Public Health Assessment

Evaluation of Exposures to Contaminants in Soil, Sediments, and Groundwater, Bremerton Gasworks Superfund Site
Bremerton, Kitsap County, Washington

December 12, 2016

Prepared by

The Washington State Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Washington State Department of Health

DOH 334-407

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's Cooperative Agreement Partner pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Introduction

Polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, and metals from the Bremerton Gasworks Superfund site in Kitsap County, Washington were released. These releases resulted in contamination of soil, groundwater, and sediment along the shoreline of the Port Washington Narrows. The Bremerton Gasworks Superfund site centers around a former manufactured gas plant (MGP) that operated from 1930 to 1963. Other past and current industrial activities adjacent to the former MGP may have also contributed to contamination. These activities include but are not limited to fuel storage and distribution, marine salvage and repair, boat part and pier float fabrication, electroplating, sheet metal duct work, concrete fabrication, possible landfill activity, etc.

This health assessment is mandated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. On September 15, 2011, U.S. Environmental Protection Agency (EPA) proposed to place the Bremerton Gasworks site in Bremerton, Washington on the National Priorities List (NPL) in accordance with Section 105 of CERCLA 42 United States Code (U.S.C.) 9605. The NPL is EPA's list of the nation's most contaminated hazardous waste sites, also known as Superfund sites. The Agency for Toxic Substances and Disease Registry's (ATSDR) goal is to conduct health assessment activities for all sites proposed for inclusion on the NPL. On May 10, 2012, EPA officially listed Bremerton Gasworks site on the NPL.

The EPA is developing plans for a remedial investigation (RI) and feasibility study (FS) for cleanup. Through this process, EPA will determine the site boundary by investigating all sources and extent of contamination. For this public health assessment, the term 'site' refers to upland, shoreline, and waterway areas near the former MGP. This includes nearby locations of current and past industrial activities that may have contributed to contamination.

Overview

The Washington State Department of Health (DOH) reviewed the analytical results of soil, groundwater, and sediment samples taken from the site prior to the completion of the 2010 Time Critical Removal Action. The sediment sampling efforts taken in 2013 are outside the scope of this document and are not included in this review. Department of Health will be preparing a separate document to address the 2010 and 2013 Time Critical Removal Actions. There are four general areas of public health concern addressed in this document:

- Potential of exposure from touching or accidentally ingesting chemicals from contaminated site soils and shoreline sediments.
- Potential of drinking contaminated groundwater.
- Potential of exposure from eating berries grown on the site and eating fish or shellfish living near the site.
- Physically unsafe areas near the site.

Department of Health reached five conclusions in this public health assessment:

Conclusion 1. Trespassing on the site could result in physical injury. This is an urgent public health hazard. Actions to prevent these hazards have been recommended.

Basis for Decision. Several physical hazards are present at the site.

- The bluff at the end of Pennsylvania Avenue is very steep and has a well-used path. This path leads to an area where a rope is necessary to go down to the shoreline. One of the owners, as well as Kitsap Public Health District, has cut this rope to discourage trespassers.
- At the bottom of the path, debris from former waste dumping is emerging from the bluff and shoreline sediment. Of concern is a rusted metal tank located adjacent to the path and hidden by brush. A person could very easily fall in or on the tank and become seriously injured.
- Two large former ballast tanks are abandoned on the shoreline. These tanks are heavy, anchored to the shoreline with an old rope, and do not move. It is not known what was in these tanks. Access at low tide could result in injury if a person tried to climb these tanks. They may even become trapped if entry is achieved.

Next Steps. To protect residents, visitors, and trespassers, Department of Health recommends the following:

- A sign be installed at the end of Pennsylvania Avenue prohibiting beach access.
- The rusted tank at the foot of the bluff be mitigated to reduce the hazard within three months of this assessment being released.
- The submarine ballast tanks be mitigated to reduce the hazard by the owner in collaboration with EPA and Washington State Department of Natural Resources (DNR) within six months of this assessment being released.

Conclusion 2. Touching or accidentally ingesting sediments for more than a year could harm the health of children or adults.

Basis for Decision. PAHs were found in sediments near seeps and a former pipe that led to the beach. Playing at the beach, touching, or accidentally ingesting these sediments could result in an increased risk for developing cancer. The risk estimates exceed EPA's range of acceptable estimated cancer risk.[1] For residents who live adjacent to the site, we estimate five additional cases of cancer will develop for every 1,000 people exposed over a lifetime (78 years). Visitors and trespassers also exceed the acceptable range of cancer risk. Further information is needed to know how widespread the contamination is along the shoreline.

Next Steps. To protect residents and visitors, Department of Health recommends the following:

- Ongoing source(s) of contaminants be identified and mitigated to reduce the potential of exposure.

[1] EPA's acceptable increased risk of developing cancer ranges from developing 1 additional cancer case in 10,000 people exposed to 1 additional case for every 1,000,000 people exposed (1×10^{-4} to 1×10^{-6}).

- People protect their health by not walking or playing on the shoreline near the site.
- Parents monitor their children's behavior while playing outdoors to prevent them from going onto the shoreline.
- EPA facilitates the maintenance of the capped area on the shoreline. The cap consists of an absorbent clay mat covered with large rocks. Maintenance is recommended to continue until the extent of contamination is known and a remedy is determined.
- Kitsap Public Health District facilitates replacement of signs on shoreline warning people of contamination.
- Site access be restricted until further characterization and health assessments are completed.

Conclusion 3. Department of Health cannot conclude if trespassers are touching contaminated soils at the site. The nature and extent of soil contamination are not known. Future changes to land use may lead to increased contact with the soil. More soil sample data will be collected during EPA's upcoming RI.

Basis for Decision. Most of the former MGP footprint and industrial locations are now covered by asphalt. People are not able to contact most of the contaminated soils. However, a small portion of the former MGP is not covered. Trespassers may come into contact with contaminated soils in this area. More sampling and information on future land use is needed to fully assess if current or future health threats exist.

Next Steps. Department of Health recommends the following:

- Site access be restricted and signed appropriately.
- Nature and extent of contamination in surface soils be characterized.
- Future land use be determined based on risks of disturbing remaining contaminants or recontamination of remediated areas.

Conclusion 4. Department of Health cannot conclude if people are being exposed to contaminants from eating fish or shellfish harvested at the site. Shellfish and fish tissue data are needed to assess any potential health threat.

Basis for Decision. Though uncommon, residents reported stories of people fishing off the bluff along the site. Commercial shellfish harvest in the area and recreational shellfish harvest on nearby public beaches have been closed for many years. Department of Health closed these areas because of combined sewer overflow releases and status as an active harbor. The intertidal area near the site is not expected to reopen for shellfish harvest. However, the site is situated within the Suquamish Tribe's usual and accustomed (U&A) subsistence fish and shellfish harvest areas. Sediments are contaminated at the site (see conclusion #2) and the extent of contamination is not known. Fish and shellfish tissue sampling and analysis are needed to determine if a health threat exists.

Next Steps. To protect the Suquamish tribal members, Department of Health recommends that EPA consider developing a fish and shellfish sampling and analysis plan.

Conclusion 5. No one is drinking the contaminated groundwater located in the vicinity of the site. No harm is expected.

Basis for Decision. The City of Bremerton has never had public drinking water wells in the vicinity of the site. Thus, the people in residences and businesses in the area are not drinking groundwater contaminated by releases at the site.

Next Steps. No further action is required.

For More Information

A copy of this public health assessment will be provided to EPA, Washington State Department of Ecology (Ecology), Washington State Department of Natural Resources (DNR), current and past owners, current tenants, City of Bremerton, the Suquamish Tribe, Kitsap Public Health District, and the Kitsap Regional Library in downtown Bremerton.

A copy of this public health assessment report will be placed on the Department of Health's web site assessment webpage: http://www.doh.wa.gov/consults. If you have any questions about this health consultation contact Lenford O'Garro at 360-236-3376 or 1-877-485-7316 at Washington State Department of Health.

For more information about ATSDR, contact the Center for Disease Control and Prevention (CDC) Information Center at 1-800-CDC-INFO (1-800-232-4636) or visit the agency's web site at www.atsdr.cdc.gov.

Purpose and Statement of Issues

The purpose of this public health assessment (PHA) is to: 1) determine whether chemical releases from the Bremerton Gasworks Superfund site pose a public health threat, 2) recommend appropriate actions to protect public health, and 3) identify data gaps where additional sampling may be needed to better assess health risks. The Bremerton Gasworks Superfund site centers around a former manufactured gas plant (MGP) that operated from 1930 to 1963. Other past and current industrial activities adjacent to the former MGP may have also contributed to contamination.

Washington State Department of Health (DOH) prepared this public health assessment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). This health assessment is mandated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. On September 15, 2011, U.S. Environmental Protection Agency (EPA) proposed to place the Bremerton Gasworks site in Bremerton, Washington on the National Priorities List (NPL) in accordance with Section 105 of CERCLA 42 United States Code (U.S.C.) 9605. The NPL is EPA's list of the nation's most contaminated hazardous waste sites, also known as Superfund sites. ATSDR's goal is to conduct health assessment activities for all sites proposed for inclusion on the NPL. On May 10, 2012, EPA officially listed Bremerton Gasworks site on the NPL.

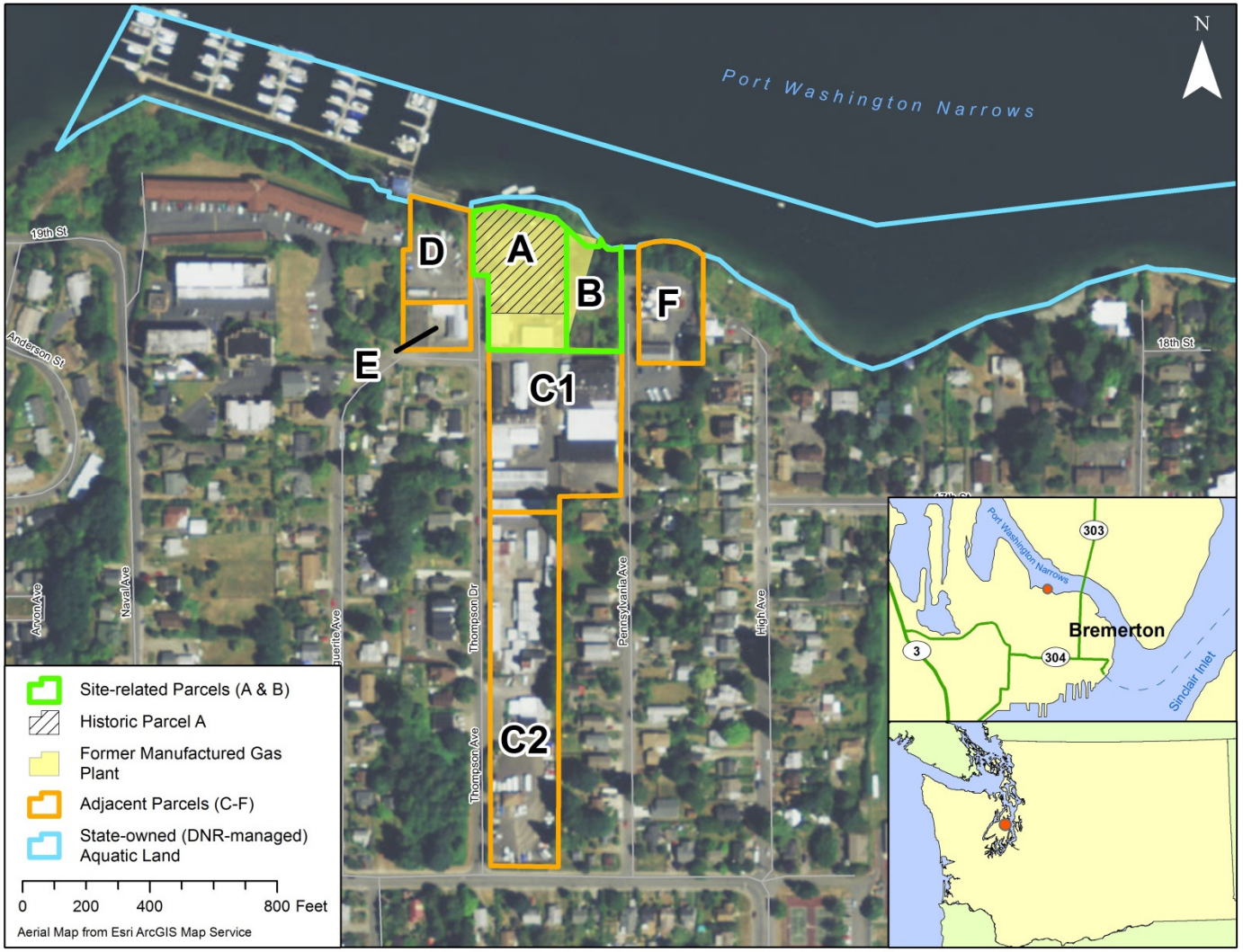
The public comment period for this PHA was from February 26, 2014 through March 28, 2014. This **final PHA report** incorporates changes or revisions and responses to public comments. This PHA is based on the information available about the site prior to the completion of the 2010 and 2013 Time Critical Removal Actions. This version of the PHA reflects Department of Health's final conclusions and recommendations for the Bremerton Gasworks Superfund Site at that time. Department of Health will be preparing a document to address the 2010 and 2013 Time Critical Removal Actions. This report will be available on the Department of Health website and at the Kitsap Regional library in Bremerton, Washington. The final PHA reports will also be available on the ATSDR website.

Background

Site Description

The Bremerton Gasworks Superfund site is located in West Bremerton, Kitsap County, Washington. The site is approximately one mile north by northwest of downtown Bremerton and the ferry dock (Figure 1). It lies along the south shoreline of the Port Washington Narrows less than a half mile west of the Warren Avenue Bridge. The site has a gentle north-facing slope with bluffs approximately 40–50 feet above sea level. The Port Washington Narrows connects Dyes Inlet to Sinclair Inlet. Sinclair Inlet drains into the Puget Sound.

Figure 1. Bremerton Gasworks Superfund area including site-related Parcels (A–F), former manufactured gas plant boundary, and state aquatic lands in Bremerton, Kitsap County, Washington.



The formal boundaries of the site have yet to be determined by EPA. Data collected during the remedial investigation (RI) and cleanup feasibility study (FS) will help determine all the sources, nature, and extent of contamination. In addition to the operations at the former MGP, other past and current industrial activities may have contributed to the contamination at the site. **For this assessment, the term 'site' refers to the upland, shoreline, and waterway areas near the former MGP footprint (Figure 1).**

Table 1 provides a list of parcels with known past or current business operations that may have contributed to contamination.

Table 1. Parcel identification and industrial activities in the area of the Bremerton Gasworks Superfund site, Bremerton, Kitsap County, Washington.

Parcel	Parcel Number	Current Activity	Past Activity
A	3711-000-001-0409 address not available	Storage (vehicles and implements)	Gas production, former product dock, metal fabrication (cutting fitting, welding, electroplating, sandblasting, and painting)
B	3741-000-022-0101 address not available	Vacant	Gas production, bulk fuel distribution, former product dock, industrial and/or municipal landfill, metal salvage, and repair of ship parts
C	**C1** 3711-000-001-0607 1723 Pennsylvania Avenue	Storage, light industrial activity (e.g., welding)	Gas production, storage, industrial activities (sheet metal shaping, pipe fitting, plumbing storage and supply, pier manufacturing, welding, building and repair of boat parts, electrical contracting, manufacture of granite countertops, etc.)
	C2 142401-2-025-2008 1512 and 1550 Thompson Drive	Storage, light industrial activity (e.g., welding)	Fabrication of concrete blocks, sewer pipes, and manholes; concrete storage; concrete covering of pier floats
D	3711-000-010-0002 1805 Thompson Drive Building B	Marina parking lot and upland boat storage	Marina parking lot and upland boat storage; former product pipeline; former product dock
E	3711-000-009-0005 1701 Thompson Drive	Vacant	Bulk fuel distribution; furniture fabrication; marine propeller electrical repair and parts supplier
F	3741-000-001-0007 1702 Pennsylvania Avenue	Bulk fuel distribution (diesel)	Bulk fuel distribution, former product pipeline and dock

Note: Site boundary has not yet been determined by the U.S. Environmental Protection Agency; operation information from site documents (Anchor 2011 (1), Ecology and Environment 2009 (2), Hart Crowser 2007 (3) and current owners; parcel information from Kitsap County Assessor (http://kcwppub3.co.kitsap.wa.us/ParcelSearch/).

Residential areas border these parcels on the east, west, and south. Thompson Drive and Pennsylvania Avenue are owned and operated by the City of Bremerton. A combined storm sewer overflow outfall runs from Pennsylvania Avenue and discharges approximately 30 yards

offshore of the site. The site is located within the Suquamish Tribe's usual and accustomed (U&A) fishing and shell fishing area. Within the U&A, the tribe has treaty-reserved fishing and shell fishing rights. The tribe co-manages fishery resources with the state of Washington.

The intertidal and subtidal lands in this area are state-owned aquatic land managed by Washington State Department of Natural Resources (DNR). This includes the land along the shoreline that is exposed and submerged with the ebb and flow of tides. The shoreline is mostly accessible when water is at four feet above mean lower low water [2] (+4) and below.

Current Conditions and Operations

The following numbered paragraphs describe known current uses on the parcels listed in Table 1 and shown in Figure 1. A brief description of parcel conditions that limit or impact human exposure to site contaminants is also provided. Access to Parcels A, B, and C1 are within a fence with locked entrance.

1. **Parcel A:** Paved area used for vehicle and implement storage (0.83 acres). The shoreline banks are steep and have large concrete retaining blocks along the water's edge. The bluffs have discarded creosote-treated wood pilings lying against the slopes underneath the brush. At the edge of the bluff, a strong creosote-like odor can be detected.
2. **Parcel B**: Area is vacant, unpaved, and largely overgrown with brush (0.6 acres). The southern edge of the parcel has two cement foundations that once supported ten above ground storage tanks (ASTs) (see historical operations below). The two cement foundations now contain standing water/dried mud. There is a fence along Pennsylvania Avenue and access is through Parcel C1. Jersey barriers (modular concrete road barriers) separate Parcel B from Parcels A and C1. Along the west side of the parcel, a former unpaved access road leads toward the shoreline. Unrestricted foot access from the shoreline in this area shows indications of trespasser habitation.
3. **Parcel C1**: Area is paved with seven buildings used for storage and light industrial activities (2.1 acres). Tenants have access through a locked fenced entrance. Motorized access to Parcels A and B are also through this entrance.
4. **Parcel C2**: Area is paved with four buildings used for storage and light industrial activities (2.47 acres). Tenants have access through a locked fence.
5. **Parcel D:** Area provides paved marina parking (0.65 acres) and moderately restricted shoreline access. The Port Washington Marina is located in the Narrows next to this parcel and runs 81 active boat slips.
6. **Parcel E**: Area is paved with vacant buildings (0.33 acres). The southeast portion of the parcel has cement foundations and exterior pipe connections. These once supported ASTs of the former bulk fueling facility (see historical operations below).
7. **Parcel F**: Area has three buildings and contains a paved bulk diesel fueling facility with six active ASTs (0.77 acres).

[2] Mean lower low water (MLLW) is the average height of the lower low waters over a 19-year period. Lower low water is the lower of the two low waters tides of the day.

Historical Operations

Bremerton Gasworks (Former MGP). The former MGP operations are a source of primary concern at the site. The former MGP covered **Parcel A, the west of Parcel B, and north of Parcel C1, and portions of the harbor area leased from DNR** (Figures 1–3). Under several different owners, this plant provided manufactured gas to the City of Bremerton customers for lighting, heating, and cooking. The MGP structures were originally constructed to extract gas from coal using the carbureted water gas process (3). This process injected steam through an incandescent bed of coke or coal. The water gas produced was then fed into a carburetor where it was enriched with light hydrocarbons. It is unknown what fuel was used to enrich the water gas. However, petroleum oil-based feed stocks commonly used included naptha; gas oils (diesel, heating, and fuel oils); and residual oils.

