Final Bremerton Gasworks Targeted Brownfields Assessment Report Bremerton, Washington

Technical Direction Document Number: 07-01-0008

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Prepared for:
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by:

ECOLOGY AND ENVIRONMENT, INC.
720 Third Avenue, Suite 1700
Seattle, Washington 98104

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List of Abbreviations and Acronyms

Acronym	Definition
AET	Apparent Effects Threshold
ARCO	Atlantic Richfield Company
AST	Aboveground storage tank
BAPE	Benzo(a)pyrene Equivalency
bgs	below ground surface
CLP	Contract Laboratory Program
E & E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
GPS	Global Positioning System
MCL	Maximum Contaminant Levels
mg/kg	milligram per kilogram
MTCA	Model Toxics Control Act
MW	Monitoring Well
NOAA	National Oceanic and Atmospheric Administration
PAHs	Polycyclic Aromatic Hydrocarbons
QA	Quality Assurance
QC	Quality Control
RACER®	Remedial Action Cost Engineering and Requirements program
RSLs	EPA Regional Screening Levels
SMS	Sediment Management Standards
SQAP	Sample Quality Assurance Plan
SQS	Sediment Quality Standards
SQuiRT	Screening Quick Reference Tables
START	Superfund Technical Assistance and Response Team
SVOC	Semi-Volatile Organic Compounds
TAL	Target Analyte List
TBA	Targeted Brownfields Assessment
TEF	Toxicity Equivalency Factor
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
VCP	Voluntary Cleanup Program
VOC	Volatile Organic Compound
WAC	Washington Administrative Code

1 Introduction

Pursuant to the United States Environmental Protection Agency, (EPA) Region 10, Superfund Technical Assessment and Response Team (START) Contract Number EP-S7-06-02 and Technical Direction Document Number 07-01-0008, Ecology and Environment, Inc. (E & E) performed a Targeted Brownfields Assessment (TBA) at the Bremerton Gasworks site, which is located in Bremerton, Washington. The EPA's Brownfields Economic Redevelopment Initiative is designed to empower states, cities, tribes, communities, and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse Brownfields sites (EPA 2002a).

The Bremerton Gasworks site consists of two adjacent properties, the McConkey and the Sesko, zoned for commercial use. This area is planned to be developed into a multipurpose commercial marine area. The multipurpose area would encompass a public access marina, commercial businesses, and potential condominium housing.

This TBA report provides limited sampling data for the Bremerton Gasworks site. The areas that were sampled consist of subsurface soils found under the asphalt-covered former gasworks facilities, subsurface soils near the former aboveground storage tank (AST) areas, and sediment along the Washington Narrows. These locations were selected based on analytical results from a previous investigation conducted under a Brownfields Assessment grant to the City of Bremerton.

The objective of this TBA is to present the results of the limited sampling for preliminary site characterization purposes. This report is organized as follows:

- Section 1 (Introduction): authority for performance of this work and summary of report contents;
- Section 2 (Site Description): description of site conditions, history, and site concerns;
- Section 3 (Investigation and Results): summary of the field effort and chemicals detected at the site and a comparison of detected chemical concentrations to analyte-specific screening criteria;
- Section 4 (Cleanup Options and Cost Estimate): cleanup options for the site based on sample results and analyte-specific screening criteria;
- Section 5 (Conclusions and Recommendations): recommendation for the site based on the information gathered during this investigation;
- Section 6 (References): list of references cited throughout the text;

- Appendix A Photographic Documentation: photographs taken during the initial site visit and during the sampling event;
- Appendix B Screening Criteria and Analytical Results: tables presenting the analyte-specific screening criteria selected and the analytical results summary tables for samples collected;
- Appendix C Sample Plan Alteration Forms: description and justification for deviations from the approved sampling plan;
- Appendix D Global Positioning System Coordinates: a list of all sample location coordinates;
- Appendix E Borehole Reports: completed borehole reports for each borehole location;
- Appendix F Quality Assurance/Quality Control and Data Validation Memoranda: a summary of Quality Assurance/Quality Control (QA/QC) information and data validation memoranda for all samples collected during the investigation; and
- Appendix G RACER Cleanup Option Cost Estimates: a comprehensive cost estimate for each Section 4 cleanup option.

2 Site Description

2.1 Location and Description

The site is located at 1725 Pennsylvania Avenue, approximately 1 mile north by northwest of downtown Bremerton (Figure 2-1) (Geoengineers 2007). The Bremerton Gasworks site is located on two adjacent properties covering approximately 3.68 acres in the city of Bremerton, Kitsap County, Washington. The site is composed of tax parcel numbers 3711-000-001-0409 and 3711-00-001-0607 (McConkey parcels) and tax parcel number 3711-000-022-0101 (Sesko parcel) (TechLaw 2006).

The site is situated in mixed use commercial, industrial, and residential areas. It is bordered by the Washington Narrows waterway to the north, South McConkey Industrial Park to the south, Thompson Avenue to the west, and Pennsylvania Avenue to the east (Figure 2-2).

The site was originally developed by the Western Gas and Utilities Corporation to provide the city of Bremerton with light, heat, and electricity by natural gas products. The gasification plant was in operation from approximately 1930 to 1956. The plant was fueled by shipments of coal delivered by boat. The gasification process may have started by processing the coal with high temperature and pressure, using boiler plant steam and measured amounts of oxygen. The final product (coal or natural gas) was sent by pipeline to local residences in Bremerton. This site also was utilized for petroleum storage and distribution from approximately 1963 to 1985. Petroleum products were stored in ASTs and distributed by underground pipeline or offloaded to vehicles. The records are not clear regarding how many of the underground fuel distribution lines were removed, if the distribution lines remain underground, or if product remains in the lines. Aerial photographs suggest that the former gasification physical plant, boiler, and ASTs apparently were removed between 1985 and 1993 (TechLaw 2006).

The McConkey properties cover approximately 3.13 acres (TechLaw 2006). These properties are operated by Trip McConkey as a mixed use commercial property and storage rental business (E & E 2007). They currently contain five separate buildings, which are leased to a metal fabrication shop, piston ring shop, granite countertop workshop, and a welding shop (TechLaw 2006). Past commercial uses include sheet metal fabrication, drum storage facilities, automotive and marine repair, metal salvage yard, painting/sandblasting activities, and petroleum bulk storage and distribution.

The Sesko property covers approximately 0.55 acres (TechLaw 2006). This property is owned by Natasha Sesko. It is currently vacant but appears to be used as temporary storage for heavy equipment. The only structures on this property are the former foundations of the AST farm (TechLaw 2006). The Sesko property was formerly utilized as a commercial AST and petroleum distribution facility (Techlaw 2006).

A bulk petroleum storage facility (ARCO, now owned by BP West Coast Products LLC) was previously located northwest of the McConkey properties. Currently, SC Fuels, a petroleum bulk storage facility, is located east of the Sesko property and Pennsylvania Avenue. Historical files for the SC Fuels facility indicate that petroleum releases have occurred (Ecology 2009).

2.2 Local Conditions

The nearest surface water to the subject property is the Washington Narrows, which is located 100 to 150 feet north of the site. The Washington Narrows is affected by tidal variation from Puget Sound.

Groundwater is located at depths ranging from 15 to 45 feet below ground surface (bgs). It is not clear if shallow groundwater at the site is influenced by tidal variations from the Washington Narrows. Groundwater follows a slight north-northwest gradient towards the Washington Narrows (Geoengineers 2007).

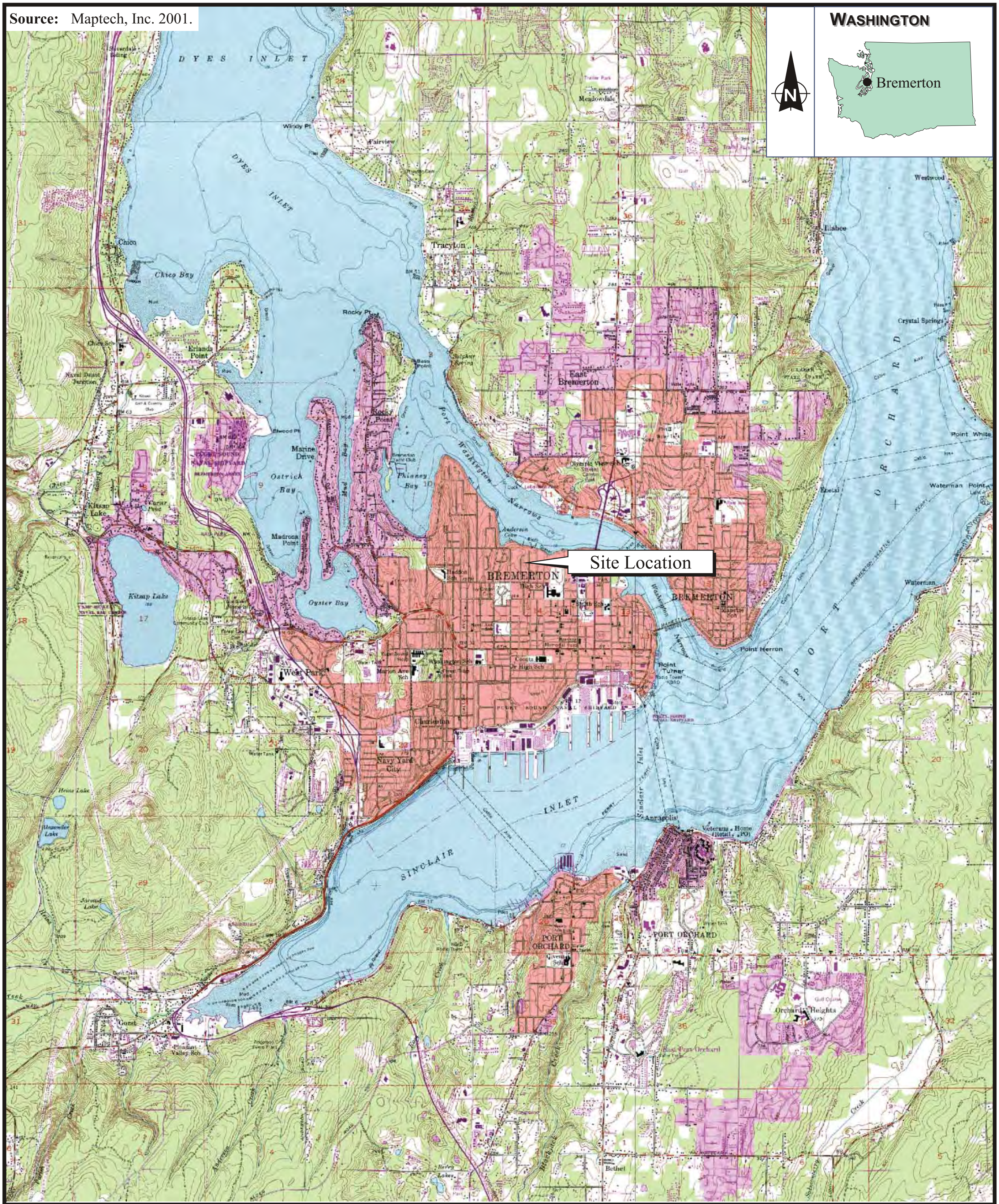
A drainage pipe was discovered down gradient from the Sesko property on the Washington Narrows beachfront (Appendix A; Photograph 0717). It is not clear where the pipe originated or what its intended use was.

2.3 Previous Investigations

In October 2006, the City of Bremerton received a Brownfields Assessment grant from EPA Region 10. This grant awarded $200,000 for additional site assessment work. The City of Bremerton proposed to redevelop a portion of the Bremerton Gasworks site as a public access marina.

The City of Bremerton contracted Geoengineers, Inc., to conduct subsurface soil sampling and monitoring well installation at eight locations. Monitoring well (MW)-1 through MW-8 were installed on May 21 through May 24, 2007. The soil borings and monitoring wells were advanced to depths ranging from 20 to 45 feet bgs. Soil samples were collected from the surface, at 5-foot intervals for each borehole. The samples were field screened for physical evidence of contamination and, based on visual observation, a minimum of two samples per borehole were submitted for laboratory analysis to TestAmerica Laboratories of Bothell, Washington. Samples were analyzed for total petroleum hydrocarbons (TPH) as gasoline, TPH as diesel, TPH as heavy oils, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls, and Target Analyte List (TAL) metals. Groundwater was encountered at depths ranging from 15 to 35 feet bgs, utilizing low flow sampling techniques.

Geoengineers discovered contamination in subsurface soils and groundwater at the site that exceeded the 2007 Washington State Department of Ecology (Ecology) Model Toxics Control Act (MTCA) cleanup levels. Soils were impacted with VOCs, PAHs, TAL metals (including arsenic), and TPH as gasoline, diesel, and oil range hydrocarbons. These soil samples were contaminated from the soil surface downward to depths greater than 30 feet bgs. Levels of VOCs, PAHs, SVOCs, heavy metals, total chromium, hexavalent chromium, and arsenic found in the groundwater exceeded MTCA screening levels (Geoengineers 2007).



