APPENDICES

APPENDIX A: Evaluation of Public Health Hazards Associated with Source Areas at Bremerton Naval Complex (BNC), Washington				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Operable Unit (OU) A: This OU covers approximately 12 acres of filled land in the southwestern portion of Bremerton Naval Complex (BNC). OU-A was created by filling an area along 1,400 feet of shoreline over time beginning in the 1940s through the early 1970s. The fill used to create this land included dredge spoils, spent sandblast grit, construction debris, and industrial wastes. OU-A is bounded by a steep 10 to 15-foot embankment consisting of riprap material along with mature hardy vegetation. The embankment is approximately 80-100 feet from the shoreline. OU-A is a flat and mostly paved area currently used as a parking lot. During the Remedial Investigation/ Feasibility Study (RI/FS) process, OU-A was divided into three zones. These zones are described below.				
Zone I Charleston Beach Parking Lot	The majority of Zone I consists of the fenced Charleston Beach parking lot, which is used by Navy personnel. Between 1946 and 1956, Zone I was enlarged to its current size. The northern portion of this zone contains the BNC boundary and borders State Highway 304. A fence divides BNC property and the state highway. Any site-related contamination is most likely a result of fill that was used to enlarge Zone I. However, the source of the fill is not known. According to site reports, it may have been the same material used to fill Zone II (the helicopter pad). Prior to being used as a parking lot, there is no record of disposal activities in Zone I. The only industrial activities associated with Zone I included a former coal bunker and two docks, one of which may have been used to load petroleum. The coal bunker and docks occupied a portion of the zone during the 1940s through the 1950s before the site was used as a parking lot.	<u>Site Inspection-1992 and Final Remedial Investigation-1995</u> During the site inspection (SI) and Phase I and II remedial investigation (RI), 169 soil samples were collected and analyzed for metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). The site report did not break down the sample collection by zone and, therefore, the 169 samples collected include all of the zones. Most samples were collected in the vegetated brush bordering the paved parking area. *Soil*: Lead (845 parts per million [ppm]), mercury (333 ppm), and arsenic (369 ppm) were detected in near-surface samples above background levels for metals. Benzo(a)pyrene (0.73 ppm) was detected in near-surface samples. Total petroleum hydrocarbon (TPH)-motor oil was also detected at 12,000 ppm in near-surface soil. *Groundwater*: Arsenic (30.4 ppb) and lead (44.4 ppb) were detected in groundwater samples.	A Feasibility Study was released in October 1995 and remedial actions, which were applied to all of OU-A, included shoreline stabilization, pavement repair and additional pavement capping, groundwater monitoring, and institutional controls. These remedial activities began in January 1998 and completed in November 2000. Additional remedial maintenance was conducted in March 2003.	OU-A - Zone I does not pose a public health hazard. Access to the site has always been restricted and people have not been exposed in the past and are not currently exposed to contaminants at levels of health concern.

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Zone II U.S.S. Missouri Parking Lot (Formerly Site 3 - Helicopter Pad)	Miscellaneous fill (e.g. copper slag grit used for sandblasting and dredge spoils from Drydock 6 construction), some now known to contain hazardous wastes, was placed in Zone II between 1946 and the early 1970s. A helicopter pad, constructed in the early 1960s, is located in the center of Zone II. Unlined pits were dug in the area beneath the helicopter pad. Between 1963 and 1972, approximately 30,000 gallons of liquid industrial wastes were disposed of in the pits. At times, the pits were dug so they would drain into Sinclair Inlet so they would be flushed and emptied by the tidal action. At other times, liquids that were poured into the pits soaked into the soil or evaporated. Substances reportedly disposed of in the unlined pits include paint and paint chips, cleaning solvents, degreasers, acids, silver nitrate, potassium permanganate, plating wastes, and construction debris.	<u>Site Inspection-1992 and Final Remedial Investigation-1995</u> During the site inspection (SI) and Phase I and II RI, 169 soil samples were collected and analyzed for metals, VOCs, SVOCs, pesticides, and PCBs. The site report did not break down the sample collection by zone and, therefore, the 169 samples collected include all of the zones. *Soil*: Lead (3,380 ppm) and arsenic (579 ppm) were detected above background levels in near-surface (0-2 feet) samples. *Groundwater*: VOCs including benzene (23 ppb) and trichloroethylene (26 parts per billion [ppb]); PAHs including benzo(a)pyrene (28 ppb), benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene (37 ppb), indeno(1,2,3-cd)pyrene, and bis(2-Ethylhexyl)phthalate; and arsenic (1,190 ppb) were detected.	In September 1995, storm drains were installed at the helicopter pad parking lot. In 1995, the entire U.S.S Missouri parking lot located in Zone II was paved.	OU-A - Zone II does not pose a public health hazard. Access to the site has always been restricted and people have not been exposed in the past and are not currently exposed to contaminants at levels of health concern.
Zone III The Upland Parking Lot	Zone III consists of a narrow strip of land used as a parking lot located between the existing railroad tracks and State Highway 304. This area reportedly represents the 1946-era shoreline. According to site documents, there is no record of disposal activities for Zone III.	<u>Site Inspection-1992 and Final Remedial Investigation-1995</u> During the site inspection (SI) and Phase I and II RI, 169 soil samples were collected and analyzed for metals, VOCs, SVOCs, pesticides, and PCBs. The site report did not break down the sample collection by zone and, therefore, the 169 samples collected include all of the zones. *Soil*: Arsenic (25 ppm) was detected in one near-surface sample. Benzo(a)pyrene (0.85 ppm) was also detected. *Groundwater*: No site-related chemicals were detected in groundwater monitoring wells. Petroleum-related chemicals were detected in a monitoring well installed approximately 100 feet northwest of OU-A –zone III. Benzene was detected in this well at a concentration of 1,200 ppb. Manganese (4,610 ppb) was also detected in this off-site monitoring well.	No corrective actions have occurred at OU-A-Zone III	OU-A - Zone III does not pose a public health hazard. Contaminants have not been detected in soil at levels that would be harmful.

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Operable Unit: B (Marine and Terrestrial) sites that were recommended for evaluation during the RI The OU-B sites were first identified during the 1983 Initial Assessment Study (IAS) (NEESA 1983) and 1990 Preliminary Assessment (PA) (NEESA 1990). OU-B comprises seven sites, six are part of OU-B terrestrial (Sites 1, 2, 7, 8, 9, and 10) and there is one OU-B Marine site (Site 6).				
Site 1 Industrial Fill Area	Site 1 covers approximately 3 acres and is located in the central portion of the shipyard on Sinclair Inlet between Mooring A and Dry dock 5. This site was used as a fill area between 1960 and 1974, containing approximately 70,000 cubic yards of fill with a thickness ranging from 37 to 50 feet. Fill materials included construction debris, rubble, spent abrasive grit (e.g., blaster sand and copper slag), and dredged sediment. After 1974, Site 1 was used as an interim storage area of spent grit before off-site disposal. In 1998, the site was paved and the Defense Reutilization Marketing Office (DRMO) was relocated from the Fleet Industrial Supply Center (FISC) to Site 1.	<u>Site Inspection Report -1992:</u> Sixteen surface soil samples were collected from a grid and analyzed for PCBs. Three soil borings were drilled and near- surface and sub-surface soil samples were collected and analyzed for VOCs, SVOCs, and metals. Two groundwater monitoring wells were installed and samples were collected and analyzed for VOCs, SVOCs, and total and dissolved metals. *Surface Soil*: PCBs were not detected at levels of concern. Lead was detected at a maximum concentration of 2,210 ppm. Other metals (e.g., arsenic, lead, cadmium, chromium, and mercury) were detected above their respective background concentrations. *Groundwater:* Several metals (e.g., arsenic [139 ppb], cadmium [67.4 ppb], chromium [661 ppb], lead [18,200 ppb], mercury [148 ppb], and thallium [1,000 ppb]) were detected.	In 1998, most of the unpaved area at Site 1 was paved to prevent contact with surface soil and to accommodate scrap metal recycling operations formerly performed at OU-NSC. As part of the remedial action conducted for OU-B marine in 2000 and 2001, the shoreline perimeter at Site 1 was stabilized by installing 360 feet of sheet pile to an average depth of 74 feet below sea level, including placing approximately 45,000 tons of riprap and a variety of rocks.	Site1 does not pose a public health hazard. Access to the Controlled Industrial Area, where Site 1 is located is restricted. Most of the site is currently paved and future land use is not expected to change.

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Site 2 Former PCB Storage Area	Site 2 covers approximately 4 acres west of the Fleet and Industrial Supply Center (FISC). The site contained several wood and concrete block structures, open storage areas, and two rail lines. A coal pier existed at this site as far back as 1903. Several buildings have been constructed at this site. Most of the older buildings have been demolished and replaced with newer ones. Waste PCB liquid and off-line PCB-containing transformers were stored outside one of the former buildings (Building 399). The site currently contains a hazardous and flammable materials warehouse (Building 997) constructed between 1994 and 1996. Two dark soil stains were identified near Building 399 during the IAS. Site reports indicate that PCBs were spilled in and around Building 399 sometime after 1961.	<u>Soil samples were collected during the 1983 IAS</u>: The maximum PCB concentration initially detected in surface soil near Building 399 was 4,000 ppm. <u>Samples were collected during the November 1991 Time Critical Removal Action</u>: Five groundwater monitoring wells were installed and 21 borings were drilled. Water collected from the monitoring wells was analyzed for VOCs, SVOCs, PCBs, and metals. *Soil (0 – 6 feet):* PCBs: PCBs were detected at a maximum concentration of 2.2 ppm. Metals*:* Lead (16,000 ppm) and mercury (63 ppm) were detected. *Groundwater:* PCBs were not detected in any groundwater samples. Results were not presented in the RI because of discrepancies between unfiltered and filtered samples. The samples collected were not considered representative of actual Site 2 groundwater concentrations.	In 1983, PCB-contaminated soils exceeding 10 ppm near former Building 399 were excavated and disposed of off site. Confirmation samples were collected for the time-critical removal action. In November 1991, an additional "time critical" removal action was conducted. The removal action also included collecting soil and groundwater samples. During the construction of the hazardous and flammable materials warehouse (Building 997), between 1994 and 1996, soils containing lead, PCBs, petroleum oil and lubricants (POLs), and asbestos were excavated and disposed of off site.	Site2 does not pose a public health hazard. Access to the Controlled Industrial Area, where Site 2 is located is restricted. PCB-contaminated soils have been removed and disposed of off site.