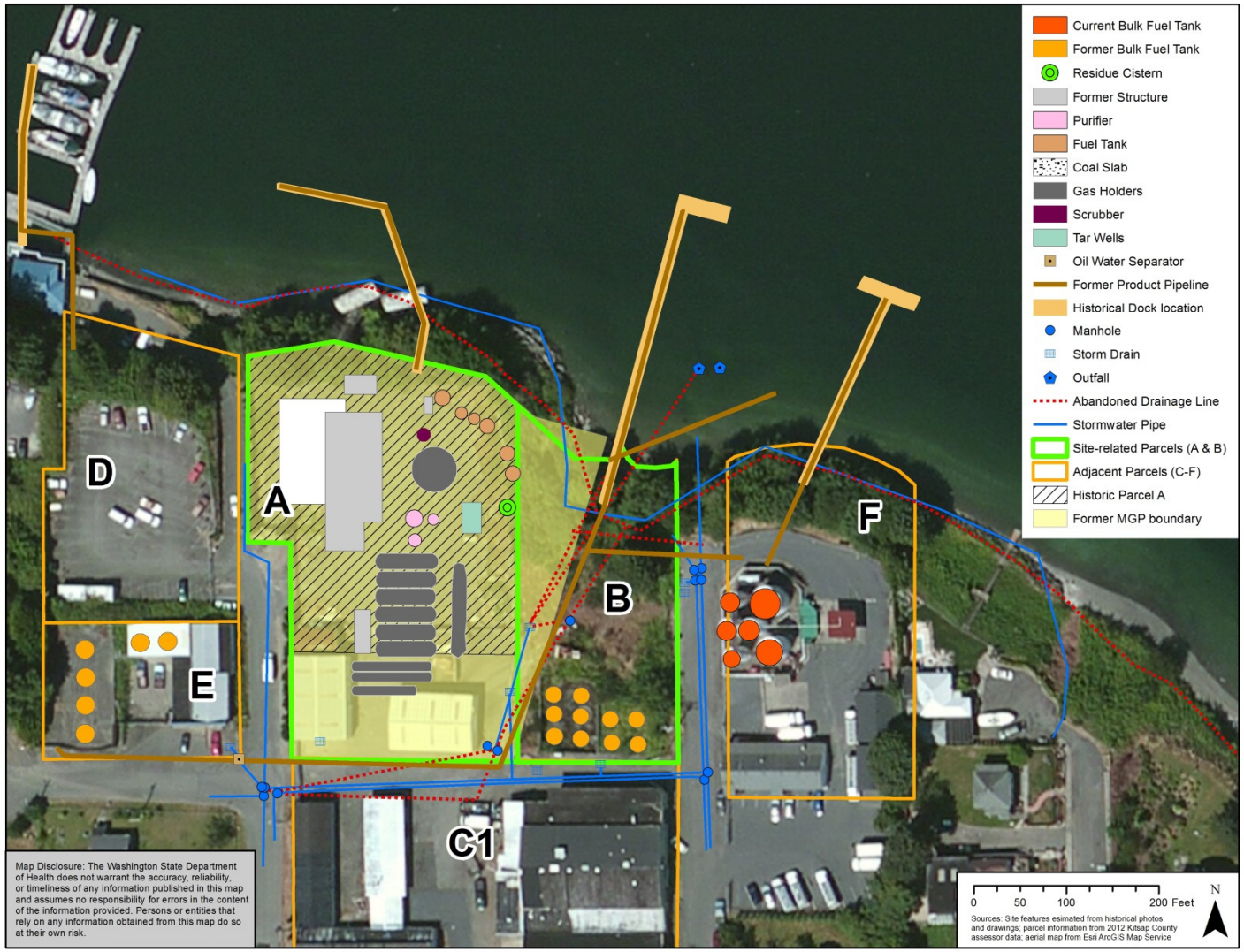
It was reported in 1942 that wood chips were used to remove the tar from the end product (3;4). The "tar-laden wood chips" and the "soot from the water gas machine" were disposed of at the edge of the plant near the oil storage tanks. These byproducts were used to fill a gully on what is presumed to be Parcel B. The tar emulsion was dumped in shallow pits dug at random in the ground. It is not known when these practices started or ended.

Figure 2 demonstrates actual structure configuration and boundaries of the former gasworks plant on a historical photo from the 1950s. Figure 3 provides a more detailed, close-up view of the former structures. These structures included a coal storage area; water gas generator; winch; gas holder and gas tanks; diesel, oil, and gasoline tanks; purifiers and scrubbers; tar well; residue cistern; and numerous underground pipes. Figure 2 shows three piers servicing the area.

The MGP used a carbureted water gas process from 1930 to 1956. From 1955 to approximately 1963, Cascade Natural Gas Corporation produced gas at the facility by blending propane and air (3;5). Over the duration of the plant's operational period, the former MGP maintained approximately 17 petroleum liquid and gas ASTs. Plant operations ceased in the 1960s and dismantling of facility structures commenced by 1971 (3).

Figure 2. Historical aerial photo of the Bremerton Gasworks Superfund site area in Bremerton, Kitsap County, Washington.

Figure 3. Former structures of the manufactured gas plant and bulk fueling facilities near the site, Bremerton, Kitsap County, Washington.



Landfill Activity. Historical photos indicate the shoreline of **Parcel B** has significantly changed over time. These changes clearly demonstrate that this area has been filled. Most fill activities occurred between 1963 and 1971 (3). No records were available to identify sources of the fill material. The bluff at the end of Pennsylvania Avenue is very steep and has a well-used path. This path leads to an area where a rope is necessary to go down to the shoreline. At the bottom of the path, debris from former waste dumping is emerging from the bluff and shoreline sediment. Of concern is a rusted metal tank located adjacent to the path and hidden by brush. A person could very easily fall in or on the tank and become seriously injured.

Bulk Fuel Facilities. Three bulk fuel facilities operated separately from the MGP and stored petroleum fuels in ASTs. The product arrived by barge and was transferred to ASTs via above and below ground pipelines, and then distributed from the ASTs (3;5). Use of the three or four former piers was consolidated over time and two or more facilities shared a single pier in later years. All former piers have been removed. It is unknown if the underground distribution pipelines still exist or if product still remains in them. The facilities were or are located on:

- **Parcel B.** Fuel facility was located adjacent to the former MGP. Ten ASTs were on site through the 1940s. Ownership and specific facility operations are unknown. The tanks were removed by the mid-1990s. In 2003, the current owner attempted to remove an underground storage tank (UST) without a permit. Washington State Department of Ecology (Ecology) has no record of USTs or removals on this parcel. It is unknown if the UST is still present.
- **Parcel E.** Six ASTs, built by Atlantic Richfield Company (ARCO), were operated by several different owners/tenants from 1942 to 1992. When ARCO operated the facility, the four ASTs on the western border were labeled as oil tanks (2;3). The plant was dismantled between the late 1980s to the early 1990s and became a furniture business until 1998, followed by a wholesale marine electronic equipment company. Ecology has no record of USTs or removals on this parcel.
- **Parcel F.** Six ASTs are currently in use by SC Fuels. The footprint of this distribution facility has changed little since the 1940s. From 1947 to 1968, the ASTs were used for petroleum products or waste oil (3). The facility now distributes biodiesel. Ecology lists four USTs as removed from the facility. Prior to removal, one UST contained unleaded gasoline, two contained leaded gasoline, and one contained waste oil.

Penn Plaza Storage LLC. This storage facility is located on Parcels A, C1, and C2. Much of the property has storage units that contain personal or industrial items. Some industrial activity by tenants has occurred or is occurring on these parcels. Historical operations include:

- Metal fabrication (cutting, fitting, welding, sandblasting, painting, and manufacturing of containment vessels) (Lee Fabricators).
- Electroplating operation.
- Sheet metal operation.
- Electrical contractor.
- Building and repairing ship parts.
- Boat repair.
- Concrete float (pier) fabrication.

- Concrete fabrication and storage (blocks, sewer pipes, and manholes).

State-Owned Aquatic Lands. A complete review of DNR-managed activities along the shoreline of the site is beyond the scope of this document. Several sources may have contributed to contamination present on the shoreline. These include:

- Known and unknown effluent drain pipes from the former MGP.
- Unknown effluent drain pipes from other industrial operations.
- Contaminated groundwater released from underground seeps.
- Surface water runoff.
- Combined sewer overflow releases.
- Product and/or fuel spills from vessels.
- Releases from industrial and municipal wastes from Parcel B.
- Boats (i.e., in the adjacent marina, traveling in the Narrows, abandoned on shoreline).
- Unknown chemicals in the two abandoned ballast tanks.
- Creosote-treated pilings from former piers.

Environmental Investigations

The following environmental investigations have occurred at the site and are listed in chronological order. Data from some of these investigations were used to evaluate the nature and extent of contamination:

In 1992, Ecology inspected Lee Fabricators, a former metal fabrication business in operation since 1986 on **Parcel A** (3). The business was inspected in response to an initiative from Ecology's Sinclair and Dyes Inlet Action Program. Ecology identified two contamination issues:

- One to two inches of uncontained sandblast grit leftover from cleaning metals prior to painting. Grit was high in metal content and entering surface runoff.
- Storage of accumulated paint sludge containing methyl ethyl ketone used to clean the paint guns.

In 1993, Ecology inspected Pier 44 Construction and CB Concrete Products located on **Parcels C1 and C2** (3). In 1994, as a result of lack of improvements of the following observations, the site was listed on Ecology's Confirmed and Suspected Contaminated Sites list:

- At CB Concrete, Ecology identified uncontained oil leaks, piles of uncovered waste concrete which drained to storm water runoff, a large pile of empty stacked fiberglass drums, and oil drums without secondary containment.
- At Pier 44 Construction, Ecology identified uncontained concrete and a dark stain on the floor from diesel used as a releasing agent from the molds.
- At Lee Fabricators, Ecology again noted uncontrolled accumulation of sandblast grit in storm water runoff and improper storage of waste oil.
- During electroplating operations at an unknown location, illegally discharged substances were disposed of into storm drains.

In 1995, DNR observed unpermitted building of ship parts and reclamation activities on **Parcels A and B**. DNR requested that Ecology perform a Site Hazard Assessment. Unrelated to these activities, a black gooey substance with a creosote odor was identified on the bluff of **Parcel B**. PAHs and metals were determined to be contaminants of concern based on one sediment and three soil samples. Ecology added the site to the state's Hazardous Site List.

In 1998, Ecology performed an initial investigation at **Parcel F**, the current bulk fuel facility located on Pennsylvania Avenue (6). Groundwater and soil samples confirmed the presence of non-halogenated solvents and petroleum products above the Washington State Model Control Act (MTCA) cleanup levels. Pacific Northwest Energy Company entered Ecology's Voluntary Cleanup Program (FS ID 2788449) in 2001. They exited the program in 2009. Department of Health did not have any site documents at the time of this review. Three leaded and unleaded 10,000-gallon USTs and a 5,000-gallon waste oil UST were removed from the facility in the early 2000s (3;6).

In 2006, EPA awarded the City of Bremerton a Brownfields Assessment grant. At that time, the city and owners wanted to develop **Parcels A and B** as a public access marina (2). Soil contamination has migrated from the soil into the groundwater beneath the site (2). Contamination of the sediments in the Washington Narrows was also identified. Contaminants of concern included PAHs, metals, total petroleum hydrocarbons (TPH), and TPH-associated non-chlorinated solvents. Several waste barrels from the City of Bremerton's Brownfield's Assessment sampling efforts are still located on **Parcels A and B**.

In 2010, Kitsap Public Health District (KPHD) investigated reports of an oily sheen on the shoreline of **Parcels A and B**. The release was from an old pipe filled with what appeared to be leftover coal tar creosote and contaminated sediment. KPHD reported the information to EPA. EPA contacted the Coast Guard, who installed a containment system and then cut and temporarily plugged the end of the pipe. The Coast Guard and EPA's Superfund Technical Assessment and Emergency Response Team (START) collected and analyzed 30 sediment samples. They identified high PAH contamination covering about 100 square feet extending out 60 feet below the high tide line. (1). The depth of contamination was not determined. The U.S. Coast Guard entered into an Administrative Order for a Pollution Incident with a former owner, Cascade Natural Gas Corporation, to stop the release. The release came from what appeared to be an abandoned sewer storm water outfall pipe. It was once connected to, or may still be connected to, an abandoned vault. The vault likely received discharge from catch basins on the former MGP footprint on **Parcels A and B** (1). Cascade Natural Gas removed approximately 60 feet of pipe and plugged the end. They excavated sediment up to five feet deep and five feet around where the pipe was removed. The

Figure 4. Contaminated sediments at low tide during October 2010 resulting in emergency action removal of product pipe and sediments Bremerton, Washington (photo courtesy of Kitsap Public Health District).

area was filled with clean sand and covered by an absorbent clay mat and large rocks. Because of remaining contamination, the site was proposed to EPA's NPL in September 2011 and listed in May 2012.

In the summer of 2013, Cascade Natural Gas and its contractors, with the EPA's oversight, collected samples on the beach north of the old Bremerton Gasworks. The key finding was areas of solid tar and oil containing polyaromatic hydrocarbons on the beach. In the fall of 2013, Cascade Natural Gas removed the solid tar and capped the oily area on the beach with a clay mat covered with a foot of imported beach material.

Cascade is conducting a more in depth remedial investigation and feasibility study (RI/FS) under the direction of EPA pursuant to the Administrative Settlement Agreement and Order on Consent.

Natural Resources

Climate. In general, the Puget Sound Lowland climate is characterized by mild, wet winters and warm, dry summers. Temperatures do not vary dramatically between the winter and summer. Winter temperatures typically range from 30ºF to 50ºF, and summer temperatures range from 50ºF to 70ºF. Precipitation is seasonal with two thirds of the rain falling between November and March. Rain is characterized as frequent and low-intensity with long-duration patterns. Precipitation in the Puget Sound Lowlands, which includes the Bremerton area, averages about 43 inches per year. Snow is rare. Winter storms can be associated with high winds and prevailing winds are from the south/southwest. Storm surges in low-lying coastal areas occur, especially when aligned with higher tides.

Geology and Marine Water Resources. The surface geology of the Puget Sound Lowlands consists mainly of glacial, alluvial, and marine sediments. Little bedrock is exposed. The typical soil in the area is Alderwood, formed from glacial till (5). Surface water and storm water flows to the city storm drain which flows into the Narrows. Surface water and storm water can also flow from Parcels C1 and A onto Parcel B then directly onto the shoreline.

The Port Washington Narrows, north of the property, is a 3-mile channel connecting Dyes Inlet to Sinclair Inlet. Sinclair Inlet drains into Puget Sound. This channel is considered a harbor area. This is a relatively deep, narrow channel with strong tidal currents and bluff-backed beaches. Tidal flows drive strong currents through the Narrows at approximately four knots. The daily cycle of tides in Puget Sound includes two unequal high tides and two unequal low tides. From day to day, the height and time of the tide varies depending on the lunar cycle. The lowest and highest tides occur near the summer and winter solstices. The extreme low tides of late fall and early winter occur near midnight. Low tides permitting access to the shoreline during the day occur about 60% of the year (218 out of 365 days) [3] mostly between March and September. At

[3] Access to the shoreline occurs when the water is less than four feet above mean lower low water (4+ tide). Mean lower low water is the average of the extreme low tides recorded at a tide station. The closest National Oceanic and Atmospheric Administration (NOAA) tide station is at Tracyton, Dyes Inlet. Estimates are days in 2011with 4+ tides or lower that occur between 7 a.m. and 7 p.m.
http://tidesandcurrents.noaa.gov/noaatidepredictions/NOAATidesFacade.jsp?Stationid=9445901

this location, tides usually range from -3 feet below to +14 feet above the average of the lowest tides recorded at the closest tide station.

Groundwater. Sand and gravel deposited during the last ice age compose the aquifers in the area. Based on topography and local drainage patterns, shallow-seated groundwater flows to the north or northeast (5). From previous reports, depth to groundwater is estimated at 10 to 20 feet deep (5).

The City of Bremerton has never had public drinking water wells in the vicinity of the site. Thus, the people in residences and businesses in the area are not drinking water contaminated by releases at the site. When Bremerton incorporated in 1901, the population was drinking from local wells and springs. It is not known if private wells were located near the site at that time or when these owners started using city water. Bremerton has provided citizens with public drinking water from several surface water sources from 1917 to present. Currently, the Union River supplies 60% of this water. The other 40% is supplied by 13 production wells that were added to the public water supply in the 1940s. None of these wells are near the site and are miles away. Private wells are not allowed to be used within the Bremerton Water Service Area. For more information on Bremerton's water sources see the city's website.[4]

Fish. A number of fish common to the Puget Sound are presumed to be in the Port Washington Narrows. Tidal currents are swift within the Port Washington Narrows and may be a deterrent to fishing. Local residents have observed fishing from boats in the Narrows and from the shoreline. This is not a frequent event.

Department of Health has set the following fish consumption advisories for the Bremerton area.[5] This advisory is not related to the Bremerton Gasworks site. Advisories are based on an adult meal size of 8 ounces (227 grams) of uncooked fish.

- Chinook salmon – no more than one meal per week (all of Puget Sound).
- Resident juvenile Chinook salmon (blackmouth salmon) – no more than one meal per month (all of Puget Sound).
- Puget Sound rockfish – no more than one meal per week from Bremerton area and most of Puget Sound. Do not eat Puget Sound rockfish from Sinclair Inlet.
- Yelloweye and canary rockfish – Do not eat.
- English sole and other flatfish – no more than one meal per week from Port Orchard Passage and no more than one meal per month from Sinclair Inlet.

No Puget Sound meal limits have been set for other species of salmon (coho, chum, pink, or sockeye).

Bivalves (Clams, Oysters, and Mussels). Shellfish bivalve species known to the area include oysters, mussels, and a variety of clams. Department of Health and Kitsap Public Health District regularly test shellfish and water for fecal and biological toxins. Department of Health has closed

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[4] http://www.ci.bremerton.wa.us/display.php?id=733

[5] http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-104.pdf

commercial harvest in the area and recreational harvest on nearby public beaches for many years because of combined sewer overflow outfalls. **Do not eat shellfish from the Bremerton Area.** Several starfish, small crabs, clam shells, and other invertebrates were observed at low tide during the site visit in July 2012.

Crab and Shrimp. Dungeness crab (*Cancer magister*) live in the subtidal sediments of the Port Washington Narrows. Spot prawn (*Pandalus playceros*), coonstripe shrimp (*P. danae and P. hypsinotus*) and pink shrimp (*P. eous and P. jordani*) are known to Puget Sound and probably present in the Narrows. Department of Health has a crab advisory for the Bremerton area. Advisories assume that an adult meal size equals 8 ounces (227 grams) of uncooked crab. **Do not eat Dungeness and red rock crab from the Bremerton area.**

Demographics

The site is located in an urban area of Bremerton. Nearby, there are industries, residences, businesses, schools, and the Port of Washington Marina. Bremerton is the largest city on the Kitsap peninsula. It's the home to the Puget Sound Naval Shipyard and U.S. Navy base.

According to the 2010 census, the population in Bremerton is 37,729, which makes up 14% of Kitsap County. A majority of the Bremerton population is white/Caucasian (76.7%). The rest of the population is classified as other race/two or more races (12.9%), African American (6.7%), and Hispanic/Latino (6%). The main language spoken in the area is English (89%), followed by Spanish (4.4%) and Asian languages (4.3%).

The area's economic status falls below the rest of Kitsap County and the state. The average median household income is $38,060, while the county is $59,358 and the state is $56,384. Approximately 14% of the families are below poverty, which is higher than the rest of the county (5.7%) and state (11.8%).

The Suquamish Tribe has "usual and accustomed" fishing rights to the area. According to the 2000 Census, the total population for the Suquamish Tribe is 616 people.

Discussion

Exposure Evaluation

The exposure evaluation consists of three components:

1. Understanding the nature and extent of environmental contamination at and around the site,
2. Identifying exposure pathways by evaluating who may be or has been exposed to site contaminants, and
3. Identifying uncertainties and data gaps to be filled that would help understand exposures to people.

Nature and Extent of Contamination

Department of Health used environmental data collected during several investigations to evaluate the nature and extent of contamination at the site. The environmental data collected in the 2013

sampling event are outside the scope of this document and will be evaluated in a future document. Figure 5 demonstrates the sample locations of data available from the site. The Environmental Investigations section contains details of these investigations. Tables 2, 3, and 4 summarize detected compounds in sediment, surface soil, and groundwater, respectively.

Sediments. Sediment samples from the shoreline have been taken during four investigations.

- In March 1995, one sediment sample (depth unknown) was analyzed for metals and semivolatile organic compounds (SVOCs) during an investigation by Ecology (5;7). These data were not used in the current evaluation. They do not represent current conditions but do identify locations of high contamination not well characterized recently.
- In June 2008, five sediment samples (depth unknown) were analyzed for metals, SVOCs, and total petroleum hydrocarbons – Diesel (TPH-Dx) (2) during the EPA Brownfield assessment.
- In October 2010, 31 sediment samples (30 centimeters (cm) deep) were analyzed for metals, SVOCs, volatile organic compounds (VOCs), and total petroleum hydrocarbons (TPH) during the emergency action removal of the leaking pipe (8). Of these, nine were covered by the interim action placement of a clay mat and rocks.
- In November 2010, samples of removed materials including three sediment samples (30 cm deep) and two samples of sediment/product in the pipe were analyzed for metals, SVOCs, VOCs, and TPH. These data were not used in the current evaluation but identify contaminants of concern.

