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ANCHOR QEA

July 10, 2019

Jing Liu, Project Manager
Washington Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, Washington 98008-5452

Re: Duwamish Shipyard, Inc. Site – Remedial Investigation Addendum
Final Arsenic Characterization Study Work Plan
Ecology Agreed Order No. DE 6735

Dear Jing:

Duwamish Shipyard, Inc. (DSI) and Anchor QEA, LLC (Anchor QEA) propose to conduct supplemental Remedial Investigation (RI) activities to address arsenic data gaps to support completion of the RI for the DSI Site (Site). The work will be performed at the Site in accordance with Agreed Order No. DE 6735.

Purpose and Background

During review and completion of the *Remediation Investigation Report, Public Review Draft*,[1] the Washington Department of Ecology (Ecology) advised Anchor QEA that it would require, as part of a supplemental RI, additional sampling to identify the potential source of elevated arsenic concentrations in groundwater in the Rail Spur area (southwest portion) of the Site. In a letter dated February 9, 2018 to DSI, Ecology indicated that "additional sampling would be needed to further characterize the arsenic groundwater contamination in the southwest portion of the property prior to the start of the FS."[2] Based on follow-up discussions with Ecology in January and March 2019, DSI agreed to prepare an Arsenic Characterization Study Work Plan for conducting additional sampling of groundwater in the Rail Spur area as part of a supplemental RI (i.e., following submittal of the *Remediation Investigation Report, Public Review Draft*). In a letter dated May 20, 2019[3] to Anchor QEA, Ecology approved the *Remediation Investigation Report, Public Review Draft*, pending completion of the aforementioned supplemental RI work. DSI and Ecology agree that these activities are necessary to better assess the nature and extent of contamination, as well as to support the evaluation and selection of any future cleanup actions, in this part of the Site.

[1] Anchor QEA, LLC, 2019. *Remedial Investigation Report, Public Review Draft*. Duwamish Shipyard, Inc. Site. Seattle, Washington. Prepared for Washington Department of Ecology. Prepared on behalf of Duwamish Shipyard, Inc. April 2019.
[2] Washington Department of Ecology, 2018. Letter to: David Templeton, Anchor QEA, LLC. From: Jing Liu, Site Manager, NWRO Toxics Cleanup Program. Regarding: Comments on the December 2017 Final Remedial Investigation Report, Duwamish Shipyard, Inc., prepared by Anchor QEA, LLC. February 9, 2018.
[3] Washington Department of Ecology, 2019. Letter to: David Templeton, Anchor QEA LLC. Regarding: Approval of the April 2019 Remedial Investigation Report, Public Review Draft, Duwamish Shipyard, Inc., prepared by Ancho QEA LLC. May 20, 2019.

Anomalously high dissolved arsenic levels (ranging from 1,020 to 2,230 micrograms per liter [µg/L] in four rounds of sampling) were detected during RI sampling (from 2014 to 2015) at Site monitoring well DSIP2-13 (Figure 1). This well is a shallow (i.e., 15 feet deep) groundwater monitoring well. It is located in the footprint of the former Rail Spur used by Reichhold Chemical when they operated on the adjacent property south of DSI. That adjacent property is now owned by CalPortland. Arsenic levels in soils from DSIP2-13 (the same station with elevated results in groundwater) either are below the soil screening level (7.3 milligrams per kilogram [mg/kg]) or are only moderately elevated (a maximum concentration of 35.5 mg/kg was observed at 3.5 to 5 feet below ground surface [bgs]). Those soil concentrations may not alone explain the source of elevated dissolved arsenic levels observed in groundwater at this station (Figure 1).

Several rounds of RI soil and groundwater sampling have been conducted throughout the former Rail Spur area of the Site in an effort to determine the nature and extent of arsenic contamination. Maximum concentrations of arsenic in groundwater (as dissolved) and soil borings are presented in Figures 1, 2a, and 2b. Arsenic levels in soils from multiple adjacent and downgradient RI stations (e.g., DSI-GP-01, DSIP2-14, DSI-01, DSI-GP-02, DSIP2-15, and DSI-MW-01) and upgradient RI stations (e.g., DSIP2-11 and DSIP2-12) are below the screening level or are very low.

Shallow groundwater collected from adjacent boring DSI-GP-01 (in 2009) had a dissolved arsenic concentration of 388 micrograms per liter (µg/L), less than half of the levels observed at DSIP2-13. Shallow groundwater also has been collected from several downgradient stations, including DSI-01 (68.4 µg/L), DSI-GP-02 (25.5 µg/L), DSI-MW-01 (maximum of 48.4 µg/L), and DSIP2-16 (maximum of 11.8 µg/L). Samples of deeper groundwater from downgradient well DSIP2-15 have never detected arsenic above the screening level. In addition, dissolved arsenic levels in groundwater from downgradient stations in the vicinity of the shoreline are below the screening level. Shallow soils from the Glacier/Reichhold Site (CalPortland property), just south of the current DSI property boundary in the Rail Spur area, have maximum arsenic levels of 2 to 24 mg/kg (Figure 2a) that are comparable to soil levels observed at the DSI Site. Upgradient Glacier/Reichhold Site soils from station MW-28S detected arsenic at 68 mg/kg (at 1 to 2 feet bgs; Figure 2a).

The results of investigations in the former Rail Spur area (including results from the Glacier/Reichhold Site) do not indicate a specific soil source of the elevated dissolved arsenic observed in shallow groundwater at DSIP2-13. The results of groundwater sampling at DSI stations adjacent to and downgradient (e.g., within 150 feet) of RI station DSIP2-13 suggest that the dissolved arsenic impacts at DSIP2-13 are localized and attenuate rapidly along the groundwater flow path (i.e., toward the Site shoreline).

One possible explanation for elevated dissolved arsenic conditions at DSIP2-13, which will be investigated as part of this supplemental RI, is that local subsurface geochemical conditions are moderately to strongly reducing and may be causing arsenic in soil to be mobilized into

groundwater at higher levels than adjacent Site areas. Based on a review of RI soil boring logs from the Rail Spur and surrounding Site areas, an approximately 7-foot-thick organic silt unit is present within a majority of the well screen interval (i.e., between approximately 5 and 15 feet bgs) at DSIP2-13. Though present in some of the adjacent Site wells (e.g., DSIP2-02 and DSIP2-16), this organic silt unit is thickest at DSIP2-13 and coincides with most of the well screen interval. In addition, based on the results of RI groundwater monitoring, groundwater at DSIP2-13 typically contains low oxidation reduction potential (approximately -190 millivolts), low sulfate levels (approximately 11.1 mg/L), and elevated sulfide levels (approximately 0.475 mg/L) when compared to other Site wells. These soil observations and geochemical results suggest that subsurface conditions at DSIP2-13 are locally more reducing and unique from other Site wells, and may be the reason for elevated dissolved arsenic concentrations observed at this location.