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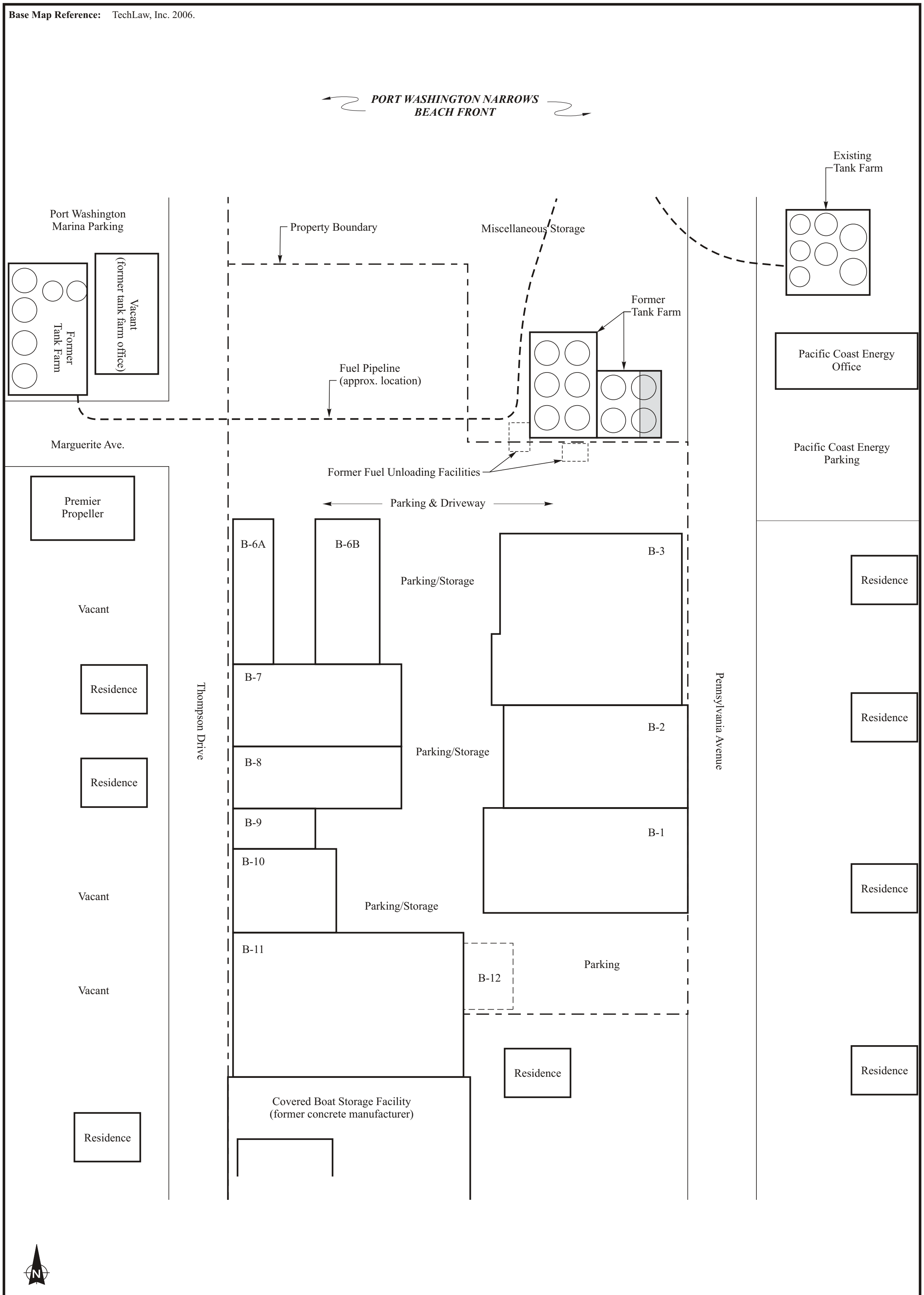
BREMERTON GASWORKS TBA Bremerton, Washington		Figure 2-1 SITE VICINITY MAP
0 .5 1 Approximate Scale in Miles	Date: 11-25-08	Drawn by: AES	10:START-3\07010008\fig 2-1



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BREMERTON GASWORKS
Bremerton, Washington

0 50 100
Approximate Scale in Feet

Figure 2-2
SITE MAP

Date:	Drawn by:	
1/26/09	AES	10:START-3\07010008\fig 2-2

3 Investigation and Results

E & E conducted a field sampling event at the Bremerton Gasworks site from May 12 through May 15 and on May 19 and June 4, 2008. Field work was conducted in cooperation with the City of Bremerton.

3.1 Sampling design

A judgmental sampling design was used for the Bremerton Gasworks TBA. This sampling design fulfills specific project objectives by collecting biased data required for preliminary site characterization. The following subsections describe the types of sampling, analysis, and measurements that were conducted. Samples were collected in accordance with an approved Sampling and Quality Assurance Plan (SQAP) (E & E 2008b). Deviations from the SQAP are described below, as well as in the Sample Plan Alteration Form provided in Appendix C.

Although general sample locations (i.e., features to sample) were selected prior to mobilization, the exact locations were selected once the field sampling crew was on site. Locations were selected to maximize the possibility of discovering areas of potential contamination. Photographic documentation of the samples, sampling locations, and site features are provided in Appendix A. A summary of sample coordinates obtained via GPS units with data loggers is provided in Appendix D.

To evaluate the presence or absence of contamination at various areas at the site, 65 samples were collected. These include QA/QC samples and waste profile samples collected from soil cuttings and well development wastewater. Sample locations are depicted in Figure 3-1.

The following areas were sampled:

- North McConkey property (26 samples from 4 locations),
- Sesko property (22 samples from 3 locations), and
- Washington Narrows beachfront (5 samples from 5 locations).

3.2 Sampling Methods

Subsurface soil samples were collected by driving a hollow-stem auger drill rig to the designated depth, then transferring the sample material into a dedicated stainless steel bowl using a dedicated stainless steel spoon. The sample material was thoroughly homogenized and placed in pre-labeled sample containers. The VOC aliquots were collected with Core-N-One soil samplers prior to sample homogenization.

The auger head was decontaminated between sample locations. Three rinsate samples (RS01WT, RS02WT, and RS03WT) were collected to ensure that decontaminated procedures were sufficient to meet the SQAP guidelines.

After sample collection, the drill borehole were either modified into a groundwater monitoring well or abandoned according to all applicable Washington State standards. Two monitoring wells (MP04 and SP02) were installed and developed for future groundwater monitoring. A copy of the borehole reports are provided in Appendix E.

Two monitoring wells were installed using a hollow-stem auger rig in accordance with the Washington State Department of Ecology Minimum Standards for Construction and Maintenance of Wells ([173-160 WAC)]. Well casings and screens were constructed of 2-inch diameter, schedule 40 PVC. Ten-foot long, 0.010-inch slotted pre-packed well screens were used during well installation. The wells were developed using a surge block and a submersible pump.

The two monitoring wells were sampled using a Grunfos submersible pump and low flow sampling techniques. Dedicated polyethylene tubing was used for each well, and a Horiba U-10 water quality meter was used to measure water quality parameters. Water quality parameters (i.e., pH, temperature, redox potential, dissolved oxygen, conductivity, and turbidity) were monitored and recorded during purging. Purging continued until water quality parameters stabilized, indicating that groundwater representative of the aquifer formation was present in the well. Stabilization requirements are three consecutive readings, taken at approximately 5-minute intervals, within the following criteria: pH (± 0.1 unit), specific conductance (± 3%), and Dissolved Oxygen (± 10%). Groundwater samples were then collected using a submersible Grunfos pump discharging directly into pre-labeled sample containers. Samples were preserved as required after sample collection, with the exception of the VOC aliquot, which was collected in pre-preserved sample containers.

All samples were submitted to an off-site fixed laboratory for VOC, SVOC, TAL Metals, TPH-Gx, and TPH-Dx analysis. QA/QC validation memoranda are provided in Appendix F. The following samples were submitted to a contract laboratory program (CLP) and EPA Manchester Environmental Laboratory for analysis as follows:

- **VOCs** - 65 samples, including QA/QC samples, were submitted for SVOC analysis using EPA Method SOM01.2. The samples were submitted to KAP Technologies Laboratory in The Woodlands, Texas, a CLP laboratory.
- **SVOCs** - 58 samples, including QA/QC samples, were submitted for SVOC analysis using EPA Method SOM01.2. The samples were submitted to KAP Technologies Laboratory in The Woodlands, Texas, a CLP laboratory.
- **TAL Metals** - 59 samples, including QA/QC samples, were submitted for TAL metals analysis using EPA Method ILM05.4. The samples were

submitted to Bonner Analytical Testing Company of Hattiesburg, Mississippi, a CLP laboratory.

- **TPH-Gx/Dx** - 59 samples, including QA/QC samples, were submitted for TPH analysis using EPA Method NWTPH-Gx/Dx. The samples were submitted to Manchester Environmental Laboratory of Manchester, Washington.

3.3 Regulatory Standards

Both the MTCA screening levels (Ecology 2008) and EPA Risk Based Regional Screening Levels (RSLs) (EPA 2009) were used to evaluate soil results for this TBA as conservative screening levels to assess whether contaminant concentrations pose a potential threat to human health and the environment under a variety of exposure conditions. RSLs are used preferentially for evaluation purposes to allow for maximum beneficial use of the site. Additionally, the EPA RSLs and Federal Maximum Contaminant levels (MCLs) are used to evaluate the groundwater encountered at the site. Finally, the newly promulgated Washington State Department of Ecology Marine Sediment Management Standards (SMS) are used to evaluate sediment samples collected from the Washington Narrows.

A description of the screening values and applicable use is included below. Available screening concentrations are presented in Tables B-1 (soil), B-2 (groundwater), and B-3 (sediment). The chosen screening concentration for each analyte is presented in the last column of these tables.

3.3.1 Washington State Department of Ecology Model Toxics Control Act

MTCA levels are determined according to three categories: Methods A, B, and C. Method A levels are generally the most conservative, may or may not be risk-based, and are intended for use at simple sites with limited numbers of contaminants. Method A values are available for residential soil and industrial soil uses. Method B levels are based on residential land use. Method B soil screening levels assume high frequency of contact in a residential setting. Method B screening levels account for exposure to children and correspond to a 1 in 1,000,000 excess lifetime cancer risk for carcinogens or a hazard quotient of 1 for noncarcinogens.

A hazard quotient is a ratio between the level to which someone may be exposed to a contaminant in the environment and a level deemed “safe” by regulatory agencies. This “safe” exposure level is usually referred to as a reference dose or reference concentration. Method C levels are based on commercial or industrial land use; therefore, soil screening levels are based on adult contact only. The risk levels for Method C are an excess lifetime cancer risk of 1 in 100,000 for carcinogens and a hazard quotient of 1 for noncarcinogens.

Under Washington State’s MTCA (Washington Administrative Code [WAC] 173-340-708(8)(e)], mixtures of carcinogenic PAHs must be evaluated as a single hazardous substance by using the toxicity equivalency factor (TEF) methodology

(Ecology 2007). A TEF is an estimate of a chemical's toxicity relative to a reference chemical; benzo(a)pyrene is the reference chemical for carcinogenic PAHs. In this report, concentrations of carcinogenic PAHs were multiplied by chemical-specific TEFs, and then the products were summed to obtain a total equivalent concentration of benzo(a)pyrene, or benzo(a)pyrene equivalency (BAPE). This sum then was compared to the MTCA cleanup level for benzo(a)pyrene. TEFs for the seven PAHs classified as Group A (known human) or Group B (probable human) carcinogens by the EPA are provided by Ecology (Ecology 2007).

The planned end use for this site includes a public access marina, commercial businesses, and potential condominium housing. Therefore, MTCA Method A unrestricted values will be employed where they are available.

3.3.2 EPA Regional Risk-Based Screening Levels

The EPA's regional RSLs for residential soil supersede the EPA Region 3 RBC Table, Region 6 HHMSSL Table, and the Region 9 PRG Table. RSLs are calculated using up-to-date toxicity values, default exposure assumptions, and default physical and chemical parameters and are not intended to be used as cleanup levels. The RSLs represent reasonable maximum exposure conditions, as defined by EPA risk assessment guidance (EPA 1991) and soil screening level guidance (EPA 1996a, 1996b, 2002b), and assume a resident at the site contacts soil via incidental ingestion, direct dermal contact, and inhalation of wind-blown soil particulates. The RSLs are maintained by the United States Department of Energy's Oak Ridge National Laboratory and are updated as new toxicity values, chemical-specific parameters, and EPA guidance become available.