In general, PAHs are elevated on the shoreline and the extent and depth are not well characterized. Several compounds were analyzed with high detection limits. Limited data suggest that metals are not of concern, but more information is needed. Table 2 summarizes detected compounds in sediment used in this evaluation.

Soils. Soil samples were taken during two investigations at the site. Table 3 summarizes detected compounds in surface soil at the site.

- In May 2008, during EPA's Brownfield assessment, core samples were taken up to 45 feet deep at the seven surface soil locations (2). Cores were separated into 5-foot samples and analyzed for metals, SVOCs, VOCs, and TPH-Dx.
- In March 1995, during the initial investigation by Ecology, three soil samples (depth unknown) were analyzed for metals and SVOCs (7). These data were not used in the current evaluation. They do not represent current conditions but do identify locations of high contamination not well characterized.

PAHs were present in elevated concentrations at a few of the subsurface locations on parcel B. PAHs and TPH were detected up to 35 feet below ground surface (2). The only metal compound found at higher concentrations was thallium in deeper soils (15 - 40 feet below ground surface). As noted in the Exposure Pathways section, the only people that would be exposed to chemicals in subsurface soils would be workers during excavation work. These workers are protected under the Occupational and Safety Health Administration (OSHA). Therefore, these exposures are not evaluated here.

Groundwater. During the Brownfield assessment in June 2008, six groundwater samples were analyzed for metals, SVOC, VOC, and TPH-Dx (2;9;10). Table 4 summarizes detected compounds in groundwater. As noted in the Exposure Pathway section, people are not drinking this contaminated groundwater. However, this water can be discharging into the narrows.

Figure 5. Sample locations from previous investigations at the Bremerton Gasworks Superfund site, Bremerton, Kitsap, Washington.

Table 2. Chemicals in **intertidal sediments** exceeding health-based comparison values, Bremerton Gasworks Superfund site, Kitsap County, Washington.

Chemical [a]	Number Detected / Total Sampled [b]	Soil CV [c] (mg/kg)	Type of CV	Range of Concentrations (mg/kg)	Number Detected (and non-detected) greater than CV
Semivolatile Organic Compounds					
Benz(a)anthracene [e]	28/36	0.48 [d]	CREG/RPF	0.16–69	**26 (7)**
Benzo(a)pyrene [e]	26/36	0.096	CREG	0.26–76	**26 (10)**
Benzo(b)fluoranthene [e]	32/36	0.12 [d]	CREG/RPF	0.13–110	**32 (4)**
Benzo(k)fluoranthene [e]	18/36	3.2 [d]	CREG/RPF	0.19–60	**2 (5)**
Benzo(g,h,i)perylene [e]	11/36	10.7 [d]	CREG/RPF	0.16–32	**2 (5)**
Chrysene [e]	29/36	0.96 [d]	CREG/RPF	0.17–80	**27 (6)**
Dibenz(a,h)anthracene [e]	5/36	0.0096 [d]	CREG/RPF	0.047–15	**5 (31)**
Fluoranthene [e]	34/36	1.2 [d]	CREG/RPF	0.34–110	**31 (2)**
Indeno(1,2,3-cd)pyrene [e]	20/36	1.4 [d]	CREG/RPF	0.15–72	**9 (14)**
Total cPAH BaP-EQ [f]	36/36	0.096 [d]	BaP CREG	**0.93–351** [e]	**36**

Source: Anchor 2011 (1); E&E 2009 (2)

Notes:

[a] Bolded chemicals have detected concentrations in sediments that require further risk evaluation.

[b] Table includes detected chemicals and chemicals with detection limits above the CV. Compounds not detected are not listed.

[c] ATSDR CVs based on child soil exposures were used for screening (CVs for sediment exposures have not been developed). To be conservative, soil CVs reflect residential exposures and are expected to overestimate sediment exposures on the shoreline.

[d] BaP CREG was used as a surrogate compounds chemicals that have no CV. BaP CREG was divided by potency factor relative (RPF) to BaP as presented by EPA 2010 (11) to obtain the CV.

[e] PAHs associated with carcinogenic effects (cPAHs). For each sample, each PAH is multiplied by potency factor relative (RPF) to BaP as presented by EPA 2010 (11). These are summed and presented as the Total cPAH BaP Equivalent (BaP-EQ).

[f] Per ATSDR, CV is health-based for non-carcinogenic effects only, not carcinogenic effects. CREG CV is below background.

Table 2 Abbreviations:

ATSDR	Agency for Toxic Substances and Disease Registry
BaP	Benzo(a)pyrene
BaP-EQ	Benzo(a)pyrene equivalents
cPAH	Polycyclic Aromatic Hydrocarbons that have carcinogenic adverse effects
CREG	ATSDR Cancer Risk Evaluation Guide
CV	Health-based comparison value (unless otherwise indicated)
EPA	U.S. Environmental Protection Agency
mg/kg	milligrams of chemical per kilograms of sediment

Table 3. Chemicals in **surface soil** samples (0–5 feet bgs) exceeding health-based comparison values, Bremerton Gasworks Superfund site, Kitsap County, Washington.

Chemical [a]	Number Detected / Total Sampled [b]	Soil CV [c]	Type of CV	Range of Concentrations (mg/kg)	Number Detected (and non-detected) greater than CV
Semivolatile Organic Compounds (mg/kg)					
Benzo(a)anthracene [e]	5/7	0.48 [d]	CREG/RPF	0.48–1.6	**2**
Benzo(a)pyrene [e]	5/7	0.096	CREG	0.57–2.5	**2**
Benzo(b)fluoranthene [e]	5/7	0.12 [d]	CREG/RPF	0.43–1.8	**2**
Benzo(k)fluoranthene [e]	5/7	3.2 [d]	CREG/RPF	0.0009 JQ– 2.2	
Benzo(g,h,i)perylene [e]	5/7	10.7 [d]	CREG/RPF	0.0011U– 2.4	
Chrysene [e]	4/7	0.96 [d]	CREG/RPF	0.52–3.9	**2**
Dibenzo(a,h)anthracene [e]	5/7	0.0096 [d]	CREG/RPF	0.78–1.1 U	**1(1)**
Fluoranthene [e]	6/7	1.2 [d]	CREG/RPF	0.0016U–12 J	**1**
Indeno(1,2,3-cd)pyrene [e]	5/7	1.4 [d]	CREG/RPF	0.0013U –2.0	**1**
Total PAH BaP Equivalents [f]	6/7	0.096 [d]	BaP CREG	**0.3–13.6** [e]	**3**
Metals (mg/kg)					
Thallium	4/7	0.78	RSL	**2.2 JQ –4.1**	**2**
Total Petroleum Hydrocarbons (mg/kg)					
Heavy oil range	3/7	2,000	MTCA	25U–**4,700J**	**1**

Source: E&E 2009 (2)

Notes:

[a] Bolded chemicals have detected concentrations in surface soil that people could come in contact with. Further evaluation is not done in this report until more information on extent and future land use is available.

[b] Chemicals analyzed but not detected are not listed. However, table includes chemicals with detection limits above the CV.

[c] ATSDR CVs based on child residential soil exposures.

[d] BaP CREG was used as a surrogate compounds chemicals that have no CV. BaP CREG was divided by potency factor relative (RPF) to BaP as presented by EPA 2010 (11) to obtain the CV.

[e] PAHs associated with carcinogenic effects (cPAHs). For each sample, each PAH is multiplied by potency factor relative (RPF) to BaP as presented by EPA 2010 (11). These are summed and presented as the Total cPAH BaP Equivalent (BaP-EQ).

[f] Per ATSDR, CV is health-based for non-carcinogenic effects only, not carcinogenic effects. CREG CV is below background.

Abbreviations:

ATSDR	Agency for Toxic Substances and Disease Registry
BaP-EQ	Benzo(a)pyrene equivalents
cEMEG	ATSDR Environmental Media Evaluation Guide based on chronic exposures (>365 days) based on MRL
cPAH	Polycyclic Aromatic Hydrocarbons that have carcinogenic adverse effects
CREG	ATSDR Cancer Risk Evaluation Guide
CV	Health-based comparison value (unless otherwise indicated)
EPA	U.S. Environmental Protection Agency
J	Chemical positively identified but outside of quality control limits and considered an estimate
JQ	Chemical detected below the reporting limit but above the detection limit and considered an estimate
mg/kg	milligrams of chemical per kilograms of sediment
MTCA	Washington State Model Toxics Control Act cleanup regulation
RSL	EPA Regional Screening Level
U	Value undetected at the detection limit given
bgs	Below ground surface

Table 4. Chemicals in **groundwater** samples exceeding health-based drinking water comparison values, Bremerton Gasworks Superfund site, Kitsap County, Washington.

Chemical [a]	Number Detected / Total Sampled [b]	Drinking Water CV (µg/L) [c]	Type of CV	Range of Concentrations (µg/L)	Number Detected (and Non-detected) greater than CV
Semivolatile Organic Compounds					
Benz(a)anthracene [e]	4/5	0.024 [d]	CREG/RPF	0.05 U–0.66	**2**
Benzo(a)pyrene (BaP) [e]	2/5	0.0048	CREG	0.05 U–1.1	**2**
Benzo(b)fluoranthene [e]	2/5	0.006 [d]	CREG/RPF	0.05 U–0.59	**2**
Benzo(k)fluoranthene [e]	3/5	0.16 [d]	CREG/RPF	0.7	**1**
Benzo(g,h,i)perylene [e]	2/5	0.53 [d]	CREG/RPF	0.12–0.82	**2**
Chrysene [e]	3/5	0.048 [d]	CREG/RPF	0.068–1.1	**2**
Dibenz(a,h)anthracene [e]	1/5	0.00048 [d]	CREG/RPF	0.05U–0.5U	**1**
Fluoranthene [e]	4/5	0.060 [d]	CREG/RPF	0.12–3.7	**4**
Indeno(1,2,3-cd)pyrene [e]	2/5	0.069 [d]	CREG/RPF	0.090–0.40	**2**
Total PAH B(a)P Equivalent [f]	4/5	0.0048 [d]	CREG	**0.61U–3.0** [e]	**4**
Methylnaphthalene, 2-	5/5	40	RMEG	0.11–**170J**	**1**
Trimethylbenzene, 1,2,4-	1/5	15	RSL	0.5U–**16**	**1**
Trimethylbenzene, 1,3,5-	1/5	87	RSL	0.5U–**98**	**1**
Metals (ug/L)					
Arsenic	8/8	0.023	CREG	**0.04–4.1**	**5**
Barium	8/8	2,000	cEMEG	0.10–**3,140**	**2**
Beryllium	4/8	4	MCL	0.37**–7.6**	**2**
Cadmium	5/8	1	cEMEG	0.16**–3.9**	**4**
Chromium [hexavalent chromium]	8/8	9	cEMEG	0.05**–1,670**	**4**
Lead	5/8	15	MCL	1.0 U**–268**	**3**
Manganese	8/8	500	RMEG	0.32**–25,600**	**4**
Vanadium	5/8	100	iEMEG	3.7 JQ**–717**	**3**
Total Petroleum Hydrocarbons					
Diesel range	5/6	500	MTCA	**510–5,500**	**2**
Volatile Organic Compounds					
Benzene	3/6	0.64	CREG	0.25U**–3,100J**	**3**
Naphthalene	3/6	100	LTHA	0.25UJ –**1,800**	**1**
Trichloroethene	2/6	0.76	CREG	0.25U–**25 UJ**	**0 (1)**

Source: Anchor 2011 (1); E&E 2009 (2)

Notes:

[a] Bolded chemicals have detected concentrations that exceeded CV.

[b] Chemicals analyzed but not detected are not listed. However, table includes chemicals with detection limits above the CV.

[c] ATSDR CVs based on child residential soil exposures.

[d] BaP CREG was used as a surrogate compounds chemicals that have no CV. BaP CREG was divided by potency factor relative (RPF) to BaP as presented by EPA 2010 (11) to obtain the CV.

[e] PAHs associated with carcinogenic effects (cPAHs). For each sample, each PAH is multiplied by potency factor relative (RPF) to BaP as presented by EPA 2010 (11). These are summed and presented as the Total cPAH BaP Equivalent (BaP-EQ).

[f] Per ATSDR, CV is health-based for non-carcinogenic effects only, not carcinogenic effects. CREG CV is below background.

Abbreviations:

ATSDR	Agency for Toxic Substances and Disease Registry
BaP-EQ	Benzo(a)pyrene equivalents
cEMEG	ATSDR Environmental Media Evaluation Guide based on chronic exposures (>365 days) based on MRL
cPAH	Polycyclic Aromatic Hydrocarbons that have carcinogenic adverse effects
CREG	ATSDR Cancer Risk Evaluation Guide
RPF	Relative Potency Factor
CV	Health-based comparison value (unless otherwise indicated)
EPA	U.S. Environmental Protection Agency
iEMEG	ATSDR Environmental Media Evaluation Guide based on intermediate exposures (90–365 days) based on MRL
MCL	EPA Maximum Contaminant Level
MTCA	Washington State Model Toxics Control Act cleanup regulation
ppm	parts per million
RMEG	ATSDR Reference Dose Media Evaluation Guide for non-carcinogenic adverse effects
LTHA	EPA Lifetime Health Advisory for drinking water
RSL	EPA Regional Screening Level
U	Value undetected at the detection limit given
UJ	Associated value is an estimated
J	Chemical positively identified but outside of quality control limits and considered an estimate
JQ	Chemical detected below the reporting limit but above the detection limit and considered an estimate
ug/L	micrograms of chemical per liter of water

Exposure Pathways

In order for a chemical to harm human health, people must come into contact with the chemical. An exposure pathway describes how a chemical moves from a source and comes into contact with people. An exposure pathway is specific to when it occurred or will occur: the past, present, or future. An exposure pathway has five elements:

1. A source of contaminants;
2. A release mechanisms into water, soil, air, or the food chain;
3. An exposure point or area;
4. An exposure route (ingestion, dermal contact, or inhalation); and
5. A potentially exposed population.

Exposure pathways may be "completed," "potential," or "eliminated." A completed pathway has all five elements in place and occurring. A potential pathway has one or more of the elements unknown. If one of the five elements is not in place and occurring, the pathway is eliminated and not evaluated. Table 5 describes the completed, potential, and eliminated exposure pathways for the Bremerton Gasworks Superfund site.

Department of health identified the following **completed pathways** at the site:

- Currently and in the past, residents, owners, and workers come in contact with contaminated sediment on the shoreline.
- Currently and in the past, inhalation of vapors from creosote-treated pilings on Parcel A is occurring. Workers, site trespassers, and residents may be exposed to chemicals being released into the air from this source.
- In the distant past, unrestricted access of the site resulted in owners, local residents, and workers contacting contaminants in soil. During the site visit, workers and owners described specific areas black with contaminated oily soil.

Table 5. Exposure Pathways for the Bremerton Gasworks Superfund site, Bremerton, Kitsap County, Washington.

Pathway Name	Exposure Pathway Elements					Time Frame	Pathway Evaluation
	Source	Media	Point of Exposure	Route of Exposure	Potentially Exposed Population		
Surface Soil	Past disposal of MGP waste; Leakage from storage tanks; Landfill debris from municipal and gasworks activities; Runoff from industrial activities.	Soil	Surface soil and on slope to shoreline	Ingestion; Dermal Contact	Trespassers; Site workers	Past	Completed
						Present	Potential
					Local residents; Trespassers; Recreational visitors	Future	Potential
Subsurface Soil	Past disposal of MGP waste; Leakage from storage tanks; Landfill debris from municipal and gasworks activities; Abandoned product pipes	Subsurface Soil	Subsurface soils	Ingestion; Dermal Contact	Site workers	Past	Potential
						Present	Potential
						Future	Potential
Surface Water	Contaminated soils released into storm water runoff; Waste product released into the Narrows	Surface Water	Storm water runoff	Ingestion; Dermal Contact	Trespassers	Past	Potential
						Present	Potential
					Local residents; Trespassers;	Future	Potential
Air	Release of volatiles from waste in surface soil and surface water runoff; Creosote- treated pilings on shoreline	Air	Air near or on property	Inhalation	Local residents; Trespassers; Recreational visitors; Tribal harvesters	Past	Completed
						Present	Completed
						Future	Potential
Public Water Supply	Past deposit of MGP waste in wells, soils; Leakage from storage tanks	Municipal Water Supply	Tap water	Ingestion	Past users of municipal water Supply	Past	Completed
			None (different water source)	None	None (different water source)	Present	Eliminated
						Future	Eliminated
Private Water Supply	Past deposit of MGP waste in wells or soils; Leakage from storage tanks	Groundwater (Private Wells)	Well water	Ingestion	Past local residents with private wells	Past	Potential
			None (different water source)	None	None (different water source)	Present	Eliminated
						Future	Eliminated

Table 5 (continued).

Pathway Name	Exposure Pathway Elements					Time Frame	Pathway Evaluation
	Source	Media	Point of Exposure	Route of Exposure	Potentially Exposed Population		
Sediment	Seeps from contaminated groundwater; Release of product from abandoned pipes; Creosote-treated pilings; Surface runoff from facility; Fuel and oil spills from boats formerly docked in the area	Sediment	Sediments on shoreline	Ingestion; Dermal Contact	Trespassers	Past	Potential
						Present	Potential
					Local residents; Trespassers; Recreational visitors; Tribal harvesters	Future	Potential
Food Chain (Biota)		Food	None	None	None	Past	Eliminated
						Present	Eliminated
			Shellfish	Ingestion	Local residents; Trespassers; Recreational visitors; Tribal harvesters	Future	Potential
Food Chain (Biota)	Seeps from contaminated groundwater; Release of product from abandoned pipes; creosote-treated pilings; Surface runoff from facility; Fuel and oil spills from boats formerly docked in the area	Food	None	None	None	Past	Eliminated
						Present	Eliminated
			Fish	Ingestion	Local residents; Trespassers; Recreational visitors; Tribal harvesters	Future	Potential

MGP manufactured gas plant

Department of Health identified the following **potential pathways** at the site:

- Occasionally and in the past, transient populations reside near areas where bluff seeps of oil have been reported. No exposures have been reported. However, there is uncertainty as to where the contamination is located relative to inhabited areas. These trespassers may come into contact with surface soils, surface water, or sediments that are contaminated. Kitsap Public Health District reported forcing trespassers to leave the site.
- Current and future workers at the site may come in contact with surface or subsurface soil contamination.
- Future use of the property may increase access to the shoreline. This would increase daily exposures of children and local residents to contaminants in surface soils and shoreline sediments.
- In the future, shellfish harvest could occur at low tide by residents, recreational visitors, and tribal subsistence harvesters. Eventually combined sewer overflows will be contained, reducing fecal contamination in shellfish. Though unlikely, public beaches in the Narrows may be opened for shellfish harvest.
- Current and future use of the Narrows for fishing is unknown. Potential areas of sediment contamination may exist near former dock structures and seeps. Fish living nearby may be contaminated. Eating these fish could result in increased exposures of contaminants that accumulate in fish.

Some exposures are not occurring at the site or are extremely unlikely. Department of Health eliminated the following exposure pathways:

- Currently, in the past, and in the future, contaminated groundwater at the site is not used as a drinking water source. Bremerton does not have source wells in the area. No private wells in the area exist. No springs on site have been identified. No exposure is expected.
- In the past and currently people may not harvest shellfish near the site. For many years, area commercial harvest and recreational harvest on nearby public beaches have been closed by Department of Health. No exposure is expected.

Data Gaps

Additional data are necessary for a more definitive assessment of human exposures and possible health effects. Sampling is recommended to be focused on locations where people live, spend time, and play.

Sediment. The intertidal shoreline will be used in the future by residents, tribal members, or recreational visitors. The extent of contamination is not known. The intertidal sediment is well characterized near the mat and rocks placed in 2010 during the emergency action. A limited number of samples beyond this area have been taken. Sediment samples have only been taken between Thompson and Pennsylvania Avenues. The depth of contamination is not known. Nothing is known about the sediments further than approximately 120 feet offshore below the low-water mark. It is possible that effluent from the former MGP was released directly into the Narrows. Most effluent would have been carried away with the tide. Heavier residues from the gasification process may have drifted down into the sediments of the narrows. Contaminants in these sediments may impact shellfish and fish that may be harvested and eaten.

The nature of contamination has only been partially identified. Of the sediment samples taken, VOCs and SVOCs have been well characterized, though some had high detection limits. The PAH data for sediment samples are adequate. Only five sediment samples were measured for metals. More information about the extent of metal contamination along the shoreline is needed. Groundwater at the site appears to be contaminated with several metals which may be released to the shoreline (see Groundwater under the Data Gaps section).