This Work Plan describes the methods to be used and quality assurance (QA)/quality control procedures to implement the additional sampling required by Ecology to further characterize arsenic groundwater contamination, as well as to characterize subsurface geochemical conditions in the Rail Spur area of the Site. In accordance with the Agreed Order (AO) deliverables schedule (Exhibit C to AO No. DE 6735), modified in June 2019, results of the supplemental RI sampling will be compiled and provided to Ecology in an RI Addendum: Arsenic Characterization Study Memorandum, which will include an evaluation and discussion of potential arsenic sources.

Investigation Methods

Figure 3 shows the proposed locations for supplemental direct-push borings for soil and groundwater sampling. Figure 3 also shows existing Site wells that will be decommissioned during this investigation. The proposed locations are approximate and subject to change based on field access, presence of utilities, and/or shallow refusal.

Health and Safety

All site investigation activities will be performed in compliance with the *Health and Safety Plan, Duwamish Shipyard Supplemental Remedial Investigation*.[4] Utility locates will be performed prior to direct-push boring activities.

Arsenic Source Characterization

Anchor QEA proposes to advance five soil borings (DSIP3-01 through DSIP3-05) and install permanent monitoring wells in two of the borings (DSIP3-04 and DSIP3-05) to further characterize subsurface geochemical conditions and to better assess the nature and extent of arsenic impacts to soil and groundwater in the vicinity of DSIP2-13 (Figure 3). Borings will be advanced by direct-push

[4] Anchor QEA, LLC, 2013. *Health and Safety Plan, Duwamish Shipyard Supplemental Remedial Investigation*. Prepared for Duwamish Shipyard, Inc. July 2013.

(i.e., Geoprobe®) methodology and will include both soil and groundwater sampling by a field geologist as described in the following sections.

As part of this work, DSI will also decommission three existing RI wells that have been damaged: DSIP2-13, DSIP2-02, and DSIP2-16. These wells will be decommissioned by a licensed driller in accordance with Washington State regulations.

Soil Sampling

Anchor QEA will subcontract a driller to advance five soil borings via direct-push drilling techniques at the locations shown in Figure 3. These locations are approximate and may be adjusted in the field based on access considerations, presence of utilities, and/or shallow refusal. Soil borings will be used for observation of soil conditions and for collection of soil samples. Groundwater sampling activities are described in the following section.

Boring locations will be field-verified using a differential global positioning system. All borings will be advanced to a maximum depth of 15 feet bgs and continuously logged and sampled at select depth intervals (see Table 1). Soils observed from each boring will be logged by the field geologist, including the soil type, presence of debris, stained soil, or odors. Anchor QEA will note all observations on an Exploratory Boring Log form (Attachment A). Boring cuttings will be contained and disposed of by the driller.

Discrete soil samples will be collected from each boring at the target sample intervals listed in Table 1. Those samples will be submitted for chemical and physical analyses to document the extent of arsenic impacts and to characterize the geochemical conditions in the subsurface. Previous RI sampling indicates that arsenic impacts are primarily associated with shallow (e.g., less than 15 feet bgs) soils.

Soil samples will be analyzed for total metals, total solids, total organic carbon, sulfide, and extractable iron and manganese oxides pursuant to the methods in Table B-1. Field QA samples will include analysis of one field duplicate and one rinse blank (see Table B-2). Laboratory analyses will be performed at Analytical Resources, Inc. (ARI), in Tukwila, Washington. Chemical extraction of soil samples (i.e., for iron and manganese oxides) will be performed at Anchor QEA's Environmental Geochemistry Laboratory in Portland, Oregon, and extracts will be shipped to ARI for analysis.

Monitoring Well Installation and Groundwater Sampling

Temporary well points will be installed using pre-packed well screens in three of the proposed boring locations (DSIP3-01 through DSIP3-03), as shown on Figure 3, to allow sampling of groundwater. Temporary monitoring wells will be constructed of approximately 1 inch inside diameter polyvinyl chloride (PVC), flush–threaded casing attached to 10 feet of flush-threaded, pre-packed well screen. The screen will extend 10 feet up from the bottom of the boring (estimated at 15 feet below ground surface), consistent with the well screen depth intervals of DSIP2-13,

DSIP2-02, and DSIP2-16. Well screen placement will be verified in the field based on the observed groundwater level. The well screen and casing will be inserted into the open borehole.

Prior to groundwater sampling, depth to water from the top of the well casing will be measured at each location using an electronic depth-to-water indicator and recorded. Groundwater from the temporary wells will be purged with a peristaltic pump equipped with dedicated polyethylene tubing until the water quality parameters (pH, specific conductivity, and temperature) stabilize. Once field-measured groundwater quality parameters become stable, the groundwater will be allowed to return to static water level (recharge). Groundwater will then be sampled with the peristaltic pump from the approximate middle of the well screen interval using low-flow methodology.

Permanent monitoring wells will be installed in two of the soil borings, DSIP3-04 and DSIP3-05. The permanent monitoring wells will be constructed of 2-inch Schedule 40 PVC flush–threaded casing attached to 10 feet of flush-threaded, pre-packed well screen. The screens will extend 10 feet from the bottom of the boring (estimated at 15 feet below ground surface), consistent with the well screen depth intervals of DSIP2-13, DSIP2-02, and DSIP2-16. Well screen placement will be verified in the field based on the observed groundwater level. Well materials will be inserted into the cased borehole using the drill casing as temporary casing. Approximately 1 to 2 feet of silica sand will be placed above the top of the pre-packed screen and the remainder of the annular space will be backfilled with bentonite chips to 1 foot below ground surface. A concrete seal and well pad will be installed from 1 foot in depth to the surface. The wells will be completed with locked, watertight caps inside flush-mounted well monuments.

At least 12 hours following well installation, the two permanent wells will be developed with a combination of surging of the well screen and purging of groundwater. The well will be considered developed after at least 10 casing volumes of water have been purged, water quality parameters (pH, specific conductance, temperature, and turbidity) have stabilized, and as much sediment and fines have been removed from the bottom of the well as feasibly possible.

At least 12 hours following development, groundwater samples will be collected from the two permanent monitoring wells. The groundwater sampling design and well construction details are summarized in Table 2.

Groundwater from the permanent wells will be sampled consistent with the procedures outlined for the temporary well points above and in Section 3.4 of the 2013 Sampling and Analysis Plan, which was Appendix A of the Ecology-approved March 2013 *Supplemental Remedial Investigation Work Plan*.[5]

[5] Anchor QEA, LLC, 2013. *Supplemental Remedial Investigation Work Plan*. Duwamish Shipyard, Inc. Seattle, Washington. Prepared for Washington Department of Ecology. On behalf of Duwamish Shipyard, Inc. March 2013.