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Site 6 (OU-B - Marine) Including Drainage Outfalls	Site 6 consists of approximately 240 acres extending from near OU-A to Site 10 East. The site is the marine portion of OUB and includes the storm drain outfalls along the piers and dry docks. The site slopes steeply to the sediment-covered sea floor and then more gently seaward toward the center of Sinclair Inlet. The bottom of the sea floor consists of a mixture of marine sediment of varying thickness and manmade debris. A combined sanitary and storm sewer system emptied industrial wastes directly into Sinclair Inlet until 1957 when all flow was directed to the city of Bremerton sewer system. The sanitary and storm drain systems were completely separated by 1975; sanitary waste continued to be directed to the city of Bremerton's sewer system but the storm drain flow was directed to Sinclair Inlet. Industrial wastes have been directed to the Industrial Waste Treatment Plant since its completion in 1979. Dredging operations have been conducted near the piers and drydocks and dredging materials have been used as fill at several sites at BNC. BNC (formerly Puget Sound Naval Shipyard) discharges industrial wastewater under an NPDES permit issued through EPA Region 10. The permit allowed eight point source discharges into Sinclair Inlet: Outfalls 003,004,and 008 discharge non-contact cooling water; Outfalls 018, 018A, and 019 discharged drydock drainage; Outfall 021 discharged treated effluent from the shipyard's steam plant; and Outfall 022 discharged storm-water from the new steam plant.	Pre-dredging samples at piers 3, 5, 6, and 7 were collected in 1978 and analyzed for metals. The results showed no significant accumulation of metals (i.e., cadmium, copper, lead, mercury, and zinc) in the sediment. Site Inspection Report - 1992 From November 30 to December 10, 1990, a total of 54 surface marine sediment samples were collected offshore. Sediment samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Marine water column samples were collected in December 1990 at 11 locations in Site 6 and two reference locations. Each water sampling station occupied a site that was also used for marine sediment sampling. Samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Fish (English sole) and biota (sea cucumbers and blue clams) samples were collected during sampling events in 1994 and 1995. Samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. *Sediment:* PAHs and some metals were detected in sediments at levels below health concern. *Water Samples:* No contaminants were detected at levels of concern in marine water samples. *Fish & Biota*: Aldrin (0.006 ppm), dieldrin (0.01 ppm), PCBs (0.19 ppm), and arsenic (7.1 ppm) were detected in fish samples. PAHs were also detected at low concentrations.	Remediation work was initiated in June 2000 and most activities completed by Fall 2001. Remediation included: Excavation of seafloor pit confined aquatic disposal (CAD) on Navy property at the southwest corner of OUB. Shoreline stabilization at Site 1, including installation of 360 feet of sheet pile. Dredging of approximately 220,000 cubic yards of contaminated sediment from near shore areas to a depth of 2 feet. Placement of a thick cap of clean material up to 12 feet thick off of OU-A in the southwest corner of BNC. Placement of a tapered layer of clean material to a thickness of 1 foot to improve marine habitat in areas adjacent to the OU-A cap.	Site 6 does not pose a public health hazard. Access to all marine portions of BNC is restricted to authorized personnel only and no fishing or shellfish harvesting is allowed In addition, The county (i.e., Kitsap County) and state (i.e, Washington State Department of Health) health departments have advisories for both chemical (bottom fish, crab, and rockfish) and biological contaminants (all shellfish). As a result of these advisories, people are not utilizing Sinclair Inlet as a resource for fish and shellfish.

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Site 7 Building 99 (Old Plating Shop)	Site 7 covers approximately 1 acre of land in the northeastern portion of the shipyard. Former Building 99 was used for metal plating activities from 1936 to 1977. Cracks in the floor of Building 99 may have allowed spilled chemicals to migrate into soil and groundwater. According to the IAS report, Trichloroethylene (TCE) was disposed of directly into the storm drains in the former plating facility in Building 99 as late as 1971. Chemicals used in the plating operations included acids, bases, sodium cyanide, calcium sulfate, and heavy metals. Between 1972 and 1974, acids and bases were transported to a pit at the west end of the shipyard (Structure 614), neutralized, and shipped off site. Storm drains from Building 99 flowed to Outfall 006 and into Sinclair Inlet until 1977, when the industrial waste treatment plant was constructed. In 1978, the plating shop was moved into the newly constructed Building 873. After 1978, Building 99 was used only as a backup and was subsequently demolished.	Site Inspection Report - 1992: The field investigation included groundwater, near-surface soil, and subsurface soil sample collection. Samples were analyzed for VOCs, SVOCs, and metals. Soil Investigation - 1994: An investigation was conducted beneath Building 873. The investigation was conducted in response to numerous spills reported for Building 873 between 1988 and 1992.Nine soil samples were collected from five locations within Building 873 and anal\yzed for VOCs, cyanide, and selected metals (i.e., cadmium, chromium, lead, and silver). *Soil:* Lead (4,290 ppm) and chromium (16,500 ppm) were detected above typical background concentrations during the site investigations. *Groundwater:* TCE (in MW402) was detected at a maximum concentration of 17,000 ppb during initial round of sampling. During subsequent sampling TCE ranged from 8,300 to 11,000 ppb. Some metals (e.g. arsenic, lead, and mercury) were also detected.	Specific corrective actions have not been identified for this site.	Site7 does not pose a public health hazard. Access to this area is restricted and people are not coming in contact with surface soil. Groundwater sampling showed significant TCE contamination; there are no current groundwater users at BNC and none is expected in the future. There are no off-site drinking water wells downgradient of this TCE plume. Groundwater flows south towards Sinclair Inlet.
Site 8 Former Building 106- Old Power Plant and Tanks 106-1 and 106-2	This 2-acre site is located in the eastern portion of the shipyard. Building 106 housed a power plant used for steam generation from 1910 to 1942. The building was demolished in 1994. In 1944, a substation for electrical power was constructed at the northern corner of Building 106. Two abandoned waste-oil tanks (106-1 and 106-2) were located north of Pier 6 and south of the former Building 106. These tanks, installed in 1910, had a capacity to hold 63,000 gallons. An abandoned waste-oil storage tank under former Building 106 was suspected to be leaking oil and PCBs into Dry Dock 3. There was visible evidence of oil stains in the vicinity of Drydock 3, where a tunnel used as an inlet for salt water to Drydock 3 may have served as a conduit for oil leaking from the tanks.	Site Inspection Report - 1992 During the SI, four water samples were collected from the end of four weep-hole discharge pipes in the bottom of Dry Dock No. 3, closest to the suspected location of some underground oil tanks. The samples were analyzed for VOCs, SVOCs, and PCBs. In addition, nine soil borings, six of which were completed as groundwater monitoring, wells were drilled. The weeps were subsequently resampled during Phase I of the RI in 1994. Further investigation including one round of post-closure groundwater sampling occurred during Phase II of OU-B RI. Site 8 Closure Investigation- 1994: An environmental investigation was conducted between 1994 and 1996. Four additional monitoring wells were installed during the investigation- 2 in	In September/October 1994, tanks 106-1 and 106-2 were filled with approximately 1,000 cubic yards of clean sand. Cement slurry was then pumped into the tanks and vault. (NEESA 1990). The central power plant underwent closure in 1994. In February 1995, portions of Site 8 were paved. Two monitoring wells were installed at this time (MW-01 and MW-02). Post-closure	Site8 does not pose a public health hazard. Access to the Controlled Industrial Area, where Site 2 is located is restricted. PCB-contaminated soils have been removed and disposed of off site. According to information in the initial assessment study, the oil storage tank may have contained PCB-contaminated oil. However, no PCBs were detected near the oil storage tanks. TPH-Diesel was detected in MW-02.

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		February 1995 and 2 in 2 in June/July 1995. Interim Action Investigation - 1995: An interim action investigation was conducted between June 28 and July 12, 1995. Two additional monitoring wells were installed and 3 soil borings were drilled. *Surface Soil:* Some metals were detected above their respective background concentration. *Groundwater:* Several metals were detected in groundwater above EPA's marine and fresh chronic ambient water quality criteria. Elevated concentrations of some PAHs were also detected. TPH-Diesel was detected (1,500 ppb) in MW-02. During the Interim Action investigation, a seep in Drydock 3 showed visible evidence of TPH contamination.	investigations were completed in 1996. A round of post-closure groundwater sampling was conducted during Phase II of OU-B investigation.	
Site 9 Crane Maintenance Area	Site 9 occupies about 1 acre in the center of the shipyard. It was primarily used for painting and maintenance of cranes east of Building 450 on R Street. Lead- and chromium-based paints were often used on the cranes and frequently stripped off. These operations resulted in debris contaminated with lead and other metals at the site. Replacement of crane tracks at the site in the late 1980s required the excavation of the upper 2 to 3 feet of underlying soil. The soil was disposed of near Site 11 (OU-C). This site is currently covered with asphalt and concrete.	Site Inspection Report - 1992 Three soil borings, two of which were completed as groundwater monitoring wells, were drilled at Site 9. *Surface Soil:* Some metals were detected above their respective background concentrations. Cadmium and mercury were the only contaminants found in concentrations that exceeded the state of Washington's clean-up standards. *Groundwater:* TCE was detected at a maximum concentration of 27 ppb.	Site 9 is being remediated as part of OU-B Terrestrial.	Site9 does not pose a public health hazard. Access to the Controlled Industrial Area, where Site 9 is located is restricted.

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Site 10 East	All of Site 10 (i.e., east, central, and west) comprises former disposal sites and shoreline fill areas used for leveling and extending the shipyard boundaries. The material used as fill varied with each of the three locations, but included construction debris, oily sludge, automobile scrap, shipyard debris, and other miscellaneous materials. Site 10 East covers approximately 5 acres of fill material extending from Pier 8 to the eastern edge of the shipyard. The site was reportedly used as a disposal site and was filled with miscellaneous materials including sandblast grit. The site was covered with gravel and some asphalt.	Site Inspection Report - 1992 Soil samples from four borings were analyzed for VOCs, SVOCs, PCBs, and metals. One monitoring well was installed and groundwater was analyzed for VOCs, SVOCs, PCBs, and metals. TPH was not analyzed in soil or groundwater. *Groundwater:* Lead was detected at a maximum concentration of 530 ppb. PAHs were also detected in groundwater samples. *Surface Soil:* Low levels of PAHs were detected in surface soil samples collected at Site 10 East.	Most of the site has been paved with 4 to 8 inches of asphalt and concrete. Site 10 East is being remediated as part of OU-D	Site10 East does not pose a public health hazard. Access to the Controlled Industrial Area is restricted and most of the site is paved with little potential to come in contact with contaminated soil.
Site 10 Central	Site 10 Central extends along the waterfront from Building 368 in the vicinity to Site 1 to Pier 4. A portion of the site was reportedly used as the shipbuilding ways burn pit. Fill material at Site 10 Central ranges from 10 to 40 feet thick and consists of sands and gravels, with wood and metal debris mixed in. Five 75,000-gallon oil recovery barges and a 600-gallon under-the-dock oil storage tank are located east of Drydock 4. The under –the-dock storage tank was abandoned.	Site Inspection Report - 1992 A sampling grid was set up during the SI to analyze the industrial fill used to create Site 10 Central. Groundwater, near-surface soil, and subsurface soil samples were collected and analyzed for VOCs, SVOCs, metals, and PCBs (soil only). *Groundwater:* Lead was detected at 545 ppb *Surface soil:* PCBs (955 ppm) were detected. Low concentrations of metals, SVOCs, and VOCs were detected. These contaminants were not detected at levels of health concern.	Site10 Central is being remediated as part of OU-B Terrestrial.	Site 10 Central does not pose a public health hazard. Access to the Controlled Industrial Area, where Site 10 central is located is restricted.

