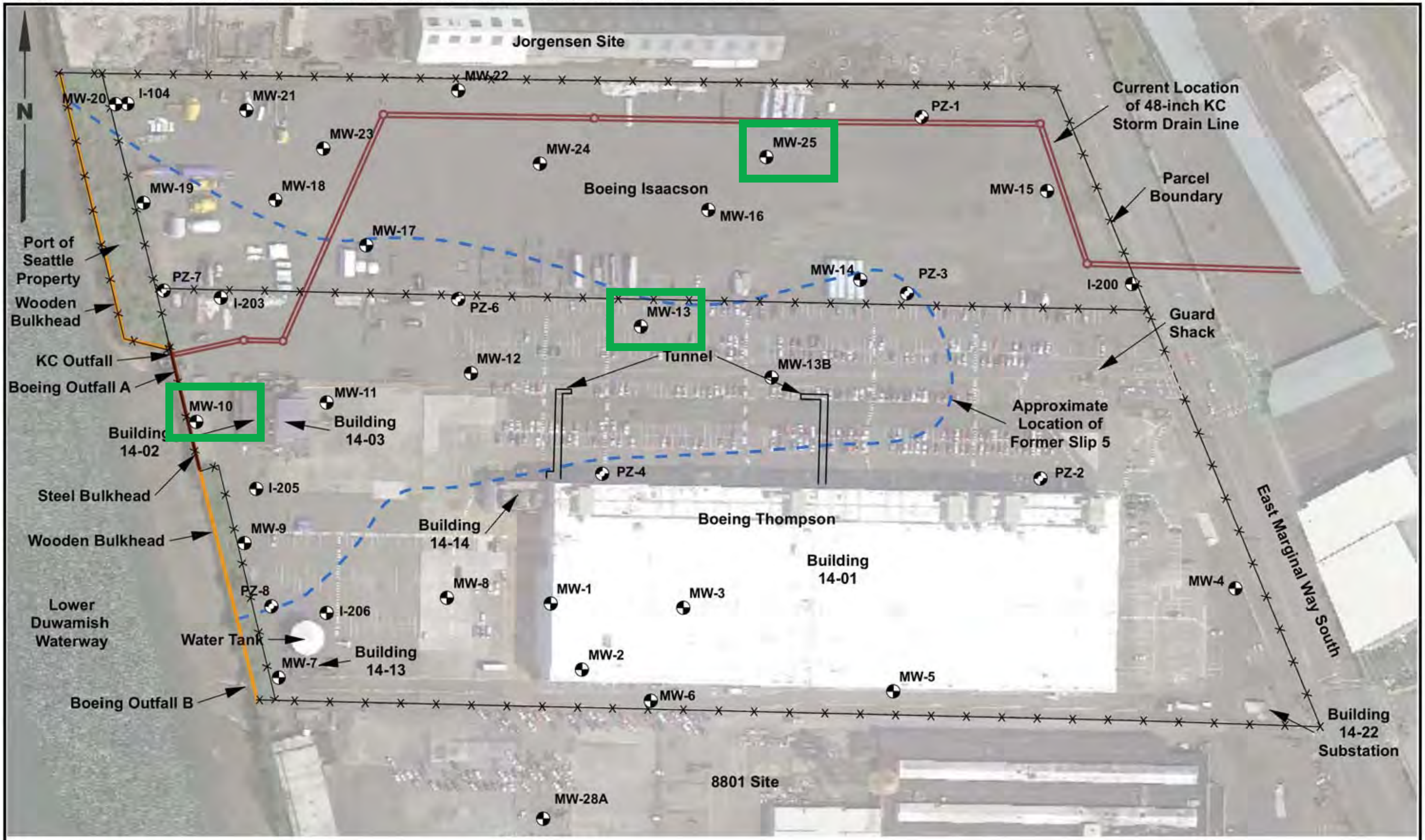


Figure 3-1
Relative Concentrations of Total PCBs in LDW Groundwater

Coordinate System:
NAD 1983 StatePlane Washington North FIPS 4601 Feet
Prepared By: cjc
File: LDW_GW_Figure_3_PCBs_in_LDW_GW_11x17.mxd
Illustrative purposes only.

Appendix A
Selected Properties and Sampling Locations

G:\Projects\025\190\213\013\RI\ES\FigureES-2CurrentSiteFeatures.mxd 3/28/2014 NAD 1983 HARN StatePlane Washington North FIPS 4601 Feet



Legend

- ◐ Monitoring Well
- ◐ Piezometer
- ×—× Fence

0 200 400

Scale in Feet

Boeing Isaacson/Thompson

Data Sources: Google Earth Pro 2012; King County Parcel Data.

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Current Site Features

Figure
ES-2

Appendix D
Comprehensive Data Tables

Table D-1
Groundwater Analytical Results: PCB Congeners and Aroclors

	LDW Adjacent Properties												
Site	Crowley Marine Services						Jorgensen Forge			Boeing Isaacson/Thompson			
Well ID	EMW-1S	DMW-6A	EMW-13S	EMW-13S-F	CMS-SW-1	CMS-SW-1-D	MW-23	MW-48	MW-51	MW-25	MW-13	MW-10	MW-10-D
Relative Location at Site	Up	Center	Down	Down	Surface	Surface	Up	Center	Down	Up	Center	Down	Down
Sample Date	3/16/2017	3/16/2017	3/16/2017	3/16/2017	3/16/2017	3/16/2017	3/31/2017	3/31/2017	3/31/2017	3/15/2017	3/15/2017	3/15/2017	3/15/2017
PCB Congeners (pg/L)													
PCB-001	0.315 U	0.393 U	9.42 J	21.1 J	2.86 U	0.439 U	3.61 J	0.175 U	1.00 U	0.285 U	2.02 J	0.513 U	0.470 U
PCB-002	0.366 U	0.420 U	0.473 U	3.34 J	0.469 U	0.463 U	0.883 J	0.177 U	0.849 U	0.317 U	0.340 U	0.613 U	0.526 U
PCB-003	0.365 U	0.419 U	0.472 U	5.18 U	0.467 U	0.462 U	0.436 J	0.189 U	0.692 U	0.316 U	0.339 U	0.612 U	0.524 U
Total Monochlorobiphenyls	0.366 U	0.420 U	9.42 J	24.4 J	2.86 U	0.463 U	4.93 J	0.189 U	1.00 U	0.317 U	2.02 J	0.613 U	0.526 U
PCB-004	0.622 U	0.793 U	18.8	18.9	18.5	18.0	0.922 U	1.18 U	1.42 U	12.5	0.682 U	0.913 U	1.01 U
PCB-005	0.703 U	0.732 U	0.791 U	1.10 U	0.724 U	0.745 U	1.03 U	1.40 U	1.47 U	0.578 U	0.701 U	1.10 U	1.06 U
PCB-006	0.730 U	0.761 U	0.822 U	1.14 U	11.8	13.7	1.08 U	1.47 U	1.55 U	0.601 U	0.729 U	1.14 U	1.10 U
PCB-007	0.659 U	0.686 U	0.741 U	1.03 U	0.679 U	0.698 U	0.968 U	1.32 U	1.39 U	0.542 U	0.657 U	1.03 U	0.990 U
PCB-008	0.705 U	0.735 U	13.1	13.4	12.7	14.3	1.05 U	1.43 U	1.51 U	6.76	0.704 U	1.10 U	1.06 U
PCB-009	0.758 U	0.790 U	0.853 U	1.18 U	0.781 U	0.803 U	1.11 U	1.51 U	1.59 U	0.624 U	0.691 U	1.18 U	1.14 U
PCB-010	0.393 U	0.502 U	0.519 U	0.613 U	0.456 U	0.560 U	0.105 U	0.725 U	0.869 U	0.352 U	0.432 U	0.578 U	0.639 U
PCB-011	6.03	6.23	5.65	9.76	8.86	8.76	6.28 U	1.35 U	5.98 U	8.72	9.42	6.63	10.2
PCB-012/013	0.766 U	0.703 U	0.895 U	1.19 U	0.769 U	3.48 J	1.03 U	1.31 U	1.25 U	0.588 U	0.780 U	1.15 U	1.07 U
PCB-014	0.619 U	0.568 U	0.724 U	0.962 U	0.622 U	0.600 U	0.806 U	1.02 U	0.976 U	0.476 U	0.631 U	0.933 U	0.869 U
PCB-015	0.703 U	0.645 U	9.37	7.66	5.47	5.54	0.976 U	1.24 U	1.18 U	9.08	0.716 U	1.06 U	0.986 U
Total Dichlorobiphenyls	6.03	6.23	46.9	49.7	57.3	63.8 J	6.28 U	1.51 U	5.98 U	37.1	9.42	6.63	10.2
PCB-016	0.258 U	0.293 U	7.93	3.41 J	2.55 U	2.97 J	2.58 J	0.349 U	0.916 J	4.81 J	0.867 J	0.506 U	0.473 U
PCB-017	0.258 U	0.216 U	7.18	2.68 J	11.3	12.3	1.61 U	0.822 U	0.679 U	4.17 J	1.04 J	0.373 U	0.349 U
PCB-018/030	0.559 U	0.980 U	17.4	6.97	22.3	23.4	3.04 J	1.26 U	1.20 U	13.6	1.69 J	0.322 U	0.843 J
PCB-019	0.229 U	0.276 U	11.1	9.91	6.94	7.55	0.447 U	0.328 U	0.342 U	19.6	0.847 J	0.449 U	0.460 U
PCB-020/028	0.955 U	1.44 U	17.2	4.51 U	23.7	23.4	5.28 J	1.55 U	1.96 U	12.6	2.32 U	1.42 U	1.80 U
PCB-021/033	0.510 U	0.779 U	9.36 J	2.12 U	5.23 U	5.09 U	3.68 U	1.45 U	1.49 U	3.63 U	2.92 U	0.258 U	0.538 U
PCB-022	0.532 J	0.361 U	6.09	1.55 J	4.76 J	4.52 J	2.55 J	0.810 U	0.821 J	4.05 J	0.812 U	0.279 U	0.742 J
PCB-023	0.135 U	0.162 U	0.241 U	0.225 U	0.151 U	0.153 U	0.149 U	0.189 U	0.184 U	0.134 U	0.167 U	0.263 U	0.250 U
PCB-024	0.144 U	0.164 U	0.250 U	0.201 J	0.157 U	0.155 U	0.153 U	0.207 U	0.209 U	0.138 U	0.184 U	0.282 U	0.264 U
PCB-025	0.255 U	0.158 U	2.76 J	1.26 J	8.76	9.30	0.760 J	0.199 U	0.194 U	1.66 U	0.641 U	0.255 U	0.333 U
PCB-026/029	0.127 U	0.153 U	2.97 J	1.46 J	14.4	16.0	1.05 U	0.177 U	0.424 U	2.46 J	0.450 U	0.247 U	0.236 U
PCB-027	0.134 U	0.152 U	2.94 J	2.32 J	5.30	5.25	0.141 U	0.191 U	0.193 U	2.26 J	0.424 J	0.262 U	0.245 U
PCB-031	0.735 U	1.22 U	16.2	3.68 U	21.1	22.8	4.28 J	1.22 U	1.81 U	8.64	2.50 U	0.933 U	0.950 U
PCB-032	0.645 U	0.853 U	6.72	4.00 J	8.40	9.14	1.46 J	0.889 J	0.856 J	8.64	1.33 J	0.723 J	0.689 U
PCB-034	0.128 U	0.154 U	0.229 U	0.214 U	0.144 U	0.380 J	0.143 U	0.183 U	0.178 U	0.127 U	0.158 U	0.250 U	0.238 U
PCB-035	0.246 U	0.243 U	0.416 U	1.20 U	0.280 U	0.557 U	0.224 U	0.364 U	0.273 U	0.705 U	0.253 U	0.456 U	0.392 U
PCB-036	0.217 U	0.214 U	4.17 J	0.435 J	1.01 U	0.919 U	0.175 U	0.285 U	0.214 U	0.211 U	2.43 U	0.402 U	0.346 U
PCB-037	0.231 U	0.228 U	6.27	1.51 U	4.29 J	3.85 J	1.94 J	0.318 U	0.807 J	4.85 J	1.15 J	1.32 J	1.73 J
PCB-038	0.223 U	0.220 U	0.374 U	0.290 U	0.254 U	0.230 U	0.185 U	0.300 U	0.225 U	0.351 J	0.229 U	0.412 U	0.355 U
PCB-039	0.202 U	0.200 U	0.340 U	0.264 U	0.230 U	0.209 U	0.175 U	0.284 U	0.213 U	0.186 U	0.208 U	0.374 U	0.322 U
Total Trichlorobiphenyls	0.532 J	1.44 U	118 J	34.2 J	131 J	141 J	21.9 J	0.889 J	3.40 J	86.0 J	7.35 J	2.04 J	3.32 J
PCB-040/041/071	0.282 U	3.50 J	32.6	4.53 J	11.8 J	11.9 J	2.65 J	0.301 U	1.44 J	12.3 J	18.1	0.328 U	0.416 U
PCB-042	0.287 U	1.34 J	14.4	2.29 J	4.73 J	4.84 J	1.29 J	0.364 J	0.577 J	7.33	8.00	0.333 U	0.57 U
PCB-043	0.299 U	0.214 U	0.281 U	0.306 U	0.201 U	0.255 U	0.210 U	0.324 U	0.375 U	0.443 J	0.259 U	0.353 U	0.444 U

Table D-1
Groundwater Analytical Results: PCB Congeners and Aroclors

	LDW Adjacent Properties												
Site	**Crowley Marine Services**						**Jorgensen Forge**			**Boeing Isaacson/Thompson**			
Well ID	**EMW-1S**	**DMW-6A**	**EMW-13S**	**EMW-13S-F**	**CMS-SW-1**	**CMS-SW-1-D**	**MW-23**	**MW-48**	**MW-51**	**MW-25**	**MW-13**	**MW-10**	**MW-10-D**
Relative Location at Site	**Up**	**Center**	**Down**	**Down**	**Surface**	**Surface**	**Up**	**Center**	**Down**	**Up**	**Center**	**Down**	**Down**
Sample Date	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/31/2017**	**3/31/2017**	**3/31/2017**	**3/15/2017**	**3/15/2017**	**3/15/2017**	**3/15/2017**
PCB Congeners (pg/L)													
PCB-044/047/065	2.96 U	17.1	179	29.9	25.8	24.3	7.18 J	10.6 J	11.2 J	34.6	116	9.15 J	9.52 J
PCB-045/051	0.374 U	0.323 U	26.0	11.7	4.62 U	5.09 J	1.42 J	11.6 U	3.27 J	28.9	4.92 U	0.527 U	0.505 U
PCB-046	0.420 U	0.363 U	7.54	2.55 J	0.459 U	0.498 U	0.259 U	0.365 U	0.374 U	6.90 U	1.82 J	0.592 U	0.568 U
PCB-048	0.262 U	0.188 U	5.27	0.669 J	2.23 J	2.58 J	0.892 J	0.277 U	0.320 U	1.90 J	1.82 U	0.308 U	0.388 U
PCB-049/069	0.219 U	5.84 J	80.3	10.4 J	22.6	21.5	1.78 J	1.49 J	0.974 J	9.18 J	51.4	3.05 J	3.77 J
PCB-050/053	0.354 U	0.306 U	36.5	19.6	7.77 J	6.88 U	0.634 J	0.240 U	0.313 U	27.1	11.5	0.498 U	0.478 U
PCB-052	1.07 U	36.8	471	66.1	43.5	45.3	3.47 U	1.19 U	1.47 U	42.1	309	7.82	7.72
PCB-054	0.283 U	0.245 U	2.00 J	0.809 J	0.309 U	0.335 U	0.166 U	0.233 U	0.238 U	1.46 U	0.320 U	0.399 U	0.383 U
PCB-055	0.187 U	0.296 U	0.533 U	0.384 U	0.245 U	0.277 U	0.367 J	0.233 U	0.208 U	0.232 U	0.317 U	0.399 U	0.409 U
PCB-056	0.191 U	2.56 U	28.2	1.59 J	6.20	6.55	2.26 J	0.477 J	0.929 J	1.54 U	6.26	1.38 U	1.55 U
PCB-057	0.180 U	0.278 U	0.509 U	0.344 U	0.237 U	0.263 U	0.196 U	0.224 U	0.204 U	0.218 U	0.305 U	0.374 U	0.399 U
PCB-058	0.167 U	0.257 U	0.471 U	0.318 U	0.219 U	0.243 U	0.164 U	0.188 U	0.171 U	0.260 J	0.282 U	0.346 U	0.369 U
PCB-059/062/075	0.208 U	0.149 U	3.95 J	1.77 J	2.06 U	2.40 U	0.668 J	0.211 U	0.248 U	4.52 J	2.16 U	0.242 U	0.307 U
PCB-060	0.183 U	0.290 U	10.4	0.376 U	2.82 J	2.67 J	1.38 J	0.229 U	0.561 J	0.725 J	1.64 U	0.391 U	1.84 J
PCB-061/070/074/076	1.30 U	15.3 J	281	12.5 J	28.6	27.2	5.58 J	1.75 U	2.23 U	9.67 U	62.0	10.8 U	12.7 J
PCB-063	0.160 U	0.175 J	2.25 J	0.305 U	0.746 J	0.596 U	0.164 U	0.188 U	0.171 U	0.193 U	0.506 J	0.331 U	0.353 U
PCB-064	0.405 U	3.54 J	42.6	3.97 J	7.99	7.67	1.53 J	0.484 U	0.764 J	13.7	19.1	1.62 U	2.25 J
PCB-066	0.582 U	5.42 J	69.0	3.80 J	16.3	16.6	3.15 J	1.15 J	1.57 J	6.01	27.2	8.54	10.1
PCB-067	0.160 U	0.247 U	0.452 U	0.306 U	0.629 J	0.569 U	0.178 U	0.204 U	0.185 U	0.275 J	0.517 J	0.332 U	0.354 U
PCB-068	0.420 U	0.452 J	2.20 J	0.975 U	0.824 J	0.578 U	0.711 J	4.56 J	1.70 J	1.20 J	1.26 J	0.971 J	1.03 J
PCB-072	0.167 U	0.257 U	1.11 J	0.319 U	0.629 J	0.540 J	0.189 U	0.216 U	0.196 U	0.451 J	0.859 J	0.346 U	0.369 U
PCB-073	0.208 U	0.149 U	0.195 U	0.212 U	0.140 U	0.178 U	0.140 U	0.217 U	0.251 U	0.133 U	0.180 U	0.245 U	0.308 U
PCB-077	0.181 U	1.01 J	4.07 J	1.11 U	1.90 J	1.65 J	0.756 J	0.222 U	0.206 U	1.03 U	1.20 J	3.24 J	3.14 U
PCB-078	0.220 U	0.349 U	0.628 U	0.452 U	0.288 U	0.327 U	0.214 U	0.249 U	0.222 U	0.273 U	0.373 U	0.470 U	0.482 U
PCB-079	0.165 U	0.262 U	11.1	0.339 U	0.216 U	0.410 J	0.446 J	0.191 U	0.170 U	0.205 U	3.23 J	0.353 U	0.362 U
PCB-080	0.170 U	0.269 U	0.484 U	0.349 U	0.222 U	0.252 U	0.164 U	0.191 U	0.171 U	0.211 U	0.288 U	0.363 U	0.372 U
PCB-081	0.196 U	0.305 U	0.782 U	0.395 U	0.259 U	0.279 U	0.420 J	0.254 U	0.237 U	0.572 U	0.549 U	0.420 U	0.424 U
Total Tetrachlorobiphenyls	2.96 U	90.5 J	1,310 J	172 J	185 J	179 J	33.1 J	18.6 J	23.0 J	191 J	638 J	32.8 J	48.9 J
PCB-082	0.521 U	11.4	120	7.62	3.38 U	3.07 U	0.659 U	0.641 U	0.465 U	4.51 U	26.3	0.845 U	1.99 U
PCB-083/099	0.441 U	48.0	509	42.7	24.1	23.4	0.492 U	0.476 U	0.336 U	28.0	133	34.3	44.3
PCB-084	0.395 U	26.9	479	96.7	9.63	8.83	0.456 U	0.446 U	0.321 U	37.5	106	1.75 U	2.24 J
PCB-085/116/117	4.88 U	13.6 J	131	7.19 J	5.69 J	5.68 J	0.433 U	0.422 U	1.38 U	11.0 J	34.8	9.22 J	10.8 J
PCB-086/087/097/109/119/125	0.377 U	64.8	603	40	22.3 J	22.7 J	0.423 U	0.411 U	0.298 U	25.8 J	169	19.6 U	21.2 U
PCB-088/091	0.359 U	12.8	198	30.3	6.48 J	7.67 J	0.381 U	0.543 J	0.269 U	18.8	42.3	4.29 J	4.10 U
PCB-089	0.454 U	0.795 U	10.8	2.11 J	0.607 U	0.794 U	0.535 U	0.518 U	0.365 U	0.646 J	2.53 J	0.749 U	1.14 U
PCB-090/101/113	1.39 J	87.4	832	51.3	37.2	36.6	1.68 J	1.12 J	1.24 U	26.5	244	40.7	47.0
PCB-092	0.399 U	15.7	189	20.0	7.46	7.74	0.451 U	0.436 U	0.308 U	10.8	45.8	7.58	6.72 U
PCB-093/098/100/102	0.336 U	1.82 U	48.8	8.32 U	1.21 J	2.25 J	0.379 U	0.371 U	0.267 U	5.23	7.96	0.544 U	0.824 U
PCB-094	0.368 U	0.499 U	6.44	1.01 U	0.504 U	0.341 U	0.430 U	0.421 U	0.303 U	0.761 U	1.20 U	0.598 U	0.905 U
PCB-095	1.28 J	72.5	1,260	279	28.4	31.8	0.364 U	0.871 J	0.857 J	115	285	13.6	14.3 U

Table D-1
Groundwater Analytical Results: PCB Congeners and Aroclors

	LDW Adjacent Properties												
Site	**Crowley Marine Services**						**Jorgensen Forge**			**Boeing Isaacson/Thompson**			
Well ID	**EMW-1S**	**DMW-6A**	**EMW-13S**	**EMW-13S-F**	**CMS-SW-1**	**CMS-SW-1-D**	**MW-23**	**MW-48**	**MW-51**	**MW-25**	**MW-13**	**MW-10**	**MW-10-D**
Relative Location at Site	**Up**	**Center**	**Down**	**Down**	**Surface**	**Surface**	**Up**	**Center**	**Down**	**Up**	**Center**	**Down**	**Down**
Sample Date	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/31/2017**	**3/31/2017**	**3/31/2017**	**3/15/2017**	**3/15/2017**	**3/15/2017**	**3/15/2017**
PCB Congeners (pg/L)													
PCB-096	0.126 U	0.330 U	10.2	2.80 J	0.151 U	0.134 U	0.141 U	0.116 U	0.142 U	2.73 J	2.65 J	0.207 U	0.145 U
PCB-103	0.302 U	0.409 U	10.0	2.05 U	0.716 U	0.531 U	0.355 U	0.347 U	0.250 U	0.639 U	1.93 U	0.489 U	0.741 U
PCB-104	0.110 U	0.111 U	0.320 U	0.134 U	0.131 U	0.116 U	0.116 U	0.0958 U	0.117 U	0.110 U	0.123 U	0.180 U	0.126 U
PCB-105	0.856 U	19.7	215	3.73 J	10.4	11.4	0.788 J	0.177 U	0.463 J	8.17	38.8	15.1	17.5
PCB-106	0.238 U	0.299 U	0.371 U	0.382 U	0.475 U	0.313 U	0.232 U	0.219 U	0.182 U	0.308 U	0.587 U	0.529 U	0.375 U
PCB-107	0.208 U	4.12 J	40.9	0.928 J	2.62 J	2.36 J	0.210 U	0.198 U	0.164 U	1.71 U	7.34	3.51 J	3.74 J
PCB-108/124	0.240 U	2.75 U	35.5	1.48 J	1.12 J	1.18 U	0.237 U	0.340 U	0.185 U	1.66 J	5.85 J	0.926 U	1.38 J
PCB-110/115	0.359 U	126	1,450	150	47.5	51.7	1.28 U	1.20 J	0.261 U	126	264	66.1	77.3
PCB-111	0.309 U	0.405 U	0.812 U	0.663 U	0.411 U	0.514 U	0.358 U	0.348 U	0.253 U	0.664 U	0.478 U	0.500 U	0.741 U
PCB-112	0.298 U	0.392 U	0.811 U	0.627 U	0.398 U	0.521 U	0.340 U	0.329 U	0.232 U	0.651 U	0.455 U	0.491 U	0.747 U
PCB-114	0.200 U	0.814 U	13.5	0.315 U	0.909 J	0.583 U	0.210 U	0.185 U	0.145 U	0.429 U	1.63 J	1.11 J	0.926 U
PCB-118	1.40 J	53.9	561	12.4	28.6	30.1	1.07 U	0.670 J	0.703 J	22.5	120	47.0	54.2
PCB-120	0.292 U	0.382 U	15.2	0.626 U	0.388 U	0.485 U	0.320 U	0.311 U	0.226 U	0.627 U	0.653 U	0.473 U	0.700 U
PCB-121	0.296 U	0.390 U	0.807 U	0.624 U	0.396 U	0.518 U	0.346 U	0.335 U	0.236 U	0.648 U	0.452 U	0.488 U	0.742 U
PCB-122	0.242 U	0.897 U	10.5	0.866 U	0.374 U	0.321 U	0.254 U	0.223 U	0.175 U	0.589 U	1.35 J	0.523 U	0.374 U
PCB-123	0.228 U	1.17 J	15.5	0.745 U	0.423 J	0.624 U	0.234 U	0.221 U	0.183 U	0.826 U	2.05 J	0.652 U	0.975 J
PCB-126	0.196 U	0.251 U	0.758 J	0.577 U	0.416 U	0.311 U	0.187 U	0.164 U	0.143 U	0.597 U	0.481 U	0.325 U	0.526 U
PCB-127	0.183 U	0.236 U	0.285 U	0.301 U	0.406 U	0.251 U	0.193 U	0.165 U	0.144 U	0.248 U	0.444 U	0.410 U	0.301 U
Total Pentachlorobiphenyls	4.07 J	558 J	6770 J	748 J	234 J	242 J	2.47 J	4.40 J	2.02 J	440 J	1,540 J	243 J	259 J
PCB-128/166	2.63 J	14.4	264	10.2 J	8.28 J	8.11 J	0.186 U	0.225 U	0.150 U	18.9	16.7	11.1 U	11.6
PCB-129/138/160/163	13.0 J	85.4	1,270	54	48.2	51.1	1.05 U	0.859 U	0.952 U	69.3	103	68.5	73.3
PCB-130	1.23 J	6.44	106	5.66	2.54 J	3.43 J	0.297 U	0.342 U	0.226 U	5.34 U	7.12	3.08 J	2.97 U
PCB-131	0.321 U	1.74 U	25.5	0.849 U	0.694 J	0.499 J	0.305 U	0.352 U	0.233 U	1.31 J	2.24 U	0.359 U	0.727 U
PCB-132	2.88 J	33.7	513	30.6	13.8	15.0	0.303 U	0.351 U	0.232 U	29.5	42.1	12.5	13.5
PCB-133	0.350 U	1.58 J	17.6	0.868 J	1.14 J	1.01 J	0.283 U	0.328 U	0.217 U	1.62 J	1.65 J	1.37 J	1.15 J
PCB-134/143	0.302 U	5.11 J	80.1	5.86 J	2.06 J	2.39 J	0.303 U	0.350 U	0.232 U	4.41 J	7.47 J	0.358 U	0.725 U
PCB-135/151	3.05 J	23.8	345	33.8	15.4	17.9	0.114 U	0.138 U	0.452 U	34.3	29.9	14.0	19.2
PCB-136	1.01 U	10.9 U	171	17.0	6.20	6.38	0.0863 U	0.105 U	0.0834 U	14.9	19.1	1.86 J	2.57 J
PCB-137	0.248 U	4.35 J	77.6	3.25 J	1.25 U	2.05 U	0.367 J	0.289 U	0.191 U	4.98 J	6.78	2.03 J	1.71 J
PCB-139/140	0.284 U	1.96 J	30.7	1.17 U	0.973 J	0.815 J	0.261 U	0.301 U	0.200 U	1.87 J	2.71 J	1.12 J	1.28 J
PCB-141	1.16 J	15.5	199	8.87	7.98	8.20	0.575 J	0.300 U	0.198 U	10.2	14.9	2.34 J	1.95 U
PCB-142	0.340 U	0.239 U	0.741 U	0.425 U	0.386 U	0.197 U	0.309 U	0.357 U	0.236 U	0.332 U	0.398 U	0.381 U	0.771 U
PCB-144	0.137 U	4.32 J	54.9	4.34 J	2.01 J	2.80 J	0.107 U	0.130 U	0.103 U	2.78 J	5.44	0.647 J	0.889 J
PCB-145	0.111 U	0.147 U	0.150 U	0.302 U	0.112 U	0.127 U	0.0910 U	0.111 U	0.0879 U	0.124 U	0.119 U	0.187 U	0.210 U
PCB-146	3.12 J	10.1	166	8.34	7.57 U	8.13	0.254 U	0.294 U	0.195 U	12.6	11.0	7.49	7.34 U
PCB-147/149	9.60 J	61.9	879	64.8	36.9	38.6	0.884 J	0.742 J	0.825 U	68.4	80.3	45.4	51.0
PCB-148	0.145 U	0.191 U	1.06 U	0.392 U	0.146 U	0.165 U	0.119 U	0.146 U	0.115 U	0.162 U	0.155 U	0.242 U	0.272 U
PCB-150	0.105 U	0.138 U	2.21 J	0.284 U	0.105 U	0.119 U	0.0866 U	0.106 U	0.0837 U	0.117 U	0.112 U	0.175 U	0.197 U
PCB-152	0.106 U	0.140 U	1.55 U	0.288 U	0.107 U	0.121 U	0.0860 U	0.105 U	0.0831 U	0.119 U	0.114 U	0.178 U	0.200 U
PCB-153/168	6.46 J	53.4	745	38.5	38.9	40.4	1.13 U	0.730 U	0.653 U	52.6	67.3	40.3	43.9

Table D-1
Groundwater Analytical Results: PCB Congeners and Aroclors

	LDW Adjacent Properties												
Site	**Crowley Marine Services**						**Jorgensen Forge**			**Boeing Isaacson/Thompson**			
Well ID	**EMW-1S**	**DMW-6A**	**EMW-13S**	**EMW-13S-F**	**CMS-SW-1**	**CMS-SW-1-D**	**MW-23**	**MW-48**	**MW-51**	**MW-25**	**MW-13**	**MW-10**	**MW-10-D**
Relative Location at Site	**Up**	**Center**	**Down**	**Down**	**Surface**	**Surface**	**Up**	**Center**	**Down**	**Up**	**Center**	**Down**	**Down**
Sample Date	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/31/2017**	**3/31/2017**	**3/31/2017**	**3/15/2017**	**3/15/2017**	**3/15/2017**	**3/15/2017**
PCB Congeners (pg/L)													
PCB-154	0.126 U	0.839 J	13.1	1.09 U	1.14 J	1.31 U	0.0989 U	0.121 U	0.0956 U	1.69 J	1.13 J	0.729 J	1.19 U
PCB-155	0.1 U	0.132 U	0.134 U	0.272 U	0.101 U	0.114 U	0.0795 U	0.0968 U	0.0768 U	0.112 U	0.107 U	0.168 U	0.188 U
PCB-156/157	0.982 U	8.37 J	134	2.44 U	4.80 U	5.79 U	0.845 U	0.622 U	0.258 U	4.77 U	10.7	5.73 U	6.61 U
PCB-158	0.994 U	7.79 U	127	3.85 J	4.20 J	4.48 J	0.150 U	0.181 U	0.121 U	6.26	11.1	3.67 U	4.30 J
PCB-159	0.0737 U	0.301 U	7.28	0.449 J	0.897 J	0.849 J	0.270 J	0.101 U	0.0866 U	1.49 U	0.351 J	0.600 J	0.310 U
PCB-161	0.216 U	0.152 U	0.471 U	0.270 U	0.245 U	0.125 U	0.204 U	0.236 U	0.157 U	0.211 U	0.253 U	0.242 U	0.490 U
PCB-162	0.0837 U	0.109 U	5.77	0.418 J	0.189 U	0.122 U	0.200 J	0.0889 U	0.0750 U	0.753 U	0.412 J	0.368 U	0.167 U
PCB-164	1.41 U	6.19	98.9	5.67	3.15 J	2.62 U	0.189 U	0.217 U	0.144 U	5.90	5.63 U	3.93 J	3.40 U
PCB-165	0.236 U	0.166 U	0.514 U	0.294 U	0.267 U	0.137 U	0.210 U	0.243 U	0.161 U	0.230 U	0.276 U	0.264 U	0.534 U
PCB-167	0.448 J	3.23 J	55.9	2.07 U	1.67 J	1.89 J	0.232 J	0.296 J	0.0870 U	3.09 J	4.39 J	2.58 J	3.07 J
PCB-169	0.187 U	0.256 U	1.69 J	0.280 U	0.403 U	0.288 U	0.379 U	0.389 U	0.229 U	0.756 J	0.195 U	0.308 U	0.376 U
Total Hexachlorobiphenyls	43.6 J	341 J	5,390 J	296 J	196 J	212 J	2.53 J	1.04 J	0.952 U	345 J	444 J	208 J	227 J
PCB-170	7.13 U	6.16	177	3.74 J	11.9	12.5	0.582 J	0.465 J	0.182 U	10.8	4.15 J	4.99	5.61
PCB-171/173	1.34 J	2.08 J	57.3	1.16 J	2.81 U	3.35 U	0.449 U	0.302 U	0.186 U	3.24 J	1.71 U	2.12 J	1.50 J
PCB-172	1.52 J	1.01 U	26.6	0.792 U	1.96 U	1.81 U	0.159 U	0.294 J	0.162 U	3.85 J	0.708 J	0.911 U	0.488 U
PCB-174	6.09	7.68	172	4.65 J	13.3	14.9	0.123 U	0.194 U	0.155 U	31.5	5.76	8.04	7.03
PCB-175	10.0	7.69	7.29	6.33 U	0.364 U	0.467 U	0.177 U	0.165 U	0.128 U	0.833 U	5.61	13.8	15.4
PCB-176	0.345 U	1.05 U	20.7	0.699 U	1.88 J	1.55 J	0.175 U	0.152 U	0.0926 U	3.25 J	0.774 U	0.179 U	0.532 J
PCB-177	3.62 J	3.13 U	93.5	2.63 J	8.38	7.74 U	0.448 J	0.221 U	0.176 U	9.23 U	2.75 J	4.08 J	4.47 J
PCB-178	1.66 U	1.22 J	27.9	1.00 U	3.20 J	2.91 U	0.179 U	0.167 U	0.130 U	10.1	0.834 J	2.04 J	2.79 J
PCB-179	2.54 J	3.35 J	66.8	2.89 J	6.17	6.45	0.137 U	0.127 U	0.0990 U	24.8	2.08 U	3.15 J	2.65 J
PCB-180/193	24.4	11.3	312	7.63 U	24.6	28.4	0.756 U	0.451 U	0.594 U	69.5	7.31 U	8.98 J	9.20 J
PCB-181	0.207 U	0.170 U	2.82 J	0.209 U	0.271 U	0.164 U	0.256 J	0.206 U	0.164 U	0.151 U	0.135 U	0.641 U	0.344 U
PCB-182	0.191 U	0.134 U	1.49 J	0.256 U	0.202 U	0.293 U	0.170 U	0.158 U	0.123 U	0.549 J	0.155 U	0.274 U	0.178 U
PCB-183/185	2.88 J	4.32 J	94.4	1.40 U	8.04 J	7.52 J	0.102 U	0.161 U	0.128 U	21.5	2.36 U	2.88 U	3.08 J
PCB-184	0.137 U	0.0963 U	0.193 U	0.183 U	0.145 U	0.210 U	0.143 U	0.133 U	0.104 U	0.0888 U	0.111 U	0.196 U	0.127 U
PCB-186	0.125 U	0.0880 U	0.176 U	0.167 U	0.132 U	0.191 U	0.128 U	0.119 U	0.0929 U	0.0811 U	0.101 U	0.179 U	0.116 U
PCB-187	0.191 U	0.134 U	176	0.256 U	18.4	20.6	0.660 J	0.161 U	0.391 J	106	0.154 U	0.273 U	0.178 U
PCB-188	0.125 U	0.0876 U	0.160 U	0.167 U	0.132 U	0.191 U	0.134 U	0.124 U	0.0968 U	0.0808 U	0.101 U	0.178 U	0.116 U
PCB-189	0.164 U	0.240 U	8.42	0.332 U	0.207 U	0.759 U	0.444 J	0.396 U	0.183 U	1.01 J	0.154 U	0.143 U	0.292 U
PCB-190	0.799 J	0.728 U	35.0	0.682 J	2.32 U	2.54 J	0.385 U	0.154 U	0.125 U	1.58 U	0.166 U	1.21 U	1.45 J
PCB-191	0.257 U	0.212 U	7.00 U	0.260 U	0.337 U	0.204 U	0.241 J	0.258 J	0.123 U	0.641 U	0.168 U	0.798 U	0.428 U
PCB-192	0.251 U	0.206 U	0.446 U	0.253 U	0.328 U	0.199 U	0.336 J	0.273 J	0.130 U	0.183 U	0.163 U	0.777 U	0.416 U
Total Heptachlorobiphenyls	53.2 J	43.8 J	1,280 J	15.8 J	95.9 J	94.5 J	2.97 J	1.29 J	0.391 J	286 J	19.8 J	47.2 J	53.7 J
PCB-194	4.39 U	2.68 U	67.8	1.44 U	7.04 U	8.78	0.861 U	0.717 J	0.724 J	48.9	1.54 U	2.12 U	2.46 U
PCB-195	1.09 J	0.332 U	22.9	1.15 U	1.46 U	1.85 U	1.03 U	0.444 J	0.198 U	8.57	0.208 U	0.852 U	0.293 U
PCB-196	0.986 U	2.59 J	39.3	0.301 U	2.75 U	3.68 U	0.290 U	0.237 U	0.147 U	24.3 U	0.929 J	3.02 J	1.02 J
PCB-197	0.0840 U	0.266 U	10.3	0.166 U	1.14 J	0.299 U	0.193 U	0.158 U	0.0974 U	1.63 U	0.150 U	0.313 U	0.174 U
PCB-198/199	6.05 J	3.07 J	82.3	1.19 U	11.2	11.4	0.295 U	0.275 J	0.149 U	124	1.53 U	3.00 J	3.76 J
PCB-200	0.0995 U	0.314 U	0.304 U	0.197 U	0.291 U	0.354 U	0.210 U	0.172 U	0.106 U	11.1	0.177 U	0.370 U	0.205 U

Table D-1
Groundwater Analytical Results: PCB Congeners and Aroclors

	LDW Adjacent Properties												
Site	**Crowley Marine Services**						**Jorgensen Forge**			**Boeing Isaacson/Thompson**			
Well ID	**EMW-1S**	**DMW-6A**	**EMW-13S**	**EMW-13S-F**	**CMS-SW-1**	**CMS-SW-1-D**	**MW-23**	**MW-48**	**MW-51**	**MW-25**	**MW-13**	**MW-10**	**MW-10-D**
Relative Location at Site	**Up**	**Center**	**Down**	**Down**	**Surface**	**Surface**	**Up**	**Center**	**Down**	**Up**	**Center**	**Down**	**Down**
Sample Date	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/16/2017**	**3/31/2017**	**3/31/2017**	**3/31/2017**	**3/15/2017**	**3/15/2017**	**3/15/2017**	**3/15/2017**
PCB Congeners (pg/L)													
PCB-201	0.375 U	0.237 U	8.06	0.148 U	0.687 U	0.814 U	0.214 U	0.175 U	0.108 U	13.2	0.134 U	0.279 U	0.479 J
PCB-202	1.28 J	0.214 U	13.8	0.134 U	2.37 J	1.81 J	0.231 U	0.189 U	0.117 U	38.0	0.480 J	1.08 U	1.07 U
PCB-203	4.61 J	0.491 U	59.0	0.307 U	6.42	5.37 U	0.290 U	0.237 U	0.146 U	83.7	0.811 J	0.578 U	2.05 U
PCB-204	0.0929 U	0.294 U	0.284 U	0.184 U	0.272 U	0.331 U	0.216 U	0.176 U	0.109 U	0.118 U	0.165 U	0.346 U	0.192 U
PCB-205	0.223 U	0.254 U	2.79 U	0.254 U	0.277 U	0.189 U	0.397 U	0.319 J	0.145 U	1.37 J	0.159 U	0.222 U	0.224 U
Total Octachlorobiphenyl	13.0 J	5.66 J	303	1.44 U	21.1 J	22.0 J	1.03 U	1.76 J	0.724 J	329 J	2.22 J	6.02 J	5.26 J
PCB-206	3.99 J	1.03 U	29.7	1.20 U	11.6 J	4.11 J	0.408 U	0.547 U	0.517 U	84.6	0.722 U	1.49 U	1.23 U
PCB-207	0.320 U	0.539 U	3.86 J	0.607 U	1.17 U	0.439 U	0.185 U	0.260 U	0.275 U	10.1	0.452 U	0.640 U	0.588 U
PCB-208	1.29 U	0.551 U	6.81	0.621 U	3.75 J	1.57 J	0.189 U	0.265 U	0.280 U	26.1	0.462 U	0.654 U	0.601 U
Total Nonachlorobiphenyl	3.99 J	1.03 U	40.4 J	1.20 U	15.4 J	5.68 J	0.408 U	0.547 U	0.517 U	121	0.722 U	1.49 U	1.23 U
PCB-209	0.730 U	0.557 U	7.86	0.222 U	2.76 U	2.09 J	0.245 J	0.175 U	0.190 U	7.63	0.288 U	0.552 U	0.398 U
Total Decachlorobiphenyl	0.730 U	0.557 U	7.86	0.222 U	2.76 U	2.09 J	0.245 J	0.175 U	0.190 U	7.63	0.288 U	0.552 U	0.398 U
Total PCB Congeners (pg/L)	124 J	1,040 J	15,270 J	1,340 J	936 J	962 J	68.1 J	28.0 J	29.5 J	1,840 J	2,660 J	546 J	608 J
Total PCB Congeners (ug/L)	0.000124 J	0.00104 J	0.01527 J	0.00134 J	0.000936 J	0.000962 J	0.0000681 J	0.0000280 J	0.0000295 J	0.00184 J	0.00266 J	0.000546 J	0.000608 J
PCB Congener TEQ (ug/L)	0.0127	0.0191	0.157	0.0337	0.0284	0.0215	0.0153	0.0141	0.0107	0.0538	0.03251	0.0233	0.0346
PCB Aroclors (ug/L)													
Aroclor 1016	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1221	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1232	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1242	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1248	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1254	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1260	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1262	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Aroclor 1268	0.010 U	0.010 U	0.010 U	0.010 UJ	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Total PCB Aroclors	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U

Table D-2
Analytical Results - Conventional Parameters

Site	Sample	Sample Date	Tidal Influence at Well	Chloride (mg/L)	Conductivity (uS/cm)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
LDW Adjacent Sites							
Duwamish Shipyard	DS-DS1P2-19-20170314	3/14/2017	No	584	2,080	1,190	8.2
	DS-DS1-PZ-01-20170314	3/14/2017	Yes	1,330	4,260	2,440	61.3
	DS-DS1-MW-6-20170314	3/14/2017	Yes	2,370	6,680	4,080	18.6
	DS-SW-1-20170314	3/14/2017	--	1,680	5,110	2,910	13.2
Glacier Northwest	GNW-MW-32S-20170321	3/21/2017	No	11.2	653	346 J	66.5 J
	GNW-MW-4S-20170321	3/21/2017	No	44.1	386	257 J	1.2 UJ
	GNW-MW-33S-20170321	3/21/2017	No	2.68	2,390	650 J	3.0 J
	GNW-SW-1-20170321	3/21/2017	--	1,310	4,090	2,240 J	15.3 J
North Terminal 115	NT115-MW-20-20170317	3/17/2017	No	13.6	645	396	4.7
	NT115-MW-3-20170317	3/17/2017	No	636	5,150	3,500	220
	NT115-MW-10-20170317	3/17/2017	No	2.22	422	264	1.1 U
Douglas Management Dock	DMD-MW-11-20170330	3/30/2017	No	752	2,470	1,320	1.1 U
	DMD-MW-17-20170330	3/30/2017	No	94.4	2,110	1,370	1.1 UJ
	DMD-MW-15-20170330	3/30/2017	Yes	669	2,940	1,680	54.4
	DMD-SW-1-20170330	3/30/2017	--	776	2,530	1,400	18.4
Industrial Container Services	ICS-DOF-MW3-20170329	3/29/2017	No	252	2,330	1,560	1.2 UJ
	ICS-DOF-MW1-20170329	3/29/2017	Yes	2,190	7,560	4,380	72.1
	ICS-SA-MW2-20170329	3/29/2017	Yes	851	3,110	1,730	2.9
Duwamish Marine Center	DMC-MW-10-20170313	3/13/2017	Yes	14.1	242	147	1.1 U
	DMC-MW-8-20170313	3/13/2017	Yes	25.5	583	360	1.1 U
	DMC-MW-16-20170313	3/13/2017	Yes	3,050	9,030	5,020	8.3
	DMC-SW-1-20170313	3/13/2017	--	2,140	6,520	3,750	4.6
Crowley Marine Services	CMS-EMW-1S-20170316	3/16/2017	No	1.56	374	242	2.4
	CMS-DMW-6A-20170316	3/16/2017	Yes	12.6	351	210	69.7
	CMS-EMW-13S-20170316	3/16/2017	Yes	1,670	4,280	2,460	2.7
	CMS-SW-1-20170316	3/16/2017	--	71.9	238	133	56.3
Jorgensen Forge	JF-MW-23-20170331	3/31/2017	No	64.6	518	263	61.0
	JF-MW-48-20170331	3/31/2017	No	1.63	202	134	3.9
	JF-MW-51-20170331	3/31/2017	Yes	9.22	377	262	10.0
Boeing Isaacson/Thompson	BIT-MW-25-20170315	3/15/2017	No	3.42	475	299	1.1 U
	BIT-MW-13-20170315	3/15/2017	No	7.81	641	448	32.2
	BIT-MW-10-20170315	3/15/2017	Yes	1.73	70.1	44.0	1.1 U
8801 Site/PACCAR	8801-MW-16A-20170328	3/28/2017	No	1.35	190	111	1.1 U
	8801-MW-42A-20170328	3/28/2017	No	7.86	306	194	10.1
	8801-MW-30A-20170328	3/28/2017	Yes	660	2,620	1,440	1.1 U

Table D-2
Analytical Results - Conventional Parameters

Site	Sample	Sample Date	Tidal Influence at Well	Chloride (mg/L)	Conductivity (uS/cm)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)
Inland Sites							
South Park Landfill	SPL-MW-12-20170320	3/20/2017	No	6.55	148	104	3.2
	SPL-MW-32-20170320	3/20/2017	No	22.3	988	606	52.0
	SPL-MW-31-20170320	3/20/2017	No	13.1	349	257	2.2
Whitehead Tyee	WT-MW-110-20170327	3/27/2017	No	8.85	388	243	1.4
	WT-MW-108-20170327	3/27/2017	No	13.1	665	416	55.5
	WT-MW-06-20170327	3/27/2017	No	9.92	343	186	18.4
North Boeing Field	NBF-NGW521-20170322	3/22/2017	No	4.25	780	478 J	1.2 UJ
	NBF-NGW520-20170322	3/22/2017	No	4.02	410	254 J	21.4 J
	NBF-NGW252-20170322	3/22/2017	No	14.4	457	296 J	1.2 UJ
EMF at KCIA	EMF-MW-7-20170322	3/22/2017	No	16.1	328	186 J	1.1 UJ
80 S Hudson Street	SHS-MW-07-20170406	4/6/2017	No	24.3	802	534	1.1 UJ
	SHS-MW-02-20170406	4/6/2017	No	2.37	232	155	50.7
Gray Line of Seattle	GLS-MW-K01-20170406	4/6/2017	No	23.3	1,090	614	68.0
WA DOT Spokane Street	DOT-MW-2-20170406	4/6/2017	No	1,290	3,860	2,080	15.1

Wells are ordered from upgradient to downgradient for each site. Where a surface water sample was collected, it follows the downgradient well.

uS/cm - microSiemens per centimeter
mg/L - milligrams per Liter
pg/L - picograms per Liter
J - estimated concentration
U - not detected at or above the reporting limit
UJ - not detected at or above the estimated reporting limit

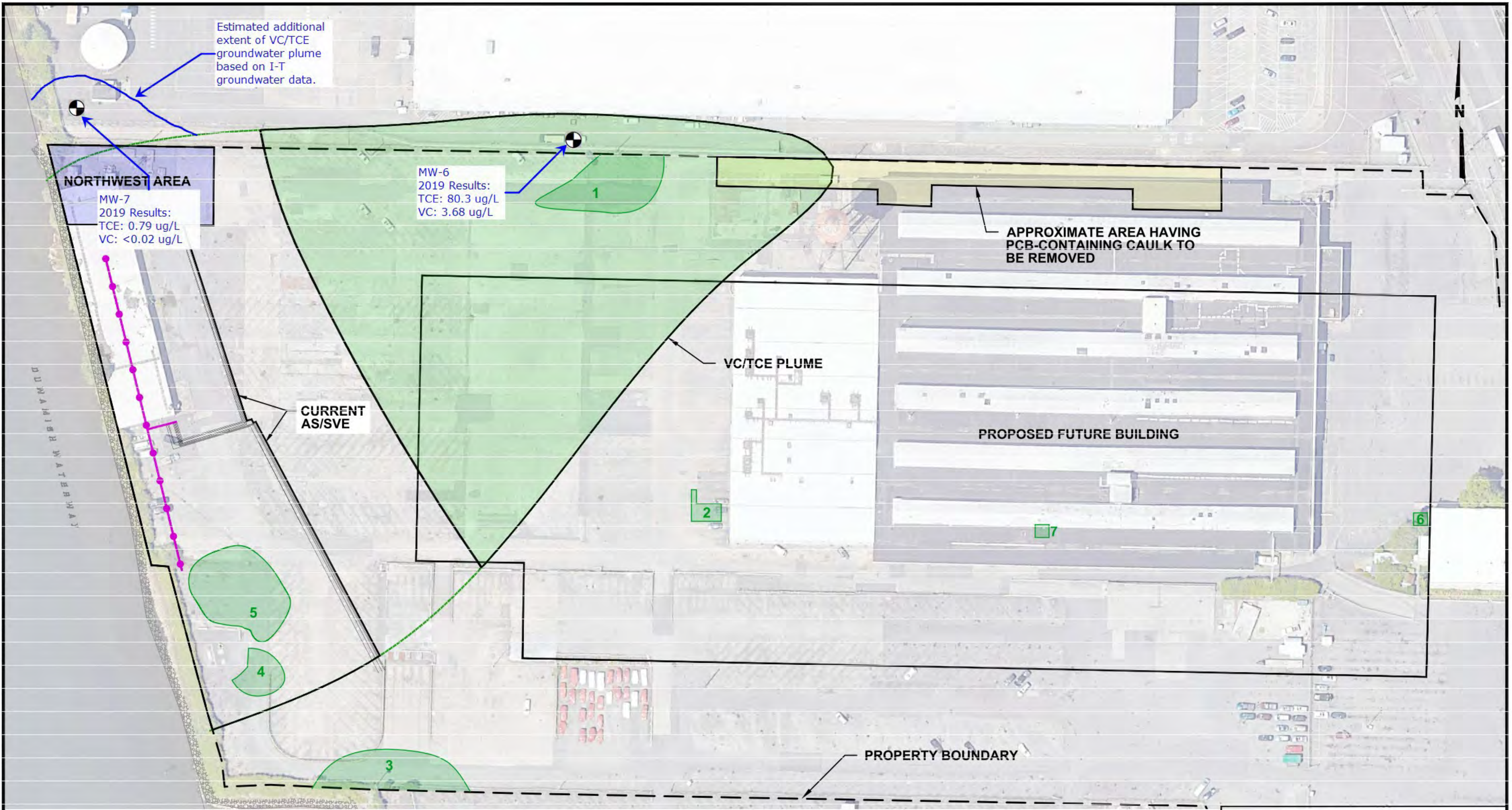
EMF - Electronics Manufacturing Facility
KCIA - King County International Airport
LDW - Lower Duwamish Waterway
PCB - polychlorinated biphenyl
WA DOT - Washington State Department of Transportation

APPENDIX C

8801 Site VC/TCE Plume

Source:

Shannon & Wilson. 2019. Public Review Draft Interim Action Work Plan, 8801 East Marginal Way S., Tukwila, Washington, Agreed Order No. 6069. Shannon & Wilson, Inc. June 7.