Groundwater samples from both temporary well points and permanent monitoring wells will be analyzed for dissolved metals and geochemical parameters (sulfate, sulfide, total organic carbon, dissolved organic carbon, total dissolved solids, total suspended solids, ammonia, dissolved iron, dissolved manganese, nitrate, phosphate, and silica). A summary of groundwater testing at each monitoring well and well details (i.e., well depth and screen interval) is provided in Table 2.

Groundwater samples selected for analysis will be analyzed for dissolved metals and geochemical parameters according the methods listed in Table B-3. Field QA samples will include analysis of one field duplicate (see Table B-2). Laboratory analyses will be performed at ARI in Tukwila, Washington.

All soil and groundwater sample containers will be kept on ice for transport to the analytical laboratories. Sample handling requirements are summarized in Table B-4. Analytical methods, laboratory method detection limits and reporting limits for all soil and groundwater parameters are defined in Table B-1 and Table B-3, respectively.

Monitoring Well Decommissioning

Three Site monitoring wells will be decommissioned during this investigation. The three wells to be decommissioned are shown in Figure 3 and listed in Table 3. The wells will be plugged in place by filling the well screen and casing with bentonite from the bottom of the well to the ground surface. The flush-mounted well monument and lid will be removed, and concrete will be emplaced at the ground surface flush with the current Site grade at each location.

Data Analysis and Reporting

Results of this investigation will be provided to Ecology in a RI Addendum: Arsenic Characterization Study Memorandum. The memorandum will include the following:

- Summary of investigation methods and findings
- Figures and tables summarizing observations and compiled analytical data
- Copies of boring and groundwater sampling logs, data validation findings, and analytical laboratory reports
- Data evaluation and a discussion of potential arsenic sources and geochemical conditions in the Rail Spur area of the Site

Following completion of the RI Addendum: Arsenic Characterization Study Memorandum, electronic data will be submitted to Ecology consistent with Environmental Information Management (EIM) data transmittal requirements.

Management of Investigation Derived Waste

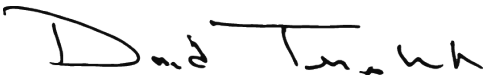
All rinse water, groundwater, and soil cuttings obtained during sampling, decommissioning, and decontamination activities will be containerized and disposed of appropriately. Containers will be located in a secure on-site area and appropriately labeled, pending waste characterization and disposal.

All disposable sampling materials and personal protective equipment used in sample processing, such as sample tubing, vinyl gloves, and paper towels, will be placed in heavy duty garbage bags or other appropriate containers. Disposable supplies will be placed in a normal refuse container for disposal as solid waste.

Schedule

Field activities are scheduled to begin in August or September 2019, pending approval of this Work Plan and availability of subcontractors and station clearance of on-site utilities by both public and private locates. Station clearance of on-site utilities by both public and private locates will be performed prior to direct-push activities.

Sincerely,



David Templeton
Anchor QEA, LLC

cc: Kyle McCleary, Duwamish Shipyard, Inc.
Kim Maree Johannessen, Johannessen & Associates, PS
Julia Fitts, LG, Anchor QEA, LLC

Attachments

Tables

Table 1 Soil Sampling Design
Table 2 Monitoring Well Installation and Groundwater Sampling Design
Table 3 Monitoring Wells to be Decommissioned

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Figure 1 Maximum Concentrations of Dissolved Arsenic in Groundwater, 2014-2015
Figure 2a Maximum Concentrations of Arsenic in Soil, 0 to 6 feet bgs
Figure 2b Maximum Concentrations of Arsenic in Soil, 6 to 15 feet bgs
Figure 3 Proposed Sampling Locations

Attachment A

Field Logs

Attachment B

Table B-1 Soil Analytes, Analytical Methods, and Laboratory Reporting Limits
Table B-2 Laboratory and Field Quality Assurance/Quality Control Sample and Analysis Summary
Table B-3 Groundwater Analytes, Analytical Methods, and Laboratory Reporting Limits
Table B-4 Sample Handling Requirements

Tables

Table 1
Soil Sampling Design

Station ID	Proposed Coordinates[1,2]		Sample Method	Target Sampling Intervals[3]	Sample ID	Soil Testing[4]			Well Type
	Easting (X)	Northing (Y)				Chemistry	Geochemistry	Physical	
DSIP3-01	1267424.11	204362.15	Geoprobe	Upper Fill (approximately 0–2 ft bgs)	DSIP3-01-Depth	Metals	Sulfide, Fe, and Mn Oxides	TS, TOC	Temporary
				Middle Fill (approximately 3–5 ft bgs)					
				Lower Fill (approximately 7–9 ft bgs)					
				Native Silt/Sand (approximately 10–12 ft bgs)					
DSIP3-02	1267435.69	204397.80	Geoprobe	See DSIP3-01	DSIP3-02-Depth				Temporary
DSIP3-03	1267546.49	204384.48	Geoprobe	See DSIP3-01	DSIP3-03-Depth				Temporary
DSIP3-04	1267329.34	204361.97	Geoprobe	See DSIP3-01	DSIP4-04-Depth				Permanent
DSIP3-05	1267594.05	204481.64	Geoprobe	See DSIP3-01	DSIP4-05-Depth				Permanent

Notes:

1. Coordinates will be verified based on finalization of sampling locations.

2. Washington State Plane North, North American Datum of 1983 (NAD 83), U.S. Survey Feet.

3. Sample depths are approximate and will depend on lithologic units encountered during sampling.

4. See Table B-1 for specific testing.

bgs: below ground surface

Fe: iron

ft: feet

Mn: manganese

TOC: total organic carbon

TS: total solids

Table 2
Monitoring Well Installation and Groundwater Sampling Design

Station ID	Proposed Coordinates[1,2]		Sample Method	Well Diameter	Well Screen Interval[3]	Sample ID	Groundwater Testing[4]		
	Easting (X)	Northing (Y)					Chemistry	Geochemistry	Field Parameters
Temporary Monitoring Wells									
DSIP3-01	1267424.11	204362.15	Low Flow	1-inch	5–15 feet bgs	DSIP3-01-Date	Dissolved Metals	Sulfate, Sulfide, TOC, DOC, TSS, TDS, Ammonia, Dissolved Fe and Mn, Nitrate, Phosphate, Silica	DO, Temp, pH, ORP, Cond, Turbidity
DSIP3-02	1267435.69	204397.80	Low Flow	1-inch	5–15 feet bgs	DSIP3-02-Date	Dissolved Metals		
DSIP3-03	1267546.49	204384.48	Low Flow	1-inch	5–15 feet bgs	DSIP3-03-Date	Dissolved Metals		
Permanent Monitoring Wells									
DSIP3-04	1267329.34	204361.97	Low Flow	2-inch	5–15 feet bgs	DSIP3-04-Date	Dissolved Metals	Sulfate, Sulfide, TOC, DOC, TSS, TDS, Ammonia, Dissolved Fe and Mn, Nitrate, Phosphate, Silica	DO, Temp, pH, ORP, Cond, Turbidity
DSIP3-05	1267594.05	204481.64	Low Flow	2-inch	5–15 feet bgs	DSIP3-05-Date	Dissolved Metals		