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Site 10 West	Site 10 West was part of the old (former) town of Charleston. The site covers approximately 34 acres and is located northeast of OU-A (formerly Site 3). It extends from the new steam plant to Z Street. According to site reports, excavation activities in the old Charleston area uncovered remnants of what may have been an old landfill. It was believed that shipyard employees and citizens of Bremerton used the landfill. Oily sludge, automobiles, construction debris from an oil distribution facility, and shipyard debris were disposed of at this site. In 1994 23 buried drums were identified in a trench approximately 10 feet from the shoreline. A 24,000- gallon tank (Structure 614) was used for storing hazardous waste between 1972 and 1983. It was subsequently used to neutralize acids, bases, and spent electroplating solutions. Structure 614 was closed in 1994.	<u>Site Inspection Report - 1992</u> January 1994 – The Navy investigated several buried drums uncovered during excavation for new utility lines in Site 10 West. Sampling was conducted during the closure activities associated with Structure 614. Groundwater and soil samples were collected and analyzed for metals. *Groundwater:* Some (unfiltered) metals (e.g., chromium, arsenic, and lead) were detected. The concentrations in dissolved (i.e., filtered) samples were not at levels of concern. *Soil:* Chromium was detected at 539 ppm and lead was detected at 1,300 ppm. Aroclor 1254 was detected at 8.4 ppm in samples collected near the buried drums.	UST 530-1 and 530-2 were filled with slurry in November 1994. Buried drums and 73 tons of contaminated soil were removed after the Navy's 1994 (Final Report for Rapid Response at Mooring G) investigation. The soil was transported to an off-site disposal facility. Wastewater from the sewer line no longer discharges directly into Sinclair Inlet An Industrial Wastewater Treatment Plant became operational in 1979. Site 10 West is being remediated as part of OU-B Terrestrial.	Site10 West does not pose a public health hazard. Access is restricted and most contaminated soil has been removed from the site.
PSNS & IMF Drydocks 1-6	There are currently six drydocks numbered in order of their construction, with the oldest drydock, Drydock 1, built in the 1890s and the youngest, Drydock 6, built in 1958. Dredged materials from the construction of the drydocks were deposited on site as well as in Sinclair Inlet. It was believed that oil seepage, observed in Drydock 3, was related to the tanks near Building 106.	During the SI, four seep samples were collected in Drydock 3 downgradient of Site 8 and analyzed for VOCs and SVOCs. VOCs or SVOCs were detected in some of the samples collected. *Surface Water Seeps*: TCE was detected at a maximum concentration of 160 ppb at Drydock 4 (location 519 – Northeast) [An estimated concentration of 530 ppb was detected at Drydock 2] PCE was detected at a maximum concentration of 200 ppb at Drydock 3 (516-Northwest) Some elevated concentrations of some metals (e.g., copper, lead, arsenic) were also detected in surface water seep samples.	All six drydocks have been modified so that all of the process water and most of the storm water exceeding established turbidity levels are collected, processed, and discharged to the sanitary sewer. This modification will reduce metal-bearing discharges into Sinclair Inlet.	The Drydocks do not pose a public health hazard. Access to the Controlled Industrial Area, where the drydocks are located is restricted.

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Site 11 Petroleum Cleanup (Currently just referred to as OU-C)	OU-C is a petroleum-contaminated site located in the north-central upland portion of the installation. The site contained three storage tanks: two underground storage tanks (USTs) and one above ground (AST). The primary source of petroleum is considered to be a 5 million-gallon concrete UST installed in 1919. It was used primarily to store No. 6 fuel oil (Bunker C). Approximately 60,000 gallons of petroleum were initially estimated to be present in the subsurface beneath and downgradient of the former tank. Tank 315, the AST, was removed in the early 1990s. Tank 316 was closed, filled with soil and industrial debris, and paved over in the early 1990s. Tank 317 was also closed and filled with soil. The primary source of petroleum contamination at OU-C is Tank 317. This was a 5-million gallon tank constructed of concrete in 1919. Approximately 60,000 gallons of petroleum was reported to have spilled to the subsurface soil, beneath and downgradient of the tank.	A series of soil, groundwater, and free product investigations were conducted between November 1998 and January 1999 to evaluate the performance of the sparging system. Gasoline, diesel, and oil hydrocarbons were detected in varying concentrations in groundwater and soil samples. Samples were collected from three monitoring wells located several hundred feet downgradient of the sparging area, toward drydock 6. No petroleum hydrocarbons were detected from these three wells.	The tank was backfilled with sandblast shot and grit. A steam sparging system was installed under a demonstration program in July 1996 and expanded in August 1997. After a series of performance assessments, the sparging system was shut down in September 1999 in favor of natural attenuation with an appropriate subsurface monitoring program. Monitoring at OU-C is conducted on a quarterly basis.	OU-C (Site 11) does not pose a public health hazard. Any remaining free product at OU-C is located between 80 and 120 feet below ground surface. There are no drinking water wells in the area and people will not come in contact with the free product because of its significant depth below ground surface. Surface soil is not impacted at levels that would pose a health hazard.

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Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Operable Unit: D				
This OU is not divided into sites.	OU-D consists of 5.3 acres of land adjacent to the state ferry terminal in the eastern most portion of BNC, currently within OU-B Terrestrial. This site was originally evaluated under industrial land use as part of the OU-B remedial investigation and feasibility study (RI/FS). OU-D includes land that has been proposed for transfer to the city of Bremerton as well as some adjacent areas that will remain BNC property, but whose land use may be reclassified as recreational. OU-D was designated in August 2003 during the development of the Proposed Plan for OU-B Terrestrial. This portion of BNC is proposed for transfer to the city of Bremerton and will require a different land use classification, from industrial to recreational, since the city plans to develop a municipal park upon any transfer of property. If the land is not transferred to the city, the land would be designated recreational and the remedy would be consistent with that land use.	The original environmental investigation for OU-D is based on limited sampling and analyses conducted as part of OU-B Terrestrial investigation. In 2003, the Navy used existing data and gathered additional soil data to conduct a focused RI/FS to evaluate impacts to human health and the environment. A total of 70 soil samples (15 surface soil from 0 – 2 feet) were collected and analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and TPHs. *Surface soil*: Arsenic (9 ppm) and lead (819 ppm) were detected above background values. Lead was only detected once above EPA action levels (400 ppm) for lead in residential soils. Some PAHs (e.g., benzo(a)pyrene[6.8 ppm] were also detected in surface soil. *Groundwater*: No groundwater samples were collected during the RI/FS investigation.	No corrective actions have occurred to date at this site. According to the September 2003, RAB meeting minutes, the proposed remedial actions for OU-D will include: repairing, cleaning, and subsequent inspection of the storm water system, paving over certain areas, installation of a vegetative cap, groundwater monitoring, and institutional controls (e.g., securing unauthorized areas). Additionally, clean fill will be placed up to the original grades and existing storm water collection systems will be used to the extent possible. In areas where storm water systems must be removed to complete the excavation and soil removal, these storm water systems will be replaced to their original condition. The Record of Decision (ROD) is expected to be released by late 2004 with remedial actions taking place shortly after.	OU-D does not pose a public health hazard. Any future use for OU-D is expected to meet all state and federal regulatory residential soil standards before any proposed transfer of property is completed and unrestricted access to the area is permitted.

APPENDIX A: Evaluation of Public Health Hazards Associated with Source Areas at Bremerton Naval Complex (BNC), Washington				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Operable Unit: Naval Supply Center (NSC)				
This OU includes the area known as the Fleet and Industrial Supply center (FISC). Site 12 - Acid Drain Slab Area is located within FISC.	OU-NSC comprises a 28 square mile area bordered by Sinclair Inlet, S Street, Z Street, and Rodgers Avenue. BNC surrounds OU-NSC on all sides. Access to the site is restricted. OU-NSC consists of a former supply pier and several buildings, including warehouses, tool houses, fuel storage facilities, industrial service areas, and offices. Many of the buildings at OU-NSC have closed down or have been removed. Throughout the history of BNC, OU-NSC has primarily served as an industrial storage area, with material stockpiles maintained, both inside buildings and outdoors, above and below ground. Materials that have been stored at OU-NSC include PCB transformers, flammable liquids, poisons (wood and denatured alcohol), explosive non-ordnance items, drugs and narcotics, mercury, acids, flammable solids, and other combustible and toxic chemicals. In the past building floor and sink drains connected to the storm water system and a few may continue to be connected today. Waste acids were deposited in an acid disposal pit. Vehicle maintenance shops have periodically dumped or spilled fuel oil near vehicle shops. According to site personnel, the OU-NSC scrap yard closed for a week in the late 1970s after a 'suspect' transformer was discovered in a pile of metal debris. PCB spills have also been reported, mainly in the area that formerly contained building 399. Surface soil at OU-NSC is composed of fill from various sources, including sandblasting grit, natural hillside dirt, and miscellaneous debris from shipyard operations. Most surface areas at OU-NSC are covered by pavement. Site 12 (Acid Drain Slab Area) was also located within OU-NSC, within the former DRMO. The pit and slab area was used to drain old batteries.	<u>IAS-1982</u> Water seepage from Dry Dock 6 was sampled for heavy metals, 1977-1978. <u>Soil Contamination by Project RCOL-1985</u> Samples were collected and analyzed for PCB's and metals. <u>Sinclair and Dyes Inlets Urban Bay Action Program-1990</u> Sediment sampling was conducted at Outfall 019. <u>Remedial Action Report for Site 2-1991</u> Soil and groundwater samples were collected and analyzed for VOCs, SVOCs, and selected metals. <u>Site Inspection-1992</u> Surface soil, sub-surface soil, and groundwater samples were collected and analyzed for VOCs, SVOCs, PCBs, metals, total and dissolved inorganics. <u>RCRA Facility Assessment-1992</u> The EPA assessed environmental releases at seven solid waste management units (SWMUs). <u>Preliminary Phase Technical Memorandum for OU-NSC -1993</u> <u>RI Phase I: April-June 1993</u> Includes surface soil, sub-surface soil, groundwater, catch basin sediment, surface water, and air monitoring. <u>DRMO Interim Action-1994</u> Soil and water samples were collected at the DMRO before and after the Interim Action as part of the Phase I RI. <u>RI Phase II: May-October 1994</u> Surface soil, sub-surface soil, groundwater, and surface water monitoring. Surface Soil (0.5 – 2 feet below ground surface [bgs]): Lead (18,400 ppm), Antimony (853 ppm), and Arsenic 31.6 ppm) were detected above ATSDR's health-based screening values.*:* Aroclor	A concrete and steel wall extends along the entire length of the waterfront and was constructed during the land filling process to control tidal erosion of the fill. During 1987, the Navy constructed a parking lot south of the DRMO (Site 10W) on soil contaminated with PCBs. Six inches of PCB contaminated soil was removed before construction and stockpiled at the north end of the lot. After construction, the Navy cleaned the area of PCBs. PCB contaminated surface soils and stockpiles were transported off site. The DRMO scrap metal lay-down area was stripped of all surface soil and pavement surface dust. Soil from the unpaved section of the DRMO salvage yard was excavated and transported off site. The acid drain pan was removed, along with soil and sediment from the pit floor. Two sewer lines underwent	OU-NSC does not pose a public health hazard. Access to the Controlled Industrial Area, where OU-NSC is located is restricted. PCB-removal actions have occurred and a number of remedial actions have occurred to reduce migration of site-related contaminants into Sinclair Inlet.

