SECOND QUARTER 2021 PROGRESS REPORT / FIRST QUARTER 2021 GROUNDWATER PERFORMANCE MONITORING REPORT
SITE: FORMER BP HARBOR ISLAND TERMINAL
CLEANUP SITE ID: 4426
1652 SW LANDER STREET
SEATTLE, WASHINGTON

CONSENT DECREE NO. 00-2-05714-8SEA

JULY 2021

Prepared for
TLP Management Services LLC
1670 Broadway
Suite 3100
Denver, CO 80202

Prepared by
TechSolve Environmental, Inc.
7518 NE 169th Street
Kenmore, WA 98028

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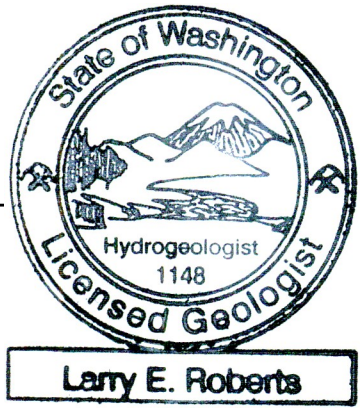
Scott K. Larsen, CHMM
Project Scientist/Project Manager
TechSolve Environmental, Inc.

Larry E. Roberts, LG, LHG
Principal Hydrogeologist/Site Manager
TechSolve Environmental, Inc.



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1. INTRODUCTION

TLP Management Services LLC is submitting this report prepared by TechSolve Environmental, Inc. (TechSolve) to summarize the First Quarter 2021 Groundwater Monitoring event and operation and maintenance of the waterfront remediation system during the second quarter (April through June) of 2021 for the Former BP Harbor Island Terminal Site. The combination of these two summary reports was based upon a Washington State Department of Ecology (Ecology) recommendation (Ecology, 2004a). This progress report satisfies reporting schedule submittal requirements pursuant to Ecology Consent Decree No. 00-2-05714-8SEA (Ecology, 2000b).

2. REMEDIATION SYSTEM OPERATIONS

Remediation systems were installed and completed at the Site in accordance with specifications outlined in the Engineering Design Report (EDR) (TechSolv and AG&M, 2000) and Cleanup Action Plan (CAP) (Ecology, 1999). Throughout most of 2021, a waterfront groundwater/Light Non-Aqueous Phase Liquid (LNAPL) remediation system has operated to remove free-phase LNAPL and dissolved petroleum hydrocarbons from groundwater at Plant 1 (Figure 1). This system was offline for several weeks in April and May of 2021 to complete field activities related to a hydraulic evaluation, as discussed in Section 5 below.

2.1. WATERFRONT SYSTEM OPERATIONS

Installation, startup, and testing of the final waterfront remediation system was completed in 2002 and 2003. Standard operation began once testing showed the system operated as designed. System construction and operation and maintenance (O&M) are detailed in the Construction Completion Report (CCR) (TechSolve, 2003b) and Final O&M Manual (TechSolve, 2003c), which were approved by Ecology (Ecology, 2004b). The O&M Manual is updated as practices or procedures change, or as systems are altered.

O&M activities are conducted on systems to ensure they operate as designed and in accordance with applicable permits. These activities include, but are not limited to:

- Weekly checks of groundwater recovery system pumping rates.
- Weekly inspections of system components and waste storage containers for integrity per the requirements of WAC 173-303-320.
- Monthly sampling of recovered groundwater influent and effluent streams to ensure compliance with King County Department of Natural Resources and Parks (KCDNR) Discharge Permit 7592-05 for discharge A43262.
- Monthly monitoring and calculation of system LNAPL recovery.
- Monthly sampling of system flow rates and hydrocarbon concentrations.

Additional maintenance activities are conducted as needed to maintain system operational integrity and to ensure discharges are within permitted ranges.

Operation of waterfront air sparging and SVE systems were discontinued in May 2008, as the bulk of available hydrocarbons had been recovered (TechSolve, 2009).

Combined LNAPL recovery (free-phase, residual, and dissolved) from final SVE and groundwater/ LNAPL recovery systems is approximately 14,557 gallons (October 2002 to June 2021) (Table 1). Interim systems, operating from 1992 through 2002, recovered an additional 15,223 gallons of LNAPL, for a combined LNAPL recovery of 29,779 gallons. The majority of LNAPL recovered by interim remediation systems was free-phase LNAPL. The majority of LNAPL recovered by final remediation systems was from enhanced biodegradation, calculated from CO_2 in SVE vapor.

Groundwater/LNAPL recovery system data presented in Table 1 show influent concentrations of dissolved benzene, diesel, and gasoline in recovered groundwater (i.e., untreated water pumped from recovery wells screened in shallow groundwater) have decreased over time. In 2021, influent concentrations of dissolved benzene, diesel, and gasoline in all monitoring events were below associated surface water cleanup levels, which are applicable to confirmational monitoring wells screened where groundwater and surface water exchange is occurring. Table 1 also shows that measurable volumes of free LNAPL have not been generated since 2008, which was the last time sufficient LNAPL was recovered to warrant off-site shipment. These data correspond with the lack of free LNAPL observed in recovery wells used by the groundwater/LNAPL recovery system. Lack of free LNAPL in wells and limited free LNAPL recovery by the groundwater/LNAPL recovery system indicate that the recovery system has captured most available free LNAPL. Evaluations conducted during 2019 (TechSolve, 2020a) and detailed in the 2019 Annual Site Report (TechSolve, 2020b) determined that free and recoverable LNAPL appears to no longer be present and LNAPL has been recovered to the extent practicable. Negotiations are ongoing with Ecology regarding the need for continued operation of the groundwater/LNAPL recovery system.

Effluent discharges from the groundwater/LNAPL recovery system to the sanitary sewer have been within KCDNR's permitted ranges (Table 1) in 2021. Average monthly effluent flow rates ranged from 0.35 to 1.44 gallons per minute (gpm) in 2021, below KCDNR's maximum permitted flow of 17.5 gpm, consistent with past rates that have decreased over time. The lower 0.35 gpm effluent flow rate for May was due to the system being offline from April 20 through May 11 for the completion of a background water level assessment associated with a hydraulic investigation, as detailed in Section 5 below.

Maintenance and repair activities of remediation systems and wells are conducted to maintain integrity, effective operation, capture, and hydraulic control along the waterfront. Notable activities conducted in the second quarter of 2021 include:

- Cleanout and service of remediation system groundwater treatment system process equipment.

- Piping and system back flushing and preventative maintenance to maintain conveyance piping and pumping wells.

Data show that the system continues to operate as designed and in accordance with permit requirements.

2.1.1. RECOVERY WELL MONITORING

Monitoring of recovery wells for free LNAPL, sheen, and dissolved phase IHS concentrations has been voluntarily conducted since 2003 and was conducted in 2021. Monitoring recovery wells for LNAPL presence helps evaluate the attainment of the associated performance criterion for groundwater/LNAPL recovery system shutdown, which is for LNAPL to be recovered to the extent practicable (i.e., below a measurable threshold of 0.01 foot in thickness). Monitoring for dissolved phase IHSs evaluates for elevated dissolved concentrations, which are an indicator of LNAPL above residual saturation levels that may be recoverable or threaten deeper groundwater. The dissolved phase IHS performance criterion for groundwater/LNAPL recovery system shutdown is attainment of groundwater CULs at conditional points of compliance (CPOCs). The established CPOCs near the groundwater/LNAPL recovery system are Confirmation Monitoring Wells AMW-01 through AMW-05, which are screened in deeper groundwater where groundwater and surface water exchange was shown to occur (Section 3). Dissolved phase IHS CULs are not required to be met in the shallow screened recovery wells for shutdown of the groundwater/LNAPL recovery system.

June 2021 recovery well monitoring (Table 2) for LNAPL presence showed no measurable LNAPL in any of the 10 recovery wells (Figure 2). Additionally, no sheen on groundwater was detectable in 8 of the recovery wells. A slight sheen was detected in 2 wells (RW-2 and RW-4). Monitoring of shallow groundwater for dissolved phase IHSs showed 7 of the 10 recovery wells were below the IHS CULs for benzene, gasoline (TPH-G), diesel (TPH-D) and oil (TPH-O) that are applicable at deeper CPOCs. Shallow groundwater samples from three wells (RW-2, RW-4, and RW-9) exceeded the diesel CUL. Groundwater from two wells (RW-2 and RW-4) exceeded the gasoline CUL. No wells exceeded the benzene CUL. These data have been consistent over the past several years and are also consistent with the results of the Waterfront Probing Investigation (TechSolve, 2020a). The investigation showed no recoverable LNAPL remaining and that dissolved phase IHSs in shallow groundwater are not likely to cause exceedances of IHS CULs at deeper CPOCs.