Notes:

1. Coordinates will be verified based on finalization of sampling locations.

2. Washington State Plane North, North American Datum of 1983 (NAD 83), U.S. Survey Feet.

3. Well screen intervals are approximate and will depend on lithologic units encountered during sampling.

4. Dissolved metals samples will be field filtered at the time of collection.

bgs: below ground surface

Cond: conductivity

DO: dissolved oxygen

DOC: dissolved organic carbon

Fe: iron

Mn: manganese

ORP: oxidation reduction potential

TDS: total dissolved solids

Temp: temperature

TOC: total organic carbon

TSS: total suspended solids

Table 3
Monitoring Wells to be Decommissioned

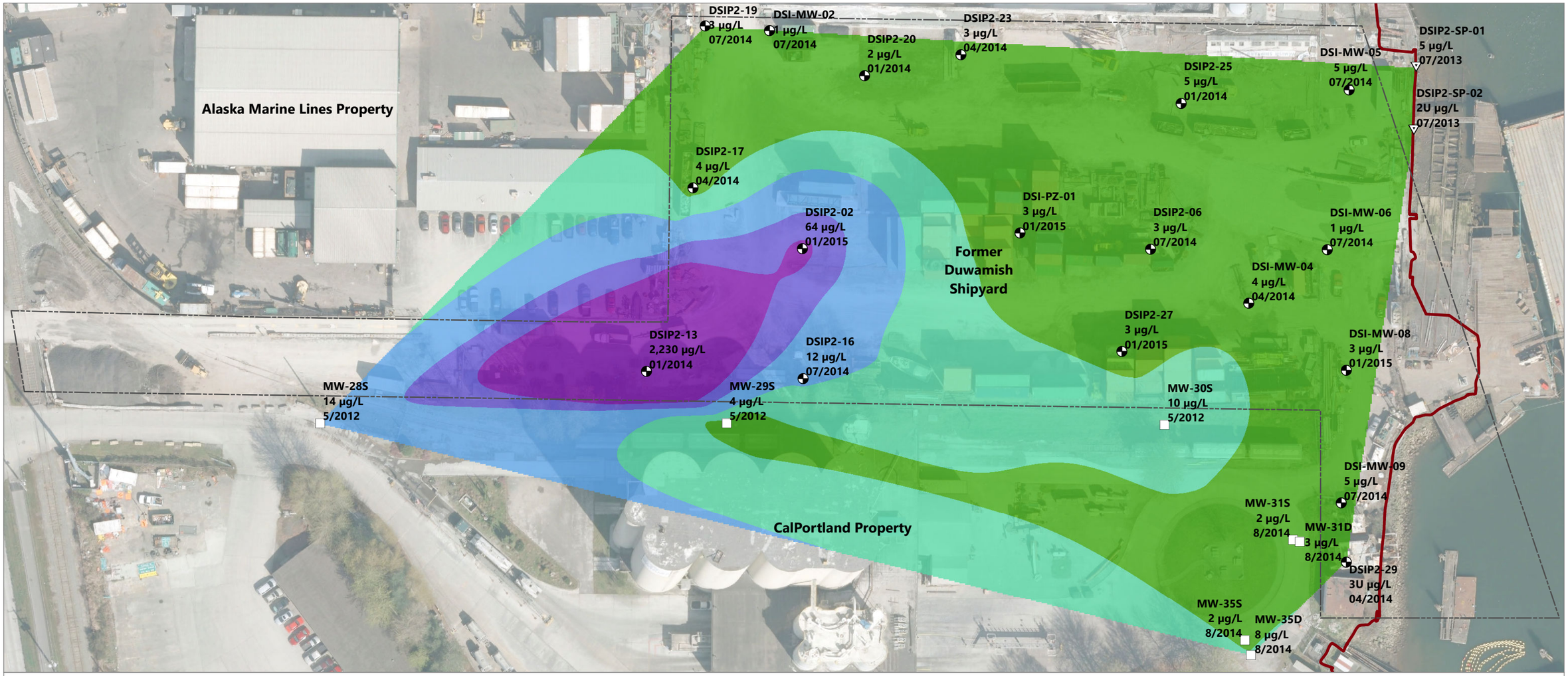
Station ID	Coordinates[1]		Surface Completion	Well Diameter	Well Screen Interval (feet bgs)	Depth to Bottom of Well (feet bgs)
	Easting (X)	Northing (Y)				
DSIP2-02	1267562.38	204456.85	Flush-mount	2-inch	5.7–15.7	17.0
DSIP2-13	1267446.25	204365.45	Flush-mount	2-inch	5.3–15.3	17.0
DSIP2-16	1267562.84	204360.20	Flush-mount	2-inch	5.2–15.2	16.0

Notes:

1. Washington State Plane North, North American Datum of 1983 (NAD 83), U.S. Survey Feet.

bgs: below ground surface

Figures



LEGEND:

Dissolved Arsenic (µg/L)
- <5 (Screening Level)
- 5 - 10 (2x)
- 10 - 25 (5x)
- 25 - 50 (10x)
- >50

- Shallow Well
- Seep
- Glacier Northwest Sampling Location

Groundwater Sampling Location
- Location ID
  Maximum Concentration
  Date

- Top of Bank (Approximate)
- DSI Property Boundary

NOTES:
1. The maximum concentration for the 2014-2015 quarterly sampling at each groundwater location was used for contouring.
2. The full reporting limit for non-detects (identified with U qualifier) was used for data contouring purposes.
3. µg/L: micrograms per liter
4. Data from the Public Review Draft Remedial Investigation Report was used for contouring.