Surface Soil. Trespassers and homeless people may temporarily live at the site and likely come in contact with surface soil. Surface soils in areas frequented by homeless people have not been sampled. The nature and extent of contamination has not been identified. There are not enough soil data to estimate future exposures, especially if the asphalt is removed. Soil beneath blackberries harvested at the end of Pennsylvania Avenue has not been sampled. Of some concern are potential leaks in the areas beneath former product pipelines.

Subsurface Soil. Other than excavation or construction workers, people do not come in contact with subsurface soils. Thus, subsurface soil data, for the most part, are not useful for estimating human exposures. Limited subsurface sampling indicated areas below Parcel B are largely contaminated with MGP product residues. Residues were detected up to 35 feet below the surface. The extent of contamination is not well characterized.

Groundwater. People are not drinking the contaminated groundwater at the site (see Exposure Pathways section). Thus direct exposure to groundwater does not occur and more groundwater information will not help understand human exposures. Little information could be found regarding the relationship between the groundwater beneath the site and seeps or springs along the shoreline. Multiple anecdotal stories of seeps have been reported, some of which have been "oily." It is not clear where, or if, the contaminated groundwater is being released along the shoreline, thus the sources of contamination have not been identified.

Air. People walking on the shoreline or working at the site would be exposed to chemicals in the air. No air sampling has been conducted at the site. Creosote-like smells were observed along the shoreline. Sources for these smells should be identified and depending on the source, air sampling and analysis should be considered. Extensive wind movement along the Narrows will dilute chemicals in the air. It is unlikely that air would stagnate or remain in one location. However, exposure to chemicals in the air cannot be estimated at this time.

Biota. The Suquamish Tribe has U&A rights to harvest shellfish and fish in the Washington Narrows. During the site visit, clam shells and crab carcasses were observed on the beach during low tide. No shellfish or fish chemical data in tissue are available. More information is needed to better understand exposures through consumption of fish and shellfish.

Nearby residents eat blackberries grown at the shoreline, particularly at the end of Pennsylvania Avenue. Concerns have been raised about potential contamination of berries. Berries have been shown to accumulate PAHs and some metals, which have been reported at the site. Neither soil samples nor berry samples have been sampled and analyzed; however, research has shown

uptake or accumulation of PAH or metals by fruit is generally low to non-detected. Therefore, this pathway is unlikely.[6]

Other Contaminants. Other contaminants were not analyzed; however, they may be present at the site. Dioxin and furan compounds may have been created during the combustion of fuel oils and gasification residues. Because of the boat repair and part fabrication that occurred at the site, soil and sediment should also be analyzed for tributyltin. Tributyltin was frequently used in marine paints.

Nearby Sources and Locations. Data from sampling to determine the nature and extent of contamination by other sources were not available. In particular, soil data from near the current and former bulk fuel centers at Parcels E and F were not available. The bulk fuel facility on Parcel F has had environmental investigations done (2). The contaminants identified petroleum contaminants in subsurface soils (2). The catchment drain network delivers site storm water at two locations distal to the site (see Figure 3). More data are needed to understand the transport of contaminants off the site.

Health Effects Evaluation

Screening Analysis

The goal of the screening analysis is to identify chemicals of potential concern at the site. Environmental data are compared with health-based CVs. CVs are chemical concentrations in soil, sediment, or water. CVs concentrations are set at levels below that of which no health effects are expected from exposure (e.g., touching, breathing, or swallowing). CVs incorporate chemical toxicity information and assumptions of daily exposure.

CVs are conservative and non-site specific and set to protect the most sensitive population, usually children. CVs are based on health guidelines with uncertainty or safety factors applied to ensure that they protect public health. **Chemicals detected below their CV** are not expected to result in health effects from exposure. These chemicals are not considered further in the public health assessment process. **Chemicals detected above their CV**, do not necessarily represent a health threat. These chemicals will undergo site-specific evaluation to determine if health effects are expected to occur. CVs are not intended to be used as environmental clean-up levels.

CVs can be based on either carcinogenic or non-carcinogenic effects. Cancer CVs are calculated from EPA's oral cancer slope factor (CSF). CVs based on cancerous effects account for a lifetime exposure (70 years). They are based on an estimated excess lifetime cancer risk of 1 extra case per 1,000,000 people exposed. Non-cancer CVs are calculated from ATSDR's Minimal Risk Levels (MRLs) or EPA's Reference Doses (RfDs). Some chemicals have both a cancer CV and non-cancer CV. When this happens, the lower of these values is used to be protective. Chemicals without a CV use a surrogate CV of a chemical that has similar structural and physiochemical features. CVs include Environmental Media Evaluation Guides (EMEGs), Cancer Risk Evaluation Guides (CREGs), and Reference Dose Media Evaluation Guides

[6] Samsoe-Petersen, L., E.H Larsen, P.B. Larsen, and P. Bruun. 2002. "Uptake of Trace Elements and PAHs by Fruit and Vegetables from Contaminated Soils." Environmental Science and Technology 36 (14):3057-3063.

(RMEGs), MTCA state cleanup levels, and EPA Regional Screening Levels (see definitions in the glossary in Appendix A).

Groundwater and soil data were adequate for screening. As a conservative approach, the screening analysis will compare sediment concentrations with soil CVs. Table 2 summarizes chemicals in sediment that exceed soil CVs. PAHs associated with carcinogenic effects (cPAHs) are of concern and will be evaluated further for resident, trespasser, and visitor exposures. Neither soil nor water exposures are evaluated further at this time. Soil data are not adequate to complete a full evaluation; more data are needed. Groundwater exposures are not occurring; therefore, they are not evaluated further. Though not evaluated further, Tables 3 and 4 summarize chemicals that exceed soil and water CVs, respectively.

The PAH chemical class includes hundreds of individual chemicals. Most PAHs are fat-loving compounds, generated from the incomplete combustion of organic matter, including oil, wood, and coal. They are found in materials such as creosote, coal, coal tar, and used motor oil. Thus, their presence at the site near the former MGP in Bremerton is not surprising. Dietary sources make up a large percentage of PAH exposure in the U.S. population (8). Grains and smoked or barbequed meat and fish contain relatively high levels of PAHs. The majority of dietary exposure to PAHs for the average person comes from ingestion of vegetables and grains (cereals). PAHs are often evaluated for adverse health effects as a group. This is based on structural similarities, metabolism, and toxicity.

Non-carcinogenic Effects

Exposure to PAHs in sediments is estimated to be lower than levels where observable non-carcinogenic effects have been reported, thus non-carcinogenic adverse effects were not considered for further assessment. Many of these compounds were several orders of magnitude below the non-carcinogenic CVs.

Carcinogenic Effects

Approximately 41% of men and women born today will be diagnosed with cancer at some time during their lifetime) (12).[7] Many factors influence the development of cancer and are not considered in this report. Some chemicals have the ability to cause cancer; others do not. Cancer risk estimates represent the increased chance (probability) of developing cancer if exposure to a chemical occurs. To estimate the risk of developing cancer the dose is multiplied by the chemical's cancer potency factor. Cancer potency factors, also known as a cancer slope factors, are chemical specific and sometimes mixtures. Some cancer potency factors are derived from human population data and others are derived from laboratory animal studies. Sometimes the doses in animal studies are much higher than encountered in the environment. Use of animal data requires extrapolation of the cancer potency from high dose studies down to low-level exposures. This process involves much uncertainty.

With some exceptions, current regulatory practice assumes there is "no safe dose" of a carcinogen. In other words, any dose of a carcinogen will result in some additional cancer risk.

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[7] According to the National Cancer Institute (NCI) based on 2007–2009 incidence rates.

The validity of "no safe dose" assumption for all cancer-causing chemicals is not clear. Some chemicals must exceed a certain dose threshold before initiating cancer. For such chemicals, cancer risk estimates are not appropriate. Unless a chemical has been shown to have a threshold, Department of Health assumes that no threshold exists.

Cancer risk that is attributable to site-related contaminants can be described in qualitative terms by considering the population size required for such an estimate to result in a single cancer case. Contaminants are considered to pose an increased cancer risk when the estimated cancer risk is greater than or equal to 1 additional cancer case per 10,000 persons exposed over a lifetime ($>=1\times10^{-4}$). One additional cancer cases per 1,000,000 persons exposed over a lifetime to 9 additional cancer cases per 100,000 persons exposed over a lifetime (1×10^{-6} to 1×10^{-5}) is considered a low cancer risk. A cancer risk is considered insignificant or indiscernible from background when the cancer risk estimate is less than 1 additional cancer per 1,000,000 persons exposed over a lifetime ($<1\times10^{-6}$). These estimates are within the range Department of Health considers acceptable risk. EPA uses this target range of risk as part of their decision making process to determine if action is warranted. That range is 1 excess cancer case per 10,000 people exposed to 1 excess cancer case per 1,000,000 people exposed ($1x10^{-4}$ to $1x10^{-6}$) in these scenarios. Ecology considers cancer risk up to 1 additional case of cancer in 100,000 people to be acceptable risk.

Because cPAHs in sediment exceed the soil comparison values, a more in-depth analysis of exposure and toxicity is warranted. Estimating exposure requires identifying how much, how often, and how long a person may come in contact with sediments. The mathematical equations used to estimate how much of a substance a person may contact are based on their actions or habits. These equations are described in Appendix C. Potential health risks were evaluated for future sediment exposures to children or adult residents playing in sediments on the shoreline and for visitors or trespassers.

The most studied PAH is benzo(a)pyrene (BaP). Several different sets of factors for assessing carcinogenic potency of other PAHs relative to BaP have been published. Commonly used approaches rely on cPAH potency data many years old and were limited to seven PAHs (8;13). These PAHs were classified by EPA as probable human carcinogens (Class B2). This classification is a result of *sufficient* evidence of carcinogenicity in animals but *inadequate* evidence in humans.

The methodology for estimating cancer risk from exposure to PAH mixtures sums the PAHs together. First, each PAH is multiplied by its relative potency factor (RPF). This factor scales the concentration relative to the potency of BaP. These modified concentrations are then summed as the BaP-Equivalent (BEQ) concentration. In 2010, EPA released a draft report updating the RPFs of selected cPAHs in mixtures (8;14). This report considered more recent data and a wider range of cPAH compounds. Cancer risk is then estimated using the current oral cancer slope factor for BaP.

Using the 95% upper confidence limit of the average sediment concentration (159 mg/kg cPAH BEQ) the following estimated cancer risk estimates were calculated for touching or accidently ingesting sediment from the shoreline at the site during daytime low tides (See Appendix C):

- For every 1,000 local residents playing or recreating on the beach sediments at low tide during the day for 218 days a year for a lifetime, there is an increased lifetime risk of developing *5 additional cancer cases* (5.3×10^{-3});
- For every 1,000 people visiting the beach sediments during the 3 summer months (90 days) for a lifetime, there is an increased lifetime risk of developing *2 additional cancer cases* (2.2×10^{-3});
- For every 10,000 adults (ages 16 years and higher) trespassing onto the site and going onto beach sediments 3 days a week for a lifetime, there is an increased lifetime risk of developing *6 additional cases of cancer cases* (5.5×10^{-4}).

Evaluation of Health Outcome Data

Evaluation of health outcome data (e.g., mortality and morbidity) in public health assessments are considered per ATSDR guidance (15). The main requirements for evaluating this type of data include:

- a completed pathway,
- high contaminant levels to result in measurable health effects,
- sufficient number of people in the completed pathway for effects to be measured, and
- a health outcome database in which disease rates for the population of concern can be identified.

This site does not meet the requirements for including an evaluation of these data. Although a completed exposure pathway exists, the exposed population is not sufficiently defined or large enough.

Child Health Considerations

Department of Health recognizes that infants and children may be more vulnerable to exposures than adults in communities with contamination issues. This vulnerability is a result of the following factors. Children are more likely:

- To play outdoors in contaminated areas by disregarding signs and wandering into restricted locations.
- To bring food into contaminated areas resulting in more hand to mouth exposures.
- To receive higher doses of a contaminant because they are smaller.
- To breathe dust and soil because they are shorter and therefore, closer to the ground.
- To sustain permanent damage if exposures occur during critical growth stages of the developing body.
- To have underdeveloped functional capacity of various organ systems and/or metabolic pathways. This can result in different rates of detoxification.

Health-based CVs were derived from health guidelines that incorporate a high level of protectiveness for children and sensitive individuals. It is likely that children will play or dig in sediments at public access points or shoreline residences. Thus, the exposure scenarios in this public health assessment treated children as the most sensitive population being exposed. In

addition, an age-dependent adjustment factor is used to protect children 2 years old and younger and 3–6 year olds. Because of child-specific behaviors, estimated cancer risks for child residents and visitors 6 years old and younger have exposures that contribute to two-thirds of the lifetime cancer risk (up to 78 years).

Community Health Concerns

The purpose of this section is to document and respond to current, specific community health concerns. Department of Health conducted two site visits, one in July and one in August 2012. Department of Health is working with EPA to develop a community involvement and communication plan. EPA and Department of Health conducted community interviews on September 18, 2012. This meeting provided an opportunity to meet with residents to discuss concerns regarding the site. On October 10, 2012, Department of Health met with the Mayor of Bremerton, Public Works Director, community outreach, and two city council members. Staff discussed the Public Health Assessment process and ways to best communicate results of the report. The community has been invited to previous meetings regarding site activities during the EPA Brownfields Assessment. EPA and the Coast Guard posted signs informing residents of actions that occurred during the emergency removal in 2010. The release into the Narrows at that time raised concerns of on-going contamination from the site.

Community members, owners, and other members of the public brought forward the following health-related concerns and questions:

1. Are the cancers that people have in the neighborhood caused by the release of chemicals from the site?

Department of Health cannot determine if any cancers in the neighborhood were caused by a chemical released from the former MGP or other industrial operations. Cancer is a term used for diseases in which abnormal cells divide without control and sometimes invade other tissues. Cancer develops over many years and has many causes. Several factors, both inside and outside the body, contribute to cancer development. Often, doctors cannot explain why one person develops cancer and another does not. Each chemical is associated with specific types of cancer. The individual chance that someone will develop cancer in response to a particular, single environmental exposure depends on 1) the potential of the chemical to cause cancer, 2) how long or how often that person was exposed, 3) genetic makeup, 4) lifestyle, and 5) pre-existing conditions. Each person is exposed differently.

Research shows that risk factors increase the chance that a person will develop cancer. The most common risk factors for cancer include: growing older, tobacco, sunlight, ionizing radiation, viruses, bacteria, hormones, family history of cancer, alcohol, poor diet, lack of physical activity, being overweight, and some environmental chemicals. About 41% of men and women born today will develop cancer at some time during their lifetime [8] (12).

[8] Rate of developing cancer based on 2007-2009 incidence rates from National Cancer Institute (NCI).

2. Is the water we drink contaminated from the site?

No. Your drinking water comes from the City of Bremerton. The City of Bremerton's public water supply is from Union River (60%) and production wells distant from the site (40%). The City has provided public drinking water since the 1940s.

3. Are the blackberries at the bottom of Pennsylvania Avenue safe to eat?

Department of Health does not know if contaminants from the site are in the blackberries at the bottom of Pennsylvania Avenue. Blackberries grow everywhere at the bottom of Pennsylvania Avenue and on the accessible areas of the Sesko property. In August, September, and October children and local residents collect and eat these berries. We recommend collecting and eating berries from a number of locations, not just one.

Research has shown uptake or accumulation of PAH or metals by fruit are generally low to non-detected. Therefore, this pathway is unlikely

4. Can we eat the shellfish collected on the shoreline or fish caught near or at the site?

For many years, Department of Health has closed commercial shellfish harvest and recreational harvest on nearby publicly owned beaches. The closure is because of combined sewer overflow releases resulting in fecal contamination on beaches. Because of this contamination, we do not recommend eating shellfish harvested near the site. We do not know if contaminants from the site are in shellfish that live in the Narrows. However, contaminants have been found in the sediments these shellfish live in.

The Department of Health also does not recommend eating fish caught near the site. We do not know how far away the contamination has moved from the site as we do not have any fish tissue data to know if these chemicals and metals are in the fish that live in the Washington Narrows.

To better address this question, Department of Health recommends:

- Sampling and analysis of fish and shellfish expected to be harvested.

5. Is it safe for tenants of the Penn Plaza Storage to come onsite?

Yes. Most of the contaminants from the site are below the asphalt or underground and are not easy to come in contact with. The storage property is fenced and locked and most tenants use the buildings briefly for storage or for light industrial activities. Department of Health recommends you do not enter the areas beyond your rented space, though they are accessible from the storage area. There are areas on the site with contaminants on the soil surface.

6. Are homeless people, who temporarily live at or near the site, exposed to contaminants or at risk of harm?

During our site visit, we found evidence of habitation and frequent use by trespassers on part of the site. Owners have reported trespassers in the past. From Pennsylvania Avenue, a very steep path leads to the shoreline. The path deviates and allows access to areas of the site that are contaminated. Coming into contact with oily residues, contaminated soil, or contaminated

surface water runoff may increase exposures to contaminants. Owners reported 'oily seeps' in the past on the hillside above where homeless people sleep.

A foot path is present from the end of Pennsylvania Avenue down to the shoreline. Kitsap Public Health District has addressed unsafe use of the area in the past and asked people to leave. A rope providing access to the shoreline has been removed a number of times. During the site visit, a rusted metal tank was observed at the bottom of path. The tank opening was covered by bushes and leaves. A person could easily trip onto or fall into the tank resulting in physical injury.

Department of Health recommends that a sign and fence prohibiting beach access be installed at the site. We recommend that physical hazards be reduced either with fencing or removal (for items such as the tank).

7. What are the big tanks on the shoreline near the site? Are they dangerous?

These tanks are former ballast tanks from a submarine that were used to allow the vessel to submerge and surface. DNR reported the presence of volatile organic compounds inside the tanks. Kitsap Public Health District did not detect these compounds in the tank in 2010. The tanks are accessible at low tide and tied to the shoreline with a rope. Access to the tanks presents a physical hazard. Department of Health recommends that the hazard posed by the tanks be reduced. Currently, the owners of the tanks are going through the permitting process for the tanks removal.

8. If the land is zoned residential or used as a park, what are the health risks for a future resident or visitor?

The future use of the land has not been determined nor has the level of remediation that will occur to reduce risk. EPA is beginning its investigation to determine the nature and extent of contamination from the site. With more soil, sediment, and tissue data a more accurate assessment of health threats will be possible.

9. Is it safe to swim in the water near the site?

We do not recommend swimming in the Washington Narrows for several reasons:

- Cold water can quickly incapacitate the best of swimmers.
- Tidal currents are so swift in the narrows that swimmers cannot break free of the current. Swimmers can be easily carried into open waters.
- Department of Health does not know the extent of contamination in the water or sediments of the Washington Narrows. Contaminants from sediments can be released into the water column.

Department of Health does not know if swimming in the Narrows will result in chemical exposures. More data are needed to determine if a health threat exists from this type of exposure.

10. Are there signs posted about health risks at the site?

Kitsap Public Health District posted signs on the beach to warn people about the contamination on the shoreline.

Conclusions

Department of Health has reviewed the analytical results of soil, groundwater, and sediment samples taken from the site. We identified PAHs, some metals, and petroleum hydrocarbons to be chemicals of potential concern. Several data gaps were identified in assessing risks to potentially exposed populations. Department of Health estimated exposures to PAHs in beach sediments for 1) residents who live adjacent to the site, 2) shoreline visitors during summer, and 3) homeless people who frequently trespass and temporarily live on the site. Other exposure pathways will be addressed in future assessments as more data become available.

Department of Health reached five conclusions in this public health assessment:

1. Trespassing on the site could result in physical injury. This is an urgent public health hazard. Several physical hazards are present at the site.

2. Touching or accidentally ingesting sediments for more than a year could harm the health of children or adults. PAHs exceed the EPA cancer risk range of 1×10^{-4} to 1×10^{-6}.

3. Department of Health cannot conclude if trespassers are touching contaminated soils at the site. The nature and extent of soil contamination are not known. Future land use may lead to contact with the soil. More soil sample data will be collected during EPA's upcoming RI.

4. Department of Health cannot conclude if people are being exposed to contaminants from eating fish or shellfish harvested at the site. Shellfish and fish tissue data are needed to assess any potential health threat.