Accessible recovery wells were also monitored for measurable LNAPL and sheen (Table 3) during a period of groundwater/LNAPL recovery system shutdown that lasted from late April through early May 2021. The system was shutdown during this period for the hydraulic evaluation discussed in Section 5 below. Six accessible recovery wells (RW-1, RW-2, RW-4, RW-7, RW-8, and RW-9) were monitored during this period. The remaining four recovery wells (RW-5, RW-6, RW-10, and GM-11S) were used as part of the hydraulic evaluation well network and were inaccessible due to the presence of monitoring equipment in the wells. No measurable LNAPL was detected in any recovery well during this period and no sheen on groundwater was detectable in three of the six wells (RW-1, RW-7, RW-8). Slight and moderate sheen were detected in the first three monitoring events in wells RW-9 and RW-2, respectively. No sheen was detectable in wells RW-9 and RW-2 in the fourth and final monitoring event prior to system restart. An oily film, too thin to be measured, and heavy sheen was detected in the first monitoring event in Well RW-4. An oil sorbent sock was then placed in Well RW-4 throughout the study to recover the oily film. A heavy sheen and no oily film were detected in the next two monitoring events in RW-4. Only a slight sheen was detected in the final monitoring event in RW-4. Overall, sheen and LNAPL presence appeared consistent with the results of monitoring conducted during periods of system operation. Lack of measurable LNAPL during system shutdown and reductions in sheen strength in recovery wells in the final monitoring event prior to restart supports previous findings (TechSolve, 2021), indicating that remaining LNAPL is likely residual and not recoverable.

2.2. INLAND SYSTEM OPERATIONS

An Inland SVE system operated from 2008 through 2014 to improve soil and groundwater conditions along the southern boundary of Plant 1. The SVE system was shut down in December 2014 as the system no longer recovered measurable petroleum hydrocarbons and induced airflow was no longer affecting biodegradation. Information regarding shutdown of the Inland SVE system was provided in the 2015 Annual Site Report (TechSolve, 2016). In 2018, a plan (TechSolve, 2018) was submitted to and approved by Ecology (Ecology 2018) to decommission the mechanical and electrical components of the Inland SVE System that required ongoing maintenance, which was implemented. The in-ground SVE piping and control manifold for this system remain onsite as a contingency in case operation of the system is warranted in the future.

Groundwater monitoring data collected along Plant 1's southern boundary indicate the system improved groundwater conditions in this area of the Site, as discussed in the following section.

3. SUMMARY OF GROUNDWATER PERFORMANCE MONITORING PROGRAM

The First Quarter 2021 Groundwater Monitoring Event was conducted in accordance with requirements of the Consent Decree, CAP, and Groundwater Compliance Monitoring and Contingency Program (GWCMCP) (TechSolv, 1999) and per Ecology approved revisions included in the EDR and detailed below. The current groundwater monitoring schedule is summarized in Table 4. Plant 1 monitoring well locations are shown on Figure 2.

Wells MW-1-T9, MW-2-T9, MW-3-T9, and MW-4-T9 were installed along the southern property boundary of Plant 1 (Figure 2) in 2005 to evaluate groundwater trends due to cleanup level exceedances in Monitoring Well AR-03. These wells were monitored quarterly until 2018, which helped evaluate the effectiveness of the Inland SVE system in meeting cleanup objectives. In 2018, monitoring revisions (TechSolve, 2018) were approved by Ecology (Ecology 2018) to eliminate monitoring of Well MW-4-T9 and reduce the monitoring frequency of Wells AR-03, GM-15S, MW-1-T9, MW-2-T9, and MW-3-T9 from quarterly to semi-annual, with agreed contingency actions to resume quarterly monitoring if cleanup levels are exceeded in these wells.

Well GM-14S was historically used to monitor for sheens on groundwater, as discussed below. As sheens are no longer detected in GM-14S, quarterly groundwater monitoring for indicator hazardous substances (IHSs) was initiated in this well in 2007.

Wells GM-16S and GM-17S are hydraulically upgradient from Plant 1. Monitoring of these wells was discontinued with approval from Ecology in March 2000 (Ecology, 2000a), as sufficient upgradient data had been collected. Monitoring was reinitiated in 2007 for potential petroleum hydrocarbon migration onto the property from upgradient, off-site sources. Revisions to the groundwater monitoring program, approved by Ecology in 2009 (Ecology, 2009), reduced the monitoring frequency of Wells GM-16S and 17S from quarterly to semi-annual as total petroleum hydrocarbons (TPH) and benzene detections had remained consistently below cleanup levels.

Voluntary monitoring for carcinogenic polynuclear aromatic hydrocarbons (cPAHs) was set to an annual basis in waterfront confirmational wells (AMW-01 through AMW-05) as extensive sampling has shown no significant detection trends. Sampling for cPAHs was last conducted in December 2020, as detailed in the 2020 Annual Site Report (TechSolve, 2021).

Wells monitored on a semi-annual basis are sampled in the first and third quarter, which typically correspond with seasonal groundwater highs and lows, respectively. As such, Wells AR-03, GM-15S, GM-16S, GM-17S, MW-1-T9, MW-2-T9, and MW-3-T9 were sampled in the first quarter of 2021. These wells will next be sampled in the third quarter of 2021.

The First Quarter 2021 Groundwater Monitoring event was conducted March 10th and 11th, 2021. Overall, first quarter 2021 groundwater elevations (Table 5) were higher than elevations measured in the third and fourth quarters of 2020. These data indicate that the seasonal groundwater high occurred in early 2021, corresponding with historic trends showing groundwater elevations rising to seasonal highs in the winter and spring and falling to seasonal lows in the summer and autumn.

First Quarter 2021 Groundwater Monitoring Event samples were submitted to ALS Laboratories of Everett, Washington (Ecology Accreditation # C601) for laboratory analysis of IHSs identified in the CAP. The IHSs include TPH as gasoline (TPH-G), TPH as diesel (TPH-D), TPH as oil (TPH-O), and benzene.

Petroleum hydrocarbon monitoring results for the First Quarter 2021 Groundwater Monitoring Event are included in Table 6 and Figure 2. The only detection of an IHS (benzene, TPH-G, TPH-D, or TPH-O) above a cleanup level was gasoline (TPH-G) in well GM-24S. Concentrations of IHSs from all other samples analyzed were below associated cleanup levels. Data trend evaluations will be presented in the 2021 Annual Site Report, in accordance with Consent Decree requirements.

Three wells (GM-11S, GM-12S, and GM-13S) have been examined monthly for the presence of LNAPL (free product) and sheens. LNAPL and sheen monitoring results are presented in Table 7. Historically, gauging for free LNAPL at Plant 1 was conducted at four wells; however, gauging of Well GM-14S was discontinued in 2004, with concurrence from Ecology (Ecology, 2004c), and converted to a monitoring well in 2007, as it has been free of LNAPL since 1999.

No sheen or measurable LNAPL have been detected in Wells GM-11S, GM-12S, and GM-13S in 2021. LNAPL and sheen monitoring for 2020 and 2019 (TechSolve, 2021) indicate that these wells met both the GWCMCP's LNAPL performance standard of no measurable LNAPL and the LNAPL cleanup standard for confirmational monitoring of no visible sheen for 1 year. The GWCMCP stipulates that once the performance standard is met in these wells, groundwater shall be sampled for concentrations of IHSs. As such, these wells are being evaluated for addition to the quarterly IHS monitoring program. These three wells will continue to be gauged for sheen and LNAPL in 2021, until Ecology concurs that the GWCMCP product performance standard has been met.

4. SUMMARY OF DATA VALIDATION

Laboratory analytical results were reported with associated laboratory quality assurance/quality control data (QA/QC). Analytical reports were reviewed, and data were validated. During this quarter, limited data were qualified with a J (the associated value is approximate) qualifier. A summary of data qualified during validation, qualifiers assigned, and reasons for data qualification are provided in Table 8. All laboratory reports are retained by TechSolve.

5. ADDITIONAL ACTIVITIES

The field work detailed in a hydraulic evaluation work plan (TechSolve, 2019) was performed in the first and second quarter of 2021. This hydraulic evaluation is intended to determine how a new seawall, installed along the Plant 1 waterfront in 2018, may have affected site hydrology. The evaluation is intended to satisfy an Ecology request (Ecology, 2015).

The work plan proposed conducting a background water level assessment as the first step in satisfying a regulatory driven evaluation. Following negotiations, Ecology approved the background water level assessment to proceed in March 2021, given that several additions and alterations to the work plan were implemented. Ecology noted in their approval that there were additional expectations and caveats related to the work that remain unresolved (Ecology, 2021).

As part of Ecology's approval to proceed with the hydraulic evaluation, three additional wells (GM-14D, HMW-01D, and HMW-01S) were agreed to be drilled, developed, and added to the Hydraulic Evaluation Well Network (Figure 3). The wells were installed and developed in March and April of 2021, respectively. Boring logs for these new wells are included in Appendix A.