0 75
Feet

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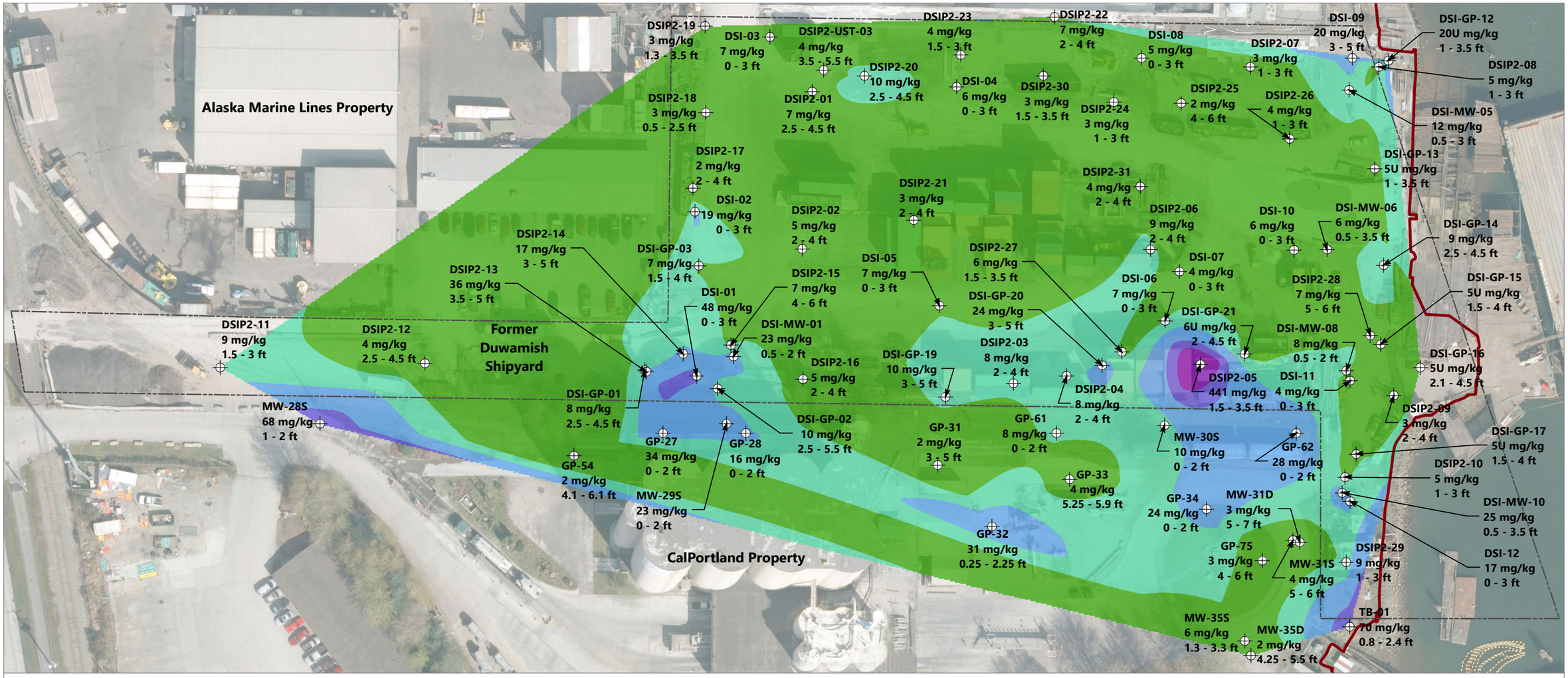
ANCHOR QEA

Figure 1
Maximum Concentrations of Dissolved Arsenic in Groundwater, 2014-2015
Remedial Investigation Addendum: Arsenic Characterization Study Work Plan
Duwamish Shipyard, Inc. Arsenic Characterization Study



LEGEND:

Arsenic (mg/kg)

- <7.3 (Screening Level)
- 7.3 - 14.6 (2x)
- 14.6 - 36.5 (5x)
- 36.5 - 73 (10x)
- >73

Soil Sampling Location

- Location ID
  Maximum Concentration
  Depth of Sample Interval

- Top of Bank (Approximate)
- DSI Property Boundary

NOTES:

1. The maximum concentration at each soil location was used for contouring at a depth of 0 to 6 feet.
2. The full reporting limit for non-detects (identified with U qualifier) was used for data contouring purposes.
3. mg/kg: milligrams per kilogram
4. Data from the Public Review Draft Remedial Investigation Report was used for contouring.

0 75
Feet

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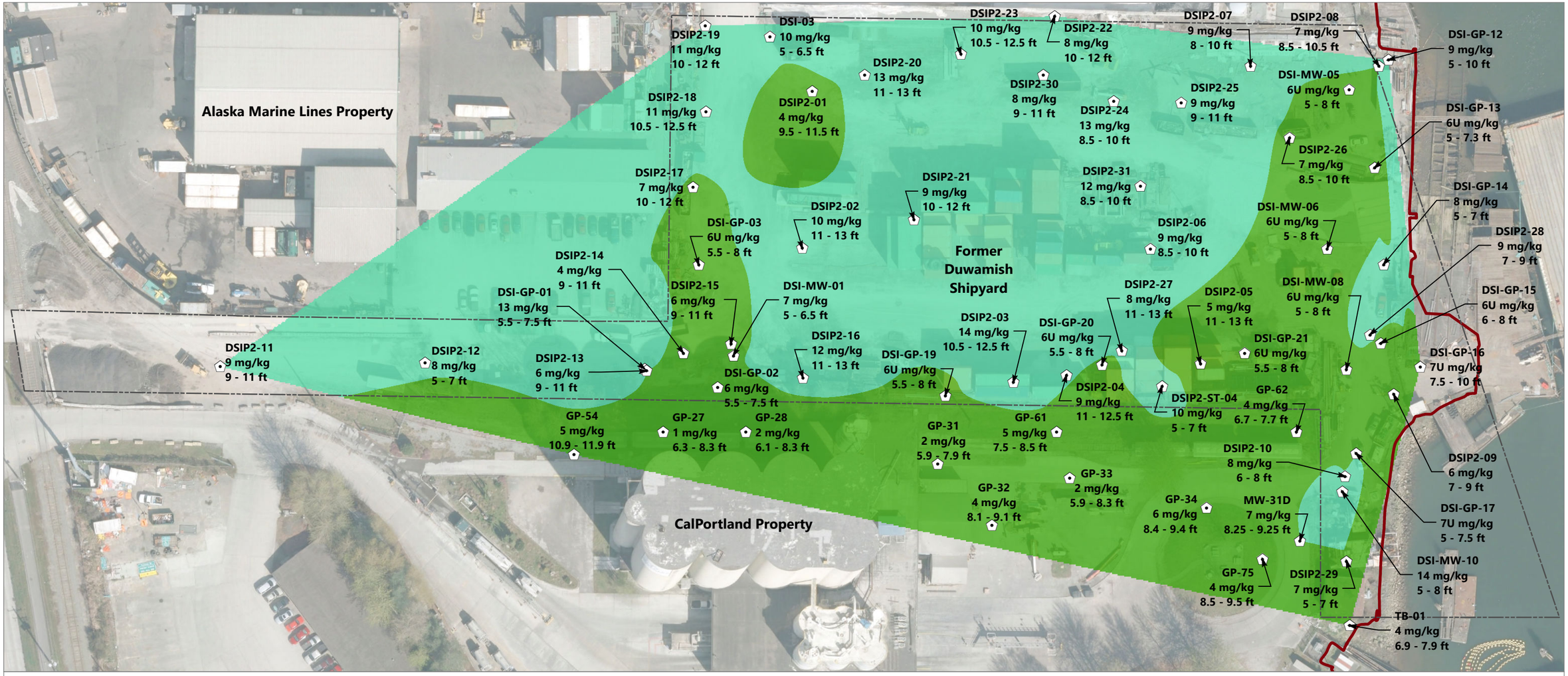
Figure 2a
Maximum Concentrations of Arsenic in Soil, 0 to 6 feet bgs
Remedial Investigation Addendum: Arsenic Characterization Study Work Plan
Duwamish Shipyard, Inc. Arsenic Characterization Study