5. No one is drinking the contaminated groundwater located in the vicinity of the site. No harm is expected.

Recommendations

To protect residents, visitors, and trespassers, Department of Health recommends the following:

- Physical hazards be mitigated to reduce the hazard within three to six months of this assessment being released.
- Until further characterization, site access be restricted based on risks of disturbing remaining contaminants or recontamination of remediated areas.
- Ongoing source(s) of contaminants be identified and mitigated to reduce the potential of exposure.
- People protect their health by not walking or playing on the shoreline between Pennsylvania Avenue and the Port Washington Narrows Marina.
- Parents monitor their children's behavior while playing outdoors to prevent them from going onto the shoreline between Pennsylvania Avenue and the Port Washington Narrows Marina.
- The nature and extent of contamination in surface soils be characterized.

- Future land use be determined based on risks of disturbing remaining contaminants or recontamination of remediated areas.

To protect the Suquamish tribal members, Department of Health recommends that EPA consider developing a fish and shellfish sampling and analysis plan.

Public Health Action Plan

Actions Completed

- EPA and Department of Health conducted community interviews on September 18, 2012.
- City of Bremerton installed a sign at the end of Pennsylvania Avenue prohibiting beach access.
- Kitsap Public Health District facilitated the replacement of signs on shoreline warning people of contamination.
- Cascade capped contaminated sediments along the shoreline by an absorbent clay mat and covered with clay rocks.
- On-site storm water system has been improved to reduce infiltration into the historical drainage system.

Actions Underway

- EPA is moving forward with the RI/FS and any interim actions.
- Owner is evaluating options to remove the submarine ballast tanks in collaboration with EPA and Washington State Department of Natural Resources (DNR).
- Cascade under EPA guidance is preforming periodic inspections and maintenance of the capped area on the shoreline. Maintenance is recommended to continue until the extent of contamination is known and a remedy is determined.
- EPA is facilitating the removal of waste barrels found on Parcel A.

Actions Planned

- Owner will remove or fence the rusted tank at the foot of the bluff within three months.
- Department of Health and EPA are collaborating on future community engagement activities.
- EPA will be developing and implementing sampling plans as part of the remedial investigation of the site. These activities may include sampling of soil, sediments groundwater, surface water, and fish or shellfish tissue.
- Department of Health will develop a fact sheet that summarizes the findings of this Public Health Assessment. We will plan to distribute the fact sheet within two months of the Public Health Assessment being approved.
- Department of Health will provide copies of this Public Health Assessment to EPA, the Suquamish Tribe, KPHD, DNR, McConkey Family Trust, Natacha Sesko, owners of Parcels D, E and F, and concerned parties when the report is approved.
- Department of Health will be available any time to answer health related questions regarding the Bremerton Gasworks Superfund site.

- Department of Health will be preparing a separate document to address the 2010 and 2013 Time Critical Removal Actions.
- A comprehensive Removal Action Report will be available from EPA.

Report Preparation

This Public Health Assessment for initial/public comment release on the Bremerton Gasworks Superfund site in Kitsap County, Washington was prepared by the Washington Department of Health (DOH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner (Department of Health). ATSDR has reviewed this document and concurs with its findings based on the information presented.

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Appendix A–Glossary

Acute	Occurring over a short time [compare with **chronic**].
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil, or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a *comparison value* used to select contaminants of potential health concern and is based on the *cancer slope factor* (CSF).
Cancer Slope Factor (CSF)	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with **acute**].
Comparison Value (CV)	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dermal Contact	Contact with (touching) the skin (see route of exposure).
Dose (for chemicals that are not radioactive)	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Environmental Media Evaluation Guide (EMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a comparison value used to select contaminants of potential health concern and is based on ATSDR's minimal risk level (MRL).
Environmental Protection Agency (EPA)	United States Environmental Protection Agency.
Epidemiology	The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor (i.e., age, sex, occupation, economic status) is associated with the health effect.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].
Hazardous Substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].
Ingestion Rate (IR)	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].
Inorganic	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.
Lowest Observed Adverse Effect Level (LOAEL)	The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Maximum Contaminant Level (MCL)	A drinking water regulation established by the federal Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Minimal Risk Level (MRL)	An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see oral **reference dose**].
Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
No Observed Adverse Effect Level (NOAEL)	The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.
Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.
Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
Reference Dose Media Evaluation Guide (RMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a *comparison value* used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).
Regional Screening Levels (RSL)	EPA's risk-based tools for evaluating and cleaning up contaminated sites (Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites).

Route of Exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Appendix B–Data Summary

Table B1. Chemical concentration (mg/kg) of **intertidal sediment samples** and health-based comparison values, Bremerton Gasworks Superfund site, Kitsap County, Washington.

Chemical [a]	Number Detected / Total Sampled [b]	Soil CV [c] (mg/kg)	Type of CV	Range of Concentrations (mg/kg)	Number Detected (and non-detected) greater than CV
Semivolatile Organic Compounds					
Benz(a)anthracene	28/36	0.48 [d]	CREG/RPF	0.16–69	26 (7)
Benzo(a)pyrene	26/36	0.096	CREG	0.26–76	26 (10)
Benzo(b)fluoranthene	32/36	0.12 [d]	CREG/RPF	0.13–110	32 (4)
Benzo(k)fluoranthene	18/36	3.2 [d]	CREG/RPF	0.19–60	2 (5)
Benzo(g,h,i)perylene	11/36	10.7 [d]	CREG/RPF	0.16–32	2 (5)
Chrysene	29/36	0.96 [d]	CREG/RPF	0.17–80	27 (6)
Dibenz(a,h)anthracene	5/36	0.0096 [d]	CREG/RPF	0.047–15	5 (31)
Fluoranthene	34/36	1.2 [d]	CREG/RPF	0.34–110	31 (2)
Indeno(1,2,3-cd)pyrene	20/36	1.4 [d]	CREG/RPF	0.15–72	9 (14)
Total cPAH BaP-EQ [f]	**36/36**	0.096 [d]	BaP CREG	**0.93–351** [e]	**36**
Acenaphthene	5/36	3,000	RMEG	0.024–15	
Acenaphthylene	5/36	3,000	RMEG*	0.048–15	
Anthracene	4/36	15,000	RMEG	0.034–15	
Biphenyl, 1,1'-	4/5	2,500	RMEG	0.024–0.1	
Bis(2-chloroethyl)ether	0/36	0.64	CREG	0.024–15U	0 (29)
Carbazole	4/36	1,300	RMEG**	0.024–15	
Chloroaniline, 4-	0/36	200	RMEG	0.024–1500U	0 (27)
Dibenzofuran	4/36	78	RSL	0.024–15	
Dinitro-2-methylphenol, 4,6-	0/36	200	iEMEG	0.048–450U	0 (6)
Dinitrophenol, 2,4-	0/36	100	RMEG	0.12–450U	0 (6)
Fluoranthene	34/36	2,000	RMEG	0.34–110	
Fluorene	4/36	2,000	RMEG	0.012–15	
Hexachlorobenzene	0/36	0.44	CREG	0.024-15U	0 (29)
Hexachlorocylclopentadiene	0/36	9	CREG	0.024-15U	0 (27)
Methylnaphthalene, 2-	4/36	200	RMEG	0.024–15	
Methylphenol, 4- (p-cresol)	1/5	310	RSL	0.017–0.024	
Naphthalene	5/36	1,000	RMEG	0.017–150	
Nitrolaniline, 4-	0/36	24	RSL	0.048–2300U	0 (31)
Nitroso-dimethylamine, N-	0/36	0.014	CREG	0.024–0.036	
Nitroso-di-n-propylamine, N-	0/36	0.10	CREG	0.024–15U	0 (31)
Pentachlorophenol	0/36	1.8	cEMEG	0.024–150U	0 (31)
Phenanthrene [Fluoranthene]	19/36	2,000	RMEG***	0.14–36	
Phthalate, Di(2-ethylhexyl)	1/36	50	CREG	0.024–150U	0 (6)
Phthalate, Diethyl	1/36	40,000	RMEG	0.024–15	

Table B1 (continued).

Chemical [a]	Number Detected / Total Sampled [b]	Soil CV [c] (mg/kg)	Type of CV	Range of Concentrations (mg/kg)	Number Detected (and non-detected) greater than CV
Pyrene	35/36	1,500	RMEG	0.50–160	
Trichlorophenol, 2,4,5-	0/36	0.64	CREG	0.0014–150U	0 (6)
Xylene, o-	1/5	10,000	cEMEG****	0.0014–0.0057	
Metals					
Aluminum	5/5	50,000	cEMEG	6020–9030	
Arsenic	5/5	15	cEMEG	1.5–5.1	
Barium	2/5	10,000	cEMEG	13.3–47	
Beryllium	5/5	100	cEMEG	1.9–2.7	
Cadmium	0/5	5	cEMEG	0.05U–0.5U	
Chromium [Hexavalent chromium]	5/5	50	cEMEG	16.6–21.2	
Cobalt	5/5	500	iEMEG	3.0–26.3	
Copper	5/5	500	iEMEG	8.6–71.7	
Iron	5/5	55,000	RSL	9,730–15,900	
Lead	5/5	250	MTCA	8.9–30	
Manganese	5/5	2,500	RMEG	135–180	
Mercury [Mercuric chloride]	1/5	15	RMEG	0.021JQ –0.1	
Nickel	5/5	1,000	RMEG	21.4–52.6	
Selenium	0/5	250	cEMEG	0.41JQ –3.5U	
Silver	0/5	250	RMEG	1.0U	
Thallium	0/5	0.78	RSL	2.5U	0 (5)
Vanadium	5/5	500	iEMEG	21.6–36.5	
Zinc	5/5	15,000	cEMEG	23.2–79.9	
Volatile Organic Compounds				–	
Acetone	1/5	45,000	RMEG	0.0066–0.028	
Benzene	1/25	13	CREG	0.0014–0.03	
Ethylbenzene	1/25	5,000	RMEG	0.0014–0.05	
Methylene chloride	19/25	300	RMEG	0.0013–1.0	
Naphthalene	1/25	1,000	RMEG	0.001–0.17	
Trichloropropane, 1,2,3-	0/25	0.023	CREG	0.0013–0.05 U	0 (20)
Xylene, m- and p-	1/25	10,000	cEMEG****	0.0014–1.0	
Total Petroleum Hydrocarbons					
Diesel range	4/5	2,000	MTCA	25–245	
Gasoline range	0/5	2,000	MTCA	5–450	
Heavy oil range	5/5	2,000	MTCA	21–615	

Source: Anchor 2011 (1); E&E 2009 (2)

Notes:

[a] Bolded chemicals have detected concentrations in sediments that require further risk evaluation.

[b] Table includes detected chemicals and chemicals with detection limits above the CV. Compounds not detected not listed.

[c] ATSDR CVs based on child soil exposures were used for screening (CVs for sediment exposures have not been developed). To be conservative, soil CVs reflect residential exposures and are expected to overestimate sediment exposures on the shoreline.

[d] BaP CREG was used as a surrogate compounds chemicals that have no CV. BaP CREG was divided by potency factor relative (RPF) to BaP as presented by EPA 2010 (11) to obtain the CV.
[e] PAHs associated with carcinogenic effects (cPAHs). For each sample, each PAH is multiplied by potency factor relative (RPF) to BaP as presented by EPA 2010 (11). These are summed and presented as the Total cPAH BaP Equivalent (BaP-EQ).
[f] Per ATSDR, CV is health-based for non-carcinogenic effects only, not carcinogenic effects. CREG CV is below background.
* Acenaphthene was used as a surrogate
** Diphenylamine was used as a surrogate
*** Fluorene was used as a surrogate
**** Total Xylenes was used as a surrogate

Table 2 Abbreviations:

ATSDR	Agency for Toxic Substances and Disease Registry
BaP	Benzo(a)pyrene
BaP-EQ	Benzo(a)pyrene equivalents
cEMEG	ATSDR Environmental Media Evaluation Guide based on chronic exposures (>365 days) based on MRL
cPAH	Polycyclic Aromatic Hydrocarbons that have carcinogenic adverse effects
CREG	ATSDR Cancer Risk Evaluation Guide
CV	Health-based comparison value (unless otherwise indicated)
EPA	U.S. Environmental Protection Agency
iEMEG	ATSDR Environmental Media Evaluation Guide based on intermediate exposures (90–365 days) based on MRL
mg/kg	milligrams of chemical per kilograms of sediment
MTCA	Washington State Model Toxics Control Act cleanup regulation
RMEG	ATSDR Reference Dose Media Evaluation Guide for non-carcinogenic adverse effects
RSL	EPA Regional Screening Level
U	Value undetected at the detection limit given

Table B2. Chemical concentrations in **surface soil** samples (0–5 feet bgs) and health-based comparison values, Bremerton Gasworks Superfund site, Kitsap County, Washington.

Chemical [a]	Number Detected / Total Sampled [b]	Soil CV [c]	Type of CV	Range of Concentrations (mg/kg)	Number Detected (and non-detected) greater than CV
Semivolatile Organic Compounds (mg/kg)					
Benzo(a)anthracene	5/7	0.48 [d]	CREG/RPF	0.48–1.6	2
Benzo(a)pyrene	5/7	0.096	CREG	0.57–2.5	2
Benzo(b)fluoranthene	5/7	0.12 [d]	CREG/RPF	0.43–1.8	2
Benzo(k)fluoranthene	5/7	3.2 [d]	CREG/RPF	0.0009 JQ– 2.2	
Benzo(g,h,i)perylene	5/7	10.7 [d]	CREG/RPF	0.0011U– 2.4	
Chrysene	4/7	0.96 [d]	CREG/RPF	0.52–3.9	2
Dibenzo(a,h)anthracene	5/7	0.0096 [d]	CREG/RPF	0.78–1.1 U	1(1)
Fluoranthene	6/7	1.2 [d]	CREG/RPF	0.0016U–12 J	1
Indeno(1,2,3-cd)pyrene	5/7	1.4 [d]	CREG/RPF	0.0013U –2.0	1
Total PAH BaP Equivalents [f]	**6/7**	0.096 [d]	BaP CREG	**0.3–13.6** [e]	**3**
Acenaphthene	3/7	3,000	RMEG	0.0011U–1.1UJ	
Acenaphthylene	3/7	3,000	RMEG*	0.0011U –2.4	
Acetophenone	1/7	5,000	RMEG	0.022U–1.8	
Anthracene	1/7	15,000	RMEG	0.0011U–1.1UJ	
Biphenyl, 1,1'-	1/7	2,500	RMEG	0.022U–0.98	
Carbazole	2/7	1,300	RMEG**	0.023U–0.56	
Dibenzofuran	1/7	78	RSL	0.022U–0.063J	
Fluoranthene	5/7	2,000	RMEG	0.0016–12J	
Fluorene	3/7	2,000	RMEG	0.0011U–4.6	
Methylnaphthalene, 2-	3/7	200	RMEG	0.0011U–100	
Naphthalene	1/7	1,000	RMEG	0.0011U–270	
Phenanthrene	5/7	2,000	RMEG***	0.0013U–40	
Phthalate, Di(2-ethylhexyl)	6/7	50	CREG	0.024UJ–0.24	
Pyrene	5/7	1,500	RMEG	0.0013U–12J	
Trimethylbenzene, 1,2,4-	1/7	62	RSL	0.022U–2.6	
Trimethylbenzene, 1,3,5-	1/7	780	RSL	0.022U–5.5	
Metals (mg/kg)					
Aluminum	7/7	50,000	cEMEG	11,200J–24,100	
Arsenic	7/7	15	cEMEG	1.08–4.17	
Barium	7/7	10,000	cEMEG	46.1J–120	
Cadmium	2/7	5	cEMEG	0.27JQ–1.2	
Chromium [Hexavalent chromium]	7/7	50	cEMEG	28.1J–49.3	
Cobalt	7/7	500	iEMEG	5.8–14.8	

Table B2 (continued).

Chemical [a]	Number Detected / Total Sampled [b]	Soil CV [c]	Type of CV	Range of Concentrations (mg/kg)	Number Detected (and non-detected) greater than CV
Copper	7/7	500	iEMEG	11.1–45.7	
Iron	7/7	55,000	RSL	10,900J–28,500	
Lead	7/7	60	IEUBK	2.4J–31.2	
Manganese	7/7	2,500	RMEG	193J–526	
Nickel	7/7	1,000	RMEG	30.1J–65.7	
Thallium	**4/7**	**0.78**	**RSL**	**2.2 JQ –4.1**	**2**
Vanadium	7/7	500	iEMEG	26.5–62.6	
Zinc	7/7	15,000	cEMEG	23.6J–114	
Total Petroleum Hydrocarbons (mg/kg)					
Diesel range	1/7	2,000	MTCA	25U–1800	
Heavy oil range	**3/7**	**2,000**	MTCA	25U–**4,700J**	**1**
Volatile Organic Compounds (ug/kg)					
Acetone	4/7	45,000	RMEG	0.0057U–1.2U	
Benzene	2/7	13	CREG	0.0011U –4.8	
Ethylbenzene	2/7	5,000	RMEG	0.0011U –3.6	
Isopropylbenzene cumene	2/7	5,000	RMEG	0.0011U –0.13	
Tetrachloroethylene	1/7	300	RMEG	0.001U –0.58U	
Toluene	3/7	4,000	RMEG	0.0011U –7.7	
Trichlorobenzene, 1,2,3-	0/7	500	RMEG****	0.0013U –0.58U	
Trichlorobenzene, 1,2,4-	0/7	500	RMEG	0.001U –0.58U	
Trichlorofluoromethane	0/7	15,000	RMEG	0.001U –0.58U	
Xylene, o-	2/7	10,000	cEMEG*****	0.001U –3.4	

Source: E&E 2009 (2)

Notes:

[a] Bolded chemicals have detected concentrations in surface soil that people could come in contact with. Further evaluation is not done in this report until more information on extent and future land use is available.

[b] Chemicals analyzed but not detected are not listed. However, table includes chemicals with detection limits above the CV.

[c] ATSDR CVs based on child residential soil exposures.

[d] BaP CREG was used as a surrogate compounds chemicals that have no CV. BaP CREG was divided by potency factor relative (RPF) to BaP as presented by EPA 2010 (11) to obtain the CV.

[e] PAHs associated with carcinogenic effects (cPAHs). For each sample, each PAH is multiplied by potency factor relative (RPF) to BaP as presented by EPA 2010 (11). These are summed and presented as the Total cPAH BaP Equivalent (BaP-EQ).

[f] Per ATSDR, CV is health-based for non-carcinogenic effects only, not carcinogenic effects. CREG CV is below background.

* Acenaphthene was used as a surrogate

** Diphenylamine was used as a surrogate

*** Fluorene was used as a surrogate

**** Trichlorobenzene, 1,2,4- was used as a surrogate

***** Total Xylenes was used as a surrogate

Abbreviations:

ATSDR	Agency for Toxic Substances and Disease Registry
BaP-EQ	Benzo(a)pyrene equivalents
cEMEG	ATSDR Environmental Media Evaluation Guide based on chronic exposures (>365 days) based on MRL
cPAH	Polycyclic Aromatic Hydrocarbons that have carcinogenic adverse effects
CREG	ATSDR Cancer Risk Evaluation Guide
CV	Health-based comparison value (unless otherwise indicated)

EPA	U.S. Environmental Protection Agency
iEMEG	ATSDR Environmental Media Evaluation Guide based on intermediate exposures (90–365 days) based on MRL
J	Chemical positively identified but outside of quality control limits and considered an estimate
JQ	Chemical detected below the reporting limit but above the detection limit and considered an estimate
mg/kg	milligrams of chemical per kilograms of sediment
MTCA	Washington State Model Toxics Control Act cleanup regulation
RMEG	ATSDR Reference Dose Media Evaluation Guide for non-carcinogenic adverse effects
RSL	EPA Regional Screening Level
U	Value undetected at the detection limit given
UJ	Chemical was not detected at or above the reporting value. The associated value is an estimate.
ug/kg	micrograms of chemical per kilograms of soil
bgs	Below ground surface

Table B3. Chemical concentrations in **groundwater** samples and health-based drinking water comparison values, Bremerton Gasworks Superfund site, Kitsap County, Washington.