Additions made by Landau Associates, Inc. based on 2019 sampling results

LEGEND

3	Soil Excavation Area
🟩	Proposed Enhanced Reductive Dechlorination Groundwater Remediation Area
🟪	Proposed In Situ Chemical Oxidation Groundwater Remediation Area
●—	Proposed Extension of Air Sparge/Soil Vapor Extraction Groundwater Remedy

0 100 200

Scale in Feet

8801 East Marginal Way South
Tukwila, Washington

PROPOSED REMEDIATION

June 2019 21-1-12567-014

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 7

Filename: \\sea-fs1\Drafting\21\12567\014\21-1-12567-014 DUA.dwg Layout: Figure 7-IAWP Date: 06-03-2019 Login: JRS

APPENDIX D

Treatability Study Work Plan

Treatability Study Work Plan
Isaacson-Thompson Site
Tukwila, Washington

December 18, 2017

Prepared for

The Boeing Company

LANDAU ASSOCIATES

Treatability Study Work Plan
Isaacson-Thompson Site
Tukwila, Washington

This document was prepared by, or under the direct supervision of, the technical professionals noted below.

Evelyn Ives

Document prepared by: Evelyn Ives, PE

Senior Project Engineer

Document reviewed by: Piper M. Roelen, PE

Senior Associate; Quality Reviewer

Date: December 18, 2017
Project No.: 0025190.217
File path: P:\025\190\002\FileRm\R\FS\Treatability Study Work Plan\Boeing_I-T_Landau_121817_Treatability Study WP.docx
Project Coordinator: tam

This page intentionally left blank.

TABLE OF CONTENTS

Page
1.0 INTRODUCTION 1-1
2.0 SAMPLE COLLECTION PLAN 2-1
  2.1 Groundwater Sampling 2-1
  2.2 Soil Sampling 2-2
  2.3 Sample Shipping 2-3
3.0 TREATABILITY TESTING PROCEDURES 3-1
  3.1 Baseline Characterization 3-1
  3.2 Initial Batch Trials 3-1
  3.3 Reaction Kinetics Trials 3-2
  3.4 Waste Disposal 3-2
4.0 SUMMARY AND EVALUATION OF RESULTS 4-1
5.0 USE OF THIS WORK PLAN 5-1

FIGURES

Figure	Title
1	Vicinity Map
2	Treatability Study Sample Locations

LIST OF ABBREVIATIONS AND ACRONYMS

cm	centimeter
DO	dissolved oxygen
FS	feasibility study
ft	feet/foot
g	grams
kg	kilograms
L	liters
LAI	Landau Associates, Inc.
LDW	Lower Duwamish Waterway
µm	micrometers
mL	milliliters
ORP	oxidation reduction potential
PRB	permeable reactive barrier
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
Site	Isaacson-Thompson site in Tukwila, Washington
SU	standard units
USCS	Unified Soil Classification System
work plan	treatability study work plan
wt%	percent weight
ZVI	zero-valent iron

1.0 INTRODUCTION

This treatability study work plan (work plan) summarizes procedures for evaluating the viability of several *in situ* treatment options for groundwater contamination at the Isaacson-Thompson site in Tukwila, Washington (Site). The Site, as shown on Figure 1, is located adjacent to the Lower Duwamish Waterway (LDW). Concentrations of dissolved metals are elevated in groundwater in the northern portion of the Site, where historic wood preserving operations were formerly located. Groundwater conditions in this area are also influenced by high pH caused by cementitious materials that were used to stabilize arsenic-contaminated soil areas in the 1990s. Fluctuations in groundwater elevations appear to bring groundwater in contact with cementitious (highly alkaline) material and cause variable pH conditions with measurements ranging up to 13.7 standard units (SU). In turn, the high pH has resulted in high concentrations of dissolved metals in groundwater. Dissolved arsenic is the main contaminant of concern, but concentrations of copper, nickel, and zinc are also elevated above preliminary[1] cleanup levels for Site groundwater.

The treatability study will be conducted to evaluate the effectiveness of five different iron-based amendments that are being considered for *in situ* treatment application at the Site. The amendments will be implemented as either an emplaced permeable reactive barrier (PRB) or an injectable solution to form a reactive zone in the Site aquifer. Amendments that will be tested for PRB application are Ferox zero-valent iron (ZVI) from Hepure and two blends of MetaFix® from Peroxychem. Amendments that will be tested for injection are ferrous sulfate and ferric chloride.

This work plan outlines the methods for collecting samples to be used in the study, conducting the treatability tests, and evaluating results. The results from this study will provide empirical bench-scale data that will be used in the Site feasibility study (FS) for Site remediation.

---

[1] Preliminary cleanup levels have not been approved by the Washington State Department of Ecology and will be proposed in the Isaacson-Thompson Feasibility Study.

2.0 SAMPLE COLLECTION PLAN

Soil and groundwater samples will be collected from three different Site locations to use in the treatability study. Locations were chosen to be representative of a range of different conditions within the contaminated groundwater zone. Groundwater will be collected from existing wells I-104, I-205(s), and MW-23. Soil borings will be drilled adjacent/near to these wells, as feasible for direct-push drilling (e.g., outside the stabilized soil mass for the boring near MW-23), for collection of soil samples, as shown on Figure 2. Wells I-104 and I-205(s) are near the shoreline, at either end of which a potential PRB would likely be installed. I-104 contained the highest shoreline concentrations of arsenic as measured during the remedial investigation (RI).[2] I-205(s) also contained concentrations of arsenic above the preliminary cleanup level, but generally were an order of magnitude lower than at I-104. However, the pH of groundwater at I-205(s) was much lower than other shoreline wells. The pH in groundwater at I-205(s) ranged from 5.4 to 6.9, while the pH at I-104 ranged from 5.4 to 9.0 during the RI sampling. The third representative location, MW-23, is located inside the stabilized soil area. Measurements of pH at MW-23 ranged up to 11.9 and dissolved arsenic concentrations were one to three orders of magnitude greater than at the shoreline wells. This location will represent the worst-case scenario for treatment requirements.

2.1 Groundwater Sampling

Groundwater samples will be collected from monitoring wells within 1 hour before and 1 hour after low tide, at a time when groundwater near the shoreline should be flowing from the Site to the LDW. Collection of groundwater samples will be completed using low-flow sampling techniques as follows:

- Depth to groundwater will be measured from the top of casing prior to extraction of water from the well.
- Before sampling, new dedicated tubing will be placed in each well. Then the well will be purged at a low pumping rate using a peristaltic pump. The pumping rate will be maintained at less than 1 liter (L) per minute and with drawdown of less than 1 foot (ft) during purging. Purging will continue until field parameters (specific conductance, pH, temperature, dissolved oxygen [DO], and oxidation reduction potential [ORP]) have stabilized.
- Purge data will be recorded on a Groundwater Sample Collection form including purge volume; time of commencement and termination of purging; any observations regarding color, turbidity, or other factors that may have been important in evaluation of sample quality; and field measurements of pH, specific conductance, temperature, DO, and ORP.
- Following the stabilization of field parameters, the flow cell will be disconnected and groundwater samples will be collected. Sample data will be recorded on a Groundwater Sample Collection form, including sample number and time collected; the observed physical characteristics of the sample (e.g., color, turbidity, etc.); and field parameters (pH, specific conductance, temperature, dissolved oxygen, and ORP).

---

[2] LAI and AMEC. 2014. Final Remedial Investigation Report, Boeing Isaacson-Thompson Site, Tukwila, Washington. Landau Associates, Inc. and AMEC Environment & Infrastructure, Inc. April 21.

- As required by the treatability study laboratory, at least 9.5 L of groundwater will be collected from each of the three wells.
- Groundwater samples will be collected directly into laboratory-provided specialized nitrogen-purged sample containers using a peristaltic pump, leaving no head space. Samples will be placed in a chilled cooler immediately after collection. Clean gloves will be worn when collecting each sample.

Groundwater samples collected from monitoring wells and piezometers for laboratory analysis will be labeled using the following format:

"Study-location-yymmdd" where location will be I-104, I-205(s), or MW-23.

2.2 Soil Sampling

Borings for collecting soil samples will be drilled using a direct-push probe rig. Borings will extend at least 5 ft below the groundwater table interface, encountered at time of drilling. Borings will be completed by a driller licensed in the state of Washington and will be monitored by a Landau Associates, Inc. (LAI) field representative. Soil will be described and classified in accordance with the Unified Soil Classification System (USCS).

Prior to initiation of drilling or any other invasive subsurface activity, the locations of each proposed exploration will be checked in the field to locate aboveground utilities or physical limitations that would prevent drilling at the proposed location. In addition, a public utility locate service will be contacted to locate underground utilities at the perimeter of the Site and a private utility locate service will be retained to clear explorations for underground utilities. The final location for each borehole will be based on the findings of the field check. Before and between drilling of each boring and at completion of the project, downhole drilling equipment will be cleaned using a high-pressure, hot water or steam washer.

During drilling, continuous soil cores will be collected at each soil boring location to classify soil lithology in accordance with the USCS. Soil cores will be obtained using a closed-piston sampling device with a 48-inch long, 1.5-inch-diameter core sampler. Soil samples will be placed directly into laboratory-supplied jars. The sampler will collect soil from an interval of 5 ft above and 5 ft below the groundwater interface. When possible, gravel larger than 1 centimeter (cm) will be removed before placing soil samples into jars. The laboratory will weigh and homogenize each soil sample upon receipt, and if necessary, remove and weigh particles greater than 4 millimeters in size.

As required by the treatability study laboratory, a minimum of 3 kilograms (kg) of soil will be collected from each soil boring. If insufficient soil volume is recovered in the 10-ft coring interval to fill all of the sample jars, then soil from a deeper interval will be collected and noted on the Log of Exploration.

Soil samples collected will be labeled using the following format:

"Study-location(-depth interval)-yymmdd" where location will be “TSB-A” for the boring adjacent to I-104; “TSB-B” for the boring adjacent to MW-23; and “TSB-C” for the boring adjacent to I-205(s).

2.3 Sample Shipping

Samples will be properly packed on ice with a completed chain-of-custody form and returned by overnight delivery to the treatability study laboratory.

3.0 TREATABILITY TESTING PROCEDURES

Treatability testing will be performed by ReSolution Partners laboratory in Madison, Wisconsin and will consist of three phases: baseline characterization, initial batch trials, and reaction kinetics trials. Each phase of testing is described below.

3.1 Baseline Characterization

Baseline characterization will be completed within the first week of laboratory receipt of samples. The soil and groundwater samples will be analyzed for pH, ORP (groundwater only), arsenic, copper, nickel, and zinc (metals by Method 6020 ICP-MS). All metal analyses will be performed by Pace Analytical in Green Bay, Wisconsin.

The baseline results will be shared with LAI to verify expected concentrations before proceeding with the initial batch trials.

3.2 Initial Batch Trials

A series of batch tests will be performed to determine metals removal efficiency from Site groundwater by five iron amendments. The initial tests will be conducted at varying amendment concentrations to identify appropriate treatment doses for Site-specific conditions. Results from each amendment trial will be compared to determine the best treatment performance. Initial amendment concentrations were developed based on vendor recommendations and are as follows:

- Ferox ZVI at dosage rates of 1 percent weight (wt%), 2.5 wt%, and 5 wt% of dry reagent.
- MetaFix (blend 1) at dosage rates of 1 wt%, 2.5 wt%, and 5 wt% of dry reagent.
- MetaFix (blend 2) at dosage rates of 1 wt%, 2.5 wt%, and 5 wt% of dry reagent.
- Ferrous sulfate heptahydrate at dosage rates of 1 wt%, 5 wt%, and 10 wt% of dry reagent.
- Ferric chloride (aqueous) at dosage rates of 1 wt%, 3 wt%, and 5 wt% of aqueous solution.

Site soil or granular fill and groundwater will be used in the batch trials at a fixed liquid-to-solid ratio and one of the reagent dosages. The Site soil will be used with the injected reagents (ferrous sulfate and ferric chloride) and the granular fill will be used with the PRB reagents (MetaFix and ZVI). LAI will provide a specification of the granular fill and ReSolution Partners will obtain a local source of material comparable to that specification or LAI will provide a sample of a local fill material.

The batch test will be done at a fixed 9-day reaction time. This reaction time is comparable to the anticipated residence time of Site groundwater within a 3-ft-thick PRB.[3]

---

[3] Based on seepage velocity of 0.35 ft per day (modeled from hydraulic parameters measured during the Isaacson-Thompson RI).

A series of 45 batches (five reagents at three dosage rates each, applied to three soil or fill and groundwater locations) will be prepared at 10:1 Site groundwater-to-aquifer soil ratios. The 10:1 ratio reflects the use of 200 grams (g; or milliliters [mL]) of groundwater to 20 g of Site soil to provide sufficient water volume for the chemical analyses. Groundwater, soil, and amendments will be added to test bottles in an oxygen-free glove box to maintain anaerobic conditions. Each reagent will be added at the dosages described above by weight of aquifer/fill soil. Additionally, one unamended control batch for each Site location will be prepared and reacted along with the amended tests. The batches will be capped and then end-over-end tumbled for mixing throughout the 9-day test. After the reaction time is complete, groundwater from each batch will be analyzed for pH, ORP, and metals (arsenic, copper, nickel, and zinc). The metals sample will be filtered at 0.45 micrometers (µm) to reflect dissolved concentrations.

Results from these batches will be reviewed before the final phase of testing is conducted. The two best performing iron amendments will be selected for reaction kinetics trials.

3.3 Reaction Kinetics Trials

Reaction kinetics trials will provide data on the speed of metals treatment for the best two performing reagents. Batch tests will be conducted at two doses and two reaction times for each of the three site locations (24 trials total). One dose will be the best-performing dose determined in the initial batch tests. A second dose will be chosen to optimize the efficiency of the treatment method, based on results from the initial batch tests. The reaction times will also be selected after evaluating the initial batch results, but will likely include one test period shorter than 9 days and one test period longer than 9 days.

The batch tests will be set up and handled in the same manner as the initial trials. Groundwater, soil, and amendments will be added to test bottles in an oxygen-free glove box and consist of fixed 10:1 liquid-to-solids ratios. The batches will be analyzed for pH, ORP, and dissolved metals (arsenic, copper, nickel, and zinc) after the designated reaction times.

3.4 Waste Disposal

After the treatability study is complete, disposal of Site soil and groundwater will be managed by ReSolution Partners under its State of Wisconsin waste generator permit. The waste will be drummed and sent to a Resource Conservation and Recovery Act (RCRA)-approved facility and documented with a waste manifest.

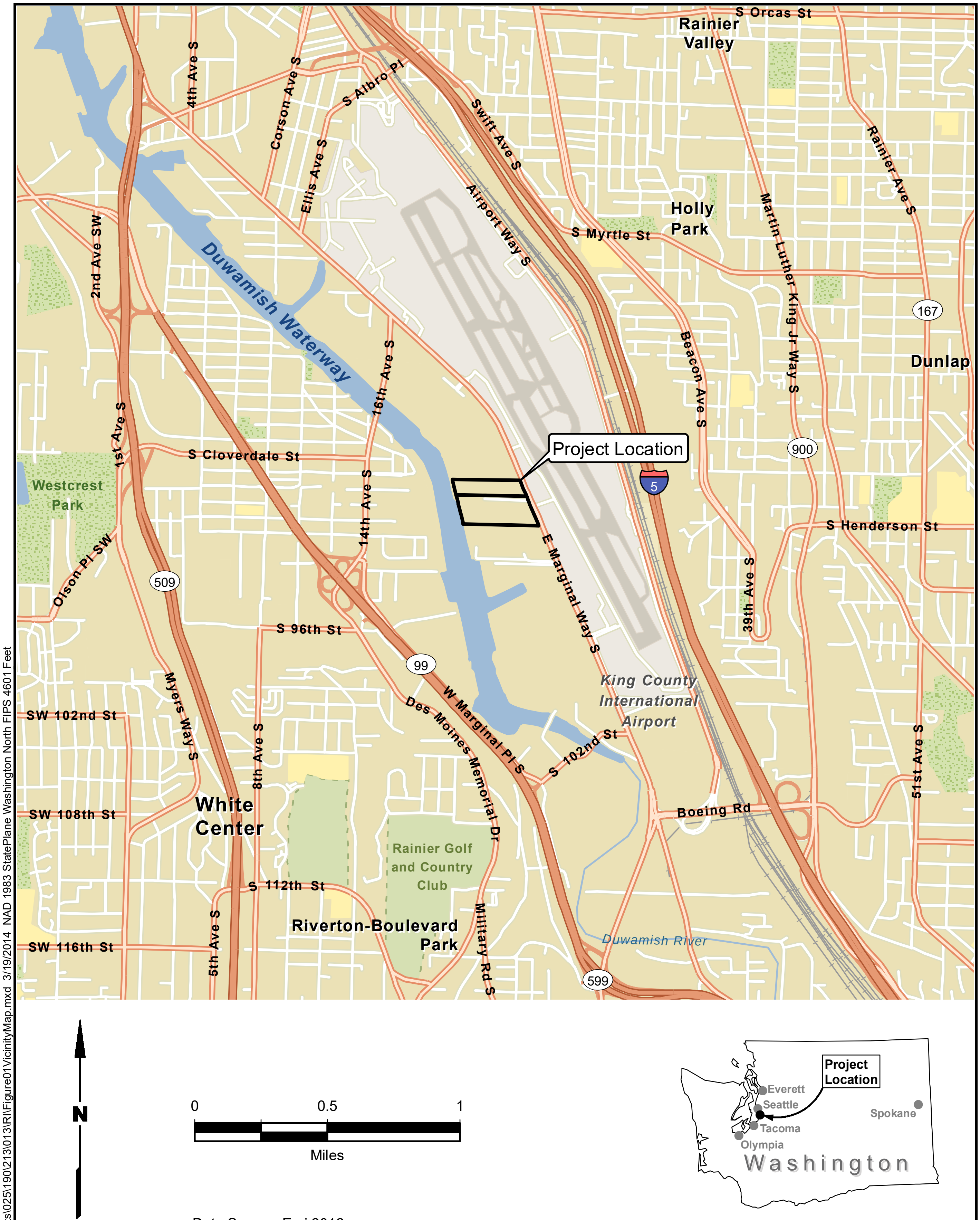
4.0 SUMMARY AND EVALUATION OF RESULTS

This treatability study aims to evaluate the most effective iron amendment-based method for *in situ* treatment of dissolved metals of concern (arsenic, copper, nickel, and zinc) in contaminated groundwater at the Site. Batch tests will be used to simulate potential treatment scenarios, including emplacement of a PRB or injection of aqueous solutions into the Site’s aquifer. As described above, Site groundwater and soil will be collected and sent to ReSolution Partners laboratory for batch testing. Treatment performance will be evaluated by comparing the dissolved metals concentrations in groundwater before and after batch test reactions are completed. Reaction kinetic data will be collected from the two best-performing treatment reagents to evaluate the approximate longevity of each treatment alternative under Site-specific conditions.

A summary of the results and evaluation of the data will be included in the Isaacson-Thompson FS. The results will also be used to identify a remedial technology that will be a component of at least one remedial alternative, and to inform cost estimates (based on identified dosing/quantity and expected longevity of the amendments) developed for the alternative(s), that will be evaluated in the FS.

5.0 USE OF THIS WORK PLAN

This Treatability Study Work Plan has been prepared for the exclusive use of The Boeing Company for specific application to the Isaacson-Thompson Site Feasibility Study. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user’s sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

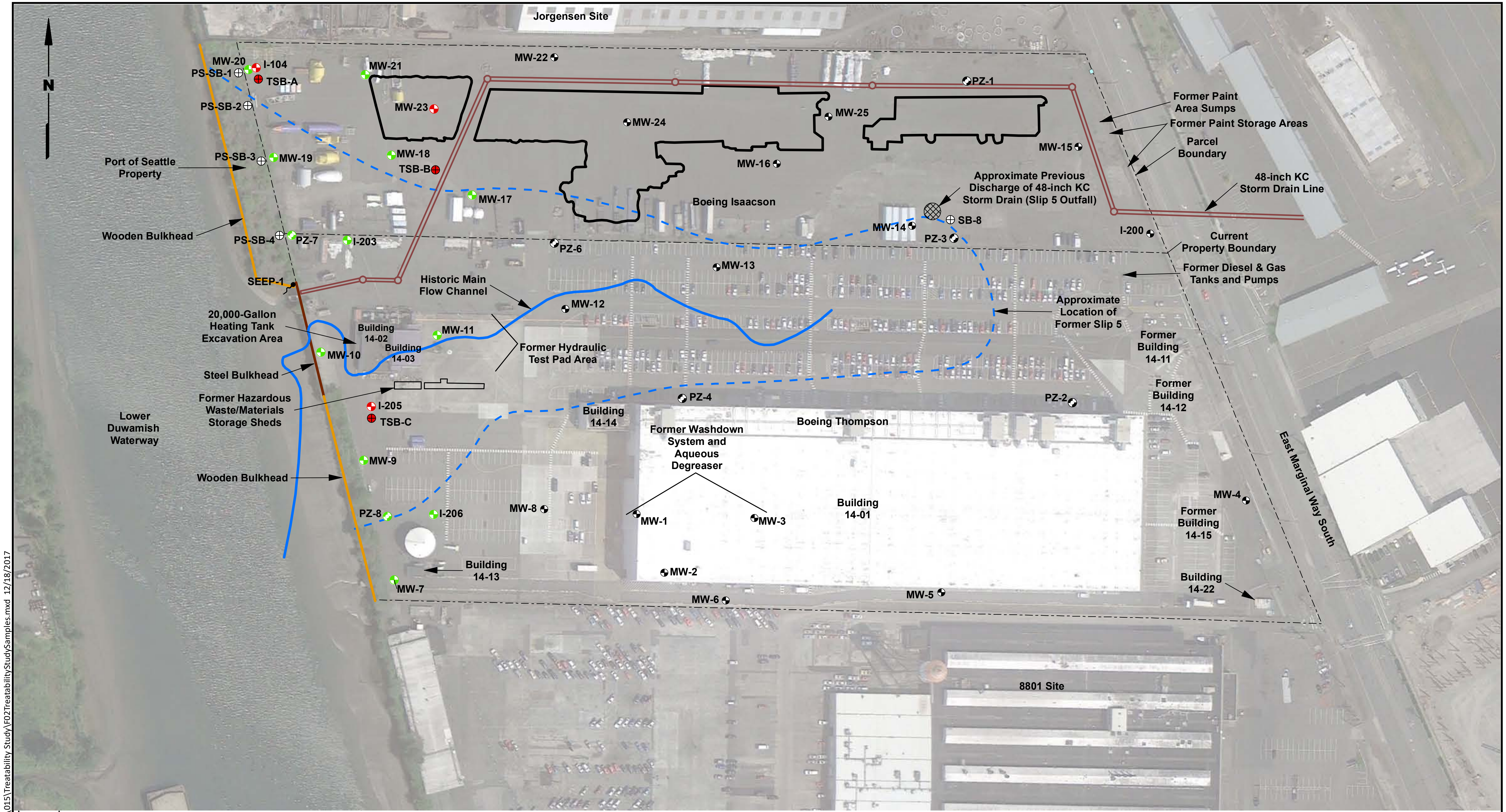


Data Source: Esri 2012

G:\Projects\025\190\213\013\RI\Figure01VicinityMap.mxd 3/19/2014 NAD 1983 StatePlane Washington North FIPS 4601 Feet

Landau Associates

Boeing Isaacson-Thompson Site Tukwila, Washington	**Vicinity Map**	Figure 1



Legend

- 🟥 MW-23 Treatability Study Groundwater Sample Location
- ● SB-23 Proposed Treatability Study Boring/Soil Sample Location
- ● MW-22 Monitoring Well Location
- 🟩 MW-10 Monitoring Well Location Where Groundwater Sampling Occured 1 Hour Before Low Tide and 1 Hour After a 0.0 Tide
- ● PZ-1 Piezometer Location
- 🟩 PZ-7 Piezometer Location Where Groundwater Sampling Occured 1 Hour Before Low Tide and 1 Hour After a 0.0 Tide
- ⊕ SB-8 Direct-Push Boring Groundwater Sample Location
- SEEP-1 Seep
- — Current Extent of Stabilized Soil Material
- - - Approximate Location of Former Slip 5

0 150 300

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

Boeing
Isaacson-Thompson Site
Tukwila, Washington

Treatability Study Sample Locations

Figure
2

G:\Projects\025\190\217\015\Treatability Study\F02TreatabilityStudySamples.mxd 12/18/2017

APPENDIX E

Treatability Study Results – Resolution Partners Lab Report

Final Report

Treatability Study Report for Metalloids and Metals in Groundwater

Boeing Isaacson-Thompson Site, Tukwila, Washington

Prepared for: Landau Associates
3 April 2018

INTRODUCTION

Landau Associates (Landau) is evaluating the performance of five reagents for remediation of metals in groundwater at a site in Seattle, Washington. The reagents will be applied either through mechanical mixing into fill material placed in a permeable reactive barrier (PRB) or injected into native soil to form a reactive zone below the water table. The reagents requested by Landau for the emplaced PRB include Ferox zero-valent iron (ZVI) from Hepure, and two blends of MetaFix from PeroxyChem. The requested injected reactive zone reagents include aqueous solutions of ferrous sulfate ($FeSO_4$) and ferric chloride ($FeCl_3$).

Landau stated that the pH of site groundwater where the reagent application is planned ranges between 5 and 11 SU. Upgradient groundwater pH is as high as 13 SU. The site is anaerobic and groundwater flow is approximately 0.35 feet per day. The remediation goal for the four constituents of concern (COCs) in groundwater are as follows:

- Arsenic 5 μg/L
- Copper 8 μg/L
- Nickel 8 μg/L
- Zinc 80 μg/L

The following summarizes the procedures and results from a series of batch tests performed on site soil and groundwater to evaluate the performance of the five reagents as presented in the ReSolution Partners proposal of 8 December 2017.

TREATABILITY STUDY

Site Sample Collection. The treatability study evaluated site soil and groundwater from three locations determined by Landau. Landau collected the following samples for the study on 23 and 24 January 2018:

Matrix	Sample Identification	Sample Volume (L)	Sample Mass (kg)
Soil	TSB-A (2.5-12.5)		4.8
	TSB-B (6-16)		5.1
	TSB-C (5-15)		4.8
Groundwater	I-205s	9.5	
	I-104	9.5	
	MW-23	9.5	

ReSolution Partners provided specialized 2.5-gallon (9.5 L) nitrogen-purged sample containers for collection of anaerobic groundwater. The containers were to be filled using low flow sampling methods (i.e., peristaltic or down-hole low-flow pump). Samples were received in good condition under chain-of-custody. Samples were placed

The soil boring samples were co-located with monitoring wells, as follows:

TSB-A	I-104
TSB-B	MW-23
TSB-C	I-205s

I-104 and TSB-A are co-located about 75 feet from the Lower Duwamish waterway and approximately 200 feet downgradient of the westernmost mass of stabilized soil. The monitoring well groundwater was sampled from alluvium below the water table between elevations of 3 to -7 feet[1]. The soil sample from TSB-A was collected from the unsaturated zone, above the elevation of the water table. The 10-foot long sample interval includes both fill and alluvium.

MW-23 and TSB-B are located below the westernmost mass of stabilized soil. The monitoring well samples groundwater from alluvium at and just below the water table

---

[1] Site hydrogeologic information from Figures 31 and 34 from Landau Associates. April 2014. Final Remedial Investigation Report, Boeing Isaacson-Thompson Site, Tukwila, Washington.

between elevations of 5 and -2 feet. The TSB-B sample interval includes stabilized soil material and alluvium between elevation estimated to be between elevations of 10 to 0 feet.

Monitoring well I-205[2] and TSB-C are in a filled area of former Slip No. 5 and about 130 feet from the Lower Duwamish Waterway. The well groundwater was sampled from alluvium about 10 to 20 feet below the water table, between elevations of -2 to -12 feet. The TSB-C sample interval includes fill between elevation estimated to be between elevations of 3 to 13 feet, above the monitoring well in the underlying alluvium.

Task 1 – Sample Preparation and Baseline Characterization.

Each soil sample was logged in, weighed and homogenized by mechanical mixing. The soil samples were described as follows:

TSB-A (2.5-12.5)	CLAY, little silt, trace 2 to 20 mm angular slag, very plastic, wet, olive brown (2.5Y4/3), odorless, in 2 of 3 containers. and SILT with clay, trace fine sand, 2 to 20 mm angular slag rounded gravel and woody debris, slightly plastic, moist, black (2.5Y2.5.1), odorless, in 1 of 3 containers.
TSB-B (6-16)	SILT with clay, little fine sand, trace 2 to 20 mm angular slag and woody debris, moderately plastic, wet, very dark grey(5Y3/1), odorless.
TSB-C (5-15)	Fine SAND and SILT, little clay, trace medium to coarse sand, 2 to 20 mm angular slag, woody debris and rounded gravel, slightly plastic, moist, black (5Y2.5/1), odorless.

Both soil types in sample TSA (2.5-12.5) were homogenized into a single composite sample.

Aliquots of each soil sample were submitted to Pace Analytical, Green Bay, Wisconsin for analyses of the four COCs by USEPA Methods 3500/6010 (ICP-AES)[3]. Laboratory reports are provided in Appendix A. ReSolution Partners measured the soil pH using

---

[2] The Final RI appears to use both I-205 and I-205s to designate the same well (this is also true for I-14 and I-104s). The treatability study assumes both designations identify the same monitoring well.

[3] Method 6010 was substituted for Method 6020 to facilitate 2-day turn-around-time.

standard electrodes in a soil/deionized water slurry. The results are summarized as follows:

Sample Identification	Moisture Content	pH (SU)	Compositional Analyses (mg/kg, dry wt.)			
			Arsenic	Copper	Nickel	Zinc
TSA (2.5-12.5)	23.9	8.79	87.9	43.9	11.5	71.0
TSB (6-16)	21.8	7.74	11.3	21.3	14.7	56.9
TSC (5-15)	27.7	6.96	79.2	91.2	14.9	92.2

Analyses met laboratory QC limits for blanks, laboratory control, matrix spike and matrix spike duplicate samples.

Aliquots of each groundwater sample were submitted to Pace Analytical, Green Bay, Wisconsin for analyses of the four COCs by USEPA Method 3010/6010 (ICP-AES)[4]. Laboratory reports are provided in Appendix A. ReSolution Partners measured the soil pH and oxidation reduction potential (ORP) using standard electrodes. The results are summarized as follows:

Sample Identification	Sampling Date	pH (SU)	ORP (mV)	Aqueous Dissolved (0.45 µm) Concentrations (µg/L)			
				Arsenic	Copper	Nickel	Zinc
I-104	2011-2012[a]	6.85	-110	1,700	0.51	0.43	2.0
	Jan 2018	8.54	+10	546	16.8 J	<2.6	79.3
MW-23	2011-2012[a]	10.61	-190	55,000	630	160	140
	Jan 2018	12.06	-220	56,200	2,180	182	491
I-205s	2011-2012[a]	5.99	-98	58	0.36	0.40	2.7
	Jan 2018	6.38	+42	<8.3	<6.3	<2.6	120
Remediation Goals				5	8	8	80

J indicates an estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Analyses met laboratory QC limits for blanks, laboratory control, matrix spike and matrix spike duplicate samples.

The 2011-2012 data were taken from the Final RI Report[1] for comparison to the current treatability samples. The results are the average over four quarterly rounds of sampling from each well (no potential outlier removal was attempted for the small sample sets). The average results for all analytes from MW-23 and for arsenic at I-104 may be biased high because there was a general 5- to 1-fold decrease in concentrations over the four rounds of sampling.

---

[4] Method 6010 was substituted for Method 6020 to facilitate 2-day turn-around-time. This raised the laboratories method detection limit for arsenic above the 5 µg/L target.

Landau Associates also collected samples for more complete chemical analyses immediately before treatability study sample collection. The results of those observations are summarized as follows:

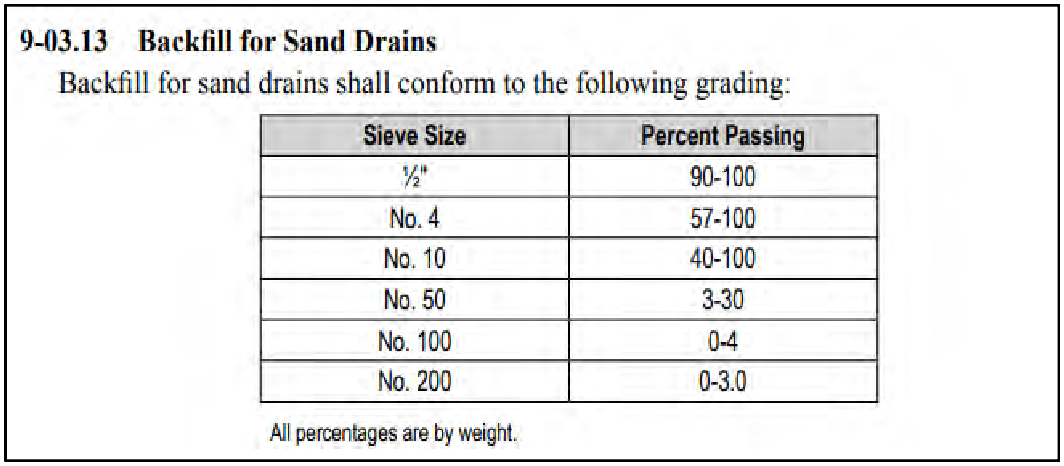
Sample Identification	pH (SU)	ORP (mV)	SEC (µS/cm)
I-104	7.40	130	17.6
MW-23	12.69	-350	5150
I-205s	6.16	-77	1000

The Landau field pH was 1 SU lower for I-104 than the ReSolution Partners as received pH while the results were comparable for the other samples. The field ORPs were about 110 to 130 mV higher than the ReSolution Partners measurements for MW-23 and I-205s while the I-104 measurement was 120 mV lower. The low ORP for I-205s is not consistent with the high DO (4.5 mg/L) measured in the field suggesting that the as received values may be more accurate.

Arsenic concentrations in 2018 were less than the historical means at I-104 and I-205s. The I-104 result is consistent with the historical decreasing arsenic concentration trend. The 2018 concentration at MW-23 was comparable to the historical mean but about 20,000 µg/L higher than the September 2012 sample from that well. Copper and zinc concentrations in 2018 were generally higher than the historical results while 2018 nickel concentrations were comparable to past results. Arsenic and copper remediation goals were exceeded at I-104 and MW-23; the nickel goal was slightly exceeded at MW-23; and the zinc goal was equaled or exceeded at all three monitoring wells.

Baseline analysis were completed under a quick turnaround schedule and shared with Landau on 1 February 2018 to verify expected concentrations before proceeding with the initial batch trials. The decision was to proceed with the study as planned given that there were significant arsenic concentrations in 2 of 3 samples and 3rd sample had a significant zinc in the absence of the other analytes.

Landau provided the following grain-size distribution specification for the granular fill material:



9-03.13 Backfill for Sand Drains

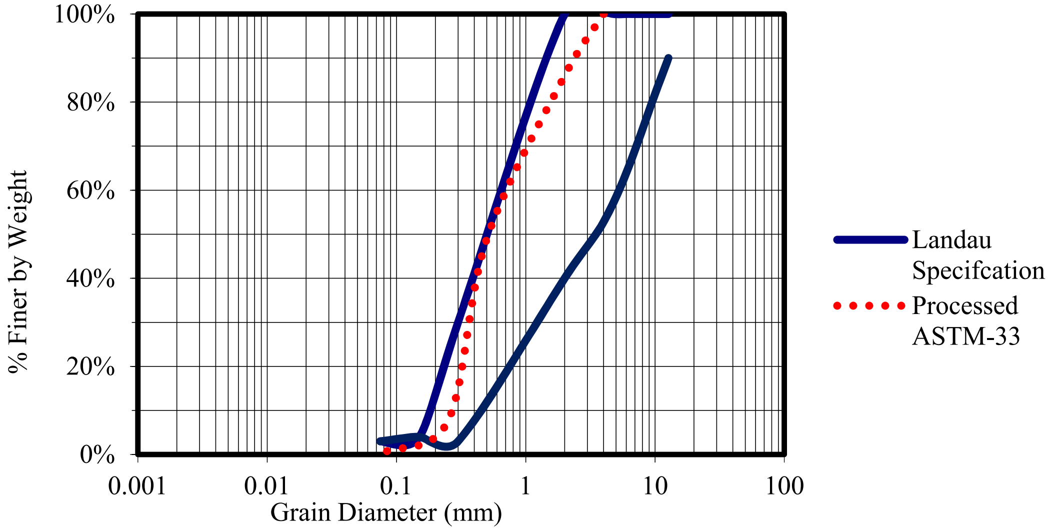
Backfill for sand drains shall conform to the following grading:

Sieve Size	Percent Passing
½"	90-100
No. 4	57-100
No. 10	40-100
No. 50	3-30
No. 100	0-4
No. 200	0-3.0

All percentages are by weight.

No other mineralogy/composition specifications were required.

ReSolution Partners acquired a commercial ASTM-33 sand as the granular fill material. The commercial sand however contained more fines that noted in the specification and also contained material in greater than 4 mm in size. Both fine and coarse material were removed by dry sieving to achieve the following grain-size distribution:



The processed material was judged acceptable for use in the treatability study by Landau.

Task 2 - Initial Batch Trials.

The initial trials were started on 2 February 2018 to screen the potential reagent options and dosage rates to identify the options that appear to have the best performance. The trials are intended to assess the relative performance of the reagents, and the dose may not represent an *in situ* application. The reagent dosage rates included:

Reagent	Dosage (wt.%)		
ZVI-F	1	2.5	5
MetaFix I-6A (I-104)	1	2.5	5
MetaFix I-7A (I-104)	1	2.5	5
MetaFix I-6AF (MW-23)	1	2.5	5
MetaFix I-7AF (MW-23)	1	2.5	5
MetaFix I-6AC (I-205s)	1	2.5	5
MetaFix I-7AC (I-205s)	1	2.5	5
Ferrous sulfate heptahydrate	1	5	10
Ferric chloride	1	3	5

The ZVI used in the trials was FEROX-PRB produced by HePure. PeroxyChem provided samples of the MetaFix Blends specific to each of the groundwater chemistries noted in the baseline analyses. Commercial grades of ferrous sulfate heptahydrate ($FeSO_4•7H_2O$) and ferric chloride ($FeCl_3$, as 40% w/v aqueous solution) in stock at ReSolution Partners were used.

A series of 51 batches (6 unamended controls plus 5 reagents at three dosage rates each, applied to three soil or one fill types and three groundwater locations) were prepared at 10:1 liquid to solid ratios. The 10:1 ratio reflects the use of 20 g of Site soil or processed sand to 200 g (mL) of groundwater to provide sufficient water volume for the chemical analyses. Samples were prepared in a glove box to minimize exposure to oxygen in the atmosphere. The batches were capped in the glove box. The capped bottles were removed from the glove box and end-over-end tumbled for 10 days[5]. At the end of the reaction period samples were analyzed for pH and ORP. Sample aliquots were filtered at 0.45 µm to reflect dissolved metals concentrations and submitted to Pace Analytical, Green Bay, Wisconsin for analyses of the four COCs by USEPA Method 3010/6010 (ICP-AES)[6]. Selected samples were subsequently rerun by USEPA Method 3010/6020 (ICP-MS) to achieve reporting limits that were comparable to the remediation goals. Laboratory reports are provided in Appendix A.

---

[5] Landau's anticipated residence time of contaminated groundwater within a 3-foot thick PRB is 9 days. The 10-day reaction time accommodated a weekend. Injected permeable zones would be wider and have a longer residence time.

[6] Method 6010 was substituted for Method 6020 to facilitate 2-day turn-around-time. This raised the laboratories method detection limit for arsenic above the 5 µg/L target.

Following the completion of the initial dose-response trials, the Landau-ReSolution project team decided to add several reagents and increase the dosages of some reagents as follows (22 February telecom):

- New reagent MetaFix I-6AF2 (8 wt.% dose) with granular fill and MW-23 groundwater,
- PeroxyChem zero-valent iron, ZVI-P (5 wt.% dose), with granular fill and I-104 groundwater; to compare with HePure FEROX-PRB at 5 wt.% dose,
- FEROX-PRB, ZVI-F, (increased dose to 10 wt.%) with granular fill and I-104 groundwater and
- FEROX-PRB, ZVI-F, (5 wt.% dose) plus ferrous sulfate (1 and 2 wt.% doses) with soil and I-104 groundwater.

Table 1 summarizes the results for emplaced PRB evaluations with ZVI, MetaFix Blends and granular fill at a 10-day reaction time. The results are discussed separately for each monitoring well given the range of chemistries reflected in the groundwater:

MW-23. No treatment met the remediation goals arsenic and nickel for groundwater representative of groundwater immediately below the *in situ* stabilized soil area. The ferrous sulfate and the MetaFix I-6AF2 could meet copper and nickel goals.

The control slightly decreased the pH compared to the groundwater only sample. The ORP was unchanged. The control reduced the aqueous arsenic, nickel and zinc concentrations by about 20 to 70 percent without the presence of reagents. Copper concentrations increased slightly. The granular fill consisted of mixed minerology and was brown, suggesting the presence of iron oxide/hydroxide coatings. Ferrous/ferric minerals may have contributed to COC reductions.

ZVI-F slightly decreased the pH at the 5 wt.% doses compared to the control; otherwise the pH increased slightly. The ORP increased by about 100 mV with ZVI-F addition. The ZVI-F increased arsenic, copper and nickel concentrations by about 10 to 15 percent compared to the control sample with no correlation to ZVI dosages. Zinc concentrations increased with ZVI dosage.

MetaFix I-6AF slightly decreased the pH compared to the control with increased dose while the ORP by increased by about 100 mV. The reagent reduced arsenic concentrations by about 30% and reduced copper by about 70% at the largest dose of 5 wt.%. Nickel concentrations increased by about 30% regardless of dose. Zinc concentrations more than doubled over the control at the lowest reagent dose and then approached the control concentration as the dosage increased.

MetaFix I-7AF slightly decreased the pH compared to the control with increased dose while the ORP showed little change. MetaFix I-7AF decreased arsenic and copper concentrations by about 30% and 80%, respectively, at a dose of to 5 wt.%. The reagent had no clear effect on nickel and zinc concentrations.

MetaFix I-6AF2 was added at a higher dose (8 wt.%) than the other MetaFix reagents (maximum 5 wt.% dose). It lowered the pH to near neutral and the arsenic and nickel concentrations and achieved the copper and zinc remediation goals.

<u>I-104.</u> All three reagents reduced the dissolved arsenic concentrations by more than 90% the remediation goal was achieved by ZVI-F at 10 wt.% and by the both mixtures of ZVI-F with ferrous sulfate. Copper and nickel were not present in the unamended control. Zinc was present at just below the remediation goal in the untreated groundwater. The reagents further reduced zinc concentrations.

The control increased the pH by 1 SU and increased the ORP by about 70 mV. As with the MW-23 sample, the control decreased the arsenic concentrations by 20%, zinc by about 80% and copper by about 60%. There was no nickel reported in the groundwater.

ZVI-F did not significantly change the pH or the ORP regardless of dose. Arsenic concentration decreased by 99% at the highest dose of 10 wt.%, to a concentration less than the 5 µg/L remediation goal. Increasing ZVI-F doses also reduced the zinc concentrations when compared to the control.

ZVI-P, at a comparable dose to the ZVI-F, had an arsenic concentration that was about three times that of ZVI-F and had comparable zinc concentrations. The ZVI-P did not perform better than the ZVI-F.

The addition of 1 or 2 wt.% ferrous sulfate to 5 wt.% ZVI-F improved the reduction of arsenic concentrations to less than the remediation goal. The zinc concentrations increased but remained below the zinc remediation goal.

MetaFix I-6A did not significantly change the pH or the ORP regardless of dose. Arsenic concentration decreased with increasing dose to a 97% reduction. There was no effect on the zinc concentrations when compared to the control.

MetaFix I-7A decreased the pH slightly and did not significantly change ORP regardless of dose. Arsenic concentration decreased with increasing dose to a 97% reduction. There was no effect on the zinc concentrations when compared to the control.

I-205s. Zinc was the only COC in groundwater. The control and all three reagents reduced the zinc concentrations to below the 80 µg/L remediation goal.

ZVI reduced the zinc concentration by about 50% at the 5 wt.% dose while both MetaFix reagents reduced the zinc concentrations by greater than approximately 80%.

Table 2 summarizes the results for the injected PRB evaluations with ferrous sulfate heptahydrate and ferric chloride with Site soils at a 10-day reaction time. The results are discussed separately for each monitoring well given the range of chemistries reflected in the groundwater:

MW-23. Both reagents reduced arsenic and zinc concentrations by greater than 90% and reduced copper concentrations up to 99%. However, the remediation goals were not reached for any of the four COCs. Ferrous sulfate raised the nickel concentration.

The control sample used Site soil that was likely in chemical equilibrium with the groundwater from MW-23. Therefore, the COC concentrations were essentially unchanged in the control sample.

Ferrous sulfate reduced the pH by 5 SU to 6.55 SU and increased the ORP by 250 mV as the dosage increased to 10 wt.%. The arsenic concentration decreased by 90% as the dose reached 10 wt.%, copper concentrations decreased by 90 to 99% and zinc decreased by about 90%. The nickel concentrations were unchanged at the lower dosages but increased at the 10 wt.% dose.

Ferric chloride reduced the pH by 4 SU to 7.92 SU and increased the ORP by 200 mV as the dosage increased to 5 wt.%. The arsenic concentration decreased by

96% as the dose reached 5 wt.%, copper concentrations decreased by 70 to 99% and zinc decreased by about 93%. The nickel concentrations decreased by about 57% at the 10 wt.% dose.

The decrease in pH and increase in ORP produced by both reagents facilitated the formation of iron oxyhydroxides (FeOOH) that provided adsorption sites for the sequestration of arsenic, copper and zinc. However, the large decreases in concentrations did not meet the remediation goals for any of the COCs.

<u>I-104.</u> Both reagents reduced arsenic concentrations by 97 to 99 percent at the 5 wt.% dosages, just slightly exceeding the remediation goal of 5 µg/L. The copper concentrations were reduced by about 80% for both reagents between 1 and 3 wt.%, meeting the copper goal. Nickel was below the remediation goals in the untreated samples. Increasing reagent dosages increased the nickel concentrations above the remediation goal. Dissolved zinc concentrations were just below the remediation goal in the untreated sample and were decreased at the lowest reagent dosages but increased above the remediation goal as dosages increased.

The control sample reduced the arsenic concentration by 23% without the presence of reagents. The copper concentration increased slightly, and the zinc concentration decreased compared to the untreated groundwater concentrations. Nickel was not present in the groundwater. The Site soil likely changed the COC concentrations because the soil sample was collected above the elevation of the I-104 groundwater sample.

Ferrous sulfate reduced the pH by 1.4 to 3.5 SU, to as low as 5.62 SU, and changed the ORP by +75 to -85 mV. The arsenic concentration decreased by 99% to just above the remediation goal at a dose of 5 wt.% (pH of 6.16 SU). Arsenic concentrations then increased as the doses increased, and the pH continued to decrease to 5.62 SU. Copper concentrations decreased by about 80% at the 1 wt.% dose and then may have increased with increasing dose and decreasing pH as the reporting limit increased to just above the copper goal of 8 µg/L. Nickel was not detected in the control and the lowest reagent dose but increased significantly as dose increased and pH decreased. Zinc was present at just below the remediation goal. The lowest ferrous sulfate dose decreased the zinc concentration, but increasing doses decreased the pH and increased zinc concentrations significantly. The addition of an alkaline buffer could mitigate the pH increase and improve performance.

Ferric chloride decreased the pH to as low as 5.05 SU and increased the ORP by 140 mV at the 5 wt.% dose. The arsenic concentration decreased by 99% to just above the remediation goal at 3 wt.%. The copper concentration was also lowered to just above its remediation goal at 3 wt.% and then increased in the 5% wt.% dose. Both nickel and zinc concentrations were low at the lowest reagent doses, but increased with increasing dose and decreasing pH. The addition of an alkaline buffer could mitigate the pH increase and improve performance.

The sequestration of arsenic by FeOOH produced by ferrous sulfate and ferric chloride follows a comparable trend as observed with the MW-23 groundwater. However, the pH decreased to lower values in I-104 when compared to the more alkaline MW-23 which may have kept more iron in solution and unavailable for FeOOH precipitation at the highest reagent dosages. The increases in copper, nickel and zinc suggests the dissolution of metal hydroxides as the pH decreased.

<u>I-205s.</u> Zinc was the only COC in groundwater. The control reduced the zinc concentrations to below the 80 µg/L remediation goal. The reagents significantly increased the zinc concentrations.

The control soil was site fill while the groundwater from I-205s was from the underlying alluvium. The pH was little changed but the ORP increased by 200 mV. The zinc concentration decreased by 30% relative to the groundwater to a level close to the remediation goal.

Ferrous sulfate reduced the pH to ≤ 5 SU and the ORP by 160 mV. The concentrations of all four COCs increased with increasing reagent dose and decreasing pH. Given the high and increasing zinc concentrations, the arsenic and copper results with high reporting limits were not reanalyzed to reduce the reporting limits.

Ferric chloride reduced the pH even more than the ferrous sulfate, to a low of 3.86 SU. The ORP initially decreased by 180 mV but then approached the control ORP as the dosage increased. The concentrations of all four COCs increased with increasing reagent dose and exceeded their remediation goals.

The results follow the trends observed with the MW-23 and I-104 groundwater. The I-205s had less buffering capacity than I-104 which resulted in pH values less than those observed with I-104. These lower pH values caused the leaching of COCs from the site fill material and/or dissolution of metal hydroxides.

The trials included 12 reagents applied to three distinct groundwater chemistries; for one oxyanion (arsenic) and three divalent metals (copper, nickel and zinc); at a 10-day reaction time. A summary table that ranks the performance of the reagents across this range of COCs and site conditions is provided in Table 3. The best dose-response for each reagent was ranked from -2 to +2, with negative values reflecting increases in COC concentrations, 0 reflecting no significant concentration change and positive values reflecting decreasing concentrations. A value of +2 indicates the reagent could meet the COC remediation goal.

The performance summary indicates that no reagents performed well across all three locations and for all four COCs:

- Beneath the stabilized soil area (MW-23) ferrous sulfate, ferric chloride and MetaFix I-6AF2 produced the greatest arsenic, copper, nickel and zinc reductions but only copper and nickel remediation goals were met. The reductions were comparable for all three reagents.
- Downgradient of the stabilized soil area (I-104) only arsenic and copper were present at concentrations above remediation goals. The MetaFix reagents significantly reduced the arsenic concentrations but did not reach the remediation goal. The reagents that included ferrous sulfate or ferric chloride could meet the arsenic goal and met or just slightly exceeded the copper goal. The highest, 10 wt.%, dose of ZVI-F also met the arsenic goal.
- In the Channel Fill Area (I-205s) only copper or zinc were present at concentrations above remediation goals in the groundwater or the soil/groundwater control. The MetaFix reagents and ZVI-F reduced arsenic, copper, nickel and zinc concentrations compared to the control. The ferrous sulfate and ferric chloride compounds increased the concentrations of all four COCs. The increase was likely due to the low pH produced by the reagents, an outcome that could be mitigated by including an alkaline buffer with the iron compounds.

Task 3 – Reaction Kinetics

Following the initial batch trials, Task 3 evaluated reaction kinetics for the best performing reagents. If the best reagent or reagents are to be used in an emplaced PRB, the reactions times will be reduced to reflect the potential of high permeability heterogeneities to increased groundwater flow velocities and shorten residence times. If the best performing reagent or reagents are to be used in injected reaction zones, one shorter reaction time will be applied to reflect the potential of high permeability heterogeneities to increased groundwater flow velocities and shorten residence times, and one longer reaction time will be used to reflect the greater width of the injected zones compared to the 3-foot wide emplaced PRB. The reaction times will be determined in consultation with Landau.

The Landau-ReSolution project team (22 February telecom) decided to include the following reagents in Task 3:

Reagent	Groundwater	Dosage (wt.%)	Reaction Times (d)
Ferrous sulfate heptahydrate	MW-23	5	5, 10* and 15
MetaFix I-6AF2	MW-23	8	5, 10 and 15
ZVI – F (HePure)	MW-23	5	5, 10* and 15
	I-104	5	5, 10* and 15
		10	5, 10 and 15
ZVI – P (PeroxyChem)	I-104	5	5 and 10
MetaFix I-6A	I-104	5	5, 10* and 15
Ferrous sulfate heptahydrate	I-104	1	5, 10* and 15
Ferrous sulfate heptahydrate + ZVI-F	I-104	1+5	5, 10* and 15
		2+5	5, 10* and 15

* indicates test was completed as part of the initial dose-response trials

No further testing of the I-205s groundwater was undertaken due to the low COC concentrations in groundwater and the effectiveness of the HePure ZVI and the MetaFix reagents.