LEGEND:

Arsenic (mg/kg)

- <7.3 (Screening Level)
- 7.3 - 14.6 (2x)
- 14.6 - 36.5 (5x)
- 36.5 - 73 (10x)
- >73

Soil Sampling Location

- Location ID
- Maximum Concentration
- Depth of Sample Interval

- Top of Bank (Approximate)
- DSI Property Boundary

NOTES:

1. The maximum concentration at each soil location was used for contouring at a depth of 6 to 15 feet.
2. The full reporting limit for non-detects (identified with U qualifier) was used for data contouring purposes.
3. mg/kg: milligrams per kilogram
4. Data from the Public Review Draft Remedial Investigation Report was used for contouring.

0 75
Feet

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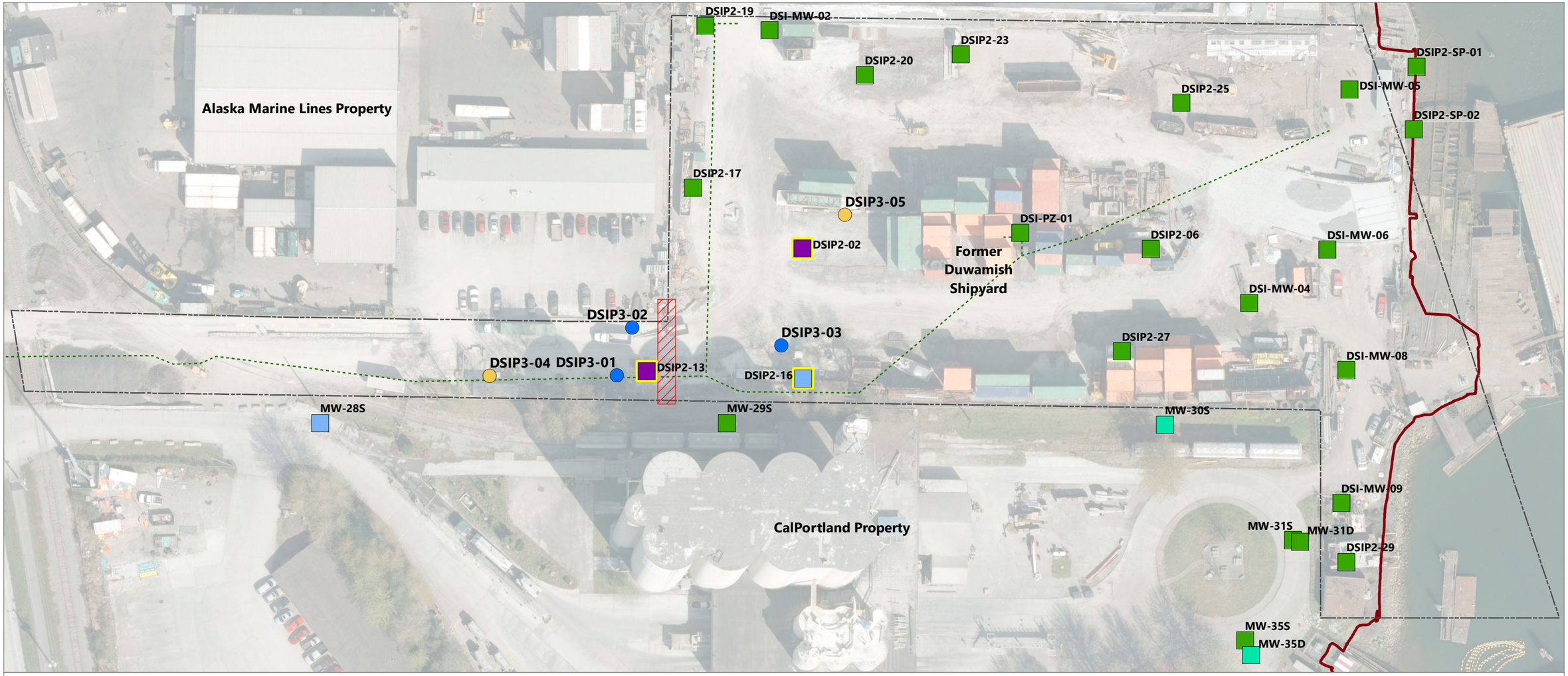
ANCHOR QEA

Figure 2b
Maximum Concentrations of Arsenic in Soil, 6 to 15 feet bgs
Remedial Investigation Addendum: Arsenic Characterization Study Work Plan
Duwamish Shipyard, Inc. Arsenic Characterization Study



LEGEND:

Dissolved Arsenic (µg/L)

- <5 (Screening Level)
- 5 - 10 (2x)
- 10 - 25 (5x)
- 25 - 50 (10x)
- > 50

- Wells to be Decommissioned

Proposed Boring Locations

- Soil Boring with Permanent Monitoring Well
- Soil Boring with Temporary Monitoring Well

- Top of Bank (Approximate)
- DSI Sanitary Sewer Line
- Approximate Power/Electrical Corridor
- DSI Property Boundary

NOTES:

1. Dissolved arsenic concentrations in groundwater are from 2014-2015 quarterly sampling.
2. Proposed boring locations are approximate and are subject to change based on access and other factors.
3. µg/L: micrograms per liter

0 75

Feet

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ANCHOR QEA

Figure 3
Proposed Sampling Locations
Remedial Investigation Addendum: Arsenic Characterization Study Work Plan
Duwamish Shipyard, Inc. Arsenic Characterization Study

Attachment A

Daily Log

ANCHOR QEA

Anchor QEA, LLC
1201 3rd Avenue, Suite 2600
Seattle, Washington 98101
Phone 206.287.9130

PROJECT NAME: **DATE:**

SITE ADDRESS: **PERSONNEL:**

WEATHER:	**WIND FROM:**	N	NE	E	SE	S	SW	W	NW	LIGHT	MEDIUM	HEAVY
		SUNNY		CLOUDY		RAIN			?	**TEMPERATURE:**	° F .	° C

[Circle appropriate units]