Chemical [a]	Number Detected / Total Sampled [b]	Drinking Water CV (µg/L) [c]	Type of CV	Range of Concentrations (µg/L)	Number Detected (and Non-detected) greater than CV
Semivolatile Organic Compounds					
Benz(a)anthracene	4/5	0.024 [d]	CREG/RPF	0.05 U–0.66	**2**
Benzo(a)pyrene (BaP)	2/5	0.0048	CREG	0.05 U–1.1	**2**
Benzo(b)fluoranthene	2/5	0.006 [d]	CREG/RPF	0.05 U–0.59	**2**
Benzo(k)fluoranthene	3/5	0.16 [d]	CREG/RPF	0.7	**1**
Benzo(g,h,i)perylene	2/5	0.53 [d]	CREG/RPF	0.12–0.82	**2**
Chrysene	3/5	0.048 [d]	CREG/RPF	0.068–1.1	**2**
Dibenz(a,h)anthracene	1/5	0.00048 [d]	CREG/RPF	0.05U–0.5U	**1**
Fluoranthene	4/5	0.060 [d]	CREG/RPF	0.12–3.7	**4**
Indeno(1,2,3-cd)pyrene	2/5	0.069 [d]	CREG/RPF	0.090–0.40	**2**
Total PAH B(a)P Equivalent [f]	**4/5**	0.0048 [d]	CREG	**0.61U–3.0** [e]	**4**
Acenaphthene	2/5	600	RMEG	0.05U–38	
Acenaphthylene	3/5	600	RMEG*	0.05U–5.4J	
Acetophenone	1/5	1,000	RMEG	0.5U–3.8	
Anthracene	4/5	3,000	RMEG	0.05U–2.9	
Biphenyl, 1,1'-	1/5	500	RMEG	0.5U–6.3	
Caprolactam	1/5	5,000	RMEG	0.48JQ–6.3J	
Carbazole	2/5	400	RMEG**	0.5U–24	
Dibenzofuran	1/5	6	RSL	0.29JQ–1.1	
Dimethylphenol, 2,4-	1/5	200	RMEG	0.5U–32	
Fluoranthene	4/5	400	RMEG	0.05U–3.7	
Fluorene	3/5	400	RMEG	0.05U–6.1	
Methylnaphthalene, 2-	**5/5**	**40**	**RMEG**	0.11–**170J**	**1**
Methylphenol, 4-	1/5	500	RMEG***	0.5U–2.3	
Phenanthrene	2/5	400	RMEG**	0.05U–6.7	
Phenol	1/5	3,000	RMEG	0.05U –33	
Phthalate, Di(2-ethylhexyl)	2/5	2.5	CREG	0.33JQ–0.78	
Phthalate, Diethyl	0/5	8,000	RMEG	0.34JQ–0.5U	
Phthalate, Butyl benzyl	1/5	2,000	RMEG	0.33JQ–1	
Pyrene	4/5	300	RMEG	0.05U–1.6	
Trimethylbenzene, 1,2,4-	**1/5**	**15**	**RSL**	0.5U–**16**	**1**
Trimethylbenzene, 1,3,5-	**1/5**	**87**	**RSL**	0.5U–**98**	**1**
Metals (ug/L)					
Antimony	6/8	4	RMEG	0.16–2.0	
Arsenic	**8/8**	**0.023**	**CREG**	**0.04–4.1**	**5**

Table B3 (continued).

Chemical [a]	Number Detected / Total Sampled [b]	Drinking Water CV (µg/L) [c]	Type of CV	Range of Concentrations (µg/L)	Number Detected (and Non-detected) greater than CV
Barium	8/8	2,000	cEMEG	0.10–3,140	**2**
Beryllium	4/8	4	MCL	0.37**–7.6**	**2**
Cadmium	5/8	1	cEMEG	0.16**–3.9**	**4**
Chromium [hexavalent chromium]	8/8	9	cEMEG	0.05**–1,670**	**4**
Cobalt	5/5	100	iEMEG	1.4 – 44.8	
Copper	1/7	100	iEMEG	0.16–111	**1**
Lead	5/8	15	MCL	1.0 U**–268**	**3**
Manganese	8/8	500	RMEG	0.32**–25,600**	**4**
Nickel	8/8	200	RMEG	0.1- 125	
Selenium	8/8	50	cEMEG	1.4 – 5.5	
Silver	8/8	50	RMEG	0.07 – 1.4	
Thallium	4/8	2	MCL	0.26 – 1.0	
Vanadium	5/8	100	iEMEG	3.7 JQ**–717**	**3**
Zinc	7/8	3,000	cEMEG	0.9 - 153	
Total Petroleum Hydrocarbons					
Diesel range	**5/6**	**500**	**MTCA**	**510–5,500**	**2**
Volatile Organic Compounds					
Acetone	0/6	9,000	RMEG	3.9JQ–500UJ	
Benzene	**3/6**	**0.64**	**CREG**	0.25U**–3,100J**	**3**
Cyclohexane	1/6	13,000	RSL	0.25U–0.38	
Ethylbenzene	1/6	700	MCL	0.25U–190JQ	
Isopropyl benzene (cumene)	1/6	1,000	RMEG	0.25U–22JQ	
Naphthalene	**3/6**	**100**	**LTHA**	0.25UJ –**1,800**	**1**
Toluene	2/6	800	RMEG	0.25U–58J	
Trichloroethene	**2/6**	**0.76**	**CREG**	0.25U–**25 UJ**	**0 (1)**
Xylene, o-	2/6	2000****	cEMEG	0.25U–640J	

Source: Anchor 2011 (1); E&E 2009 (2)

Notes:

[a] Bolded chemicals have detected concentrations that exceeded CV.

[b] Chemicals analyzed but not detected are not listed. However, table includes chemicals with detection limits above the CV.

[c] ATSDR CVs based on child residential soil exposures.

[d] BaP CREG was used as a surrogate compounds chemicals that have no CV. BaP CREG was divided by potency factor relative (RPF) to BaP as presented by EPA 2010 (11) to obtain the CV.

[e] PAHs associated with carcinogenic effects (cPAHs). For each sample, each PAH is multiplied by potency factor relative (RPF) to BaP as presented by EPA 2010 (11). These are summed and presented as the Total cPAH BaP Equivalent (BaP-EQ).

[f] Per ATSDR, CV is health-based for non-carcinogenic effects only, not carcinogenic effects. CREG CV is below background.

* Acenaphthene was used as a surrogate

** Fluorene was used as a surrogate

*** cresol, m was used as a surrogate

**** Total Xylenes was used as a surrogate

Abbreviations:

ATSDR Agency for Toxic Substances and Disease Registry

BaP-EQ Benzo(a)pyrene equivalents

cEMEG ATSDR Environmental Media Evaluation Guide based on chronic exposures (>365 days) based on MRL

cPAH	Polycyclic Aromatic Hydrocarbons that have carcinogenic adverse effects
CREG	ATSDR Cancer Risk Evaluation Guide
CV	Health-based comparison value (unless otherwise indicated)
EPA	U.S. Environmental Protection Agency
iEMEG	ATSDR Environmental Media Evaluation Guide based on intermediate exposures (90–365 days) based on MRL
RMEG	ATSDR Reference Dose Media Evaluation Guide for non-carcinogenic adverse effects
LTHA	EPA Lifetime Health Advisory for drinking water
RSL	EPA Regional Screening Level
U	Value undetected at the detection limit given
UJ	Chemical was not detected at or above the reporting value. The associated value is an estimate.
J	Chemical positively identified but outside of quality control limits and considered an estimate
JQ	Chemical detected below the reporting limit but above the detection limit and considered an estimate
PAH	Polycyclic Aromatic Hydrocarbons
µg/L	micrograms of chemical per liter of water

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Appendix C–Exposure and Risk Methodology and Assumptions

This appendix of the public health assessment (for initial/public comment release) for the Bremerton Gasworks Superfund Site provides the methodology and assumptions (Table C1) used to calculate exposure doses for people coming into contact with the intertidal sediment at the site. A summary of exposure doses and health risk calculations are summarized for carcinogenic risks (Table C2).

The following scenarios for sediment exposures have been defined for this site:

- Future hypothetical resident (adult and child) playing at the beach daily (218 days/year).
- Visitor (adult and child) during the summer months (or frequency of 1–2 times per year, approximately 90 days/year).
- Trespasser (adult) on the sediments 3 days a week (156 days/year).

Data Compilation

For chemicals with samples detected below the reporting limit but above the detection limit, the estimated value was used. Estimated values were designated by a "J" flag. Compounds that were not detected (designated with a U flag) were assumed to be present at the detection limit.

When possible, exposure point concentrations for sediments were derived by using a conservative estimate of the mean concentration. This conservative estimate is typically the upper limit of a 95% confidence interval (95% UCL) of the average concentration. The 95% UCL was calculated by ProUCL 4.1.00[9] (16). The method of calculation was based on sample size, coefficient of variation, and the underlying distribution of the data. The sediment sampling source, location, number, and analytical data are listed in Appendix C and Table 2 in the main text.

At this time, there are not sufficient soil, air, fish and shellfish tissue data to estimate potential exposures. After these data gaps have been filled, these pathways can also be evaluated. All intertidal sediment samples from the Brownfield Assessment (2) and the emergency interim action (1) were combined together to calculate the sediment exposure point concentration (C_s) for incidental ingestion and dermal contact at the beach. The data from the Ecology investigation in 1995 were not used as they are 15 years old.

It is important to point out that although residents have unrestricted access to the shoreline at this time, tidal fluctuations prevent access to sediments and decrease exposure frequency. Low tides permitting access to the shoreline during the day[10] occur about 60% of the year (218 out of 365 days) mostly between March and September. Department of Health assumed that a resident

[9] http://www.epa.gov/osp/hstl/tsc/software.htm

[10] Estimated number of days with low tides permitting access to the shoreline during the day were assumed to occur between 7 a.m. and 7 p.m., includes +4 tides or less relative to the average of the lowest tides recorded at this tide station (mean lower low water), and are based on NOAA 2011 data from the Tracyton, Dyes Inlet, tide station.

nearby could be exposed a maximum number of 218 days and likely will be exposed much less frequently.

Sediment Exposure Cancer Dose Calculations

This section provides the assumptions and calculations used to estimate daily intakes for exposure to chemicals in sediments at the site. Cancer exposure doses were calculated for incidental ingestion of sediment and dermal absorption of sediment adhered to skin. Inhalation of sediment particles was not considered as a route of exposure since inhalation of dust particles from wet sediments are not expected to occur. Volatile and semi-volatile organic chemicals in sediments have been identified as contaminants of concern.

The following equations were used to calculate cancer exposures doses and risks:

Equation C1: Incidental Ingestion Route

$Cancer\ Dose_{ing} = \frac{C_s \times IR \times EF \times CF}{BW}$ Where, $EF = \frac{F \times ED}{AT}$

The exposure factor (EF) will vary depending on the scenario (see scenario-specific calculations for EF in Table C1).

Equation C2: Skin Contact Route

$Cancer\ Dose_{der} = \frac{C_s \times AF \times ABS \times AD \times CF \times SA \times EF}{BW}$ Where, $EF = \frac{F \times ED}{AT}$

Again, the exposure factor (EF) will vary depending on the scenario (see scenario-specific calculations for EF in Table C1).

Equation C3: Carcinogenic mutagenic risks (CMR) or (Carcinogenic risks)

$CMR = Cancer\ Dose \times CSF \times ADAF$

If the carcinogenic risks are greater than an increased incidence of 1 cancer per 1,000,000 people (1×10^{-6}), the exposure dose is discussed further in the text.

Table C1. Exposure assumptions used in exposure evaluation of people in contact with sediments at the former MGP in Bremerton, Washington.

Parameter and Abbreviation		Value	Units	Source
Cancer exposure dose for ingestion route	D(ing)	Calc.	mg/kg-day	D(ing) = C*IR*CF*EF/BW
Cancer exposure dose for dermal route	D(der)	Calc.	mg/kg-day	D(der) = (C*AF*ABS*AD*CF*EF*SA)/BW
Concentration in sediment	C_s	Calc.	mg/kg	Mean chemical-specific concentration for sediment (95% UCL of the mean if adequate data available)
Conversion factor	CF	0.000001	kg/mg	Converts from kilograms soil to milligrams soil
Age-specific body weight	BW	9.2	kg	Body weight, Child 0.5 to < 1 year (EFH)
		11.4		Body weight, Child 1 to < 2 years (EFH)
		17.4		Body weight, Child 2 to < 6 years (EFH)
		31.8		Body weight, Child 6 to < 11 years (EFH)
		56.8		Body weight, Child 11 to < 16 years (EFH)
		71.6		Body weight, Child 16 to < 21 years (EFH)
		80		Body weight, Adult 21 to < 65 years (EFH)
		76		Body weight, Adult 65+ years (EFH)
Exposure factor (EF=F*ED/AT)	EF	Variable	unitless	Local resident (daily exposure at low tide)
				Visitor
				Trespasser
Frequency	F	218	days/year	Resident: low tides occur during the day for 60% of the year (218/365 based on NOAA 2011 data)
		~90		Visitor: summertime months (3 months a year)
		156		Trespasser: onsite 3 days a week
Age-specific exposure duration	ED	0.5	year	Child 0.5 to < 1 year
		1		Child 1 to < 2 years
		4		Child 2 to < 6 years
		5		Child 6 to < 11 years
		5		Child 11 to <16 years
		5		Child 16 to <21 years
		44		Adult 21 to < 65 years
		14		Adult 65+
Averaging time	AT	28470	day	Tribal averaging time, number of days in lifetime (78 years*365 days per year)
Age-dependent adjustment factor for mutagenicity	ADAF	10	unitless	Children < 2 years
		3		Children 2 to < 16 years
		1		Young adults and adults 16 years and older
Cancer risk	CMR	Calc.	$(mg/kg\text{-}day)^{-1}$	Increased risk of getting cancer CMR=D*CSF*ADAF
Cancer slope factor	CSF	7.3	unitless	For BaP used as a reference chemical for cPAHs, published by EPA

Table C1 (continued).

Parameter and Abbreviation		Value	Units	Source
Ingestion Parameters				
Incidental ingestion rate (central tendency)	IR	60	mg/day	Child 0.5 to < 1 year
		100		Child 1 to < 21 years
		50		Adult
Dermal Parameters				
Absorption duration	AD	1	day	Fraction of day sediment is in contact with the skin (worst-case) RAGS E
Skin-sediment adherence factor	AF	0.2	mg/cm^2	Amount of sediment that adheres to skin, child 1-6 years (RAGS E)
		0.07		Amount of sediment that adheres to skin, child and adult (7-31 years) (RAGS E)
Dermal absorption factor	ABS	PAH 0.13	unitless	Chemical-specific, fraction of chemical that absorbs through the skin in 24-hours (EPA RSL; EPA RAGS E)
Surface area	SA	2900	cm^2	Surface area exposed, child 1-6 years (RAGS E)
		5700		Surface area exposed, child and adult 7-31 years (RAGS E)

Sources: Guidance for developing soil screening levels for Superfund sites Abbreviations not defined in the table:

BaP Benzo(a)Pyrene used as the reference compound for PAHs with carcinogenic effects (cPAH)
Calc. Calculated
cm centimeters
EFH EPA Exposure Factors Handbook 2011
EPA U.S. Environmental Protection Agency
mg milligram
NOAA National Oceanic Atmospheric Administration
kg kilogram
cPAH polycyclic aromatic hydrocarbons with carcinogenic effects
RAGS E EPA Risk Assessment Guidance for Superfund Part E, Volume 1: Human Health Evaluation Manual (Part E - Supplemental Guidance for Dermal Risk Assessment)
RSL EPA Regional Screening Levels
UCL upper confidence limit of the mean

Results

Table C2. Estimated cancer risks resulting from central tendency exposures to carcinogenic polycyclic aromatic hydrocarbons (cPAH)[a] in intertidal sediments near the former MGP from Bremerton, Kitsap County, Washington.

Exposure Pathway	Age	Concentration (mg/kg) [b]	Estimated Cancer Dose			Cancer Slope Factor	ADAF	Increased Cancer Risk			Age [c]	Total Cancer Risk
			Incidental Ingestion	Dermal Contact	Total Dose			Incidental Ingestion	Dermal Contact	Total Cancer Risk		
Resident (daily during low tides)	Child 0.5 to < 1 year	159	3.97E-6	4.99E-6	8.96E-6	7.3[a]	10	2.90E-4	3.64E-4	6.54E-4	Young Child	3.1E-03
	Child 1 to < 2 years		1.07E-5	8.05E-6	1.87E-5		10	7.80E-4	5.88E-4	1.37E-3		
	Child 2 to < 6 years		2.80E-5	2.11E-5	4.91E-5		3	6.13E-4	4.62E-4	1.08E-3		
	Child 6 to < 11 years		1.91E-5	2.84E-5	4.75E-5		3	4.19E-4	6.21E-4	1.04E-3	Older Child	1.4E-03
	Child 11 to <16 years		1.07E-5	1.59E-5	2.66E-5		3	2.35E-4	1.26E-4	3.61E-4		
	Child 16 to <21 years		8.50E-6	1.26E-5	2.11E-5		1	6.21E-5	3.33E-5	9.54E-5	Young Adult to Adult	7.6E-04
	Adult 21 to < 65 years		3.35E-5	3.47E-5	6.82E-5		1	2.44E-4	2.54E-4	4.98E-4		
	Adult 65+		1.12E-5	1.16E-5	2.28E-5		1	8.19E-5	8.49E-5	1.67E-4		
	Lifetime		**1.26E-4**	**1.37E-4**	**2.63E-4**			**2.72E-03**	**2.35E-03**	**5.26E-3**		**5.26E-3**
Visitor (daily during summertime only)	Child 0.5 to < 1 year	159	1.64E-6	2.06E-6	3.70E-6		10	1.20E-4	1.50E-4	2.70E-4	Young Child	1.28E-03
	Child 1 to < 2 years		4.41E-6	3.32E-6	7.73E-6		10	3.22E-4	2.43E-4	5.65E-4		
	Child 2 to < 6 years		1.16E-5	8.71E-6	2.03E-5		3	2.53E-4	1.91E-4	4.44E-4		
	Child 6 to < 11 years		7.90E-6	1.17E-5	1.96E-5		3	1.73E-4	2.57E-4	4.30E-4	Older Child	5.79E-04
	Child 11 to <16 years		4.42E-6	6.56E-6	1.10E-5		3	9.69E-5	5.20E-5	1.49E-4		
	Child 16 to <21 years		3.51E-6	5.20E-6	8.71E-6		1	2.56E-5	1.38E-5	3.94E-5	Young Adult to Adult	3.14E-04
	Adult 21 to < 65 years		1.38E-5	1.43E-5	2.82E-5		1	1.01E-4	1.05E-4	2.06E-4		
	Adult 65+		4.63E-6	4.80E-6	9.43E-6		1	3.38E-5	3.51E-5	6.89E-5		
	Lifetime		**5.19E-5**	**5.67E-5**	**1.09E-4**			**1.12E-03**	**1.05E-03**	**2.17E-3**		**2.17E-3**
Trespasser (3 days per week)	Child 16 to <21 years	159	6.08E-6	9.02E-6	1.51E-5		1	4.44E-5	2.38E-5	6.83E-5	Young Adult to Adult	5.44E-04
	Adult 21 to < 65 years		2.40E-5	2.49E-5	4.88E-5		1	1.75E-4	1.81E-4	3.56E-4		
	Adult 65+		8.02E-6	8.32E-6	1.63E-5		1	5.86E-5	6.08E-5	1.19E-4		

Notes:
a – Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) classified by EPA as Group B2 Probable Human Carcinogens; calculations performed with EPA's slope factor 7.3 $(mg/kg\text{-}day)^{-1}$.
Concentrations of each PAHs multiplied by carcinogenic potency factors relative to Benzo(a)pyrene (BaP) according to EPA 2010 and summed/expressed as BaP equivalents (BEQ).
b – Concentration represents 95% upper confidence limit of the mean sediment samples
c – Age groupings are young (0.5 to < 6 years), older (6 to < 16 years old) and young adult/adult (16 years and older)
Abbreviations: EPA – Environmental Protection Agency; mg/kg – milligrams chemical per kilogram sediment
ADAF - Age-dependent adjustment factor for mutagenicity
$(mg/kg\text{-}day)^{-1}$ – milligrams per kilograms per day

Appendix D- Response to Public Comment

This appendix describes how public comments were addressed and/or incorporated into the final Bremerton Gasworks Public Health Assessment. Comments are summarized and responded to below.

Comment 1: My son and I moved to Bremerton in August of 2006 and we have walked on the sandy beach off Ohio Street, waded in the H20, and on one occasion we harvested Periwinkel shellfish when I observed some Asian women doing so. We have also eaten blackberries off of Pennsylvania Street at the intersection of 15th and Pennsylvania, not near the water or the industrial area. Also, my son did play at the beach site and all along the beach under the Warren Avenue bridge with a friend when he was 11 or 12. Finally, my son participated in a Puget Sound water quality survey when he was in 5th grade, taking samples from the Ohio location.

My concern is, since all of these activities are being evaluated, I am wondering if there should be any health concerns for my now 17 year old son and me, the 50 plus mother.

Response 1: *No, we don't see any health concerns associated with the activities you've mentioned. For harvesting blackberries, studies have shown that berries tend not to pick up PAHs. For future harvest, we recommend making sure berries are washed before eaten for any dust that may have settled on the outside of the berry itself. ,*

The Environmental Protection Agency submitted a letter with multiple comments. Specific comments are addressed below. A copy of the full letter is available at the end of this Appendix.