3.3.3 Groundwater Screening Concentrations

Groundwater screening levels in Appendix B Table B-2 include the MTCA Method A screening levels, Washington State and federal MCLs, and EPA RSLs for groundwater. All groundwater values presented in Table B-2 assume that groundwater is currently used as drinking water or could reasonably be used as a drinking water source in the future. The MTCA Method A groundwater screening standards were established under WAC 173-340-740 (2). Under chapter 246-290-310 WAC, Washington State has identified MCLs for chemicals in drinking water. Washington State MCLs consist of primary and secondary chemical and physical parameters and are intended to ensure safe public drinking water resources. State MCLs are at least as stringent as federal drinking water standards, or MCLs, that are part of the Safe Drinking Water Act. Like state MCLs, federal MCLs are legally enforceable standards applicable to public water systems. Primary standards establish limits for chemical contaminants in drinking water and are based on protection of public health or limitations of treatment technologies. Secondary standards are non-enforceable guidelines pertaining to cosmetic or aesthetic parameters (e.g., color, taste, and odor). Table B-2 lists both state and federal MCLs for target analytes relevant to this site.

The EPA's RSLs for tap water are protective of exposures via direct ingestion of tap water and inhalation of volatile chemicals present in tap water. The RSLs are not protective of exposure to chemicals through dermal contact with water. As with the soil RSLs, the EPA RSLs for tap water are managed by the United States Department of Energy's Oak Ridge National Laboratory and are updated as new toxicity values, chemical-specific parameters, and EPA guidance become available. These tap water standards were utilized when no applicable MTCA, state, or federal MCLs were available. They should be applied if groundwater is utilized as a drinking water source. They should not be considered applicable as a cleanup screening value.

3.3.4 Washington State Marine Sediment Management Standards

SMSs are provided under Chapter 173-204 of the WAC. These standards are intended to reduce adverse effects on biological resources resulting from contaminated sediments. The sediment quality standards (SQS) included in the SMS provide chemical concentration criteria used to identify levels of sediments below which adverse acute or chronic effects on biological resources are not expected to occur.

Table B-3 of this report lists the target analytes, as provided in Table I under chapter 173-204-320 WAC. The SQS values in Table I of the WAC are "normalized" on a total organic carbon (TOC) basis for non-ionic organic compounds such as PAHs, chlorinated benzenes, phthalates, and PCBs, and on a dry weight basis for compounds such as metals and phenols.

To normalize to TOC, the dry weight concentration of a chemical of concern is divided by the fraction representing the percentage of TOC present in the sediment, then adjusted to parts per million. Normalization of compounds such as metals and phenols is unnecessary because laboratory data are provided on a dry weight basis. The TOC content in sediment at the Bremerton Gasworks site was not measured as part of the study; therefore, the concentration of the chemicals of concern at these stations could not be directly compared to the Washington State SQS.

3.3.5 National Oceanic and Atmospheric Administration Screening Quick Reference Tables

The National Oceanic and Atmospheric Administration (NOAA) provides screening levels for chemicals in freshwater and marine sediments, surface water, and surface soil. These values are listed in the Screening Quick Reference Tables (SQuiRT) (Buchman 2008). The SQuiRTs include multiple chemical-specific screening values based on a variety of test methods, target species, and biological endpoints. The tables are intended for screening purposes only and are not to be used as cleanup values. Table B-3 lists apparent effects thresholds (AETs) listed in the SQuiRTs, which are benchmarks based on the relationship between chemical concentrations in sediment and adverse effects observed in benthic communities or toxicity tests. The AET represents the highest observed concentration that does not result in an adverse effect.

3.4 Sampling Results

Sample results are presented in Appendix B. Subsurface soil sample results are presented by depth from the borehole auger in Tables B-4 through B-12. Groundwater sample results are presented in Table B-13. Finally, sediment sample results are presented in Table B-14. Maps depicting concentrations of analytes that exceed their analyte-specific screening criteria are presented in Figures 3-2 through Figure 3-12. The maps are organized by sample depth for subsurface soil samples and by matrix for groundwater and sediment samples. The analyte-specific screening value is presented in the first column of each table for comparison purposes. Data validation memoranda are provided in Appendix F. Analytical results were evaluated according to the following steps prior to being reported in the tables:

- Analytes that were not detected in any samples within a table were omitted from their respective tables;
- All detected concentrations are shown in bold type; a nondetected concentration is shown as the detection limit reported by the laboratory (i.e., 0.66 U);
- Analytes detected at concentrations greater than the analyte-specific screening value were considered a potential concern, and the concentration is shaded; and
- Analytes without comparative criteria levels are listed in the tables but could not be qualitatively evaluated.

Based on EPA Region 10 policy, evaluation of aluminum, calcium, iron, magnesium, potassium, and sodium (i.e., common earth crust metals) is generally used only in mass tracing, which is beyond the scope of this report. Furthermore, these analytes are not associated with toxicity to humans under normal circumstances (EPA 1996a). For these reasons, these analytes are not included in the evaluation or discussion but are provided in the analytical summary tables.

Alphanumeric identification numbers applied by the START to each sample location (e.g., MP01) are used in the report as the sample location identifiers.

3.4.1 North McConkey Property

The North McConkey property was the former location of the gasworks boilers and associated buildings. Four borehole locations (MP01 through MP04) and one monitoring well (MP04) were installed on the North McConkey property. Samples were collected at 5-foot intervals from ground surface to a total maximum depth of 40 feet bgs. A total of 23 soil samples and three groundwater samples were collected.

Subsurface soil sample results are presented by sampling interval in Appendix B, Tables B-4 through B-12. Sample results indicate the presence of arsenic at concentrations that exceed the MTCA Method A screening criteria of 0.39 milligrams per kilogram (mg/kg) in all samples at all depths. The natural background soil concentration for arsenic ranges between 1.1 and 7.5 mg/kg

(ATSDR 2005). Based on the natural background soil concentration, it appears that the levels of arsenic found in the site soils may be naturally occurring, even though they are above the MTCA Method A screening criteria. A total of seven SVOCs have been detected at concentrations that exceeded their analyte-specific screening criteria. Additionally, these SVOCs were only detected in samples collected from the 0 to 5 feet bgs interval. No VOCs or TPH were detected in the samples at concentrations that exceeded their screening criteria.

Groundwater sample results are presented in Appendix B, Table B-13. Sample results indicate the presence of four TAL metals at concentrations that exceeded their analyte-specific screening criteria. Of these TAL metals, arsenic, chromium, and lead were detected at concentrations that exceeded their screening criteria in all of the groundwater samples. Benzene ranged from 5.4 μg/L to70 μg/L in two samples, which exceeded the 0.41 μg/L EPA RSL screening criteria, and naphthalene ranged from 0.45 μg/L to 2.3 μg/L in two samples, which exceeded the 0.14 μg/L EPA RSL screening criteria. Ethylbenzene was detected in one sample at concentrations that exceeded its analyte-specific screening criteria. No SVOC analytes were detected at concentrations that exceeded their analyte-specific screening criteria.

3.4.2 Sesko Property

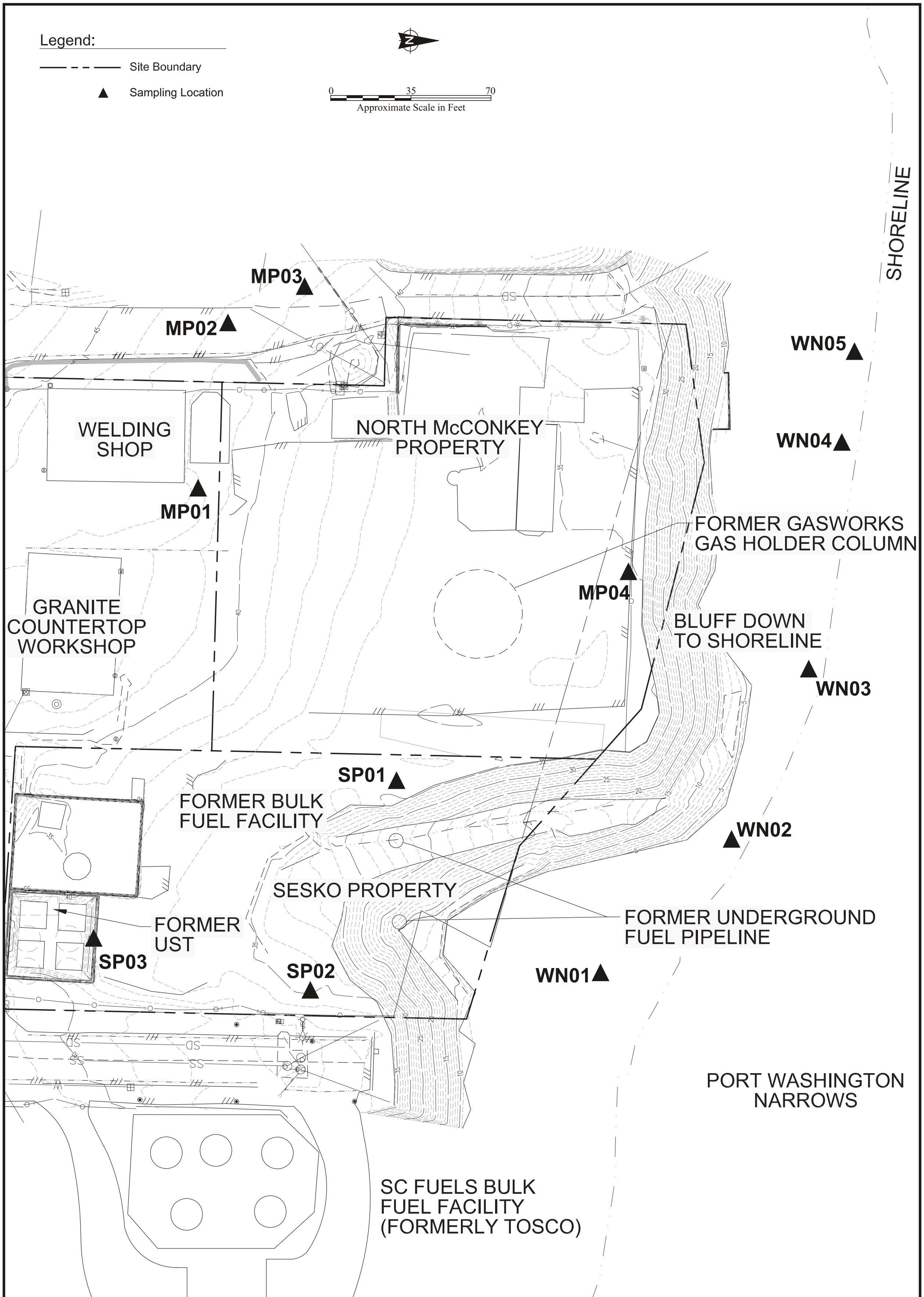
The Sesko property was the former location of multiple petroleum ASTs. Three borehole locations (SP01 through SP03) and one monitoring well (SP02) were installed on the Sesko property. Samples were collected at 5-foot intervals from ground surface to a total maximum depth of 45 feet bgs. A total of 19 soil samples and three groundwater samples were collected.

Sample results are presented by sampling interval in Appendix B, Tables B-4 though B-12. Sample results indicate the presence of arsenic at concentrations that exceed the MTCA Method A screening criteria of 0.39 mg/kg in nearly all samples, except SP02 at 15 feet bgs. The natural background soil concentration for arsenic ranges between 1.1 and 7.5 mg/kg (ATSDR 2005). Thallium also was detected at concentrations that exceeded the EPA RSL screening criteria at borehole SP03 at 20, 30, and 35 feet bgs. Sample results also indicate the presence of nine SVOCs, three VOCs, and two TPHs at concentrations that exceeded the MTCA Method A or EPA RSL screening criteria at sample borehole SP03. Benzene was detected at concentrations that exceeded Method A screening criteria of 30 μg/kg at most sample depths at this borehole.