TIME	COMMENTS

Signature: ______________________

ANCHOR QEA

LOG OF GEOPROBE EXPLORATORY BORING

CLIENT/PROJECT NAME_____ BORING #_____

PROJECT NUMBER_____ DATE BEGAN_____

GEOLOGIST/ENGINEER_____ DATE COMPLETED_____

DRILLING CONTRACTOR_____ TOTAL DEPTH_____

DRILLING METHOD_____ SHEET_____OF_____

HOLE DIAMETER_____

OTHER*	COMMENTS	SAMPLING DATA: SAMPLING METHOD	SAMPLE NUMBER	FID / PID (ppm)	RECOVERY (feet)	DRIVE (1-5, 1=easy 5=hard)	DEPTH SAMPLED	DEPTH IN FEET	SOIL GROUP SYMBOL (USCS)	Field location of boring / LITHOLOGIC DESCRIPTION
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		

Remarks:

WELL DEVELOPMENT FORM

Project No.	Date: Well:	
Site Location:	Initial DTB:	Final DTB:
Name:	Initial DTW:	Final DTW:
Development Method:	Pore Volume:	
Total Water Removed:	Casing Diameter:	
Water Contained ? NO	Meter #:	
Estimate of specific capacity or recharge to well:		

Time	Cum. Vol. Removed	Sand/Silt (ml/1000ml)	Temp.	EC	pH	DTW (TOC)	Appearance/Comments

GROUNDWATER SAMPLING DATA SHEET

ANCHOR QEA

1201 3rd Avenue, Suite 2600
Seattle, Washington 98101
Office: 206.287.9130

PROJECT NAME: **WELL ID:**

SITE ADDRESS: **BLIND ID:**

DUP ID: **NA**

WIND FROM:	N	NE	E	SE	S	SW	W	NW	LIGHT	MEDIUM	HEAVY
WEATHER:	SUNNY		CLOUDY		RAIN		?		**TEMPERATURE:**	° F . ° C	

[Circle appropriate units]

HYDROLOGY/LEVEL MEASUREMENTS (Nearest 0.01 ft)

Date	Time	DT-Bottom	DT-Product	DT-Water	DTP-DTW [Product Thickness]	DTB-DTW [Water Column]		[Water Column x Gal/ft] Volume (gal)
/ /	:	.	.	.	.	.	X 1	.
/ /	:	.	.	.	.		X 3	.

Gal/ft = (dia./2)^2 x 0.163	1" = 0.041	2" = 0.163	3" = 0.367	4" = 0.653	6" = 1.469	10" = 4.080	12" = 5.875

§ METHODS: (A) Submersible Pump (B) Peristaltic Pump (C) Disposable Bailer (D) PVC/Teflon Bailer (E) Dedicated Bailer (F) Dedicated Pump (G) Other =

GROUNDWATER SAMPLING DATA (if product is detected, do NOT sample) Sample Depth: [√ if used]

Bottle Type	Date	Time	Method §	Amount & Volume mL	Preservative [circle]	Ice	Filter	pH	√
VOA Glass	/ /	:		3	40 ml HCl	YES	NO		
Amber Glass	/ /	:			250, 500, 1L (None) (HCl) (H_2SO_4)	YES	NO		
White Poly	/ /	:			250, 500, 1L None	YES	NO	NA	
Yellow Poly	/ /	:			250, 500, 1L H_2SO_4	YES	NO		
Green Poly	/ /	:			250, 500, 1L NaOH	YES	NO		
Red Total Poly	/ /	:			250, 500, 1L HNO_3	YES	NO		
Red Diss. Poly	/ /	:			250, 500, 1L HNO_3	YES	YES		
	/ /	:			250, 500, 1L	YES			
		Total Bottles (include duplicate count):							

Analysis Allowed per Bottle Type

BOTTLE TYPE	TYPICAL ANALYSIS ALLOWED PER BOTTLE TYPE (Circle applicable or write non-standard analysis below)
VOA - Glass	(8021) (8260B) (BTEX) (NWTPH-Gx)
AMBER - Glass	(PAH) (TPH-HCID) (NWTPH-Dx) (TPH-418.1) (Oil &Grease) (8081A)
WHITE - Poly	(pH) (Conductivity) (TDS) (TSS) (BOD) (Turbidity) (Alkalinity) (HCO_3/CO_3) (Cl) (SO_4) (NO_3) (NO_2) (F)
YELLOW - Poly	(COD) (TOC) (Total PO_4) (Total Keldahl Nitrogen) (NH_3) (NO_3/NO_2)
GREEN - Poly	(Cyanide)
RED TOTAL - Poly	(As) (Sb) (Ba) (Be) (Ca) (Cd) (Co) (Cr) (Cu) (Fe) (Pb) (Mg) (Mn) (Ni) (Ag) (Se) (Tl) (V) (Zn) (Hg) (K) (Na)
RED DISSOLVED - Poly	(As) (Sb) (Ba) (Be) (Ca) (Cd) (Co) (Cr) (Cu) (Fe) (Pb) (Mg) (Mn) (Ni) (Ag) (Se) (Tl) (V) (Zn) (Hg) (K) (Na) (Hardness) (Silica)

WATER QUALITY DATA Purge Start Time: : Pump/Bailer Inlet Depth:

Meas.	Method §	Purged (gal)	pH	E Cond (µS)	°F Temp °C	Other	Diss O_2 (mg/l)	Water Quality
4		.	.		.		.	
3		.	.		.		.	
2		.	.		.		.	
1		.	.		.		.	
0		**0.00**	.		.		.	

[Casing] [Select A-G] [Cumulative Totals] [Circle units] [Clarity, Color]

SAMPLER:

(PRINTED NAME) (SIGNATURE)

Attachment B

Table B-1
Soil Analytes, Analytical Methods, and Laboratory Reporting Limits

Parameter	Analytical Method	Method Detection Limit	Reporting Limit
Conventional and Physical Parameters			
Total Solids (%)	SM2540B	--	0.01
Total Organic Carbon (%)	Plumb 1981	--	0.02
Metals (mg/kg)			
Antimony	USEPA 6020A	0.02	0.2
Arsenic	USEPA 6020A	0.02	0.2
Beryllium	USEPA 6020A	0.03	0.2
Barium	USEPA 6020A	0.06	0.5
Cadmium	USEPA 6020A	0.03	0.1
Chromium	USEPA 6020A	0.13	0.5
Copper	USEPA 6020A	0.34	0.5
Lead	USEPA 6020A	0.07	0.1
Mercury	USEPA 7471A	0.00525	0.025
Nickel	USEPA 6020A	0.05	0.5
Selenium	USEPA 6020A	0.44	0.5
Silver	USEPA 6020A	0.02	0.2
Thallium	USEPA 6020A	0.008	0.2
Zinc	USEPA 6020A	0.8	4
Geochemical Parameters (mg/kg)			
Iron Oxide[1]	SSSA 1996, Chapter 23	--	--
Manganese Oxide[1]	SSSA 1996, Chapter 23	--	--
Sulfide, total	SM4500-S2 D-0	1.00	1.00

Notes:

a. Method Detection Limits (MDLs) are determined by 40 Code of Federal Regulations (CFR) Part 136 and included for informational purposes.

b. Detected concentrations between the MDL and the reporting limit (RL) will be reported as estimated.

c. Concentrations below detection will be reported at the RL.

d. Final MDL and RL values may differ slightly based on sample dry weight correction, adjustment for sample size, and sample dilution due to matrix interference or non-target analytes.