The groundwater/LNAPL Recovery system was shut down for the initial portion of the study to allow water levels to equilibrate to natural conditions. Field data was collected from the Hydraulic Evaluation Well Network from late April through Early May 2021. Aqua TROLL 200 data loggers were setup and installed in the wells in late April. Pressure and salinity data were collected by the data logger on 10-minute intervals over a three-week period. Field gauging of water levels was conducted throughout the study to check instrument accuracy and verify readings. Field monitoring for measurable LNAPL and sheen in accessible recovery wells was also conducted during the period of groundwater/LNAPL recovery system shutdown, as detailed in Section 2.1.1. Data is currently being evaluated and findings will be documented to Ecology in a forthcoming report.

6. SUMMARY

This report summarizes operation of remediation systems during the second quarter of 2021 (April through June 2021) and the First Quarter 2021 Groundwater Monitoring Event. In accordance with the Consent Decree, the Third Quarter 2021 Progress Report / Second Quarter 2021 Groundwater Monitoring Report will be the next report submitted to Ecology. This report will be submitted to Ecology by October 15, 2021.

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TABLES

Table 1. Waterfront Groundwater System Petroleum Hydrocarbon Recovery Rates
Site: Former BP Harbor Island Terminal

GROUNDWATER SYSTEM EFFICIENCIES

SAMPLE DATE	UNITS	Influent Benzene	Effluent Benzene	% Reduction	Influent Diesel	Effluent Diesel	% Reduction	Influent Ethylbenzene	Effluent Ethylbenzene	% Reduction	Influent Gasoline	Effluent Gasoline	% Reduction	Influent Oil	Effluent Oil	% Reduction	Influent Toluene	Effluent Toluene	% Reduction	Influent Xylenes	Effluent Xylenes	% Reduction
2002 Averages	µg/L	225.3	14.3	91%	7,315	7,020	4%	55.2	6.2	75%	1,770	336	82%	831	804	5%	17.0	2.5	88%	88.8	9.9	87%
2003 Averages	µg/L	137.7	19.5	76%	4,945	4,648	-1%	44.5	12.9	69%	1,854	678	62%	760	763	0%	42.7	5.4	61%	154.1	50.3	68%
2004 Averages	µg/L	93.5	3.2	82%	10,285	9,342	-6%	76.8	4.7	79%	4,383	840	59%	762	1,026	-8%	116.6	2.2	82%	356.6	23.0	75%
2005 Averages	µg/L	76.7	14.5	84%	4,162	5,987	-9%	170.8	45.4	81%	10,090	3,229	70%	864	750	15%	566.9	121.0	84%	1,327.7	367.9	78%
2006 Averages	µg/L	38.9	1.2	89%	11,263	2,174	42%	42.1	0.9	90%	4,944	202	94%	665	666	0%	55.6	0.8	77%	485.1	5.2	96%
2007 Averages	µg/L	8.8	1.5	60%	1,223	906	18%	6.6	0.8	56%	407	115	63%	598	598	0%	1.0	0.5	21%	19.8	1.9	50%
2008 Averages	µg/L	10.0	1.1	70%	540	468	6%	5.5	0.7	39%	279	76	61%	505	504	0%	0.7	0.5	40%	10.6	1.6	65%
2009 Averages	µg/L	5.2	1.0	48%	369	561	8%	4.1	1.6	31%	407	182	46%	497	489	2%	0.8	0.7	44%	15.2	7.4	33%
2010 Averages	µg/L	3.9	0.7	76%		2,193	*NA*	6.8	1.7	78%	915	336	*65%*		*410*	*NA*	*0.9*	*0.9*	*NA*	26.3	6.7	69%
2011 Averages	µg/L	3.2	0.5	80%		1,714	*NA*	2.4	1.0	53%	439	89	*69%*		*492*	*NA*	*1.0*	*1.0*	*NA*	7.1	3.0	29%
2012 Averages	µg/L	3.6	1.3	48%		2,787	*NA*	1.9	1.2	37%	362	144	*61%*		*636*	*NA*	*1.0*	*1.0*	*NA*	5.7	3.4	48%
2013 Averages	µg/L	1.0	0.5	45%		1,333	*NA*	1.1	0.5	49%	356	124	*57%*		*433*	*NA*	*0.5*	*0.5*	*NA*	2.4	1.0	78%
2014 Averages	µg/L	1.7	0.3	61%		1,699	*NA*	0.6	0.3	46%	539	122	*79%*		*236*	*NA*	*0.5*	*0.3*	*NA*	1.5	0.5	61%
2015 Averages	µg/L	2.3	0.4	66%		5,175	*NA*	1.6	0.4	60%	1,146	406	*64%*		*396*	*NA*	*0.5*	*0.4*	*NA*	2.8	0.5	74%
2016 Averages	µg/L	2.2	0.6	76%		2,292	*NA*	2.3	0.5	81%	1,282	582	*50%*		*248*	*NA*	*0.4*	*0.4*	*NA*	2.9	1.0	62%
2017 Averages	µg/L	1.9	0.4	74%		4,325	*NA*	1.0	0.4	63%	1,421	641	*56%*		*349*	*NA*	*0.5*	*0.4*	*NA*	1.0	0.7	55%
2018 Averages	µg/L	1.1	0.7	60%		1,673	*NA*	0.7	0.7	7%	359	136	*62%*		*346*	*NA*	*0.5*	*0.5*	*NA*	1.3	0.9	30%
2019 Averages	µg/L	0.5	0.4	50%		1,539	*NA*	0.7	0.7	NA	231	68	*60%*		*584*	*NA*	*0.7*	*0.7*	*NA*	2.0	2.0	NA
2020 Averages	µg/L	0.7	*0.5*	*NA*		588	*NA*	*1.0*	*1.0*	*NA*	100	51	*65%*		*750*	*NA*	*1.0*	*1.0*	*NA*	*3.0*	*3.0*	*NA*
1/21/2021	µg/L	1.80	*0.50*	*NA*		3,900	*NA*	*1.00*	*1.00*	*NA*	140	*50*	*NA*		*750*	*NA*	*1.00*	*1.00*	*NA*	*3.00*	*3.00*	*NA*
2/18/2021	µg/L	9.50	*0.50*	*NA*		1,000	*NA*	*1.00*	*1.00*	*NA*	170	*50*	*NA*		*750*	*NA*	*1.00*	*1.00*	*NA*	6.60	*3.00*	*NA*
3/18/2021	µg/L	0.71	*0.50*	*NA*		610	*NA*	*1.00*	*1.00*	*NA*	78	*50*	*NA*		*750*	*NA*	*1.00*	*1.00*	*NA*	*3.00*	*3.00*	*NA*
4/15/2021	µg/L	0.80	*0.50*	*NA*		560	*NA*	*1.00*	*1.00*	*NA*	200	*50*	*NA*		*750*	*NA*	*1.00*	*1.00*	*NA*	*3.00*	*3.00*	*NA*
5/20/2021	µg/L	*0.50*	*0.50*	*NA*		260	*NA*	*1.00*	*1.00*	*NA*	97	*50*	*NA*		*750*	*NA*	*1.00*	*1.00*	*NA*	*3.00*	*3.00*	*NA*
6/24/2021	µg/L	*0.50*	*0.50*	*NA*		*250*	*NA*	*1.00*	*1.00*	*NA*	140	*50*	*NA*		*750*	*NA*	*1.00*	*1.00*	*NA*	*3.00*	*3.00*	*NA*
SURFACE WATER CLEANUP LEVELS		71 µg/L			10,000 µg/L			NA			1,000 µg/L			10,000 µg/L			NA			NA		
KCDNR DISCHARGE LIMITS			70 µg/L			100,000 µg/L			1,700 µg/L			NA			100,000 µg/L			1,400 µg/L			NA	
2019 Averages:		2.3 µg/L	.5 µg/L	#DIV/0!	NA	1,097 µg/L	NA	1. µg/L	1. µg/L	*NA*	138 µg/L	50 µg/L	#DIV/0!	NA	750 µg/L	NA	1. µg/L	1. µg/L	NA	3.6 µg/L	3. µg/L	*NA*