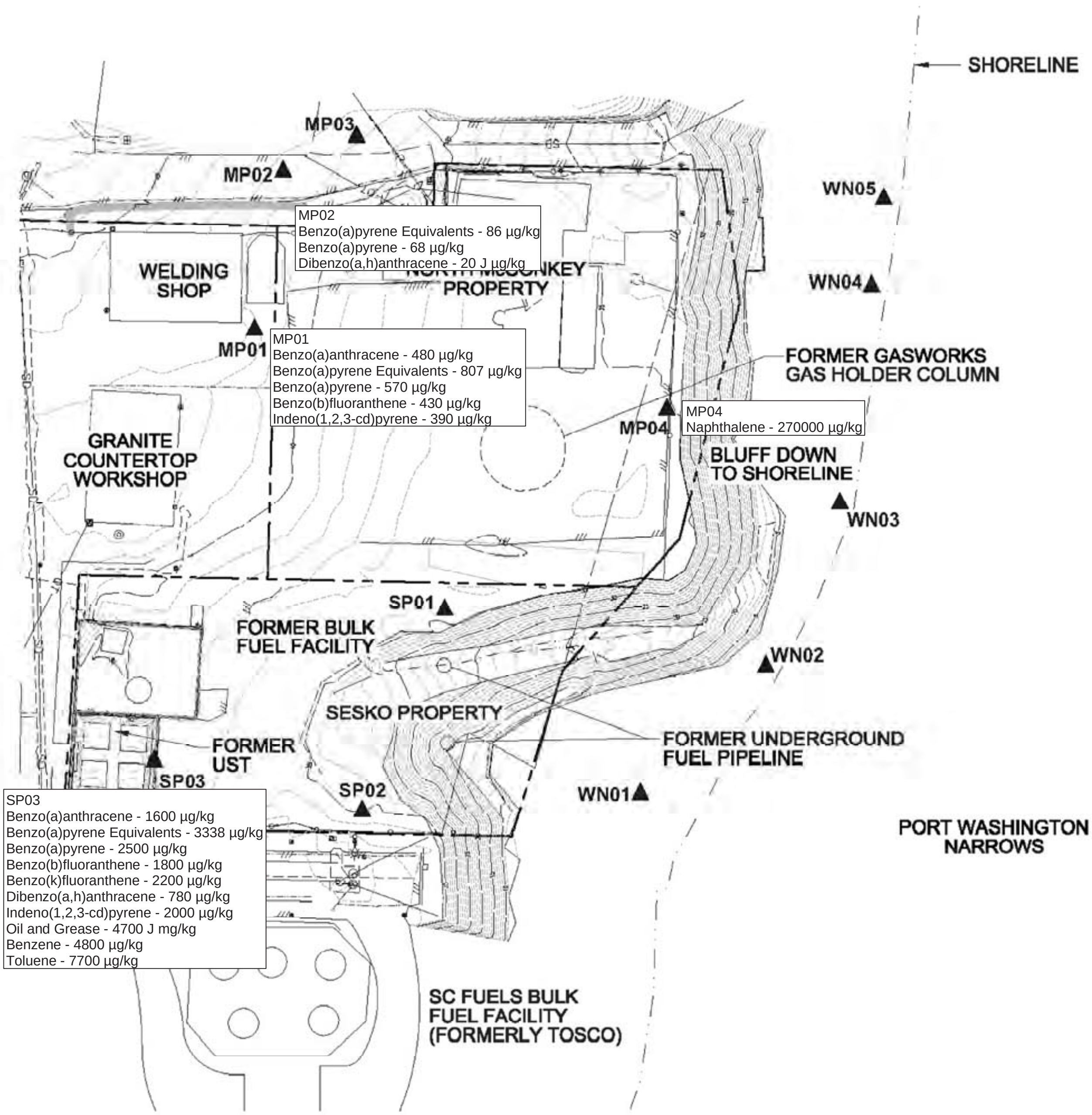
Groundwater sample results are presented in Appendix B, Table B-13. Sample results indicated the presence of four TAL metals at concentrations that exceeded their analyte-specific screening criteria. Arsenic was the only analyte detected above the analyte-specific screening criteria in all three of the groundwater samples. A total of seven SVOCs were detected at concentrations that exceeded their analyte-specific screening criteria. Groundwater collected at sample location SP02GW did not contain any SVOCs that exceeded their screening criteria. Diesel Range Organics and two VOCs were detected above their screening criteria in sample SP03GW. No VOCs were detected above their screening criteria in samples SP01GW or SP02GW.

3.4.3 Washington Narrows

The Washington Narrows beachfront is located directly adjacent to the North McConkey and Sesko properties. Five boreholes (WN01SD throughWN05SD) were hand-augered up to a depth of 30 centimeters bgs with dedicated stainless steel split-spoon samplers. Samples were collected during low tide. Sample results are presented in Appendix B, Table B-14. Several product seeps were noted near sample locations WN01SD, WN02SD, and WN03SD. Many SVOCs were prevalent at levels that exceeded their analyte-specific screening criteria at WN01SD, WN02SD, WN03SD, and WN04SD. Only pentachlorophenol was detected above the analyte-specific screening criteria for WN05SD. No TAL metals, VOCs, or TPH range analytes were detected above their analyte-specific screening criteria in any sediment samples.



ecology and environment, inc. International Specialists in the Environment Seattle, Washington	BREMERTON GASWORKS TBA Bremerton, Washington	Figure 3-1 SAMPLING LOCATIONS
	Base Map Reference: GeoEngineers 2007.	Date: 1/26/09 · Drawn by: AES · 10:START-3\07010008\fig 3-1



Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

NOT TO SCALE

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BREMERTON GAS WORKS TBA

Bremerton, Washington

Figure 3-2
Subsurface Soil Contaminant (0-5 bgs) Concentration Map

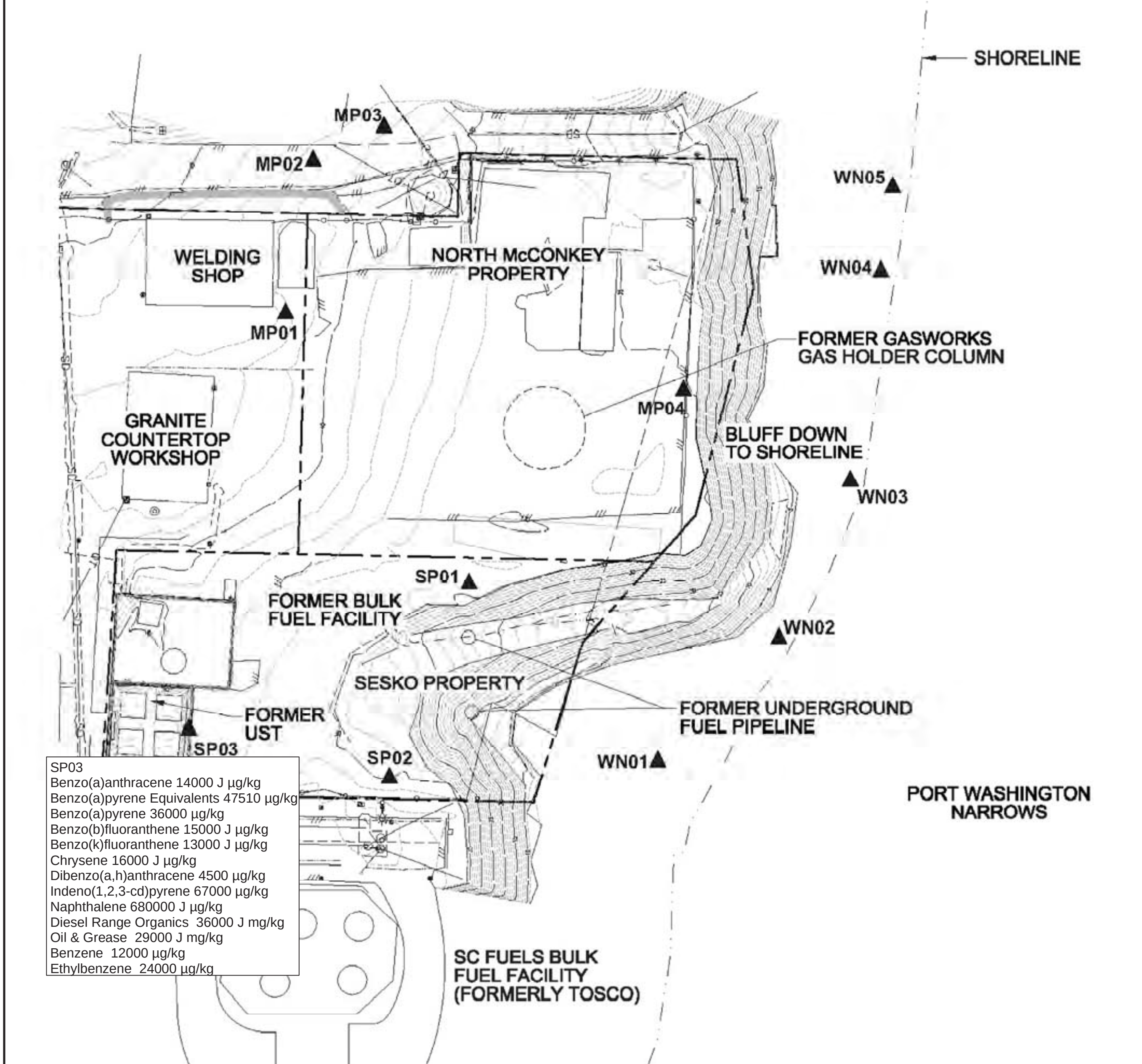
Job Id: 002233.0178.01BR

Date: 3/26/2009

GIS Analyst: avh

Map Source Information:

\edms-projects\Bremerton Gasworks\fig 0-5 bgs_new.mxd



SP03
Benzo(a)anthracene 14000 J µg/kg
Benzo(a)pyrene Equivalents 47510 µg/kg
Benzo(a)pyrene 36000 µg/kg
Benzo(b)fluoranthene 15000 J µg/kg
Benzo(k)fluoranthene 13000 J µg/kg
Chrysene 16000 J µg/kg
Dibenzo(a,h)anthracene 4500 µg/kg
Indeno(1,2,3-cd)pyrene 67000 µg/kg
Naphthalene 680000 J µg/kg
Diesel Range Organics 36000 J mg/kg
Oil & Grease 29000 J mg/kg
Benzene 12000 µg/kg
Ethylbenzene 24000 µg/kg

Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

BREMERTON GAS WORKS TBA

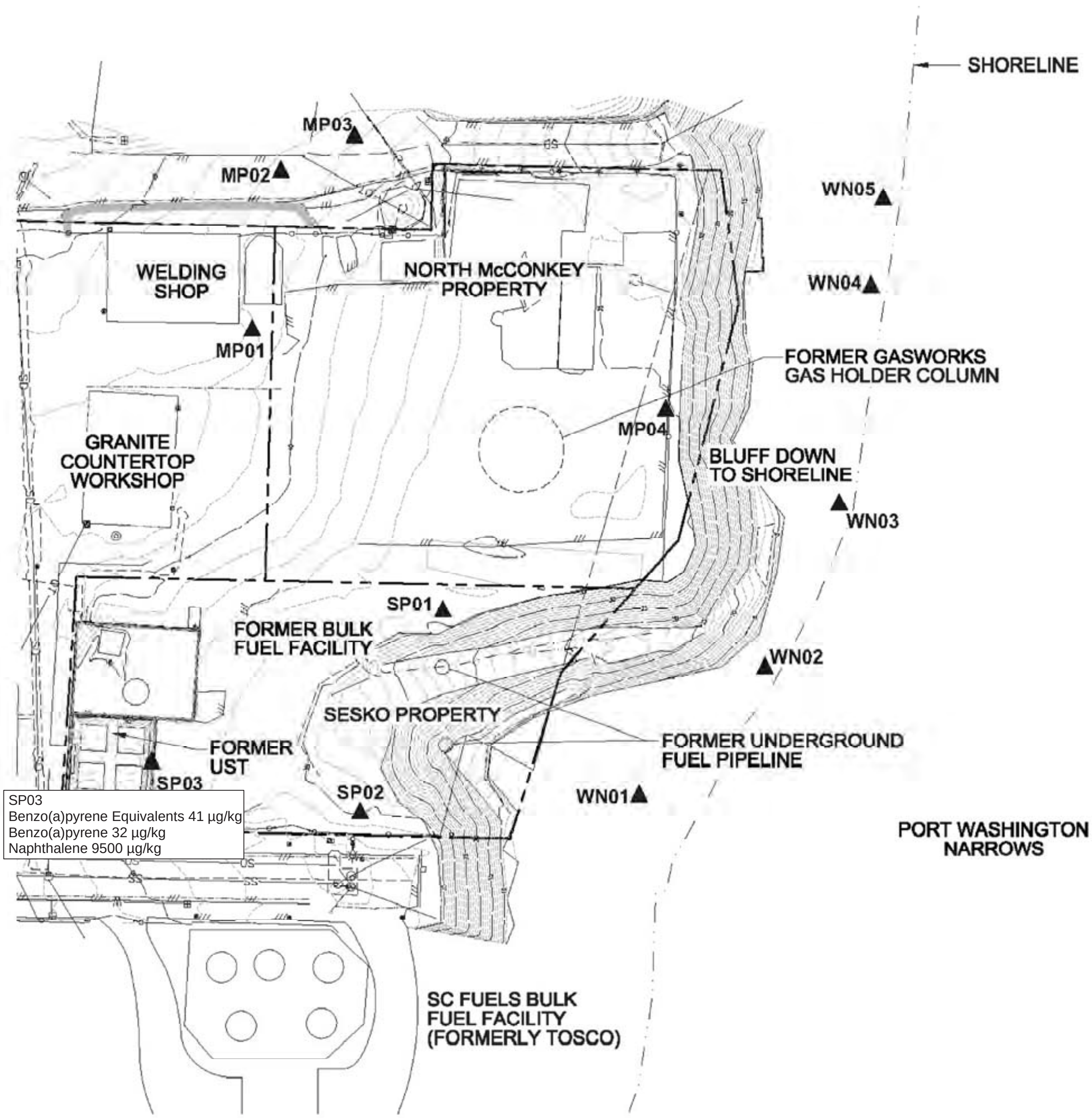
Bremerton, Washington

Figure 3-3
Subsurface Soil Contaminant (5-10 Bgs) Concentration Map

Job Id: 002233.0178.01BR
Date: 3/26/2009
GIS Analyst: avh
Map Source Information:

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

\\edms-projects\Bremerton Gasworks\fig 5-10 bgs_new.mxd



NOT TO SCALE

ecology and environment, inc.
International Specialists in the Environment
Portland, Oregon

BREMERTON GAS WORKS TBA

Bremerton, Washington

Figure 3-4
Subsurface Soil Contaminant (10-15 Bgs) Concentration Map

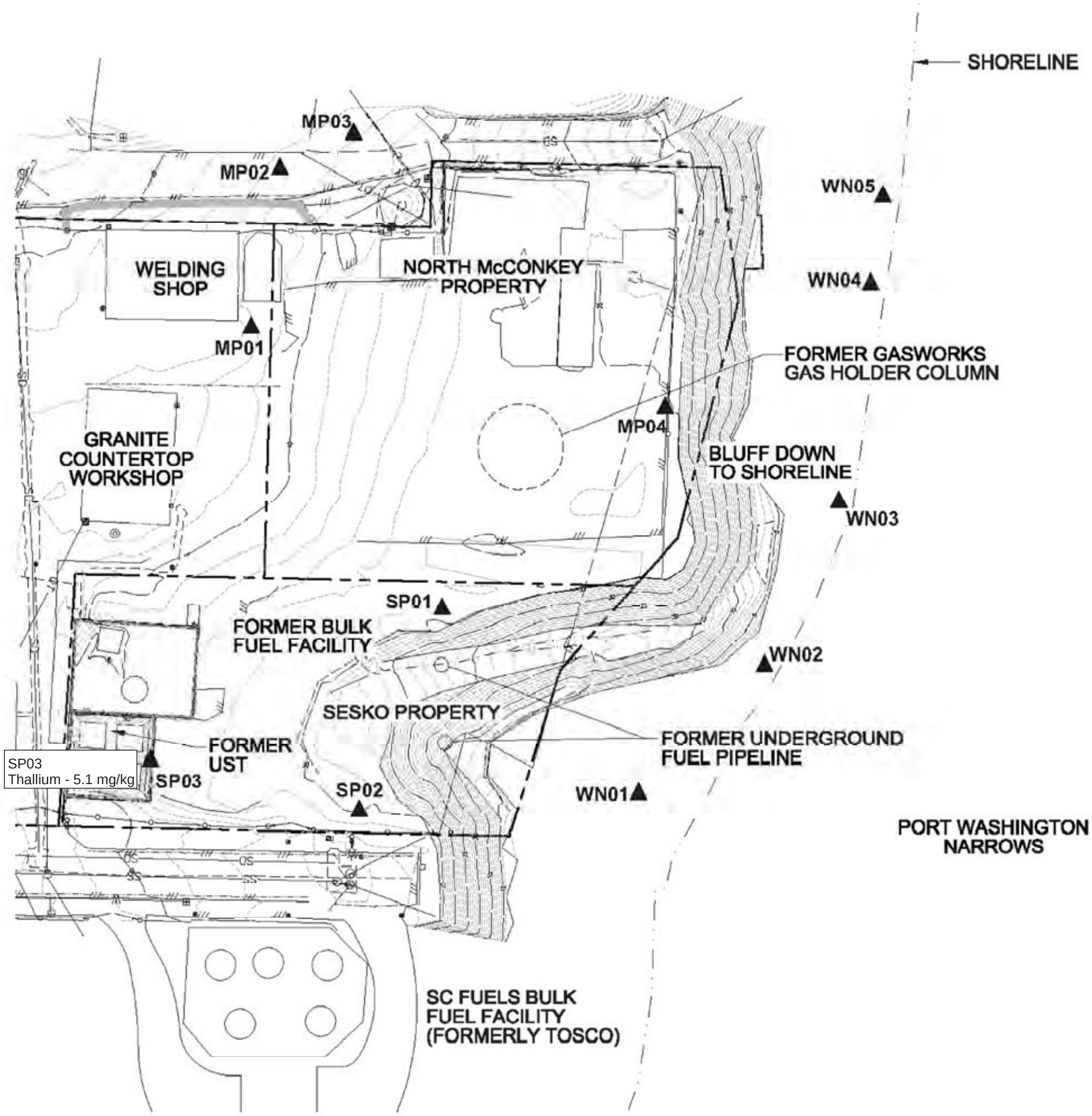
Job Id: 002233.0178.01BR

Date: 3/26/2009

GIS Analyst: avh

Map Source Information:

\edms-projects\Bremerton Gasworks\fig 10-15 bgs_new.mxd



Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

NOT TO SCALE

BREMERTON GAS WORKS TBA

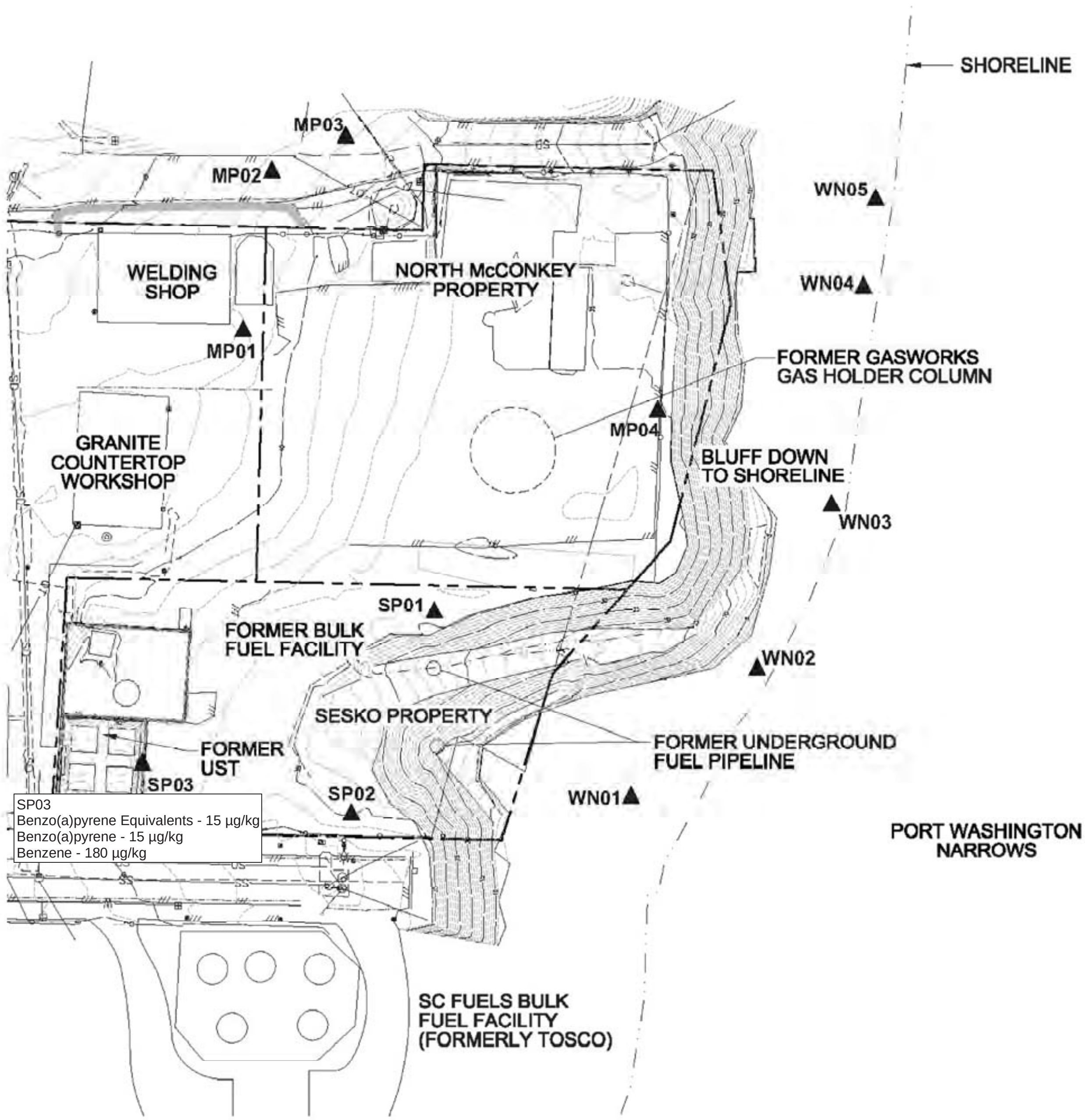
Bremerton, Washington

Figure 3-5
Subsurface Soil Contaminant (15-20 Bgs) Concentration Map

Job Id: 002233.0178.01BR
Date: 3/26/2009
GIS Analyst: avh
Map Source Information:

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

\edms-projects\Bremerton Gasworks\fig 15-20 bgs_new.mxd



Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

NOT TO SCALE

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

BREMERTON GAS WORKS TBA

Bremerton, Washington

Figure 3-6
Subsurface Soil Contaminant (20-25 Bgs) Concentration Map

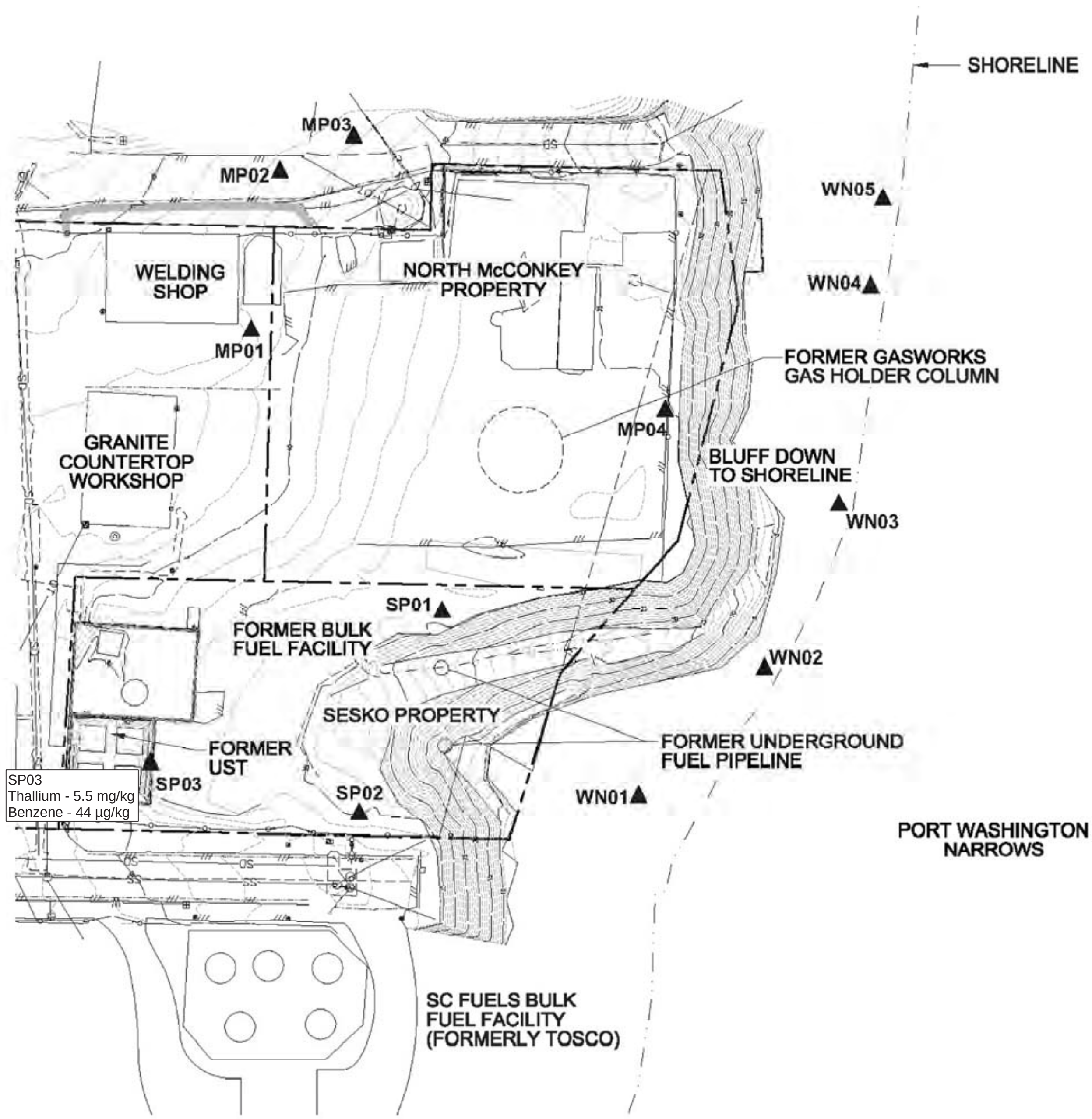
Job Id: 002233.0178.01BR

Date: 3/26/2009

GIS Analyst: avh

Map Source Information:

\edms-projects\Bremerton Gasworks\fig 20-25 bgs_new.mxd



Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

NOT TO SCALE

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

BREMERTON GAS WORKS TBA

Bremerton, Washington

Figure 3-7
Subsurface Soil Contaminant (25-30 Bgs) Concentration Map

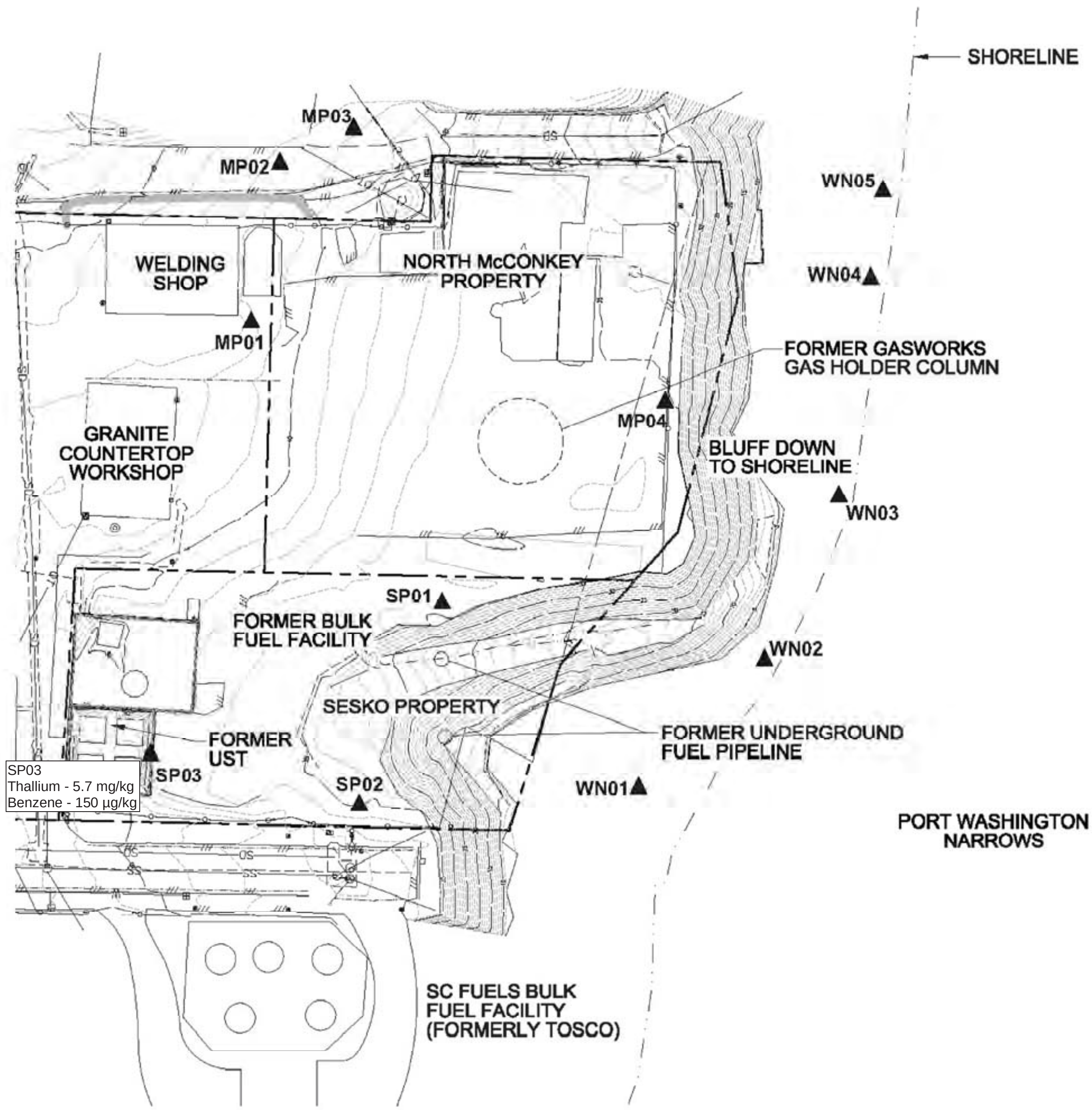
Job Id: 002233.0178.01BR

Date: 3/26/2009

GIS Analyst: avh

Map Source Information:

\edms-projects\Bremerton Gasworks\fig 25-30 bgs_new.mxd



Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

NOT TO SCALE

BREMERTON GAS WORKS TBA

Bremerton, Washington

Figure 3-8
Subsurface Soil Contaminant (30-35 Bgs) Concentration Map

Job Id: 002233.0178.01BR

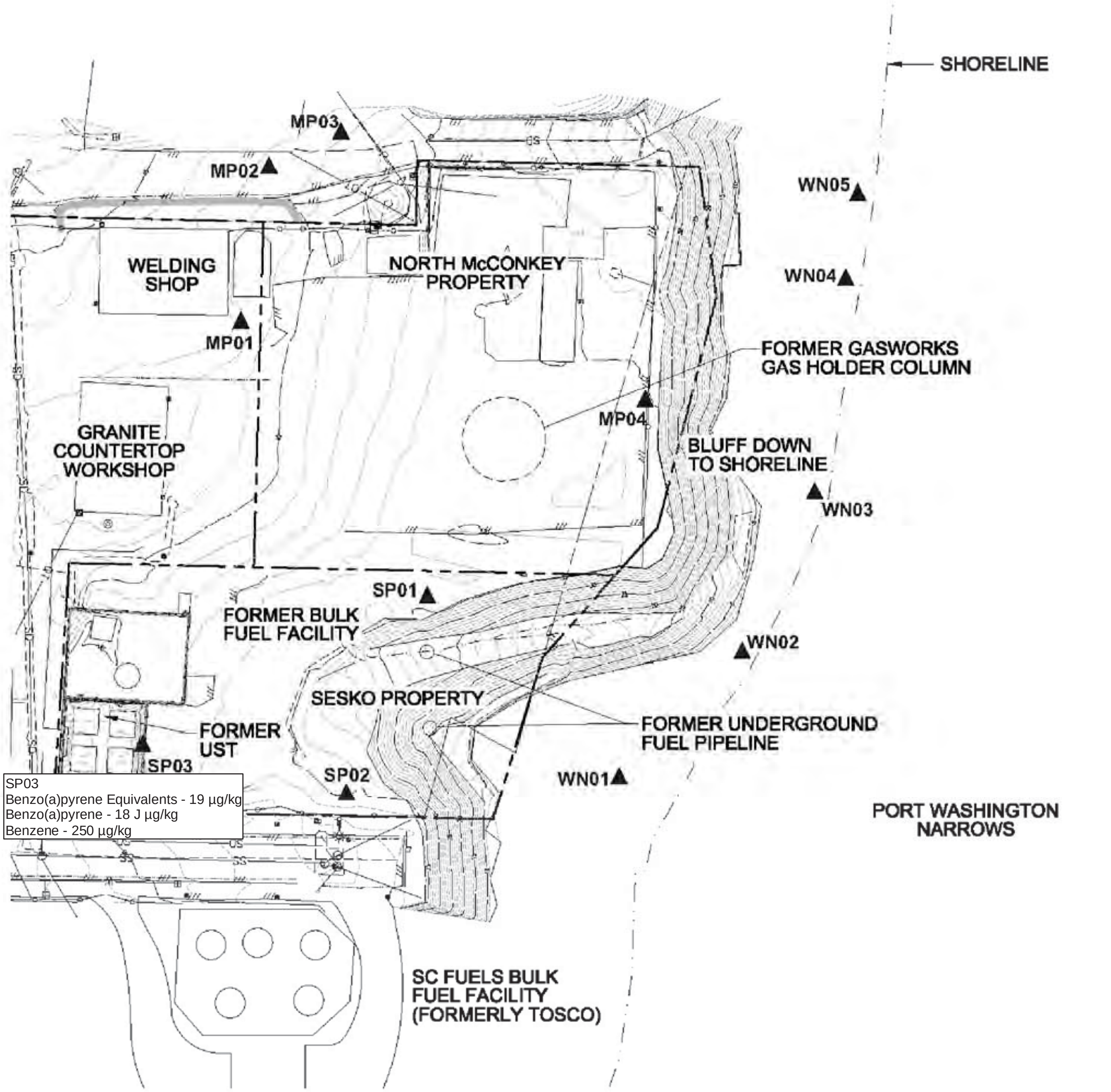
Date: 3/26/2009

GIS Analyst: avh

Map Source Information:

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

\edms-projects\Bremerton Gasworks\fig 30-35 bgs_new.mxd



Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

NOT TO SCALE

BREMERTON GAS WORKS TBA

Bremerton, Washington

Figure 3-9
Subsurface Soil Contaminant (35-40 bgs) Concentration Map

Job Id: 002233.0178.01BR

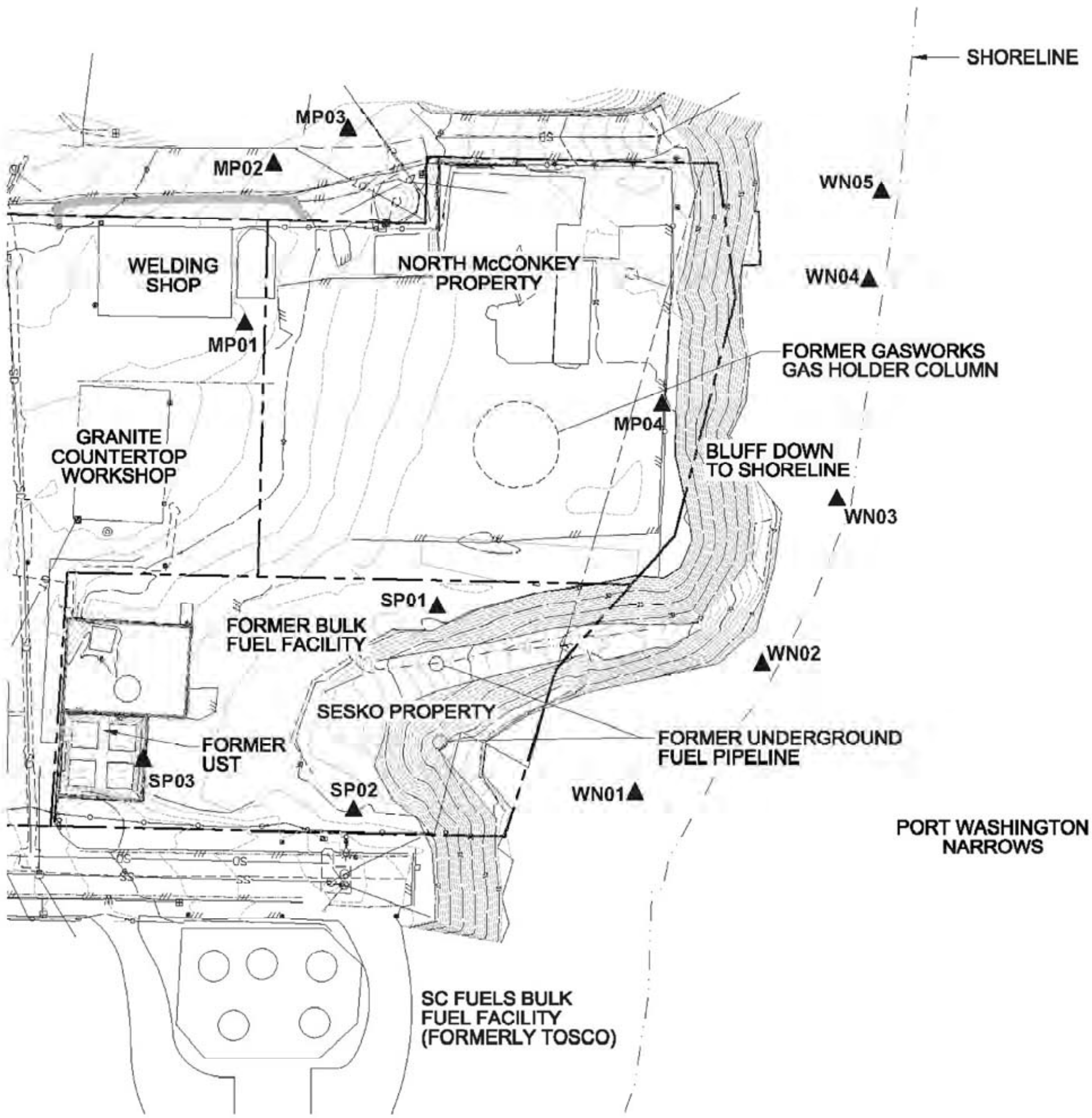
Date: 3/26/2009

GIS Analyst: avh

Map Source Information:

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

\edms-projects\Bremerton Gasworks\fig 35-40 bgs_new.mxd



Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

NOT TO SCALE

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

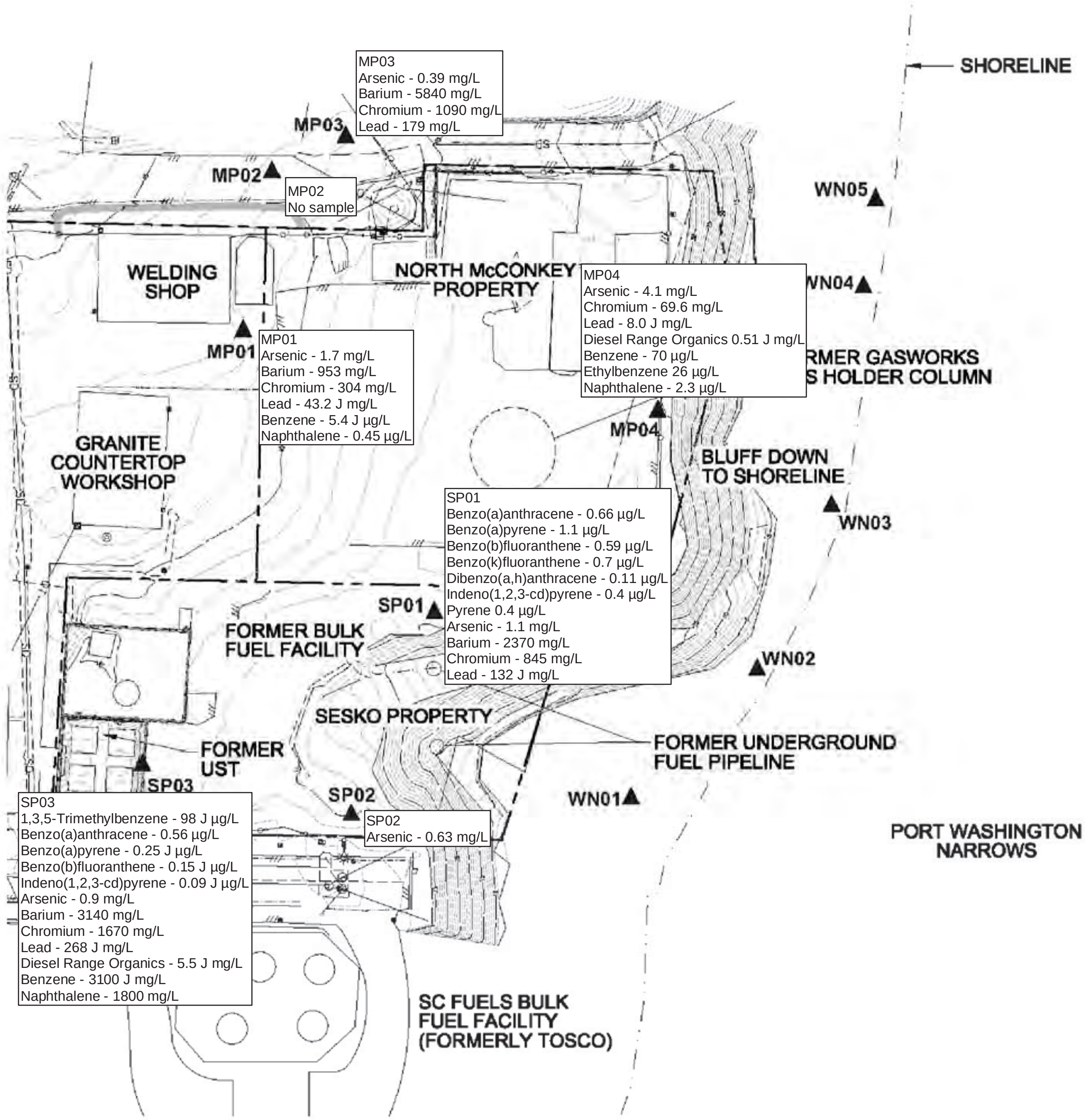
BREMERTON GAS WORKS TBA

Bremerton, Washington

Figure 3-10
Subsurface Soil Contaminant (40-45 Bgs) Concentration Map

Job Id: 002233.0178.01BR
Date: 3/26/2009
GIS Analyst: avh
Map Source Information:

\edms-projects\Bremerton Gasworks\fig 40-45 bgs_new.mxd



Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

NOT TO SCALE

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

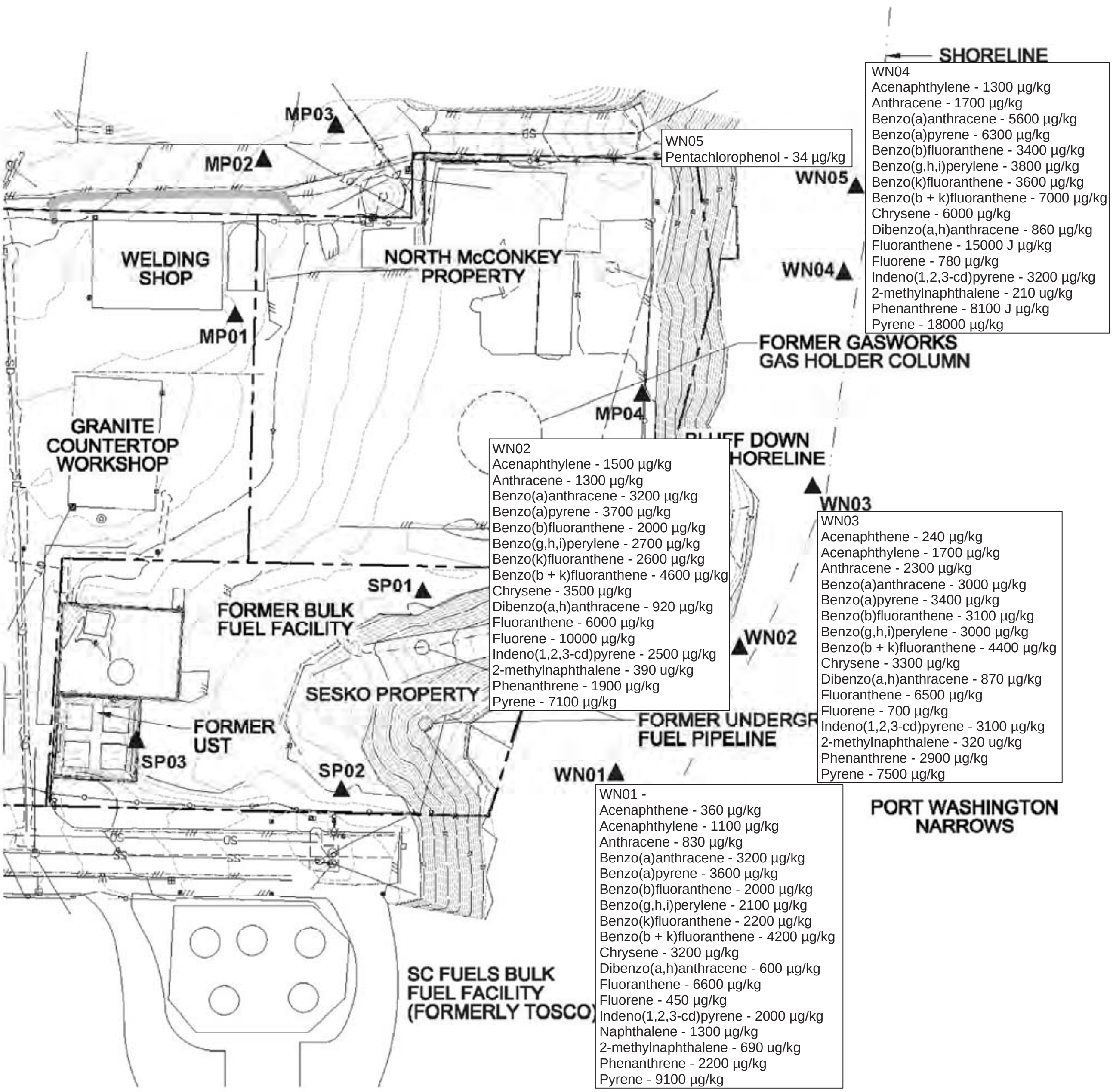
BREMERTON GAS WORKS TBA

Bremerton, Washington

Figure 3-11
Groundwater Contaminant Concentration Map

Job Id: 002233.0178.01BR
Date: 3/24/2009
GIS Analyst: avh
Map Source Information:

\edms-projects\bremerton gasworks\fig 3-11_ groundwater.mxd



Key	
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
J	The result is an estimated value

NOT TO SCALE

BREMERTON GAS WORKS TBA

Bremerton, Washington

Figure 3-12
Sediment Contaminant Concentration Map

Job Id: 002233.0178.01BR

Date: 3/24/2009

GIS Analyst: avh

Map Source Information:

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

\edms-projects\bremerton gasworks\fig 3-12 sediment.mxd

4 Cleanup Options and Cost Estimate

The preliminary investigation conducted during this TBA indicates that cleanup actions may be required at the Bremerton Gasworks site. The following preliminary evaluation of site cleanup options is based on the analytical data gathered during the investigation for the TBA. Before any cleanup action is implemented, further assessment of the site is recommended to close any data gaps in support of an effective remedial action design. Changes in site conditions would require a reevaluation of the following discussion. The cleanup actions and rationale are presented in Tables 4-1 and 4-2. It is recommended that the Ecology Voluntary Cleanup Program (VCP) be consulted prior to conducting any cleanup activities. It is also recommended that future investigations include the collection of surface water samples from Washington Narrows.

This TBA focused on VOC, SVOC, TAL Metals, and TPH-series compounds as the contaminants of concern in all locations. The decision to focus on these contaminants was based on information available and best professional judgment. Given this limitation, it is possible that other contaminants could also be presenting levels that exceed MTCA Method A or EPA RSLs.

The cost estimates included in this section were created by utilizing Remedial Action Cost Engineering and Requirements (RACER®) 2008. RACER® 2008 is a cost estimating computer program that was originally developed for the United States Air Force in 1992 and has since been utilized to meet the needs of various federal agencies and departments, including the United States Army Corp of Engineers and EPA. RACER® 2008 runs on a Microsoft Access platform.

The cleanup options and rationale are presented in Table 4-1. The estimated costs associated with each option are presented in Table 4-2. The inflation mark up from 2008 dollars to 2009 dollars was estimated using the RS Means Historical Cost Indexes. These indexes estimate the national average cost to construct a given project in a given year so that years can be compared side by side. In this case, the national average cost to construct a project in the year 2008 was compared to the national average cost to construct a project in 2009. Based on these indexes, the inflation mark up from 2008 to 2009 was estimated to be 3%. The cleanup option costs are also expressed in terms of present dollars. Because some cost items, such as monitoring, are incurred over a period of time, however, the actual costs may vary from the costs in this analysis.

For the preliminary cost estimate, the quantities of various input parameters (e.g., volume of contaminated soil, number of monitoring wells necessary, etc.) are roughly estimated based on site observations and best engineering judgment. Any new or differing discoveries will most likely affect the estimated costs projected herein.

The cleanup options are presented in order of least to most aggressive in approach. Cleanup options and associated prices are listed below. These estimates include a 15 percent contingency to allow for unforeseen costs. They do not, however, include additional study/investigation, design, long-term monitoring (beyond 5 years), 5-year reviews, site closeout, or other activities. A comprehensive estimate for each option is included in Appendix G.

Option 1

The first cleanup option includes excavation of contaminated soil “hot spots” and installation of an additional four monitoring wells to determine whether groundwater contamination is migrating and, if so, in which direction. The scope of this option is limited to installing monitoring wells, collecting the initial subsurface soil samples, and monitoring groundwater for one year.

Excavation of contaminated soil is recommended at the “hot spots” found at SP03 and MP04. The excavations are anticipated to be 25 by 25 feet to an average depth of 12.5 feet bgs and will contain approximately 600 cubic yards of contaminated soil. For disposal purposes, the contaminated soil is assumed to be hazardous waste. The excavation will be backfilled with clean soil.

Monitoring wells are intended for initial soil and quarterly groundwater sample collection only and not for groundwater treatment. This includes the installation of four 2-inch diameter PVC groundwater monitoring wells (well depth 45 feet bgs) in addition to the existing monitoring wells. Groundwater samples collected from the new wells will help determine whether contamination is migrating in groundwater. This option includes collection of soil samples during installation of the monitoring wells for vertical and horizontal subsurface characterization.

Once the four wells are installed and developed according to standard procedures, a groundwater sample plus a field duplicate will be collected for analysis. Groundwater sampling will be repeated quarterly for three additional quarters (i.e., for one full year). Additional monitoring (with associated sampling costs) may be necessary if the groundwater condition does not meet regulatory standards after the one-year period. Additional monitoring can be conducted to determine whether natural attenuation is occurring, or in conjunction with additional treatment. Such additional monitoring is subject to applicable cleanup regulations under Ecology’s authority.