A series of 22 batches were prepared at 10:1 solid to liquid ratios. The 10:1 ratio reflects the use of 20 g of Site soil or sand to 200 g (mL) of co-located groundwater to provide sufficient water volume for the chemical analyses. Samples were prepared in a glove box to minimize exposure to oxygen in the atmosphere. The batches were capped in the glove box. The capped bottles were removed from the glove box and end-over-end tumbled for the specified reaction durations. At the end of the reaction periods, samples were analyzed for pH, ORP. Sample aliquots were filtered at 0.45 µm to reflect dissolved metals concentrations and submitted to Pace Analytical, Green Bay, Wisconsin for analyses of the four COCs by USEPA Method 3010/6010(ICP-AES) or 6020 (ICP-

MS) when reporting limits needed to be reduced to reflect remediation goals. Laboratory reports are provided in Appendix A.

The results of the analyses are summarized in Table 4 for emplaced PRB evaluations with ZVI, MetaFix Blends and ferrous sulfate with ZVI in granular fill. The results are discussed separately for each monitoring well given the range of chemistries reflected in the groundwater:

MW-23. Neither ZVI-F or MetaFix I-6AF2 performance significantly changed at reaction times between 5 and 15 days.

ZVI-F did not meet the remediation goals for any COC at 5, 10 and 15 days of reaction time. For arsenic, copper and zinc the data suggest that the reagent increased dissolved concentrations. This suggest the granular fill may have reacted with the ZVI-F over time.

MetaFix I-6AF2 performed better than ZVI-F for all four reagents and at all three reaction times but could only meet remediation goals for copper and zinc.

I-104. Increased reaction times improved the performance of the higher dose of ZVI-F and I-6A but only the high dose ZVI-F and low-dose ZVI-F with ferrous sulfate met remediation goals for all four COCs.

ZVI-F performance at the 5 wt.% dose did not change with reaction time. At the 10 wt.% dose the concentrations of arsenic were reduced to below its remediation goal at 10 and 15 days reaction time. Copper, nickel and zinc goals were met at all reaction times for both dosages.

ZVI-P performance was unchanged at 5 and 10 days reaction time, with arsenic failing to meet the remediation goal.

The mixtures of ferrous sulfate with 5 wt.% ZVI-F meet all COC remediation goals at 5,10 and 15 days reaction time.

The performance of MetaFix I-6A with arsenic may have improved slightly at 10 and 15 days reaction time but the reagent could not meet the 5 µg/L remediation goal.

Table 5 summarizes the results for the injected PRB evaluations with ferrous sulfate heptahydrate and ferric chloride with Site soils. The results are discussed separately for each monitoring well given the range of chemistries reflected in the groundwater:

MW-23. Ferrous sulfate performance improved slightly for zinc with increased reaction time but neither arsenic or nickel goals were met at 5, 10 or 15 days reaction time.
I-104. Ferrous sulfate performance generally did not change significantly over the 5, 10 or 15-day reaction times. The changes were small, but dissolved copper concentrations may have increased to just above its remediation goal at the 15-day reaction time.

In summary, only the high (10 wt.%) dose of ZVI-F may have shown a meaningful improvement in arsenic reductions between 5 and 10 days of reaction time at MW-23 or I-104.

CONCLUSIONS

The conclusions are provided by location as follows:

- **MW-23, beneath the previously stabilized soil mass.** Ferrous sulfate heptahydrate (5 wt.% dose) and MetaFix I-6AF2 (8 wt.% dose) had comparable arsenic performance with ~90% reductions in concentrations but did not reach the remediation goal. The MetaFix reduced the nickel concentration by ~60% but did not reach the remediation goal. Both reagents could meet the copper and zinc remediation goals

- **I-104, downgradient of the stabilized soil mass.** The ZVI-F (HePure FEROX-PRB) with a 10 wt.% dose and the ZVI-F at 5 wt.% with 1 wt.% ferrous sulfate met the remediation goals for all four COCs. The addition of the ferrous sulfate resulted in faster reaction times to meet the goals due to the rapid reaction of the readily solubilized sulfate salt.

- **I-205s, within the former channel.** ZVI-F at a 1 wt.% dose and both MetaFix I-6AC and I-7AC at 5 wt.% doses met the remediation goals for all four COCs.

Table 1. Task 2 Initial dose-response trials for emplaced reagents at 10-d reaction time.

Test Media	Reagent	Dose (wt.%)	pH (SU)	ORP (mV)	Concentrations (µg/L)			
					Arsenic	Copper	Nickel	Zinc
MW-23 Groundwater and Granular Fill	Groundwater only	NA	12.06	-220	56,200	2,180	182	491
	Control (no reagents)	0	12.01	-210	44,100	2,690	146	133
	ZVI-F	1.0	12.14	-120	50,700	2,960	157	137
		2.5	12.13	-120	48,100	2,890	156	127
		5.0	11.98	-110	51,700	3,190	170	154
	MetaFix I-6AF	1.0	12.00	-110	44,400	2,400	182	300
		2.5	11.88	-120	38,300	1,600	184	220
		5.0	11.73	-110	32,300	775	197	165
	MetaFix I-7AF	1.0	11.94	-180	40,000	1,780	156	161
		2.5	11.84	-190	33,900	1,080	148	110
		5.0	11.67	-200	30,600	589	143	127
	MetaFix I-6AF2	8.0	7.47	-130	4,150	**<6.3**	77.8	**44.9**
I-104 Groundwater and Granular Fill	Groundwater only	NA	8.54	10	546	16.8J	**<2.6**	**79.3**
	Control (no reagents)	0	9.54	76	443	**<6.3**	**<2.6**	**15.7J**
	ZVI-F	1.0	9.67	42	32.5	**<6.3**	**<2.6**	**20.9J**
		2.5	9.51	52	27.5	**6.6J**	**<2.6**	**20.5J**
		5.0	9.46	49	11.9J	**<6.3**	**<2.6**	**16.2J**
		10.0	9.28	-160	**2.3**	**<6.3**	**<2.6**	**9.8J**
	ZVI-P	5.0	9.17	170	36.3	**<6.3**	**<2.6**	**9.9J**
	Ferrous Sulfate Heptahydrate + ZVI-F	1.0+5.0	7.24	-110	**1.8**	**<6.3**	**<2.6**	**31.5**
		2.0+5.0	6.85	-84	**1.1J**	**<6.3**	**<2.6**	**34.7J**
	MetaFix I-6A	1.0	9.22	89	25.3	**<6.3**	**<2.6**	**17.8J**
		2.5	8.89	79	25.0	**<6.3**	**<2.6**	**15.7J**
		5.0	9.20	74	15.3J	**<6.3**	**<2.6**	**17.6J**
	MetaFix I-7A	1.0	9.35	88	33.8	**<6.3**	**<2.6**	**18.0J**
		2.5	9.39	110	15.9J	**<6.3**	**<2.6**	**23.2J**
		5.0	9.14	84	17.4J	**<6.3**	**<2.6**	**15.7J**

Test Media	Reagents	Dose (wt.%)	pH (SU)	ORP (mV)	Concentrations (µg/L)			
					Arsenic	Copper	Nickel	Zinc
I-205s Groundwater and Granular Fill	Groundwater only	NA	6.38	42	<8.3	**<6.3**	**<2.6**	120
	Control (no reagents)	0	6.72	110	<8.3	14.2J	**7.8J**	**54.2**
	ZVI	1.0	7.15	-140	**0.48J**	**<6.3**	**<2.6**	**43.4**
		2.5	7.13	-150	**0.68J**	**<6.3**	**<2.6**	**40.6**
		5.0	7.16	-160	**≤0.28**	**<6.3**	**<2.6**	**27.1J**
	MetaFix I-6AC	1.0	8.63	67	7.0	**<6.3**	**6.6J**	**16.3J**
		2.5	9.73	35	6.7	**<6.3**	**<2.6**	**<9.3**
		5.0	11.14	-40	**1.4**	**<6.3**	**<2.6**	**<9.3**
	MetaFix I-7AC	1.0	8.31	100	6.2	**<6.3**	**<2.6**	**13.9J**
		2.5	9.78	40	**5.1**	**<6.3**	**<2.6**	**<9.3**
		5.0	10.94	-25	**1.3**	**<6.3**	**<2.6**	**<9.3**
Remediation Goals					**5**	**8**	**8**	**80**

Notes: Analyses by Method 6010, unless underlined. Underlined results by Method 6020 to achieve lower reporting limits.

Shaded results are less than or equal to remediation goals.

ZVI-F: HePure Ferox-PRB and ZVI-P: PeroxyChem

Table 2. Task 2 Initial dose-response trials for injected reagents at 10-day reaction time.

Test Media	Reagent	Dose (wt.%)	pH (SU)	ORP (mV)	Concentrations (µg/L)			
					Arsenic	Copper	Nickel	Zinc
MW-23 Groundwater and TSB-B Soil	Groundwater only	NA	12.06	-220	56,200	2,180	182	491
	Control (no reagents)	0	11.63	-350	49,000	2,960	180	563
	Ferrous sulfate heptahydrate	1.0	10.84	-230	29,600	1,830	203	469
		5.0	6.88	-170	4,870	**<6.3**	155	**44.8**
		10	6.55	-100	4,900	<10.9	376	127J
	Ferric chloride	1.0	11.27	-370	44,100	2,420	172	309
		3.0	9.99	-260	21,800	770	171	841
		5.0	7.92	-170	1,800	28.6	76.6	**40.3**
I-104 Groundwater and TSB-A Soil	Groundwater only	NA	8.54	10	546	16.8J	**<2.6**	**79.3**
	Control (no reagents)	0	9.19	15	418	37.3	**<2.6**	**10.8J**
	Ferrous sulfate heptahydrate	1.0	7.76	90	10.3J	**6.5J**	**<2.6**	**39.1J**
		5.0	6.16	-100	**5.2J**	<10.9	263	697
		10	5.62	-10	85.9J	<10.9	668	1,790
	Ferric chloride	1.0	7.93	23	50.0	10.7J	**<2.6**	**22.4J**
		3.0	6.43	100	**2.0**	**8.3J**	**8.8J**	87.8
		5.0	5.05	150	14.5J	120	87.9	1,010
I-205s Groundwater and TSB-C Soil	Groundwater only	NA	6.38	42	**<8.3**	**<6.3**	**<2.6**	120
	Control (no reagents)	0	6.00	250	**<8.3**	**<6.3**	**<2.6**	83.3
	Ferrous sulfate heptahydrate	1.0	5.12	120	15.8J	**<6.3**	48.2	255
		5.0	4.87	78	<83.4	<62.8	310	883
		10	4.65	89	<83.4	<62.8	702	1,410
	Ferric chloride	1.0	5.69	69	11.4J	**6.9J**	9.3J	106
		3.0	4.49	150	9.6J	22.4	69.0	553
		5.0	3.86	200	13.1J	122	114	839
Remediation Goals					**5**	**8**	**8**	**80**

Notes: Analyses by Method 6010, unless underlined. Underlined results by Method 6020 to achieve lower reporting limits.

Shaded results are less than or equal to remediation goals.

Table 3. Task 2 initial dose-response trials general reagent rankings (not dose-specific).

Reagent	MW-23				I-104				I-205s			
	Arsenic	Copper	Nickel	Zinc	Arsenic	Copper	Nickel	Zinc	Arsenic	Copper	Nickel	Zinc
ZVI-F	0	-1	0	0	2	2	2	2	2	2	2	2
ZVI-P	1	2	1	2	1	2	2	2				
MetaFix I-6AF	1	1	-1	-1								
MetaFix I-7AF	1	1	0	0								
MetaFix I-6AF2	1	2	1	2								
MetaFix I-6A					1	2	2	2				
MetaFix I-7A					1	2	2	2				
MetaFix I-6AC									2	2	2	2
MetaFix I-7AC									2	2	2	2
Ferrous Sulfate	1	2	0	2	2	2	2	2	-2	-2	-2	-2
Ferric Chloride	1	1	1	2	2	2	2	2	-1	-2	-2	-2
Ferrous Sulfate+ZVI-F					2	2	2	2				

Notes: ZVI-F: HePure Ferox-PRB and ZVI-P: PeroxyChem

0 = little concentration change

1 = some concentration reduction

-1 = some concentration increase

2 = concentration reduction to ≤ goals

-2 = significant concentration increase

Table 4. Task 3 Kinetic response trials for emplaced reagents.

Test Media	Reagent	Dose (wt.%)	Reaction Time (d)	pH (SU)	ORP (mV)	Concentrations (µg/L)			
						Arsenic	Copper	Nickel	Zinc
MW-23 Groundwater and Granular Fill	Groundwater only	NA	NA	12.06	-220	56,200	2,180	182	491
	Control (no reagents)	0	NA	12.01	-210	44,100	2,690	146	133
	ZVI-F	5.0	5	11.63	-330	37,900	920	148	259
			10	11.98	-110	51,700	3,190	170	154
			15	11.85	-300	55,600	2,630	181	1,120
	MetaFix I-6AF2	8.0	5	7.51	-130	2,690	**<6.3**	47.8	84.0
			10	7.47	-130	4,150	**<6.3**	77.8	**44.9**
			15	7.29	-110	2,650	**<6.3**	77.4	**44.2**
I-104 Groundwater and Granular Fill	Groundwater only	NA	NA	8.54	10	546	16.8J	**<2.6**	**79.3**
	Control (no reagents)	0	NA	9.54	76	443	**<6.3**	**<2.6**	**15.7J**
	ZVI-F	5.0	5	9.56	-42	26.3	**<6.3**	**<2.6**	**11.9J**
			10	9.46	49	11.9J	**<6.3**	**<2.6**	**16.2J**
			15	9.67	-180	43.8	**<6.3**	**<2.6**	**19.7J**
		10.0	5	9.42	-160	34.2	**<6.3**	**<2.6**	**16.2J**
			10	9.28	-160	**2.3**	**<6.3**	**<2.6**	**9.8J**
			15	9.62	-190	**1.3**	**<6.3**	**<2.6**	**19.3J**
	ZVI-P	5.0	5	9.99	170	27.6	**<6.3**	**<2.6**	**12.4J**
			10	9.17	170	36.3	**<6.3**	**<2.6**	**9.9J**
	Ferrous Sulfate Heptahydrate and ZVI-F	1.0+5.0	5	7.21	-160	**1.1**	**<6.3**	**<2.6**	**49.8**
			10	7.24	-110	**1.8**	**<6.3**	**<2.6**	**31.5**
			15	7.52	-160	**0.73J**	**<6.3**	**<2.6**	**42.4**
		2.0+5.0	5	6.91	-120	**1.2J**	**<6.3**	**<2.6**	**55.2**
			10	6.85	-84	**1.1J**	**<6.3**	**<2.6**	**34.7J**
			15	7.01	-130	**<1.4**	**<6.3**	**<2.6**	**44.0**
	MetaFix I-6A	5.0	5	8.74	-140	47.9	**<6.3**	**<2.6**	**16.6J**
			10	9.20	74	15.3J	**<6.3**	**<2.6**	**17.6J**
			15	8.89	-130	23.2J	**<6.3**	**<2.6**	**34.0J**
Remediation Goals						**5**	**8**	**8**	**80**

Notes: Analyses by Method 6010, unless underlined. Underlined results completed by Method 6020 to achieve lower reporting limits.

Shaded results are less than or equal to remediation goals.

ZVI-F: HePure Ferox-PRB and ZVI-P: PeroxyChem

Table 5. Task 3 Kinetic trials for injected reagents.

Test Media	Reagent	Dose (wt.%)	Reaction Time (d)	pH (SU)	ORP (mV)	Concentrations (µg/L)			
						Arsenic	Copper	Nickel	Zinc
MW-23 Groundwater and TSB-B Soil	Groundwater only	NA	NA	12.06	-220	56,200	2,180	182	491
	Control (no reagents)	0	NA	11.63	-350	49,000	2,960	180	563
	Ferrous sulfate heptahydrate	5.0	5	7.03	-85	7,780	**<6.3**	141	**76.9**
			10	6.88	-170	4,870	**<6.3**	155	**44.8**
			15	6.69	230	7,420	**<6.3**	124	**56.6**
I-104 Groundwater and TSB-A Soil	Groundwater only	NA	NA	8.54	10	546	16.8J	**<2.6**	**79.3**
	Control (no reagents)	0	NA	9.19	15	418	37.3	**<2.6**	**10.8J**
	Ferrous sulfate heptahydrate	1.0	5	7.41	-210	17.2	**<6.3**	**4.2J**	**57.6**
			10	7.76	90	10.3J	**6.5J**	**<2.6**	**39.1J**
			15	7.51	-140	17.1J	10.6J	**3.6J**	**46.3**
Remediation Goals						**5**	**8**	**8**	**80**

Notes: Analyses by Method 6010, unless underlined. Underlined results completed by Method 6020 to achieve lower reporting limits.

Shaded results are less than or equal to remediation goals.

Appendix A
Laboratory Reports

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

February 02, 2018

Angela Hassell
ReSolution Partners, LLC.
967 Jonathon Drive
Madison, WI 53713

RE: Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Dear Angela Hassell:

Enclosed are the analytical results for sample(s) received by the laboratory on January 30, 2018. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Dan Milewsky
dan.milewsky@pacelabs.com
(920)469-2436
Project Manager

Enclosures

cc: Kevin Baker, ReSolution Partners, LLC.
Bernd Rehm, ReSolution Partners, LLC.

CERTIFICATIONS

Project:	183-001A PC-LANDAU
Pace Project No.:	40164061

Green Bay Certification IDs

1241 Bellevue Street, Green Bay, WI 54302
Florida/NELAP Certification #: E87948
Illinois Certification #: 200050
Kentucky UST Certification #: 82
Louisiana Certification #: 04168
Minnesota Certification #: 055-999-334
New York Certification #: 12064
North Dakota Certification #: R-150
Virginia VELAP ID: 460263
South Carolina Certification #: 83006001
Texas Certification #: T104704529-14-1
Wisconsin Certification #: 405132750
Wisconsin DATCP Certification #: 105-444
USDA Soil Permit #: P330-16-00157
Federal Fish & Wildlife Permit #: LE51774A-0

SAMPLE SUMMARY

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Lab ID	Sample ID	Matrix	Date Collected	Date Received
40164061001	**I-205**	Water	01/29/18 08:00	01/30/18 08:55
40164061002	**IT-TSA**	Solid	01/26/18 14:00	01/30/18 08:55
40164061003	**MW-23**	Water	01/29/18 08:20	01/30/18 08:55
40164061004	**IT-TSB**	Solid	01/26/18 13:50	01/30/18 08:55
40164061005	**I-104**	Water	01/29/18 08:40	01/30/18 08:55
40164061006	**IT-TSC**	Solid	01/26/18 13:40	01/30/18 08:55

SAMPLE ANALYTE COUNT

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
40164061001	**I-205**	EPA 6010	JLD	4	PASI-G
40164061002	**IT-TSA**	EPA 6010	JLD	4	PASI-G
		ASTM D2974-87	DXS	1	PASI-G
40164061003	**MW-23**	EPA 6010	JLD	4	PASI-G
40164061004	**IT-TSB**	EPA 6010	JLD	4	PASI-G
		ASTM D2974-87	DXS	1	PASI-G
40164061005	**I-104**	EPA 6010	JLD	4	PASI-G
40164061006	**IT-TSC**	EPA 6010	JLD	4	PASI-G
		ASTM D2974-87	DXS	1	PASI-G

SUMMARY OF DETECTION

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Lab Sample ID Method	Client Sample ID Parameters	Result	Units	Report Limit	Analyzed	Qualifiers
40164061001	**I-205**					
EPA 6010	Zinc	120	ug/L	40.0	01/31/18 16:15	
40164061002	**IT-TSA**					
EPA 6010	Arsenic	87.9	mg/kg	6.5	01/31/18 13:59	M0
EPA 6010	Copper	43.9	mg/kg	3.3	01/31/18 13:59	
EPA 6010	Nickel	11.5	mg/kg	1.3	01/31/18 13:59	
EPA 6010	Zinc	71.0	mg/kg	5.2	01/31/18 13:59	
ASTM D2974-87	Percent Moisture	23.9	%	0.10	01/30/18 18:01	
40164061003	**MW-23**					
EPA 6010	Arsenic	56200	ug/L	2500	01/31/18 13:27	
EPA 6010	Copper	2180	ug/L	20.0	01/31/18 16:17	
EPA 6010	Nickel	182	ug/L	10.0	01/31/18 16:17	
EPA 6010	Zinc	491	ug/L	40.0	01/31/18 16:17	
40164061004	**IT-TSB**					
EPA 6010	Arsenic	11.3	mg/kg	6.1	01/31/18 14:11	
EPA 6010	Copper	21.3	mg/kg	3.0	01/31/18 14:11	
EPA 6010	Nickel	14.7	mg/kg	1.2	01/31/18 14:11	
EPA 6010	Zinc	56.9	mg/kg	4.9	01/31/18 14:11	
ASTM D2974-87	Percent Moisture	21.8	%	0.10	01/30/18 18:01	
40164061005	**I-104**					
EPA 6010	Arsenic	546	ug/L	25.0	01/31/18 16:20	
EPA 6010	Copper	16.8J	ug/L	20.0	01/31/18 16:20	
EPA 6010	Zinc	79.3	ug/L	40.0	01/31/18 16:20	
40164061006	**IT-TSC**					
EPA 6010	Arsenic	79.2	mg/kg	6.4	01/31/18 14:13	
EPA 6010	Copper	91.2	mg/kg	3.2	01/31/18 14:13	
EPA 6010	Nickel	14.9	mg/kg	1.3	01/31/18 14:13	
EPA 6010	Zinc	92.2	mg/kg	5.1	01/31/18 14:13	
ASTM D2974-87	Percent Moisture	27.7	%	0.10	01/30/18 18:01	

PROJECT NARRATIVE

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Method: **EPA 6010**
Description: 6010 MET ICP
Client: ReSolution Partners, LLC.
Date: February 02, 2018

General Information:
6 samples were analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3050 with any exceptions noted below.

The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 280167

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 40164061002

M0: Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.

- MS (Lab ID: 1644090)
  - Arsenic

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

ANALYTICAL RESULTS

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Sample: I-205 **Lab ID: 40164061001** Collected: 01/29/18 08:00 Received: 01/30/18 08:55 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	01/30/18 16:06	01/31/18 16:15	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	01/30/18 16:06	01/31/18 16:15	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	01/30/18 16:06	01/31/18 16:15	7440-02-0	
Zinc	**120**	ug/L	40.0	9.3	1	01/30/18 16:06	01/31/18 16:15	7440-66-6	

ANALYTICAL RESULTS

Project:	183-001A PC-LANDAU
Pace Project No.:	40164061

Sample: IT-TSA **Lab ID: 40164061002** Collected: 01/26/18 14:00 Received: 01/30/18 08:55 Matrix: Solid

Results reported on a "dry weight" basis and are adjusted for percent moisture, sample size and any dilutions.

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**87.9**	mg/kg	6.5	1.4	1	01/30/18 15:59	01/31/18 13:59	7440-38-2	M0
Copper	**43.9**	mg/kg	3.3	1.1	1	01/30/18 15:59	01/31/18 13:59	7440-50-8	
Nickel	**11.5**	mg/kg	1.3	0.30	1	01/30/18 15:59	01/31/18 13:59	7440-02-0	
Zinc	**71.0**	mg/kg	5.2	1.2	1	01/30/18 15:59	01/31/18 13:59	7440-66-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**23.9**	%	0.10	0.10	1		01/30/18 18:01		

ANALYTICAL RESULTS

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Sample: MW-23 **Lab ID: 40164061003** Collected: 01/29/18 08:20 Received: 01/30/18 08:55 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**56200**	ug/L	2500	834	100	01/30/18 16:06	01/31/18 13:27	7440-38-2	
Copper	**2180**	ug/L	20.0	6.3	1	01/30/18 16:06	01/31/18 16:17	7440-50-8	
Nickel	**182**	ug/L	10.0	2.6	1	01/30/18 16:06	01/31/18 16:17	7440-02-0	
Zinc	**491**	ug/L	40.0	9.3	1	01/30/18 16:06	01/31/18 16:17	7440-66-6	

ANALYTICAL RESULTS

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Sample: IT-TSB **Lab ID: 40164061004** Collected: 01/26/18 13:50 Received: 01/30/18 08:55 Matrix: Solid

Results reported on a "dry weight" basis and are adjusted for percent moisture, sample size and any dilutions.

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**11.3**	mg/kg	6.1	1.3	1	01/30/18 15:59	01/31/18 14:11	7440-38-2	
Copper	**21.3**	mg/kg	3.0	1.0	1	01/30/18 15:59	01/31/18 14:11	7440-50-8	
Nickel	**14.7**	mg/kg	1.2	0.28	1	01/30/18 15:59	01/31/18 14:11	7440-02-0	
Zinc	**56.9**	mg/kg	4.9	1.1	1	01/30/18 15:59	01/31/18 14:11	7440-66-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**21.8**	%	0.10	0.10	1		01/30/18 18:01		

ANALYTICAL RESULTS

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Sample: I-104 **Lab ID: 40164061005** Collected: 01/29/18 08:40 Received: 01/30/18 08:55 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**546**	ug/L	25.0	8.3	1	01/30/18 16:06	01/31/18 16:20	7440-38-2	
Copper	**16.8J**	ug/L	20.0	6.3	1	01/30/18 16:06	01/31/18 16:20	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	01/30/18 16:06	01/31/18 16:20	7440-02-0	
Zinc	**79.3**	ug/L	40.0	9.3	1	01/30/18 16:06	01/31/18 16:20	7440-66-6	

ANALYTICAL RESULTS

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Sample: IT-TSC **Lab ID: 40164061006** Collected: 01/26/18 13:40 Received: 01/30/18 08:55 Matrix: Solid

Results reported on a "dry weight" basis and are adjusted for percent moisture, sample size and any dilutions.

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3050								
Arsenic	**79.2**	mg/kg	6.4	1.3	1	01/30/18 15:59	01/31/18 14:13	7440-38-2	
Copper	**91.2**	mg/kg	3.2	1.0	1	01/30/18 15:59	01/31/18 14:13	7440-50-8	
Nickel	**14.9**	mg/kg	1.3	0.29	1	01/30/18 15:59	01/31/18 14:13	7440-02-0	
Zinc	**92.2**	mg/kg	5.1	1.2	1	01/30/18 15:59	01/31/18 14:13	7440-66-6	
Percent Moisture	Analytical Method: ASTM D2974-87								
Percent Moisture	**27.7**	%	0.10	0.10	1		01/30/18 18:01		

QUALITY CONTROL DATA

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

QC Batch: 280167
Analysis Method: EPA 6010
QC Batch Method: EPA 3050
Analysis Description: 6010 MET
Associated Lab Samples: 40164061002, 40164061004, 40164061006

METHOD BLANK: 1644088
Matrix: Solid
Associated Lab Samples: 40164061002, 40164061004, 40164061006

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	mg/kg	<1.0	5.0	1.0	01/31/18 13:54	
Copper	mg/kg	<0.82	2.5	0.82	01/31/18 13:54	
Nickel	mg/kg	<0.23	1.0	0.23	01/31/18 13:54	
Zinc	mg/kg	<0.93	4.0	0.93	01/31/18 13:54	

LABORATORY CONTROL SAMPLE: 1644089

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/kg	50	47.7	95	80-120	
Copper	mg/kg	50	50.6	101	80-120	
Nickel	mg/kg	50	50.4	101	80-120	
Zinc	mg/kg	50	54.4	109	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1644090 1644091

Parameter	Units	40164061002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	mg/kg	87.9	65.3	65.6	175	154	134	101	75-125	13	20	M0
Copper	mg/kg	43.9	65.3	65.6	119	118	114	112	75-125	1	20	
Nickel	mg/kg	11.5	65.3	65.6	73.5	72.9	95	94	75-125	1	20	
Zinc	mg/kg	71.0	65.3	65.6	138	136	102	98	75-125	2	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

QC Batch: 280161
Analysis Method: EPA 6010
QC Batch Method: EPA 3010
Analysis Description: 6010 MET
Associated Lab Samples: 40164061001, 40164061003, 40164061005

METHOD BLANK: 1644057
Matrix: Water
Associated Lab Samples: 40164061001, 40164061003, 40164061005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<8.3	25.0	8.3	01/31/18 13:12	
Copper	ug/L	<6.3	20.0	6.3	01/31/18 13:12	
Nickel	ug/L	<2.6	10.0	2.6	01/31/18 13:12	
Zinc	ug/L	<9.3	40.0	9.3	01/31/18 13:12	

LABORATORY CONTROL SAMPLE: 1644058

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	ug/L	500	468	94	80-120	
Copper	ug/L	500	485	97	80-120	
Nickel	ug/L	500	485	97	80-120	
Zinc	ug/L	500	509	102	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1644059 1644060

Parameter	Units	40163898001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	ug/L	10.2J	500	500	489	496	96	97	75-125	1	20	
Copper	ug/L	<6.3	500	500	499	501	99	100	75-125	0	20	
Nickel	ug/L	30.2	500	500	513	512	97	96	75-125	0	20	
Zinc	ug/L	58.3	500	500	570	566	102	101	75-125	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

QC Batch: 280175
QC Batch Method: ASTM D2974-87
Analysis Method: ASTM D2974-87
Analysis Description: Dry Weight/Percent Moisture
Associated Lab Samples: 40164061002, 40164061004, 40164061006

SAMPLE DUPLICATE: 1644112

Parameter	Units	40164067001 Result	Dup Result	RPD	Max RPD	Qualifiers
Percent Moisture	%	6.2	6.2	0	10	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	183-001A PC-LANDAU
Pace Project No.:	40164061

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

TNTC - Too Numerous To Count

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-G	Pace Analytical Services - Green Bay

ANALYTE QUALIFIERS

M0	Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: 183-001A PC-LANDAU
Pace Project No.: 40164061

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
40164061002	**IT-TSA**	EPA 3050	280167	EPA 6010	280247
40164061004	**IT-TSB**	EPA 3050	280167	EPA 6010	280247
40164061006	**IT-TSC**	EPA 3050	280167	EPA 6010	280247
40164061001	**I-205**	EPA 3010	280161	EPA 6010	280244
40164061003	**MW-23**	EPA 3010	280161	EPA 6010	280244
40164061005	**I-104**	EPA 3010	280161	EPA 6010	280244
40164061002	**IT-TSA**	ASTM D2974-87	280175		
40164061004	**IT-TSB**	ASTM D2974-87	280175		
40164061006	**IT-TSC**	ASTM D2974-87	280175		

40164061

page 1 of 1

Analytical Lab: Pace Analytical
Address: 1241 Bellevue Street
City/State/Zip: Green Bay, WI 54302
Lab Contact: Dan Milewsky
Phone Number: (920)-469-2436

Sampler Name (print): Kevin Baker
Phone Number: 608-669-6949

Client Name: ReSolution Partners, LLC
Project ID: PC-Landau
Project Number: 183-001a
Address: 967 Jonathon Drive
City/State/Zip: Madison, WI 53719
Project Manager: Angela Hassell

Report To: Angela Hassell
Email Address: ahassell@resolutionpartnersllc.net
Report To: Kevin Baker
Email Address: kbaker@resolutionpartnersllc.net
Report To: Bernd Rehm
Email Address: brehm@resolutionpartnersllc.net
Invoice To: Angela Hassell

	Sample Information							Preservative							Matrix						Analyze For:					TAT		
	Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	Arsenic	Copper	Nickel	Zinc		RUSH: 2 days *	Standard	non-regulatory
001	I-205	1/29/2018	0800	1			x	x	x						x						x	x	x	x	1-125mlpD	x		
002	IT-TSA	1/26/2018	1400	1			x	x											x		x	x	x	x	1-4ozcgA	x		
003	MW-23	1/29/2018	0820	1			x	x	x						x						x	x	x	x	1-250mlpD	x		
004	IT-TSB	1/26/2018	1350	1			x	x											x		x	x	x	x	1-4ozcgA	x		
005	I-104	1/29/2018	0840	1			x	x	x						x						x	x	x	x	1-250mlpD	x		
006	IT-TSC	1/26/2018	1340	1			x	x											x		x	x	x	x	1-4ozcgA	x		

Special Instructions: * Note 2 day TAT. Requested water reporting limits : Arsenic 5 ug/L, Copper 8 ug/L, Nickel 8 ug/L, Zinc 80 ug/L or better, Method 6020.

Laboratory Comments:

Method of Shipment: Wilco

Tracking No: 1626504-1

Relinquished By/Date: Kevin L Baker 1/29/18

Received By/Date:

Relinquished By/Date: Walco 1-30-18 0855

Received By/Date: Susan Wylie Pace 1-30-18 0855

Pace Analytical™

Sample Condition Upon Receipt

Pace Analytical Services, LLC. - Green Bay WI
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Client Name: Re Solution Partners

Project #

WO# : 40164061

40164061

Courier: ☐ Fed Ex ☐ UPS ☐ Client ☐ Pace Other: Waltco
Tracking #: 1626504

Custody Seal on Cooler/Box Present: ☐ yes ☑ no   Seals intact: ☐ yes ☐ no
Custody Seal on Samples Present: ☐ yes ☑ no   Seals intact: ☐ yes ☐ no
Packing Material: ☐ Bubble Wrap ☑ Bubble Bags ☐ None ☐ Other
Thermometer Used N/A   **Type of Ice:** [✓ Wet] Blue Dry None   ☑ Samples on ice, cooling process has begun
Cooler Temperature Uncorr: ROI /Corr: **Biological Tissue is Frozen:** ☐ yes ☐ no
Temp Blank Present: ☐ yes ☑ no

Temp should be above freezing to 6°C.
Biota Samples may be received at ≤ 0°C.

Person examining contents:
Date: 1-30-18
Initials: SKW

		Comments:
Chain of Custody Present:	☑Yes ☐No ☐N/A	1.
Chain of Custody Filled Out:	☑Yes ☐No ☐N/A	2.
Chain of Custody Relinquished:	☑Yes ☐No ☐N/A	3.
Sampler Name & Signature on COC:	☐Yes ☑No ☐N/A	4.
Samples Arrived within Hold Time:	☑Yes ☐No ☐N/A	5.
- VOA Samples frozen upon receipt	☐Yes ☐No	Date/Time:
Short Hold Time Analysis (<72hr):	☐Yes ☑No ☐N/A	6.
Rush Turn Around Time Requested:	☑Yes ☐No ☐N/A	7. 2 day TAT 1-30-18 SKW
Sufficient Volume:	1-30-18 SKW ~~☐Yes~~ [✓ ☐No] ☐N/A	8. NO MS/MSD Volume 1-30-18 SKW
Correct Containers Used:	☑Yes ☐No ☐N/A	9.
-Pace Containers Used:	☐Yes ☑No ☐N/A	
-Pace IR Containers Used:	☐Yes ☐No ☑N/A	
Containers Intact:	☑Yes ☐No ☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes ☐No ☑N/A	11.
Sample Labels match COC:	☑Yes ☐No ☐N/A	12.
-Includes date/time/ID/Analysis Matrix: S+W		
All containers needing preservation have been checked. (Non-Compliance noted in 13.)	☑Yes ☐No ☐N/A	13. ☑ HNO3 ☐ H2SO4 ☐ NaOH ☐ NaOH +ZnAct
All containers needing preservation are found to be in compliance with EPA recommendation. (HNO3, H2SO4 ≤2; NaOH+ZnAct ≥9, NaOH ≥12)	☑Yes ☐No ☐N/A	
exceptions: VOA, coliform, TOC, TOX, TOH, O&G, WIDROW, Phenolics, OTHER:	☐Yes ☑No	Initial when completed SKW / Lab Std #ID of preservative / Date/ Time:
Headspace in VOA Vials (>6mm):	☐Yes ☐No ☑N/A	14.
Trip Blank Present:	☐Yes ☐No ☑N/A	15.
Trip Blank Custody Seals Present	☐Yes ☐No ☑N/A	
Pace Trip Blank Lot # (if purchased):		

Client Notification/ Resolution:
If checked, see attached form for additional comments ☐
Person Contacted: Date/Time:
Comments/ Resolution:

Project Manager Review: Rmr for PM   **Date:** 1/30/18

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

February 23, 2018

Angela Hassell
ReSolution Partners, LLC.
967 Jonathon Drive
Madison, WI 53713

RE: Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Dear Angela Hassell:

Enclosed are the analytical results for sample(s) received by the laboratory on February 14, 2018. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Dan Milewsky

Dan Milewsky
dan.milewsky@pacelabs.com
(920)469-2436
Project Manager

Enclosures

cc: Kevin Baker, ReSolution Partners, LLC.
Bernd Rehm, ReSolution Partners, LLC.

CERTIFICATIONS

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40164620

Green Bay Certification IDs

1241 Bellevue Street, Green Bay, WI 54302
Florida/NELAP Certification #: E87948
Illinois Certification #: 200050
Kentucky UST Certification #: 82
Louisiana Certification #: 04168
Minnesota Certification #: 055-999-334
New York Certification #: 12064
North Dakota Certification #: R-150
Virginia VELAP ID: 460263
South Carolina Certification #: 83006001
Texas Certification #: T104704529-14-1
Wisconsin Certification #: 405132750
Wisconsin DATCP Certification #: 105-444
USDA Soil Permit #: P330-16-00157
Federal Fish & Wildlife Permit #: LE51774A-0

SAMPLE SUMMARY

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Lab ID	Sample ID	Matrix	Date Collected	Date Received
40164620001	**SAMPLE 1-SOIL CONTROL**	Water	02/12/18 10:00	02/14/18 08:40
40164620002	**SAMPLE 1-FS 1%**	Water	02/12/18 10:05	02/14/18 08:40
40164620003	**SAMPLE 1-FS 5%**	Water	02/12/18 10:10	02/14/18 08:40
40164620004	**SAMPLE 1-FS 10%**	Water	02/12/18 10:15	02/14/18 08:40
40164620005	**SAMPLE 1-FC 1%**	Water	02/12/18 10:20	02/14/18 08:40
40164620006	**SAMPLE 1-FC 3%**	Water	02/12/18 10:25	02/14/18 08:40
40164620007	**SAMPLE 1-FC 5%**	Water	02/12/18 10:30	02/14/18 08:40
40164620008	**SAMPLE 1-GF CONTROL**	Water	02/12/18 10:35	02/14/18 08:40
40164620009	**SAMPLE 1-MF1 1%**	Water	02/12/18 10:40	02/14/18 08:40
40164620010	**SAMPLE 1-MF1 2.5%**	Water	02/12/18 10:45	02/14/18 08:40
40164620011	**SAMPLE 1-MF1 5%**	Water	02/12/18 10:50	02/14/18 08:40
40164620012	**SAMPLE 1-MF2 1%**	Water	02/12/18 10:55	02/14/18 08:40
40164620013	**SAMPLE 1-MF2 2.5%**	Water	02/12/18 11:00	02/14/18 08:40
40164620014	**SAMPLE 1-MF2 5%**	Water	02/12/18 11:05	02/14/18 08:40
40164620015	**SAMPLE 1-ZVI 1%**	Water	02/12/18 11:10	02/14/18 08:40
40164620016	**SAMPLE 1-ZVI 2.5%**	Water	02/12/18 11:15	02/14/18 08:40
40164620017	**SAMPLE 1-ZVI 5%**	Water	02/12/18 11:20	02/14/18 08:40
40164620018	**SAMPLE 2-CONTROL**	Water	02/12/18 11:25	02/14/18 08:40
40164620019	**SAMPLE 2-FS 1%**	Water	02/12/18 11:30	02/14/18 08:40
40164620020	**SAMPLE 2-FS 5%**	Water	02/12/18 11:35	02/14/18 08:40
40164620021	**SAMPLE 2-FS 10%**	Water	02/12/18 11:40	02/14/18 08:40
40164620022	**SAMPLE 2-FC 1%**	Water	02/12/18 11:45	02/14/18 08:40
40164620023	**SAMPLE 2-FC 3%**	Water	02/12/18 11:50	02/14/18 08:40
40164620024	**SAMPLE 2-FC 5%**	Water	02/12/18 11:55	02/14/18 08:40
40164620025	**SAMPLE 2-GF CONTROL**	Water	02/12/18 12:00	02/14/18 08:40
40164620026	**SAMPLE 2-MF1 1%**	Water	02/12/18 12:05	02/14/18 08:40
40164620027	**SAMPLE 2-MF1 2.5%**	Water	02/12/18 12:10	02/14/18 08:40
40164620028	**SAMPLE 2-MF1 5%**	Water	02/12/18 12:15	02/14/18 08:40
40164620029	**SAMPLE 2-MF2 1%**	Water	02/12/18 12:20	02/14/18 08:40
40164620030	**SAMPLE 2-MF2 2.5%**	Water	02/12/18 12:25	02/14/18 08:40
40164620031	**SAMPLE 2-MF2 5%**	Water	02/12/18 12:30	02/14/18 08:40
40164620032	**SAMPLE 2-ZVI 1%**	Water	02/12/18 12:35	02/14/18 08:40
40164620033	**SAMPLE 2-ZVI 2.5%**	Water	02/12/18 12:40	02/14/18 08:40
40164620034	**SAMPLE 2-ZVI 5%**	Water	02/12/18 12:45	02/14/18 08:40
40164620035	**SAMPLE 3-CONTROL**	Water	02/12/18 12:50	02/14/18 08:40
40164620036	**SAMPLE 3-FS 1%**	Water	02/12/18 12:55	02/14/18 08:40
40164620037	**SAMPLE 3-FS 5%**	Water	02/12/18 13:00	02/14/18 08:40

SAMPLE SUMMARY

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Lab ID	Sample ID	Matrix	Date Collected	Date Received
40164620038	**SAMPLE 3-FS 10%**	Water	02/12/18 13:05	02/14/18 08:40
40164620039	**SAMPLE 3-FC 1%**	Water	02/12/18 13:10	02/14/18 08:40
40164620040	**SAMPLE 3-FC 3%**	Water	02/12/18 13:15	02/14/18 08:40
40164620041	**SAMPLE 3-FC 5%**	Water	02/12/18 13:20	02/14/18 08:40
40164620042	**SAMPLE 3-GF CONTROL**	Water	02/12/18 13:25	02/14/18 08:40
40164620043	**SAMPLE 3-MF1 1%**	Water	02/12/18 13:30	02/14/18 08:40
40164620044	**SAMPLE 3-MF1 2.5%**	Water	02/12/18 13:35	02/14/18 08:40
40164620045	**SAMPLE 3-MF1 5%**	Water	02/12/18 13:40	02/14/18 08:40
40164620046	**SAMPLE 3-MF2 1%**	Water	02/12/18 13:45	02/14/18 08:40
40164620047	**SAMPLE 3-MF2 2.5%**	Water	02/12/18 13:50	02/14/18 08:40
40164620048	**SAMPLE 3-MF2 5%**	Water	02/12/18 13:55	02/14/18 08:40
40164620049	**SAMPLE 3-ZVI 1%**	Water	02/12/18 14:00	02/14/18 08:40
40164620050	**SAMPLE 3-ZVI 2.5%**	Water	02/12/18 14:05	02/14/18 08:40
40164620051	**SAMPLE 3-ZVI 5%**	Water	02/12/18 14:10	02/14/18 08:40

SAMPLE ANALYTE COUNT

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
40164620001	**SAMPLE 1-SOIL CONTROL**	EPA 6010	JLD	4	PASI-G
40164620002	**SAMPLE 1-FS 1%**	EPA 6010	JLD	4	PASI-G
40164620003	**SAMPLE 1-FS 5%**	EPA 6010	JLD	4	PASI-G
40164620004	**SAMPLE 1-FS 10%**	EPA 6010	JLD	4	PASI-G
40164620005	**SAMPLE 1-FC 1%**	EPA 6010	JLD	4	PASI-G
40164620006	**SAMPLE 1-FC 3%**	EPA 6010	JLD	4	PASI-G
40164620007	**SAMPLE 1-FC 5%**	EPA 6010	JLD	4	PASI-G
40164620008	**SAMPLE 1-GF CONTROL**	EPA 6010	JLD	4	PASI-G
40164620009	**SAMPLE 1-MF1 1%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620010	**SAMPLE 1-MF1 2.5%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620011	**SAMPLE 1-MF1 5%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620012	**SAMPLE 1-MF2 1%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620013	**SAMPLE 1-MF2 2.5%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620014	**SAMPLE 1-MF2 5%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620015	**SAMPLE 1-ZVI 1%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620016	**SAMPLE 1-ZVI 2.5%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620017	**SAMPLE 1-ZVI 5%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620018	**SAMPLE 2-CONTROL**	EPA 6010	JLD	4	PASI-G
40164620019	**SAMPLE 2-FS 1%**	EPA 6010	JLD	4	PASI-G
40164620020	**SAMPLE 2-FS 5%**	EPA 6010	JLD	4	PASI-G
40164620021	**SAMPLE 2-FS 10%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	2	PASI-G
40164620022	**SAMPLE 2-FC 1%**	EPA 6010	JLD	4	PASI-G
40164620023	**SAMPLE 2-FC 3%**	EPA 6010	JLD	4	PASI-G
40164620024	**SAMPLE 2-FC 5%**	EPA 6010	JLD	4	PASI-G
40164620025	**SAMPLE 2-GF CONTROL**	EPA 6010	JLD	4	PASI-G
40164620026	**SAMPLE 2-MF1 1%**	EPA 6010	JLD	4	PASI-G
40164620027	**SAMPLE 2-MF1 2.5%**	EPA 6010	JLD	4	PASI-G

SAMPLE ANALYTE COUNT

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
40164620028	**SAMPLE 2-MF1 5%**	EPA 6010	JLD	4	PASI-G
40164620029	**SAMPLE 2-MF2 1%**	EPA 6010	JLD	4	PASI-G
40164620030	**SAMPLE 2-MF2 2.5%**	EPA 6010	JLD	4	PASI-G
40164620031	**SAMPLE 2-MF2 5%**	EPA 6010	JLD	4	PASI-G
40164620032	**SAMPLE 2-ZVI 1%**	EPA 6010	JLD	4	PASI-G
40164620033	**SAMPLE 2-ZVI 2.5%**	EPA 6010	JLD	4	PASI-G
40164620034	**SAMPLE 2-ZVI 5%**	EPA 6010	JLD	4	PASI-G
40164620035	**SAMPLE 3-CONTROL**	EPA 6010	JLD	4	PASI-G
40164620036	**SAMPLE 3-FS 1%**	EPA 6010	JLD	4	PASI-G
40164620037	**SAMPLE 3-FS 5%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	2	PASI-G
40164620038	**SAMPLE 3-FS 10%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620039	**SAMPLE 3-FC 1%**	EPA 6010	JLD	4	PASI-G
40164620040	**SAMPLE 3-FC 3%**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40164620041	**SAMPLE 3-FC 5%**	EPA 6010	JLD	4	PASI-G
40164620042	**SAMPLE 3-GF CONTROL**	EPA 6010	JLD	4	PASI-G
40164620043	**SAMPLE 3-MF1 1%**	EPA 6010	JLD	4	PASI-G
40164620044	**SAMPLE 3-MF1 2.5%**	EPA 6010	JLD	4	PASI-G
40164620045	**SAMPLE 3-MF1 5%**	EPA 6010	JLD	4	PASI-G
40164620046	**SAMPLE 3-MF2 1%**	EPA 6010	JLD	4	PASI-G
40164620047	**SAMPLE 3-MF2 2.5%**	EPA 6010	JLD	4	PASI-G
40164620048	**SAMPLE 3-MF2 5%**	EPA 6010	JLD	4	PASI-G
40164620049	**SAMPLE 3-ZVI 1%**	EPA 6010	JLD	4	PASI-G
40164620050	**SAMPLE 3-ZVI 2.5%**	EPA 6010	JLD	4	PASI-G
40164620051	**SAMPLE 3-ZVI 5%**	EPA 6010	JLD	4	PASI-G

PROJECT NARRATIVE

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Method: **EPA 6010**
Description: 6010 MET ICP
Client: ReSolution Partners, LLC.
Date: February 23, 2018

General Information:
51 samples were analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 281201

A matrix spike/matrix spike duplicate was not performed due to insufficient sample volume.

QC Batch: 281203

A matrix spike/matrix spike duplicate was not performed due to insufficient sample volume.

QC Batch: 281208

A matrix spike/matrix spike duplicate was not performed due to insufficient sample volume.

Additional Comments:

Analyte Comments:

QC Batch: 281201

D3: Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

- SAMPLE 1-FS 10% (Lab ID: 40164620004)
  - Arsenic
  - Copper
- SAMPLE 1-FS 5% (Lab ID: 40164620003)
  - Arsenic
  - Copper

PROJECT NARRATIVE

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Method: **EPA 6010**
Description: 6010 MET ICP
Client: ReSolution Partners, LLC.
Date: February 23, 2018

Analyte Comments:

QC Batch: 281203

D3: Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

- SAMPLE 2-FS 10% (Lab ID: 40164620021)
  - Copper
  - Zinc
- SAMPLE 3-FS 10% (Lab ID: 40164620038)
  - Arsenic
  - Copper
- SAMPLE 3-FS 5% (Lab ID: 40164620037)
  - Arsenic
  - Copper

PROJECT NARRATIVE

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40164620

Method: **EPA 6020**
Description: 6020 MET ICPMS
Client: ReSolution Partners, LLC.
Date: February 23, 2018

General Information:
13 samples were analyzed for EPA 6020. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 281388

A matrix spike/matrix spike duplicate was not performed due to insufficient sample volume.

Additional Comments:

Analyte Comments:

QC Batch: 281388

D3: Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

- SAMPLE 2-FS 10% (Lab ID: 40164620021)
  - Copper
  - Zinc
- SAMPLE 3-FS 10% (Lab ID: 40164620038)
  - Copper
- SAMPLE 3-FS 5% (Lab ID: 40164620037)
  - Arsenic
  - Copper

PROJECT NARRATIVE

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40164620

Method: **EPA 6020**
Description: 6020 MET ICPMS
Client: ReSolution Partners, LLC.
Date: February 23, 2018

This data package has been reviewed for quality and completeness and is approved for release.