Comment 2: EPA notes that PHA does not reflect an up-to-date understanding of conditions and information related to the Bremerton Gasworks Superfund Site. We believe that using the most up-to-date information about the site would likely affect DOH's characterization of risks, conclusions and recommended next steps.

Additional data gathering and evaluation of polycyclic aromatic hydrocarbon (PAH) levels in beach sediments was completed during the summer of 2013. As a result of that sampling effort, a second Time Critical Removal Action (TCRA) was conducted on the beach in October 2013. The removal action consisted of the excavation of sediments and placement of an organo-clay mat cap in the vicinity of the ballast tanks located on the beach. The current draft of the PHA does not acknowledge this information nor does it reflect this information in the DOH's assessment of exposures to beach sediments and the risks associated with such exposures. The data gathered and actions taken in 2013 would likely influence DOH's characterization of risks at the site, conclusions, and recommended actions.

The final Removal Evaluation Report, which reports the results of the beach sampling effort, can be found at http://www.epa.gov/region10/pdf/sites/bremerton_gasworks/bremerton_gasworks_final_removal_evaluation_report_12-10-13.pdf. The final Removal Action Report, which documents the work performed during the TCRA, has not yet been completed. We will notify you when it is in final form and we will provide you with a link to the report at that time.

Response 2: *This document does not address the removal and sampling actions taken in 2010 and 2013. We have clarified this in the introduction and our exposure evaluation.*

Comment 3: EPA also believes that the PHA could be improved if the discussion of exposures and estimated risks to the public were presented in a more "plain English" style. As presently written, the PHA is likely to leave some readers with questions about how exposures and risks were estimated and, more importantly, what those estimates mean to people who live nearby or traverse portions the site.

Response 3: *The PHA is written for a wide variety of audiences. We have written the summary at the beginning of the document for a non-technical audience allowing the rest of the document to give more information as needed. Regarding the exposure discussion on page 22 of this document, we believe that it is written in a clear and concise manner.*

Comment 4: The PHA should consistently indicate whether the recommended actions (removal or fencing of rusty tank and removal of ballast tanks) are currently taking place or represent recommended future actions. As currently written, the PHA is not clear about the timing of the recommended actions.

Response 4: *DOH has recommended that physical hazards be removed within three to six months of this document being released on page 41 of this document.*

Comment 5: We recommend that the PHA discuss the relative risk trade-offs between disturbing the areas around the rusty tank and ballast tanks and potentially exposing workers (and subsequent visitors) to contaminants that may cause health risks versus the reduced physical risks that would result from the recommended actions. This is particularly important to discuss since the PHA characterizes these physical risks as "urgent public health hazards." The PHA does not provide any information that indicates whether disturbing a potentially contaminated, yet-to-be characterized, area of the site to remove a physical hazard is the best course of action and outweighs potential risks from exposure to contamination.

Response 5: *There continues to be public access to the beach and, therefore, the rusty tank and ballast tanks remain physical hazards. The Pacific Northwest and Puget Sound area are prone to seismic activity. During an earthquake, these ballast tanks could roll and injure or kill someone on the beach. The rusty tank (55-gallon drum) is alongside a footpath in the hillside and someone could accidently step on or in it, resulting in injury. Since the tank is rusted there is the strong possibility that injury could lead to tetanus or death. These physical hazards would be acute in nature as opposed to the chronic exposure that would occur from possible chemical exposure to PAHs. Furthermore, during removal of the rusty tank or ballast tanks, precautionary and preventative measures and soil and sediment samples would be taken before refilling the hole.*

Comment 6: Please be advised that reducing risks associated strictly with physical hazards is not within the EPA's purview under our CERCLA authorities. We will address physical hazards as we do our work, as situations dictate, and our work will be designed and conducted in a manner so as not to create any additional physical risks. Addressing physical risks not associated with

our actions taken pursuant to CERCLA is the responsibility of the owners of properties where such risks exist.

Response 6: *Your comment has been noted. However, CERCLA states under Section 104 Response authorities, (7) Confidentiality of Information.— (iii) The hazards to health and the environment posed by the substance, including physical hazards (such as explosion) and potential acute and chronic health hazards.* For more information, seehttp://www.epw.senate.gov/cercla.pdf

Comment 7: The DOH estimates that for residents, 5 additional cases of cancer will develop for every 1,000 people exposed to beach sediments over a lifetime. We recommend that the PHA provide additional discussion about how this conclusion was derived/calculated so that readers (particularly the general public) can better understand what this means. Some of this is explained in Appendix C, but the document could be improved by better explaining things in the main body of the PHA.

Response 7: *The Conclusion provided at the beginning of the document is meant only to summarize the information. Starting on page 35, we go through a more detailed discussion of the health effects from exposure. The more detailed explanation of how information was derived will remain in the appendix of the assessment.*

Comment 8: A clear presentation of what data were used to derive the risk value presented in the PHA. Table C2 shows that a 159 mg/kg carcinogenic PAH (cPAH) concentration was used to calculate cancer risk (BaP equivalent), yet the PHA is not clear about which sediment samples were used to derive this concentration. Figure 5 shows locations where sampling has taken place, yet there is no place in the PHA that shows (or discusses) which of those data points ultimately were used in deriving the estimated risk at the site. This should be clarified.

Response 8: *The 95% upper confidence limit of the mean sediment samples was used in PHA to obtain the 159 mg/kg cPAH. Therefore, all 36 sediment samples were used. This is discussed on page 59 of this document.*

Comment 9: The PHA does not indicate whether sediment cPAH levels used to estimate risk include sediment concentrations in the area currently covered by the organo-clay mat installed as part of the 2010 TCRA. As the exposure pathway to contaminated sediments has been eliminated in this area (and is expected to remain so until a long-term remedy is implemented at the site), the PHA should discuss if data from this area were (or were not) used in estimating risk. If data from this area were used, the PHA should discuss why they have been used despite the fact that there is no human health exposure pathway on that portion of the beach.

Response 9: *This document does not address the removal and sampling actions taken in 2010 and 2013. We have clarified this in the introduction and our exposure evaluation. This will be addressed in a future Letter Health Consultation.*

Comment 10: The PHA uses the term “residents” in the discussions related to exposures and potential health effects. The DOH should clearly identify what populations are considered as

"residents" in the PHA because, while residential areas border the upland parcels evaluated in the PHA, there are no people residing on the upland parcels and beach areas included in the assessment. Because DOH has ascribed risks exclusively to exposures to contaminated sediments on the beach (a non-residential area), it is important to clarify which "residents" are at risk and why they are assumed to be exposed to the contaminated sediments.

Response 10: *We have clarified "residents" as those who live adjacent to the site and are assumed to have more potential for exposure than other people who may use the site.*

Comment 11: A clearer, plain English description of lifetime exposures should be provided in the PHA. It is currently characterized as "over a lifetime" equating to 70 years, but is does not explain if risks are based on constant exposures to cPAHs in sediments 24 hours-per-day, 7 days-per-week for 70 years or some other variation. The PHA does indicate that exposures to beach sediments were estimated to be 218 days per year, based on the tides, but it is no clear how this value is ultimately used in the risk calculations. This should be clarified. Perhaps showing an example of the equations presented in Appendix C with the actual numbers used would be a helpful tool on this front.

Response 11: *We have included the number of years that is calculated for lifetime in the Basis of Decision on pages 61. The number of years is 78 years.*

Comment 12: Estimated exposures to cPAH levels in beach sediments reflecting all existing data, including those contained in the 2013 Final Removal Evaluation Report (link to report provided above), would likely result in calculated risks that are different from those presented in the current version of the PHA.

Response 12: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction and our exposure evaluation.*

Comment 13: The PHA does not clearly explain why warning signs about blackberry consumption are recommended, when the DOH is unable to conclude that people are being exposed to contaminants in blackberries collected at the site. The PHA should provide additional information that supports the recommended action, given the inability to determine whether or not a risk exists.

Response 13: *The comment has been addressed on page 38. Research has shown uptake or accumulation of PAH or metals by fruit are generally low to non-detected. Therefore, this pathway is unlikely.*

Comment 14: Exposure Pathways and Data Gaps
These sections state that "some contaminants are known to accumulate in berries" and "(b)erries have been shown to accumulate PAHs and some metals reported at the site," yet there are no citations of information sources that support these statements. The PHA should include references to the sources of those conclusions. This information will be helpful to EPA as we determine the scope of our investigation of the site.

Response 14: *The comment has been addressed. A footnote has been added on page 33 of this document.*

Comment 15: The DOH should ensure that actions are placed in the correct sections of the Action Plan. Some actions currently characterized as "Actions Underway" appear to be more appropriately characterized as either being completed or being (or recommended to be) planned.

Response 15: *The comment has been addressed on page 42.*

Comment 16: Add "Warning signs have been installed by Cascade Natural Gas, with EPA and KPHD oversight, at the end of Pennsylvania Avenue and on the beach below the former gasworks plant site," (or something similar) to the "Actions Completed" section. Remove sign installation recommendations from the "Actions Underway" section.

Response 16: *The comment has been addressed on page 42.*

Comment 17: The PHA states (under Actions Planned) that "DOH is working with EPA to develop a community involvement and communication plan." While EPA is working closely with DOH in coordinating public engagement for the Bremerton Gasworks Superfund Site, this statement is incorrect as it was not (and is not) EPA's intention to develop a joint involvement and communication plan with DOH. EPA has completed its initial version of the Community Involvement Plan for the remedial investigation and feasibility study work at the site in April 2013 (http://www.epa.gov/region10/pdf/sites/bremerton_gasworks/bremerton_gasworks_cip_042013.pdf). This should be noted in the Actions Completed section. We have coordinated, and will continue to coordinate, with DOH on outreach efforts related to the site to the extent that such efforts make sense for both agencies and the public.

Response 17: *We have revised the language to state DOH and EPA are collaborating on future community engagement activities.*

Comment 18: Under Planned Actions, the PHA states that "EPA is considering developing sampling plans to collect and analyzing (sic) fish, shellfish, and berries." We recommend that this statement be revised as follows: "EPA will be developing and implementing sampling plans as part of the remedial investigation of the site. DOH recommends that those plans include sampling and analysis of fish, shellfish and berries."

Response 18: *Comment has been addressed on page 42.*

Comment 19: In addition to the parties identified in the current draft of the PHA, EPA suggests that copies of the approved PHA also be provided to the owners of the properties covered by the assessment (McConkey Family Trust, Natacha Sesko, the State of Washington (Department of Natural Resources), owners of Parcels D, E and F). We also recommend providing a copy to Cascade Natural Gas, who is responsible for investigating the site under EPA's oversight.

Response 19: *DOH plans on sending these stakeholders copies of the approved PHA.*

Cascade Natural Gas provided a letter with multiple comments. Specific comments are addressed below. A copy of the full letter is available at the end of this Appendix.

Comment 20: Cascade's primary concern regarding the Assessment is that it is not reflective of current conditions at the Bremerton Gas Works site (Site), and as a result, overstates the health risks associated with Site conditions. The Assessment appears to have been prepared in the summer and fall of 2012. Please note that on May 1, 2013, Cascade and the U.S. Environmental Protection Agency (EPA) entered into an Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study of the Site (AOC; Docket No 10-2013-0104). Since the execution of the AOC, Cascade and EPA have completed significant evaluations, sampling, risk mitigation measures and cleanup activities at the Site that are not reflected in the Assessment. We understand that the Assessment was prepared to reflect conditions at the time of the National Priorities Listing (NPL) in 2012. However, we recommend that these completed activities (Remedial Work) be referenced in the Assessment

Response 20: *The comment has been addressed. We have noted the completed remedial work on page 19 of this document.*

Comment 21: The historical sample data used to estimate chemical exposure to sediment is outdated. Remedial Work has changed the Site conditions and updated data, collected in 2013, are available to characterize the beach. The average concentration for the beach is currently seven times lower than what was applied in the Assessment. The risk levels calculated in the Assessment are likely greater than reasonable maximum exposures scenarios under current site conditions.

Response 21: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction, our exposure evaluation and action taken section.*

Comment 22: Hydrocarbon materials were removed from the western beach area, and a cap was placed over a portion of the western beach area with elevated PAH concentrations. The cap design is similar to that which was placed during the 2010 TCRA, which has been performing well since that time. These actions have further reduced potential health risks associated with the beach area by reducing PAH concentrations in exposed beach sediments

***Response* 22:** *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction, our exposure evaluation and action completed section.*

Comment 23: Signage has been installed at the three beach access points to alert potential beach users of the presence of contaminated sediments. The signs were developed to meet the requirements of EPA and the Kitsap Public Health District. The placement of the signs is consistent with recommendations made in the draft Assessment.

Response 23: *This comment has been addressed. We have noted the signage in the action completed section on page 42.*

Comment 24: Improvements to the storm water system at the Site have been completed to reduce the potential for storm water infiltration into the historical drainage network.

Response 24: *We have noted the improvement to the storm water system in the action completed section on page 42.*

Comment 25: A comprehensive Removal Action Report is in preparation summarizing all of the work performed. That report will be available from EPA once it has been finalized.

Response 25: *We have added this information to the action planned section on page 42.*

Comment 26: We request that DOH update the Assessment to reflect the Remedial Work, as this work resulted in a reduction in beach sediment PAH concentrations relative to those cited in the draft Assessment (a result of the two completed TCRAs). PAH concentrations cited in the Assessment currently do not accurately represent site conditions.

Response 26: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction and our exposure evaluation.*

Comment 27: We also request that DOH update the Assessment to include the installation of signage in coordination with the Kitsap Public Health District and EPA.

Response 27: *This comment has been addressed. We have noted the signage in the action completed section on page 42.*

Comment 28: Page 9: History. Please revise the first paragraph to reflect the fact that the former gas works manufactured gas from coal and other petroleum products from 1930 through 1955. Although the facility continued to be utilized by the company until 1963, gas blending was conducted between 1955 and 1963 by blending propane and air. Propane-air operations conducted between 1955 and 1963 did not likely contribute to contamination at the Site.

Response 28: *Further information regarding the facility is addressed on page 13, Historical Operations section.*

Comment 29: Page 9: Site Boundary. Please revise the last paragraph to reflect the fact that Cascade and EPA have not yet established the formal boundaries of the Site, but that Gas Works operations were confined to two parcels (Parcel A and Parcel B). Surrounding past and current industrial activities may have contributed to contamination in the area, but these sources are not currently considered part of the Site.

Response 29: *Your comment has been noted. The information has been updated on what is now page 12.*

Comment 30: Figures 1, 2. 3. and 5. Please correct the boundary between Parcel A and Parcel C1, which does not reflect recent lot line adjustments. In addition, Parcels C1, C2, D, E, and F are not part of the Site and should not be designated "Site-related parcels." Instead, we suggest

these parcels be designated as "adjacent properties with current or past industrial activities." Finally, on Figures 1 and 2 the boundary of the DNR-managed aquatic land is inaccurate, and should be shown as adjacent to Parcel A.

Response 30: *Your comment has been noted. The figures have been updated.*

Comment 31: Table 1. Gas production is not known to have occurred on parcels other than Parcel A or Parcel B (as defined by current boundaries).

Response 31: *Your comment has been noted. However, the previous boundaries indicate the northern portion of Parcel C which has been now incorporated into Parcel A.*

Comment 32: Page 12: History. Update the narrative regarding Historical Operations. The former gas works covered Parcel A (current legal boundaries) and the west portion of Parcel B and portions of the harbor area leased from DNR.

Response 32: *Comment has been addressed in the updated figures. However, the previous boundaries indicate the northern portion of Parcel C which has been now incorporated into Parcel A.*

Comment 33: Page 13: History. Please correct the last paragraph to provide that gas was produced by blending propane and air starting in 1955, and that all operations ceased in 1963.

Response 33: *We have adjusted the years to reflect your comment.*

Comment 34: Page 17: drum removal. Please revise the third paragraph to reflect the fact that the drums containing investigation derived waste are associated with the City of Bremerton's Brownfield's Assessment.

Response 34: *Comment has been addressed.*

Comment 35: Page 17: 2010 TCRA. Please revise the fourth paragraph to reflect the fact that: (1) the initial laboratory characterization of the material within the pipe was "coal tar creosote" rather than "coal tar product"; and (2) Cascade entered into an Administrative Order for a Pollution Incident with the U.S. Coast Guard rather than an Agreed Order with EPA.

Response 35: *Comment has been addressed.*

Comment 36: Page 17: 2010 TCRA. Please correct the statement "The release came from what appeared to be an abandoned sewer storm water outfall pipe. It was once connected to, or may still be connected to, an abandoned vault. The vault likely received discharge from catch basins on the former MGP footprint on Parcels A and B(1)" The outfall was formerly connected to a now abandoned City drainage system that included multiple inputs upstream of the site. The 2013 TCRA identified and capped potential remaining inputs to the drainage system.

Response 36: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction and our exposure evaluation.*

Comment 37: Page 18: RI/FS. Please revise the first full sentence on page 18 to describe that the RI/FS is being conducted by Cascade under the direction of the EPA pursuant to the AOC.

Response 37: *Comment has been addressed.*

Comment 38: Please clarify that the fish consumption advisories for the Bremerton Area were not established as a result of Site conditions, and are based on factors other than potential contamination at the Site (p. 19).

Response 38: *Comment has been addressed. A sentence has been added stating: This advisory is not related to the Bremerton Gasworks Site.*

Comment 39: Please update the discussion of the Nature and Extent of Contamination (pp. 20-26) to reference that current conditions within the beach area have been characterized as part of the 2013 Removal Evaluation, and that the 2010 TCRA and the 2013 TCRA each contributed to reductions in PAH concentrations in exposed beach sediments. The historical 2008 and 2010 beach samples collected by Ecology & Environment (E&E) are no longer representative of current conditions. In the event that DOH does not incorporate the most current data into the Assessment, please clearly state that the cutoff date for data evaluated as part of the Assessment is 2010 (prior to the 2010 TCRA), and that more recent data are available but have not been evaluated by DOH.

Response 39: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction and our exposure evaluation.*

Comment 40: General. Include reference to ongoing RI/FS scoping, including development of risk assessment methods to be applied to the Site under EPA direction.

Response 40: *Actions planned are documented in the Public Health Action Plan on page 39.*

Comment 41: Table 5 and associated text. Please use the phrase "future on-Site resident" instead of the phrase "local resident" to avoid potential confusion regarding risks to residents living in the vicinity of the Site. The "local resident" scenario does not reflect risks to existing residents living in the vicinity of the Site. As used in the Assessment, the term "local resident" means a hypothetical future individual living within the boundaries of the Site. The hypothetical future on-site resident scenario would apply only if the property within the Site was converted from industrial use to residential use without prior cleanup or institutional control measures being implemented.

Response 41: *We have clarified "residents" as those who live adjacent to the site and are assumed to have more potential for exposure than other people who may use the site and will be using this term within the document.*

Comment 42: Table 5 and Page 22: Blackberries. The tables and narrative regarding blackberry related risks should be updated to reflect that accumulation of organic pollution and trace elements in plants from soil is unlikely to be a significant pathway for cPAHs (refer to Samsoe-Petersen, L., E.H Larsen, P.B. Larsen, and P. Bruun. 2002. "Uptake of Trace Elements and PAHs by Fruit and Vegetables from Contaminated Soils*." Environmental Science and Technology* 36 QQ: 3057-3063; refer also to Simonich, S.L., and R.A. Hites. 1995. "Critical Review: Organic Pollution Accumulation in Vegetation." *Environmental Science and Technology* 29(12):2905-2915.). For these compounds, atmospheric deposition is also unlikely to be a significant pathway given that most of the Site remains paved and/or vegetated or is wetted by tidal action, reducing potential for fugitive dust generation.

Response 42: *Comment has been addressed. Table 5 has been updated and a footnote reference was added to page 34.*

Comment 43: Page 29: Seeps. The text in the first bullet point states that "bluff seeps of oil have been reported," but no references are provided. If a reliable observation of such seeps is available, please reference the source and provide it to EPA and Cascade for their review. Otherwise, this statement should be deleted from the Assessment.

Response 43: *This information was found in the Hart Crowser 2007 document, reference number 3 on pages 20 and 25.*

Comment 44: Page 29: Remedial Work. Include a paragraph referencing that risks associated with the Site have been reduced since the listing of the Site on the NPL through sediment removal, capping, and placement of signage to limit access to the beach area pending completion of the RI/FS and any required final Site cleanup measures.