Subsurface soil and groundwater samples will be handled appropriately and sent to a commercial laboratory for analysis. Additional long-term groundwater monitoring is not included with this option. The estimated cost to complete remediation Option 1 is $338,984 (Table 4-2).

Option 2
The second cleanup option includes the installation of four monitoring wells and excavation of contaminated soil "hot spots" (as described in Option 1) with the addition of installation of a groundwater pump and treat system.

The groundwater pump and treat system will use carbon absorption to remove the contaminant. Treated water will be discharged to a publically owned treatment works. This system is estimated to operate at a maximum rate of 9 gallons per minute. This option includes installation of four extraction wells in addition to the four monitoring wells. Monitoring well samples will be collected quarterly for five years to monitor the groundwater condition. The treated effluent condition will be sampled monthly for five years. The cost also includes regular maintenance and change out of the carbon adsorption unit. Additional monitoring (with associated sampling costs) may be necessary if the groundwater condition does not meet regulatory standards at the end of the proposed five-year monitoring period. Such additional monitoring is subject to applicable cleanup regulations under Ecology's authority. The estimated cost to complete remediation Option 2 is $ 973,331 (Table 4-2).

Option 3 –
The third cleanup option includes Option 2 plus the dredging and disposal of sediments, installation of an upland barrier wall, and installation of an upland asphalt cap.

Nearshore dredging of the Washington Narrows beachfront will require barge-based excavation equipment. Dredging best practices will require bathymetric surveying, deployment of sediment booms, silt curtains, and sediment dewatering. The dredging area is located north of the Sesko property on the Washington Narrows. The dredging excavation is anticipated to be 50 by 350 feet at a depth of 4 feet, or approximately 2,600 cubic yards for off-site disposal at a non-hazardous waste facility.

A soil-bentonite upland barrier wall will prevent upland contamination from migrating to the Washington Narrows beachfront. A soil bentonite barrier wall is constructed via an excavated slurry trench, pouring liquid bentonite and mixing in clean fill soil. This type of barrier wall was installed at the McCormick and Baxter Superfund site in Portland, Oregon. The soil bentonite wall was selected due to its lower cost compared to sheet piling and its effective use in a marine environment (E & E 2004).

Installation of an asphalt surface cap includes a high density polyethylene geomembrane. This will prevent surface water runoff from coming into contact with contaminated site soils, potentially carrying contaminants to the groundwater and Washington Narrows. The high density polyethylene geomembrane will be layered with a drainage layer on top, overlain by the asphalt surface. This will allow any stormwater infiltrating the asphalt to flow downgradient without entering the vadose zone. The estimated cost to complete remediation Option 3 is $2,867,432 (Table 4-2).

Qualifiers Relating to Clean Up Options

Based on the limited information acquired during the investigation, several assumptions were used to determine the cost estimates. All site work will be conducted in Level D personal protective equipment (coveralls, hard hats, safety glasses, steel-toe safety boots, and reflective vests). For disposal purposes, excavated "hot spot" soil materials are assumed to be "hazardous" materials. Dredged sediments are assumed to be "non-hazardous" materials as per state and federal disposal regulations. Additional costs to sample previously installed monitoring wells are not included in the estimates. All estimates are based on 2009 dollars.

Table 4-1 Cleanup Estimate Option and Rationale

Cleanup Action	Rationale
Option 1 - Excavation of contaminated soil and monitoring well installation	Lowest cost option: removing contaminated soil and collection of additional data for future remediation decision making purposes.
Option 2 - Excavation of contaminated soil and installation of a pump and treat groundwater system	Mid-range cost option: collecting additional data, removing contaminated soil, and treating groundwater. This option immediately addresses upland contamination.
Option 3 - Dredging of shoreline sediments, installation of an upland barrier wall, and installation of an upland asphalt cap.	High range cost, the most comprehensive option: addresses removal of contaminated soils, sediments, and groundwater. This option also prevents residual contamination from migrating into the lowland sediments.

Table 4-2 Preliminary Cost Estimate for Cleanup Action

Remediation Options	Description	Estimated Cost
Option 1	**Excavation of hot spot contaminated soil and monitoring well installation**	
	Soil Excavation and Off-Site Disposal (hazardous waste) - assumes excavation of 2 upland hot spots (600 cubic yards total); offsite disposal at hazardous waste facility; backfilling; decontamination facilities; analytical testing	$183,466
	Monitoring Well Installation - Install 4 monitoring wells to 45' bgs (includes initial subsurface soil sampling/analysis, and one year of groundwater monitoring)	$102,582
	Subtotal	**$286,048**
	Contingency[a] (+15%)	$42,907
	2009 Inflation adjustment [b]	$10,029
	Total	**$338,984**
Option 2	**Excavation of hot spot contaminated soil and installation of a pump and treat groundwater system**	
	Soil Excavation and Off-Site Disposal (hazardous waste) - assumes excavation of 2 upland hot spots (600 cy total); offsite disposal at hazardous waste facility; backfilling; decontamination facilities; analytical testing	$183,466
	Monitoring Well Installation - assumes 4 monitoring wells to 45' bgs (includes sampling/analysis)	$42,587
	Groundwater Treatment - assumes 150' x 350' contamination plume; pump and treat with filtration and 2 carbon vessels (in series) w/ treated water discharge to POTW	$148,804
	Groundwater Treatment O&M and Monitoring- assumes 5 year operation and monitoring	$446,477
	Subtotal	**$821,334**
	Contingency[a] (+15%)	$123,200
	2009 Inflation adjustment [b]	$28,797
	Total	**$973,331**
Option 3	**Dredging of shoreline sediments, installation of an upland barrier wall, and installation of an upland asphalt cap.**	
	Soil Excavation and Off-Site Disposal (Haz) - assumes excavation of 2 upland hot spots (600 cy total); offsite disposal at haz facility; backfilling; decontamination facilities; analytical testing	$183,466
	Monitoring Well Installation - assumes 4 monitoring wells to 45' bgs (includes sampling/analysis)	$42,587
	Groundwater Treatment - assumes 150' x 350' contamination plume; pump and treat with filtration and 2 carbon vessels (in series) with treated water discharge to POTW	$148,804
	Groundwater Treatment O&M and Monitoring - assumes 5 year operation and monitoring	$446,477
	Barrier Wall - assumes soil bentonite barrier wall (i.e., slurry wall) around GW plume; dimensions: 1000' long x 60' deep with 12" protective gravel cover	$539,517
	Upland Cap - assumes cap dimensions 150' x 350'; HDPE geomembrane with drainage/protection layer overlain with 3" thick asphalt surface layer (includes gas vents and perimeter security fence)	$411,935
	Sediment Dredging - assumes nearshore sediment dredging using water-based equipment; includes bathymetric surveying (pre and post construction), sediment BMPs (e.g., booms, silt curtains, etc.), and sediment dewatering; dredge area 50' x 350' x 4' deep or approx. 2600 cubic yards	$453,126
	Sediment Disposal - assumes offsite transportation and disposal of dredged sediment (following dewatering/solidification) at non-haz facility; 2600 cubic yards	$193,737
	Subtotal	**$2,419,649**
	Contingency[a] (+15%)	$362,947
	2009 Inflation adjustment [b]	$84,836
	Total	**$2,867,432**

Notes:

1. Costs estimates developed using Remedial Action Cost Engineering and Requirements (RACER®), 2008, Software System for Windows
2. Estimates do not include additional study/investigation (e.g., RI/FS), design, long term monitoring, 5 year reviews, site closeout, etc.
3. Costs includes direct costs plus a location modifier of 1.021 (Washington State Average) and overhead and profit (25% field office overhead, 10% subcontractor profit, and 15% prime profit).

[a] The 15% contingency allows for unforeseen costs.

[b] Inflation mark up estimated using the RSMeans Historical Cost Index inflation mark up from 2008 to the first quarter of 2009

5 Conclusions

The Bremerton Gasworks site, which is located in Bremerton, Washington, was the subject of this TBA. During the investigation, potential sources of contamination were identified. The field sampling event was conducted from May 12 to May 15 and on May 19 and June 4, 2008. For this TBA, seven subsurface boreholes locations were drilled to total depths of 45 feet bgs. A total of 65 subsurface soil and groundwater samples were collected. Five sediment samples were collected from the beach along the Washington Narrows. The analytical results for these samples were compared to either MTCA Method A or EPA RSL screening criteria values for soil and groundwater, NOAA SQuiRTs and Washington State SQS values for sediments.

SVOCs, TAL metals, TPHs, and VOCs are present at various locations around the site but in no discernable pattern. The aerial extent of contamination is limited to several localized “hot spots,” but lateral extent is limited to specific subsurface layers. VOC and SVOC contamination does appear to decrease with depth at all borehole locations at the McConkey Property and the Sesko Property. Analytical results of the subsurface soil samples indicate that arsenic is present in all locations at all sample intervals at concentrations that exceed its analyte-specific screening criteria. Based on the natural background soil concentration (1.1 mg/kg to 7.5 mg/kg), it appears that the levels of arsenic found in the site soils may be naturally occurring, even though they are above the MTCA Method A screening criteria.

Analytical results of the on-site groundwater samples indicate that soil contamination has migrated to groundwater. Sample results indicate that SVOC, TPH-diesel, and VOC contamination is present in the water table.

Analytical results of the sediment samples collected on the Washington Narrows indicated the presence of SVOCs at concentrations that exceeded their screening criteria. Based on the analytical results, it appears that contamination from previous operations at the site has migrated to the sediments and, potentially, the surface water in Washington Narrows. Several active seeps were discovered along the Washington Narrows beachfront.

The cleanup options and estimated costs discussed in Section 4 include three remediation options. The first option includes removal of approximately 600 cubic yards of contaminated soil and installation of four monitoring wells to gather additional groundwater contamination data. The second option includes action to be taken under option 1, plus installation of a groundwater pump and treat system. The third option includes remediation options 1 and 2, plus installation of an upland barrier wall, installation of an asphalt soil cap, and sediment dredging of the Washington Narrows sediments. Additional cleanup options that were not discussed in Section 4 may be available as well.

Based on analytical results and professional judgment, it is recommended that the City of Bremerton consult with the Department of Ecology to expedite the remediation process.

6 References

ATSDR, 2005. Bremerton Naval Complex including Puget Sound Naval Shipyard Bremerton, Kitsap County, Washington. National Technical Information Service, Springfield, Virgina.

Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages. http://response.restoration.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf

______, March 2008b, Bremerton Gasworks Targeted Brownfields Assessment Sampling and Quality Assurance Plan, Bremerton, Washington. Prepared for the United States Environmental Protection Agency contract number S&-02-06, Seattle, Washington

______, February 2, 2007, START interview with McConkey property operator Trip McConkey, Bremerton, WA.

______, April 2004, McCorkmick and Baxter Remedial Action Construction Summary Report Assessment, Portland, Oregon. Prepared for the Oregon Department of Environmental Quality task order 71-03-12, Portland, Oregon

GeoEngineers, September 20, 2007, *Preliminary Upland Assessment Report, McConkey/Sesko Properties*, Seattle, WA .

RACER, Remedial Action Cost Engineering and Requirements (RACER), 2008, Software System for Windows

RSMeans, Historical Cost Index 2008 – 2009 edition, Phillip R. Wairer, R.S. Means Company, Chicago, IL.

TechLaw, Inc., August 22, 2006, *Phase I Targeted Brownfields Site Assessment,* Port Orchard, WA.

United States Environmental Protection Agency (EPA), March 2009, EPA Mid-Atlantic Risk Assessment Risk Based Concentration Tables http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/faq.htm

______, October 2002a, EPA Brownfields Economic Redevelopment Initiative, Office of Solid Waste and Emergency Response, Quick Reference Sheet, 500-F00-241.

_____, December 2002b. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. December 2002. http://www.epa.gov/superfund/health/conmedia/soil/index.html

_____,1996a. Soil Screening Guidance: User's Guide. Office of Emergency and Remedial Response. Washington, DC. OSWER No. 9355.4-23 http://www.epa.gov/superfund/health/conmedia/soil/index.htm#user

_____,1996b. Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. Washington, DC. OSWER No. 9355.4-17A http://www.epa.gov/superfund/health/conmedia/soil/introtbd.htm

______,1991. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals). Office of Emergency and Remedial Response. EPA/540/R-92/003. December 1991.

Washington State Department of Ecology (Ecology), March 2009, Facility/Site Search Database, Facility Identification Number 2788449 https://fortress.wa.gov/ecy/facilitysitesearch/FSDetailReport.aspx?id=2788449

______,October 2008, *Model Toxics Control Act* Cleanup *Regulations Chapter 173-340 WAC*, Publication Number 94-06, Washington State Department of Ecology Toxics Cleanup Program.

______,Ecology. 2007. Evaluating the toxicity and assessing the carcinogenic risk of environmental mixtures using toxicity equivalency factors *https://fortress.wa.gov/ecy/clarc/FocusSheets/tef.pdf*