APPENDIX A: Evaluation of Public Health Hazards Associated with Source Areas at Bremerton Naval Complex (BNC), Washington				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
		1260 was detected in a sample collected south of the DRMO (maximum concentration = 1,331 ppm). Benzo(a)pyrene (5.1 ppm), Bis(2-ehtlyhexyl)phthalate (.92 ppm) were detected above ATSDR's health-based screening values. Diesel and motor oil were detected in soil at 41,000 and 12,000 ppm respectively *Catch Basin Sediments: Metals:* Lead (4,300), Antimony (170 ppm), Arsenic (52.3 ppm), and Nickel (4,340 ppm) were detected above ATSDR's health-based screening values. Aroclor 1260 was detected at 15 ppm. Benzo(a)pyrene (1.1 ppm) was detected above ATSDR's health-based screening value. Diesel and motor oil were detected in sediment at 4,100 and 41,000 ppm respectively. *Surface Water:* Surface water showed positive detects for Lead (503 ppm), Antimony (45.8 ppm) and Cadmium (17 ppm). *SVOCs:* Surface water tested positive for benzo(a)pyrene and Bis(2-ethylhexyl)phthalate, 5 and 33 ppm respectively. *TPH*: Diesel and motor oil were detected in surface water at 3,000 and 15,000 ppm respectively. *Groundwater:* Arsenic (12.4 ppm), Cadmium (8.8 ppm), Manganese (70.32 ppm) and Thallium (3.9 ppm*).* *SVOCs:* Groundwater tested positive for benzo(a)pyrene (1 ppm), Bis(2-ethlyhexyl)phthalate (80 ppm). *TPH*: Diesel and motor oil were detected in groundwater at 1,300 and 4,000 ppm respectively. VOCs: Groundwater tested positive for Benzene (1 ppm), Bromodichloromethane (1 ppm), 1,2-Dichloroethane (2 ppm), and Trichloroethene (58 ppm).	cleaning, and excavations up to 4 feet deep were backfilled with crushed rock, asphalt pavement, ballast, and rip-rap. The Final Record of Decision (ROD) for OU-NSC was prepared in November 1996. The remedial action for OU-NSC includes paving unpaved areas, inspecting and sealing the existing paved areas of the site, controlling ponding, removing sediments and repairing the stormwater sewer system, implementing institutional controls, and conducting an initial 5-year monitoring program. The ROD also specifies compliance with other BNC-wide programs (e.g., petroleum management, soil excavation). In 1998, the DRMO, which occupied approximately 3 acres of land on FISC (i.e., OU-NSC) property, was relocated to Site 1 (Industrial Fill Area) and all activities associated with the DRMO were subsequently transferred.	

APPENDIX A: Evaluation of Public Health Hazards Associated with Source Areas at Bremerton Naval Complex (BNC), Washington				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
			According to site reports, annual monitoring and inspection activities at OU-NSC consists of semi-annual groundwater sampling of five existing monitoring wells and annual inspection of institutional controls (e.g., pavement cap, storm water (catch basin) system, and fencing).	
Other Sites not Associated with OUs				
Site 4 Leaking Transformer Site (Building 845)	Around 1970, approximately five gallons of PCB-containing transformer oil was reportedly released near Building 845. The oil spilled onto asphalt.	A soil sample was collected during the Initial Assessment Study (IAS). According to the report, the sample contained less than ten parts per million (ppm) of PCB. Analysis of the soil sample collected during the IAS indicated that this site contains low concentrations of PCB.	The asphalt was dug up and removed to an appropriate off-site disposal location.	Site 4 does not pose a public health hazard. The building is reportedly located on top of a hill. It is possible that the transformer oil could have run off from the asphalt and contaminated nearby soil. However, it is very unlikely that the small quantities of PCB released at this site pose a danger to human health.

APPENDIX A: Evaluation of Public Health Hazards Associated with Source Areas at Bremerton Naval Complex (BNC), Washington

Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Site 5 Bachelor Officers' Quarters (BOQ) Transformer Room, Building 847.	Soon after Building 847 was constructed in 1969, approximately one gallon of PCB transformer oil spilled onto the concrete floor inside the transformer room.	Tests showed no PCBs were detected at or above cleanup levels.	The spill was cleaned up using solvent and rags. The materials used in the cleanup were disposed of off site.	Site 5 does not pose a public health hazard. The small amount of PCB-containing transformer oil that was released was cleaned up immediately after the spill and disposed of off site.

Sources:

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URS Group, Inc. 2004. Final RI/FS OU-D. March 5, 2004.

Notes:

bgs = below ground surface

APPENDIX B: List of Comparison Values used by ATSDR

Comparison Values

ATSDR scientists select contaminants for further evaluation by comparing them against health-based comparison values (CVs). These are developed by ATSDR from available scientific literature related to exposure and health effects. CVs are derived for each of the different media and reflect an estimated contaminant concentration that is *not likely* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., an amount of water or soil consumed or an amount of air breathed) and body weight.

ATSDR comparison values are media-specific concentrations that are considered to be safe under default conditions of exposure. They are used as screening values in the preliminary identification of site-specific “contaminants of concern.” The latter term should not be misinterpreted as an implication of “hazard.” As ATSDR uses the phrase, a “contaminant of concern” is a chemical substance detected at the site in question and selected by the health assessor for further evaluation of potential health effects. Generally, a chemical is selected as a “contaminant of concern” because its maximum concentration in air, water, or soil at the site exceeds one of ATSDR's comparison values.

Nevertheless, it must be emphasized that comparison values are not thresholds of toxicity. Although concentrations at or below the relevant comparison values could reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. The principal purpose behind conservative, health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health hazards before they become actual public health consequences. Thus comparison values are designed to be preventive-rather than predictive-of adverse health effects. The probability that such effects will actually occur does not depend on environmental concentrations alone, but on a unique combination of site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure.

Listed and described below are the various comparison values that ATSDR uses to select chemicals for further evaluation, as well as other non-ATSDR values that are sometimes used to put environmental concentrations into perspective.

CREG	=	Cancer Risk Evaluation Guides
MRL	=	Minimal Risk Level
EMEG	=	Environmental Media Evaluation Guides
IEMEG	=	Intermediate Environmental Media Evaluation Guide
RMEG	=	Reference Dose Media Evaluation Guide
RfD	=	Reference Dose
RfC	=	Reference Dose Concentration
RBC	=	Risk-Based Concentration
MCL	=	Maximum Contaminant Level

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors, or cancer potency factors, using default values for exposure rates. That said, however, neither CREGs nor cancer slope factors can be used to make realistic predictions of cancer risk. The true risk is always unknown and could be as low as zero.

Minimal Risk Levels (MRL) are estimates of daily human exposure to a chemical (doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious non-cancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute (≤14 days), intermediate (15-364 days), and chronic (≥365 days) exposures. MRLs for specific chemicals are published in ATSDR toxicological profiles.

Environmental Media Evaluation Guides (EMEGs) are concentrations that are calculated from ATSDR minimal risk levels by factoring in default body weights and ingestion rates. They factor in body weight and ingestion rates for acute exposures (Acute EMEGs — those occurring for 14 days or less), for intermediate exposures (Intermediate EMEGs — those occurring for more than 14 days and less than 1 year), and for chronic exposures (Chronic EMEGs — those occurring for one year [365 days] or greater).

Reference Dose Media Evaluation Guide (RMEG) is the concentration of a contaminant in air, water or soil that corresponds to EPA's RfD for that contaminant when default values for body weight and intake rates are taken into account.

Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause noncarcinogenic adverse health effects. Like ATSDR's MRL, EPA's RfD is a dose expressed in mg/kg/day.

Reference Concentrations (RfC) is a concentration of a substance in air that EPA considers unlikely to cause noncancer adverse health effects over a lifetime of chronic exposure.

Risk-Based Concentrations (RBC) are media-specific concentrations derived by Region III of the Environmental Protection Agency from RfD's, RfC's, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

Maximum Contaminant Levels (MCLs) represent contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day.

More information about the ATSDR evaluation process can be found in ATSDR's Public Health Assessment Guidance Manual at http://www.atsdr.cdc.gov/HAC/HAGM/. A hard copy can be obtained by contacting the ATSDR information line toll-free at (888) 422-8737.

APPENDIX C: ATSDR's Methods, Assumptions, and Calculations

ATSDR evaluates whether community members have been (past), are (current), or will be (future) exposed to harmful levels of chemicals. ATSDR screens the concentrations of contaminants in environmental media (e.g., groundwater or soil) against health-based comparison values (CVs) (Refer to Appendix B). Because CVs are not thresholds of toxicity, environmental levels that exceed CVs would not necessarily produce adverse health effects. If a chemical is found in the environment at levels exceeding its corresponding CV, ATSDR estimates site-specific exposure and evaluates the likelihood of adverse health effects. *ATSDR emphasizes that a public health hazard exists only if there is exposure to a hazardous substance at sufficient concentration, frequency, and duration for harmful effects to occur.*

What is meant by exposure?

ATSDR's PHAs are driven by evaluation of the potential for human exposure, or contact with environmental contaminants. Chemical contaminants released into the environment have the potential to cause adverse health effects. However, *a release does not always result in human exposure*. People can only be exposed to a contaminant if they come in contact with it-if they breathe, eat, drink, or come into skin contact with a substance containing the contaminant.

How does ATSDR determine which exposure situations to evaluate?

ATSDR scientists evaluate site conditions to determine if people could have been, are, or could be exposed (i.e., exposed in a past scenario, a current scenario, or a future scenario) to site-related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (soil, sediment, water, air, or biota) has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation.

If exposure was, is, or could be possible, ATSDR scientists consider whether contamination is present at levels that might affect public health. ATSDR scientists select contaminants for further evaluation by comparing them against health-based comparison values (CVs). These are developed by ATSDR from available scientific literature related to exposure and health effects. CVs are derived for each of the different media and reflect an estimated contaminant concentration that is *not likely* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., an amount of water or soil consumed or an amount of air breathed) and body weight.

How does ATSDR evaluate exposures that may have occurred in the past?