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-SOIL CONTROL **Lab ID: 40164620001** Collected: 02/12/18 10:00 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 11:56	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 11:56	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 11:56	7440-02-0	
Zinc	**83.3**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 11:56	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-FS 1% **Lab ID: 40164620002** Collected: 02/12/18 10:05 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**15.8J**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 11:59	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 11:59	7440-50-8	
Nickel	**48.2**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 11:59	7440-02-0	
Zinc	**255**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 11:59	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-FS 5% **Lab ID: 40164620003** Collected: 02/12/18 10:10 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<83.4**	ug/L	250	83.4	10	02/14/18 14:41	02/15/18 12:01	7440-38-2	D3
Copper	**<62.8**	ug/L	200	62.8	10	02/14/18 14:41	02/15/18 12:01	7440-50-8	D3
Nickel	**310**	ug/L	100	26.2	10	02/14/18 14:41	02/15/18 12:01	7440-02-0	
Zinc	**883**	ug/L	400	93.3	10	02/14/18 14:41	02/15/18 12:01	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-FS 10% **Lab ID: 40164620004** Collected: 02/12/18 10:15 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<83.4**	ug/L	250	83.4	10	02/14/18 14:41	02/15/18 12:04	7440-38-2	D3
Copper	**<62.8**	ug/L	200	62.8	10	02/14/18 14:41	02/15/18 12:04	7440-50-8	D3
Nickel	**702**	ug/L	100	26.2	10	02/14/18 14:41	02/15/18 12:04	7440-02-0	
Zinc	**1410**	ug/L	400	93.3	10	02/14/18 14:41	02/15/18 12:04	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-FC 1% **Lab ID: 40164620005** Collected: 02/12/18 10:20 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**11.4J**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:06	7440-38-2	
Copper	**6.9J**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:06	7440-50-8	
Nickel	**9.3J**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:06	7440-02-0	
Zinc	**106**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:06	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-FC 3% **Lab ID: 40164620006** Collected: 02/12/18 10:25 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**9.6J**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:09	7440-38-2	
Copper	**22.4**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:09	7440-50-8	
Nickel	**69.0**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:09	7440-02-0	
Zinc	**553**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:09	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-FC 5% **Lab ID: 40164620007** Collected: 02/12/18 10:30 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**13.1J**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:11	7440-38-2	
Copper	**122**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:11	7440-50-8	
Nickel	**114**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:11	7440-02-0	
Zinc	**839**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:11	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-GF CONTROL **Lab ID: 40164620008** Collected: 02/12/18 10:35 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:18	7440-38-2	
Copper	**14.2J**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:18	7440-50-8	
Nickel	**7.8J**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:18	7440-02-0	
Zinc	**54.2**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:18	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-MF1 1% **Lab ID: 40164620009** Collected: 02/12/18 10:40 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:21	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:21	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:21	7440-02-0	
Zinc	**13.9J**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:21	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**6.2**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 20:57	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-MF1 2.5% **Lab ID: 40164620010** Collected: 02/12/18 10:45 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:23	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:23	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:23	7440-02-0	
Zinc	**<9.3**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:23	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**5.1**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 21:12	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-MF1 5% **Lab ID: 40164620011** Collected: 02/12/18 10:50 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:25	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:25	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:25	7440-02-0	
Zinc	**<9.3**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:25	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**1.3**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 21:27	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-MF2 1% **Lab ID: 40164620012** Collected: 02/12/18 10:55 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:28	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:28	7440-50-8	
Nickel	**6.6J**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:28	7440-02-0	
Zinc	**16.3J**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:28	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**7.0**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 21:35	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-MF2 2.5% **Lab ID: 40164620013** Collected: 02/12/18 11:00 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:30	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:30	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:30	7440-02-0	
Zinc	**<9.3**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:30	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**6.7**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 21:42	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-MF2 5% **Lab ID: 40164620014** Collected: 02/12/18 11:05 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:33	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:33	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:33	7440-02-0	
Zinc	**<9.3**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:33	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**1.4**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 22:05	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-ZVI 1% **Lab ID: 40164620015** Collected: 02/12/18 11:10 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:35	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:35	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:35	7440-02-0	
Zinc	**43.4**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:35	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**0.48J**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 22:12	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-ZVI 2.5% **Lab ID: 40164620016** Collected: 02/12/18 11:15 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:38	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:38	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:38	7440-02-0	
Zinc	**40.6**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:38	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**0.68J**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 22:19	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 1-ZVI 5% **Lab ID: 40164620017** Collected: 02/12/18 11:20 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 12:40	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 12:40	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 12:40	7440-02-0	
Zinc	**27.1J**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 12:40	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**<0.28**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 22:27	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-CONTROL **Lab ID: 40164620018** Collected: 02/12/18 11:25 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**49000**	ug/L	250	83.4	10	02/14/18 14:41	02/15/18 12:47	7440-38-2	
Copper	**2960**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 14:38	7440-50-8	
Nickel	**180**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 14:38	7440-02-0	
Zinc	**563**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 14:38	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-FS 1% **Lab ID: 40164620019** Collected: 02/12/18 11:30 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**29600**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 14:45	7440-38-2	
Copper	**1830**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 14:45	7440-50-8	
Nickel	**203**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 14:45	7440-02-0	
Zinc	**469**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 14:45	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-FS 5% **Lab ID: 40164620020** Collected: 02/12/18 11:35 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**4870**	ug/L	25.0	8.3	1	02/14/18 14:41	02/15/18 14:49	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:41	02/15/18 14:49	7440-50-8	
Nickel	**155**	ug/L	10.0	2.6	1	02/14/18 14:41	02/15/18 14:49	7440-02-0	
Zinc	**44.8**	ug/L	40.0	9.3	1	02/14/18 14:41	02/15/18 14:49	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-FS 10% **Lab ID: 40164620021** Collected: 02/12/18 11:40 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**4900**	ug/L	250	83.4	10	02/14/18 14:42	02/15/18 14:52	7440-38-2	
Copper	**<62.8**	ug/L	200	62.8	10	02/14/18 14:42	02/15/18 14:52	7440-50-8	D3
Nickel	**376**	ug/L	100	26.2	10	02/14/18 14:42	02/15/18 14:52	7440-02-0	
Zinc	**<93.3**	ug/L	400	93.3	10	02/14/18 14:42	02/15/18 14:52	7440-66-6	D3
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Copper	**<10.9**	ug/L	36.5	10.9	10	02/19/18 07:16	02/21/18 22:34	7440-50-8	D3
Zinc	**127J**	ug/L	153	46.0	10	02/19/18 07:16	02/21/18 22:34	7440-66-6	D3

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-FC 1% **Lab ID: 40164620022** Collected: 02/12/18 11:45 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**44100**	ug/L	250	83.4	10	02/14/18 14:42	02/15/18 13:04	7440-38-2	
Copper	**2420**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:54	7440-50-8	
Nickel	**172**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:54	7440-02-0	
Zinc	**309**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:54	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-FC 3% **Lab ID: 40164620023** Collected: 02/12/18 11:50 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**21800**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:07	7440-38-2	
Copper	**770**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:07	7440-50-8	
Nickel	**171**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:07	7440-02-0	
Zinc	**841**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:07	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-FC 5% **Lab ID: 40164620024** Collected: 02/12/18 11:55 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**1800**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:09	7440-38-2	
Copper	**28.6**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:09	7440-50-8	
Nickel	**76.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:09	7440-02-0	
Zinc	**40.3**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:09	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-GF CONTROL **Lab ID: 40164620025** Collected: 02/12/18 12:00 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**44100**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:17	7440-38-2	
Copper	**2690**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:17	7440-50-8	
Nickel	**146**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:17	7440-02-0	
Zinc	**133**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:17	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-MF1 1% **Lab ID: 40164620026** Collected: 02/12/18 12:05 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**40000**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:19	7440-38-2	
Copper	**1780**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:19	7440-50-8	
Nickel	**156**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:19	7440-02-0	
Zinc	**161**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:19	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-MF1 2.5% **Lab ID: 40164620027** Collected: 02/12/18 12:10 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**33900**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:22	7440-38-2	
Copper	**1080**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:22	7440-50-8	
Nickel	**148**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:22	7440-02-0	
Zinc	**110**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:22	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-MF1 5% **Lab ID: 40164620028** Collected: 02/12/18 12:15 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**30600**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:24	7440-38-2	
Copper	**589**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:24	7440-50-8	
Nickel	**143**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:24	7440-02-0	
Zinc	**127**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:24	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-MF2 1% **Lab ID: 40164620029** Collected: 02/12/18 12:20 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**44400**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:27	7440-38-2	
Copper	**2400**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:27	7440-50-8	
Nickel	**182**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:27	7440-02-0	
Zinc	**300**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:27	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-MF2 2.5% **Lab ID: 40164620030** Collected: 02/12/18 12:25 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**38300**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:29	7440-38-2	
Copper	**1600**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:29	7440-50-8	
Nickel	**184**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:29	7440-02-0	
Zinc	**220**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:29	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-MF2 5% **Lab ID: 40164620031** Collected: 02/12/18 12:30 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**32300**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:32	7440-38-2	
Copper	**775**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:32	7440-50-8	
Nickel	**197**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:32	7440-02-0	
Zinc	**165**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:32	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-ZVI 1% **Lab ID: 40164620032** Collected: 02/12/18 12:35 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**50700**	ug/L	250	83.4	10	02/14/18 14:42	02/16/18 10:40	7440-38-2	
Copper	**2960**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:34	7440-50-8	
Nickel	**157**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:34	7440-02-0	
Zinc	**137**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:34	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-ZVI 2.5% **Lab ID: 40164620033** Collected: 02/12/18 12:40 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**48100**	ug/L	250	83.4	10	02/14/18 14:42	02/16/18 10:42	7440-38-2	
Copper	**2890**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:37	7440-50-8	
Nickel	**156**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:37	7440-02-0	
Zinc	**127**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:37	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 2-ZVI 5% **Lab ID: 40164620034** Collected: 02/12/18 12:45 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**51700**	ug/L	250	83.4	10	02/14/18 14:42	02/16/18 10:45	7440-38-2	
Copper	**3190**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:40	7440-50-8	
Nickel	**170**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:40	7440-02-0	
Zinc	**154**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:40	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-CONTROL **Lab ID: 40164620035** Collected: 02/12/18 12:50 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**418**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:47	7440-38-2	
Copper	**37.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:47	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:47	7440-02-0	
Zinc	**10.8J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:47	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-FS 1% **Lab ID: 40164620036** Collected: 02/12/18 12:55 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**10.3J**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:49	7440-38-2	
Copper	**6.5J**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:49	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:49	7440-02-0	
Zinc	**39.1J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:49	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-FS 5% **Lab ID: 40164620037** Collected: 02/12/18 13:00 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<83.4**	ug/L	250	83.4	10	02/14/18 14:42	02/15/18 13:52	7440-38-2	D3
Copper	**<62.8**	ug/L	200	62.8	10	02/14/18 14:42	02/15/18 13:52	7440-50-8	D3
Nickel	**263**	ug/L	100	26.2	10	02/14/18 14:42	02/15/18 13:52	7440-02-0	
Zinc	**697**	ug/L	400	93.3	10	02/14/18 14:42	02/15/18 13:52	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**5.2J**	ug/L	10.0	2.8	10	02/19/18 07:16	02/21/18 22:42	7440-38-2	D3
Copper	**<10.9**	ug/L	36.5	10.9	10	02/19/18 07:16	02/21/18 22:42	7440-50-8	D3

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-FS 10% **Lab ID: 40164620038** Collected: 02/12/18 13:05 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**85.9J**	ug/L	250	83.4	10	02/14/18 14:42	02/15/18 13:54	7440-38-2	D3
Copper	**<62.8**	ug/L	200	62.8	10	02/14/18 14:42	02/15/18 13:54	7440-50-8	D3
Nickel	**668**	ug/L	100	26.2	10	02/14/18 14:42	02/15/18 13:54	7440-02-0	
Zinc	**1790**	ug/L	400	93.3	10	02/14/18 14:42	02/15/18 13:54	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Copper	**<10.9**	ug/L	36.5	10.9	10	02/19/18 07:16	02/21/18 22:49	7440-50-8	D3

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-FC 1% **Lab ID: 40164620039** Collected: 02/12/18 13:10 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**50.0**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:57	7440-38-2	
Copper	**10.7J**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:57	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:57	7440-02-0	
Zinc	**22.4J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:57	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-FC 3% **Lab ID: 40164620040** Collected: 02/12/18 13:15 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 13:59	7440-38-2	
Copper	**8.3J**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 13:59	7440-50-8	
Nickel	**8.8J**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 13:59	7440-02-0	
Zinc	**87.8**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 13:59	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**2.0**	ug/L	1.0	0.28	1	02/19/18 07:16	02/21/18 22:57	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-FC 5% **Lab ID: 40164620041** Collected: 02/12/18 13:20 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**14.5J**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 11:31	7440-38-2	
Copper	**120**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 11:31	7440-50-8	
Nickel	**87.9**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 11:31	7440-02-0	
Zinc	**1010**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 11:31	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-GF CONTROL **Lab ID: 40164620042** Collected: 02/12/18 13:25 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**443**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:09	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:09	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:09	7440-02-0	
Zinc	**15.7J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:09	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-MF1 1% **Lab ID: 40164620043** Collected: 02/12/18 13:30 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**33.8**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:16	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:16	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:16	7440-02-0	
Zinc	**18.0J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:16	7440-66-6	

ANALYTICAL RESULTS

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40164620

Sample: SAMPLE 3-MF1 2.5% **Lab ID: 40164620044** Collected: 02/12/18 13:35 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**15.9J**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:18	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:18	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:18	7440-02-0	
Zinc	**23.2J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:18	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-MF1 5% **Lab ID: 40164620045** Collected: 02/12/18 13:40 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**17.4J**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:21	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:21	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:21	7440-02-0	
Zinc	**15.7J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:21	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-MF2 1% **Lab ID: 40164620046** Collected: 02/12/18 13:45 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**25.3**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:23	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:23	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:23	7440-02-0	
Zinc	**17.8J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:23	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-MF2 2.5% **Lab ID: 40164620047** Collected: 02/12/18 13:50 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**25.0**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:26	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:26	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:26	7440-02-0	
Zinc	**15.7J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:26	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-MF2 5% **Lab ID: 40164620048** Collected: 02/12/18 13:55 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**15.3J**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:28	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:28	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:28	7440-02-0	
Zinc	**17.6J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:28	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-ZVI 1% **Lab ID: 40164620049** Collected: 02/12/18 14:00 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**32.5**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:31	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:31	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:31	7440-02-0	
Zinc	**20.9J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:31	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-ZVI 2.5% **Lab ID: 40164620050** Collected: 02/12/18 14:05 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**27.5**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:33	7440-38-2	
Copper	**6.6J**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:33	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:33	7440-02-0	
Zinc	**20.5J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:33	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Sample: SAMPLE 3-ZVI 5% **Lab ID: 40164620051** Collected: 02/12/18 14:10 Received: 02/14/18 08:40 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**11.9J**	ug/L	25.0	8.3	1	02/14/18 14:42	02/15/18 14:36	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	02/14/18 14:42	02/15/18 14:36	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	02/14/18 14:42	02/15/18 14:36	7440-02-0	
Zinc	**16.2J**	ug/L	40.0	9.3	1	02/14/18 14:42	02/15/18 14:36	7440-66-6	

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

QC Batch: 281201 Analysis Method: EPA 6010
QC Batch Method: EPA 3010 Analysis Description: 6010 MET

Associated Lab Samples: 40164620001, 40164620002, 40164620003, 40164620004, 40164620005, 40164620006, 40164620007, 40164620008, 40164620009, 40164620010, 40164620011, 40164620012, 40164620013, 40164620014, 40164620015, 40164620016, 40164620017, 40164620018, 40164620019, 40164620020

METHOD BLANK: 1648564 Matrix: Water

Associated Lab Samples: 40164620001, 40164620002, 40164620003, 40164620004, 40164620005, 40164620006, 40164620007, 40164620008, 40164620009, 40164620010, 40164620011, 40164620012, 40164620013, 40164620014, 40164620015, 40164620016, 40164620017, 40164620018, 40164620019, 40164620020

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<8.3	25.0	8.3	02/15/18 11:49	
Copper	ug/L	<6.3	20.0	6.3	02/15/18 11:49	
Nickel	ug/L	<2.6	10.0	2.6	02/15/18 11:49	
Zinc	ug/L	<9.3	40.0	9.3	02/15/18 11:49	

LABORATORY CONTROL SAMPLE & LCSD: 1648565 1648566

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Arsenic	ug/L	500	480	503	96	101	80-120	5	20	
Copper	ug/L	500	503	504	101	101	80-120	0	20	
Nickel	ug/L	500	489	487	98	97	80-120	1	20	
Zinc	ug/L	500	531	532	106	106	80-120	0	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

QC Batch: 281203 Analysis Method: EPA 6010
QC Batch Method: EPA 3010 Analysis Description: 6010 MET

Associated Lab Samples: 40164620021, 40164620022, 40164620023, 40164620024, 40164620025, 40164620026, 40164620027, 40164620028, 40164620029, 40164620030, 40164620031, 40164620032, 40164620033, 40164620034, 40164620035, 40164620036, 40164620037, 40164620038, 40164620039, 40164620040

METHOD BLANK: 1648567 Matrix: Water

Associated Lab Samples: 40164620021, 40164620022, 40164620023, 40164620024, 40164620025, 40164620026, 40164620027, 40164620028, 40164620029, 40164620030, 40164620031, 40164620032, 40164620033, 40164620034, 40164620035, 40164620036, 40164620037, 40164620038, 40164620039, 40164620040

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<8.3	25.0	8.3	02/15/18 12:55	
Copper	ug/L	<6.3	20.0	6.3	02/15/18 12:55	
Nickel	ug/L	<2.6	10.0	2.6	02/15/18 12:55	
Zinc	ug/L	<9.3	40.0	9.3	02/15/18 12:55	

LABORATORY CONTROL SAMPLE & LCSD: 1648568 1648569

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Arsenic	ug/L	500	473	501	95	100	80-120	6	20	
Copper	ug/L	500	497	516	99	103	80-120	4	20	
Nickel	ug/L	500	478	500	96	100	80-120	4	20	
Zinc	ug/L	500	521	542	104	108	80-120	4	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

QC Batch: 281208 Analysis Method: EPA 6010
QC Batch Method: EPA 3010 Analysis Description: 6010 MET
Associated Lab Samples: 40164620041, 40164620042, 40164620043, 40164620044, 40164620045, 40164620046, 40164620047, 40164620048, 40164620049, 40164620050, 40164620051

METHOD BLANK: 1648570 Matrix: Water
Associated Lab Samples: 40164620041, 40164620042, 40164620043, 40164620044, 40164620045, 40164620046, 40164620047, 40164620048, 40164620049, 40164620050, 40164620051

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<8.3	25.0	8.3	02/15/18 14:01	
Copper	ug/L	<6.3	20.0	6.3	02/15/18 14:01	
Nickel	ug/L	<2.6	10.0	2.6	02/15/18 14:01	
Zinc	ug/L	<9.3	40.0	9.3	02/15/18 14:01	

LABORATORY CONTROL SAMPLE & LCSD: 1648571 1648572

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Arsenic	ug/L	500	506	511	101	102	80-120	1	20	
Copper	ug/L	500	521	524	104	105	80-120	1	20	
Nickel	ug/L	500	503	512	101	102	80-120	2	20	
Zinc	ug/L	500	538	547	108	109	80-120	2	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

QC Batch: 281388
Analysis Method: EPA 6020
QC Batch Method: EPA 3010
Analysis Description: 6020 MET
Associated Lab Samples: 40164620009, 40164620010, 40164620011, 40164620012, 40164620013, 40164620014, 40164620015, 40164620016, 40164620017, 40164620021, 40164620037, 40164620038, 40164620040

METHOD BLANK: 1649813
Matrix: Water
Associated Lab Samples: 40164620009, 40164620010, 40164620011, 40164620012, 40164620013, 40164620014, 40164620015, 40164620016, 40164620017, 40164620021, 40164620037, 40164620038, 40164620040

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<0.28	1.0	0.28	02/21/18 20:35	
Copper	ug/L	<1.1	3.6	1.1	02/21/18 20:35	
Zinc	ug/L	<4.6	15.3	4.6	02/21/18 20:35	

LABORATORY CONTROL SAMPLE & LCSD: 1649814 1649815

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Arsenic	ug/L	500	526	529	105	106	80-120	1	20	
Copper	ug/L	500	544	546	109	109	80-120	0	20	
Zinc	ug/L	500	526	531	105	106	80-120	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40164620

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

TNTC - Too Numerous To Count

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-G	Pace Analytical Services - Green Bay

BATCH QUALIFIERS

Batch: 281253

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

Batch: 281257

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

Batch: 281258

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

Batch: 281509

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

ANALYTE QUALIFIERS

D3	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40164620

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
40164620001	**SAMPLE 1-SOIL CONTROL**	EPA 3010	281201	EPA 6010	281257
40164620002	**SAMPLE 1-FS 1%**	EPA 3010	281201	EPA 6010	281257
40164620003	**SAMPLE 1-FS 5%**	EPA 3010	281201	EPA 6010	281257
40164620004	**SAMPLE 1-FS 10%**	EPA 3010	281201	EPA 6010	281257
40164620005	**SAMPLE 1-FC 1%**	EPA 3010	281201	EPA 6010	281257
40164620006	**SAMPLE 1-FC 3%**	EPA 3010	281201	EPA 6010	281257
40164620007	**SAMPLE 1-FC 5%**	EPA 3010	281201	EPA 6010	281257
40164620008	**SAMPLE 1-GF CONTROL**	EPA 3010	281201	EPA 6010	281257
40164620009	**SAMPLE 1-MF1 1%**	EPA 3010	281201	EPA 6010	281257
40164620010	**SAMPLE 1-MF1 2.5%**	EPA 3010	281201	EPA 6010	281257
40164620011	**SAMPLE 1-MF1 5%**	EPA 3010	281201	EPA 6010	281257
40164620012	**SAMPLE 1-MF2 1%**	EPA 3010	281201	EPA 6010	281257
40164620013	**SAMPLE 1-MF2 2.5%**	EPA 3010	281201	EPA 6010	281257
40164620014	**SAMPLE 1-MF2 5%**	EPA 3010	281201	EPA 6010	281257
40164620015	**SAMPLE 1-ZVI 1%**	EPA 3010	281201	EPA 6010	281257
40164620016	**SAMPLE 1-ZVI 2.5%**	EPA 3010	281201	EPA 6010	281257
40164620017	**SAMPLE 1-ZVI 5%**	EPA 3010	281201	EPA 6010	281257
40164620018	**SAMPLE 2-CONTROL**	EPA 3010	281201	EPA 6010	281257
40164620019	**SAMPLE 2-FS 1%**	EPA 3010	281201	EPA 6010	281257
40164620020	**SAMPLE 2-FS 5%**	EPA 3010	281201	EPA 6010	281257
40164620021	**SAMPLE 2-FS 10%**	EPA 3010	281203	EPA 6010	281258
40164620022	**SAMPLE 2-FC 1%**	EPA 3010	281203	EPA 6010	281258
40164620023	**SAMPLE 2-FC 3%**	EPA 3010	281203	EPA 6010	281258
40164620024	**SAMPLE 2-FC 5%**	EPA 3010	281203	EPA 6010	281258
40164620025	**SAMPLE 2-GF CONTROL**	EPA 3010	281203	EPA 6010	281258
40164620026	**SAMPLE 2-MF1 1%**	EPA 3010	281203	EPA 6010	281258
40164620027	**SAMPLE 2-MF1 2.5%**	EPA 3010	281203	EPA 6010	281258
40164620028	**SAMPLE 2-MF1 5%**	EPA 3010	281203	EPA 6010	281258
40164620029	**SAMPLE 2-MF2 1%**	EPA 3010	281203	EPA 6010	281258
40164620030	**SAMPLE 2-MF2 2.5%**	EPA 3010	281203	EPA 6010	281258
40164620031	**SAMPLE 2-MF2 5%**	EPA 3010	281203	EPA 6010	281258
40164620032	**SAMPLE 2-ZVI 1%**	EPA 3010	281203	EPA 6010	281258
40164620033	**SAMPLE 2-ZVI 2.5%**	EPA 3010	281203	EPA 6010	281258
40164620034	**SAMPLE 2-ZVI 5%**	EPA 3010	281203	EPA 6010	281258
40164620035	**SAMPLE 3-CONTROL**	EPA 3010	281203	EPA 6010	281258
40164620036	**SAMPLE 3-FS 1%**	EPA 3010	281203	EPA 6010	281258
40164620037	**SAMPLE 3-FS 5%**	EPA 3010	281203	EPA 6010	281258
40164620038	**SAMPLE 3-FS 10%**	EPA 3010	281203	EPA 6010	281258
40164620039	**SAMPLE 3-FC 1%**	EPA 3010	281203	EPA 6010	281258
40164620040	**SAMPLE 3-FC 3%**	EPA 3010	281203	EPA 6010	281258
40164620041	**SAMPLE 3-FC 5%**	EPA 3010	281208	EPA 6010	281253
40164620042	**SAMPLE 3-GF CONTROL**	EPA 3010	281208	EPA 6010	281253
40164620043	**SAMPLE 3-MF1 1%**	EPA 3010	281208	EPA 6010	281253
40164620044	**SAMPLE 3-MF1 2.5%**	EPA 3010	281208	EPA 6010	281253
40164620045	**SAMPLE 3-MF1 5%**	EPA 3010	281208	EPA 6010	281253
40164620046	**SAMPLE 3-MF2 1%**	EPA 3010	281208	EPA 6010	281253
40164620047	**SAMPLE 3-MF2 2.5%**	EPA 3010	281208	EPA 6010	281253
40164620048	**SAMPLE 3-MF2 5%**	EPA 3010	281208	EPA 6010	281253

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40164620

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
40164620049	**SAMPLE 3-ZVI 1%**	EPA 3010	281208	EPA 6010	281253
40164620050	**SAMPLE 3-ZVI 2.5%**	EPA 3010	281208	EPA 6010	281253
40164620051	**SAMPLE 3-ZVI 5%**	EPA 3010	281208	EPA 6010	281253
40164620009	**SAMPLE 1-MF1 1%**	EPA 3010	281388	EPA 6020	281509
40164620010	**SAMPLE 1-MF1 2.5%**	EPA 3010	281388	EPA 6020	281509
40164620011	**SAMPLE 1-MF1 5%**	EPA 3010	281388	EPA 6020	281509
40164620012	**SAMPLE 1-MF2 1%**	EPA 3010	281388	EPA 6020	281509
40164620013	**SAMPLE 1-MF2 2.5%**	EPA 3010	281388	EPA 6020	281509
40164620014	**SAMPLE 1-MF2 5%**	EPA 3010	281388	EPA 6020	281509
40164620015	**SAMPLE 1-ZVI 1%**	EPA 3010	281388	EPA 6020	281509
40164620016	**SAMPLE 1-ZVI 2.5%**	EPA 3010	281388	EPA 6020	281509
40164620017	**SAMPLE 1-ZVI 5%**	EPA 3010	281388	EPA 6020	281509
40164620021	**SAMPLE 2-FS 10%**	EPA 3010	281388	EPA 6020	281509
40164620037	**SAMPLE 3-FS 5%**	EPA 3010	281388	EPA 6020	281509
40164620038	**SAMPLE 3-FS 10%**	EPA 3010	281388	EPA 6020	281509
40164620040	**SAMPLE 3-FC 3%**	EPA 3010	281388	EPA 6020	281509

40164620

page 1 of 6

Analytical Lab:	Pace Analytical	**Client Name:**	ReSolution Partners, LLC	Report To:	Angela Hassell
Address:	1241 Bellevue Street	Project ID:	PC-Landau, Seattle WA	Email Address:	ahassell@resolutionpartnersllc.net
City/State/Zip:	Green Bay, WI 54302	Project Number:		Report To:	Kevin Baker
Lab Contact:	Dan Milewsky	Address:	967 Jonathon Drive	Email Address:	kbaker@resolutionpartnersllc.net
Phone Number:	(920)-469-2436	City/State/Zip:	Madison, WI 53719	Report To:	Bernd Rehm
Sampler Name (print):	Kevin Baker	Project Manager:	Angela Hassell	Email Address:	brehm@resolutionpartnersllc.net
Phone Number:	608-669-6949		60-669-1248	Invoice To:	Angela Hassell

	Sample Information							Preservative							Matrix						Analyze For:								TAT		
	Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	Arsenic	Copper	Nickel	Zinc					RUSH: 2 days *	Standard	
001	Sample 1-Soil Control	2/12/2018	1000	1			x	x	x							x					x	x	x	x					x		
002	Sample 1-FS 1%	2/12/2018	1005	1			x	x	x							x					x	x	x	x					x		
003	Sample 1-FS 5%	2/12/2018	1010	1			x	x	x							x					x	x	x	x					x		
004	Sample 1-FS 10%	2/12/2018	1015	1			x	x	x							x					x	x	x	x					x		
005	Sample 1-FC 1%	2/12/2018	1020	1			x	x	x							x					x	x	x	x					x		
006	Sample 1-FC 3%	2/12/2018	1025	1			x	x	x							x					x	x	x	x					x		
007	Sample 1-FC 5%	2/12/2018	1030	1			x	x	x							x					x	x	x	x					x		
008	Sample 1-GF Control	2/12/2018	1035	1			x	x	x							x					x	x	x	x					x		
009	Sample 1-MF1 1%	2/12/2018	1040	1			x	x	x							x					x	x	x	x					x		
010	Sample 1-MF1 2.5%	2/12/2018	1045	1			x	x	x							x					x	x	x	x					x		

Special Instructions: * Note 2 day TAT. Requested reporting limits : As 5 ug/L, Cu 8 ug/L, Ni 8 ug/L, Zn 80 ug/L or better. Start with Method 6010 to achieve TAT. Achieve final reporting limits with 6020 as necessary for 10-day TAT

Laboratory Comments:

Method of Shipment: Waltco

Tracking No: 1634924-1

Relinquished By/Date: 2/13/18

Received By/Date:

Relinquished By/Date: Waltco 2-14-18 0840

Received By/Date: Susan K Wylie Pace 2-14-18 0840

40164620

page 2 of 6

Analytical Lab:	Pace Analytical	**Client Name:**	ReSolution Partners, LLC	Report To:	Angela Hassell
Address:	1241 Bellevue Street	Project ID:	PC-Landau, Seattle WA	Email Address:	ahassell@resolutionpartnersllc.net
City/State/Zip:	Green Bay, WI 54302	Project Number:		Report To:	Kevin Baker
Lab Contact:	Dan Milewsky	Address:	967 Jonathon Drive	Email Address:	kbaker@resolutionpartnersllc.net
Phone Number:	(920)-469-2436	City/State/Zip:	Madison, WI 53719	Report To:	Bernd Rehm
Sampler Name (print):	Kevin Baker	Project Manager:	Angela Hassell	Email Address:	brehm@resolutionpartnersllc.net
Phone Number:	608-669-6949	Phone Number:	60-669-1248	Invoice To:	Angela Hassell

	Sample Information							Preservative							Matrix						Analyze For:								TAT		
	Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	Arsenic	Copper	Nickel	Zinc					RUSH: 2 days *	Standard	
011	Sample 1-MF1 5%	2/12/2018	1050	1			x	x	x							x					x	x	x	x					x		
012	Sample 1-MF2 1%	2/12/2018	1055	1			x	x	x							x					x	x	x	x					x		
013	Sample 1-MF2 2.5%	2/12/2018	1100	1			x	x	x							x					x	x	x	x					x		
014	Sample 1-MF2 5%	2/12/2018	1105	1			x	x	x							x					x	x	x	x					x		
015	Sample 1-ZVI 1%	2/12/2018	1110	1			x	x	x							x					x	x	x	x					x		
016	Sample 1-ZVI 2.5%	2/12/2018	1115	1			x	x	x							x					x	x	x	x					x		
017	Sample 1-ZVI 5%	2/12/2018	1120	1			x	x	x							x					x	x	x	x					x		
018	Sample 2-Control	2/12/2018	1125	1			x	x	x							x					x	x	x	x					x		
019	Sample 2-FS 1%	2/12/2018	1130	1			x	x	x							x					x	x	x	x					x		
020	Sample 2-FS 5%	2/12/2018	1135	1			x	x	x							x					x	x	x	x					x		

Special Instructions: * Note 2 day TAT. Requested reporting limits : As 5 ug/L, Cu 8 ug/L, Ni 8 ug/L, Zn 80 ug/L or better. Start with Method 6010 to achieve TAT. Achieve final reporting limits with 6020 as necessary for 10-day TAT

Laboratory Comments:

Method of Shipment: Waltco

Tracking No: 1634924-1

Relinquished By/Date: 2/13/18

Received By/Date:

Relinquished By/Date: Waltco 2-14-18 0840

Received By/Date: 2-14-18 0840 Pace

40164620

page 3 of 6

Analytical Lab: Pace Analytical
Address: 1241 Bellevue Street
City/State/Zip: Green Bay, WI 54302
Lab Contact: Dan Milewsky
Phone Number: (920)-469-2436
Sampler Name (print): Kevin Baker
Phone Number: 608-669-6949

Client Name: ReSolution Partners, LLC
Project ID: PC-Landau, Seattle WA
Project Number:
Address: 967 Jonathon Drive
City/State/Zip: Madison, WI 53719
Project Manager: Angela Hassell
Phone Number: 60-669-1248

Report To: Angela Hassell
Email Address: ahassell@resolutionpartnersllc.net
Report To: Kevin Baker
Email Address: kbaker@resolutionpartnersllc.net
Report To: Bernd Rehm
Email Address: brehm@resolutionpartnersllc.net
Invoice To: Angela Hassell

	Sample Information							Preservative							Matrix						Analyze For:								TAT	
	Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	Arsenic	Copper	Nickel	Zinc					RUSH: 2 days *	Standard
021	Sample 2-FS 10%	2/12/2018	1140	1			x	x	x							x					x	x	x	x					x	
022	Sample 2-FC 1%	2/12/2018	1145	1			x	x	x							x					x	x	x	x					x	
023	Sample 2-FC 3%	2/12/2018	1150	1			x	x	x							x					x	x	x	x					x	
024	Sample 2-FC 5%	2/12/2018	1155	1			x	x	x							x					x	x	x	x					x	
025	Sample 2-GF Control	2/12/2018	1200	1			x	x	x							x					x	x	x	x					x	
026	Sample 2-MF1 1%	2/12/2018	1205	1			x	x	x							x					x	x	x	x					x	
027	Sample 2-MF1 2.5%	2/12/2018	1210	1			x	x	x							x					x	x	x	x					x	
028	Sample 2-MF1 5%	2/12/2018	1215	1			x	x	x							x					x	x	x	x					x	
029	Sample 2-MF2 1%	2/12/2018	1220	1			x	x	x							x					x	x	x	x					x	
030	Sample 2-MF2 2.5%	2/12/2018	1225	1			x	x	x							x					x	x	x	x					x	

Special Instructions: * Note 2 day TAT. Requested reporting limits : As 5 ug/L, Cu 8 ug/L, Ni 8 ug/L, Zn 80 ug/L or better. Start with Method 6010 to achieve TAT. Achieve final reporting limits with 6020 as necessary for 10-day TAT

Laboratory Comments:

Method of Shipment: Waltco
Tracking No: 1634924-1

Relinquished By/Date: Kevin L Baker 2/13/18
Received By/Date:

Relinquished By/Date: Waltco 2-14-18 0840
Received By/Date: Susan Myke 2-14-18 0840 Pace

40164620

page 4 of 6

Analytical Lab:	Pace Analytical	**Client Name:**	ReSolution Partners, LLC
Address:	1241 Bellevue Street	Project ID:	PC-Landau, Seattle WA
City/State/Zip:	Green Bay, WI 54302	Project Number:	
Lab Contact:	Dan Milewsky	Address:	967 Jonathon Drive
Phone Number:	(920)-469-2436	City/State/Zip:	Madison, WI 53719
Sampler Name (print):	Kevin Baker	Project Manager:	Angela Hassell
Phone Number:	608-669-6949	Phone Number:	60-669-1248

Report To: Angela Hassell
Email Address: ahassell@resolutionpartnersllc.net
Report To: Kevin Baker
Email Address: kbaker@resolutionpartnersllc.net
Report To: Bernd Rehm
Email Address: brehm@resolutionpartnersllc.net
Invoice To: Angela Hassell

	Sample Information							Preservative							Matrix						Analyze For:								TAT	
	Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	Arsenic	Copper	Nickel	Zinc					RUSH: 2 days *	Standard
031	Sample 2-MF2 5%	2/12/2018	1230	1			x	x	x							x					x	x	x	x					x	
032	Sample 2-ZVI 1%	2/12/2018	1235	1			x	x	x							x					x	x	x	x					x	
033	Sample 2-ZVI 2.5%	2/12/2018	1240	1			x	x	x							x					x	x	x	x					x	
034	Sample 2-ZVI 5%	2/12/2018	1245	1			x	x	x							x					x	x	x	x					x	
035	Sample 3-Control	2/12/2018	1250	1			x	x	x							x					x	x	x	x					x	
036	Sample 3-FS 1%	2/12/2018	1255	1			x	x	x							x					x	x	x	x					x	
037	Sample 3-FS 5%	2/12/2018	1300	1			x	x	x							x					x	x	x	x					x	
038	Sample 3-FS 10%	2/12/2018	1305	1			x	x	x							x					x	x	x	x					x	
039	Sample 3-FC 1%	2/12/2018	1310	1			x	x	x							x					x	x	x	x					x	
040	Sample 3-FC 3%	2/12/2018	1315	1			x	x	x							x					x	x	x	x					x	

Special Instructions: * Note 2 day TAT. Requested reporting limits : As 5 ug/L, Cu 8 ug/L, Ni 8 ug/L, Zn 80 ug/L or better. Start with Method 6010 to achieve TAT. Achieve final reporting limits with 6020 as necessary for 10-day TAT

Laboratory Comments:

Method of Shipment: Waltco
Tracking No: 1634924-1

Relinquished By/Date: Ken K Bak 2/13/18
Received By/Date:

Relinquished By/Date: Waltco 2-14-18 0840
Received By/Date: Susan Wyl 2-14-18 0840 Pace

40164620

page 5 of 6

Analytical Lab: Pace Analytical
Address: 1241 Bellevue Street
City/State/Zip: Green Bay, WI 54302
Lab Contact: Dan Milewsky
Phone Number: (920)-469-2436
Sampler Name (print): Kevin Baker
Phone Number: 608-669-6949

Client Name: ReSolution Partners, LLC
Project ID: PC-Landau, Seattle WA
Project Number: 0
Address: 967 Jonathon Drive
City/State/Zip: Madison, WI 53719
Project Manager: Angela Hassell
Phone Number: 60-669-1248

Report To: Angela Hassell
Email Address: ahassell@resolutionpartnersllc.net
Report To: Kevin Baker
Email Address: kbaker@resolutionpartnersllc.net
Report To: Bernd Rehm
Email Address: brehm@resolutionpartnersllc.net
Invoice To: Angela Hassell

	Sample Information							Preservative							Matrix						Analyze For:								TAT		
	Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	Arsenic	Copper	Nickel	Zinc					RUSH: 2 days *	Standard	
041	Sample 3-FC 5%	2/12/2018	1320	1			x	x	x							x					x	x	x	x					x		
042	Sample 2-GF Control	2/12/2018	1325	1			x	x	x							x					x	x	x	x					x		
043	Sample 3-MF1 1%	2/12/2018	1330	1			x	x	x							x					x	x	x	x					x		
044	Sample 3-MF1 2.5%	2/12/2018	1335	1			x	x	x							x					x	x	x	x					x		
045	Sample 3-MF1 5%	2/12/2018	1340	1			x	x	x							x					x	x	x	x					x		
046	Sample 3-MF2 1%	2/12/2018	1345	1			x	x	x							x					x	x	x	x					x		
047	Sample 3-MF2 2.5%	2/12/2018	1350	1			x	x	x							x					x	x	x	x					x		
048	Sample 3-MF2 5%	2/12/2018	1355	1			x	x	x							x					x	x	x	x					x		
049	Sample 3-ZVI 1%	2/12/2018	1400																												
050	Sample 3-ZVI 2.5%	2/12/2018	1405																												

Special Instructions: * Note 2 day TAT. Requested reporting limits : As 5 ug/L, Cu 8 ug/L, Ni 8 ug/L, Zn 80 ug/L or better. Start with Method 6010 to achieve TAT. Achieve final reporting limits with 6020 as necessary for 10-day TAT.

Laboratory Comments:

Method of Shipment: Waltco
Tracking No: 1634924-1

Relinquished By/Date: Kevin L Baker 2/13/18
Received By/Date:

Relinquished By/Date: Waltco 2-14-18 0840
Received By/Date: Susan Wyke Pace 2-14-18 0840

40164620

page 6 of 6

Analytical Lab: 1241 Bellevue Street
Address: Green Bay, WI 54302
City/State/Zip: Dan Milewsky
Lab Contact: (920)-469-2436
Phone Number: Kevin Baker
Sampler Name (print): 608-669-6949
Phone Number: 0

Client Name: PC-Landau, Seattle WA
Project ID: 0
Project Number: 967 Jonathon Drive
Address: Madison, WI 53719
City/State/Zip: Angela Hassell
Project Manager: 60-669-1248
Phone Number: 0

Report To: Angela Hassell
Email Address: ahassell@resolutionpartnersllc.net
Report To: Kevin Baker
Email Address: kbaker@resolutionpartnersllc.net
Report To: Bernd Rehm
Email Address: brehm@resolutionpartnersllc.net
Invoice To: Angela Hassell

Sample Information							Preservative							Matrix						Analyze For:								TAT		
Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	x	x	x	x					RUSH: 2 days *	Standard	
051 Sample 3-ZVI 5%	2/12/2018	1410	1			x	x	x							x					x	x	x	x					x		

Special Instructions: * Note 2 day TAT. Requested reporting limits : As 5 ug/L, Cu 8 ug/L, Ni 8 ug/L, Zn 80 ug/L or better. Start with Method 6010 to achieve TAT. Achieve final reporting limits with 6020 as necessary for 10-day TAT.

Laboratory Comments:

Method of Shipment: Waltco
Tracking No: 1634924-1

Relinquished By/Date: Kevin L Baker 2/13/18
Received By/Date:

Relinquished By/Date: Waltco 2-14-18 0840
Received By/Date: Susan Wyle 2-14-18 0840 Pace

Pace Analytical Services, LLC
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Sample Preservation Receipt Form

Client Name: Resolution Partners Project # 40164620

Initial when completed: Skw Date/ Time:

All containers needing preservation have been checked and noted below: ☑Yes ☐No ☐N/A Lab Std #ID of preservation (if pH adjusted):

Pace Lab #	Glass							Plastic							Vials						Jars			General			VOA Vials (>6mm) *	H2SO4 pH ≤2	NaOH+Zn Act pH ≥9	NaOH pH ≥12	HNO3 pH ≤2	pH after adjusted	Volume (mL)
	AG1U	AG1H	AG4S	AG4U	AG5U	AG2S	BG3U	BP1U	BP2N	BP2Z	BP3U	BP3C	BP3N	BP3S	DG9A	DG9T	VG9U	VG9H	VG9M	VG9D	JGFU	WGFU	WPFU	SP5T	ZPLC	GN							
001													/																		X		2.5 / 5 / 10
002													/																		X		2.5 / 5 / 10
003													/																		X		2.5 / 5 / 10
004													/																		X		2.5 / 5 / 10
005													/																		X		2.5 / 5 / 10
006													/																		X		2.5 / 5 / 10
007													/																		X		2.5 / 5 / 10
008													/																		X		2.5 / 5 / 10
009													/																		X		2.5 / 5 / 10
010													/																		X		2.5 / 5 / 10
011													/																		X		2.5 / 5 / 10
012													/																		X		2.5 / 5 / 10
013													/																		X		2.5 / 5 / 10
014													/																		X		2.5 / 5 / 10
015													/																		X		2.5 / 5 / 10
016													/																		X		2.5 / 5 / 10
017													/																		X		2.5 / 5 / 10
018													/																		X		2.5 / 5 / 10
019													/																		X		2.5 / 5 / 10
020													/																		X		2.5 / 5 / 10

Exceptions to preservation check: VOA, Coliform, TOC, TOX, TOH, O&G, WI DRO, Phenolics, Other: ________ Headspace in VOA Vials (>6mm) : ☐Yes ☐No ☑N/A ***If yes look in headspace column**

AG1U	1 liter amber glass	**BP1U**	1 liter plastic unpres	**DG9A**	40 mL amber ascorbic	**JGFU**	4 oz amber jar unpres
AG1H	1 liter amber glass HCL	**BP2N**	500 mL plastic HNO3	**DG9T**	40 mL amber Na Thio	**WGFU**	4 oz clear jar unpres
AG4S	125 mL amber glass H2SO4	**BP2Z**	500 mL plastic NaOH, Znact	**VG9U**	40 mL clear vial unpres	**WPFU**	4 oz plastic jar unpres
AG4U	120 mL amber glass unpres	**BP3U**	250 mL plastic unpres	**VG9H**	40 mL clear vial HCL		
AG5U	100 mL amber glass unpres	**BP3C**	250 mL plastic NaOH	**VG9M**	40 mL clear vial MeOH	**SP5T**	120 mL plastic Na Thiosulfate
AG2S	500 mL amber glass H2SO4	**BP3N**	250 mL plastic HNO3	**VG9D**	40 mL clear vial DI	**ZPLC**	ziploc bag
BG3U	250 mL clear glass unpres	**BP3S**	250 mL plastic H2SO4			**GN:**	1-125mlp

Page 1 of 3

Pace Analytical Services, LLC
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Sample Preservation Receipt Form

Client Name: Resolution Partners Project #: 40164620

	Glass							Plastic							Vials						Jars			General									
Pace Lab #	AG1U	AG1H	AG4S	AG4U	AG5U	AG2S	BG3U	BP1U	BP2N	BP2Z	BP3U	BP3C	BP3N	BP3S	DG9A	DG9T	VG9U	VG9H	VG9M	VG9D	JGFU	WGFU	WPFU	SP5T	ZPLC	GN	VOA Vials (>6mm) *	H2SO4 pH ≤2	NaOH+Zn Act pH ≥9	NaOH pH ≥12	HNO3 pH ≤2	pH after adjusted	Volume (mL)
021													1																		X		2.5 / 5 / 10
022													1																		X		2.5 / 5 / 10
023													1																		X		2.5 / 5 / 10
024													1																		X		2.5 / 5 / 10
025													1																		X		2.5 / 5 / 10
026													1																		X		2.5 / 5 / 10
027													1																		X		2.5 / 5 / 10
028																										1					X		2.5 / 5 / 10
029																										1					X		2.5 / 5 / 10
030																										1					X		2.5 / 5 / 10
031																										1					X		2.5 / 5 / 10
032																										1					X		2.5 / 5 / 10
033																										1					X		2.5 / 5 / 10
034																										1					X		2.5 / 5 / 10
035													1																		X		2.5 / 5 / 10
036																										1					X		2.5 / 5 / 10
037																										1					X		2.5 / 5 / 10
038																										1					X		2.5 / 5 / 11
039																										1					X		2.5 / 5 / 12
040																										1					X		2.5 / 5 / 13
041																										1					X		2.5 / 5 / 14
042																										1					X		2.5 / 5 / 15
043																										1					X		2.5 / 5 / 16
044																										1					X		2.5 / 5 / 17
045																										1					X		2.5 / 5 / 18
046																										1					X		2.5 / 5 / 19
047																										1					X		2.5 / 5 / 20
048																										1					X		2.5 / 5 / 21
049																										1					X		2.5 / 5 / 22
050																										1					X		2.5 / 5 / 23

Page 2 of 3

Pace Analytical Services, LLC
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Sample Preservation Receipt Form

Client Name: Resolution Partners Project #: 40164620

	Glass							Plastic							Vials						Jars			General									
Pace Lab #	AG1U	AG1H	AG4S	AG4U	AG5U	AG2S	BG3U	BP1U	BP2N	BP2Z	BP3U	BP3C	BP3N	BP3S	DG9A	DG9T	VG9U	VG9H	VG9M	VG9D	JGFU	WGFU	WPFU	SP5T	ZPLC	GN	VOA Vials (>6mm) *	H2SO4 pH ≤2	NaOH+Zn Act pH ≥9	NaOH pH ≥12	HNO3 pH ≤2	pH after adjusted	Volume (mL)
051																										1					X		2.5 / 5 / 10
052																																	2.5 / 5 / 10
053																																	2.5 / 5 / 10
054																																	2.5 / 5 / 10
055																																	2.5 / 5 / 10
056																																	2.5 / 5 / 10
057																																	2.5 / 5 / 10
058																																	2.5 / 5 / 10
059																																	2.5 / 5 / 10
060																																	2.5 / 5 / 10
061																																	2.5 / 5 / 10
062																																	2.5 / 5 / 10
063																																	2.5 / 5 / 10
064																																	2.5 / 5 / 10
065																																	2.5 / 5 / 10
066																																	2.5 / 5 / 10
067																																	2.5 / 5 / 10
068																																	2.5 / 5 / 11
069																																	2.5 / 5 / 12
070																																	2.5 / 5 / 13
071																																	2.5 / 5 / 14
072																																	2.5 / 5 / 15
073																																	2.5 / 5 / 16
074																																	2.5 / 5 / 17
075																																	2.5 / 5 / 18
076																																	2.5 / 5 / 19
077																																	2.5 / 5 / 20
078																																	2.5 / 5 / 21
079																																	2.5 / 5 / 22
080																																	2.5 / 5 / 23

Page 3 of 3

Pace Analytical 1241 Bellevue Street, Green Bay, WI 54302	Document Name: **Sample Condition Upon Receipt (SCUR)**	Document Revised: 31Jan2018
	Document No.: **F-GB-C-031-rev.06**	Issuing Authority: Pace Green Bay Quality Office

Sample Condition Upon Receipt Form (SCUR)

Project #: WO# : 40164620

40164620

Client Name: ReSolution Partners

Courier: ☐ CS Logistics ☐ Fed Ex ☐ Speedee ☐ UPS ☒ Waltco ☐ Client ☐ Pace Other:

Tracking #: 1634924

Custody Seal on Cooler/Box Present: ☐ yes ☒ no Seals intact: ☐ yes ☐ no

Custody Seal on Samples Present: ☐ yes ☒ no Seals intact: ☐ yes ☐ no

Packing Material: ☒ Bubble Wrap ☐ Bubble Bags ☐ None ☐ Other

Thermometer Used SR - N/A **Type of Ice:** [✓ Wet] Blue Dry None ☒ Samples on ice, cooling process has begun

Cooler Temperature Uncorr: ROI Corr:

Temp Blank Present: ☐ yes ☒ no **Biological Tissue is Frozen:** ☐ yes ☐ no

Temp should be above freezing to 6°C.
Biota Samples may be received at ≤ 0°C.

Person examining contents:
Date: 2-14-18
Initials: SEW

Chain of Custody Present:	☒Yes ☐No ☐N/A	1.
Chain of Custody Filled Out:	☒Yes ☐No ☐N/A	2.
Chain of Custody Relinquished:	☒Yes ☐No ☐N/A	3.
Sampler Name & Signature on COC:	☐Yes ☒No ☐N/A	4.
Samples Arrived within Hold Time:	☒Yes ☐No ☐N/A	5.
- VOA Samples frozen upon receipt	☐Yes ☐No	Date/Time:
Short Hold Time Analysis (<72hr):	☐Yes ☒No ☐N/A	6.
Rush Turn Around Time Requested:	☒Yes ☐No ☐N/A	7. 2 day TAT 2-14-18 SEW
Sufficient Volume: ☐Yes ☒No ☐N/A MS/MSD	☐Yes ☒No ☐N/A	8.
Correct Containers Used:	☒Yes ☐No ☐N/A	9. all bottles 2/3 empty 2-14-18 SEW
-Pace Containers Used:	☐Yes ☒No ☐N/A	
-Pace IR Containers Used:	☐Yes ☐No ☒N/A	
Containers Intact:	☒Yes ☐No ☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes ☐No ☒N/A	11.
Sample Labels match COC:	☒Yes ☐No ☐N/A	12.
-Includes date/time/ID/Analysis Matrix: W		
Trip Blank Present:	☐Yes ☐No ☒N/A	13.
Trip Blank Custody Seals Present	☐Yes ☐No ☒N/A	
Pace Trip Blank Lot # (if purchased):		

Client Notification/ Resolution: If checked, see attached form for additional comments ☐

Person Contacted: Date/Time:

Comments/ Resolution:

Project Manager Review: AL for DM **Date:** 2/14/18

From: Angela Hassell <ahassell@resolutionpartnersllc.net>
To: Dan Milewsky <Dan.Milewsky@pacelabs.com>
CC: Bernd Rehm <brehm@resolutionpartnersllc.net>, Kevin Baker <kbaker@resolutionpartnersllc.net>
Date: 2/16/2018 3:27 PM
Subject: RE: REPORT PC-LANDAU, SEATTLE WA (Pace Project # 40164620)

Thanks, Dan. Please re-run using 6020 quick turn for the following:

Sample 1 MF1 1% (arsenic)
Sample 1 MF1 2.5% (arsenic)
Sample 1 MF1 5% (arsenic)
Sample 1 MF2 1% (arsenic)
Sample 1 MF2 2.5% (arsenic)
Sample 1 MF2 5% (arsenic)
Sample 1 ZVI 1% (arsenic)
Sample 1 ZVI 2.5% (arsenic)
Sample 1 ZVI 5% (arsenic)
Sample 2 FS 10% (copper and zinc)
Sample 3 FS 5% (arsenic and copper)
Sample 3 FS 10% (copper)
Sample 3 FC 3% (arsenic)

Angela

From: Dan Milewsky [mailto:Dan.Milewsky@pacelabs.com]
Sent: Friday, February 16, 2018 1:51 PM
To: Angela Hassell <ahassell@resolutionpartnersllc.net>
Cc: Bernd Rehm <brehm@resolutionpartnersllc.net>; Kevin Baker <kbaker@resolutionpartnersllc.net>
Subject: REPORT PC-LANDAU, SEATTLE WA (Pace Project # 40164620)

ICP data is attached. Let me know if you want As run by ICPMS for the samples that were ND. (we may not be able to reach 5 ug/L for those samples ND for Arsenic with a D3 qualifier)

Dan Milewsky
Project Manager
Pace Analytical Services
1241 Bellevue Street
Green Bay, WI 54302
920.412-8566 (Direct/Cell) | 920.469.2436<tel:9204692436> (Green Bay Lab) |
www.pacelabs.com<http://www.pacelabs.com>

[X]

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

March 20, 2018

Angela Hassell
ReSolution Partners, LLC.
967 Jonathon Drive
Madison, WI 53713

RE: Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Dear Angela Hassell:

Enclosed are the analytical results for sample(s) received by the laboratory on March 07, 2018. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

Report revised to provide results for arsenic analysis by EPA 6020 on samples -005 and -006.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Dan Milewsky
dan.milewsky@pacelabs.com
(920)469-2436
Project Manager

Enclosures

cc: Kevin Baker, ReSolution Partners, LLC.
Bernd Rehm, ReSolution Partners, LLC.