METRO DISCHARGE DATA

Observation Date	Days since last monitoring reading	Average flow (GPM)	Total Flow Between Observation dates (gallons)	Pounds of Benzene Removed	Pounds of Gasoline Removed	Pounds of Diesel Removed	Pounds of Oil Removed	Pounds of Toluene Removed	Pounds of Ethylbenzene Removed	Pounds of Xylenes Recovered	Total Gallons Gas, Diesel, and Oil
2002 Totals and Averages	65	4.18	322,785	0.62	4.99	19.42	2.30	0.05	0.13	0.22	**3.90**
2003 Totals and Averages	361	8.03	4,114,867	4.43	62.20	169.14	26.05	1.18	1.47	5.05	**37.76**
2004 Totals and Averages	338	9.58	4,570,461	3.54	175.70	419.25	28.95	5.35	3.16	14.66	**92.43**
2005 Totals and Averages	359	11.17	5,827,144	3.43	447.43	155.78	41.55	25.29	7.69	59.98	**100.52**
2006 Totals and Averages	365	6.40	3,220,733	0.80	192.72	663.65	19.09	2.85	1.89	20.04	**128.92**
2007 Totals and Averages	360	3.17	1,599,607	0.15	9.08	18.30	8.40	0.02	0.11	0.48	**5.20**
2008 Totals and Averages	363	3.19	1,645,810	0.14	3.95	7.21	6.95	0.01	0.08	0.15	**2.59**
2009 Totals and Averages	369	2.98	1,569,390	0.07	5.75	7.81	6.40	0.01	0.06	0.22	**2.89**
2010 Totals and Averages	372	2.17	1,185,127	0.037	8.62	18.84	4.26	0.01	0.05	0.19	**4.66**
2011 Totals and Averages	356	1.90	949,880	0.026	5.13	17.55	3.54	0.01	0.03	0.13	**3.81**
2012 Totals and Averages	371	1.89	948,600	0.034	3.97	25.92	3.47	0.01	0.02	0.04	**4.81**
2013 Totals and Averages	365	1.33	700,450	0.014	2.26	8.80	3.43	0.003	0.01	0.02	**2.08**
2014 Totals and Averages	332	1.62	761,480	0.010	3.43	10.95	1.55	0.003	0.00	0.01	**2.33**
2015 Totals and Averages	358	1.71	874,680	0.015	6.56	36.53	2.92	0.004	0.01	0.02	**6.68**
2016 Totals and Averages	370	1.90	999,770	0.021	13.12	20.02	1.94	0.004	0.03	0.03	**5.26**
2017 Totals and Averages	364	1.65	866,030	0.014	11.96	33.39	2.62	0.004	0.01	0.01	**7.52**
2018 Totals and Averages	371	1.20	641,740	0.006	2.16	9.61	1.79	0.002	0.004	0.007	**1.96**
2019 Totals and Averages	357	1.26	611,500	0.002	1.30	8.72	2.89	0.003	0.003	0.009	**1.84**
2020 Totals and Averages	378	1.06	572,320	0.003	0.46	2.70	3.58	0.005	0.005	0.014	**0.93**
January-21	43	1.44	60,290	0.0010	0.07	1.21	0.38	0.0005	0.0005	0.0015	**0.23**
February-21	28	1.28	51,720	0.0024	0.07	1.06	0.32	0.0004	0.0004	0.0021	**0.20**
March-21	33	0.95	38,490	0.0016	0.04	0.26	0.24	0.0003	0.0003	0.0015	**0.08**
April-21	30	0.91	36,890	0.0002	0.04	0.18	0.23	0.0003	0.0003	0.0009	**0.06**
May-21	35	0.35	17,770	0.0001	0.02	0.06	0.11	0.0001	0.0001	0.0004	**0.03**
June-21	21	0.77	39,040	0.0002	0.04	0.08	0.24	0.0003	0.0003	0.0010	**0.05**
2021 Totals and Averages	190	0.95	244,200	0.006	0.28	2.85	1.53	0.002	0.002	0.007	**0.65**
		TOTALS:	**32,226,574 gal**	**13.4**	**961.1**	**1656.4**	**173.2**	**34.8**	**14.8**	**101.3**	
	Maximum permitted GPM:	**17.5**	**Gallons Gas, Diesel, & Oil Recovered:**	**156.3**	**237.3**	**22.7**		**TOTAL GALLONS RECOVERED:**			**416.73**

Oil Water Separator Data

Observation Date	Monthly LNAPL Recovery (gal)
February-03	19.6
April-03	6.9
May-03	2.5
July-03	2
December-03	20
January-04	25
June-04	35
August-04	50
September-04	8
November-04	10
December-04	3.5
January-05	0
February-05	35
July-05	110
February-06	5
March-06	2
December-06	30
March-08	30
Total Gallons LNAPL Recovered	**395**

TOTAL PETROLEUM RECOVERY	
Total lbs. Dissolved Gas, Diesel, and Oil Recovered in Groundwater (2002-Present)	2,791 lbs
Total Gallons Dissolved Gas, Diesel, and Oil Recovered in Groundwater (2002-Present)*	**417 gal**
Total Gallons LNAPL Recovered by Final Recovery System (2002-Present)	**395 gal**
Total Gallons LNAPL Recovered by Interim Recovery System (1992-2002)	**9,312 gal**
Total Gallons of TPH Vapor Recovered by Final SVE System (2003-2008)**	**2,334 gal**
Total Gallons of TPH Vapor Recovered by Interim SVE System (1996-2002)**	**1,248 gal**
Total Gallons TPH Recovered from Final SVE System due to Biodegradation (2003-2008)***	**11,411 gal**
Total Gallons TPH Recovered from Interim SVE System due to Biodegradation (1996-2002)***	**4,664 gal**
Total Gallons Recovered by Final Recovery Systems (2002-Present)	**14,557 gal**
Total Gallons Recovered by Interim Recovery Systems (1992-2002)	**15,223 gal**
Total Gallons of Petroleum Removed (1992-Present)	**29,781 gal**

Definitions:

gal - gallons
GPM - Gallons per minute
NA - Not available
LNAPL - Light non-aqueous phase liquid (oil)
SVE - Soil vapor extraction
TPH - Total petroleum hydrocarbons
µg/L - micrograms per liter

Notes:

LNAPL Recovery is recorded periodically when sufficient product has been accumulated to be transported off-site for disposal.
Influent diesel and oil samples are no longer analyzed, as influent and effluent samples are collected before and after, respectively, a diffused air stripper, which is not intended or effective at removing diesel or oil.
Effluent sample data are representative of the outflow water to King County Metro sanitary sewer.
The average µg/L of the preceding month and the month of reference are used to calculate pounds of compound removed.
Data presented in *italicized text* represent non-detections. The *italicized result* is reported at the laboratory reporting limit
If influent concentrations are below the laboratories reporting limit, the percent reduction is calculated using the reporting limit. The actual percent reduction is ≥ the reported value.

* Calculation of lbs. of Recovered Product:
To convert µg/L to lbs./gallon - (µg/L)x(3.785l/gal)=ug/gal, (ug/gal)x(ug/(2.2046x10-9lbs))=lbs./gal
lbs./gal of chemical constituent x total gallons recovered =lbs. of chemical recovered
Density of Gasoline utilized for conversions from pounds to gallons is 6.15 lbs./gal
Density of Diesel utilized for conversions from pounds to gallons 6.98 lbs./gal
Density of Oil utilized for conversions from pounds to gallons 7.63 lbs./gal
Benzene, toluene, ethylbenzene, and xylenes volumes are not included in the Total Gallons calculations, as they are assumed to be included in TPH as gasoline.

** / *** SVE Recovery Calculations for TPH and Biodegradation, which are maintained in separate tables.

C = Average Influent TPH concentration (ppmv)
Q = Influent Flow Rate (SCFM)
Mc = Molecular wt. of Carbon Dioxide = 44
Mg = Molecular wt. of Gasoline = 87
Density of Gasoline for conversions is 6.15 lbs./gal

** TPH recovered by SVE system was calculated in lbs./hr. = C x Q x Mg x 1.583 x 10^{-7}
1.583 x 10^{-7} is a constant and is derived as follows:
10^{-6} ppmv x 60min/1hr x 1 lb. Mole/379 cu.ft.

Table 2. Groundwater/LNAPL Recovery Well Performance Monitoring
June 2021
Site: Former BP Harbor Island Terminal

Well	Date	Measurable LNAPL (>0.01')	Sheen on Groundwater (No, SS, MS, HS)	TPH-G WTPH-G (mg/L)	TPH-D WTPH-DX (mg/L)	TPH-O WTPH-DX (mg/L)	Benzene (µg/L)
RW-1	6/16/2021	No	None	0.11	0.29	ND	ND
RW-2	6/16/2021	No	**SS**	**2.5**	**200**	<38	11.0
RW-4	6/16/2021	No	**SS**	**2.4**	**47**	<15	15.0
RW-5	6/16/2021	No	None	0.25	0.38	ND	1.50
RW-6	6/16/2021	No	None	ND	0.32	ND	ND
RW-7	6/16/2021	No	None	ND	0.67	ND	ND
RW-8	6/16/2021	No	None	0.11	2.10	ND	ND
RW-9	6/16/2021	No	None	ND	**66**	<19	ND
RW-10	6/16/2021	No	None	0.077	1.60	0.79	ND
GM-11S	6/16/2021	No	None	0.95	2.7	ND	2.9
Cleanup Level		No (<0.01')	No Sheen*	1*	10*	10*	71*
Method Reporting Limit				0.05	0.25	0.75	0.5

Note: * Listed cleanup levels and values in **bold** that exceed these levels are applicable at conditional points of compliance (CPoCs). Recovery wells are not CPoCs for parameters with a " * " and values above listed cleanup levels are not exceedances.

mg/L Milligrams per liter.