In addition to evaluating current and future exposures associated with chemical contaminants, ATSDR is often asked to evaluate what people may have been exposed to in the past and determine whether such exposures were likely to cause illness or health effects. The question of past exposures is usually much more difficult to determine because critical information such as sampling data, consumption patterns, and demographic profiles are often lacking or incomplete. ATSDR uses whatever past information is available to make the best possible public health hazard determination for past exposures. However, for some sites, the reality is that sufficient information is not available to adequately address past exposures.

If someone is exposed, will they get sick?

Exposure does not always result in harmful health effects. The type and severity of health effects a person can experience because of contact with a contaminant depend on the exposure concentration (how much), the frequency and/or duration of exposure (how long), the route or pathway of exposure (breathing, eating, drinking, or skin contact), and the multiplicity of exposure (combination of contaminants). Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status of the exposed individual influence how that person absorbs, distributes, metabolizes, and excretes the contaminant. Together, these factors and characteristics determine the health effects that may occur.

In almost any situation, there is considerable uncertainty about the true level of exposure to environmental contamination. To account for this uncertainty and to be protective of public health, ATSDR scientists often use worst-case exposure level estimates as the basis for determining whether adverse health effects are possible. These estimated exposure levels usually are much higher than the levels that people are really exposed to. If the exposure levels indicate that adverse health effects are possible, ATSDR performs a more detailed review of exposure, also consulting the toxicologic and epidemiologic literature for scientific information about the health effects from exposure to hazardous substances.

Contaminant Data Evaluation

In public health assessments, ATSDR addresses the likelihood that exposure to contaminants at the maximum or average concentrations detected would result in adverse health effects. While the relative toxicity of a chemical is important, the response of the human body to a chemical exposure is determined by several additional factors, including the concentration (how much), the duration of exposure (how long), and the route of exposure (breathing, eating, drinking, or skin contact). Lifestyle factors (i.e., occupation and personal habits) also have a major impact on the likelihood, magnitude, and duration of exposure. Individual characteristics such as age, sex, nutritional status, overall health, and genetic constitution affect how a human body absorbs, distributes, metabolizes, and eliminates a contaminant. A unique combination of all these factors will determine the individual's physiologic response to a chemical contaminant and any adverse health effects the individual could suffer as a result of the chemical exposure.

ATSDR has determined levels of chemicals that can reasonably (and conservatively) be regarded as harmless, based on the scientific data the agency has collected in its toxicological profiles. The resulting comparison values and health guidelines, which include ample safety factors to ensure protection of sensitive populations, are used to screen contaminant concentrations at a site and to select substances (“chemicals of concern”) that agency environmental health scientists and toxicologists scrutinize more closely.

It is a point of key importance that ATSDR’s (as well as state and federal regulatory agency) comparison values, screening numbers and health guidelines define very conservative and protective levels of environmental contamination and are not thresholds of toxicity. This means that although concentrations at or below a comparison value could reasonably be considered safe, it does not automatically follow that any concentration above a comparison value will necessarily produce toxic effects. To the contrary, ATSDR's comparison values are intentionally designed to be much lower, usually by orders of magnitude, than the corresponding no-effect levels (or lowest-effect levels) determined from scientific studies. ATSDR uses comparison values (regardless of source) solely for the purpose of screening individual contaminants. In this highly conservative procedure, ATSDR may decide that a compound warrants further evaluation if the highest single recorded concentration of that contaminant in the medium in question exceeds that compounds lowest available comparison value (e.g., cancer risk evaluation guides or other chronic exposure values) for the most sensitive, potentially exposed individuals (e.g., children or pica children). This conservative process results in the selection of many contaminants as "chemicals of concern" that will not, upon closer scrutiny, be judged to pose any hazard to human health. Still, ATSDR judges it prudent to use a screen that "lets through" many harmless contaminants rather than one that overlooks even a single potential hazard to public health. Even those contaminants of concern that are ultimately labeled in the toxicologic evaluation as potential public health hazards are so identified solely on the basis of the maximum concentration detected. The reader should keep in mind the protective nature of this approach when considering the potential health implications of ATSDR's evaluations.

Because a contaminant must first enter the body before it can produce any effect on the body, adverse or otherwise, the toxicologic discussion in public health assessments focuses primarily on completed pathways of exposure, i.e., contaminants in media to which people are known to have been, or are reasonably expected to have been, exposed. Examples are water that could be used for drinking, and air in the breathing zone.

To determine whether people were, or continue to be, exposed to contaminants originating from a site, ATSDR evaluates the factors that lead to human exposure. These factors or elements include (1) a source of contamination, (2) transport through an environmental medium, (3) a point of exposure, (4) a route of human exposure, and (5) an exposed population. Exposure pathways fall into one of three categories:

> *Completed Exposure Pathway*. ATSDR calls a pathway "complete" if it is certain that people are exposed to contaminated media. Completed pathways require that the five elements exist and indicate that exposure to the contaminant has occurred, is occurring, or will occur.
>
> *Potential Exposure Pathway*. Potential pathways are those in which at least one of the five elements is missing but could exist. Potential pathways indicate that exposure to a contaminant could have occurred, could be occurring, or could occur in the future. Potential exposure pathways refer to those pathways where (1) exposure is documented, but there is not enough information available to determine whether the environmental medium is contaminated, or (2) an environmental medium has been documented as contaminated, but it is unknown whether people have been, or could be, exposed to the medium.
>
> *Eliminated Exposure Pathway*. In an eliminated exposure pathway, at least one of the five elements is missing and will never be present. From a human health perspective, pathways can be eliminated from further consideration if ATSDR is

able to show that (1) an environmental medium is not contaminated, or (2) no one is exposed to contaminated media.

Site-specific Risk-based Screening Value Methodology
ATSDR does not have their own screening values for fish and shellfish tissue and often relies on EPA's Region III Risk-Based Concentrations (RBCs) Table to screen chemical contaminants detected in fish tissue. EPA's reference doses (RfDs) and cancer slope factors (CSFs) are typically combined with EPA's standard exposure assumptions to derive the RBCs.

Rather than applying EPA's standard assumptions about ingestion rates, ATSDR used site-specific ingestion rates reported in the Fish Consumption Survey of the Suquamish Indian Tribe (Suquamish Tribe 2000). This was done to provide a more realistic assessment of exposure risk. According to the fish consumption survey, the mean consumption rate of all finfish and shellfish for adult respondents was 2.71 grams per kilogram per day (g/kg/day). The mean body weight for all adult respondents was 79 kg. This converts to a mean (average) ingestion rate of 213 grams per day (i.e., 2.71 g/kg/day X 79 kg).

The fish/shellfish data were screened using site-specific RBCs with the following equations:

Carcinogen: RBC = TR*BWa*ATc/EFr*EDtot*(IRF/1000)*CPSo

Non-carcinogen: RBC = THQ*RfDo*BWa*ATn/EFr*EDtot*(IRF/1000)

ABBREVIATIONS
ATc = Averaging time carcinogens (d)
Atn = Averaging time non-carcinogens (d)
BWa = Body Weight, Adult (kg)
CPSo = Carcinogenic potency slope oral (risk per mg/kg/d)
EDtot = Exposure duration, total (y)
EFr = Exposure Frequency (d/y)
IRF = Fish ingestion (g/d)
RfDo = Reference dose oral (mg/kg/d)
TR = Target Cancer Risk (0.000001)
THQ = Target hazard quotient (1)

Exposure Dose Estimation Methodology

This section details the methods, assumptions, and calculations that ATSDR used to estimate potential exposure doses from exposure from the consumption of contaminated fish. To be protective and account for the uncertainty surrounding how representative the exposure factors are for potential future consumers of fish and shellfish within Sinclair Inlet, ATSDR used health-protective assumptions to estimate the reasonable maximum exposure level (for example, assuming the 90^{th} percentile of reported fish and shellfish ingestion [i.e., consumption] rates among the Suquamish Tribe). This estimate calculates an average daily exposure dose in milligrams of contaminant per kilogram body weight per day (mg/kg/day). It is intentionally conservative and overestimates the amount of chemical exposure that people eating fish and shellfish from Sinclair Inlet would actually have.

Deriving Exposure Doses

As noted above, exposure doses are typically expressed in milligrams per kilogram per day (mg/kg/day). When estimating exposure doses, health assessors evaluate chemical concentrations to which people could be exposed, together with the length of time and the frequency of exposure. Collectively, these factors influence an individual's physiological response to chemical exposure and potential outcomes. Where possible, ATSDR used site-specific information about the frequency and duration of exposures. In cases where site-specific information was not available, ATSDR applied several conservative exposure assumptions to estimate exposures.

Calculating exposure dose from eating fish from Sinclair Inlet

ATSDR used site-specific information (e.g., Suquamish Tribe Consumption Survey) about the frequency and consumption patterns of potential future heavy/subsistence fish/shellfish consumers. In cases where site-specific information was not available, ATSDR applied conservative exposure assumptions to estimate exposures.

As an example, the following equation was used to estimate human exposure from eating fish and shellfish from Sinclair Inlet:

$$\text{Estimated exposure dose (mg/kg/day)} = \frac{C \times IR^{4} \times EF \times ED \times AR}{BW \times AT}$$

See Table C-1 for explanation of equation abbreviations and the assumptions used in calculating dose.

[4] Ingestion rates are often presented in units of grams per day. In order to obtain the proper units in the exposure dose equation (i.e., mg/kg/day), the ingestion rate may need to be divided by 1,000 to obtain a unit of kilograms (kg) per day.

Table C-1: Dose Assumptions: Exposure to Fish and Shellfish			
Parameter	**Abbrev**	**Child**	**Adult**
Chemical Concentration in Fish[1]	C	Average Concentration (ppm)	Average Concentration (ppm)
Ingestion Rate[2]	IR	Salmon (90th % = 79 g/d) /1,000 = 0.079 kg/d English sole (90th % = 21.5g/day) /1,000 = 0.0215 kg/d All Shellfish[5] (90th percentile = 203.5 g/d) /1,000 = 0.2035 kg/d	Salmon (90th % = 158 g/d) / 1,000 = 0.158 kg/d English sole (90th % = 43 g/day) / 1,000 = 0.043 kg/d All Shellfish (90th percentile = 407g/d) /1,000 = 0.407 kg/d
Absorption Rate	AR	0.1 (10%) Arsenic Only	0.1 (10%) Arsenic Only
Exposure Frequency[3]	EF	350 days/year	350 days/year
Exposure Duration[3]	ED	6 years	30 years
Body Weight[4]	BW	16.8 kg	79 kg
Averaging Time Cancer effects	AT	N/A	25550 (70 years x 365 days/year)
Averaging Time Non-cancer effects	AT	2190 (6 years x 365 days/year)	10950 (30 years x 365 days/year)

Notes:

[1] Average chemical-specific concentrations for each species were used to estimate dose

[2] Fish ingestion rates are based on the 90th percentile of fish consumption reported by Suquamish adults in the Fish Consumption Survey (The Suquamish Tribe 2000). Child ingestion rates are assumed to be half the adult rate.

[3] ATSDR 1992, EPA 1997

[4] Body weight values are based on average adult and children weights reported in the Fish Consumption Survey ((The Suquamish Tribe 2000).