REPORT OF LABORATORY ANALYSIS

CERTIFICATIONS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Green Bay Certification IDs

1241 Bellevue Street, Green Bay, WI 54302
Florida/NELAP Certification #: E87948
Illinois Certification #: 200050
Kentucky UST Certification #: 82
Louisiana Certification #: 04168
Minnesota Certification #: 055-999-334
New York Certification #: 12064
North Dakota Certification #: R-150
Virginia VELAP ID: 460263
South Carolina Certification #: 83006001
Texas Certification #: T104704529-14-1
Wisconsin Certification #: 405132750
Wisconsin DATCP Certification #: 105-444
USDA Soil Permit #: P330-16-00157
Federal Fish & Wildlife Permit #: LE51774A-0

SAMPLE SUMMARY

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Lab ID	Sample ID	Matrix	Date Collected	Date Received
40165514001	**DAY 5 MW-23 / SOIL + 5% FS**	Water	03/06/18 10:00	03/07/18 08:50
40165514002	**DAY 5 MW-23 / GF + 8% I-6AF2**	Water	03/06/18 10:05	03/07/18 08:50
40165514003	**DAY 5 MW-23 / GF + 5% FZ**	Water	03/06/18 10:10	03/07/18 08:50
40165514004	**DAY 5 I-104 / SOIL + 1% FS**	Water	03/06/18 10:15	03/07/18 08:50
40165514005	**DAY 5 I-104 / GF + 1%FS + 5%FZ**	Water	03/06/18 10:20	03/07/18 08:50
40165514006	**DAY 5 I-104 / GF + 2%FS + 5%FZ**	Water	03/06/18 10:25	03/07/18 08:50
40165514007	**DAY 5 I-104 / GF + 5% I-6A**	Water	03/06/18 10:30	03/07/18 08:50
40165514008	**DAY 5 I-104 / GF + 5% FZ**	Water	03/06/18 10:35	03/07/18 08:50
40165514009	**DAY 5 I-104 / GF + 10% FZ**	Water	03/06/18 10:40	03/07/18 08:50

SAMPLE ANALYTE COUNT

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
40165514001	**DAY 5 MW-23 / SOIL + 5% FS**	EPA 6010	JLD	4	PASI-G
40165514002	**DAY 5 MW-23 / GF + 8% I-6AF2**	EPA 6010	JLD	4	PASI-G
40165514003	**DAY 5 MW-23 / GF + 5% FZ**	EPA 6010	JLD	4	PASI-G
40165514004	**DAY 5 I-104 / SOIL + 1% FS**	EPA 6010	JLD	4	PASI-G
40165514005	**DAY 5 I-104 / GF + 1%FS + 5%FZ**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40165514006	**DAY 5 I-104 / GF + 2%FS + 5%FZ**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40165514007	**DAY 5 I-104 / GF + 5% I-6A**	EPA 6010	JLD	4	PASI-G
40165514008	**DAY 5 I-104 / GF + 5% FZ**	EPA 6010	JLD	4	PASI-G
40165514009	**DAY 5 I-104 / GF + 10% FZ**	EPA 6010	JLD	4	PASI-G

SUMMARY OF DETECTION

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Lab Sample ID Method	Client Sample ID Parameters	Result	Units	Report Limit	Analyzed	Qualifiers
40165514001	**DAY 5 MW-23 / SOIL + 5% FS**					
EPA 6010	Arsenic	7780	ug/L	25.0	03/09/18 14:02	
EPA 6010	Nickel	141	ug/L	10.0	03/09/18 14:02	
EPA 6010	Zinc	76.9	ug/L	40.0	03/09/18 14:02	
40165514002	**DAY 5 MW-23 / GF + 8% I-6AF2**					
EPA 6010	Arsenic	2690	ug/L	25.0	03/08/18 18:08	
EPA 6010	Nickel	47.8	ug/L	10.0	03/08/18 18:08	
EPA 6010	Zinc	84.0	ug/L	40.0	03/08/18 18:08	
40165514003	**DAY 5 MW-23 / GF + 5% FZ**					
EPA 6010	Arsenic	37900	ug/L	25.0	03/08/18 18:11	
EPA 6010	Copper	920	ug/L	20.0	03/08/18 18:11	
EPA 6010	Nickel	148	ug/L	10.0	03/08/18 18:11	
EPA 6010	Zinc	259	ug/L	40.0	03/08/18 18:11	
40165514004	**DAY 5 I-104 / SOIL + 1% FS**					
EPA 6010	Arsenic	17.2J	ug/L	25.0	03/08/18 18:13	
EPA 6010	Nickel	4.2J	ug/L	10.0	03/08/18 18:13	
EPA 6010	Zinc	57.6	ug/L	40.0	03/08/18 18:13	
40165514005	**DAY 5 I-104 / GF + 1%FS + 5%FZ**					
EPA 6010	Zinc	49.8	ug/L	40.0	03/08/18 18:21	
EPA 6020	Arsenic	1.1	ug/L	1.0	03/19/18 23:40	
40165514006	**DAY 5 I-104 / GF + 2%FS + 5%FZ**					
EPA 6010	Zinc	55.2	ug/L	40.0	03/08/18 18:23	
EPA 6020	Arsenic	1.2J	ug/L	2.0	03/19/18 23:47	D3
40165514007	**DAY 5 I-104 / GF + 5% I-6A**					
EPA 6010	Arsenic	47.9	ug/L	25.0	03/08/18 18:25	
EPA 6010	Zinc	16.6J	ug/L	40.0	03/08/18 18:25	
40165514008	**DAY 5 I-104 / GF + 5% FZ**					
EPA 6010	Arsenic	26.3	ug/L	25.0	03/08/18 18:28	
EPA 6010	Zinc	11.9J	ug/L	40.0	03/08/18 18:28	
40165514009	**DAY 5 I-104 / GF + 10% FZ**					
EPA 6010	Arsenic	34.2	ug/L	25.0	03/08/18 18:30	
EPA 6010	Zinc	16.2J	ug/L	40.0	03/08/18 18:30	

PROJECT NARRATIVE

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Method: **EPA 6010**
Description: 6010 MET ICP
Client: ReSolution Partners, LLC.
Date: March 20, 2018

General Information:
9 samples were analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Method: **EPA 6020**
Description: 6020 MET ICPMS
Client: ReSolution Partners, LLC.
Date: March 20, 2018

General Information:
2 samples were analyzed for EPA 6020. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 283575

A matrix spike/matrix spike duplicate was not performed due to insufficient sample volume.

Additional Comments:

Analyte Comments:

QC Batch: 283575

D3: Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.
- DAY 5 I-104 / GF + 2%FS + 5%FZ (Lab ID: 40165514006)
  - Arsenic

This data package has been reviewed for quality and completeness and is approved for release.

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Sample: **DAY 5 MW-23 / SOIL + 5% FS** **Lab ID:** **40165514001** Collected: 03/06/18 10:00 Received: 03/07/18 08:50 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**7780**	ug/L	25.0	8.3	1	03/08/18 07:37	03/09/18 14:02	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/08/18 07:37	03/09/18 14:02	7440-50-8	
Nickel	**141**	ug/L	10.0	2.6	1	03/08/18 07:37	03/09/18 14:02	7440-02-0	
Zinc	**76.9**	ug/L	40.0	9.3	1	03/08/18 07:37	03/09/18 14:02	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Sample: DAY 5 MW-23 / GF + 8% I-6AF2 **Lab ID: 40165514002** Collected: 03/06/18 10:05 Received: 03/07/18 08:50 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**2690**	ug/L	25.0	8.3	1	03/08/18 07:37	03/08/18 18:08	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/08/18 07:37	03/08/18 18:08	7440-50-8	
Nickel	**47.8**	ug/L	10.0	2.6	1	03/08/18 07:37	03/08/18 18:08	7440-02-0	
Zinc	**84.0**	ug/L	40.0	9.3	1	03/08/18 07:37	03/08/18 18:08	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Sample: DAY 5 MW-23 / GF + 5% FZ **Lab ID: 40165514003** Collected: 03/06/18 10:10 Received: 03/07/18 08:50 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**37900**	ug/L	25.0	8.3	1	03/08/18 07:37	03/08/18 18:11	7440-38-2	
Copper	**920**	ug/L	20.0	6.3	1	03/08/18 07:37	03/08/18 18:11	7440-50-8	
Nickel	**148**	ug/L	10.0	2.6	1	03/08/18 07:37	03/08/18 18:11	7440-02-0	
Zinc	**259**	ug/L	40.0	9.3	1	03/08/18 07:37	03/08/18 18:11	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Sample: DAY 5 I-104 / SOIL + 1% FS **Lab ID: 40165514004** Collected: 03/06/18 10:15 Received: 03/07/18 08:50 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**17.2J**	ug/L	25.0	8.3	1	03/08/18 07:37	03/08/18 18:13	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/08/18 07:37	03/08/18 18:13	7440-50-8	
Nickel	**4.2J**	ug/L	10.0	2.6	1	03/08/18 07:37	03/08/18 18:13	7440-02-0	
Zinc	**57.6**	ug/L	40.0	9.3	1	03/08/18 07:37	03/08/18 18:13	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Sample: **DAY 5 I-104 / GF + 1%FS + 5%FZ** **Lab ID:** **40165514005** Collected: 03/06/18 10:20 Received: 03/07/18 08:50 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	03/08/18 07:37	03/08/18 18:21	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/08/18 07:37	03/08/18 18:21	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/08/18 07:37	03/08/18 18:21	7440-02-0	
Zinc	**49.8**	ug/L	40.0	9.3	1	03/08/18 07:37	03/08/18 18:21	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**1.1**	ug/L	1.0	0.28	1	03/19/18 05:59	03/19/18 23:40	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Sample: DAY 5 I-104 / GF + 2%FS + 5%FZ **Lab ID: 40165514006** Collected: 03/06/18 10:25 Received: 03/07/18 08:50 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	03/08/18 07:37	03/08/18 18:23	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/08/18 07:37	03/08/18 18:23	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/08/18 07:37	03/08/18 18:23	7440-02-0	
Zinc	**55.2**	ug/L	40.0	9.3	1	03/08/18 07:37	03/08/18 18:23	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**1.2J**	ug/L	2.0	0.56	2	03/19/18 05:59	03/19/18 23:47	7440-38-2	D3

REPORT OF LABORATORY ANALYSIS

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Sample: DAY 5 I-104 / GF + 5% I-6A **Lab ID: 40165514007** Collected: 03/06/18 10:30 Received: 03/07/18 08:50 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**47.9**	ug/L	25.0	8.3	1	03/08/18 07:37	03/08/18 18:25	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/08/18 07:37	03/08/18 18:25	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/08/18 07:37	03/08/18 18:25	7440-02-0	
Zinc	**16.6J**	ug/L	40.0	9.3	1	03/08/18 07:37	03/08/18 18:25	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Sample: DAY 5 I-104 / GF + 5% FZ **Lab ID: 40165514008** Collected: 03/06/18 10:35 Received: 03/07/18 08:50 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**26.3**	ug/L	25.0	8.3	1	03/08/18 07:37	03/08/18 18:28	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/08/18 07:37	03/08/18 18:28	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/08/18 07:37	03/08/18 18:28	7440-02-0	
Zinc	**11.9J**	ug/L	40.0	9.3	1	03/08/18 07:37	03/08/18 18:28	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

Sample: DAY 5 I-104 / GF + 10% FZ **Lab ID: 40165514009** Collected: 03/06/18 10:40 Received: 03/07/18 08:50 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**34.2**	ug/L	25.0	8.3	1	03/08/18 07:37	03/08/18 18:30	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/08/18 07:37	03/08/18 18:30	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/08/18 07:37	03/08/18 18:30	7440-02-0	
Zinc	**16.2J**	ug/L	40.0	9.3	1	03/08/18 07:37	03/08/18 18:30	7440-66-6	

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

QC Batch: 282724 Analysis Method: EPA 6010
QC Batch Method: EPA 3010 Analysis Description: 6010 MET
Associated Lab Samples: 40165514001, 40165514002, 40165514003, 40165514004, 40165514005, 40165514006, 40165514007, 40165514008, 40165514009

METHOD BLANK: 1656316 Matrix: Water
Associated Lab Samples: 40165514001, 40165514002, 40165514003, 40165514004, 40165514005, 40165514006, 40165514007, 40165514008, 40165514009

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<8.3	25.0	8.3	03/08/18 17:41	
Copper	ug/L	<6.3	20.0	6.3	03/08/18 17:41	
Nickel	ug/L	<2.6	10.0	2.6	03/08/18 17:41	
Zinc	ug/L	<9.3	40.0	9.3	03/08/18 17:41	

LABORATORY CONTROL SAMPLE: 1656317

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	ug/L	500	478	96	80-120	
Copper	ug/L	500	478	96	80-120	
Nickel	ug/L	500	471	94	80-120	
Zinc	ug/L	500	509	102	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1656318 1656319

Parameter	Units	40165287001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	ug/L	14.4J	500	500	497	497	97	96	75-125	0	20	
Copper	ug/L	28.3	500	500	516	522	98	99	75-125	1	20	
Nickel	ug/L	9.1J	500	500	478	484	94	95	75-125	1	20	
Zinc	ug/L	50.4	500	500	561	570	102	104	75-125	2	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165514

QC Batch: 283575
Analysis Method: EPA 6020
QC Batch Method: EPA 3010
Analysis Description: 6020 MET
Associated Lab Samples: 40165514005, 40165514006

METHOD BLANK: 1660667
Matrix: Water
Associated Lab Samples: 40165514005, 40165514006

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<0.28	1.0	0.28	03/19/18 22:48	

LABORATORY CONTROL SAMPLE & LCSD: 1660668 1660669

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Arsenic	ug/L	500	496	509	99	102	80-120	3	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40165514

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

TNTC - Too Numerous To Count

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-G	Pace Analytical Services - Green Bay

BATCH QUALIFIERS

Batch: 283666

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

ANALYTE QUALIFIERS

D3	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40165514

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
40165514001	**DAY 5 MW-23 / SOIL + 5% FS**	EPA 3010	282724	EPA 6010	282835
40165514002	**DAY 5 MW-23 / GF + 8% I-6AF2**	EPA 3010	282724	EPA 6010	282835
40165514003	**DAY 5 MW-23 / GF + 5% FZ**	EPA 3010	282724	EPA 6010	282835
40165514004	**DAY 5 I-104 / SOIL + 1% FS**	EPA 3010	282724	EPA 6010	282835
40165514005	**DAY 5 I-104 / GF + 1%FS + 5%FZ**	EPA 3010	282724	EPA 6010	282835
40165514006	**DAY 5 I-104 / GF + 2%FS + 5%FZ**	EPA 3010	282724	EPA 6010	282835
40165514007	**DAY 5 I-104 / GF + 5% I-6A**	EPA 3010	282724	EPA 6010	282835
40165514008	**DAY 5 I-104 / GF + 5% FZ**	EPA 3010	282724	EPA 6010	282835
40165514009	**DAY 5 I-104 / GF + 10% FZ**	EPA 3010	282724	EPA 6010	282835
40165514005	**DAY 5 I-104 / GF + 1%FS + 5%FZ**	EPA 3010	283575	EPA 6020	283666
40165514006	**DAY 5 I-104 / GF + 2%FS + 5%FZ**	EPA 3010	283575	EPA 6020	283666

40165514

page 1 of 1

Analytical Lab: Pace Analytical
Address: 1241 Bellevue Street
City/State/Zip: Green Bay, WI 54302
Lab Contact: Dan Milewsky
Phone Number: (920)-469-2436

Sampler Name (print): Kevin Baker
Phone Number: 608-669-6949

Client Name: ReSolution Partners, LLC
Project ID: PC-Landau, Seattle WA
Project Number:
Address: 967 Jonathon Drive
City/State/Zip: Madison, WI 53719
Project Manager: Angela Hassell
60-669-1248

Report To: Angela Hassell
Email Address: ahassell@resolutionpartnersllc.net
Report To: Kevin Baker
Email Address: kbaker@resolutionpartnersllc.net
Report To: Bernd Rehm
Email Address: brehm@resolutionpartnersllc.net
Invoice To: Angela Hassell

	Sample Information							Preservative							Matrix						Analyze For:				TAT	
	Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	Arsenic	Copper	Nickel	Zinc	RUSH: 2 days *	Standard
001	Day 5 MW-23 / SOIL + 5% FS	3/6/2018	1000	1			x	x	x							x					x	x	x	x	x	
002	Day 5 MW-23 / GF + 8% I-6AF2	3/6/2018	1005	1			x	x	x							x					x	x	x	x	x	
003	Day 5 MW-23 / GF + 5% FZ	3/6/2018	1010	1			x	x	x							x					x	x	x	x	x	
004	Day 5 I-104 / SOIL + 1% FS	3/6/2018	1015	1			x	x	x							x					x	x	x	x	x	
005	Day 5 I-104 / GF + 1% FS + 5% FZ	3/6/2018	1020	1			x	x	x							x					x	x	x	x	x	
006	Day 5 I-104 / GF + 2% FS + 5% FZ	3/6/2018	1025	1			x	x	x							x					x	x	x	x	x	
007	Day 5 I-104 / GF + 5% I-6A	3/6/2018	1030	1			x	x	x							x					x	x	x	x	x	
008	Day 5 I-104 / GF + 5% FZ	3/6/2018	1035	1			x	x	x							x					x	x	x	x	x	
009	Day 5 I-104 / GF + 10% FZ	3/6/2018	1040	1			x	x	x							x					x	x	x	x	x	

Special Instructions: * Note 2 day TAT. Requested reporting limits : As 5 ug/L, Cu 8 ug/L, Ni 8 ug/L, Zn 80 ug/L or better. Start with Method 6010 to achieve TAT. Achieve final reporting limits with 6020 as necessary for 5-day TAT.

Laboratory Comments:

Method of Shipment: Waltco
Tracking No:

Relinquished By/Date: 3-6-18
Received By/Date:

Relinquished By/Date: Waltco 3-7-18 0830
Received By/Date: 3-7-18 0850

Pace Analytical Services, LLC
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Sample Preservation Receipt Form

Client Name: Resolution Partners Project # 40165514

Initial when completed: SKW Date/ Time:

All containers needing preservation have been checked and noted below: ☑Yes ☐No ☐N/A Lab Std #ID of preservation (if pH adjusted):

	Glass							Plastic							Vials						Jars			General			VOA Vials (>6mm) *	H2SO4 pH ≤2	NaOH+Zn Act pH ≥9	NaOH pH ≥12	HNO3 pH ≤2	pH after adjusted	Volume (mL)
Pace Lab #	AG1U	AG1H	AG4S	AG4U	AG5U	AG2S	BG3U	BP1U	BP2N	BP2Z	BP3U	BP3C	BP3N	BP3S	DG9A	DG9T	VG9U	VG9H	VG9M	VG9D	JGFU	WGFU	WPFU	SP5T	ZPLC	GN							
001																										1					✓		2.5 / 5 / 10
002																										1					✓		2.5 / 5 / 10
003																										1					✓		2.5 / 5 / 10
004																										1					✓		2.5 / 5 / 10
005																										1					✓		2.5 / 5 / 10
006																										1					✓		2.5 / 5 / 10
007																										1					✓		2.5 / 5 / 10
008																										1					✓		2.5 / 5 / 10
009																										1					✓		2.5 / 5 / 10
010																																	2.5 / 5 / 10
011																																	2.5 / 5 / 10
012																																	2.5 / 5 / 10
013																																	2.5 / 5 / 10
014																																	2.5 / 5 / 10
015																																	2.5 / 5 / 10
016																																	2.5 / 5 / 10
017																																	2.5 / 5 / 10
018																																	2.5 / 5 / 10
019																																	2.5 / 5 / 10
020																																	2.5 / 5 / 10

Exceptions to preservation check: VOA, Coliform, TOC, TOX, TOH, O&G, WI DRO, Phenolics, Other: ________ Headspace in VOA Vials (>6mm) : ☐Yes ☐No ☑N/A ***If yes look in headspace column**

AG1U	1 liter amber glass	**BP1U**	1 liter plastic unpres	**DG9A**	40 mL amber ascorbic	**JGFU**	4 oz amber jar unpres
AG1H	1 liter amber glass HCL	**BP2N**	500 mL plastic HNO3	**DG9T**	40 mL amber Na Thio	**WGFU**	4 oz clear jar unpres
AG4S	125 mL amber glass H2SO4	**BP2Z**	500 mL plastic NaOH, Znact	**VG9U**	40 mL clear vial unpres	**WPFU**	4 oz plastic jar unpres
AG4U	120 mL amber glass unpres	**BP3U**	250 mL plastic unpres	**VG9H**	40 mL clear vial HCL		
AG5U	100 mL amber glass unpres	**BP3C**	250 mL plastic NaOH	**VG9M**	40 mL clear vial MeOH	**SP5T**	120 mL plastic Na Thiosulfate
AG2S	500 mL amber glass H2SO4	**BP3N**	250 mL plastic HNO3	**VG9D**	40 mL clear vial DI	**ZPLC**	ziploc bag
BG3U	250 mL clear glass unpres	**BP3S**	250 mL plastic H2SO4			**GN:**	1-125mlp D

Pace Analytical™ 1241 Bellevue Street, Green Bay, WI 54302	Document Name: **Sample Condition Upon Receipt (SCUR)**	Document Revised: 31Jan2018
	Document No.: **F-GB-C-031-rev.06**	Issuing Authority: Pace Green Bay Quality Office

Sample Condition Upon Receipt Form (SCUR)

Client Name: ReSolution Partners

Project #: **WO# : 40165514**

40165514

Courier: ☐ CS Logistics ☐ Fed Ex ☐ Speedee ☐ UPS ☑ Waltco ☐ Client ☐ Pace Other:

Tracking #: 1654986

Custody Seal on Cooler/Box Present: ☐ yes ☑ no Seals intact: ☐ yes ☐ no

Custody Seal on Samples Present: ☐ yes ☑ no Seals intact: ☐ yes ☐ no

Packing Material: ☑ Bubble Wrap ☐ Bubble Bags ☐ None ☐ Other

Thermometer Used SR - 68 **Type of Ice:** [✓ Wet] Blue Dry None ☑ Samples on ice, cooling process has begun

Cooler Temperature Uncorr: 4 /Corr: 4

Temp Blank Present: ☐ yes ☑ no **Biological Tissue is Frozen:** ☐ yes ☐ no

Temp should be above freezing to 6°C.
Biota Samples may be received at ≤ 0°C.

Person examining contents:
Date: 3-7-18
Initials: SW

Chain of Custody Present:	☑Yes	☐No	☐N/A	1.
Chain of Custody Filled Out:	☑Yes	☐No	☐N/A	2.
Chain of Custody Relinquished:	☑Yes	☐No	☐N/A	3.
Sampler [✓ Name & Signature] on COC:	☐Yes	☑No	☐N/A	4.
Samples Arrived within Hold Time:	☑Yes	☐No	☐N/A	5.
- VOA Samples frozen upon receipt	☐Yes	☐No		Date/Time:
Short Hold Time Analysis (<72hr):	☐Yes	☑No	☐N/A	6.
Rush Turn Around Time Requested:	☑Yes	☐No	☐N/A	7. 2 day TAT 3-7-18 SW
Sufficient Volume: ☐Yes ☑No ☐N/A MS/MSD	☐Yes	☑No	☐N/A	8. all sample bottles 1/2 empty 3-7-18 SW
Correct Containers Used:	☑Yes	☐No	☐N/A	9.
-Pace Containers Used:	☐Yes	☑No	☐N/A	
-Pace IR Containers Used:	☐Yes	☐No	☑N/A	
Containers Intact:	☑Yes	☐No	☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes	☐No	☑N/A	11.
Sample Labels match COC:	☑Yes	☐No	☐N/A	12.
-Includes date/time/ID/Analysis Matrix: W				
Trip Blank Present:	☐Yes	☐No	☑N/A	13.
Trip Blank Custody Seals Present	☐Yes	☐No	☑N/A	
Pace Trip Blank Lot # (if purchased):				

Client Notification/ Resolution: If checked, see attached form for additional comments ☐

Person Contacted: Date/Time:

Comments/ Resolution:

Project Manager Review: AL for DM **Date:** 3/7/18

Page 2 of 2

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

March 20, 2018

Angela Hassell
ReSolution Partners, LLC.
967 Jonathon Drive
Madison, WI 53713

RE: Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

Dear Angela Hassell:

Enclosed are the analytical results for sample(s) received by the laboratory on March 13, 2018. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

Report revised to include arsenic analysis by EPA 6020 on samples -002, -003, and -004.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Dan Milewsky
dan.milewsky@pacelabs.com
(920)469-2436
Project Manager

Enclosures

cc: Kevin Baker, ReSolution Partners, LLC.
Bernd Rehm, ReSolution Partners, LLC.

CERTIFICATIONS

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40165783

Green Bay Certification IDs

1241 Bellevue Street, Green Bay, WI 54302
Florida/NELAP Certification #: E87948
Illinois Certification #: 200050
Kentucky UST Certification #: 82
Louisiana Certification #: 04168
Minnesota Certification #: 055-999-334
New York Certification #: 12064
North Dakota Certification #: R-150
Virginia VELAP ID: 460263
South Carolina Certification #: 83006001
Texas Certification #: T104704529-14-1
Wisconsin Certification #: 405132750
Wisconsin DATCP Certification #: 105-444
USDA Soil Permit #: P330-16-00157
Federal Fish & Wildlife Permit #: LE51774A-0

SAMPLE SUMMARY

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

Lab ID	Sample ID	Matrix	Date Collected	Date Received
40165783001	**DAY 10 MW-23/ GF+8% I-6AF2**	Water	03/12/18 10:00	03/13/18 08:55
40165783002	**DAY 10 I-104/ GF+ 1% FS+ 5% FZ**	Water	03/12/18 10:05	03/13/18 08:55
40165783003	**DAY 10 I-104/ GF+ 2% FS+ 5% FZ**	Water	03/12/18 10:10	03/13/18 08:55
40165783004	**DAY 10 I-104/ GF+ 10% FZ**	Water	03/12/18 10:15	03/13/18 08:55
40165783005	**DAY 5 I-104/ GF+ 5% PZ**	Water	03/12/18 10:20	03/13/18 08:55

SAMPLE ANALYTE COUNT

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
40165783001	**DAY 10 MW-23/ GF+8% I-6AF2**	EPA 6010	JLD	4	PASI-G
40165783002	**DAY 10 I-104/ GF+ 1% FS+ 5% FZ**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40165783003	**DAY 10 I-104/ GF+ 2% FS+ 5% FZ**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40165783004	**DAY 10 I-104/ GF+ 10% FZ**	EPA 6010	JLD	4	PASI-G
		EPA 6020	SDW	1	PASI-G
40165783005	**DAY 5 I-104/ GF+ 5% PZ**	EPA 6010	JLD	4	PASI-G

SUMMARY OF DETECTION

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

Lab Sample ID Method	Client Sample ID Parameters	Result	Units	Report Limit	Analyzed	Qualifiers
40165783001	**DAY 10 MW-23/ GF+8% I-6AF2**					
EPA 6010	Arsenic	4150	ug/L	25.0	03/15/18 15:36	
EPA 6010	Nickel	77.8	ug/L	10.0	03/15/18 15:36	
EPA 6010	Zinc	44.9	ug/L	40.0	03/15/18 15:36	
40165783002	**DAY 10 I-104/ GF+ 1% FS+ 5% FZ**					
EPA 6010	Zinc	31.5J	ug/L	40.0	03/15/18 15:43	
EPA 6020	Arsenic	1.8	ug/L	1.0	03/19/18 23:08	
40165783003	**DAY 10 I-104/ GF+ 2% FS+ 5% FZ**					
EPA 6010	Zinc	34.7J	ug/L	40.0	03/15/18 15:46	
EPA 6020	Arsenic	1.1J	ug/L	2.0	03/19/18 23:21	D3
40165783004	**DAY 10 I-104/ GF+ 10% FZ**					
EPA 6010	Zinc	9.8J	ug/L	40.0	03/15/18 15:48	
EPA 6020	Arsenic	2.3	ug/L	1.0	03/19/18 23:34	
40165783005	**DAY 5 I-104/ GF+ 5% PZ**					
EPA 6010	Arsenic	27.6	ug/L	25.0	03/15/18 15:50	
EPA 6010	Zinc	12.4J	ug/L	40.0	03/15/18 15:50	

PROJECT NARRATIVE

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40165783

Method: **EPA 6010**
Description: 6010 MET ICP
Client: ReSolution Partners, LLC.
Date: March 20, 2018

General Information:
5 samples were analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40165783

Method:	**EPA 6020**
Description:	6020 MET ICPMS
Client:	ReSolution Partners, LLC.
Date:	March 20, 2018

General Information:
3 samples were analyzed for EPA 6020. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 283575

A matrix spike/matrix spike duplicate was not performed due to insufficient sample volume.

Additional Comments:

Analyte Comments:

QC Batch: 283575

D3: Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

- DAY 10 I-104/ GF+ 2% FS+ 5% FZ (Lab ID: 40165783003)
  - Arsenic

This data package has been reviewed for quality and completeness and is approved for release.

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA

Pace Project No.: 40165783

Sample: DAY 10 MW-23/ GF+8% I-6AF2 **Lab ID: 40165783001** Collected: 03/12/18 10:00 Received: 03/13/18 08:55 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**4150**	ug/L	25.0	8.3	1	03/13/18 14:20	03/15/18 15:36	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/13/18 14:20	03/15/18 15:36	7440-50-8	
Nickel	**77.8**	ug/L	10.0	2.6	1	03/13/18 14:20	03/15/18 15:36	7440-02-0	
Zinc	**44.9**	ug/L	40.0	9.3	1	03/13/18 14:20	03/15/18 15:36	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

Sample: DAY 10 I-104/ GF+ 1% FS+ 5% FZ **Lab ID: 40165783002** Collected: 03/12/18 10:05 Received: 03/13/18 08:55 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	03/13/18 14:20	03/15/18 15:43	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/13/18 14:20	03/15/18 15:43	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/13/18 14:20	03/15/18 15:43	7440-02-0	
Zinc	**31.5J**	ug/L	40.0	9.3	1	03/13/18 14:20	03/15/18 15:43	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**1.8**	ug/L	1.0	0.28	1	03/19/18 05:59	03/19/18 23:08	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

Sample: DAY 10 I-104/ GF+ 2% FS+ 5% FZ **Lab ID: 40165783003** Collected: 03/12/18 10:10 Received: 03/13/18 08:55 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	03/13/18 14:20	03/15/18 15:46	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/13/18 14:20	03/15/18 15:46	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/13/18 14:20	03/15/18 15:46	7440-02-0	
Zinc	**34.7J**	ug/L	40.0	9.3	1	03/13/18 14:20	03/15/18 15:46	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**1.1J**	ug/L	2.0	0.56	2	03/19/18 05:59	03/19/18 23:21	7440-38-2	D3

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

Sample: DAY 10 I-104/ GF+ 10% FZ **Lab ID: 40165783004** Collected: 03/12/18 10:15 Received: 03/13/18 08:55 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	03/13/18 14:20	03/15/18 15:48	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/13/18 14:20	03/15/18 15:48	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/13/18 14:20	03/15/18 15:48	7440-02-0	
Zinc	**9.8J**	ug/L	40.0	9.3	1	03/13/18 14:20	03/15/18 15:48	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**2.3**	ug/L	1.0	0.28	1	03/19/18 05:59	03/19/18 23:34	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

Sample: DAY 5 I-104/ GF+ 5% PZ **Lab ID: 40165783005** Collected: 03/12/18 10:20 Received: 03/13/18 08:55 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**27.6**	ug/L	25.0	8.3	1	03/13/18 14:20	03/15/18 15:50	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/13/18 14:20	03/15/18 15:50	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/13/18 14:20	03/15/18 15:50	7440-02-0	
Zinc	**12.4J**	ug/L	40.0	9.3	1	03/13/18 14:20	03/15/18 15:50	7440-66-6	

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

QC Batch: 283214
Analysis Method: EPA 6010
QC Batch Method: EPA 3010
Analysis Description: 6010 MET
Associated Lab Samples: 40165783001, 40165783002, 40165783003, 40165783004, 40165783005

METHOD BLANK: 1658659
Matrix: Water
Associated Lab Samples: 40165783001, 40165783002, 40165783003, 40165783004, 40165783005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<8.3	25.0	8.3	03/15/18 14:45	
Copper	ug/L	<6.3	20.0	6.3	03/15/18 14:45	
Nickel	ug/L	<2.6	10.0	2.6	03/15/18 14:45	
Zinc	ug/L	<9.3	40.0	9.3	03/15/18 14:45	

LABORATORY CONTROL SAMPLE: 1658660

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	ug/L	500	469	94	80-120	
Copper	ug/L	500	492	98	80-120	
Nickel	ug/L	500	488	98	80-120	
Zinc	ug/L	500	491	98	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1658661 1658662

Parameter	Units	40165797001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	ug/L	10.6J	500	500	490	487	96	95	75-125	0	20	
Copper	ug/L	<6.3	500	500	496	491	98	97	75-125	1	20	
Nickel	ug/L	15.8	500	500	486	481	94	93	75-125	1	20	
Zinc	ug/L	11.4J	500	500	490	484	96	95	75-125	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

QC Batch: 283575 Analysis Method: EPA 6020
QC Batch Method: EPA 3010 Analysis Description: 6020 MET
Associated Lab Samples: 40165783002, 40165783003, 40165783004

METHOD BLANK: 1660667 Matrix: Water
Associated Lab Samples: 40165783002, 40165783003, 40165783004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<0.28	1.0	0.28	03/19/18 22:48	

LABORATORY CONTROL SAMPLE & LCSD: 1660668 1660669

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Arsenic	ug/L	500	496	509	99	102	80-120	3	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40165783

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

TNTC - Too Numerous To Count

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-G	Pace Analytical Services - Green Bay

BATCH QUALIFIERS

Batch: 283666

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

ANALYTE QUALIFIERS

D3	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40165783

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
40165783001	**DAY 10 MW-23/ GF+8% I-6AF2**	EPA 3010	283214	EPA 6010	283294
40165783002	**DAY 10 I-104/ GF+ 1% FS+ 5% FZ**	EPA 3010	283214	EPA 6010	283294
40165783003	**DAY 10 I-104/ GF+ 2% FS+ 5% FZ**	EPA 3010	283214	EPA 6010	283294
40165783004	**DAY 10 I-104/ GF+ 10% FZ**	EPA 3010	283214	EPA 6010	283294
40165783005	**DAY 5 I-104/ GF+ 5% PZ**	EPA 3010	283214	EPA 6010	283294
40165783002	**DAY 10 I-104/ GF+ 1% FS+ 5% FZ**	EPA 3010	283575	EPA 6020	283666
40165783003	**DAY 10 I-104/ GF+ 2% FS+ 5% FZ**	EPA 3010	283575	EPA 6020	283666
40165783004	**DAY 10 I-104/ GF+ 10% FZ**	EPA 3010	283575	EPA 6020	283666

40165783

page 1 of 1

Analytical Lab: Pace Analytical
Address: 1241 Bellevue Street
City/State/Zip: Green Bay, WI 54302
Lab Contact: Dan Milewsky
Phone Number: (920)-469-2436

Sampler Name (print): Kevin Baker
Phone Number: 608-669-6949

Client Name: ReSolution Partners, LLC
Project ID: PC-Landau, Seattle WA
Project Number:
Address: 967 Jonathon Drive
City/State/Zip: Madison, WI 53719
Project Manager: Angela Hassell
60-669-1248

Report To: Angela Hassell
Email Address: ahassell@resolutionpartnersllc.net
Report To: Kevin Baker
Email Address: kbaker@resolutionpartnersllc.net
Report To: Bernd Rehm
Email Address: brehm@resolutionpartnersllc.net
Invoice To: Angela Hassell

	Sample Information							Preservative							Matrix						Analyze For:				TAT	
	Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	Arsenic	Copper	Nickel	Zinc	RUSH: 2 days *	Standard
001	Day 10 MW-23 / GF + 8% I-6AF2	3/12/2018	1000	1			x	x	x							x					x	x	x	x	x	
002	Day 10 I-104 / GF + 1% FS + 5% FZ	3/12/2018	1005	1			x	x	x							x					x	x	x	x	x	
003	Day 10 I-104 / GF + 2% FS + 5% FZ	3/12/2018	1010	1			x	x	x							x					x	x	x	x	x	
004	Day 10 I-104 / GF + 10% FZ	3/12/2018	1015	1			x	x	x							x					x	x	x	x	x	
005	Day 5 I-104 / GF + 5% PZ	3/12/2018	1020	1			x	x	x							x					x	x	x	x	x	

Special Instructions: * Note 2 day TAT. Requested reporting limits : As 5 ug/L, Cu 8 ug/L, Ni 8 ug/L, Zn 80 ug/L or better. Start with Method 6010 to achieve TAT. Achieve final reporting limits with 6020 as necessary for 5-day TAT.

Laboratory Comments:

Method of Shipment:
Tracking No:

Relinquished By/Date: 3/12/18
Received By/Date:

Relinquished By/Date: 3/13/18 0855
Received By/Date: 3/13/18 0855

Pace Analytical Services, LLC
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Sample Preservation Receipt Form

Client Name: Resolution

Project # 40168783

All containers needing preservation have been checked and noted below: ☑Yes ☐No ☐N/A Lab Std #ID of preservation (if pH adjusted):

Initial when completed: RB Date/ Time:

	Glass							Plastic							Vials						Jars			General									
Pace Lab #	AG1U	AG1H	AG4S	AG4U	AG5U	AG2S	BG3U	BP1U	BP2N	BP2Z	BP3U	BP3C	BP3N	BP3S	DG9A	DG9T	VG9U	VG9H	VG9M	VG9D	JGFU	WGFU	WPFU	SP5T	ZPLC	GN	VOA Vials (>6mm) *	H2SO4 pH ≤2	NaOH+Zn Act pH ≥9	NaOH pH ≥12	HNO3 pH ≤2	pH after adjusted	Volume (mL)
001																										—					✓		2.5 / 5 / 10
002																										—					✓		2.5 / 5 / 10
003																										—					✓		2.5 / 5 / 10
004																										—					✓		2.5 / 5 / 10
005																										—					✓		2.5 / 5 / 10
006																																	2.5 / 5 / 10
007																																	2.5 / 5 / 10
008																																	2.5 / 5 / 10
009																																	2.5 / 5 / 10
010																																	2.5 / 5 / 10
011																																	2.5 / 5 / 10
012																																	2.5 / 5 / 10
013																																	2.5 / 5 / 10
014																																	2.5 / 5 / 10
015																																	2.5 / 5 / 10
016																																	2.5 / 5 / 10
017																																	2.5 / 5 / 10
018																																	2.5 / 5 / 10
019																																	2.5 / 5 / 10
020																																	2.5 / 5 / 10

Exceptions to preservation check: VOA, Coliform, TOC, TOX, TOH, O&G, WI DRO, Phenolics, Other:________ Headspace in VOA Vials (>6mm) : ☐Yes ☐No ☑N/A ***If yes look in headspace column**

AG1U	1 liter amber glass
AG1H	1 liter amber glass HCL
AG4S	125 mL amber glass H2SO4
AG4U	120 mL amber glass unpres
AG5U	100 mL amber glass unpres
AG2S	500 mL amber glass H2SO4
BG3U	250 mL clear glass unpres
BP1U	1 liter plastic unpres
BP2N	500 mL plastic HNO3
BP2Z	500 mL plastic NaOH, Znact
BP3U	250 mL plastic unpres
BP3C	250 mL plastic NaOH
BP3N	250 mL plastic HNO3
BP3S	250 mL plastic H2SO4
DG9A	40 mL amber ascorbic
DG9T	40 mL amber Na Thio
VG9U	40 mL clear vial unpres
VG9H	40 mL clear vial HCL
VG9M	40 mL clear vial MeOH
VG9D	40 mL clear vial DI
JGFU	4 oz amber jar unpres
WGFU	4 oz clear jar unpres
WPFU	4 oz plastic jar unpres
SP5T	120 mL plastic Na Thiosulfate
ZPLC	ziploc bag
GN:	100 ml pD

Pace Analytical 1241 Bellevue Street, Green Bay, WI 54302	Document Name: **Sample Condition Upon Receipt (SCUR)**	Document Revised: 31Jan2018
	Document No.: **F-GB-C-031-rev.06**	Issuing Authority: Pace Green Bay Quality Office

Sample Condition Upon Receipt Form (SCUR)

Project #: **WO#: 40165783**

40165783

Client Name: ReSolution

Courier: ☐ CS Logistics ☐ Fed Ex ☐ Speedee ☐ UPS ☑ Waltco ☐ Client ☐ Pace Other:

Tracking #: 1654984-1

Custody Seal on Cooler/Box Present: ☑ yes ☐ no Seals intact: ☑ yes ☐ no

Custody Seal on Samples Present: ☐ yes ☑ no Seals intact: ☐ yes ☐ no

Packing Material: ☐ Bubble Wrap ☐ Bubble Bags ☑ None ☐ Other

Thermometer Used SR - 66 **Type of Ice:** [✓ Wet] Blue Dry None ☑ Samples on ice, cooling process has begun

Cooler Temperature Uncorr: 3 /Corr: 3.5

Temp Blank Present: ☐ yes ☑ no **Biological Tissue is Frozen:** ☐ yes ☐ no

Temp should be above freezing to 6°C.
Biota Samples may be received at ≤ 0°C.

Person examining contents:
Date: 3/13/18
Initials: DS

Chain of Custody Present:	☑Yes	☐No	☐N/A	1.
Chain of Custody Filled Out:	☑Yes	☐No	☐N/A	2.
Chain of Custody ~~Relinquished~~:	☑Yes	☐No	☐N/A	3. No Rel. Time DS 3/13/18
Sampler Name ~~& Signature~~ on COC:	☐Yes	☑No	☐N/A	4.
Samples Arrived within Hold Time:	☑Yes	☐No	☐N/A	5.
- VOA Samples frozen upon receipt	☐Yes	☐No		Date/Time:
Short Hold Time Analysis (<72hr):	☐Yes	☑No	☐N/A	6.
Rush Turn Around Time Requested:	☑Yes	☐No	☐N/A	7.
Sufficient Volume: ☐Yes ☑No ☐N/A MS/MSD	☐Yes	☐No	☑N/A	8.
Correct Containers Used:	☑Yes	☐No	☐N/A	9.
-Pace Containers Used:	☑Yes	☐No	☐N/A	
-Pace IR Containers Used:	☐Yes	☐No	☑N/A	
Containers Intact:	☑Yes	☐No	☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes	☐No	☑N/A	11.
Sample Labels match COC:	☑Yes	☐No	☐N/A	12.
-Includes date/time/ID/Analysis Matrix: W				
Trip Blank Present:	☐Yes	☑No	☐N/A	13.
Trip Blank Custody Seals Present	☐Yes	☐No	☑N/A	
Pace Trip Blank Lot # (if purchased):				

Client Notification/ Resolution:

If checked, see attached form for additional comments ☐

Person Contacted: Date/Time:

Comments/ Resolution:

Project Manager Review: RMR for DM **Date:** 3/13/18

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

March 28, 2018

Angela Hassell
ReSolution Partners, LLC.
967 Jonathon Drive
Madison, WI 53713

RE: Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Dear Angela Hassell:

Enclosed are the analytical results for sample(s) received by the laboratory on March 17, 2018. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

Revised Report: ICPMS Arsenic was added to select samples.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Dan Milewsky
dan.milewsky@pacelabs.com
(920)469-2436
Project Manager

Enclosures

cc: Kevin Baker, ReSolution Partners, LLC.
Bernd Rehm, ReSolution Partners, LLC.

REPORT OF LABORATORY ANALYSIS

CERTIFICATIONS

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40166070

Green Bay Certification IDs

1241 Bellevue Street, Green Bay, WI 54302
Florida/NELAP Certification #: E87948
Illinois Certification #: 200050
Kentucky UST Certification #: 82
Louisiana Certification #: 04168
Minnesota Certification #: 055-999-334
New York Certification #: 12064
North Dakota Certification #: R-150
Virginia VELAP ID: 460263
South Carolina Certification #: 83006001
Texas Certification #: T104704529-14-1
Wisconsin Certification #: 405132750
Wisconsin DATCP Certification #: 105-444
USDA Soil Permit #: P330-16-00157
Federal Fish & Wildlife Permit #: LE51774A-0

SAMPLE SUMMARY

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Lab ID	Sample ID	Matrix	Date Collected	Date Received
40166070001	**DAY 15 MW-23/SOIL + 5% FS**	Water	03/16/18 10:00	03/17/18 07:45
40166070002	**DAY 15 MW-23/GF + 8% I-6AFS**	Water	03/16/18 10:05	03/17/18 07:45
40166070003	**DAY 15 MW-23/GF + 5% FZ**	Water	03/16/18 10:10	03/17/18 07:45
40166070004	**DAY 15 I-104/SOIL+ 1% FS**	Water	03/16/18 10:15	03/17/18 07:45
40166070005	**DAY 15 I-104/GF+ 1% FS+5% FZ**	Water	03/16/18 10:20	03/17/18 07:45
40166070006	**DAY 15 I-104/GF+ 2% FS+5% FZ**	Water	03/16/18 10:25	03/17/18 07:45
40166070007	**DAY 15 I-104/GF+ 5% I-6A**	Water	03/16/18 10:30	03/17/18 07:45
40166070008	**DAY 15 I-104/GF+ 5% FZ**	Water	03/16/18 10:35	03/17/18 07:45
40166070009	**DAY 15 I-104/GF+ 10% FZ**	Water	03/16/18 10:40	03/17/18 07:45
40166070010	**DAY 10 I-104/GF+ 5% PZ**	Water	03/16/18 10:45	03/17/18 07:45

SAMPLE ANALYTE COUNT

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
40166070001	**DAY 15 MW-23/SOIL + 5% FS**	EPA 6010	JLD	4	PASI-G
40166070002	**DAY 15 MW-23/GF + 8% I-6AFS**	EPA 6010	JLD	4	PASI-G
40166070003	**DAY 15 MW-23/GF + 5% FZ**	EPA 6010	JLD	4	PASI-G
40166070004	**DAY 15 I-104/SOIL+ 1% FS**	EPA 6010	JLD	4	PASI-G
40166070005	**DAY 15 I-104/GF+ 1% FS+5% FZ**	EPA 6010	JLD	4	PASI-G
		EPA 6020	DS1	1	PASI-G
40166070006	**DAY 15 I-104/GF+ 2% FS+5% FZ**	EPA 6010	JLD	4	PASI-G
		EPA 6020	DS1	1	PASI-G
40166070007	**DAY 15 I-104/GF+ 5% I-6A**	EPA 6010	JLD	4	PASI-G
40166070008	**DAY 15 I-104/GF+ 5% FZ**	EPA 6010	JLD	4	PASI-G
40166070009	**DAY 15 I-104/GF+ 10% FZ**	EPA 6010	JLD	4	PASI-G
		EPA 6020	DS1	1	PASI-G
40166070010	**DAY 10 I-104/GF+ 5% PZ**	EPA 6010	JLD	4	PASI-G

SUMMARY OF DETECTION

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Lab Sample ID Method	Client Sample ID Parameters	Result	Units	Report Limit	Analyzed	Qualifiers
40166070001	**DAY 15 MW-23/SOIL + 5% FS**					
EPA 6010	Arsenic	7420	ug/L	25.0	03/20/18 13:18	
EPA 6010	Nickel	124	ug/L	10.0	03/20/18 13:18	
EPA 6010	Zinc	56.6	ug/L	40.0	03/20/18 13:18	
40166070002	**DAY 15 MW-23/GF + 8% I-6AFS**					
EPA 6010	Arsenic	2650	ug/L	25.0	03/20/18 13:21	
EPA 6010	Nickel	77.4	ug/L	10.0	03/20/18 13:21	
EPA 6010	Zinc	44.2	ug/L	40.0	03/20/18 13:21	
40166070003	**DAY 15 MW-23/GF + 5% FZ**					
EPA 6010	Arsenic	55600	ug/L	250	03/20/18 14:01	
EPA 6010	Copper	2630	ug/L	20.0	03/20/18 13:28	
EPA 6010	Nickel	181	ug/L	10.0	03/20/18 13:28	
EPA 6010	Zinc	1120	ug/L	40.0	03/20/18 13:28	
40166070004	**DAY 15 I-104/SOIL+ 1% FS**					
EPA 6010	Arsenic	17.1J	ug/L	25.0	03/20/18 13:30	B
EPA 6010	Copper	10.6J	ug/L	20.0	03/20/18 13:30	
EPA 6010	Nickel	3.6J	ug/L	10.0	03/20/18 13:30	
EPA 6010	Zinc	46.3	ug/L	40.0	03/20/18 13:30	
40166070005	**DAY 15 I-104/GF+ 1% FS+5% FZ**					
EPA 6010	Zinc	42.4	ug/L	40.0	03/20/18 13:33	
EPA 6020	Arsenic	0.73J	ug/L	2.0	03/26/18 22:28	D3
40166070006	**DAY 15 I-104/GF+ 2% FS+5% FZ**					
EPA 6010	Zinc	44.0	ug/L	40.0	03/20/18 13:35	
40166070007	**DAY 15 I-104/GF+ 5% I-6A**					
EPA 6010	Arsenic	23.2J	ug/L	25.0	03/20/18 13:38	B
EPA 6010	Zinc	34.0J	ug/L	40.0	03/20/18 13:38	
40166070008	**DAY 15 I-104/GF+ 5% FZ**					
EPA 6010	Arsenic	43.8	ug/L	25.0	03/20/18 13:40	B
EPA 6010	Zinc	19.7J	ug/L	40.0	03/20/18 13:40	
40166070009	**DAY 15 I-104/GF+ 10% FZ**					
EPA 6010	Zinc	19.3J	ug/L	40.0	03/20/18 13:43	
EPA 6020	Arsenic	1.3	ug/L	1.0	03/26/18 22:54	
40166070010	**DAY 10 I-104/GF+ 5% PZ**					
EPA 6010	Arsenic	36.3	ug/L	25.0	03/20/18 13:45	B
EPA 6010	Zinc	9.9J	ug/L	40.0	03/20/18 13:45	

PROJECT NARRATIVE

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40166070

Method: **EPA 6010**
Description: 6010 MET ICP
Client: ReSolution Partners, LLC.
Date: March 28, 2018

General Information:
10 samples were analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

QC Batch: 283681

B: Analyte was detected in the associated method blank.
- BLANK for HBN 283681 [MPRP/174 (Lab ID: 1660958)
  - Arsenic

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Method: **EPA 6020**
Description: 6020 MET ICPMS
Client: ReSolution Partners, LLC.
Date: March 28, 2018

General Information:
3 samples were analyzed for EPA 6020. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 284130

A matrix spike/matrix spike duplicate was not performed due to insufficient sample volume.

Additional Comments:

Analyte Comments:

QC Batch: 284130

D3: Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

- DAY 15 I-104/GF+ 1% FS+5% FZ (Lab ID: 40166070005)
  - Arsenic
- DAY 15 I-104/GF+ 2% FS+5% FZ (Lab ID: 40166070006)
  - Arsenic

This data package has been reviewed for quality and completeness and is approved for release.