µg/L Micrograms per liter.

ND Constituent not detected above reporting limit. A less than sign (<) preceeding a value indicates a ND at the listed value.

TPH Total petroleum hydrocarbons.

TPH-D Total petroleum hydrocarbons as diesel.

TPH-G Total petroleum hydrocarbons as gasoline.

TPH-O Total petroleum hydrocarbons as oil.

WTPH-DX Washington State Method for Analysis of Diesel in Soil and Water - Extended.

WTPH-G Washington State Method for Analysis of Gasoline in Soil and Water.

SS Slight sheen observed on groundwater.

MS Meduim sheen obaserved on groundwater.

HS Heavy sheen observed on groundwater.

Table 3. System Shutdown Groundwater/LNAPL Recovery Well Product Monitoring
April & May 2021
Site: Former BP Harbor Island Terminal

Well	Date	Measurable LNAPL (>0.01')	Sheen on Groundwater (No, SS, MS, HS)
RW-1	4/29/2021	No	No
RW-1	5/4/2021	No	No
RW-1	5/7/2021	No	No
RW-1	5/11/2021	No	No
RW-2	4/29/2021	No	**MS**
RW-2	5/4/2021	No	**MS**
RW-2	5/7/2021	No	**MS**
RW-2	5/11/2021	No	No
RW-4	4/29/2021	No*	**HS***
RW-4	5/4/2021	No*	**HS***
RW-4	5/7/2021	No*	**HS***
RW-4	5/11/2021	No*	**SS***
RW-5	Not Accessible. Well was part of hydraulic evaluation transducer study.		
RW-6	Not Accessible. Well was part of hydraulic evaluation transducer study.		
RW-7	4/29/2021	No	No
RW-7	5/4/2021	No	No
RW-7	5/7/2021	No	No
RW-7	5/11/2021	No	No
RW-8	4/29/2021	No	No
RW-8	5/4/2021	No	No
RW-8	5/7/2021	No	No
RW-8	5/11/2021	No	No
RW-9	4/29/2021	No	**SS**
RW-9	5/4/2021	No	**SS**
RW-9	5/7/2021	No	**SS**
RW-9	5/11/2021	No	No
RW-10	Not Accessible. Well was part of hydraulic evaluation transducer study.		
GM-11S	Not Accessible. Well was part of hydraulic evaluation transducer study.		
Cleanup Level		No	No[(1)]

Note:
[(1)] The cleanup criterion for no sheen on groundwater is applicable at conditional points of compliance (CPoCs) only. Recovery wells are not CPoCs. Sheen detections in recovery wells do not represent an exceedance of the sheen criterion.

* Sorbent sock maintained in RW-4 during study due to presence of LNAPL film, which was too thin to measure (i.e., <0.01' thick).

SS Slight sheen observed on groundwater.

MS Meduim sheen obaserved on groundwater.

HS Heavy sheen observed on groundwater.

Table 4. Groundwater Performance Monitoring Schedule
Site: Former BP Harbor Island Terminal

	Analyses Conducted by Quarter			
Well	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Plant 1				
MW-1-T9	Benzene, TPH-G, TPH-D, TPH-O	(1)	Benzene, TPH-G, TPH-D, TPH-O	(1)
MW-2-T9	Benzene, TPH-G, TPH-D, TPH-O	(1)	Benzene, TPH-G, TPH-D, TPH-O	(1)
MW-3-T9	Benzene, TPH-G, TPH-D, TPH-O	(1)	Benzene, TPH-G, TPH-D, TPH-O	(1)
GM-14S	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O
GM-15S	Benzene, TPH-G, TPH-D, TPH-O	(1)	Benzene, TPH-G, TPH-D, TPH-O	(1)
GM-16S	Benzene, TPH-G, TPH-D, TPH-O		Benzene, TPH-G, TPH-D, TPH-O	
GM-17S	Benzene, TPH-G, TPH-D, TPH-O		Benzene, TPH-G, TPH-D, TPH-O	
GM-24S	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O
AR-03	Benzene, TPH-G, TPH-D, TPH-O	(1)	Benzene, TPH-G, TPH-D, TPH-O	(1)
AMW-01	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O, cPAHs
AMW-02	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O, cPAHs
AMW-03	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O, cPAHs
AMW-04	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O, cPAHs
AMW-05	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O	Benzene, TPH-G, TPH-D, TPH-O, cPAHs
Plant 2				
All Plant 2 monitoring has been discontinued.				

Notes: Field Duplicate and QA/QC samples collected from wells highlighted in bold.
TPH-G - Gasoline Range organics utilizing NWTPH-Gx method
TPH-D - Diesel Range Organics utilizing NWTPH-Dx
TPH-O - Extended Range Organics (Motor Oil) utilizing NWTPH-Dx
Benzene is analyzed for utilizing EPA 8021 or 8260B.
cPAHs - Carcinogenic Polycyclic Aromatic Hydrocarbons utilizing EPA 8270SIM
Field Parameters (pH, Temperature, Conductivity, Turbidity, Water Level, & Product Level) are recorded from all wells sampled
(1) - If a groundwater cleanup level exceedance occurs in first or third quarter in any of these highlighted wells, all (1) wells will be sampled the following quarter. Wells exceeding cleanup levels will continue quarterly monitoring until four consecutive quarters below cleanup level are achieved.

Table 5. Groundwater Performance Monitoring Groundwater Elevations
First Quarter 2021
Site: Former BP Harbor Island Terminal

Well	Date	TOC Elevation (ft msl)	Depth to Water (ft below TOC)	Groundwater Elevation (ft NGVD29)
Plant 1				
GM-14S	3/11/2021	8.57	3.66	4.91
GM-15S	3/10/2021	8.92	4.63	4.29
GM-16S	3/11/2021	8.53	4.18	4.35
GM-17S	3/11/2021	9.19	3.98	5.21
GM-24S	3/11/2021	7.62	2.74	4.88
AR-03	3/10/2021	9.35	5.23	4.12
AMW-01	3/10/2021	8.88	5.39	3.49
AMW-02	3/10/2021	12.14	9.13	3.01
AMW-03	3/10/2021	12.07	9.34	2.73
AMW-04	3/10/2021	8.00	4.94	3.06
AMW-05	3/10/2021	8.14	4.78	3.36
MW-1-T9	3/11/2021	9.07	4.99	4.08
MW-2-T9	3/11/2021	9.23	4.78	4.45
MW-3-T9	3/11/2021	8.73	4.54	4.19

Definitions and Notes:

ft	Feet
NA	Not available. Well elevations have not been surveyed.
NGVD 29	National Geodetic Vertical Datum of 1929
NM	Not measured. Well was not gauged or sampled due to inaccessibility caused by the Island redevelopment activities.
TOC	Top of casing

Table 6. Summary of Analytical Results for Groundwater - TPH-G, TPH-D, TPH-O, and Benzene
First Quarter 2021
Site: Former BP Harbor Island Terminal

Well	Date	TPH-G WTPH-G (µg/L)	TPH-D WTPH-DX (µg/L)	TPH-O WTPH-DX (µg/L)	Benzene (µg/L)
Plant 1					
GM-14S	3/11/2021	700	440	ND	ND
GM-15S	3/10/2021	ND	ND	ND	ND
GM-16S	3/11/2021	59	460	ND	ND
GM-17S	3/11/2021	ND	ND	ND	ND
GM-24S	3/11/2021	**2,300 J**	680 J	ND	0.59
AR-03	3/10/2021	ND	430	ND	ND
AMW-01	3/10/2021	ND	ND	ND	ND
AMW-02	3/10/2021	ND	ND	ND	0.94
AMW-03	3/10/2021	ND	ND	ND	ND
AMW-04	3/10/2021	ND	ND	ND	ND
AMW-05	3/10/2021	ND	ND	ND	ND
MW-1-T9	3/11/2021	170	330	ND	ND
MW-2-T9	3/11/2021	260	ND	ND	ND
MW-3-T9	3/11/2021	740	280	ND	ND
Cleanup Level		1,000	10,000	10,000	71
Method Reporting Limit		50	250	750	0.5

Note: Values in **bold** exceed the cleanup level.

µg/L Micrograms per liter.

ND Constituent not detected above reporting limit.

NR Not required. Well was not tested for these analyses, as per Ecology approval. redevelopment activities.

TPH Total petroleum hydrocarbons.

TPH-D Total petroleum hydrocarbons as diesel.

TPH-G Total petroleum hydrocarbons as gasoline.

TPH-O Total petroleum hydrocarbons as oil.

WTPH-DX Washington State Method for Analysis of Diesel in Soil and Water - Extended.

WTPH-G Washington State Method for Analysis of Gasoline in Soil and Water.