Response 44: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction and our exposure evaluation.*

Comment 45: Page 29: Sediment Data Gaps. Update the discussion of sediment data gaps to reference the completion of additional data collection in 2013 as described in the Final Removal Evaluation Report (Aspect and Anchor QEA 2013). That data collection provides a more recent characterization of Site conditions, and also addresses the detection limits issues associated with the older sediment data collected by E&E.

Response 45: *Comment has been addressed.*

Comment 46: General. As noted above, we recommend that the "resident" / "local resident" scenario be retitled throughout the document as "future on-site resident" to avoid confusion about what is reflected in this scenario.

Response 46: *We have clarified "residents" as those who live adjacent to the site and are assumed to have more potential for exposure than other people who may use the site and will be using this term within the document.*

Comment 47: Page 34: Cancer Risks. This summary text should be revised in accordance with the following:

The average exposed sediment concentration has been significantly reduced as represented by data available from the 2013 Removal Evaluation sampling effort. The maximum remaining exposed sediment concentration is 66.4 mg/kg, which is well below the previous maximum (351 mg/kg) referenced in the Assessment. Using the updated data, the average exposed sediment cPAH concentration (95% UCL of average) is 22.4 mg/kg, which is well below the 159 mg/kg average on which the Assessment is based. This section should be revised to include these updated values in order to reflect reductions in contaminant concentrations and other risk mitigation measures that were achieved through the 2013 TCRA.

If DOH does not update the risk assessment based on the 2013 Removal Evaluation sampling effort, this section should clearly state that the average sediment concentration is based on conditions prior to completion of the 2010 and 2013 TCRA activities, and does not reflect reductions in contaminant concentrations or other risk mitigation measures achieved by those completed actions.

Response 47: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction and our exposure evaluation.*

Comment 48: The beach recreation assumptions (i.e., 218 days per year for "future on-site resident" and 90 days per year for "visitor") used for the risk estimates should be explicitly stated along with the risk outputs at the top of p. 34 so that report users can understand how their beach use relates to those contained in the risk estimates.

Response 48: *Comment has been addressed.*

Comment 49: Page 35: Question 1. The response provided to this question is not clear and may result in confusion. We suggest the first sentence of this response clearly state that DOH is not capable of determining the cause of any cancers that people may have in the neighborhood, and the Assessment is not meant to imply that the release of chemicals at the Site has resulted in cancer in any individuals. The response should further clarify that many factors are believed to result in an increased risk of cancer, and these factors include many variables other than exposure to the chemicals present at the Site.

Response 49: *The sentence was adjusted and moved to the beginning of the response.*

Comment 50: Page 36: Question 3. Suggest adding language and literature citations to clarify that accumulation of cPAHs in plants from soil is unlikely to be a significant pathway (Samsoe-Petersen et al. 2002 and Simonich, S.L., et al. 1995). Please also include text stating that signage has been placed as part of the 2013 TCRA to restrict access to this area. Please also note that "Sesko Property" is not defined in the Assessment - "Parcel B" should be used instead.

Response 50: *Comment has been addressed. A footnote reference was added to page 34.*

Comment 51: Page 36: Question 4. Please update the bullets under this response to note that signs have been installed as part of the 2013 TCRA including warnings to not harvest or consume shellfish.

Response 51: *Comment has been addressed.*

Comment 52: Page 37: Questions 6 and 7. The response to Question 6 includes a statement regarding 'oily seeps' but does not indicate where that citation comes from. The source of the statement should either be clearly cited, or the statement should be deleted. In addition, please state that warning signs have been placed as part of the 2013 TCRA to restrict access to the Site.

Response 52: *Comment has been addressed. The information was found in the Hart Crowser 2007 document, reference number 3 on pages 20 and 25.*

Comment 53: Page 37: Question 8. As noted above, please change the term "resident" to "future on-site resident" to avoid confusion about what is represented by this scenario.

Response 53: *The term "future" has been added to the question to clarify*

Comment 54: Page 38: Question 10. Please update this response to state that updated signage has been installed as part of the 2013 TCRA, and that the language was developed by the Kitsap County Health Department and EPA.

Response 54: *Comment has been addressed.*

Comment 55: First Paragraph. As above, please rename the resident exposure scenario to clarify that this represents "future on-site residents" and not residents that currently live in the vicinity of the Site.

Response 55: *This is not addressing future residents. It is referring to current residents who live adjacent to the site.*

Comment 56: Conclusion 1: Physical injury. The discussion of physical injury/hazard appears to go beyond the scope of the Assessment as described on p. 9. Consider deleting this conclusion.

Response 56: *Addressing physical hazards falls within the scope of our health assessments.*

Comment 57: Conclusion 2: Touching or Ingesting. Please update this conclusion based on the most recent data or clarify that the risk estimates are based on conditions present at the time the Site was listed on the NPL, and that actions have been taken to reduce exposed sediment concentrations and limit beach access.

Response 57*: This document does not address the removal and sampling actions taken in 2010 and 2013. We have clarified this in the introduction and our exposure evaluation.*

Comment 58: Page 38: Bullet 1. The discussion of physical injury/hazard appears to go beyond the scope of the Assessment as described on p. 9. Consider deleting this recommendation. Given the status of the Site, any physical removals would need to be conducted under EPA direction.

Response 58: *Addressing physical hazards falls within the scope of our health assessments.*

Comment 59: Page 39: Bullet 2. Please acknowledge that updated signage was installed as part of the 2013 TCRA. This recommendation can be deleted or adjusted to state that "signage installed as part of the 2013 TCRA should be maintained until further characterization is completed"

Response 59: *Comment has been addressed.*

Comment 60: Page 39: Bullet 3. Please acknowledge the TCRA elements completed in 2013. The identification of potential ongoing sources is being addressed as part of the RI/FS.

Response 60: *This document is only addressing the 2010 data.*

Comment 61: Page 39: Bullets 4 and 5. Consider re-wording to clarify what is meant by "the shoreline near the Site" and "the shoreline." For example, this could be referenced as the "posted beach area located between Pennsylvania Avenue and the Port Washington Narrows Marina."

Response 61: *Site descriptions have been added to the two bullets.*

Comment 62: Page 39: Bullet 8. Please rephrase this text to clarify that decisions about land use are separate decisions based on zoning and owner direction, but are considered as part of the RI/FS and EPA's cleanup decision. Suggested wording is "The RI/FS consider how risks at the Site may be affected by potential future land uses."

Response 62: *The question is in regard to future health risks at the site and it is indicated in the response that EPA will do a future investigation to determine the nature and extent of the contamination at the site.*

Comment 63: Actions Completed (p. 39). We recommend the narrative in this section be updated to include the following additional bullets:

- "In May 2013 Cascade entered into the Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study of the Site (AOC)."
- "Under EPA oversight, Cascade completed a Removal Evaluation, providing updated data regarding conditions at the beach area."
- "Under EPA oversight, Cascade conducted a TCRA in addition to that performed in 2010. This action included removal and capping of beach sediments, posting of updated warning signs, and additional actions to address upland stormwater."

Response 63: *This document does not address the removal and sampling actions taken in 2010 and 2013. We have clarified this in the introduction and our exposure evaluation.*

Comment 64: Actions Underway (p. 39).'We recommend that the bullets in this section be updated as follows:

- Bullets 2 and 3. We suggest these bullets be deleted, as signage has already been installed in these areas by Cascade under EPA direction.
- Bullet 4. We suggest this bullet be deleted or revised to account for the fact that further investigation as part of the RI/FS may be required before the partially buried tank at the foot of the bluff on Parcel B may be safely removed. EPA should be consulted prior to making recommendations that specific actions be taken within specific timeframes.
- Bullet 5. Consider restating this bullet to account for the fact that DNR and EPA are evaluating options to remove the submarine ballast tanks, which are owned by Natasha Sesko.
- Bullet 6. This bullet should be restated as follows: "Consistent with the AOC and under EPA oversight, Cascade is performing periodic inspections of the two capped areas of the shoreline. These inspections will continue throughout performance of the RI/FS."

Response 64: *Comment has been addressed.*

Comment 65: Actions Planned (pp. 39-40). We recommend that the bullets in this section be updated as follows:

- Bullet 2. This bullet should be restated as follows: "EPA is scoping investigation activities to be performed as part of the RI/FS. These activities may include sampling of soil, sediments groundwater, surface water, and fish or shellfish tissue."

Response 65: *Comment has been addressed.*

Comment 66: Appendix B (Site data):

- Table B-1. This table should be updated to include references to: 1) the availability of more recent data from the 2013 Removal Evaluation; and 2) the completion of the 2010 TCRA and the 2013 TCRA, which resulted in reductions to exposed sediment PAH concentrations.

Response 66: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction and our exposure evaluation.*

Comment 67: Please update Appendix C with data collected during the 2013 Removal Evaluation, and note that the risk exposure estimates do not reflect contaminant reductions and other risk mitigation measures that were achieved through the 2013 TCRA. Otherwise, please clarify that the exposure estimates do not reflect the concentration reductions and other risk mitigation measures that were achieved through the 2010 or 2013 TCRA activities performed by Cascade under Coast Guard and EPA oversight.

Response 67: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction and our exposure evaluation.*

Comment 68: Page 56: Data Compilation. Please recalculate risk based on the 2013 sediment data. In the alternative, please clarify that data collected after 2010 were not used in the risk

calculations, and that the 2013 sediment data show a substantial reduction in exposed sediment PAH concentrations in comparison to the older data.

Response 68: *This document does not address the removal and sampling actions taken in 2013 and we have clarified this in the introduction and our exposure evaluation.*

Comment 69: Table C2. Please update references to "resident" in the text and in Table C2 and instead reference use the term "future on-site resident" to avoid confusion about what is addressed under this scenario.

Response 69: *We've determined that residents are people living adjacent to the site and have defined it in the beginning of the document.*

Comment 70: Page 56: Beach Use. Prior to the bullet Points, please specifically state the frequency of beach use (i.e., 218, 90, and 156 days per year) associated with each of the three exposure scenarios evaluated.

Response 70: *We have inserted the frequency of days and years into each bullet.*

The Suquamish Tribe provided a letter with multiple comments. Specific comments are addressed below. A copy of the full letter is available at the end of this Appendix.

Comment 71: Page 7. The Tribe is in the process of getting Dyes Inlet re-certified and has the goal of eventually addressing all areas currently classified as prohibited from harvest. Once re-certified, the Tribe would resume harvesting in this area; including the Area of Actual Contamination.

Response 71: *Your comment has been noted.*

Comment 72: Page 9. Extent of contamination should include both vertical and horizontal extent.

Response 72: *The EPA is planning on doing a more extensive sampling effort that will include that information. We will review this data when it becomes available.*

Comment 73: Page 11. Please include information regarding Suquamish current and future use of the site.

Response 73: *We have included on page 11 information about the usual and accustomed fishing area for the Suquamish Tribe. For more information about the Suquamish Tribe visit http://www.suquamish.nsn.us/.*

Comment 74: Page 12. Historic use should also include Tribal use of the area. The Tribe has a strong pre-historical, historical, and contemporary connection in the Port Washington Narrows/Sinclair Inlet area that is significant and well documented. Ethnographic and archaeological evidence demonstrates that the Suquamish people have lived, gathered food stuffs, ceremonial and spiritual items, and hunted and fished (for human consumption) for

thousands of years near and within the Zone of Actual Contamination (personal communication, Dennis Lewarch, 2008). The Port Washington Narrows vicinity was known as a good clamming, fishing and duck harvest area.

Response 74: *This section is addressing the historical operations of the manufactured gas plant from 1930s to present.*

Comment 75: Page 19 (Fish). Juvenile fish (including ESA listed species) are found within the nearshore areas of Puget Sound including but not limited to Dyes and Sinclair Inlet.

The latest and best scientific information regarding the origin and migratory behavior of PS Chinook salmon in Sinclair Inlet is the 2006 report entitled "Juvenile salmon use of Sinclair Inlet, Washington in 2001 and 2002" (Freshet al. 2006). Based on beach seining of nearshore areas of the inlet during 2001 and 2002, Freshet al. concluded that the inlet is used by hatchery origin and wild juvenile Chinook originating from outside Sinclair Inlet and that these exogenous fish are present from *July through September.* The 2006 report further concludes: "*Juvenile Chinook salmon are present in Sinclair Inlet from early spring through early fall, at a minimum. Clearly, Sinclair Inlet shorelines are host to juvenile Chinook salmon from throughout Puget Sound during the late spring and summer months, and likely include both hatchery origin and natural origin. Therefore, proper management of nearshore habitats is important not only for local origin fish, but also for those that originate from a considerable distance. [emphasis added]"*

Juvenile chum, coho, and steelhead salmon as well as cutthroat trout are also documented in both Sinclair and Dyes Inlet.

There is documented sand lance spawning in the vicinity of the project.

Response 75: *Your comment has been noted.*

Comment 76: Page 18. There is no mention of marine mammal and/or mammal use (whales, seals, river otters, etc.).

Response 76: *DOH has not included mention of marine mammal consumption rates as they are not a resident species. We have also not seen any studies discussion mammal consumption rates.*

Comment 77: Page 18. There is no mention of bird use.

Response 77: *DOH has not included mention of bird consumption rates as they are not a resident species. We have also not seen any studies discussion mammal consumption rates.*

Comment 78: The Port Washington Narrows is an area that is part of an active tribal and state sea cucumber fishery.

Response 78: *Your comment has been noted.*

Comment 79: Page 19 and 35-40 (consumption advisories). Even though Tribal members are aware of contamination issues there are very strong cultural and spiritual ties to the land and resources that may preclude avoidance. Institutional controls (IC's) such as harvest advisories should not be used as long term, permanent options. Achievement of human health protective levels should be attained through the reduction of concentrations in sediment and surface water. The Suquamish Tribe does not consider limitation of treaty rights to be "positive behavior change". Institutional controls need to be a temporary solution with eventual clean up. Institutional controls should NOT be considered remediation.

Response 79: *The Department of Health provides fish advisories to make people aware of potential risk from eating fish and shellfish from certain areas. We will share your concerns about institutional controls with the Environmental Protection Agency, who is overseeing the cleanup.*

Comment 80: Pages 23-25 do not clearly show potential risk to Suquamish tribal members.

Response 80: *This information can be found in Table 5 on page 30 and 31.*

Comment 81: Page 29. There is no discussion of dioxin/furan sampling in the data gaps section.

Response 81: *There is mention of the potential for dioxins to be present at the site due to past activities.*

Comment 82: Page 29. It is not clear why groundwater is an unlikely source as tidal pumping could result in the mobilization of contaminants.

Response 82: *The statement is pointing out that because groundwater at the site is not used as a source of drinking water, its unlikely people will be exposed through ingestion.*

Comment 83: Page 29. How can sediment contamination be "well characterized" if the vertical and horizontal extent is unknown?

Response 83: *This statement is referring to the area that has been capped.*

Comment 84: Page 30 (Biota). Which areas are more productive or provide more resources are irrelevant with regard to consumption rates and cleanup.

Response 84: *Comment has been addressed. The sentence about no information on ecological sustainability has been removed.*

Comment 85: Page 31. There is no discussion in the document on environmental justice issues. Including but not limited to the disproportionate risks borne by tribal members.

Response 85: *DOH currently does not have enough data to provide a more definitive assessment of human exposures and possible health effects. DOH will evaluate new data as it becomes available and include recommendations to protect tribal members who eat fish and shellfish at a high subsistence consumption rate.*

Comment 86: Page 33 (consumption rates). There is no discussion of future use. With increasing enrollment numbers, growing interest in traditional foods and practices and current suppression effects (lower consumption rates due to the effects of, or concerns about, environmental contamination) we can likely expect consumption rates in Port Gamble Bay to increase over time. The Suquamish survey indicated that a large number of respondents reported eating less seafood now than twenty years ago due to issues that included accessibility/availability of finfish and shellfish and increased pollution. Harvest restrictions for finfish and shellfish due to pollution concerns affect the availability of these seafood resources to Tribal members. However, as closed areas recover and are reopened to harvest, consumption rates increase.

Response 86: *There is a general fish advisory for the area which can be found at www.doh.wa.gov/fish. Generally, the aim of fish advisories is not towards permanent reductions in fish consumption. Instead, it is to increase the intake of fish and shellfish obtained from areas not, or less, affected by contamination. Currently, the area is closed for shellfish harvest due to combined sewer overflow outfalls. DOH will evaluate new data as it becomes available in the future to determine if adjusting the recommendations is appropriate.*

Comment 87: Page 38 (recommendations). Are the recommendations culturally relevant? What are the unintended health and cultural consequences of fish advisories and/or harvest restrictions for tribal members?

Response 87: *There is a general fish advisory for the area which can be found at www.doh.wa.gov/fish. Generally, the aim of fish advisories is not towards permanent reductions in fish consumption. Instead, it is to increase the intake of fish and shellfish obtained from areas not, or less, affected by contamination. Currently, the area is closed for shellfish harvest due to combined sewer overflow outfalls.*

References

1. Anchor. Completion report (Final), Former Bremerton MGP Site, Incident action and time critical removal action. January 2011. Prepared for the U.S. Coast Guard Sector Puget Sound Incident Management Division on behalf of Cascade Natural Gas Corporation by Ancor QEA, LLC. 2011.

2. E&E. Final Bremerton Gasworks Targeted Brownfields Assessment Report, Bremerton Washington. Technical Document Number 07-01-0008, August 2009. Prepared for the U.S. Environmental Protection Agency by Ecology and Environment, Inc. 2009.

3. Hart Crowser. Historical Characterization and Data Gaps, Old Bremerton Gasworks Property, 1725 Pennsylvania Avenue, Washington. May 2, 2007. Prepared for Washington State Department of Ecology by Hart Crowser. 2007.

4. S.R.Tymstra. Investigation of the Western Gas Company of Washington, Bremerton, Washington pertaining to fire-hazard at the gas plant, disposal of by-products, proposed piping ordinances. Requested by the Mayor of Bremerton 8 pp (as reproduced in Hart Crowser 2007). 1942.

5. TechLaw. Old Bremerton Gasworks Site, McConkey Properties, Targeted Brownfields Assessment, Bremerton, Washington. November 10, 2006. Prepared by TechLaw, Inc. for submission to U.S. Environmental Protection Agency, Contract No. EP-S7-06-03, Task 06-07-0005. 2006.

6. Ecology. Cleanup Site Search (Pacific Coast Energy Co.; FS ID 2788449), Accessed November 2012. https://fortress.wa.gov/ecy/gsp/SiteSearchPage.aspx. Washington State Department of Ecology. 2012.

7. Ecology. Initial inspection report. Washington State Department of Ecology. 1995.

8. ATSDR. Toxicological Profile for polycyclic aromatic hydrocarbons. Agency for Toxic Substances and Disease Registry. Atlanta. 2000.

9. E&E. Sampling and quality assurance project plan, Bremerton Gasworks Targeted Brownfields Assessment Bremerton Washington. March 2008. Prepared for the U.S. Environmental Protection Agency by Ecology and Environment Inc. 2008.

10. E&E. Memorandum from Bryan Vasser to Renee Nordeen both of Ecology and Environment Inc. (E&E) dated March 28, 2011 regarding the Bremerton MGP waste release emergency action, Bremerton WA sampling methodology, analytical protocol and use of global positioning systeme equiment. 2011.

11. U.S.EPA. Provisional guidance for quantitative risk assessment of polycyclic aromatic hydrocarbons. EPA/600/R-93/089. Office of Research and Development. U.S. Environmental Protection Agency. 2010.

12. NCI. Howlader N, Noone AM, Krapcho M, Neyman N, Aminou R, Altekruse SF, Kosary CL, Ruhl J, Tatalovich Z, Cho H, Mariotto A, Eisner MP, Lewis DR, Chen HS, Feuer EJ, Cronin KA (eds). *SEER Cancer Statistics Review, 1975-2009 (Vintage 2009 Populations)*, National Cancer Institute. Bethesda, MD, http://seer.cancer.gov/csr/1975_2009_pops09/ based on November 2011 SEER data submission, posted to the SEER web site. 2012.

13. U.S.EPA. Development of a relative potency factor (RPF) approach for polycyclic aromatic hydrocarbon (PAH) mixtures. EPA/635/R-08/012A. U.S. Environmental Protection Agency. 1993.

14. U.S.EPA. Provisional guidance for quantitative risk assessment of polycyclic aromatic hydrocarbons. EPA/600/R-93/089. Office of Research and Development. U.S. Environmental Protection Agency. 2013.

15. ATSDR. Public Health Assessment Guidance Manual (Updated). Agency for Toxic Substances and Disease Registry. Atlanta. January 2005.

16. U.S.EPA. ProUCL Version 4.1.00 Technical Guide Statistical software for environmental applications for data sets with and without nondetect observations. EPA/600/R-07/041. U.S. Environmental Protection Agency. 2010.