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 15 MW-23/SOIL + 5% FS **Lab ID: 40166070001** Collected: 03/16/18 10:00 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**7420**	ug/L	25.0	8.3	1	03/19/18 15:17	03/20/18 13:18	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:18	7440-50-8	
Nickel	**124**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:18	7440-02-0	
Zinc	**56.6**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:18	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 15 MW-23/GF + 8% I-6AFS **Lab ID: 40166070002** Collected: 03/16/18 10:05 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**2650**	ug/L	25.0	8.3	1	03/19/18 15:17	03/20/18 13:21	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:21	7440-50-8	
Nickel	**77.4**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:21	7440-02-0	
Zinc	**44.2**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:21	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 15 MW-23/GF + 5% FZ **Lab ID: 40166070003** Collected: 03/16/18 10:10 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**55600**	ug/L	250	83.4	10	03/19/18 15:17	03/20/18 14:01	7440-38-2	
Copper	**2630**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:28	7440-50-8	
Nickel	**181**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:28	7440-02-0	
Zinc	**1120**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:28	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 15 I-104/SOIL+ 1% FS **Lab ID: 40166070004** Collected: 03/16/18 10:15 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**17.1J**	ug/L	25.0	8.3	1	03/19/18 15:17	03/20/18 13:30	7440-38-2	B
Copper	**10.6J**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:30	7440-50-8	
Nickel	**3.6J**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:30	7440-02-0	
Zinc	**46.3**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:30	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 15 I-104/GF+ 1% FS+5% FZ **Lab ID: 40166070005** Collected: 03/16/18 10:20 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	03/19/18 15:17	03/20/18 13:33	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:33	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:33	7440-02-0	
Zinc	**42.4**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:33	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**0.73J**	ug/L	2.0	0.56	2	03/23/18 08:36	03/26/18 22:28	7440-38-2	D3

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 15 I-104/GF+ 2% FS+5% FZ **Lab ID: 40166070006** Collected: 03/16/18 10:25 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	03/19/18 15:17	03/20/18 13:35	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:35	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:35	7440-02-0	
Zinc	**44.0**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:35	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**<1.4**	ug/L	5.0	1.4	5	03/23/18 08:36	03/26/18 22:41	7440-38-2	D3

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 15 I-104/GF+ 5% I-6A **Lab ID: 40166070007** Collected: 03/16/18 10:30 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**23.2J**	ug/L	25.0	8.3	1	03/19/18 15:17	03/20/18 13:38	7440-38-2	B
Copper	**<6.3**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:38	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:38	7440-02-0	
Zinc	**34.0J**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:38	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 15 I-104/GF+ 5% FZ **Lab ID: 40166070008** Collected: 03/16/18 10:35 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**43.8**	ug/L	25.0	8.3	1	03/19/18 15:17	03/20/18 13:40	7440-38-2	B
Copper	**<6.3**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:40	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:40	7440-02-0	
Zinc	**19.7J**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:40	7440-66-6	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 15 I-104/GF+ 10% FZ **Lab ID: 40166070009** Collected: 03/16/18 10:40 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**<8.3**	ug/L	25.0	8.3	1	03/19/18 15:17	03/20/18 13:43	7440-38-2	
Copper	**<6.3**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:43	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:43	7440-02-0	
Zinc	**19.3J**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:43	7440-66-6	
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Arsenic	**1.3**	ug/L	1.0	0.28	1	03/23/18 08:36	03/26/18 22:54	7440-38-2	

ANALYTICAL RESULTS

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Sample: DAY 10 I-104/GF+ 5% PZ **Lab ID: 40166070010** Collected: 03/16/18 10:45 Received: 03/17/18 07:45 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Arsenic	**36.3**	ug/L	25.0	8.3	1	03/19/18 15:17	03/20/18 13:45	7440-38-2	B
Copper	**<6.3**	ug/L	20.0	6.3	1	03/19/18 15:17	03/20/18 13:45	7440-50-8	
Nickel	**<2.6**	ug/L	10.0	2.6	1	03/19/18 15:17	03/20/18 13:45	7440-02-0	
Zinc	**9.9J**	ug/L	40.0	9.3	1	03/19/18 15:17	03/20/18 13:45	7440-66-6	

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

QC Batch: 283681 Analysis Method: EPA 6010
QC Batch Method: EPA 3010 Analysis Description: 6010 MET
Associated Lab Samples: 40166070001, 40166070002, 40166070003, 40166070004, 40166070005, 40166070006, 40166070007, 40166070008, 40166070009, 40166070010

METHOD BLANK: 1660958 Matrix: Water
Associated Lab Samples: 40166070001, 40166070002, 40166070003, 40166070004, 40166070005, 40166070006, 40166070007, 40166070008, 40166070009, 40166070010

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	10.2J	25.0	8.3	03/20/18 12:42	
Copper	ug/L	<6.3	20.0	6.3	03/20/18 12:42	
Nickel	ug/L	<2.6	10.0	2.6	03/20/18 12:42	
Zinc	ug/L	<9.3	40.0	9.3	03/20/18 12:42	

LABORATORY CONTROL SAMPLE: 1660959

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	ug/L	500	492	98	80-120	
Copper	ug/L	500	482	96	80-120	
Nickel	ug/L	500	492	98	80-120	
Zinc	ug/L	500	502	100	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1660960 1660961

Parameter	Units	40166071001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic	ug/L	8.4J	500	500	519	540	102	106	75-125	4	20	
Copper	ug/L	<6.3	500	500	501	504	100	100	75-125	1	20	
Nickel	ug/L	<2.6	500	500	496	498	99	99	75-125	1	20	
Zinc	ug/L	388	500	500	904	887	103	100	75-125	2	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

QC Batch: 284130
Analysis Method: EPA 6020
QC Batch Method: EPA 3010
Analysis Description: 6020 MET
Associated Lab Samples: 40166070005, 40166070006, 40166070009

METHOD BLANK: 1663019
Matrix: Water
Associated Lab Samples: 40166070005, 40166070006, 40166070009

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic	ug/L	<0.28	1.0	0.28	03/26/18 22:09	

LABORATORY CONTROL SAMPLE & LCSD: 1663020 1663021

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Arsenic	ug/L	500	507	501	101	100	80-120	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	PC-LANDAU, SEATTLE WA
Pace Project No.:	40166070

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

TNTC - Too Numerous To Count

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-G	Pace Analytical Services - Green Bay

BATCH QUALIFIERS

Batch: 284181

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

ANALYTE QUALIFIERS

B	Analyte was detected in the associated method blank.
D3	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: PC-LANDAU, SEATTLE WA
Pace Project No.: 40166070

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
40166070001	**DAY 15 MW-23/SOIL + 5% FS**	EPA 3010	283681	EPA 6010	283772
40166070002	**DAY 15 MW-23/GF + 8% I-6AFS**	EPA 3010	283681	EPA 6010	283772
40166070003	**DAY 15 MW-23/GF + 5% FZ**	EPA 3010	283681	EPA 6010	283772
40166070004	**DAY 15 I-104/SOIL+ 1% FS**	EPA 3010	283681	EPA 6010	283772
40166070005	**DAY 15 I-104/GF+ 1% FS+5% FZ**	EPA 3010	283681	EPA 6010	283772
40166070006	**DAY 15 I-104/GF+ 2% FS+5% FZ**	EPA 3010	283681	EPA 6010	283772
40166070007	**DAY 15 I-104/GF+ 5% I-6A**	EPA 3010	283681	EPA 6010	283772
40166070008	**DAY 15 I-104/GF+ 5% FZ**	EPA 3010	283681	EPA 6010	283772
40166070009	**DAY 15 I-104/GF+ 10% FZ**	EPA 3010	283681	EPA 6010	283772
40166070010	**DAY 10 I-104/GF+ 5% PZ**	EPA 3010	283681	EPA 6010	283772
40166070005	**DAY 15 I-104/GF+ 1% FS+5% FZ**	EPA 3010	284130	EPA 6020	284181
40166070006	**DAY 15 I-104/GF+ 2% FS+5% FZ**	EPA 3010	284130	EPA 6020	284181
40166070009	**DAY 15 I-104/GF+ 10% FZ**	EPA 3010	284130	EPA 6020	284181

40166070

page 1 of 1

Analytical Lab: Pace Analytical
Address: 1241 Bellevue Street
City/State/Zip: Green Bay, WI 54302
Lab Contact: Dan Milewsky
Phone Number: (920)-469-2436

Sampler Name (print): Kevin Baker
Phone Number: 608-669-6949

Client Name: ReSolution Partners, LLC
Project ID: PC-Landau, Seattle WA
Project Number:
Address: 967 Jonathon Drive
City/State/Zip: Madison, WI 53719
Project Manager: Angela Hassell
60-669-1248

Report To: Angela Hassell
Email Address: ahassell@resolutionpartnersllc.net
Report To: Kevin Baker
Email Address: kbaker@resolutionpartnersllc.net
Report To: Bernd Rehm
Email Address: brehm@resolutionpartnersllc.net
Invoice To: Angela Hassell

	Sample Information							Preservative							Matrix						Analyze For:				TAT	
	Description	Date Sampled	Time Sampled	No. of Containers	Grab	Composite	Filtered	Ice	HNO3	HCl	NaOH	H2SO4 plastic	H2SO4 glass	Other:	Groundwater	Waste Water	Drinking Water	Sludge	Soil	Other :	Arsenic	Copper	Nickel	Zinc	RUSH: 2 days *	Standard
001	Day 15 MW-23 / SOIL + 5% FS	3/16/2018	1000	1			x	x	x							x					x	x	x	x	x	
002	Day 15 MW-23 / GF + 8% I-6AF2	3/16/2018	1005	1			x	x	x							x					x	x	x	x	x	
003	Day 15 MW-23 / GF + 5% FZ	3/16/2018	1010	1			x	x	x							x					x	x	x	x	x	
004	Day 15 I-104 / SOIL + 1% FS	3/16/2018	1015	1			x	x	x							x					x	x	x	x	x	
005	Day 15 I-104 / GF + 1% FS + 5% FZ	3/16/2018	1020	1			x	x	x							x					x	x	x	x	x	
006	Day 15 I-104 / GF + 2% FS + 5% FZ	3/16/2018	1025	1			x	x	x							x					x	x	x	x	x	
007	Day 15 I-104 / GF + 5% I-6A	3/16/2018	1030	1			x	x	x							x					x	x	x	x	x	
008	Day 15 I-104 / GF + 5% FZ	3/16/2018	1035	1			x	x	x							x					x	x	x	x	x	
009	Day 15 I-104 / GF + 10% FZ	3/16/2018	1040	1			x	x	x							x					x	x	x	x	x	
010	Day 10 I-104 / GF + 5% PZ	3/16/2018	1045	1			x	x	x							x					x	x	x	x	x	

Special Instructions: * Note 2 day TAT. Requested reporting limits : As 5 ug/L, Cu 8 ug/L, Ni 8 ug/L, Zn 80 ug/L or better. Start with Method 6010 to achieve TAT. Achieve final reporting limits with 6020 as necessary for 5-day TAT.

Laboratory Comments:

Method of Shipment:
Tracking No:

Relinquished By/Date: 3/16/18
Received By/Date:

Relinquished By/Date: Waltco 3/17/18 0745
Received By/Date: Katie Schuman Pace 3/17/18 0745

Pace Analytical Services, LLC
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Sample Preservation Receipt Form

Client Name: ReSolution

Project # 40166070

All containers needing preservation have been checked and noted below: ☑Yes ☐No ☐N/A Lab Std #ID of preservation (if pH adjusted):

Initial when completed: KJ

Date/ Time:

	Glass							Plastic							Vials						Jars			General									
Pace Lab #	AG1U	AG1H	AG4S	AG4U	AG5U	AG2S	BG3U	BP1U	BP2N	BP2Z	BP3U	BP3C	BP3N	BP3S	DG9A	DG9T	VG9U	VG9H	VG9M	VG9D	JGFU	WGFU	WPFU	SP5T	ZPLC	GN	VOA Vials (>6mm) *	H2SO4 pH ≤2	NaOH+Zn Act pH ≥9	NaOH pH ≥12	HNO3 pH ≤2	pH after adjusted	Volume (mL)
001																										│					✓		2.5 / 5 / 10
002																										│					✓		2.5 / 5 / 10
003																										│					✓		2.5 / 5 / 10
004																										│					✓		2.5 / 5 / 10
005																										│					✓		2.5 / 5 / 10
006																										│					✓		2.5 / 5 / 10
007																										│					✓		2.5 / 5 / 10
008																										│					✓		2.5 / 5 / 10
009																										│					✓		2.5 / 5 / 10
010													1													X					✓		2.5 / 5 / 10
011																											KJ 3/21/18						2.5 / 5 / 10
012																																	2.5 / 5 / 10
013																																	2.5 / 5 / 10
014																																	2.5 / 5 / 10
015																																	2.5 / 5 / 10
016																																	2.5 / 5 / 10
017																																	2.5 / 5 / 10
018																																	2.5 / 5 / 10
019																																	2.5 / 5 / 10
020																																	2.5 / 5 / 10

Exceptions to preservation check: VOA, Coliform, TOC, TOX, TOH, O&G, WI DRO, Phenolics, Other:________ Headspace in VOA Vials (>6mm) : ☐Yes ☐No ☑N/A ***If yes look in headspace column**

AG1U	1 liter amber glass
AG1H	1 liter amber glass HCL
AG4S	125 mL amber glass H2SO4
AG4U	120 mL amber glass unpres
AG5U	100 mL amber glass unpres
AG2S	500 mL amber glass H2SO4
BG3U	250 mL clear glass unpres

BP1U	1 liter plastic unpres
BP2N	500 mL plastic HNO3
BP2Z	500 mL plastic NaOH, Znact
BP3U	250 mL plastic unpres
BP3C	250 mL plastic NaOH
BP3N	250 mL plastic HNO3
BP3S	250 mL plastic H2SO4

DG9A	40 mL amber ascorbic
DG9T	40 mL amber Na Thio
VG9U	40 mL clear vial unpres
VG9H	40 mL clear vial HCL
VG9M	40 mL clear vial MeOH
VG9D	40 mL clear vial DI

JGFU	4 oz amber jar unpres
WGFU	4 oz clear jar unpres
WPFU	4 oz plastic jar unpres

SP5T	120 mL plastic Na Thiosulfate
ZPLC	ziploc bag
GN:	125mLpD

Pace Analytical™ 1241 Bellevue Street, Green Bay, WI 54302	Document Name: **Sample Condition Upon Receipt (SCUR)**	Document Revised: 31Jan2018
	Document No.: **F-GB-C-031-rev.06**	Issuing Authority: Pace Green Bay Quality Office

Sample Condition Upon Receipt Form (SCUR)

Project #: **WO# : 40166070**

40166070

Client Name: ReSolution

Courier: ☐ CS Logistics ☐ Fed Ex ☐ Speedee ☐ UPS ☑ Waltco ☐ Client ☐ Pace Other:

Tracking #: 1654992-1

Custody Seal on Cooler/Box Present: ☐ yes ☑ no Seals intact: ☐ yes ☐ no

Custody Seal on Samples Present: ☐ yes ☑ no Seals intact: ☐ yes ☐ no

Packing Material: ☐ Bubble Wrap ☐ Bubble Bags ☑ None ☐ Other

Thermometer Used SR - NA **Type of Ice:** [✓ Wet] Blue Dry None ☑ Samples on ice, cooling process has begun

Cooler Temperature Uncorr: /Corr: NA

Temp Blank Present: ☐ yes ☑ no **Biological Tissue is Frozen:** ☐ yes ☐ no

Temp should be above freezing to 6°C.
Biota Samples may be received at ≤ 0°C.

Person examining contents:
Date: 3/17/18
Initials: Kf

Chain of Custody Present:	☑Yes ☐No ☐N/A	1.
Chain of Custody Filled Out:	☑Yes ☐No ☐N/A	2. no time Kf 3/17/18
Chain of Custody Relinquished:	☑Yes ☐No ☐N/A	3. ← Kf 3/17/18
Sampler Name & Signature on COC:	Kf 3/17/18 ~~☑Yes~~ [✓ ☑No] ☐N/A	4.
Samples Arrived within Hold Time:	☑Yes ☐No ☐N/A	5.
- VOA Samples frozen upon receipt	☐Yes ☐No	Date/Time:
Short Hold Time Analysis (<72hr):	☐Yes ☑No ☐N/A	6.
Rush Turn Around Time Requested:	[✓ ☑Yes] ~~☑No~~ ☐N/A	Kf 3/17/18 7.
Sufficient Volume: ☐Yes ☑No ☐N/A MS/MSD	☐Yes ☑No ☐N/A	8.
Correct Containers Used:	☑Yes ☐No ☐N/A	9.
-Pace Containers Used:	☑Yes ☐No ☐N/A	
-Pace IR Containers Used:	☐Yes ☐No ☑N/A	
Containers Intact:	☑Yes ☐No ☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes ☐No ☑N/A	11.
Sample Labels match COC:	☑Yes ☐No ☐N/A	12.
-Includes date/time/ID/Analysis Matrix: W		
Trip Blank Present:	☐Yes ☐No ☑N/A	13.
Trip Blank Custody Seals Present	☐Yes ☐No ☑N/A	
Pace Trip Blank Lot # (if purchased):		

Client Notification/ Resolution:

If checked, see attached form for additional comments ☐

Person Contacted: Date/Time:

Comments/ Resolution:

Project Manager Review: RnR for DM **Date:** 3/17/18

Page 2 of 2

APPENDIX F

Numerical Model Documentation

Technical Memorandum

TO: Lindsey Erickson, The Boeing Company

FROM: Ben Lee, PE

DATE: July 25, 2022

RE: **Appendix F—Numerical Model Documentation**
Boeing Isaacson-Thompson Feasibility Study
Tukwila, Washington
Project No. 0025190.222

Introduction

This technical memorandum documents the construction and use of a numerical groundwater flow model (model) used to evaluate various remedial alternatives to manage existing groundwater contamination beneath The Boeing Company's (Boeing's) Isaacson-Thompson Site (Site) located in Tukwila, Washington. The location of the Site is shown on Figure F-1. Site features are shown on Figure F-2. Existing soil and groundwater contamination at the Site is described in the Site Remedial Investigation (RI) Report (Landau 2014). The various remedial alternatives considered for implementation at the Site are described in the Site Feasibility Study (FS) Report. The model described in this technical memorandum was used to assess the feasibility and efficacy of FS Alternative 1 (Containment and Hydraulic Capture via Capping and Groundwater Extraction) and Alternative 2 (Containment and Hydraulic Control via Capping and Vertical Barrier). The following sections describe the basic hydrogeologic setting in the vicinity of the Site, the construction and calibration of the model, and the results of the model simulations.

Hydrogeologic Setting

The following description of the geologic and hydrogeologic conditions beneath the Site is adapted from the RI and FS reports.

Geologic Conditions

The geology of the lower Duwamish River (river) valley is characterized by the historical fluvial depositional environment and the anthropogenic changes made to the river that resulted in the current configuration of the Lower Duwamish Waterway (LDW). Naturally occurring soils in the vicinity of the Site generally consist of low permeability to moderately permeable alluvial deposits of interbedded silt, clay, silty sand, and sand. The river historically meandered across the river valley floor but was channelized in the 1900s for shipping and commerce. The constructed LDW channel resulted in the movement and deposition of dredge fill and other large quantities of sand, silt, gravel, and other fill material.

Observations during the RI indicate that subsurface soil conditions at the Site consist of approximately 2 to 19.5 feet (ft) of fill overlying native deposits. The fill generally consists of silty sand to sandy gravel (some of which likely originated as dredged native material from the area and so can be difficult to distinguish from the underlying native material; Fabritz et al. 1998) as well as bricks, wood debris, and slag material. The native alluvial deposits typically consist of fine sand and silty fine sand with silt lenses and are characterized by the presence of small in-place roots, wood fragments, and peat, which are indicators of the original ground surface elevation prior to fill placement. The relatively young shallow native material (fine sand and silty fine sand) grades downward to alluvial sand (interbedded with silt layers) associated with the historical prograding delta front of the Duwamish River (Booth and Herman 1998). Younger sediments are underlain by lower estuarine deposits of sand and silty sand grading downward to sandy silt, present to depths of approximately 100 ft below ground surface (bgs). Glacially consolidated silt and clay occur beneath the Site starting at around 100 ft bgs (Booth and Herman 1998).

Uplands to the east of the valley are underlain by relatively low-permeability sedimentary bedrock (Blakely Formation) and Vashon till. The uplands and valley wall west of the LDW are composed of glacial deposits including Vashon recessional outwash and till.

Hydrogeologic Conditions

The near-surface groundwater regime within the lower Duwamish River valley is generally characterized as a shallow, single-aquifer system. The Site is located at and near the east bank of the LDW, with current ground surface at approximately 16.5–19.5 ft above mean lower low water (MLLW). Groundwater in the vicinity of the Site is typically unconfined. The water table is shallow (i.e., within approximately 10–15 ft of the ground surface). The alluvial aquifer system reaches depths of approximately 100 ft in the area of the Site (Booth and Herman 1998, Fabritz et al. 1998). The LDW aquifer hydraulic conductivity ranges from approximately 3 to 300 ft per day (Booth and Herman 1998). Based on boring log soil descriptions and grain size data, hydraulic conductivity of the alluvium beneath the Site is estimated to be 1–100 ft per day, with decreasing values with depth (associated with subsurface material grading siltier with depth). River stage and groundwater levels at the Site are tidally influenced. Depth to water at the Site measured during the RI (quarterly monitoring events on March 6, June 13, September 10, and December 5, 2012, all collected during an intermediate tide) typically ranged from 11 ft to 17 ft bgs. Groundwater level elevations measured on March 6, 2012 (during seasonally high groundwater conditions; Landau 2014), were generally between approximately 4.5 and 7.5 ft North American Vertical Datum of 1988 (NAVD88; or approximately 7–10 ft MLLW)[1] throughout the Site.

The lower Duwamish River valley is a regional groundwater discharge area for the surrounding uplands; groundwater flow throughout the Duwamish Basin is toward the LDW (Booth and Herman

---

[1] The vertical datum referenced in the text of the RI is MLLW; the vertical datum referenced in a number of figures in the RI is NAVD88. For the purposes of groundwater modeling, all elevations were converted, if necessary, to NAVD88. The difference between the NAVD88 and MLLW datums at the Site location is approximately 2.48 ft (i.e., to convert an elevation referenced to MLLW to one referenced to NAVD88, subtract 2.48 ft).

1998, Fabritz et al. 1998). As such, groundwater at the Site generally flows from east to west toward the LDW, except at some locations immediately adjacent to the shoreline, where groundwater is tidally influenced and groundwater may flow north or south prior to discharge to the LDW in response to localized subsurface conditions. For example, groundwater flow directions near the shoreline may be affected by the various existing bulkheads and other anthropomorphic structures described in the FS report. Generally, the horizontal head gradient of the alluvial aquifer system of the lower Duwamish River valley is between 0.001 and 0.01 ft per ft.

The LDW is comprised of both marine and fresh surface water. Following the initial dredging and realignment of the LDW, saltwater from Puget Sound extended back into the waterway and intruded beneath the upland groundwater. As a result, a saltwater wedge is present at depth beneath the LDW. The saltwater also intruded from the LDW to groundwater at properties along its shoreline. The presence of brackish or saline water in the aquifer can affect groundwater flow because the less dense fresh groundwater tends to move above the higher density saline water. The density difference between the freshwater aquifer system and the saltwater of the LDW tends to concentrate the outflow of the surficial aquifer into the intertidal areas (i.e., in the upper portion of the groundwater column).

Tidal influences in upland groundwater monitoring wells are dependent on several factors including soil type, distance from the shoreline, and the presence of hydraulic barriers. These factors cause the magnitude of tidal influences observed in upland monitoring wells to be reduced, or altogether eliminated, in comparison to tidal fluctuations observed in the LDW. In addition to attenuation of the magnitude of tidal fluctuations, the timing of observed tidal extremes (i.e., minimum or maximum groundwater elevation fluctuations caused by tidal influences) in upland monitoring wells typically lags behind the timing observed in the LDW.

A tidal study during the RI showed that groundwater elevations at Site monitoring wells are influenced by tidal elevations to varying degrees. The amplitude of tidal fluctuations is dependent on the distance from the LDW (the amplitude decreases as distance increases) and the bulkhead material between the well and the LDW (the steel bulkhead appears to mute the amplitude more than the wooden bulkheads). The study indicated that tidal fluctuations generally do not occur more than 400 ft from the LDW. Lag times also generally increase with distance from the LDW.

Model Construction

This section describes the construction of the three-dimensional model and application of boundary conditions to represent the geologic and hydrogeologic conditions present beneath the Site. The model was developed using Aquaveo’s Groundwater Modeling System (GMS) graphical user interface and solved with the US Geological Survey (USGS)-developed MODFLOW-NWT code (Niswonger et al. 2011). GMS allows for the graphical representation of the conceptual model of a hydrogeologic system, direct importation of that conceptual model to a three-dimensional MODFLOW grid, and convenient visualization of the model solution. The conceptual model was developed based on available data, as described above. The datums used for model inputs are Washington State Plane North (NAD83) for horizontal extent and NAVD88 for vertical extent.

Model Domain and Grid Design

The model was constructed to provide a simplified representation of the hydrogeologic setting and hydraulic boundary conditions in the vicinity of the Site. The model domain includes an approximately 5-mile north-to-south aligned segment of the alluvial valley along the east side of the LDW, with the Site located in the approximate north-south center. The western margin of the model domain runs along the LDW; the eastern margin of the model domain extends approximately 1 mile east from the LDW to the contact between the alluvial valley and the eastern uplands. Model grid cells were constructed of varying sizes, from 10-ft by 10-ft (or 100 square feet for each cell) in the direct vicinity of the Site to 500-ft by 500-ft away from the Site. The varying grid size was implemented to provide detailed modeling results in the Site vicinity while maintaining computational efficiency. The vertical extent of the model is 120 ft, extending from 20 ft NAVD88 (top of model) down to -100 ft NAVD88 (bottom of model). The model was constructed with 21 layers, all 5 ft thick except the top layer (Layer 1). Layer 1 was constructed to be 20 ft thick to avoid cell drying instability. The dimensions and layout of the model grid and grid cells are shown on Figure F-3.

Time Discretization

The model was set up and run in steady-state mode. As such, time-variant fluctuations present in the actual hydrogeologic setting (e.g., precipitation recharge, tidal influences, seasonal groundwater level fluctuations, etc.) are represented by simplified (or "average") conditions.

Hydraulic Parameters

Hydraulic parameters, including horizontal hydraulic conductivity (K_h), vertical hydraulic conductivity (K_v), and porosity, were assigned to the model as summarized below:

- Hydraulic conductivity
  - Layers 1 through 13 (or 20 ft to -60 ft NAVD88):
    - K_h = 100 ft per day
    - K_v = 10 ft per day (for a vertical anisotropy, or the ratio of K_v to K_h, of 0.1, a commonly assumed value)
  - Layers 14 through 21 (or -60 to -100 ft NAVD88):
    - K_h = 10 ft per day
    - K_v = 1 ft per day (for a vertical anisotropy of 0.1)

- Porosity = 0.25 (within the range of typical values for sand and silty sand material; Fetter 2001) for all model layers.

These hydraulic parameter values were determined during model calibration to be acceptable and so were retained for remedial action simulations.

Boundary Conditions

This section describes the hydraulic boundary conditions that were applied to the model to represent model domain hydraulic inflow and outflow.

Specified Head

Specified head (CHD package) boundary conditions were applied on the east, north and south margins of the model domain to represent an assumed unconfined water table in the alluvium sloping uniformly and gradually upward from the river to the eastern edge of the valley alluvium where recharge enters the model domain as groundwater underflow from upland recharge (Booth and Herman 1998, Fabritz et al. 1998). The CHD boundary condition is applied to all model layers to represent this underflow and background unconfined water table condition. CHD head values were applied as summarized below:

- East model boundary: The eastern boundary (representing groundwater seepage into the alluvium from the uplands) was initially estimated at 10 ft NAVD88 based on results of regional modeling (Fabritz et al. 1998). It was adjusted to 8.2 ft NAVD88 during model calibration to match observed water levels on the eastern two-thirds of the property where groundwater is least influenced by tides and bulkheads.
- North and south model boundaries: These boundaries are represented by a linear gradient from the eastern specified head boundary elevation (described above) to the river head stage elevation (described below).

River

The river (RIV package) boundary condition was applied to the western margin of the model domain to represent the LDW. The RIV boundary condition was assigned to cells in Layers 1 through 4 on the west margin of the active model domain (application of the RIV package to those layers was used to accommodate the estimated river depth near the Site).

- River stage elevations were initially estimated at 5.6 ft at the south end of the model, and 0.9 ft at the north end of the model domain, based on a linear interpolation of the reported mean stage height on Mar 6, 2012 at the USGS Green River Tukwila gage, converted to NAVD88, and an assumed stage height of 0 ft at the mouth of the LDW, 3.75 miles downstream of the Site. The initial estimates were revised during calibration, resulting in stage elevations decreasing linearly from 6.6 ft on the south end to 1.8 ft on the north end.

- River bottom elevation was assumed to be -15 ft NAVD88, based on bathymetry from a 2003 David Evans and Associates survey presented in Lower Duwamish Waterway Group 2010 Remedial Investigation Report maps (Windward 2010).
- Riverbed conductance was assigned assuming a K of 1 ft per day, a reach length in each cell of 10 ft (cell size), a river width of 400 ft, and a 10 ft thickness of riverbed materials; the resulting conductance is 400 cubic feet per day per foot ($ft^3/d/ft$).

Because tidal influences on groundwater levels appear to be limited for the majority of the Site, the steady state simulation (neglecting diurnal fluctuations in river levels) was considered an appropriate simplification used in the model development for the purposes of simulating select remedial action alternatives.

Bulkheads

Known bulkheads along the shore of the LDW in the vicinity of the Site are represented in the model using the horizontal flow barrier (HFB) package, which simulates thin, vertical low-permeability features that impede the horizontal flow of groundwater (Hsieh and Freckleton 1993). The HFB requires a parameter known as the “hydraulic characteristic” calculated from the barrier K/barrier width; this parameter lowers the horizontal conductance between cells. Bulkhead locations were digitized from Site maps. HFB barriers were applied to layers 1 through 9, assuming each bulkhead was 60 ft deep (consistent with the steel bulkhead as-builts). Initial hydraulic characteristic estimates were 0.015 d^{-1} for the steel bulkhead and 0.5 d^{-1} for the wooden bulkheads. These values were adjusted to 0.05 d^{-1} for wooden, and 0.0015 d^{-1} for steel, bulkheads during calibration.

Precipitation Recharge

The majority of the Site—as well as much of the wider model domain area—is highly developed and covered with impervious surfaces (e.g., concrete, asphalt, and buildings) and because stormwater flows are collected and conveyed by a piping network to discharge to the LDW. Therefore, precipitation recharge to groundwater was assumed to be negligible and was not represented as a model boundary condition.

Saltwater Wedge

The potential elevated saline conditions in the deeper portions of the groundwater column (i.e., related to the saltwater wedge in the LDW) is unlikely to influence shallow groundwater flow conditions at the Site. Consequently, higher density salt water was not represented in the model.

Particle Tracking

The particle tracking code MODPATH was used in conjunction with model solutions to simulate the advective flow of groundwater. MODPATH simulates advective groundwater flow by tracking the movement of particles in the aquifer over time. The program can be used to assess groundwater flow velocity and flow patterns throughout the model domain.

Model Calibration

Model calibration was completed with both quantitative and qualitative methods. Calibration was performed manually by iteratively modifying model hydraulic parameters (e.g., K) and boundary conditions (e.g., specified head levels, river levels, bulkhead hydraulic characteristic value) and assessing the resulting simulated head field with respect to observations.

Quantitative calibration was completed by attempting to simulate observed groundwater elevations from March 6, 2012 (Landau 2014). Quantitative calibration included minimizing mean absolute error (MAE) and root mean squared error (RMSE) of residuals.[2] Additionally, qualitative calibration was completed to approximately represent the findings from previous studies (Lower Duwamish Coalition conceptual and numerical models), outside data (USGS river gages, bathymetry, geologic data and interpretations), and onsite findings (tidal analysis and K estimates).

Following model calibration, groundwater flow velocity computed using MODPATH indicated flow of 0.35 ft per day (or approximately 130 ft per year). The simulated hydraulic gradient across the Site was 0.001 ft per ft. Leakage from the valley aquifer to the LDW along the western river boundary of the entire model domain was 1.84 cubic feet per second (cfs). The MAE was 0.37 ft and the RMSE was 0.69 ft. A plot of observed head versus simulated head is provided on Figure F-4 to graphically show the results of the calibration. Simulated head contours from the calibrated model are shown on Figure F-5.

Model Sensitivity Analysis

Brief sensitivity testing was performed on selected hydraulic conductivity, specified head elevation, river stage elevation, river conductance, and bulkhead hydraulic characteristic parameters by changing (i.e., increasing and decreasing) each parameter individually by a factor of 10 (for hydraulic conductivity, conductance, hydraulic characteristic) or by 50 percent (for elevations). Model sensitivity to the river boundary was also tested by changing the river setting from being applied to Layers 1 through 4 to instead being applied to Layer 4 only (where river bottom occurs). Metrics included visual inspection of fit to heads (spatial distribution of error), MAE and RMSE, percent difference in model inflows—model outflows, total river leakage, and groundwater flow velocities estimated from MODPATH simulation on each head solution. Based on these metrics, model results appear to be relatively sensitive to boundary elevations and hydraulic conductivity, whereas results appear relatively insensitive to conductance and hydraulic characteristic. Order-of-magnitude changes

---

[2] The calibration residual for a particular observation point (i.e., a well with observed water level data) is calculated as the observed head minus the simulated head at that location.

to hydraulic conductivity cause a proportional change in the river leakage and groundwater velocity; MAE and RMSE increased somewhat with the 10x increase in hydraulic conductivity but were barely affected by the 10x decrease in hydraulic conductivity. Adjustments to riverbed conductance by +/- 10x produced minimal changes in all calibration metrics. Similarly, changes to the hydraulic characteristic of bulkheads produced negligible effects on all calibration metrics. Changes to the elevations of specified head and river stage boundaries had a pronounced effect on residuals, spatial fits, river leakage and flow velocities. At wells MW10, MW9, and I205, anomalously high water levels were observed. At these well, the model simulation underpredicted heads by more than 1 ft. The relatively poor calibration at these locations may relate to physical problems with these particular wells causing them to be hydraulically disconnected from the groundwater system (as discussed in the RI report).

Remedial Alternatives Simulations

The calibrated model was subsequently used to evaluate the feasibility of two remedial alternatives discussed in the FS report. The alternatives assessed with the model included:

- Alternative 1: Containment and Hydraulic Capture via Capping and Groundwater Extraction
- Alternative 2: Containment and Hydraulic Control via Capping and Vertical Barrier.

Alternative 1: Hydraulic Capture

Alternative 1 was assessed by simulating extraction wells located within the Site in a north-south line along the LDW perpendicular to groundwater flow direction and several injection wells on the upgradient (east) portion of the Site. The objective of this alternative is to capture and extract contaminated groundwater before it would otherwise discharge to the LDW. To simulate the wells (both extraction and injection), the wells (WEL package) boundary condition package was used. Simulated wells were placed in Layer 2 (or between 0 and -5 ft NAVD88). Simulated groundwater extraction is initiated in MODFLOW by entering a negative volumetric flow rate from the well; simulated injection is initiated by entering a positive flow rate to the well. MODPATH was used, with particle starting locations throughout the contaminated area of the Site, to assess the effectiveness of the extraction wells at removing contaminated groundwater before it would otherwise be discharged to the LDW. The number of extraction wells and the simulated extraction rate from each of the wells were adjusted up until all of the simulated MODPATH particles were captured by the extraction wells (i.e., none of the particles continued to discharge to the LDW) under steady state conditions. The total simulated groundwater extraction rate from all extraction wells was divided approximately evenly between the three injection wells for injection back into the upgradient injection wells (assuming injection of treated extracted groundwater). Nine simulated extraction wells with rates between 2.5 and 3 gallons per minute (gpm)—for a total of approximately 25 gpm—were required to achieve capture. The location of extraction and injection wells, the extraction/injection rates applied to each well, and resulting MODPATH particle tracks, are shown on Figure F-6.

Alternative 2: Hydraulic Capture with Vertical Barrier

This alternative was assessed by simulating a vertical barrier (or barriers) surrounding the contaminated groundwater area and extracting groundwater from within the barrier. The objective of this alternative is to capture contaminated groundwater from leaving the area within the vertical barriers and migrating to downgradient areas of the Site and discharging to the LDW. As in the Alternative 1 scenario, simulated extracted groundwater was injected (assumed to have been treated) at upgradient injection wells. The vertical barriers were simulated in model Layers 1 and 2 (or from ground surface to approximately -5 ft NAVD88, or 25 ft bgs) using the HFB package (similar to the simulation of the bulkheads discussed above), with the hydraulic characteristic set to 0.0 d^{-1} (representing a complete barrier to horizontal flow. Simulated extraction wells were placed in Layer 2 (or between approximately 0 and -5 ft NAVD88 and toward the bottom of the cutoff barriers) within the vertical barrier areas and located strategically to capture contaminated groundwater. MODPATH was used to assess the effectiveness of groundwater capture for this alternative, with particle starting points placed throughout the area defined by the vertical barriers.

The number and location of extraction wells and the simulated extraction rate from each of the wells were adjusted up until all of the simulated MODPATH particles were shown to be captured by the extraction wells (i.e., none of the particles continued to downgradient areas of the Site) under steady state conditions. A total of five simulated extraction wells were used, with simulated extraction rates 1.5 and 2 gpm per well—for a total of 9 gpm overall—in order to achieve capture.[3] Additional downgradient extraction wells may be considered to provide additional protection for the LDW. The extracted groundwater may be injected (following treatment) to an upgradient location at the Site. For the purposes of the Alternative 2 simulation, and because the HFB barriers effectively cut off the extraction wells hydraulically from horizontal groundwater flow, the re-injection of the extracted groundwater was not simulated in the model. The location of the HFB barriers and extraction wells, the extraction rates applied to each well, and resulting MODPATH particle tracks, are shown on Figure F-7.

Limitations

The groundwater modeling described herein is a good tool to represent complex groundwater conditions and remedial scenarios at the Site. However, the model representation of the system is simplified relative to *in situ* conditions and should be considered approximate. Actual conditions not fully represented by the model include non-uniform hydraulic conductivity fields, highly complicated groundwater recharge mechanisms and dynamic interactions between the groundwater beneath the Site and surface water of the LDW, and transient (i.e., time-variant) groundwater extraction rates that may, in reality, be greater initially than simulated in the steady state model simulations. While the

---

[3] Note that additional wells were added to the final alternative descriptions to provide additional capture for minimizing potential discharge of contaminated groundwater to the LDW.

model provides a reasonable representation of the groundwater flow conditions in the vicinity of the Site, there are likely to be discrepancies between simulated heads and actual groundwater levels experienced at the Site.

Use of This Memorandum

This memorandum has been prepared for the exclusive use of Boeing for specific application to the Isaacson-Thompson Site. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau, shall be at the user's sole risk. Landau warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. Landau makes no other warranty, either express or implied.

LANDAU ASSOCIATES, INC.

Ben Lee, PE, CWRE
Senior Associate

BDL/EFW/ljl
[P:\025\190\002\FILERM\R\FS\4_PUBLIC REVIEW FS\APP F - GW MODEL\APPF - NUMERICAL GROUNDWATER FLOW MODEL_TM_072522.DOCX]

Attachments

Figure F-1. Vicinity Map
Figure F-2. Current Site Features
Figure F-3. Model Grid and Boundary Conditions
Figure F-4. Model Calibration Results
Figure F-5. Calibrated Simulation Head Contours
Figure F-6. Alternative 1 Simulation
Figure F-7. Alternative 2 Simulation

References

Booth, D. and L. Herman. 1998. Duwamish Industrial Area, Hydrogeologic Pathways Project: Duwamish Basin Groundwater Pathways Conceptual Model Report. Duwamish Coalition. April.

Fabritz, J., J.Massmann, and D. Booth. 1998. Duwamish Basin Groundwater Pathways, Development of a Three-Dimensional Numerical Groundwater Flow Model for the Duwamish River Basin [N 0206]. August.

Fetter, C.W. 2001. *Applied Hydrogeology*, 4th ed. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Hsieh, P.A and J.R. Freckleton. 1993. Documentation of a Computer Program to Simulate Horizontal-Flow Barriers Using the US Geological Survey's Modular Three-Dimensional Finite-Difference Groundwater Flow Model. Report No. 92-477. US Geological Survey.

Landau. 2014. Final Remedial Investigation Report, Boeing Isaacson-Thompson Site, Tukwila, Washington (Volumes 1 and 2). Landau Associates, Inc. April 21.

Niswonger, R.G., S. Panday, and M. Ibaraki. 2011. MODFLOW-NWT, A Newton Formulation for MODFLOW-2005. US Geological Survey.

Windward. 2010. Final Lower Duwamish Waterway Remedial Investigation Report. Lower Duwamish Waterway Group, Windward Environmental LLC. July 9.

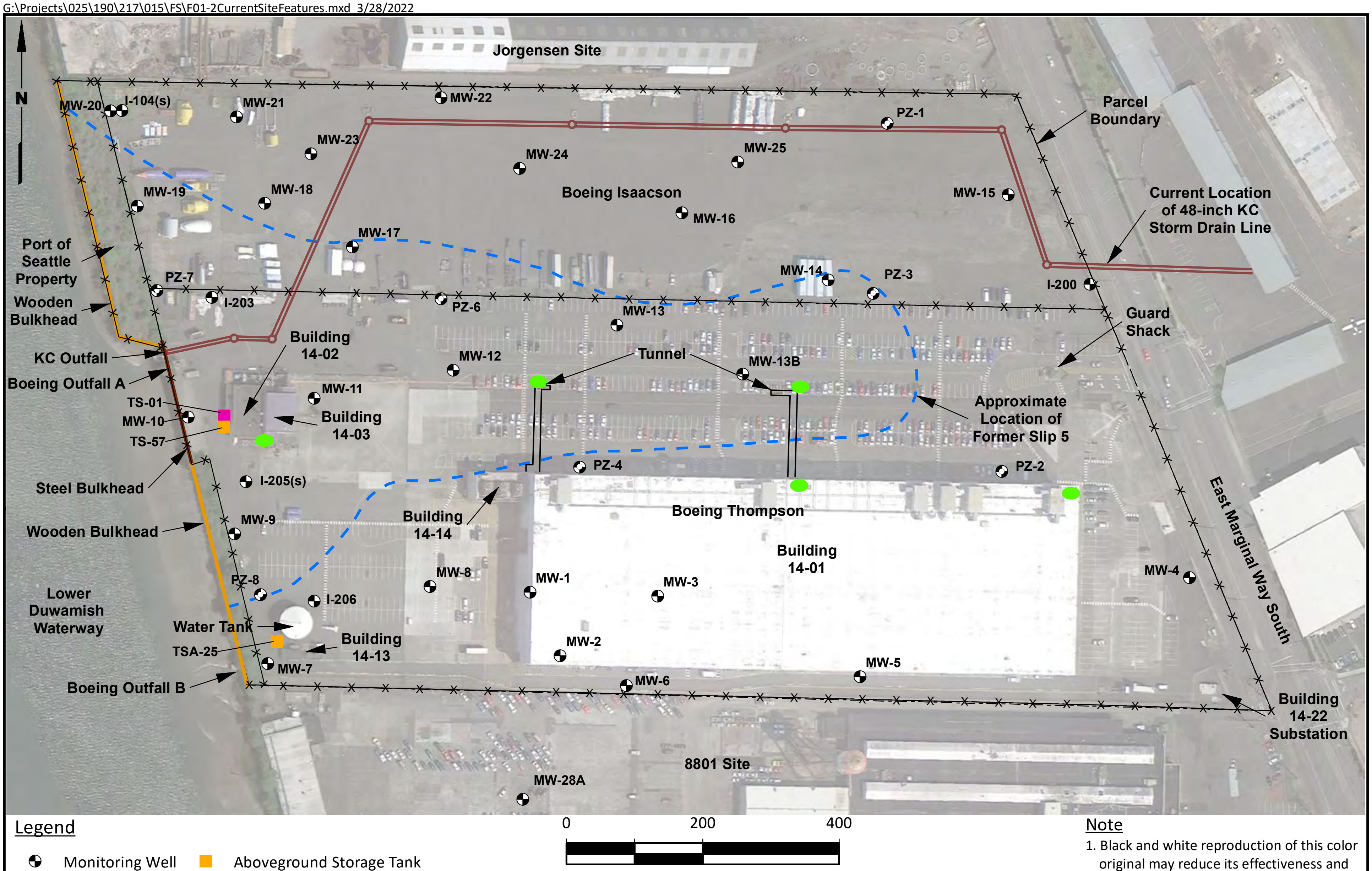
Data Source: Esri 2012

G:\Projects\025\190\217\015\FS\F01-1VicinityMap.mxd 4/16/2018 NAD 1983 StatePlane Washington North FIPS 4601 Feet

Landau Associates

Boeing Isaacson-Thompson Site Tukwila, Washington	**Vicinity Map**	Figure F-1

G:\Projects\025\190\217\015\FS\F01-2CurrentSiteFeatures.mxd 3/28/2022



Legend

- ⊕ Monitoring Well
- ⊘ Piezometer
- ×—× Fence
- 🟧 Aboveground Storage Tank
- 🟪 Underground Storage Tank
- 🟢 Sump

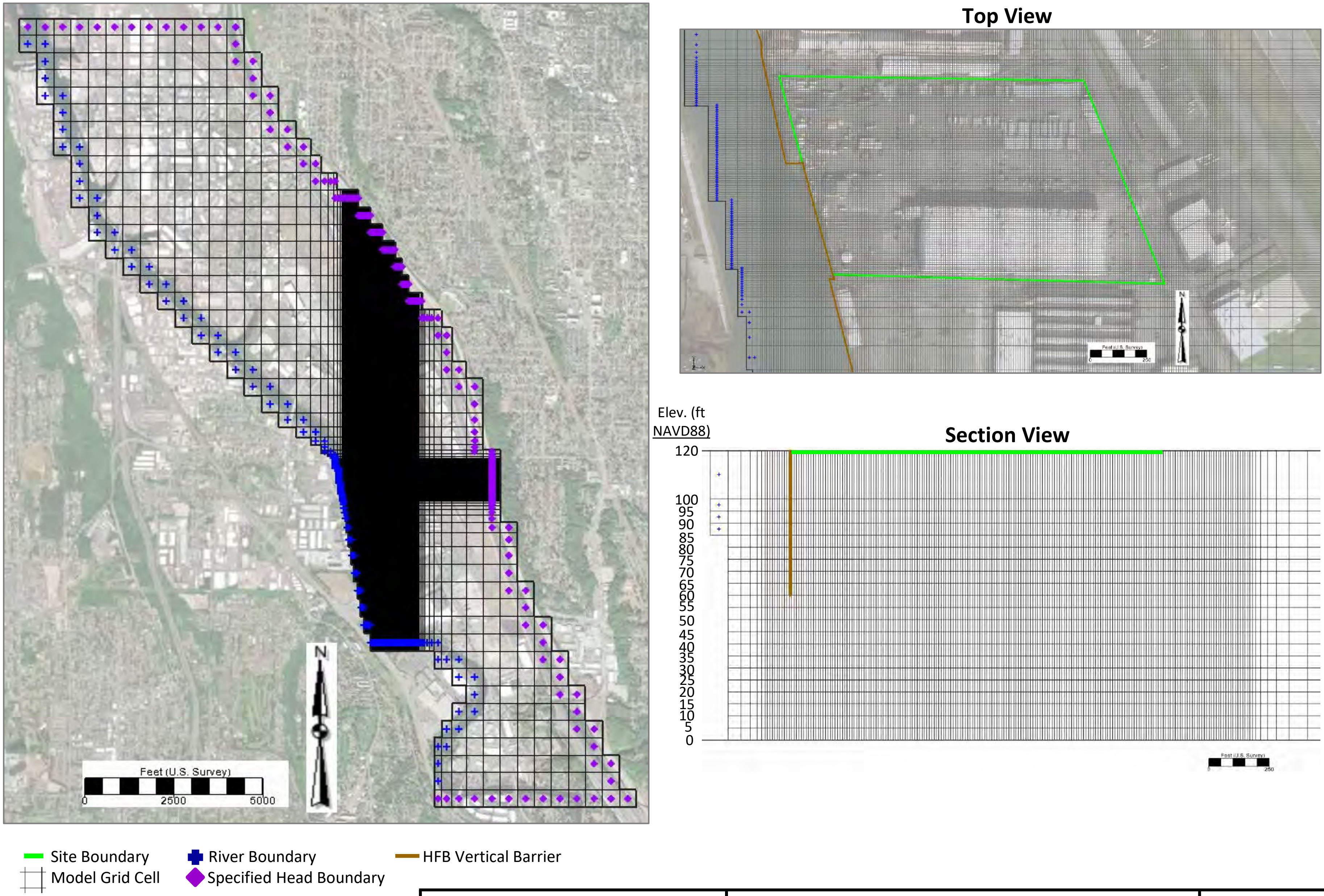
Data Sources: Google Earth Pro 2012; King County Parcel Data.