J Estimated value.

UJ Not detected at an estimated value.

R Rejected value.

Table 7. Summary of Free Product Measurement Results for Groundwater
2021 Monitoring Data
Site: Former BP Harbor Island Terminal

Well	Date	Free Product (feet)
Plant 1		
GM-11S	1/21/2021	None
GM-11S	2/18/2021	None
GM-11S	3/18/2021	None
GM-11S	4/15/2021	None
GM-11S	5/20/2021	None
GM-11S	6/24/2021	None
GM-12S	1/21/2021	None
GM-12S	2/18/2021	None
GM-12S	3/18/2021	None
GM-12S	4/15/2021	None
GM-12S	5/20/2021	None
GM-12S	6/24/2021	None
GM-13S	1/21/2021	None
GM-13S	2/18/2021	None
GM-13S	3/18/2021	None
GM-13S	4/15/2021	None
GM-13S	5/20/2021	None
GM-13S	6/24/2021	None
Cleanup Level		No Sheen

Notes: Values in **bold** exceed the cleanup level.

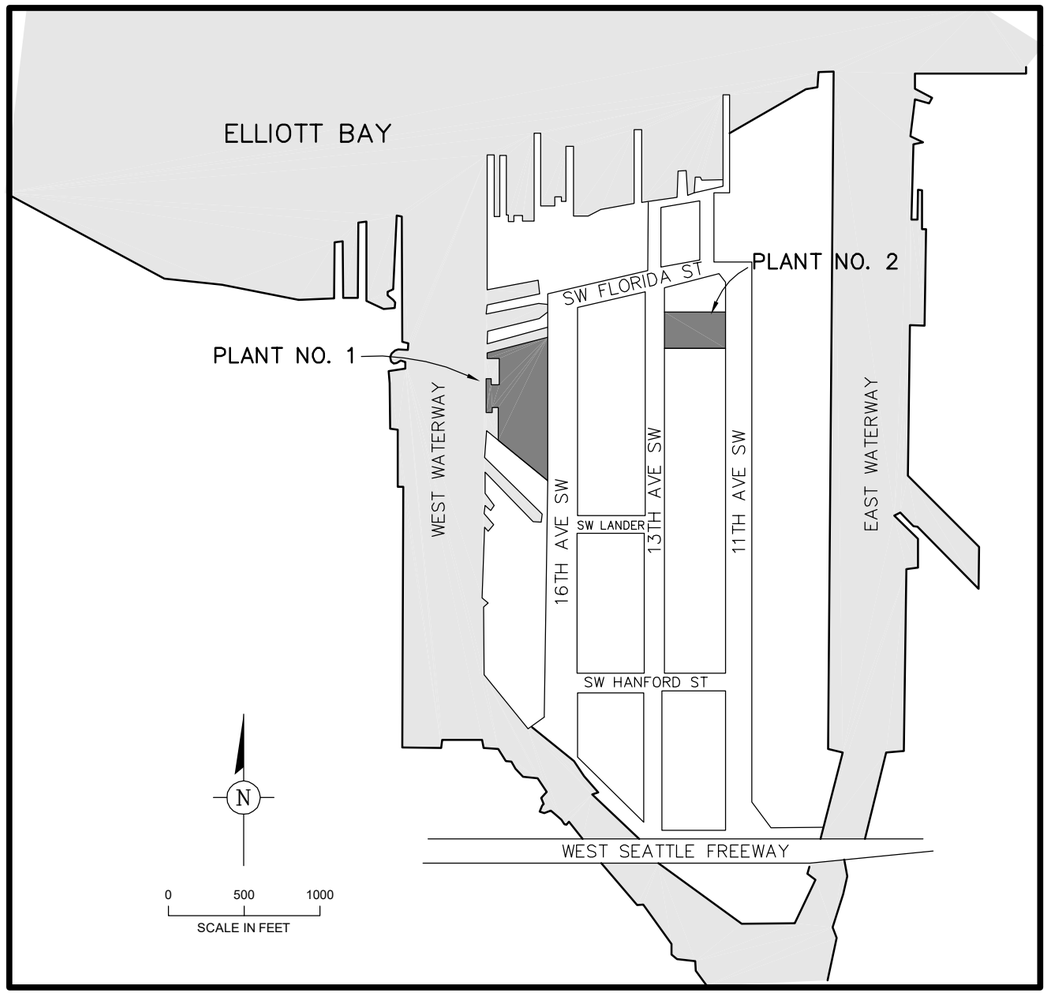
Table 8. Summary of Data Validation Results
Groundwater Performance Monitoring
First Quarter 2021
Site: Former BP Harbor Island Terminal

Sample ID	Constituent	Qualifier	Reason
P1-GWGM-24S-121 P1-GWGM-224S-121	Gasoline	J	The RPD for diesel in the field duplicate pair P1-GWGM-24S-120 / P1-GWGM-224S-121 is greater than 20%. Results for these samples are, therefore, qualified as estimated values (J).
P1-GWGM-24S-121 P1-GWGM-224S-121	Diesel	J	The RPD for diesel in the field duplicate pair P1-GWGM-24S-120 / P1-GWGM-224S-121 is greater than 20%. Results for these samples are, therefore, qualified as estimated values (J).

Definitions:
J The associated value is approximate.
RPD Relative Percent Difference

FIGURES

AREA PLAN



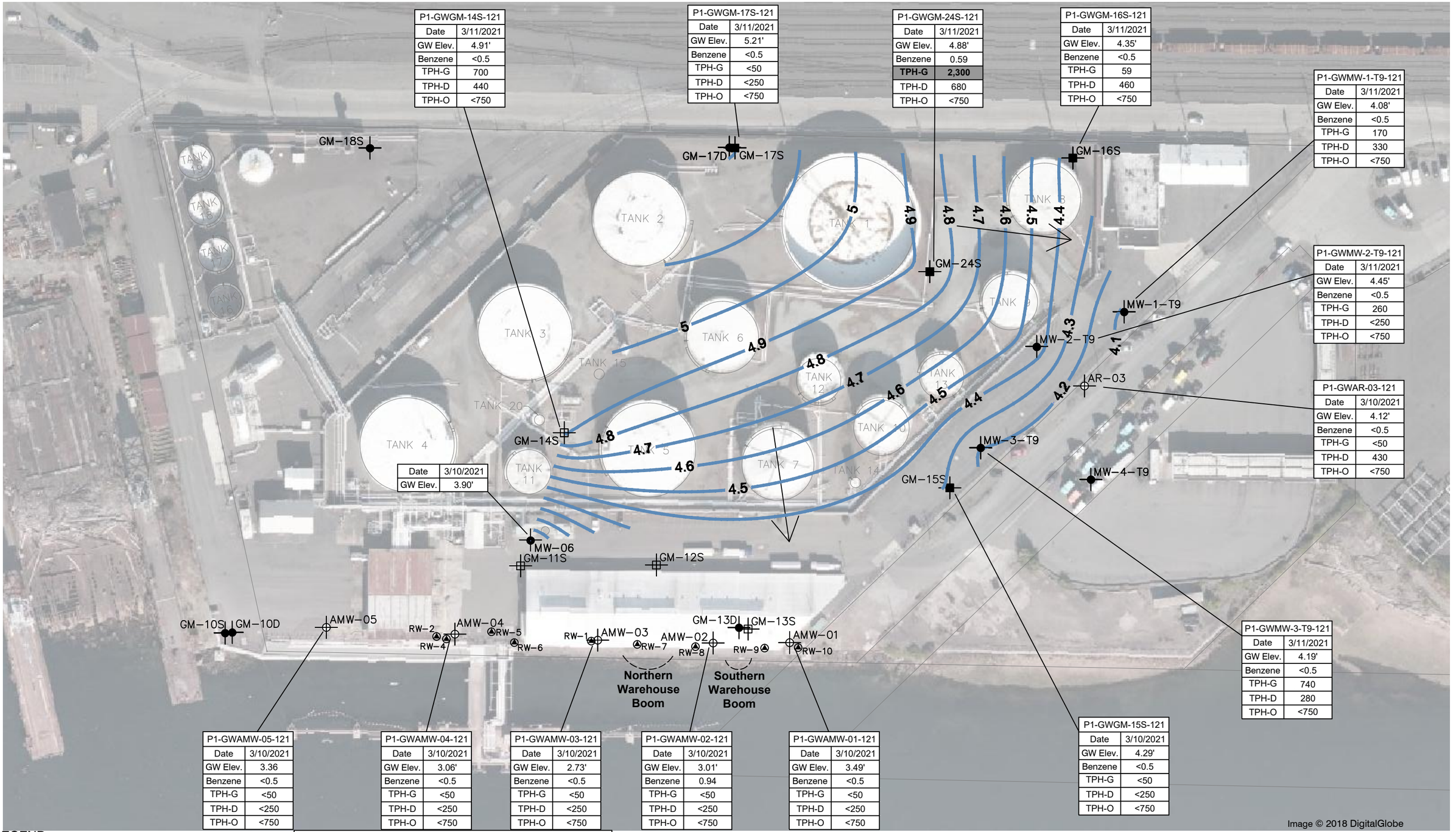
SITE PLAN

TECHSOLVE ENVIRONMENTAL
7518 NE 169th Street, Kenmore WA 98028
(425) 402-8277 FAX (425) 402-7917