[5] Ingestion rates were based on reported total shellfish consumption by the Suquamish Tribe. Actual contaminant concentrations were based on species that contained the highest level of a chemical. For PCBs and arsenic average concentrations detected in caged mussels were used and for mercury the average concentrations detected in rockfish was used.

Table C-2. Estimated Exposure Dosed from Eating Fish/Shellfish from Sinclair Inlet

Non-Cancer Health Effects

Chemical	Type of fish	Average Conc. (mg/kg)*	Adult Dose (mg/kg/day)	Child Dose (mg/kg/day)	Reference Value** (mg/kg/day)	Health Concern
Arsenic	Salmon (chinook)	1.2	**2.3×10^{-4}**	**5.4×10^{-4}**	3×10^{-4} (0.0003)	Unlikely
	English sole	7.5	**3.9×10^{-4}**	**9.2×10^{-4}**	3×10^{-4} (0.0003)	Unlikely
	Shellfish (mussels)	0.5	**2.5×10^{-4}**	**5.8×10^{-4}**	3×10^{-4} (0.0003)	Unlikely
BEHP	English sole	1.02	5.3×10^{-4}	1.3×10^{-3}	2×10^{-2} (0.02)	Unlikely
DDE	Salmon (chinook)	0.02	3.8×10^{-5}	9×10^{-5}	5×10^{-4} (0.0005)	Unlikely
	English sole	0.003	1.6×10^{-6}	3.7×10^{-6}	5×10^{-4} (0.0005)	Unlikely
Dieldrin	Salmon (chinook)	0.001	1.9×10^{-6}	4.5×10^{-6}	5×10^{-5} (0.00005)	Unlikely
	English sole	0.01	5.2×10^{-6}	1.2×10^{-5}	5×10^{-5} (0.00005)	Unlikely
	Sea Cucumber	0.0003	1.5×10^{-6}	3.5×10^{-6}	5×10^{-5} (0.00005)	Unlikely
Isophorone	Shellfish (mussels)	30.3	1.5×10^{-1}	**3.5×10^{-1}**	2×10^{-1} (0.2)	Unlikely
Mercury	Salmon (chinook)	0.1	1.9×10^{-4}	**4.5×10^{-4}**	1×10^{-4} (0.0001)	Unlikely
	English sole	0.08	4.2×10^{-5}	9.8×10^{-5}	1×10^{-4} (0.0001)	Unlikely
	Shellfish (Rockfish)	0.8	**4.2×10^{-4}**	**9.9×10^{-4}**	1×10^{-4} (0.0001)	Possible
PCBs (Aroclor 1260)	Salmon	0.016	**3.1×10^{-5}**	**7.2×10^{-5}**	2×10^{-5} (0.00002)	Unlikely
	English sole	0.1	**5.2×10^{-5}**	**1.2×10^{-4}**	2×10^{-5} (0.00002)	Unlikely
	Shellfish (mussels)	0.02	**8.4×10^{-5}**	**2×10^{-4}**	2×10^{-5} (0.00002)	Unlikely

* All estimates of dose for fish are based on fillets.
** The Reference Value represents either ATSDR's chronic Minimal Risk Level (MRL) or, when not available, EPA's Reference Dose (RfD).

Table C-3. Estimated Exposure Dose from Eating Fish from Sinclair Inlet

Cancer Health Effects

Chemical	Type of fish	Average* Conc. (mg/kg)	Adult Dose (mg/kg/day)	Cancer Risk (unitless)	Reference Range**	Health Concern
Arsenic	English sole	7.5	1.7×10^{-4}	**2.5×10^{-4}**	1×10^{-4} 1×10^{-6}	Unlikely
BEHP	English sole	1.02	2.3×10^{-4}	3.2×10^{-6}	1×10^{-4} 1×10^{-6}	Unlikely
Benzo(a)pyrene	Shellfish (sea cucumber)	0.001	2.1×10^{-6}	1.6×10^{-5}	1×10^{-4} 1×10^{-6}	Unlikely
DDE	Salmon (chinook)	0.02	1.6×10^{-5}	5.6×10^{-6}	1×10^{-4} 1×10^{-6}	Unlikely
Dieldrin	English sole	0.01	2.2×10^{-6}	3.6×10^{-5}	1×10^{-4} 1×10^{-6}	Unlikely
PCBs	English sole	0.1	2.2×10^{-5}	4.5×10^{-5}	1×10^{-6}	Unlikely

* All estimates of dose for fish are based on fillets.

** EPA, which has regulatory authority, generally considers action to be warranted when cancer risk exceeds 1×10^{-4}. Action generally is not required if risk falls within the range of 1×10^{-4} and 1×10^{-6}; however, this is judged on a case-by-case basis (U.S. EPA, 1989). Risk less than 1×10^{-6} is considered below concern by regulatory agencies (EPA 1989).

Discussion
Tables C-2 and C-3 present estimated doses for non-cancer and cancer health effects respectively. It is important to keep in mind that the health guidance values (i.e., reference values), just like ATSDR's comparison values, are *not* thresholds of toxicity. However, if an estimated dose to a substance is below its reference value we can say with considerable confidence that health effects will not occur in people. ATSDR has provided a brief discussion for each of the chemical contaminants that were evaluated further:

Arsenic: Arsenic is a naturally occurring element that is prevalent in many different media, including soil, water, and seafood tissues. There are two primary forms of arsenic, inorganic and organic arsenic. Inorganic arsenic is typically found as a greater proportion of total arsenic in water and soils, whereas organic arsenic is most often the primary form in fish and shellfish tissue. People may be exposed to both inorganic and organic arsenic, but the toxicity associated with each form is very different. Understanding the difference between inorganic and organic arsenic is very important because the organic forms are usually much less harmful than the inorganic forms.

ATSDR's evaluation of arsenic in fish and shellfish tissue included comparing concentrations detected in samples to ATSDR's health-based screening values. Since the arsenic levels in some fish and shellfish tissues exceeded the media-specific comparison value (See Table 2) ATSDR estimated the arsenic exposure dose based on information known about the site and/or reasonable health-protective assumptions about the frequency and duration of exposure. These assumptions were presented in Table C1.

The estimated non-cancer arsenic dose for all three species evaluated (Chinook salmon, English sole, and mussels) exceeded its reference dose. ATSDR reviewed the toxicological literature to assess the likelihood of adverse health effects given the doses that we estimated people might be exposed to. Unlike many chemicals, there is good human dose-response information for arsenic exposure. However, much of this data pertains to inorganic arsenic via ingestion of water rather than the less toxic form of organic arsenic that is found primarily in fish and shellfish tissue.

The lowest chronic exposure dose documented that resulted in non-cancer adverse health effects was 0.005 mg/kg/day in humans. This dose was reported to cause fatigue, headache, dizziness, loss of sleep, and numbness in a person exposed to arsenic in water. However, most of the non-cancer lowest observed adverse effect levels (LOAELs) were at least an order of magnitude (i.e., 10 times) higher than the 0.005 mg/kg/day exposure dose. The highest estimated dose for inorganic arsenic in English sole was 0.0009, which was for children. This is about 5 times lower than any dose associated with human health effects identified in the scientific literature. On the basis of this information, ATSDR believes it is unlikely that people will experience health effects from arsenic in English sole or other species sampled from Sinclair Inlet (ATSDR 2000).

A review of the cancer health effects literature shows that lung cancer was observed in a person who was exposed to 0.001 mg/kg/day of arsenic in water. The estimated inorganic arsenic dose from consuming English sole is about 6 times lower than any dose associated with cancer effects in people. Again, the scientific data that have been reviewed suggests that it is very unlikely that people will develop cancer from the arsenic levels found in English sole or other species sampled from Sinclair Inlet (ATSDR 2000).

BEHP: The estimated non-cancer dose for English sole did not exceed its corresponding reference value. No further evaluation is required.

DDE: The estimated non-cancer and cancer dose for Chinook salmon and English sole did not exceed their corresponding reference values or upper bound cancer risk range (i.e., 1×10^{-4}). No further evaluation is required.

Dieldrin: The estimated non-cancer and cancer dose for the three species evaluated (Chinook salmon, English sole, and sea cucumbers) did not exceed their corresponding reference values or upper bound cancer risk range (i.e., 1×10^{-4}). No further evaluation is required.

Isophorone: Isophorone is used extensively as a solvent in some printing inks, paints, lacquers, adhesives, finishes, and pesticides. Since this compound has many different applications, release to the environment may originate from a wide variety of industrial sources. Although it is mostly a man-made compound, isophorone has been found to occur naturally in cranberries (ATSDR, 1989).

Although the estimated child dose of isophorone slightly exceeded its reference value in mussels, this is based on the average concentration of only detected values. Isophorone was only detected in a third of the mussel samples collected and we believe that it is very likely that peoples' actual dose would be well below the reference value of 0.2 mg/kg/day. Therefore, ATSDR concludes that the concentrations of isophorone detected in mussel tissue collected from Sinclair Inlet are not harmful.

Mercury: Mercury is an element that occurs both naturally in the environment and also has many industrial uses such as the manufacture of batteries, electrical equipment, some fungicide and pesticide products as well as other products. There are different forms of mercury found in the environment. The form of mercury that accumulates in the food chain is methylmercury, a type of organic mercury. Methylmercury can accumulate in the food chain.

The estimated mercury dose associated with consuming Chinook salmon exceeded the reference value by about a factor of 5 in children. The estimated mercury dose from consuming rockfish exceeded the reference value for both adults and children. A review of the toxicological literature shows that adverse health effects have not been observed at the estimated doses presented in Table C-2 (ATSDR 1999). However, as a precautionary measure ATSDR recommends not consuming rockfish from Sinclair Inlet until additional monitoring shows that average mercury levels have declined.

PCBs: The MRL for PCBs is 0.00002 mg/kg/day. The estimated PCB dose for both adults and children exceeded this value. MRLs are estimates of human exposure to a chemical that are unlikely to be associated with any appreciable risk of non-cancer effects. Although some epidemiological studies have been conducted to assess the health effects of PCBs, animal studies comprise the largest body of toxicological data for PCBs. Under chronic exposure situations subtle health effects (referred to as less serious - lowest observed adverse effect levels [LOAEL]) occurred at doses of 0.005 mg/kg/day or greater in animals. These low-level exposures were most typically associated with very subtle immunological and developmental effects. The estimated doses for children and adults are 12 to 100 times lower than any observed non-cancer health effects in the literature. PCB doses associated with cancer in animal studies are generally greater than 1 mg/kg/day, which is about 400 to 500 times higher than the estimated doses from consuming fish or shellfish from Sinclair Inlet (ATSDR 2000b). On the basis of the available toxicological data, we do not believe that current PCB levels measured in fish and shellfish tissues within Sinclair Inlet are at levels likely to result in harm. Because there is some uncertainty associated with the health effects of PCBs at low exposures, ATSDR recommends adults not consume English sole from Sinclair Inlet more than once a month (8 ounce serving) until monitoring shows that average PCB levels are declining. Children should only consume about one-half the portion (e.g., 4 ounces) or about half as many servings.