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site Tukwila, Washington	**Current Site Features**	Figure F-2

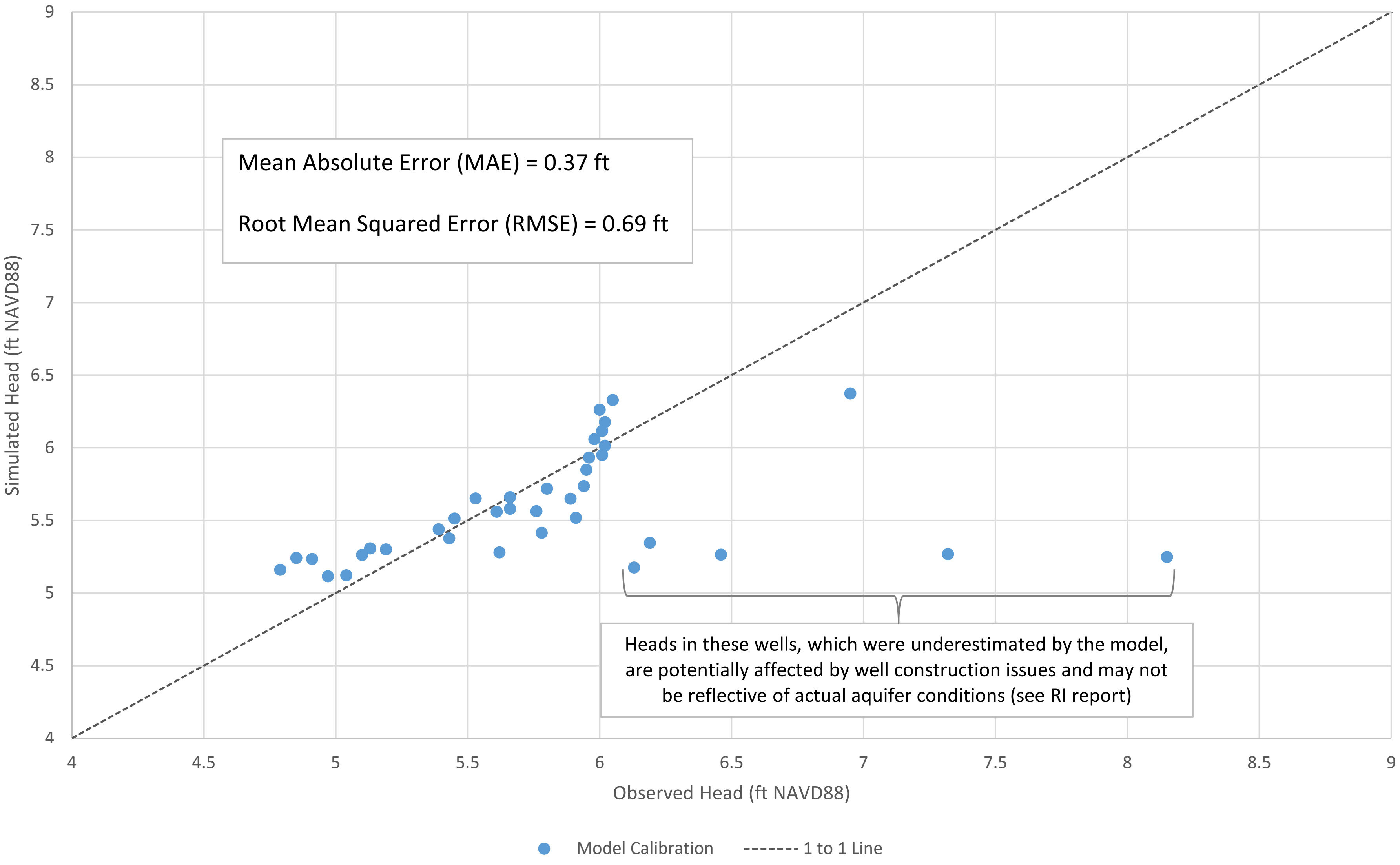


LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Model Grid and Boundary Conditions

Figure
F-3



Mean Absolute Error (MAE) = 0.37 ft

Root Mean Squared Error (RMSE) = 0.69 ft

Heads in these wells, which were underestimated by the model, are potentially affected by well construction issues and may not be reflective of actual aquifer conditions (see RI report)

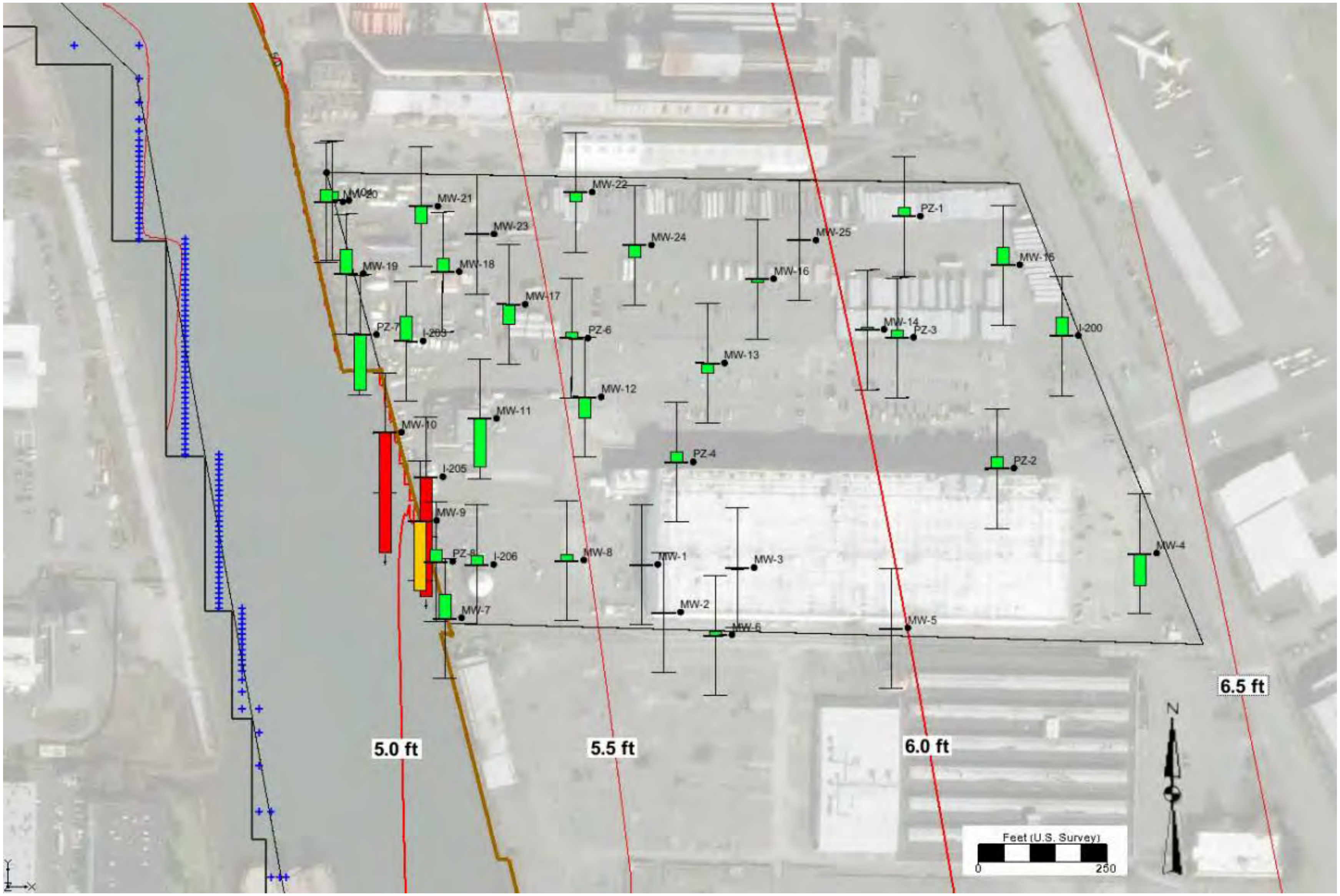
LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Model Calibration Results

Figure

F-4



— Simulated Head (ft NAVD88)

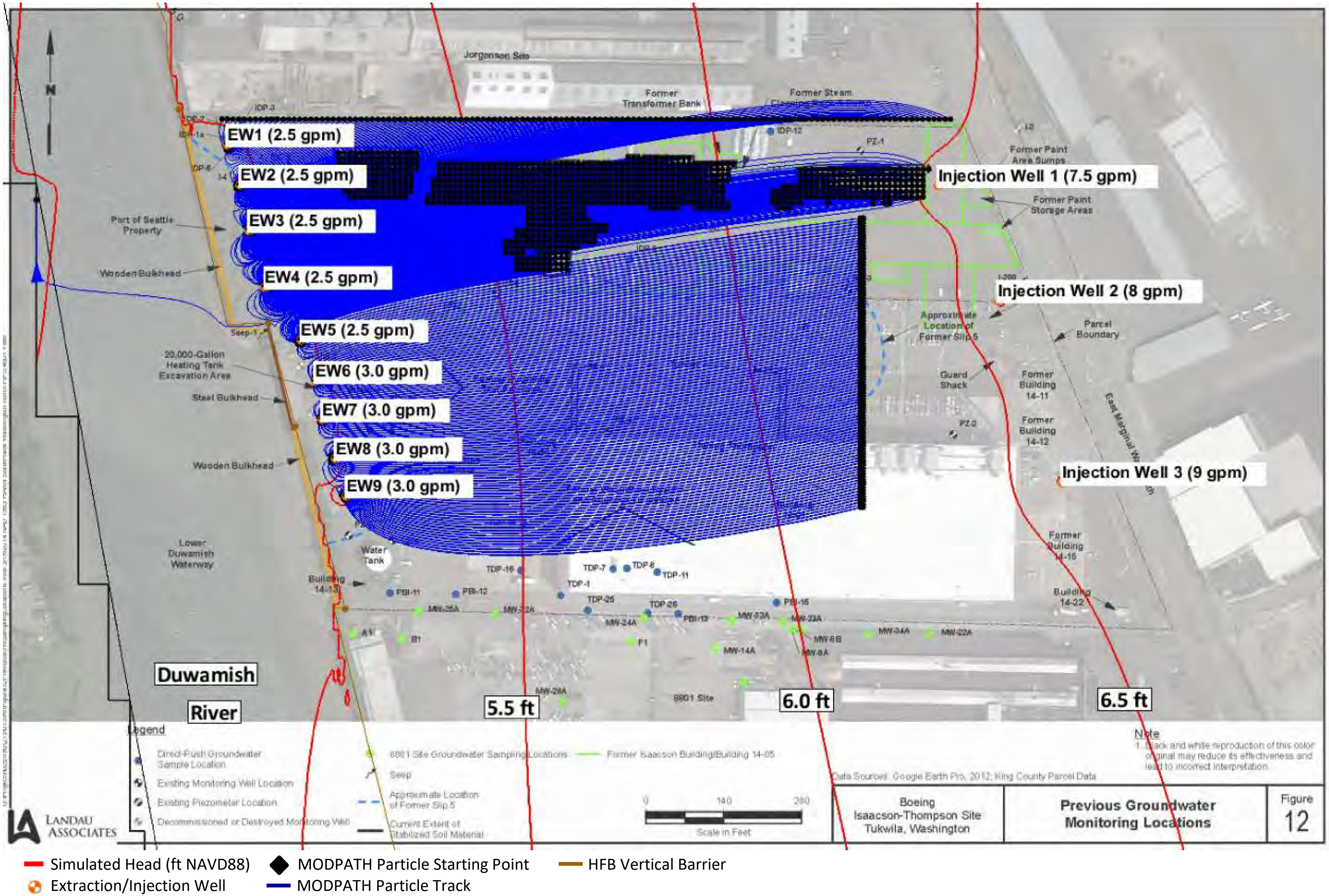
● Monitoring (Observation) Well with Calibration Residual

LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Calibrated Simulation Head Contours

Figure
F-5



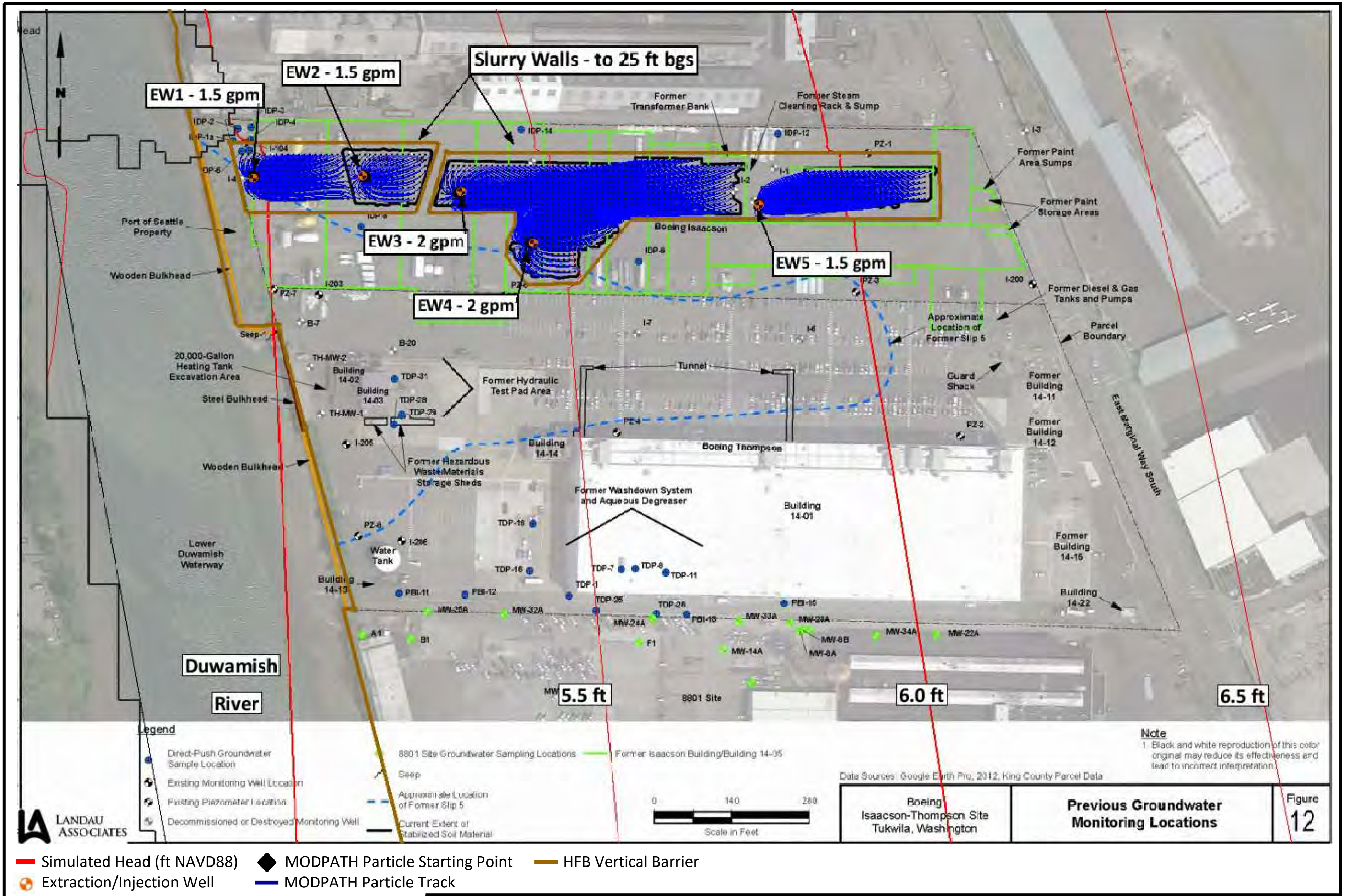
Landau Associates

Boeing Isaacson-Thompson Site
Tukwila, Washington

Alternative 1 Simulation

Figure
F-6

7/11/22 P:\025\190\002\FileRm\R\FS\4_Public Review FS\App F - GW model\Figure 7 Alternative 2 Simulation.docx



LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Alternative 2 Simulation

Figure
F-7

APPENDIX G

Supplemental Remedial Alternative Evaluation and Disproportionate Cost Analysis

Technical Memorandum

TO: Molly Taptich, The Boeing Company

FROM: Piper Roelen, PE

DATE: June 30, 2023

RE: **Boeing Isaacson-Thompson Feasibility Study**
Summary of Supplemental Remedial Alternative Evaluation and Disproportionate Cost Analysis
Tukwila, Washington
Project No. 0025190.223.015

Landau Associates, Inc. (Landau) prepared this technical memorandum on behalf of The Boeing Company (Boeing) in response to the Washington State Department of Ecology (Ecology) comment letter, dated January 31, 2023, regarding the Final Feasibility Study (FS) Report—For Public Review (dated August 5, 2022) for the Boeing Isaacson-Thompson cleanup site (Site) and the subsequent meeting on April 11, 2023 between Boeing, Ecology, and Landau. Specifically, the purpose of this memorandum is to document the results and supporting documentation for Boeing's supplemental remedial alternative evaluation and disproportionate cost analysis (DCA) comparing the preferred remedial alternative identified in the August 2022 version of the FS report (Alternative 3) with Ecology's additional remedial alternative (identified herein as Alternative 1B), as required in Ecology's January 31, 2023 comment letter.

Remedial Alternative Evaluation and Disproportionate Cost Analysis

Ecology's Alternative 1B consists of a shoreline slurry wall and extraction wells for hydraulic control/capture of dissolved-phase groundwater contamination and shoreline remedial excavation of contaminated soil on the Port of Seattle (Port) Sliver Property (see attached Figure 5-1B). This technical memorandum:

- Describes the process Landau used to model and determine the conceptual design elements for Alternative 1B (i.e., number, location, and pumping rate of extraction wells and injection wells) that were needed to evaluate and develop estimated costs for the alternative.
- Provides the results of the evaluation of Alternative 1B against the Model Toxic Control Act (MTCA) threshold and other requirements in Washington Administrative Code (WAC) 173-340-360(2)(a&b); this evaluation process is described in the main Feasibility Study (FS) Report text and is the same process that was performed for each of the other remedial alternatives evaluated in the FS.
- Provides the results of the evaluation of environmental benefits associated with the DCA evaluation criteria in WAC 173-340-360(3)(f); this evaluation process is also described in the main FS text and is the same process that was performed for each of the other remedial alternatives.
- Provides the results of the focused DCA comparing Alternative 1B and Alternative 3.

Groundwater Modeling and Conceptual Design for Alternative 1B

Per Ecology's direction, Landau used the previously prepared Site-specific groundwater model to develop the conceptual configuration and components of Alternative 1B. The information from the modeling was also used to evaluate general impacts to groundwater hydraulic behavior, identify preliminary design parameters and details, and provide information necessary to develop cost estimates for Alternative 1B.

Several different modeling runs were performed to provide various information to help inform the subsequent evaluations. The modeling process and results are documented in Attachment 1 (Slurry Wall Simulations—Model Description and Results Technical Memorandum). Modeling runs conducted included:

- A model run simulating natural groundwater conditions with the slurry wall in place (extending 25 feet [ft] below ground surface [bgs] to the approximate elevation of the marine/river meander silt layer and across the length of the property) to evaluate shoreline bounding and groundwater particle flow directions.
- Model runs with iterative increases in slurry wall depth to the evaluate how deep the wall would have to be before particles stopped flowing beneath the slurry wall (i.e., forced flow around the wall to the north or south—observed for 120 ft slurry wall depth).
- Iterative modeling runs with different numbers and pumping rates for extraction wells along the shoreline (upgradient of the slurry wall; 25 ft deep) to determine necessary parameters needed to simulate complete capture of groundwater flowing across the Site.
- Additional iterative modeling runs with different pumping rates for 8 extraction wells and set injection rates at 3 injection wells at the upgradient end of the Site to determine necessary parameters needed to simulate complete capture of groundwater flowing across the Site including reinjection of treated groundwater (and how much water would have to be "wasted" to maintain a balanced system).

These modeling runs provided general information about the behavior of Site groundwater flow and capture at the Site and the adjacent sites to the north and south. The modeling also indicated that for a 25-ft slurry wall depth (extending across the length of the property), Alternative 1B would need to consist of 8 extraction wells pumping at approximately 4 gallons per minute (gpm) each (32 gpm total) paired with 3 injection wells at a flow rate of approximately 5.3 gpm each (15 gpm total) to maintain hydraulic control and capture of Site groundwater. Based on these parameters, the estimated cost for construction, operations, maintenance, and monitoring of the system for 50 years (same time frame used for Alternatives 1–4 would be approximately $31,000,000 (see attached Table 5-2f; with estimated FS range of accuracy of minus 30 percent to plus 50 percent).

Alternative 1B Compliance with MTCA Threshold and Other Requirements

Landau evaluated Alternative 1B against the MTCA threshold and other requirements in WAC 173-340-360(2)(a&b). The results of this evaluation are included in attached Table 6-1b (along with the evaluation for Alternative 3) and indicated that Alternative 1B would be compliant with the MTCA requirements.

Alternative 1B Relative Benefits Evaluation and Ranking

Landau evaluated Alternative 1B against the MTCA DCA evaluation criteria in WAC 173-340-360(3)(f). The results of this evaluation are included in attached Table 6-2b (along with the relative benefits for Alternative 3).

Disproportionate Cost Analysis for Alternative 1B and Alternative 3

Using the information obtained from the benefit evaluation, a DCA was performed consistent with MTCA; WAC 173-340-360[3]) to evaluate and compare the relative benefits and costs of Alternative 1B to the relative benefits and costs of Alternative 3 to determine which alternative better meets the criterion of using permanent solutions to the maximum extent practicable. The results of the DCA are included in the attached Table 6-3b.

“Permanent solution” or “permanent cleanup action” means a cleanup action in which cleanup standards of WAC 173-340-700 through 173-340-760 can be met without further action being required at the site being cleaned up or any other site involved with the cleanup action, other than the approved disposal of any residue from the treatment of hazardous substances.

Costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative.

This alternatives evaluation determined that estimated costs of Alternative 1B and Alternative 3 are similar (though the estimated cost for Alternative 3 of $30,100,000 was determined to be approximately $900,000 lower than for Alternative 1B’s estimated cost of $31,000,000). Due to the similar costs of the two alternatives, the key consideration for determining which alternative better meets the criterion of “permanent to the maximum extent practicable” is which one provides higher relative benefits. Alternative 3 was determined to have higher relative benefits compared to Alternative 1B for the following MTCA DCA criteria:

- **Permanence**—Alternative 3 was determined to be more permanent than Alternative 1B because, once installed, the permeable reactive barrier (PRB) will provide continuous and ongoing treatment of groundwater and permanent protection of surface water. During the entire duration of cleanup, there will only be short periods of time, approximately every

10 years, when treatment is temporarily suspended during PRB media changeouts. Whereas Alternative 1B will not provide continuous and uninterrupted groundwater extraction and treatment (due to numerous operational factors—see additional discussion below), which is necessary for permanent protection of surface water for this alternative. While the groundwater model indicates that the installation of the slurry wall would result in longer flow paths for contaminated groundwater to reach surface water (via flow under or around the wall), it does not prevent flow to surface water when all or part of the extraction system is not properly functioning or stops operating.

- ***Effectiveness Over the Long Term***—Similar to the Permanence criterion, Alternative 3 was determined to have better effectiveness over the long term than Alternative 1B, in large part because of the high risk of periodic short- to moderate-duration treatment failure due to numerous factors related to operation of the extraction system under Alternative 1B. These factors include power failures, equipment failures (e.g., extraction well pumps, transfer pumps, control systems/computers), and biofouling or mineral fouling of extraction wells, injection wells, treatment media, which would result in incomplete or complete failure to capture and/or treat contaminated groundwater. The longer the system operates, the more prone the system would be to these type of failures due to aging equipment and the cumulative impacts of fouling over time. Furthermore, Alternative 3 provides a higher degree of long-term effectiveness because the PRB provides *in situ* treatment, contaminant destruction (for volatile contaminants), and immobilization (of metals) compared to Alternative 1B, which relies on *ex situ* treatment and disposal of spent treatment media. Alternative 1B also requires treatment of extracted groundwater to meet both cleanup standards and discharge permit limits to allow reinjection to groundwater and discharge to surface water or the sanitary sewer system; failure to treat to these standards and limits would result in uncontrolled discharge of contamination to groundwater or surface water and/or permit violations.
- ***Technical and Administrative Implementability***—The implementability criterion is where the biggest difference in benefits between Alternative 3 and Alternative 1B was identified. Alternative 1B has significantly more challenges from both the technical and administrative standpoint.
- ***Technical Challenges***—Alternative 1B would involve a significantly higher level and frequency of operations, maintenance, and monitoring than Alternative 3 to address the risks of operational or treatment failure discussed above, including continuous monitoring of system operational parameters and frequent cleaning, rehabilitation, or replacement of well pumps, injection and extraction wells, and treatment system media to address the near certain occurrence of biofouling or mineral scaling/fouling (due to aeration of naturally reduced groundwater at the Site during the extraction, treatment, and reinjection process) and to ensure proper functionality and hydraulic capture/containment. As identified by the groundwater modeling, Alternative 1B also has significant risk associated with implementation that may result in unintended consequences including:
    - a) modifying the gradients and groundwater flow paths on the neighboring Jorgensen Forge (Jorgensen) cleanup site to the north or the 8801 East Marginal Way South (8801) cleanup site to the south through reinjection of groundwater and groundwater mounding at the slurry wall;

  b) pushing contaminated groundwater from the Site onto the Jorgensen or 8801 sites through reinjection of groundwater and mounding at the slurry wall;
  c) pulling contaminated groundwater from the Jorgensen or 8801 sites onto the Site and potentially passing contaminants through the Site treatment system that may not be designed for the types or magnitude of contaminants from those sites; and/or
  d) pulling bioinjection fluid from the 8801 site onto the Site and causing or exacerbating fouling of extraction wells, extraction pumps, and treatment media.

  Balancing the groundwater extraction system to provide exactly the necessary extraction rates to capture only groundwater passing through the Site and preventing the issues indicate above would be extremely difficult and complicated, especially considering that the hydraulics in the nearshore environment at the Site are constantly changing due to tidal influences (which would not be mitigated by the slurry wall).

- ***Administrative Challenges***—Alternative 1B also has greater administrative implementation challenges than Alternative 3, including permitting and compliance monitoring and reporting for discharge of treated groundwater (through an industrial waste discharge permit, National Pollutant Discharge Elimination System [NPDES] permit, and/or Underground Injection Control [UIC] permit). Alternative 1B would also have the same permitting and other administrative requirements as Alternative 3, including a grading permit and shoreline permit, a stormwater pollution prevention plan, and permitting/approvals for in-water work (e.g., Joint Aquatic Resource Protection Act permit; US Army Corps of Engineers nationwide permit; Washington Department of Fish & Wildlife hydraulic project approval), and filing of institutional controls.
- ***Considerations of Public Concern***—Though the public has not yet been provided with opportunity to comment on the FS, it is assumed that the public will have greater concern with Alternative 1B because of the lower permanence, effectiveness, and implementability benefits compared to Alternative 3.

For the ***Protectiveness*** and ***Management of Short-Term Risks*** criteria (the other two DCA criterion besides cost), the two alternatives were determined to have roughly the same level of relative benefit. For Protectiveness, both alternatives rely on removal of contaminated soil near the shoreline and treatment of groundwater near the shoreline to be protective of surface water and sediments and to meet groundwater cleanup standards, respectively. Both alternatives also rely on capping and institutional controls to protect human health by mitigating the risk of direction human contact and exposure to contaminated media. For Management of Short-Term Risks, both alternatives include similar levels of remedial excavation; the use of heavy equipment for construction of the PRB and the slurry wall are substantially similar; and Alternative 1B has more frequent long-term operational and maintenance requirements for mechanical and electrical systems, whereas Alternative 3 has significantly less frequent PRB changeouts that include more heavy construction requirements.

Conclusion of Supplemental Alternative Evaluation and DCA

Boeing has worked with Ecology during the past several years and through four previous drafts of the FS to develop and select a remedial action that will be protective of human health and the environment and address source control objectives for the Lower Duwamish Waterway. Through this process, Alternative 3 (PRB and remedial excavation) was previously determined to meet MTCA requirements and source control objectives and was identified as the preferred remedial alternative. Boeing has now complied with Ecology's requirement to evaluate an additional alternative (Alternative 1B). As demonstrated by the evaluation of this new alternative and DCA comparison to Alternative 1B, Alternative 3 is protective, more permanent, more effective over the long term, and has less technical and administrative implementability challenges than Alternative 1B. And by virtue of Alternative 3 having similar costs to Alternative 1B, but higher relative benefits, Alternative 3 is permanent to the maximum extent practicable and is still the preferred remedial action.

Based on this supplemental evaluation, Boeing requests that Ecology approve the preferred remedy as presented in the prior drafts of the FS and not consider hydraulic control and capture as a required element in the final remedy for the Site. With Ecology's approval, Boeing will be able to finalize the FS and proceed with preparation of a draft cleanup action plan so that public review and comment can proceed without further delay, and ultimately so that Boeing can proceed with cleanup of the Site as expeditiously as possible.

We appreciate Ecology's consideration and look forward to discussing and coming to consensus that Alternative 3 is the preferred final remedy for the Site during our planned meeting next week. Please contact me if you have any questions.

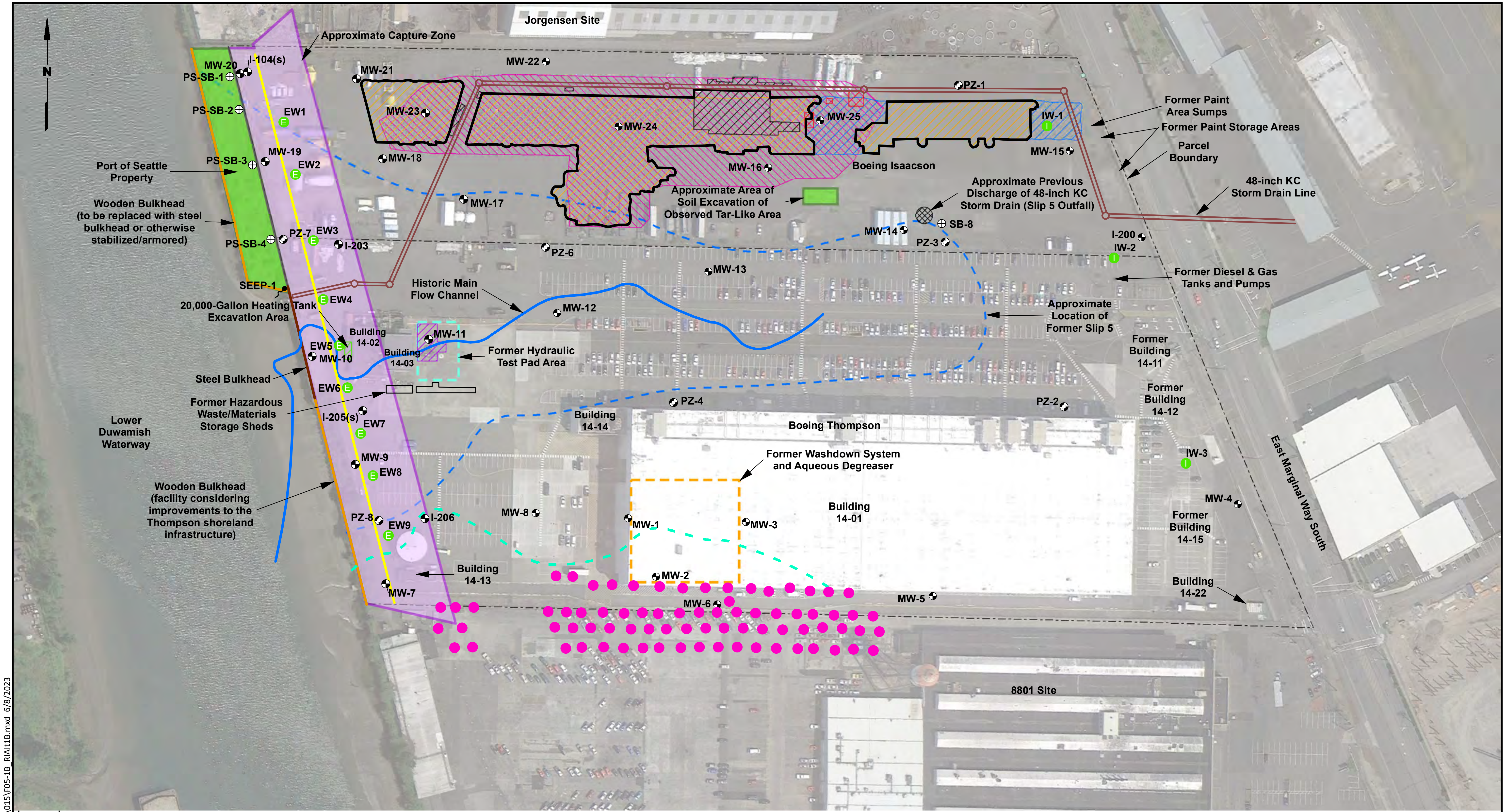
LANDAU ASSOCIATES, INC.

Piper Roelen, PE
Principal

PMR/ljl
[P:\025\190\002\FILERM\R\FS\5_PUBLIC REVIEW FS - REV 1\APP G - SUPP DCA\APP G_SUPPLEMENTALDCA_TM 06.30.2023.DOCX]

Attachments

Figure 5-1B. Alternative 1B
Table 5-2f. Alternative 1B Cost Estimate
Table 6-1b. Supplemental Summary of Remedial Alternatives Compliance with MTCA Threshold Requirements
Table 6-2b. Supplemental Relative Benefits Ranking Considerations
Table 6-3b. Supplemental Summary of Disproportionate Cost Analysis
Attachment 1. Slurry Wall Simulations—Model Description and Results Technical Memorandum



Legend

MW-22	Monitoring Well Location	SB-8	Direct-Push Boring Groundwater Sample Location
EW-1	Extraction Well Location	PZ-1	Piezometer Location
IW-1	Injection Well Location		

- ▨ 1984 Excavation
- ▨ 1988 Excavation
- ▨ 1990 Excavation
- ▨ 1991 Excavation
- ▨ 1993-1995 Excavation
- ▨ 2004 Excavation
- ▨ 2008 Removal of Stabilized Soil Mound
- Current Extent of Stabilized Soil Material
- Approximate Location of Former Slip 5
- Approximate Extent of TCE/VC from 8801 Site
- 🟪 Approximate Capture Zone
- 🟩 Approximate Area of Soil Excavation
- ● Bioinjection Point for 8801 Site on/near Boeing Property (approx.; not all shown)
- Slurry Wall

0 150 300

Scale in Feet

Data Sources: Google Earth Pro, 2012; King County Parcel Data

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

G:\Projects\025\190\218\015\F05-1B_RIAlt1B.mxd 6/8/2023

LANDAU ASSOCIATES

Boeing Isaacson-Thompson Site
Tukwila, Washington

Alternative 1B - Hydraulic Containment and Capture via Slurry Wall and Groundwater Extraction, Shoreline Excavation, and Containment

Figure
5-1B

Table 5-2f
Remedial Alternative 1B Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 1B: Containment and Hydraulic Control via Capping and Vertical Barrier

Assumptions: Install slurry wall containment parallel and adjacent to LDW and 5 extraction wells for hydraulic control of stabilized soil area, install treatment system for extracted water, 2 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Work Plans/Design/Reporting/Other					
GET System Work plan	1	LS	$ 35,700	$ 35,700	
Institutional Controls/Restrictive Covenants	1	LS	$ 11,900	$ 11,900	Restrictive covenant on the property deed filed w/County
SMA/TMC Compliance Planning and Design	1	LS	$ 96,390	$ 96,390	Coordination and planning w/City of Tukwila and Ecology for remedial alternative design compliance w/SMA and TMC/Tukwila SMP, develop Landscaping/Vegetation Management Plan
Permitting	1	LS	$ 119,000	$ 119,000	Includes: NPDES, UIC Permit, JARPA, HPA, Biological Assessment, Shoreline Permitting, and SEPA checklist
Access agreements	1	LS	$ 29,750	$ 29,750	If necessary for Port and Jorgensen properties
Bid Package/Procurement	1	LS	$ 17,850	$ 17,850	
Construction report	1	LS	$ 17,850	$ 17,850	Upon completion
Design Peer Review	0	LS	$ 11,900	$ -	
Engineering Design	6	%	$ 14,666,257	$ 879,975	Assume 6% of capital costs; engineering designs and specifications; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Construction Management/Oversight	6	%	$ 14,666,257	$ 879,975	Assume 6% of capital costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Project Management	5	%	$ 24,681,625	$ 1,234,081	Assume 5% of total costs; per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Ecology Oversight	5	%	$ 24,681,625	$ 1,234,081	Assume 5% of total costs
Task Subtotal				*$ 4,556,553*	
Preconstruction Submittals and Tasks					
Health and Safety Plan	1	LS	$ 2,500	$ 2,500	
Schedule	1	LS	$ 625	$ 625	
Other submittals	1	LS	$ 625	$ 625	Equipment/materials list, manuals, instructions, certificates, etc.
TESC Plan	1	LS	$ 6,250	$ 6,250	SEPA-required TESC plan for work near Duwamish
Permit Applications	1	LS	$ 3,750	$ 3,750	Grading permit, construction permit, electrical permit, etc., as applicable.
Mobilization	1	LS	$ 62,500	$ 62,500	Mobilize equipment and materials to site
Task Subtotal				*$ 76,250*	
Extraction Wells and Injection Wells					
6" Extraction Wells (~25 deep)	8	LS	$ 15,000	$ 120,000	6" stainless-steel casing/screen (all drilling related costs)
Well vaults & installation	8	EA	$ 15,000	$ 120,000	Includes transducer, flow meter, cables, well seals, and installation
4" submersible pump w/controls	8	EA	$ 8,750	$ 70,000	Includes pumps (Grundfos 5SQ05-90 - 5 GPM 1/2 HP or equivalent), controls, transducer, cables, well seals, 1" stainless-steel riser, and installation
2" Injection Wells (~25' deep)	3	LS	$ 11,250	$ 33,750	2" steel casing, wire wrapped screen (all drilling related costs)
Well vaults & installation	3	EA	$ 7,500	$ 22,500	Includes transducer, flow meter, cables, well seals, 1" stainless-steel riser, and installation
Task Subtotal				*$ 366,250*	
Slurry Wall					
Slurry wall construction	22,875	SF	$ 53	$ 1,200,938	Slurry wall linear horizontal linear footage ~ 915 ft, depth ~ 25 ft. Contractor quote of ~$53 (adj for infl)/vertical square foot
Spoils disposal	1,627	TN	$ 70	$ 113,216	2-ft thick wall - 1,627 CY spoils (assume 60% of wall volume), 1.6 tons/CY. Disposal at Subtitle D facility.
Task Subtotal				*$ 1,314,154*	
Groundwater Extraction and Treatment System					
Site Preparation	1	LS	$ 12,500	$ 12,500	Erosion and sediment control, site prep for building/trenching
Treatment Building	1	LS	$ 25,000	$ 25,000	Prefab building - 26 gauge metal walls and roof, 30' x 20' with 14' eave height (from RSMeans)
Precipitation system and filter press (PCB treatment)	1	LS	$ 375,000	$ 375,000	Treatment to remove contaminants associated with suspended solids and pH adjustment. Cost assumes Evoqua Model CPS-10-2-SA and 250 mm J-Press or equivalent
Ion exchange resin tanks	2	LS	$ 1,031	$ 2,063	Two 11-cubic foot resin tanks plumbed in lead-lag formation for residual arsenic polishing
Ion exchange resin (initial purchase)	22	CF	$ 1,900	$ 41,800	Arsenic-specific ion exchange media
Redundant System	1	LS	$ 456,363	$ 456,363	ECY - Create redundant treatment system

Table 5-2f
Remedial Alternative 1B Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 1B: Containment and Hydraulic Control via Capping and Vertical Barrier

Assumptions: Install slurry wall containment parallel and adjacent to LDW and 5 extraction wells for hydraulic control of stabilized soil area, install treatment system for extracted water, 2 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Extraction Well Piping and Conduits					
Electric and water trenching, excavator	240	CY	$ 63	$ 15,000	Piping from extraction wells to treatment building (assume trench = 2'Wx2.5'Dx1100'L)
Bedding Material, place, compact	100	CY	$ 44	$ 4,400	
Backfill, compact	140	CY	$ 25	$ 3,500	
HDPE 2" water line, installed, welded	1100	LF	$ 120	$ 132,000	SDR 11, includes connection to existing conveyance system
Electrical conduit, assemble, install	1100	LF	$ 40	$ 44,000	
Electrical cable	1100	LF	$ 31	$ 34,375	
Communications conduit, assemble, install	1100	LF	$ 40	$ 44,000	
Communications cable	1100	LF	$ 56	$ 61,875	
Injection Well Piping and Conduits					
Transfer tank and valving	1	LS	$ 12,500	$ 12,500	Influent collection tank for flow equalization
Booster pump w/controls	1	EA	$ 10,000	$ 10,000	Includes pumps, controls, transducer, cables, and installation
Communications and water trenching, excavator	530	CY	$ 63	$ 33,125	Piping from treatment system to injection wells (assume trench = 2'Wx2.5'Dx2400'L)
Bedding Material, place, compact	210	CY	$ 44	$ 9,240	
Backfill, compact	320	CY	$ 25	$ 8,000	
HDPE 2" water line, installed, welded	2,400	LF	$ 120	$ 288,000	SDR 11
Electrical conduit, assemble, install	50	LF	$ 25	$ 1,250	electrical for discharge pump
Electrical cable	50	LF	$ 31	$ 1,563	electrical for discharge pump
Communications conduit, assemble, install	2,400	LF	$ 25	$ 60,000	from treatment system to injection wells
Communications cable	2,400	LF	$ 56	$ 135,000	from treatment system to injection wells
Redundant System	1	LS	$ 22,500	$ 22,500	ECY - Create redundant treatment system
Bypass Effluent Outfall to Boeing Storm Sewer					
Treated effluent line trenching, excavator	280	CY	$ 63	$ 17,500	Piping from extraction wells to treatment building (assume trench = 2'Wx8'Dx400'L); for "wasting excess treated water"
Bedding Material, place, compact	40	CY	$ 44	$ 1,760	
Backfill, compact	240	CY	$ 25	$ 6,000	
HDPE 4" water line, installed, welded	400	LF	$ 125	$ 50,000	SDR 11, includes connection to existing conveyance system
Tap and connection into existing storm sewer line	1	LS	$ 2,000	$ 2,000	Install Tee/Wye or saddle fitting onto existing storm sewer outfall line
General					
Electrical Permit	1	LS	$ 6,250	$ 6,250	
New Transformer/Electrical Supply Upgrade	1	EA	$ 437,500	$ 437,500	Upgrade transformers, electrical cables and controls as needed for additional load and run lengths
Control panel enclosures/panels/other equipment	1	EA	$ 37,500	$ 37,500	Below ground vault for controls; electrical panels; grounding, supports, other equipment
Electrical Labor	1	LS	$ 50,000	$ 50,000	
Instrumentation/Controls	1	LS	$ 375,000	$ 375,000	Well control panels & equipment, and PLC programming
System startup and testing	1	LS	$ 25,000	$ 25,000	
Redundant System	1	LS	$ 925,000	$ 925,000	ECY - Create redundant treatment system
Task Subtotal				*$ 3,766,563*	

Table 5-2f
Remedial Alternative 1B Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 1B: Containment and Hydraulic Control via Capping and Vertical Barrier

Assumptions: Install slurry wall containment parallel and adjacent to LDW and 5 extraction wells for hydraulic control of stabilized soil area, install treatment system for extracted water, 2 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Observed Tar-Like Area Remedial Excavation					
Excavation and loading of contaminated soil	370	cy	$ 25	$ 9,259	Assume 2,000 SF excavation area with depth of 5 ft
Hauling	593	ton	$ 5.50	$ 3,259	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($165/hr x 1 hr/trip / 30 tons/trip)
Disposal	593	ton	$ 70	$ 41,244	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Import backfill	370	cy	$ 15	$ 5,704	Assume structural fill from clean borrow source
Place, grade, and compact backfill	370	cy	$ 25	$ 9,259	Compacted in 6" lifts to 95% max density
Repaving	222	sy	$ 59	$ 13,067	4" HMA Asphalt
Task Subtotal				*$ 81,793*	
PoS Property Remedial Excavation					
Site Preparation	1	LS	$ 12,500	$ 12,500	Grubbing and clearing; erosion and sediment control, general site prep
Coffer Dam	1	LS	$ 587,500	$ 587,500	Place on water side of project to protect LDW. Cost based on vendor quote.
Remove Existing PoS Bulkhead	450	LF	$ 169	$ 75,938	Assume derrick and crew @ $10,000 per day. Production of 75LF per day
Asphalt Paving Demo/Disposal	-	SF	$ 1.25	$ -	
Excavation dewatering (Port property)	30	day	$ 14,400	$ 432,000	Includes dewatering, onsite water treatment, and discharge/disposal; assume 200 gpm dewatering for 30 days (avg. cost $0.03/gallon based on best judgement).
Excavation and loading of contaminated soil	-	CY	$ 25.00	$ -	18' deep, soil contamination w/metals, PAH, PCB
Hauling	-	TN	$ 5.50	$ -	Assume 1.6 tons/CY. Hauling soil to 3rd & Lander or Alaska Street Transfer Station - ($125/hr x 1 hr/trip /30 tons/trip)
Disposal	-	TN	$ 68	$ -	Assume 1.6 tons/CY. Disposal at Rabanco or Waste Management Subtitle D solid waste
Import backfill	-	cy	$ 15	$ -	Assume structural fill from clean borrow source; include armoring of shoreline as needed.
Place, grade, and compact backfill	-	cy	$ 24	$ -	Compacted in 6" lifts to 95% max density
Repaving	50	SY	$ 59	$ 2,940	4" HMA Asphalt . Based on cost from similar work in Washington
Install Steel Sheet Pile	1	LS	$ 1,814,875	$ 1,814,875	Includes materials, equipment and labor
Concrete Bulkhead Cap	150	CY	$ 1,417	$ 212,499	
Sheetpile Wall Termination	2	ea	$ 25,000	$ 50,000	Allowance at each end of wall
Furnish and Install Cathodic Protection System	1	LS	$ 43,750	$ 43,750	
Implement Landscaping/Vegetation Mgmt Plan	1	LS	$ 125,000	$ 125,000	Assumed budget to address design elements necessary to comply with Tukwila SMP.
Task Subtotal				*$ 3,357,002*	
Construction Contingency	35%	pct	$ 8,962,010	*$ 3,136,704*	low/mid range of scope contingency for groundwater treatment and vertical barriers (slurry wall) (20%) plus mid range of bid contingency (15%); per EPA Guide to FS Cost Estimates (EPA 540-R-00-002, July 2000)
Contractor bond fee, overhead, and profit	20%	pct	$ 8,962,010	*$ 1,792,402*	
Sales Tax (commercial equipment/services)	9.5%	pct	$ 8,962,010	*$ 851,391*	WSST

Table 5-2f
Remedial Alternative 1B Detailed Cost Estimation
Boeing Isaacson-Thompson
Feasibility Study

Alternative 1B: Containment and Hydraulic Control via Capping and Vertical Barrier

Assumptions: Install slurry wall containment parallel and adjacent to LDW and 5 extraction wells for hydraulic control of stabilized soil area, install treatment system for extracted water, 2 injection wells for treated water discharge, replace wooden bulkhead on Port property with steel bulkhead, cap and contain remaining contaminated soil.

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL	Comments
Routine Operations, Maintenance, and Monitoring				Nominal Rate	
		Discount Rate		4.2%	December 12, 2022 OMB App. C Circular No. A-94 30-year nominal interest rate = 4.2% (Per Proposed MTCA Rulemaking Language: Discount future costs using the current U.S. Treasury nominal interest rate for bonds of comparable maturity to the period of analysis. If project costs exceed 30 years, use the current U.S. Treasury 30-year nominal interest rate.)
Groundwater Treatment System OM&M	50	yr	$ 54,800	$ 1,137,981	Annual estimated costs (includes utilities, permit fees) - Calculated from EPA Guidance: Arsenic Treatment Technologies for Soil, Waste, and Water (2002) adjusted for inflation
Extraction/Injection Well System O&M	50	yr	$ 11,900	$ 247,116	Annual estimated cost for well and well pump maintenance, cleaning, rehabilitation
Electrical Usage	50	yr	$ 2,570	$ 53,361	8 x 0.5 hp pumps (11 kw*hr/day/well x $0.08/kw/hr x 365 days/yr * 8 wells); treatment system
Ion Exchange Media Usage	100	events	$ 26,800	$ 627,669	Assume 2 changeout per year at $26,800 per changeout for media ($22,000) and labor ($4,800)
Filter Cake Disposal	50	yr	$ 3,045	$ 63,233	Assume approximately 1 ton/year filter cake disposed of as hazardous waste
NPDES Permit and Reporting	50	yr	$ 25,140	$ 522,059	$20,140/yr per 2023 rate schedule. Assume $5K/year annual reporting costs
Routine groundwater sampling and reporting CPOC	50	yr	$ 59,500	$ 1,235,582	Assume annual sampling of 10 CPOC monitoring wells for metals, PCBs, and vinyl chloride. Includes annual reporting.
Routine groundwater sampling and reporting On-Site	50	yr	$ 59,500	$ 1,235,582	Assume annual sampling of 10 CPOC monitoring wells for metals, PCBs, and vinyl chloride. Includes annual reporting.
Non-routine OM&M and reporting	4	LS	$ 312,500	$ 535,515	Assume GET system major equipment replacement (pumps, controls, transducers, flow meters) costs at 10, 20, 30, 40, and 50 yrs
Annual Cap Inspections	50	yrs	$ 10,000	$ 207,661	Asphalt cap inspections, reporting, and average for periodic maintenance
OM&M Contingency	100%	pct	$ 5,865,760	*$ 5,865,760*	
Task Subtotal				*$ 11,731,520*	
			Total	**$ 31,000,000**	
Estimated Cost Range (-30% to +50%)			$ 21,700,000 to	$ 46,500,000	

Abbreviations and Acronyms:

CY = cubic yard
ea = each
EPA = US Environmental Protection Agency
FS = feasibility Study
ft = feet/foot
GET = groundwater extraction and treatment system
GPM = gallons per minute
HDPE = high-density polyethylene
HMA = hot mix asphalt
HPA = hydraulic project approval
JARPA = Joint Aquatic Resource Permit Application
kw/hr = kilowatts per hour
LF = linear feet
LS = lump sum
mm = millimeter
O&M = operation and maintenance
OM&M = operation, maintenance, and monitoring
OMB = Office of Management and Budget
pct = percent
% = percent
PLC = programmable logic control
Port = Port of Seattle
PoS = Port of Seattle
SEPA = State Environmental Policy Act
sy = square yard
TESC = temporary erosion and sediment control
UIC = underground injection control
WSST = Washington State Sales Tax
yr = year

Table 6-1b
Supplemental Summary of Remedial Alternatives Compliance with MTCA Threshold Requirements
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:	Alternative 1B	Alternative 3
Description:	Hydraulic Containment and Capture via Slurry Wall and Groundwater Extraction, Shoreline Excavation, and Containment	In Situ Groundwater Treatment, Shoreline Excavation, and Containment
Compliance with Model Toxics Control Act (MTCA) Threshold Criteria (Washington Administrative Code [WAC] 173-340-360[2][a])		
- Protect human health and the environment.	**Yes** - Alternative will protect human health and the environment through containment and excavation of contaminated soil and capture and treatment of contaminated groundwater.	**Yes** - Alternative will protect human health and the environment through containment and excavation of contaminated soil and treatment of contaminated groundwater.
- Comply with cleanup standards (WAC 173-360-700 through 760).	**Yes** - Containment and Institutional Controls (ICS) used for soil not complying with cleanup standards; groundwater complies with cleanup standards at conditional point of compliance (CPOC).	**Yes** - Containment and ICs used for soil not complying with cleanup standards; groundwater complies with cleanup standards at CPOC.
- Comply w/applicable state/federal laws (WAC 173-360-710).	**Yes** - Alternative complies with applicable laws (see FS report Section 3.0 for Alternative 1).	**Yes** - Alternative complies with applicable laws (see FS report Section 3.0).
- Provide for compliance monitoring (WAC 173-360-410).	**Yes** - Alternative includes provisions for compliance monitoring (health and safety monitoring during construction/operation and maintenance (O&M), soil cap monitoring for ICs, long-term groundwater confirmation monitoring).	**Yes** - Alternative includes provisions for compliance monitoring (health and safety monitoring during construction/O&M, soil cap monitoring for ICs, long-term groundwater confirmation monitoring).
Compliance with other requirements (WAC 173-340-360[2][b])		
Permanent Solutions to the Maximum Extent Practicable (WAC 173-340-360[3])		
- Permanent to the Maximum Extent Practicable.	**No** - See Disproportionate Cost Analysis (Table 6-2b).	**Yes** - See Disproportionate Cost Analysis (Table 6-2b).

Table 6-1b
Supplemental Summary of Remedial Alternatives Compliance with MTCA Threshold Requirements
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:	**Alternative 1B**	**Alternative 3**
Description:	**Hydraulic Containment and Capture via Slurry Wall and Groundwater Extraction, Shoreline Excavation, and Containment**	**In Situ Groundwater Treatment, Shoreline Excavation, and Containment**
Reasonable Restoration Time Frame (WAC 173-340-360[4][b])		
- Provide for a reasonable restoration time frame.	**Yes** - Estimated restoration time frame is **4 years** for design, construction, implementation, and demonstration that groundwater CULs are being met at CPOC. ICs and long-term monitoring of groundwater and cap needed to ensure compliance. See factors below. *Note: If the groundwater pCUL is required to be met by this alternative at the standard point of compliance (Site-wide), the restoration time frames would be indeterminately long because of the presence of the Stabilized Soil Area and contaminants in the former Slip 5 fill, which represent infinite contaminant sources.*	**Yes** - Estimated restoration time frame is **4 years** for design, construction, excavation, and demonstration that groundwater CULs are being met at CPOC. ICs and long-term monitoring of groundwater and cap needed to ensure compliance. See factors below. *Note: If the groundwater pCUL is required to be met by this alternative at the standard point of compliance (Site-wide), the restoration time frames would be indeterminately long because of the presence of the Stabilized Soil Area and contaminants in the remainder of the former Slip 5 fill, which represent infinite contaminant sources.*
- Potential risk to human health and environment (1).	Low - Capping of contaminated soil and capture of contaminated groundwater to minimize migration to the Lower Duwamish Waterway (LDW) protects human health and the environment.	Low - Capping and excavation of contaminated soil and treatment of contaminated groundwater to minimize migration to the LDW protects human health and the environment.
- Practicability of achieving shorter restoration time.	See Disproportionate Cost Analysis (Table 6-2b).	See Disproportionate Cost Analysis (Table 6-2b).
- Current use of Site, surrounding area, and associated resources that are, or may be affected by releases from the Site.	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses
- Potential future use of Site, surrounding area, and resources that are, or may be, affected by releases from the Site.	Onsite: Industrial. Surrounding areas: Industrial, LDW. Resources: Surface water beneficial uses.	Onsite: Industrial Surrounding areas: Industrial, LDW Resources: Surface water beneficial uses
- Availability of alternative water supplies.	**Yes**. The Site is located within the Tukwila city limits, which is supplied by a municipal water supply.	**Yes**. The Site is located within the Tukwila city limits, which is supplied by a municipal water supply.
- Likely effectiveness/reliability of institutional controls. (1)	**High**. Site is fenced and access controlled industrial site.	**High**. Site is fenced and access controlled industrial Site.

Table 6-1b
Supplemental Summary of Remedial Alternatives Compliance with MTCA Threshold Requirements
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:	Alternative 1B	Alternative 3
Description:	**Hydraulic Containment and Capture via Slurry Wall and Groundwater Extraction, Shoreline Excavation, and Containment**	**In Situ Groundwater Treatment, Shoreline Excavation, and Containment**
- Ability to monitor migration of hazardous substances. (1)	**High**. Appropriate groundwater monitoring network present and will be supplemented, as necessary, to adequately monitor groundwater after implementation. Compliance soil sampling will be conducted after excavation.	**High**. Appropriate groundwater monitoring network present and will be supplemented, as necessary, to adequately monitor groundwater after implementation. Compliance soil sampling will be conducted after excavation.
- Toxicity of hazardous substances at the site. (1)	Contaminant and media dependent - Soil (dermal contact): low to moderate Water (surface water beneficial uses): low to high	Contaminant and media dependent - Soil (dermal contact): low to moderate Water (surface water beneficial uses): low to high
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the Site or under similar conditions.	Negligible	Negligible
Consider Public Concerns (WAC 173-340-600[13])		
- Consider public concerns.	**Yes** - Public notice and public comment period will be provided for review of the remedial investigation/feasibility study (RI/FS) (possibly combined with cleanup action plan [CAP]). No comments from public with concerns about Site cleanup alternatives have been received.	**Yes** - Public notice and public comment period will be provided for review of the RI/FS (possibly combined with CAP). No comments from public with concerns about Site cleanup alternatives have been received.

Notes:

(1) Ratings used: Low, Moderate, or High.