Site Location Map

Site: Former BP Harbor Island Terminal
1652 Southwest Lander Street
Seattle, WA 98134

FIGURE
1



P1-GWGM-14S-121	
Date	3/11/2021
GW Elev.	4.91'
Benzene	<0.5
TPH-G	700
TPH-D	440
TPH-O	<750

P1-GWGM-17S-121	
Date	3/11/2021
GW Elev.	5.21'
Benzene	<0.5
TPH-G	<50
TPH-D	<250
TPH-O	<750

P1-GWGM-24S-121	
Date	3/11/2021
GW Elev.	4.88'
Benzene	0.59
TPH-G	**2,300**
TPH-D	680
TPH-O	<750

P1-GWGM-16S-121	
Date	3/11/2021
GW Elev.	4.35'
Benzene	<0.5
TPH-G	59
TPH-D	460
TPH-O	<750

P1-GWMW-1-T9-121	
Date	3/11/2021
GW Elev.	4.08'
Benzene	<0.5
TPH-G	170
TPH-D	330
TPH-O	<750

P1-GWMW-2-T9-121	
Date	3/11/2021
GW Elev.	4.45'
Benzene	<0.5
TPH-G	260
TPH-D	<250
TPH-O	<750

P1-GWAR-03-121	
Date	3/10/2021
GW Elev.	4.12'
Benzene	<0.5
TPH-G	<50
TPH-D	430
TPH-O	<750

Date	3/10/2021
GW Elev.	3.90'

P1-GWMW-3-T9-121	
Date	3/11/2021
GW Elev.	4.19'
Benzene	<0.5
TPH-G	740
TPH-D	280
TPH-O	<750

P1-GWAMW-05-121	
Date	3/10/2021
GW Elev.	3.36
Benzene	<0.5
TPH-G	<50
TPH-D	<250
TPH-O	<750

P1-GWAMW-04-121	
Date	3/10/2021
GW Elev.	3.06'
Benzene	<0.5
TPH-G	<50
TPH-D	<250
TPH-O	<750

P1-GWAMW-03-121	
Date	3/10/2021
GW Elev.	2.73'
Benzene	<0.5
TPH-G	<50
TPH-D	<250
TPH-O	<750

P1-GWAMW-02-121	
Date	3/10/2021
GW Elev.	3.01'
Benzene	0.94
TPH-G	<50
TPH-D	<250
TPH-O	<750

P1-GWAMW-01-121	
Date	3/10/2021
GW Elev.	3.49'
Benzene	<0.5
TPH-G	<50
TPH-D	<250
TPH-O	<750

P1-GWGM-15S-121	
Date	3/10/2021
GW Elev.	4.29'
Benzene	<0.5
TPH-G	<50
TPH-D	<250
TPH-O	<750

LEGEND

- GM-16S — Monitoring Well
- AMW-01 — Performance/Confirmation Well
- GM-13D — Performance Well
- GM-13S — Product Performance Well
- 3.1 — Groundwater Contour (Feet MSL)

Sample ID	
Date	Date Sample Collected
GW Elev.	Groundwater Elevation in Feet Mean Sea Level (MSL)
Benzene	Benzene (EPA 8260) in µg/L
TPH-G	Total Petroleum Hydrocarbons as Gasoline (NWTPH-GX) in µg/L
TPH-D	Total Petroleum Hydrocarbons as Diesel (NWTPH-DX) in µg/L
TPH-O	Total Petroleum Hydrocarbons as Oil (NWTPH-DX) in µg/L

Notes: **Bold** - Detected concentration exceeds site specific cleanup level
< = Not detected at listed laboratory reporting limit

N

0 50 100
SCALE IN FEET

TECHSOLVE ENVIRONMENTAL
7518 N.E. 169th Street
Kenmore, WA 98028
P:(425) 402-8277 F:(425) 402-7917

Plant 1 First Quarter 2021 Groundwater Monitoring Analytical Results

Site: Former BP Harbor Island Terminal
1652 Southwest Lander Street
Seattle, WA 98134

FIGURE
2

LEGEND

GM-16S	MONITORING WELL	RW-6	RECOVERY WELL
AMW-01	PERFORMANCE/CONFIRMATION WELL	SW-1	STILLING WELL
GM-13D	PERFORMANCE WELL	B-006	PIEZOMETER WELL
GM-13S	PRODUCT PERFORMANCE WELL		

N

0 50 100
SCALE IN FEET

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7518 N.E. 169th Street
Kenmore, WA 98028
P:(425) 402-8277 F:(425) 402-7917

Plant 1 Hydraulic Evaluation Transducer Study Wells

Site: BP Harbor Island Terminal
1652 Southwest Lander Street
Seattle, WA 98134

FIGURE
3

APPENDIX A

Boring Logs for New Wells GM-14D, HMW-01D, and HMW-01S

TECHSOLVE ENVIRONMENTAL

Soil Boring Log

Project Name and Location: **Former BP Harbor Island Terminal, Plant 1 1652 SW Lander Street, Seattle, WA 98134**	Boring Number: **GM-14D**	Page: **1** of **2**
	Contractor: **Cascade Drilling**	Drilling Method: **Hollow Stem Auger**
	Drill Crew: **J. Goble, C. Jones**	Drill Rig: **CME-75**
	Date Started: **3/26/2021**	Date Completed: **3/26/2021**
Surface Elevation: **11.71 feet (NAVD88)**	Logged by: **E. Lottsfeldt**	Protective Cover: **8" Morris Flush Mount Monument**
Top of Casing Elevation: **11.22 feet (NAVD88)**		
Surveyed Coordinates (NAD 83): Northing: **216080.4**	Easting: **1264432.8**	
Screened Interval (ft bgs): **35 - 40**	Screen: **5' - 2" dia. 010 Slot PVC**	Water Level While Drilling (ft bgs): **6'**
Filter Pack Interval (ft bgs): **33 - 41.5**	Riser: **35' - 2" dia. PVC**	
Seal Interval (ft bgs): **3 - 33**	Seal Type: **Bentonite Chips**	Water Level at Completion (ft bgs): **6'**
Grout Interval (ft bgs): **NA**	Filter Pack: **2/12 Sand**	

Depth (ft bgs)	Recovery(in.)	Blow Counts	Sample Interval	OVM/PID (ppm)	Sheen Test: NS: none, SS: slight, MS: moderate, HS: heavy	USCS Symbol	Well Construction	Sample Description: Lithology, color, constituents, density, moisture, other features, (interpretation)
1							Locking Cap	Crushed gravel, 6 inches.
2							Concrete / Monument	Soft clear with vacuum truck to 6 feet.
3							Well Casing 2" PVC	
4								
5		3				SP	8-Inch dia. Drilled Hole	Sand, dark gray, 100% fine to medium sand, loose, wet, moderate hydrocarbon odor, fill.
6	18"	3		12	HS	SP		
7		3				SP		
8							Bentonite Chips	
9								
10		3				SP		Same as above, mild hydrocarbon odor.
11	18"	4		70	HS	SP		
12		5				SP		
13								
14								
15		5				SP		Same as above, mild hydrocarbon odor.
16	18"	6		34	MS	SP		
17		7				SP		
18								
19								
20		6				SP		Same as above, mild hydrocarbon odor, native.
21	18"	7		5	SS	SP		
22		7				SP		

Project Name and Location: **Former BP Harbor Island Terminal, Plant 1 1652 SW Lander Street, Seattle, WA 98134**	Boring Number: **GM-14D**	Page: **2** of **2**

Depth (ft bgs)	Recovery(in.)	Blow Counts	Sample Interval	OVM/PID (ppm)	Sheen Test: NS: none, SS: slight, MS: moderate, HS: heavy	USCS Symbol	Well Construction	Sample Description: Lithology, color, constituents, density, moisture, other features, (interpretation)
23								
24								
25		7				SP	Well Casing 2" PVC	
26	18"	7		0	NS	SP		Same as above, very dark gray to black sand, trace shell fragments, slight hydrogen sulfide odor, native.
27		7				SP	8-Inch dia. Drilled Hole	
28								
29								
30		7				SP	Bentonite Chips	Same as above, trace shell fragments, no odor.
31	18"	8		0	NS	SP		
32		8				SP		
33								
34							Sand pack, 2/12	
35		6				SP		Same as above, slight hydrogen sulfide odor.
36	18"	8		0	NS	SP		
37		8				SP	Well Screen, 2" dia' 0.01-inch slot PVC	
38								
39								
40		6				SP		
41	18"	7		0	NS	SP	Threaded PVC end cap	Same as above, trace shell fragments, no odor.
42		6				SP		Bottom of hole at 41.5 feet below ground surface surface (bgs). Groundwater at 6 feet bgs.
43								
44								Blow counts taken using a 2.5-inch diameter split-spoon sampler driven with a 140-pound hammer falling from 30 inches.
45								Sampling method: Split Spoon.