APPENDIX D: Calculation of Recommended Maximum Consumption Frequencies for Fish and Shellfish Species Sampled in Sinclair Inlet: Assumptions, Methodology and Table

ATSDR calculated the recommended maximum number of days per year people (both adults and children) can safely consume fish and shellfish from Sinclair Inlet (Table E1a and E1b) based on the following assumptions:

<u>ATSDR Assumptions and Methodology</u>

ATSDR used FDA's suggested maximum tolerable daily intake, EPA's reference dose, and various research studies in our evaluation. We calculated a recommended maximum number of days per year people can safely consume fish and shellfish from Sinclair Inlet based on the following assumptions:

- ATSDR used a child body weight of 16.8 kg (generally represents children between 2 and 4 years of age) based on the results of the Suquamish Consumption survey.

- ATSDR used an adult body weight of 79 kg based on the results of the Suquamish Consumption survey.

- ATSDR assumed that Sinclair Inlet would be the sole source of fish and shellfish ingested. This is an important assumption will, for many people, will not be the case. Most people, even those who may rely on local fish and shellfish for a significant portion of their diet (i.e., subsistence fishers) would likely obtain a portion of their catch from other sources. Therefore, the recommended number of safe consumption days would likely be a very conservative estimate.

- ATSDR's Tolerable Dose for the chemicals listed (excluding arsenic and lead) represent EPA's Reference Dose, an estimate (with uncertainty spanning perhaps a factor of ten) of the daily exposure of a person over a lifetime (70 years) to a contaminant that is unlikely to cause adverse health effects.

  EPA's Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause non-carcinogenic adverse health effects over a lifetime of exposure. ATSDR considered both cancer and non-cancer effects. However, for purposes of calculating recommended maximum consumption frequencies, ATSDR relied on the reference dose (or in the case of arsenic FDA's tolerable total intake and for lead FDA's estimated dietary effect level – see below) because it generally provides the most conservative recommendations for the number of days per year fish and shellfish can safely be consumed. Arsenic is the only contaminant where the cancer risk estimate exceeded the cancer risk range of 1 cancer case in 10,000 people.

- For arsenic, ATSDR used 10% of the total concentration of arsenic actually detected in shellfish tissue, which represents the toxic inorganic form.

- ATSDR's tolerable dose value for arsenic is based on FDA's tolerable total intake for inorganic arsenic (0.130 mg/person/day). We divided this value by 79 kg to get the tolerable dose for a 79 kg person. ATSDR used FDA's tolerable intake value rather than EPA's RfD for arsenic because of the understanding that EPA's RfD for arsenic is a very health-protective value based on toxicity data where people are exposed primarily via drinking water, where studies have demonstrated greater bioavailability and toxicity in comparison to arsenic in fish and shellfish. ATSDR believes that FDA's tolerable intake for inorganic arsenic is a more realistic, but still health-protective value, for exposure of arsenic via fish and shellfish.

- For lead, ATSDR used FDA's estimated dietary effect level of 0.250 mg/day divided by 79 kg to give an estimated dose for a corresponding blood lead level of 10 ug/dL. This value is divided by 4, which provides a safety factor and also to account for transference of maternal blood lead to the fetus.

$$\frac{0.250 \text{ mg/day}}{79 \text{ kg}} \div 4 = 0.00079 \text{ mg/kg/day (ATSDR's Tolerable Dose for lead)}$$

- Two ingestion rates (5.6 and 8 ounces per day) were used for adults and one-half the adult ingestion rate was assumed for children.

The following formula was used to calculate our maximum recommended consumption frequency.

ATSDR's Maximum Recommended Consumption Frequency (days/year) (kg/day) =

$$\frac{\text{Body weight (kg)} \times \text{Tolerable Dose (mg/kg/day)} \times 365 \text{ (days/year)}}{\text{Maximum Chemical Concentration (mg/kg)} \times \text{Ingestion Rate}}$$

Based on the Suquamish survey, these ingestion rates are considered to be health-protective estimates for subsistence consumption of salmon and other fish. It should be noted, however, that shellfish consumption rates can be substantially higher (e.g., the 95th percentile consumption rates for the Suquamish Tribe have been reported as high as 22 ounces per day for all shellfish). This may, however, include shellfish species not harvested in great frequency within Sinclair Inlet.

- An important limitation of the recommended maximum consumption frequencies presented in Tables E-1a and E-1b is that the calculations do not reflect cumulative impacts from exposure to multiple contaminants in fish and shellfish. At the present time, methods to assess the issue of low-level exposure to multiple contaminants have not been refined and adequately tested in a manner that would meet scientific standards.

Table D-1a: Recommended Maximum Consumption Frequency (Days Per Year) for adults

ADULT

Maximum Concentration in Fish and Shellfish	Arsenic*$	Lead	Mercury**	Heptachlor	DDE	BEHP	Dieldrin***	Isophorone****	PCBs*****
Salmon	1.4	0.04	0.12	NA	0.006	NA	0.002	NA	0.014
English Sole	11.9	1.2	0.14	0.0034	0.006	1.4	0.01	NA	0.2
Shellfish	2.4	NA	1.15	NA	NA	NA	0.0005	33	0.021

Recommended Safe Consumption Frequency (Days per year)

5.6 OZ Ingestion (0.158 kg/day)	Arsenic*$	Lead	Mercury**	Heptachlor	DDE	BEHP	Dieldrin***	Isophorone****	PCBs*****
Salmon	2,151	3,559	456	NA	15,208	NA	4,563	NA	261
English Sole	253	119	391	26,838	15,208	2,607	913	NA	18
Shellfish/other (See notes below for species)	1,255	NA	48	NA	NA	NA	18,250	1,107	174

8 OZ Ingestion Rate (0.227 kg/day)	Arsenic	Lead	Mercury**	Heptachlor	DDE	BEHP	Dieldrin***	Isophorone****	PCBs*****
Salmon	1,497	2,447	318	NA	10,586	NA	3,176	NA	181
English Sole	176	83	272	18,680	10,586	1,815	635	NA	13
Shellfish/other (See notes below for species)	873	NA	33	NA	NA	NA	12,703	770	121

Notes:
Shaded rows represent the maximum concentrations detected during sampling events.
Shaded cells indicate that the recommended consumption frequency is less than 365 days per year, and therefore not unlimited.
Non-shaded rows represent
Chemicals detected in Shellfish/Other (includes mussels, rockfish, and sea cucumbers)
* Arsenic was detected in mussels and sea cucumber
**Mercury was detected in Rockfish
*** Dieldrin was detected in the sea cucumber
**** Isophorone was detected in mussels
***** PCBs were detected in mussels

$ ATSDR assumed that 10 percent of the total arsenic concentration detected was in the inorganic form. This is based on US FDA's findings that the inorganic component of total arsenic in shellfish comprises approximately 10 percent of total arsenic.

NA = Not applicable because the chemical was not detected or detected below health-based screening values

Table D-1b: Recommended Maximum Consumption Frequency (Days Per Year) for children

CHILD

Maximum Concentration in Fish and Shellfish	Arsenic*$	Lead	Mercury**	Heptachlor	DDE	BEHP	Dieldrin***	Isophorone****	PCBs*****
Salmon	1.4	0.04	0.12	NA	0.006	NA	0.002	NA	0.014
English Sole	11.9	1.2	0.14	0.0034	0.006	1.4	0.01	NA	0.2
Shellfish	2.4	NA	1.15	NA	NA	NA	0.0005	33	0.021

Recommended Safe Consumption Frequency (Days per year)

2.8 Ounce Ingestion (0.079 kg/day)	Arsenic*$	Lead	Mercury**	Heptachlor	DDE	BEHP	Dieldrin***	Isophorone****	PCBs*****
Salmon	915	1514	194	NA	6,468	NA	1,941	NA	111
English Sole	108	50	391	11,415	6,468	1109	388	NA	8
Shellfish/other (See notes below for species)	534	NA	20	NA	NA	NA	7,762	470	74

4 Ounce Ingestion Rate (0.1135 kg/day)	Arsenic	Lead	Mercury**	Heptachlor	DDE	BEHP	Dieldrin***	Isophorone****	PCBs*****
Salmon	637	1054	135	NA	4,502	NA	1,351	NA	77
English Sole	75	35	116	794	4,502	772	270	NA	5.4
Shellfish/other (See notes below for species)	371	NA	14	NA	NA	NA	5,403	327	51

Notes:
Shaded rows represent the maximum concentrations detected during sampling events.
Shaded cells indicate that the recommended consumption frequency is less than 365 days per year, and therefore not unlimited.
Non-shaded rows represent

Chemicals detected in Shellfish/Other (includes mussels, rockfish, and sea cucumbers)
* Arsenic was detected in mussels and sea cucumber
**Mercury was detected in Rockfish
*** Dieldrin was detected in the sea cucumber
**** Isophorone was detected in mussels
***** PCBs were detected in mussels

$ ATSDR assumed that 10 percent of the total arsenic concentration detected was in the inorganic form. This is based on US FDA's findings that the inorganic component of total arsenic in shellfish comprises approximately 10 percent of total arsenic.

NA = Not applicable because the chemical was not detected or detected below health-based screening values

APPENDIX E: ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption: The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute: Occurring over a short time [compare with chronic].

Acute exposure: Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect: A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect: A change in body function or cell structure that might lead to disease or health problems.

Aerobic: Requiring oxygen [compare with anaerobic].

Ambient: Surrounding (for example, ambient air).

Anaerobic: Requiring the absence of oxygen [compare with aerobic].

Analyte: A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study: A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect: A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level: An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation: Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study: A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring : Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake: The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing: Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota: Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden: The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assistance Panel].

Cancer: Any one of a group of diseases that occur when cells in the body become abnormal and grows or multiplies out of control.

Cancer risk: A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen: A substance that causes cancer.

Case study: A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study: A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number: A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system: The part of the nervous system that consists of the brain and the spinal cord.

CERCLA: [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980].

Chronic: Occurring over a long time [compare with acute].

Chronic exposure: Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure].

Cluster investigation: A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP): A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

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.

Completed exposure pathway: [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. The Superfund Amendments and Reauthorization Act (SARA) later amended this law.

Concentration: The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

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.

Delayed health effect: A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal: Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact: Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology: The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit: The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention: Measures used to prevent a disease or reduce its severity.

Disease registry: A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD: United States Department of Defense.

DOE: United States Department of Energy.

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.

Dose: (for radioactive chemicals). The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship: The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

ENVVEST: In 2000, the U.S. Navy, EPA (Region X), and the Washington State Department of Ecology signed a Final Project Agreement to initiate project ENVironmental InVESTment (INVEST). The project is part of EPA’s excellence and Leadership program which was developed to give communities, state and local agencies, federal facilities, and industry the opportunity to propose cleaner, cheaper, and smarter ways of protecting the environment. The goal of ENVVEST is to protect and improve the health of surface waters of Sinclair and Dyes Inlets by developing a more environmentally protective strategy for managing pollutant sources in the Inlets than the regulatory framework that is currently in place.