Table 6-2b
Supplemental Relative Benefits Ranking Considerations
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:			**Alternative 1**		**Alternative 3**
Alternative Name:			**Hydraulic Containment and Capture via Slurry Wall and Groundwater Extraction, Shoreline Excavation, and Containment**		**In Situ Groundwater Treatment, Shoreline Excavation, and Containment**
Relative Benefits Ranking for DCA					
Evaluation Criteria: WAC 173-340-360(3)(f)	**Weighting Factor**	**Benefit Score**	**Ranking Considerations (1)**	**Benefit Score**	**Ranking Considerations (1)**
- Overall Protectiveness	**30%**	**7**	**Excellent** • Focused removal of contaminated soil and fill along shoreline protects surface water and sediments. • Cap to mitigate risk of direct contact with contaminated media. • Groundwater extraction and treatment to prevent migration of contaminated groundwater to surface water/sediment and attain groundwater cleanup standards at conditional point of compliance (CPOC).	**7**	**Excellent** • Focused removal of contaminated soil and fill along shoreline protects surface water and sediments. • Cap to mitigate risk of direct contact with contaminated media. • Permeable Reactive Barrier (PRB) provides long-term treatment of contaminated groundwater and protection of surface water/sediment and attain groundwater cleanup standards at CPOC.
- Permanence	**20%**	**4**	**Fair** • Focused removal of soil along shoreline permanently removes contaminated soil near surface water; however, moderate quantities of contaminated soil moved to engineered landfill. • Contaminated soil left in place across much of Site. • Permanence of containment maintained through institutional controls. • Requires continuous and uninterrupted groundwater extraction and treatment for permanent protection of surface water (slurry wall does not prevent flow to surface water. • Containment and control/extraction of arsenic-contaminated groundwater and ex situ treatment to attain groundwater cleanup standards at CPOC.	**5**	**Good** • Focused removal of soil along shoreline permanently removes contaminated soil near surface water; however, moderate quantities of contaminated soil moved to engineered landfill. • Contaminated soil left in place across much of Site. • Permanence of containment maintained through institutional controls • PRB provides long-term groundwater treatment with minimal risk of remedy failure once demonstrated effective, but periodic replacement of media required. • In situ treatment of arsenic-contaminated groundwater to attain groundwater cleanup standards at CPOC.

Table 6-2b
Supplemental Relative Benefits Ranking Considerations
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:			Alternative 1		Alternative 3
Alternative Name:			Hydraulic Containment and Capture via Slurry Wall and Groundwater Extraction, Shoreline Excavation, and Containment		In Situ Groundwater Treatment, Shoreline Excavation, and Containment
Relative Benefits Ranking for DCA					
- Long-Term Effectiveness	20%	6	**Good** • Removal of soil along shoreline permanently reduces risk of contaminated soil migration to sediment and leaching to groundwater adjacent to surface water. • Provides groundwater hydraulic control that will minimize migration of contaminated groundwater to surface water and sediment. Groundwater treatment is ex situ and offsite disposal of treatment media • High risk for short term or partial remedy failure because long-term groundwater extraction and treatment (GET) system and injection well operations susceptible to periodic short- to long-term shutdowns due to equipment failures (e.g., extraction pumps, transfer pumps), power outages, control system failures, well/treatment system fouling and rehabilitation, or extraction system otherwise fails to capture full extent of groundwater contamination onsite. • Moderate quantities of contaminated soil moved to engineered landfill. • Risk of contact with remaining contaminated media is mitigated by cap. • Long-term effectiveness relies on consistent and reliable system monitoring and evaluation, frequent O&M, and institutional controls.	7	**Excellent** • Removal of soil along shoreline permanently reduces risk of contaminated soil migration to sediment and leaching to groundwater adjacent to surface water. • PRB provides in situ treatment/destruction/immobilization continuous and ongoing protection, but relies on monitoring to determine when to replace media. • PRB provides continuous and ongoing protection, but relies on monitoring to determine when to replace media. • Low to moderate risk of partial remedy failure for preferential flow and early contaminant breakthrough; however, design can be mitigated through design (e.g., thicker PRB in most contaminated areas) • Moderate quantities of contaminated soil moved to engineered landfill. • Risk of contact with remaining contaminated media is mitigated by cap. • Long-term effectiveness relies on monitoring and institutional controls.
- Manageability of Short-Term Risk	10%	7	**Excellent** • Moderate risk of contact with contaminated soil and groundwater during excavation of shoreline areas and installation of slurry wall; will be completed by HAZWOPER-certified drillers and contractors. • Moderate worker safety risk during excavation and hauling, backfilling, and slurry wall installation; will be completed by a qualified contractor. • Minimal worker safety risk during drilling, GET system construction. • Long term operations and maintenance (O&M) of extraction/injection wells and treatment system present minor risks for equipment maintenance and many trips to the site.	7	**Excellent** • Moderate risk of contact with contaminated soil and groundwater during excavation of shoreline areas and installation of PRB; will be completed by HAZWOPER-certified drillers and contractors. • Moderate worker safety risk during excavation and hauling, backfilling, and PRB installation/replacement; will be completed by a qualified contractor.

Table 6-2b
Supplemental Relative Benefits Ranking Considerations
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:			**Alternative 1**		**Alternative 3**
Alternative Name:			**Hydraulic Containment and Capture via Slurry Wall and Groundwater Extraction, Shoreline Excavation, and Containment**		**In Situ Groundwater Treatment, Shoreline Excavation, and Containment**
Relative Benefits Ranking for DCA					
- Implementability	**10%**	**4**	**Fair** • Technical implementation provides some challenges; - installation of slurry wall, removal of shoreline bulkhead and contaminated soil, and construction of durable habitat bench/bank or replacement bulkhead provide moderate technical challenges for preventing contaminated soil entering the waterway - construction of GET system relatively uncomplicated; - proper treatment of groundwater, long term O&M of extraction/injection wells and treatment system may present significant challenges related to fouling and rehabilitation or replacement of extraction/injection wells and treatment system - significant risk associated with implementation of a) modifying hydraulics on neighboring cleanup sites to the north (Jorgensen) and south (8801) through reinjection of groundwater and mounding at slurry wall and/or b) pulling contaminated groundwater and bioinjection fluid onto the Isaacson-Thompson site and fouling extraction wells and passing contaminants through treatment system not designed for contaminants from those sites. - balancing system flows to avoid these issues extremely difficult due to tidal influence resulting in continuously changing hydraulic conditions near the shoreline (area of hydraulic capture) • Administration implementation challenges include grading permit stormwater pollution prevention plan (SWPPP), permitting for discharge of treated groundwater (industrial waste discharge permit, National Pollutant Discharge Elimination System [NPDES] permit, or Underground Injection Control [UIC] permit), permitting for in-water work (Joint Aquatic Resource Protection Act [JARPA]/ US Army Corps of Engineers [USACE]/Washington Department of Fish and Wildlife [WDFW] permit), and filing institutional controls.	**6**	**Good** • Technical implementation provides some challenges; installation of PRB, removal of shoreline bulkhead and contaminated soil, and construction of durable habitat bench/bank or replacement bulkhead provide moderate technical challenges for preventing contaminated soil entering the waterway. • Administration implementation challenges include grading permit, SWPPP permit/plan; permitting for in-water work (JARPA/USACE/WDFW permit), and filing institutional controls.
- Consideration of Public Concerns	**10%**	**5**	**Good** • Provides excellent level of overall protectiveness, fair permanence, and good long-term effectiveness. • Public comments/concerns will be addressed during RI/FS/CAP public comment period(s).	**6**	**Good** • Provides excellent level of overall protectiveness, good permanence, and excellent long-term effectiveness. • Public comments/concerns will be addressed during RI/FS/CAP public comment period(s).

Table 6-2b
Supplemental Relative Benefits Ranking Considerations
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number:		**Alternative 1**		**Alternative 3**
Alternative Name:		**Hydraulic Containment and Capture via Slurry Wall and Groundwater Extraction, Shoreline Excavation, and Containment**		**In Situ Groundwater Treatment, Shoreline Excavation, and Containment**
Relative Benefits Ranking for DCA				
Estimated Cost ($)	**$31,000,000**		**$30,100,000**	
Overall Weighted Benefit Score	**5.7**	**Fair**	**6.4**	**Good/Excellent**
Comparative Overall Benefit/Cost (2)	**5.5**		**6.4**	

Notes:

(1) Ratings used: Poor (1-2), Fair (3-4), Good (5-6), Excellent (7-8), and Superior (9-10).

(2) Benefit/Cost Ratio scaled (divided) by lowest cost alternative score in order to compare ranges similar in scale to comparative overall benefit.

Table 6-3b
Supplemental Summary Disproportionate Cost Analysis
Boeing Isaacson-Thompson
Feasibility Study

Alternative Number and Name	**Alternative 1B** **Containment and Hydraulic Capture via Capping and Groundwater Extraction**				**Alternative 3** ***In Situ* Groundwater Treatment, Shoreline Excavation, and Containment**			
Relative Benefits Ranking for Disproportionate Cost Analysis [Washington Administrative Code [WAC] 173-340-360(2)(b)(i) and WAC 173-340-36093)(f)]								
***Comparative Overall Benefit* (a)**		Score	Weighting Factor	Weighted Score		Score	Weighting Factor	Weighted Score
- Overall Protectiveness	Excellent	7	0.3	2.1	Excellent	7	0.3	2.1
- Permanence	Fair	4	0.2	0.8	Good	5	0.2	1
- Long-Term Effectiveness	Good	6	0.2	1.2	Excellent	7	0.2	1.4
- Manageability of Short-Term Risk	Excellent	7	0.1	0.7	Excellent	7	0.1	0.7
- Implementability	Fair	4	0.1	0.4	Good	6	0.1	0.6
- Consideration of Public Concerns	Good	5	0.1	0.5	Good	6	0.1	0.6
Overall Weighted Benefit Score				**5.7**				**6.4**

Disproportionate Cost Analysis - Quantitative Evaluation

Overall Weighted Benefit Score	5.7	6.4
Estimated Remedy Cost	$31,000,000	$30,100,000
Relative Benefit/Cost Ratio (b)	5.5	6.4
Costs Disproportionate to Incremental Benefits	Yes	No
Remedy Permanent to the Maximum Extent Practicable?	No	**Yes**
Preferred Alternative	**No**	**Yes**

Notes:

(a) Ratings used: Poor (1-2), Fair (3-4), Good (5-6), Excellent (7-8), and Superior (9-10).

(b) Benefit/Cost Ratio scaled (multiplied) by lowest cost between alternatives in order to compare ranges similar in scale to comparative overall benefit.

ATTACHMENT 1

Slurry Wall Simulations—Model Description and Results Technical Memorandum

Technical Memorandum

TO: Molly Taptich, The Boeing Company

FROM: Nicole Mehr, LG and Ben Lee, PE

DATE: June 30, 2023

RE: **Boeing Isaacson-Thompson Feasibility Study**
Slurry Wall Simulations
Model Description and Results
Tukwila, Washington
Project No. 0025190.223.015

Background

The Washington State Department of Ecology (Ecology) has required The Boeing Company (Boeing) to perform a supplemental evaluation of an additional remedial action alternative in conjunction with the feasibility study (FS) for the Boeing Isaacson-Thompson site (Site). The additional remedial action to be evaluated includes the installation of a sub-surface slurry wall along the western boundary of the Site combined with groundwater extraction wells to provide hydraulic containment of groundwater flowing westward beneath the Site prior to discharging to the Lower Duwamish Waterway (LDW).

To evaluate the feasibility and potential effectiveness of the slurry wall at the Site, Landau Associates, Inc. (Landau) utilized the existing steady-state numerical groundwater flow model (model) developed for the Site, which was documented previously (Landau 2022; Appendix F to this FS). The model was built using the US Geological Survey (USGS) numerical MODFLOW model code, accessed using Aquaveo's Groundwater Modeling System (GMS) graphical user interface. The model was based on the hydrogeologic conceptual model of the Site, calibrated to observed groundwater levels throughout the Site, and provides a reasonable simulation of groundwater flow conditions beneath the Site for the purpose of evaluating FS alternatives. The objective of the current modeling effort was to determine how the installation of a slurry wall would alter the groundwater flow patterns at the Site and potentially provide capture of contaminated groundwater (in combination with extraction wells). In theory, a slurry wall installed along the western (downgradient) edge of the Site (without the presence of extraction wells) would change the groundwater flow directions and velocities so that groundwater would flow around the barrier (either laterally or vertically) before flowing into the LDW. The addition of extraction wells for capture of contaminated groundwater and re-injection of treated water through injection wells may be used in conjunction with the slurry wall to further modify groundwater flow patterns beneath the Site.

Model Set Up

Landau used MODFLOW's hydraulic flow barrier (HFB) package to simulate the slurry wall, the well (WEL) package to simulate extraction and injection wells, and the USGS MODPATH add-on code to delineate simulated particle flow path lines showing groundwater flow directions at the Site. The model was run with various slurry wall construction scenarios. MODPATH tracks the flow path of simulated water particles that are released at user-defined locations using the MODFLOW simulated head solution as the flow field. The particles can be tracked in both forward (forward through time) and reverse (backward through time) tracking modes.

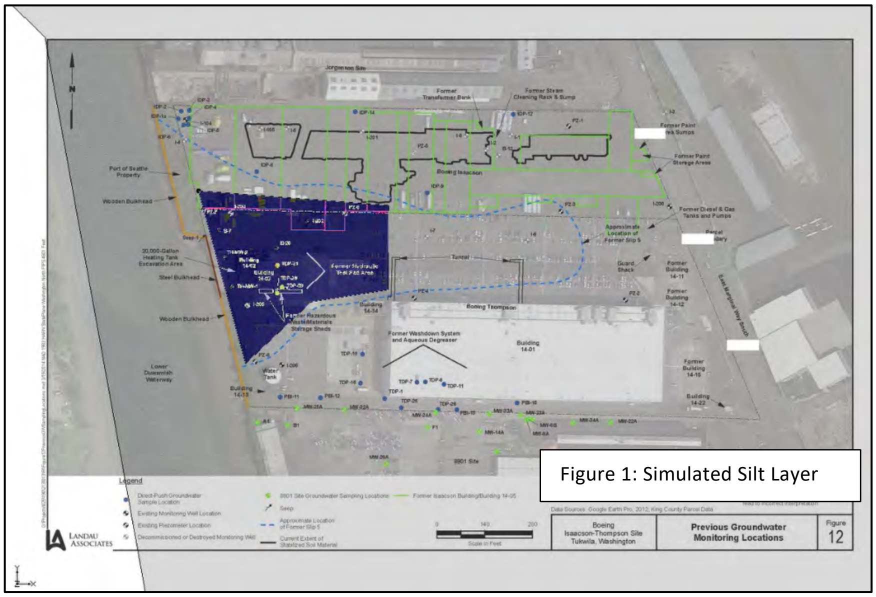


Figure 1: Simulated Silt Layer

Landau further modified the existing model by representing an apparent laterally continuous unit (over a localized area) of low-permeability silt observed in portions of the Site from approximately 20 to 25 feet (ft) below ground surface (bgs) by applying a zone of low hydraulic conductivity in a similar simulated depth range (i.e., layer 2 of the model) within the area highlighted in purple on Figure 1 above. The silt layer depth and spatial layout were based on boring data collected during the remedial investigation (RI) and other prior Site investigation activities. The hydraulic conductivity assigned to the area of layer 2 shaded in Figure 1 was reduced from 100 to 0.03 ft per day (ft/day) to represent the low permeability silt layer. The hydraulic conductivity value of 0.03 ft/day was chosen based on estimates provided by Domenico and Schwartz (1990) for silt. The modification of hydraulic conductivity in this limited area and depth range did not produce appreciable changes in steady-state groundwater flow or water level elevations throughout the model and, therefore, re-calibration of the model was deemed unnecessary.

Figure 2 shows the simulated ambient (no slurry wall or injection/extraction wells on) groundwater level elevations at the Site in model layer 2 (representing shallow groundwater) with the low permeability silt layer included in the model. Particle tracks were initiated at arbitrary locations along the eastern and northern boundaries of the Site. Particles were simulated to initially start at the water table. The particle track colors correspond to the cell layer (21 layers total) that the particle is in at any given location. Dark blue particle track colors generally show shallow layer flow while green shows flow in intermediate layers, and yellow/orange shows deep layer flow. The particle track starting locations and numbers of particles are held constant for all simulations described below in order to show the differences in groundwater flow patterns under each simulation.

Figure 2 shows that, under ambient conditions, the particles move vertically downward around the existing simulated bulkheads, which are simulated with the HFB package but with a hydraulic characteristic value set to allow a small amount of flow through them, shown as the orange line and described in the original model report, Landau (2022).

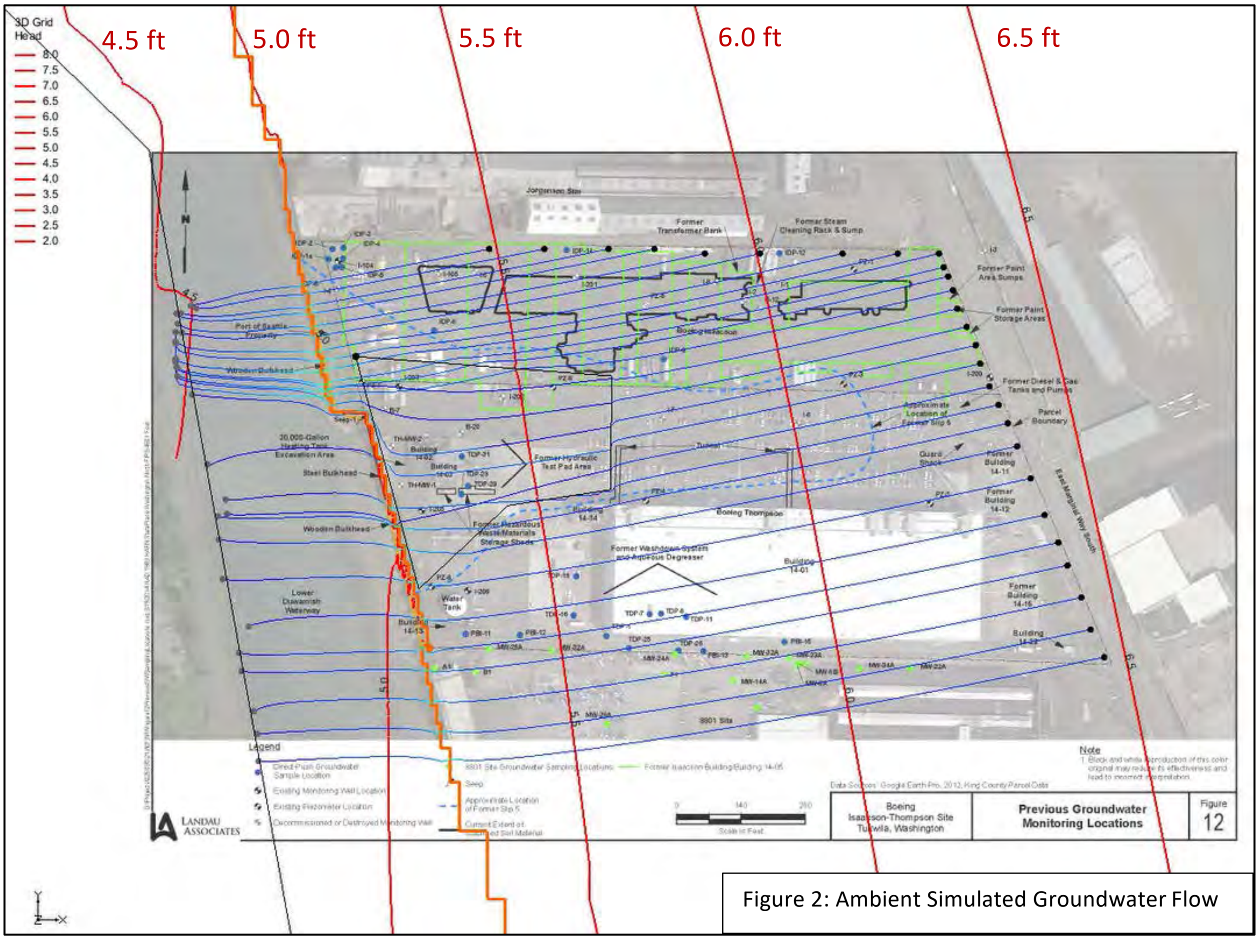


Figure 2: Ambient Simulated Groundwater Flow

Slurry Wall—Base Conditions

Figure 3 shows the simulated groundwater level elevations at the Site in layer 2 with a slurry wall simulated in layers 1 and 2, which corresponds to land surface to a depth of approximately 25 ft bgs. The slurry wall was represented as a non-permeable HFB (i.e., it was set with a hydraulic characteristic of 0.0 day-1 to prevent any lateral flow through the wall), depicted by the second orange barrier in Figure 2 and extending across the western boundary of the Site.

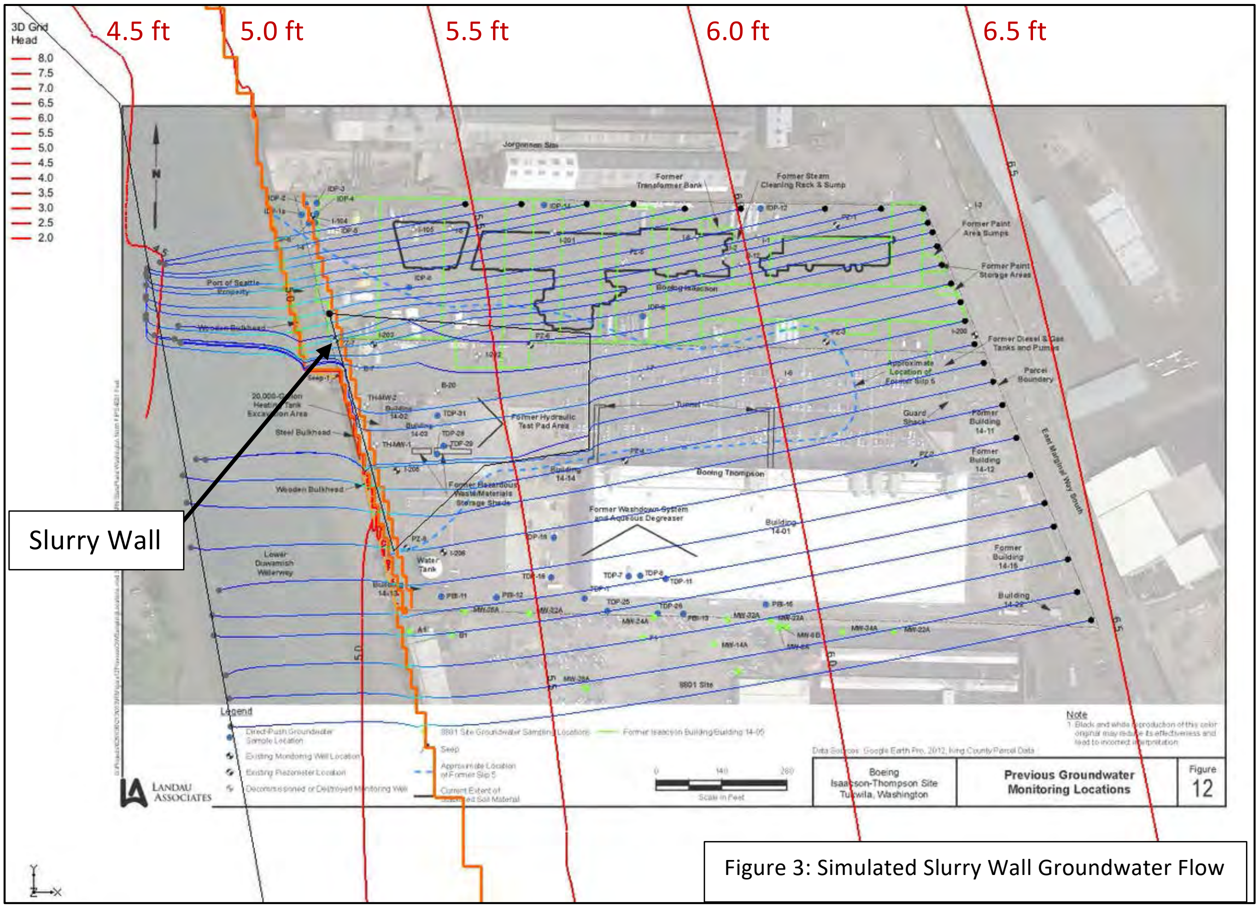


Figure 3: Simulated Slurry Wall Groundwater Flow

The same simulation in plan view is shown below in Figures 4 and 5. The figures show that the particles travel vertically downward to move past the barriers in orange. After the particles pass the barrier, the particles then travel upward toward the river boundary where they terminate (i.e., leave the model).

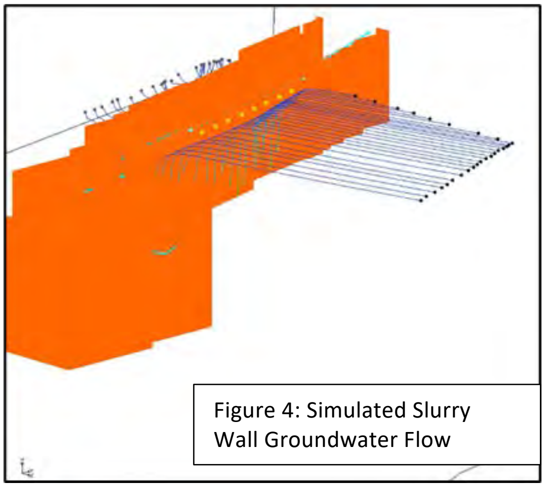


Figure 4: Simulated Slurry Wall Groundwater Flow

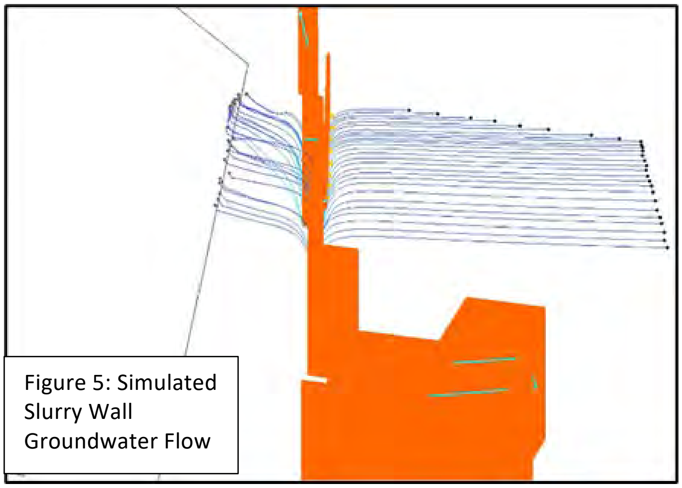


Figure 5: Simulated Slurry Wall Groundwater Flow

Slurry Wall Depth Evaluation

To evaluate hydraulic behavior and groundwater flow under or around the slurry wall, a series of model runs was performed with increasingly greater slurry wall depths from the base condition (25-ft-deep slurry wall).

Figures 6 through 9 show the simulated groundwater level elevations at the Site in layer 2 with a slurry wall simulated at various depths to show the impact of the wall depth on groundwater flow directions. With successively deeper simulated slurry wall depths, the simulated particles appear to flow more around—and less under—the slurry wall, expected.

Figure 6 shows the simulation with the slurry wall extended to a depth of 40 ft bgs (i.e., layers 1 to 5).

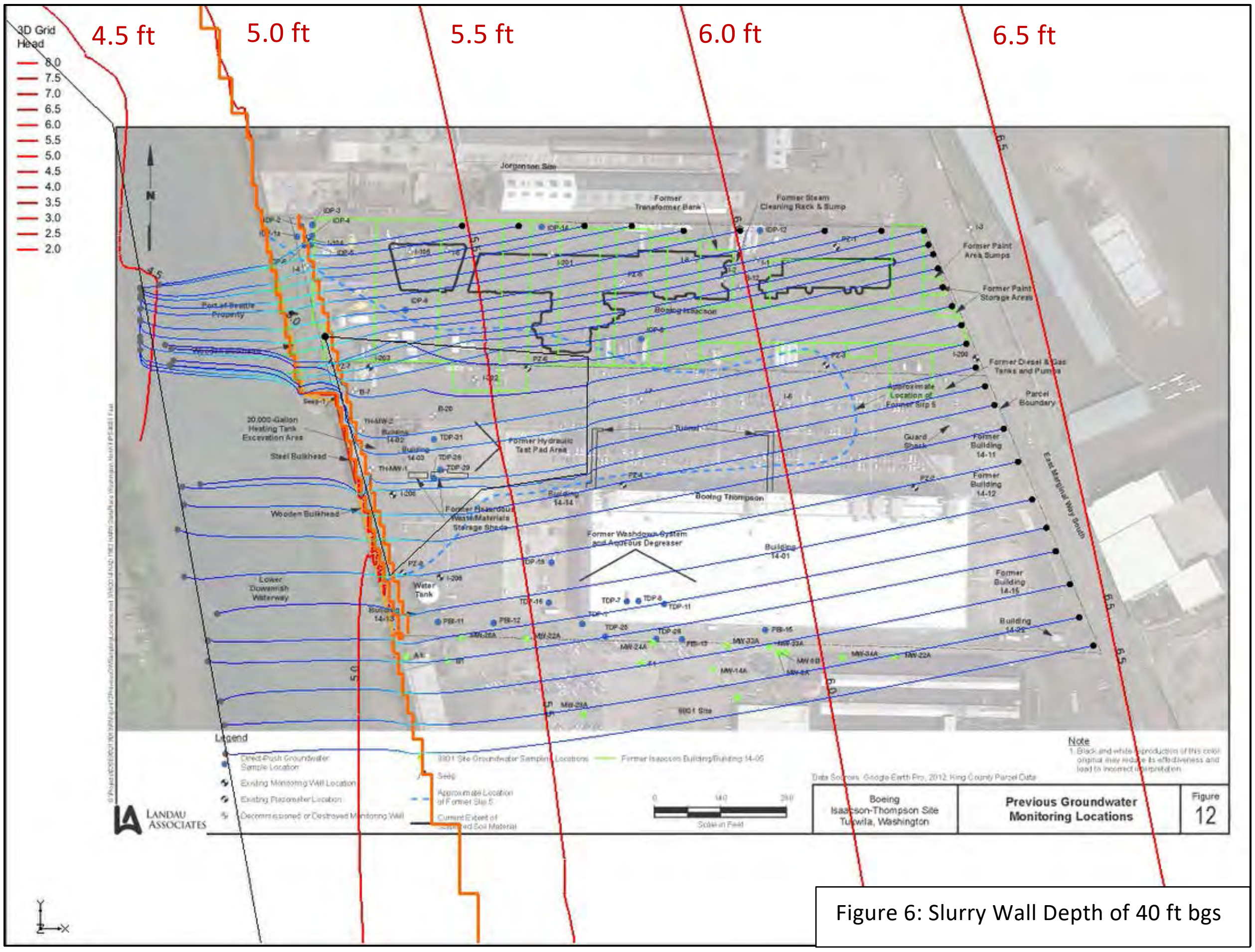


Figure 6: Slurry Wall Depth of 40 ft bgs

Figure 7 shows the simulation with the slurry wall extended to a depth of 65 ft bgs (i.e., layers 1 to 10).

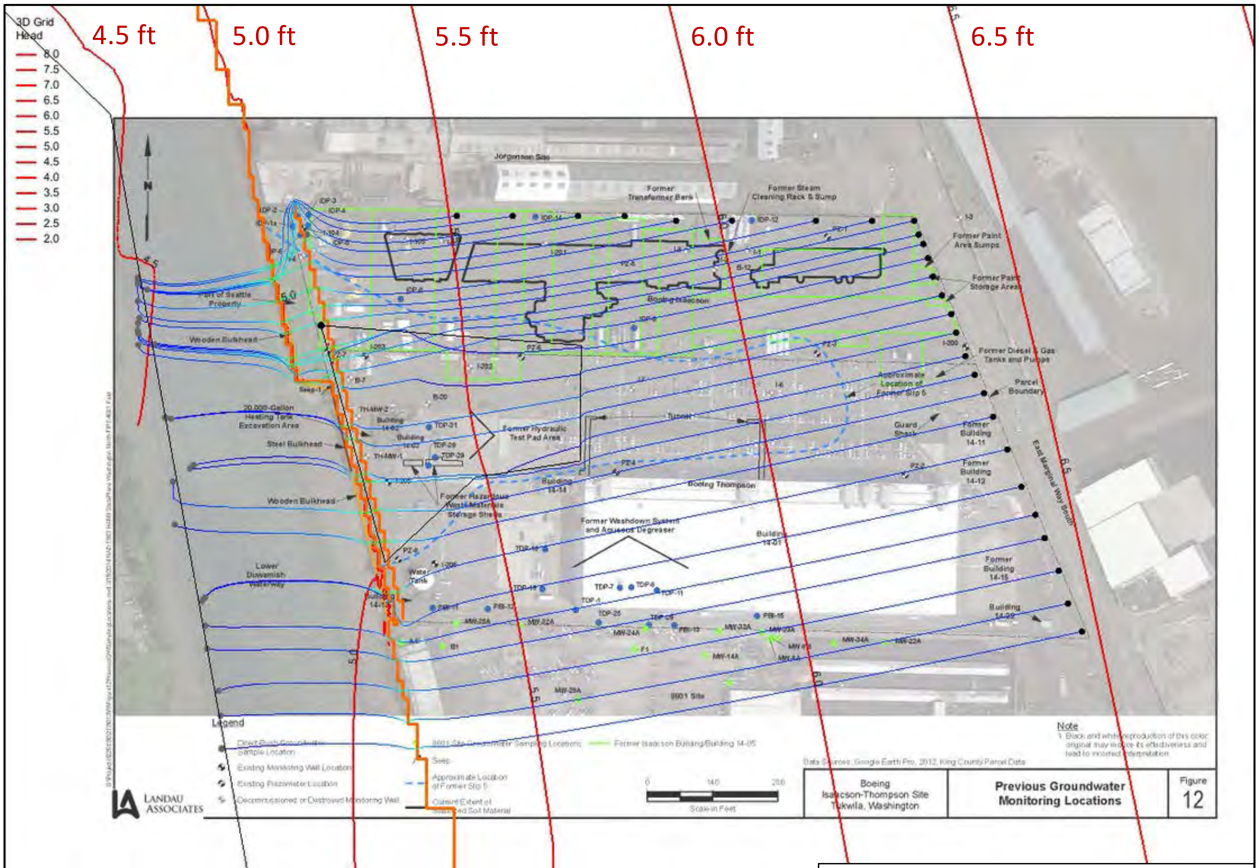


Figure 7: Slurry Wall Depth of 65 ft bgs

Figure 8 shows the simulation with the slurry wall extended to a depth of 90 ft bgs (layers 1 to 15).

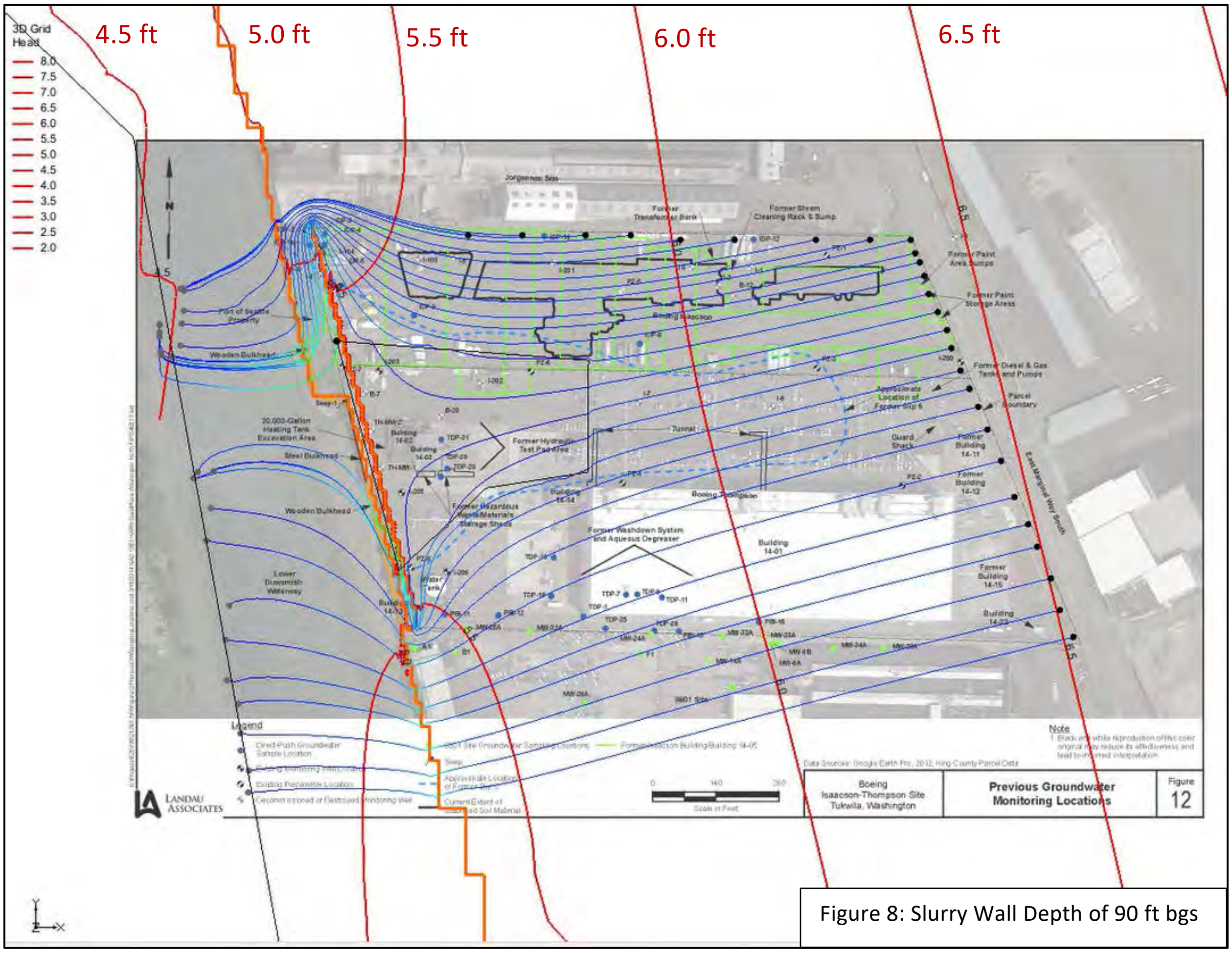


Figure 8: Slurry Wall Depth of 90 ft bgs

Figure 9 shows the simulation with the slurry wall extended to a depth of 120 ft bgs (i.e., layers 1 to 20).

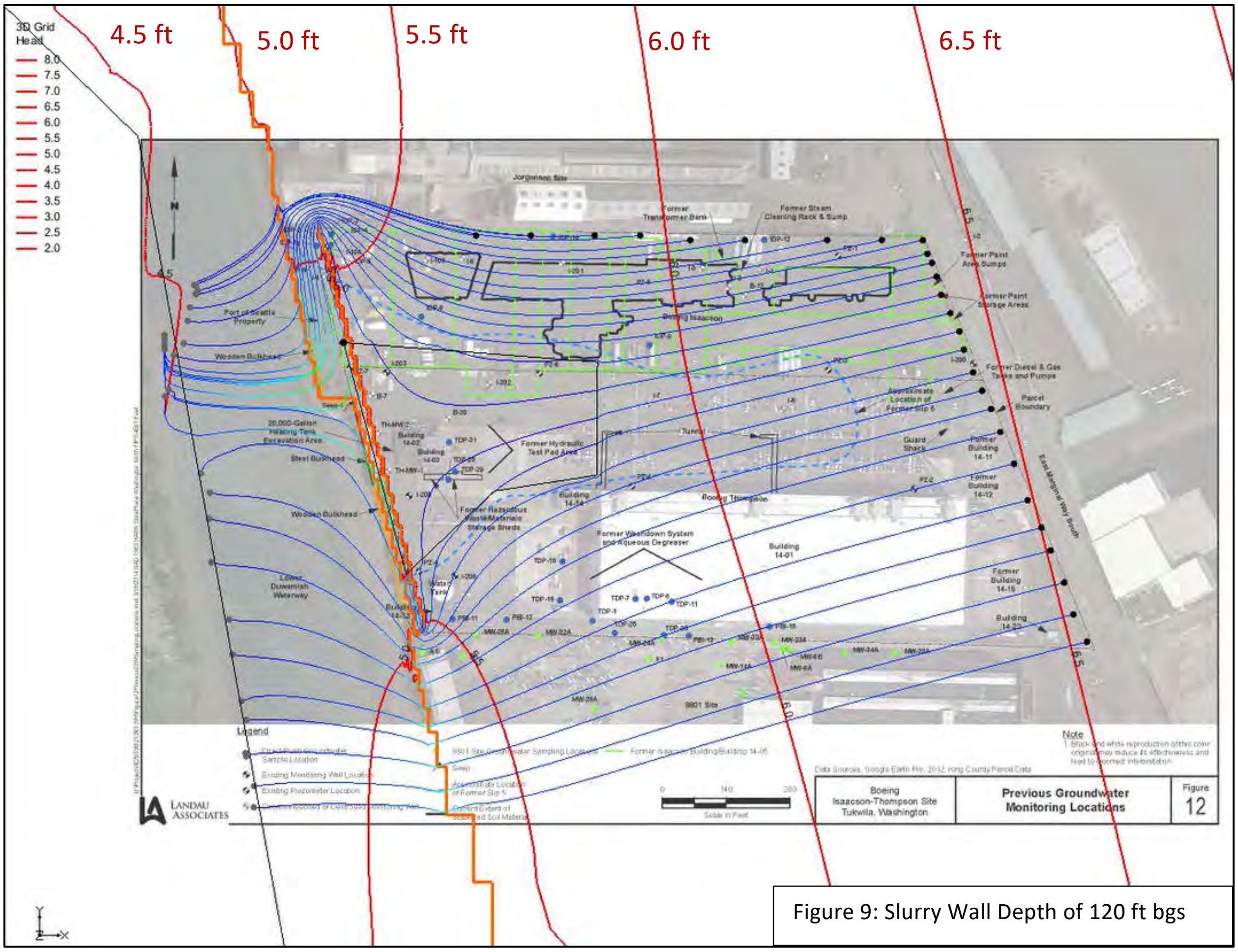


Figure 9: Slurry Wall Depth of 120 ft bgs

Based on these simulations, it appears that a slurry wall depth of approximately 90 ft bgs would likely be required to prevent underflow of groundwater beneath the slurry wall (i.e., to provide vertical containment of Site groundwater or to force the majority of Site groundwater flow around the slurry wall and create significantly longer flow paths to the LDW). While not a necessary requirement of the slurry wall, the results of this modeling exercise are helpful to understand hydraulic behavior at the Site and the effects of a slurry wall in this location along the shoreline.

Hydraulic Containment Evaluation (with Extraction Wells and Injection Wells)

To assess the feasibility of containing contaminated groundwater on-Site to prevent discharge to the LDW and/or impacts to neighboring properties, Landau used the model to assess the effectiveness of a combination of slurry wall installation and groundwater extraction wells. Because the extracted groundwater could be treated on-Site and re-injected upgradient to provide additional clean water flushing of the subsurface material beneath the Site and/or reduce the volume of water that would need to be discharged to sewer or surface water, Landau assessed the use of both extraction and injection wells in conjunction with the slurry wall concept. For the purposes of this assessment, Landau simulated the slurry wall to a depth of 25 ft bgs (i.e., relatively shallow), included eight simulated extraction wells along the eastern side of the slurry wall (each pumping at a rate of 4 gallons per minute [gpm; 770 cubic feet per day]) and three simulated injection wells in the eastern (upgradient) portion of the Site (each injecting at a rate of 5.3 gpm [1,020.25 cubic feet per day]).[1] The injection and extraction wells were simulated in layer 1, which corresponds to a depth of 0–20 ft bgs. The extraction wells are spaced approximately 100 ft apart. The injection wells are spaced approximately 340 ft apart. Figure 10 shows simulated water level elevation contours from layer 1 and forward particle tracks in blue that start at the injection wells.

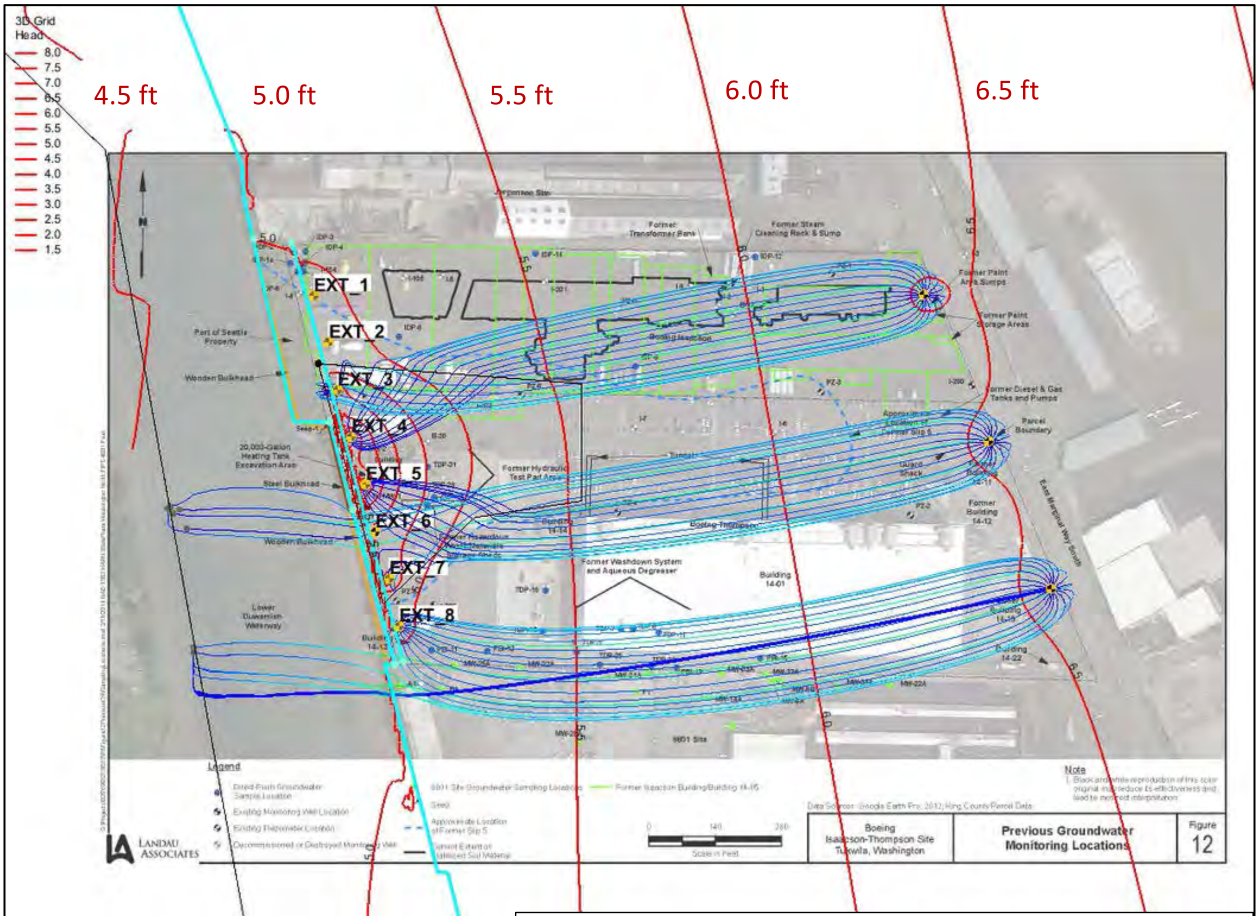


Figure 10: Injection & Extraction Well Simulation Forward Particle

---

[1] The injection and extraction rates are based on steady-state model simulations. Actual well injection and extraction rates may vary significantly from these simulated steady-state rates.

Figure 11 shows the results of the same simulation as above but different particle track visualization, namely particle tracks that start at the extraction wells and show the reverse flow direction (i.e., like looking back in time).

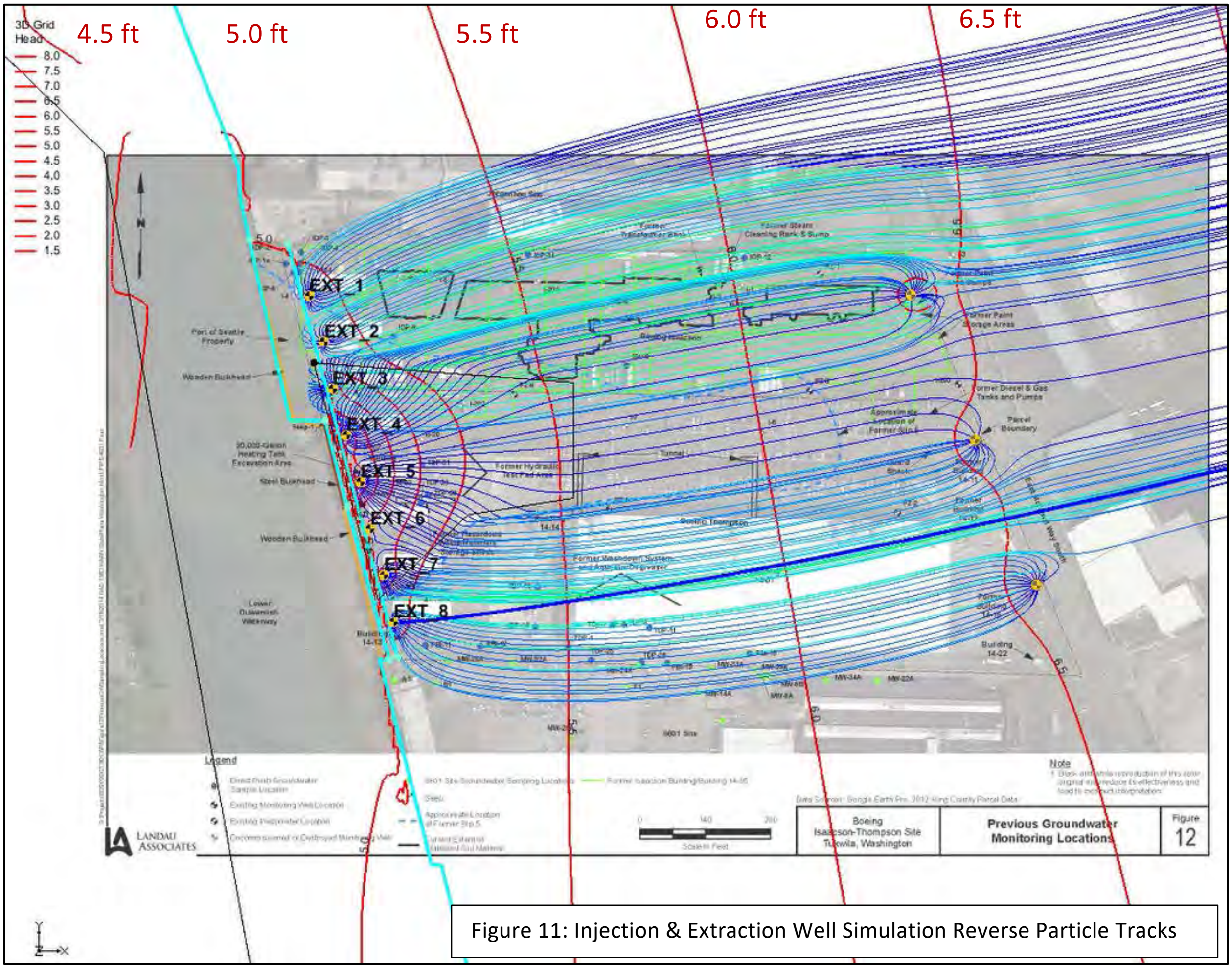


Figure 11: Injection & Extraction Well Simulation Reverse Particle Tracks

Based on these simulations, it appears that a combined extraction rate of 32 gpm from eight extraction wells, and a combined injection rate of 16 gpm at three injection wells would be sufficient to capture groundwater flow at the Site with the slurry wall at a depth of 25 ft bgs. Based on these conclusions, these parameters were assumed for the conceptual design and for developing costs for this remedial alternative, and for use in the supplemental remedial alternative evaluation.

LANDAU ASSOCIATES, INC.

Nicole Mehr

Nicole Mehr, LG
Senior Project Geologist

Ben Lee, PE
Senior Associate

BDL/NKM/PMR/ljl
[P:\025\190\002\FILERM\R\FS\5_PUBLIC REVIEW FS - REV 1\APP G - SUPP DCA\APP G - ATTACHMENT MODEL RESULTS WRITEUP\ATTACH 1_SLURRY WALL MODEL SIMULATIONS_TM 063023.DOCX]

References

Domenico, P.A. and F.W. Schwartz. 1990. *Physical and Chemical Hydrogeology*. New York: John Wiley & Sons.

Landau. 2022. Technical Memorandum: Appendix F—Numerical Model Documentation, Boeing Isaacson-Thompson Feasibility Study, Tukwila, Washington. Landau Associates, Inc. July 25.