TechSolve Environmental, Inc.
7518 NE 169th St
Kenmore, WA 98028
425-402-8277
Email: info@techsolveinc.com

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Soil Boring Log

Project Name and Location: **Former BP Harbor Island Terminal, Plant 1 1652 SW Lander Street, Seattle, WA 98134**	Boring Number: **HMW-01D**	Page: **1** of **2**
	Contractor: **Cascade Drilling**	Drilling Method: **Hollow Stem Auger**
	Drill Crew: **J. Goble, C. Jones**	Drill Rig: **CME-75**
	Date Started: **3/25/2021**	Date Completed: **3/25/2021**
Surface Elevation: **12.25 feet (NAVD88)**	Logged by: **E. Lottsfeldt**	Protective Cover: **12" HD Morrison Flush Mount Monument**
Top of Casing Elevation: **11.82 feet (NAVD88)**		
Surveyed Coordinates (NAD 83): Northing: **216489.2**	Easting: **1264227.8**	
Screened Interval (ft bgs): **35 - 40**	Screen: **5' - 2" dia. 010 Slot PVC**	Water Level While Drilling (ft bgs): **10'**
Filter Pack Interval (ft bgs): **33 - 41.5**	Riser: **35' - 2" dia. PVC**	
Seal Interval (ft bgs): **2 - 33**	Seal Type: **Bentonite Chips**	Water Level at Completion (ft bgs): **10'**
Grout Interval (ft bgs): **NA**	Filter Pack: **2/12 Sand**	

Depth (ft bgs)	Recovery(in.)	Blow Counts	Sample Interval	OVM/PID (ppm)	Sheen Test: NS: none, SS: slight, MS: moderate, HS: heavy	USCS Symbol	Well Construction	Sample Description: Lithology, color, constituents, density, moisture, other features, (interpretation)
1							Locking Cap	Asphalt (12 inches)
2							Concrete / Monument	Soft clear with vacuum truck to 6.5 feet. Large rocks and riprap drilled through to 10 feet.
3							Well Casing 2" PVC	
4								
5							8-Inch dia. Drilled Hole	
6								
7								
8							Bentonite Chips	
9								
10		6		0	NS	SP		Sand, dark gray, 95% fine to medium sand, 5% rounded gravel, medium dense, wet, no odor, fill.
11	18"	7		0	NS	SP		
12		6		0	NS	SP		
13								
14								
15		9		0	NS	SP		Same as above, 100% medium sand, 1" silt interbed, trace wood fragments, slight hydrogen sulfide odor, native soils.
16	18"	10		0	NS	SP		
17		10		0	NS	SP		
18								
19								
20		8		0	NS	SP		Same as above, trace shell fragments, moderate hydrogen sulfide odor.
21	18"	11		0	NS	SP		
22		11		0	NS	SP		

Project Name and Location: **Former BP Harbor Island Terminal, Plant 1 1652 SW Lander Street, Seattle, WA 98134**	Boring Number: **HMW-01D**	Page: **2** of **2**

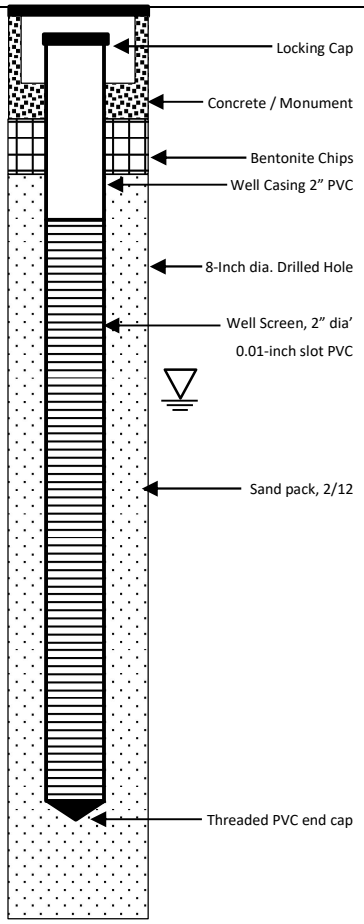
Depth (ft bgs)	Recovery(in.)	Blow Counts	Sample Interval	OVM/PID (ppm)	Sheen Test: NS: none, SS: slight, MS: moderate, HS: heavy	USCS Symbol	Well Construction	Sample Description: Lithology, color, constituents, density, moisture, other features, (interpretation)
23								
24								
25		8		0	NS	SP	Well Casing 2" PVC	Same as above, dark gray sand, 3" silt interbed, trace shell fragments, strong hydrogen sulfide odor.
26	18"	11		0	NS	SP		
27		11		0	NS	SP	8-Inch dia. Drilled Hole	
28								
29								
30		10		0	NS	SP	Bentonite Chips	Same as above, dark gray, 100% fine to medium sand, no shells, no odor
31	18"	12		0	NS	SP		
32		14		0	NS	SP		
33								
34							Sand pack, 2/12	
35		11		0	NS	SP		Same as above, dark gray to black, 100% fine to medium sand.
36	18"	13		0	NS	SP		
37		15		0	NS	SP	Well Screen, 2" dia' 0.01-inch slot PVC	
38								
39								
40		12		0	NS	SP		
41	18"	15		0	NS	SP	Threaded PVC end cap	Same as above, 3" silt interbed.
42		15		0	NS	SP		Bottom of hole at 41.5 feet below ground surface surface (bgs). Groundwater at 10 feet bgs.
43								
44								Blow counts taken using a 2.5-inch diameter split-spoon sampler driven with a 140-pound hammer falling from 30 inches.
45								Sampling method: Split Spoon.

TechSolve Environmental, Inc.
7518 NE 169th St
Kenmore, WA 98028
425-402-8277
Email: info@techsolveinc.com

TECHSOLVE ENVIRONMENTAL

Soil Boring Log

Project Name and Location: **Former BP Harbor Island Terminal, Plant 1 1652 SW Lander Street, Seattle, WA 98134**	Boring Number: **HMW-01S**	Page: **1** of **1**
	Contractor: **Cascade Drilling**	Drilling Method: **Hollow Stem Auger**
	Drill Crew: **J. Goble, C. Jones**	Drill Rig: **CME-75**
	Date Started: **3/25/2021**	Date Completed: **3/25/2021**
Surface Elevation: **12.15 feet (NAVD88)**	Logged by: **E. Lottsfeldt**	Protective Cover: **12" HD Morrison Flush Mount Monument**
Top of Casing Elevation: **11.78 feet (NAVD88)**		
Surveyed Coordinates (NAD 83): Northing: **216484.5**	Easting: **1264228.7**	
Screened Interval (ft bgs): **4-14**	Screen: **10' – 2" dia. 010 Slot PVC**	Water Level While Drilling (ft bgs):
Filter Pack Interval (ft bgs): **3-14**	Riser: **4' – 2" dia. PVC**	**7'**
Seal Interval (ft bgs): **2-3**	Seal Type: **Bentonite Chips**	Water Level at Completion (ft bgs):
Grout Interval (ft bgs): **NA**	Filter Pack: **2/12 Sand**	**7'**

Depth (ft bgs)	Recovery (in.)	Blow Counts	Sample Interval	OVM/PID (ppm)	Sheen Test: NS: none, SS: slight, MS: moderate, HS: heavy	USCS Symbol	Well Construction	Sample Description: Lithology, (USCS), color, constituents, density, moisture, other features, (interpretation)
1								Asphalt (12 inches)
2								Soft clear with vacuum truck to 7 feet.
3								
4								
5		2		0	NS	SP		Poorly graded sand, dark gray, 100% fine to medium sand, loose, wet, interbedded silt lens, fill.
6	18"	2		0	NS	SP		
7		3		0	NS	SP		
8								
9								
10		6		0	NS	SP		Same as above, transition to medium sand, trace shell fragments at 11 feet, native.
11	18"	7		0	NS	SP		
12		7		0	NS	SP		
13								
14								
15		7		0	NS	SP		Same as above, fine to medium sand, trace wood and shell fragments, ½ inch silt lens.
16	18"	9		0	NS	SP		
17		9		0	NS	SP		Bottom of hole at 16.5 feet below ground surface (bgs). Groundwater encountered at 7 feet bgs.
18								
19								Blow counts taken using a 2.5-inch diameter split-spoon sampler driven with a 140-pound hammer falling from 30 inches
20								
21								Sampling method: Split Spoon.
22								