1. Iron and manganese oxides are prepared from soil samples and analyzed for dissolved metals in the extraction liquid.

mg/kg: milligrams per kilogram

SSSA: Soil Science Society of America

USEPA: U.S. Environmental Protection Agency

Table B-2
Laboratory and Field Quality Assurance/Quality Control Sample and Analysis Summary

Analysis Type	Field Quality Assurance Samples			Laboratory Quality Control Elements							
	Rinsate Blank[1]	Field Duplicates[1]	Temperature Blank	Initial Calibration	Ongoing Calibration	Replicates[3]	Matrix Spikes	LCS/Blank Spike	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
Total solids	NA	1 per event	1 per cooler	Each batch[2]	NA	1 per 20 samples	NA	NA	NA	NA	NA
Total dissolved solids, total suspended solids	NA	1 per event	1 per cooler	Each batch[2]	NA	1 per 20 samples	NA	NA	NA	1 per 20 samples	NA
Total and dissolved organic carbon	NA	1 per event	1 per cooler	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	1 per 20 samples	NA
Metals	1 per equipment type	1 per event	1 per cooler	Daily or each batch[4]	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	1 per 20 samples	NA
Sulfide, ammonia	NA	NA	1 per cooler	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	1 per 20 samples	NA
Sulfate, nitrate, phosphorous	NA	NA	1 per cooler	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	1 per 20 samples	NA

Notes:
1. Not required for geochemical parameters.
2. Calibration and certification of drying ovens and weighing scales are conducted bi-annually.
3. A matrix spike duplicate may be analyzed in lieu of a sample duplicate.
4. Initial calibration verification and calibration blank must be analyzed at the beginning of each batch.
LCS: laboratory control sample
NA: not applicable

Table B-3
Groundwater Analytes, Analytical Methods, and Laboratory Reporting Limits

Parameter	Analytical Method	Method Detection Limit	Reporting Limit
Metals, Dissolved (µg/L)			
Antimony	USEPA 6020A	0.01	0.2
Arsenic	USEPA 6020A	0.015	0.2
Beryllium	USEPA 6020A	0.005	0.2
Barium	USEPA 6020A	0.02	0.5
Cadmium	USEPA 6020A	0.01	0.1
Chromium	USEPA 6020A	0.045	0.5
Copper	USEPA 6020A	0.158	0.5
Lead	USEPA 6020A	0.046	0.1
Mercury	USEPA 7471A	0.0069	0.1
Nickel	USEPA 6020A	0.079	0.5
Selenium	USEPA 6020A	0.127	0.5
Silver	USEPA 6020A	0.008	0.2
Thallium	USEPA 6020A	0.004	0.2
Zinc	USEPA 6020A	0.497	4
Geochemical Parameters (mg/L)			
Metals, Dissolved (µg/L)			
Iron	USEPA 6010C	7.5	50
Manganese	USEPA 6010C	0.28	1
Metals, Total (mg/L)			
Silicon	USEPA 6010C	0.0052	0.06
Conventionals (mg/L)			
Total Organic Carbon	USEPA 9060A	--	0.5
Dissolved Organic Carbon	USEPA 9060A	--	0.5
Ammonia	SM4500-NH3 H-97	--	0.04
Nitrate	USEPA 300.0	--	0.1
Total phosphorous	SM4500	--	0.008
Sulfate	USEPA 300.0	--	0.1
Sulfide	SM4500-S2 D-0	--	0.05
Total Dissolved Solids	SM2540C	--	1
Total Suspended Solids	SM2540D	--	5

Notes:

a. Method Detection Limits (MDLs) are determined by 40 Code of Federal Regulations (CFR) Part 136 and included for informational purposes.

b. Detected concentrations between the MDL and the reporting limit (RL) will be reported as estimated.

c. Concentrations below detection will be reported at the RL.

d. Final MDL and RL values may differ slightly based on adjustment for sample size and sample dilution due to matrix interference or non-target analytes.

µg/L: micrograms per liter

mg/L: milligrams per liter

USEPA: U.S. Environmental Protection Agency

Table B-4
Sample Handling Requirements

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique
Soil				
Total solids	50 g	8-oz glass	14 days	Cool/4°C
			6 months	Freeze -18°C
Total organic carbon	50 g	from TS container	14 days	Cool/4°C
			6 months	Freeze -18°C
Total metals (with Hg)[2]	50 g	from TS container	6 months; 28 days for Hg	Cool/4°C
			2 years (except Hg)	Freeze -18°C
Sulfide	50 g	4-oz glass or HDPE	7 days	Cool/4°C, no headspace, zinc acetate
Iron and manganese oxides	50 g	4-oz glass	None established	Cool/4°C
Water				
Total silicon	200 mL	500 mL HDPE	6 months	HNO_3 to pH < 2
Dissolved metals (includes Mn, Fe, and Hg)	100 mL	500 mL HDPE	6 months; 28 days for Hg	Field Filter, HNO_3 to pH < 2
Total dissolved solids	500 mL	1L HDPE	7 days	Cool/4°C
Total suspended solids	1000 mL	1L HDPE	7 days	Cool/4°C
Sulfate	100 mL	500 mL HDPE	28 days	Cool/4°C
Nitrate, phosphate	100 mL	500 mL HDPE or glass	48 hours	Cool/4°C
Sulfide (dissolved, H2S)	100 mL	500 mL HDPE	Filter within 24 hours; 7 days to analysis	Cool/4°C
Ammonia	100 mL	500 mL HDPE	28 days	H2SO4 to pH < 2/ Cool/4°C
Total organic carbon	50 mL	250 mL amber glass	28 days	H2SO4 to pH < 2/ Cool/4°C
Dissolved organic carbon	50 mL	250 mL amber glass	28 days	Field filter, H2SO4 to pH < 2 Cool/4°C

Table B-4
Sample Handling Requirements

Notes:

1. Container size, type, and sample size required may change based on laboratory guidance.
2. All sample containers will have lids with Teflon inserts.

Fe: iron

g: gram

H2SO4: sulfuric acid

HDPE: high density polyethylene

Hg: mercury

HNO_3: nitric acid

L: liter

mL: milliliter

Mn: manganese

oz: ounce

TS: total solids