Environmental media: Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism: Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA: United States Environmental Protection Agency.

Epidemiologic surveillance: [see Public health surveillance].

Epidemiology: The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

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].

Exposure assessment: The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction: A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation: The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway: The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry: A system of ongoing follow-up of people who have had documented environmental exposures.

Feasibility study: A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS): A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds: Training sessions for physicians and other health care providers about health topics.

Groundwater: Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life (t½): The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard: A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat): The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste: Potentially harmful substances that have been released or discarded into the environment.

Health consultation: A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education: Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation: The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion: The process of enabling people to increase control over, and to improve, their health.

Health statistics review: The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard: The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence: The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

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].

Inhalation: The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure: Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro: In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo: Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

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.

Medical monitoring: A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism: The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite: Any product of metabolism.

mg/kg: Milligram per kilogram.

mg/cm2: Milligram per square centimeter (of a surface).

mg/m3: Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration: Moving from one location to another.

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 reference dose].

Morbidity: State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality: Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen: A substance that causes mutations (genetic damage).

Mutation: A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL): EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP): A Part of the Department of Health and Human Services, NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard: A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

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.

No public health hazard: A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL: [see National Priorities List for Uncontrolled Hazardous Waste Sites].

Physiologically based pharmacokinetic model (PBPK model): A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica: A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume: A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure: The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population: A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP): A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

Ppb: Parts per billion.

Ppm: Parts per million.

Prevalence: The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey: The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention: Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session: An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period: An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action: A list of steps to protect public health.

Public health advisory: A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA): An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard: A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories: Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement: The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance: The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting: A public forum with community members for communication about a site.

Puget Sound Ambient Monitoring Program (PSAMP): PSAMP is a multi-agency consortium of scientists and natural resource managers responsible for assessing and monitoring the environmental health of the Puget Sound ecosystem and to identify environmental problems. The program was initiated in 1989 and coordinates the activities of four state agencies in conducting ambient monitoring of eight major ecosystem components, including quality of sediments, freshwater and saltwater, health of fishes, shellfish, birds, and mammals, and condition of habitats. In fulfilling its mandate, the PSAMP evaluates and monitors status and trends using five key indicators: chemical contamination, microbial (e.g., fecal) contamination, condition of near shore habitats, abundance of organisms, and water quality.

Radioisotope: An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide: Any radioactive isotope (form) of any element.

RCRA: [see Resource Conservation and Recovery Act (1976, 1984)].

Receptor population: People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD): An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry: A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation: The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA): This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA: RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD: [see reference dose].

Risk: The probability that something will cause injury or harm.

Risk reduction: Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication: The exchange of information to increase understanding of health risks.

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].

Safety factor: [see uncertainty factor].

SARA: [see Superfund Amendments and Reauthorization Act].

Sample: A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size: The number of units chosen from a population or an environment.

Solvent: A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination: The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations: People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder: A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics: A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance: A chemical.

Substance-specific applied research: A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund: [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA).

Superfund Amendments and Reauthorization Act (SARA): In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water: Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance: [see public health surveillance].

Survey: A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect: A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen: A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent: Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile: An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology: The study of the harmful effects of substances on humans or animals.

Tumor: An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor: Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard: A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs): Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:

Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Center for Environmental Health (CDC) (http://www.cdc.gov/nceh/dls/report/glossary.htm)

National Library of Medicine (NIH) (http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

For more information on the work of ATSDR, please contact:
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APPENDIX F: ATSDR'S RESPONSE TO PUBLIC COMMENTS

The Agency for Toxic Substances and Disease Registry released the BNC/Puget Sound Naval Shipyard Public Health Assessment (PHA) for public review and comment on April 28, 2005. The public comment period, which ended on May 27, 2005, was announced in a press release on May 5, 2005. The PHA was made available for public comment at the following locations:

Kitsap Regional Library
Central Branch
1301 Sylvan Way
Bremerton, Washington 98310
phone: 360-405-9100

Kitsap Regional Library
Martin Luther King Jr. Branch
612 Fifth Avenue
Bremerton, Washington 98337
Phone: 360-377-3955

For those comments that questioned the factual validity of a statement made in the PHA, ATSDR verified and, when appropriate, corrected any errors. The following responses to public comments do not include editorial comments such as word spelling or sentence syntax received during the public comment period. All references to page and line numbers pertain to the Public Comment PHA Release not the Final PHA.

Comment 1: The document uses the phrase microbial contamination in this sentence. Later in the document they use bacterial contamination. The latter is more helpful for the reader, therefore it is recommended biological be changed to bacterial throughout the document when referring to the contamination causing shellfish beds to remain closed. Suggest that the text also note that the main source of bacterial contamination is from sewage.

Response: ATSDR acknowledges the inconsistency in terminology and has modified the document to ensure that there is consistency throughout the report. However, not all contamination from sewage and other effluent is bacterial (e.g., some of the contamination may contain viral or protozoan (giardia) contamination that could pose a public health hazard. Therefore, the term that is best suited to describe this non-chemical contamination is "microbial," and ATSDR will use this term consistently throughout the report. Also, please note the text box that appears on page 25 explains the difference between microbial and chemical contamination. This should clarify the term so as not to imply "biological" agents used as military weapons.

Comment 2: The text indicates there are no firing ranges. The BNC does have a small indoor firing range used for small arms target practice. This sentence should be re-worded to clarify that there are no outdoor areas where large munitions were fired.

Response: Correction has been made

Comment 3: The text states "Radiological and very limited ordnance operations were also conducted at the shipyard." This paragraph seems to be covering both historic and current operations. Ordnance operations no longer occur in the Shipyard, however radiological operations continue. The last two sentences refer only to non-naval nuclear propulsion program (NNPP) radiological waste. Recommend the last two sentences in this paragraph be deleted and the following sentence added instead: "Radioactivity has not been found to be a pollutant of concern."

Response: ATSDR has revised the text accordingly.

Comment 4: Storm drains still collect runoff and send it to Sinclair Inlet. It appears the reference is to the process water treatment plant. The plant now sends treated effluent to the City of Bremerton sanitary waste treatment system.

Response: Correction has been made

Comment 5: The section should also include reference to non-point sources contributing to the pollution of the inlet.

Response: Correction has been made

Comment 6: The Navy's long-term monitoring plan has been approved by EPA, Ecology, and the Suquamish Tribe. The frequency of monitoring and the type of marine tissue samples that will be collected are delineated in pertinent RODs. Under CERCLA and this plan, the Navy has commited to monitoring of English sole (a widely accepted indicator species for bottom fish)and sediment for PCBs and mercury to determine trends and progress toward the OU B Marine cleanup goals. English Sole is the agreed indicator species from the OU B Marine ROD. The Navy does not anticiapte sampling mulitple species of bottom fish and shellfish.

The Navy currently has no plans to modify the long-term monitoring specified in the OU B ROD. The Navy's plans for regular marine monitoring, developed in collaboration with State and Federal agencies, include sampling in years 2003, 2005, 2007, 2012, and 2017.

Response: As ATSDR has noted in the PHA, there may be longer-lived species that inhabit Sinclair Inlet that have the potential to accumulate contaminants. Although English sole may be a suitable indicator species for most fish species, ATSDR believes that one or two additional shellfish species should also be monitored as an added measure of safety.

Comment 7: The completed actions as stated are confusing and inaccurate (same actions are stated differently in multiple paragraphs). Suggest condensing to the following three paragraphs:

(1) In 2000 and 2001, as part of the selected remedy for addressing contaminated sediments in OU B Marine, the Navy conducted a dredging project to make contaminated sediments inaccessible to surface biota and marine life in the near shore areas. The Navy created the Confined Aquatic Disposal (CAD) pit in the westernmost portion of OU B Marine. Approximately 200,000 cubic yard of sediment containing PCBs and other site-related contaminants were excavated, placed into the CAD, and covered with a sand and native sediment cap (URS 2002; BNC 2004a).

(2) Because of unexpected contaminant releases from the CAD during dredging operations, the Navy conducted additional environmental monitoring to better characterize the nature and extent of contamination on a portion of state owned aquatic lands that border BNC property near the CAD. The Navy released a report titled “Explanation of Significant Differences” in February 2004 to address additional remedial work. The Navy completed enhanced natural recovery actions for this area in March 2004.

(3) In 2003 and 2004, as part of the selected remedy for OU B Terrestrial, the Navy conducted shoreline stabilization by installing riprap and fish mix (i.e., boulders and pebbles) to help prevent soil erosion into the marine environment and enhance fish habitat.

Response: ATSDR has revised the PHA to reflect the recommended changes.

Comment 8: Change to “The repairs are currently 80% complete with an expected completion date of late 2005.

Response: Updated information has been added to final PHA. The Navy has informed ATSDR that repairs are actually 90% complete and this is the figure that will be used.

Comment 9: Delete “shellfish”. The long term monitoring is just for marine sediments and English sole. (Sea cucumbers were also sampled on a one-time basis, as part of the plan.)

Response: Correction has been made.

Comment 10: Change to “The Navy has finalized a Record of Decision (ROD) for OU D and plans to complete remedial actions for this OU by the end of 2005. “

Response: New information has been added to final PHA.

Comment 11: Were Puget Sound wide averages calculated for organic compounds for the various species?

***Response*:** No. Averages were only available for inorganics.

Comment 12: The text compares organic normalized PCB concentrations early in this paragraph with bulk dry weight concentrations in the last sentence.

Response: ATSDR cites the data that are available – not all sediment data were presented as organic normalized PCB concentrations. A caveat will be added to alert the reader that the normalized and bulk dry weight data are not directly comparable.

Comment 13: Non-point sources such as private septic tanks along the shoreline contribute significantly to polluting the inlet.

***Response*:** ATSDR acknowledges that other non-point sources contribute to Sinclair Inlet pollution.

Comment 14: Confirmation sampling for geoducks – please clarify that the state and Puget Sound treaty tribes would be responsible for managing any hypothetical Sinclair inlet geoduck harvest and therefore would be responsible for setting any sampling requirements.

***Response*:** Clarification has been made. ATSDR has also recommended that the Navy consider sampling geoducks if Sinclair Inlet is shown to be a viable resource and the Suquamish Tribe is interested in commercial harvesting.

Comment 15: Child ingestion rates are stated to be half the adult rate, not the 90th percentile. Also, child rates were calculated in the Suquamish Survey in Table T-14, please clarify if these numbers were not used for the benefit of erring on the conservative.

Response: ATSDR assumed that child ingestion rates were ½ of adult ingestion rates. This is an assumption that ATSDR often uses for child ingestion rates and believes that it is health-protective.

Comment 16: It is unclear looking at the Suquamish survey how the adult consumption rates were calculated. Please clarify.

Response: Refer to page 42 (Table T-5) of the Suquamish Consumption Survey for the ingestion rates ATSDR used to calculate estimated dose.

We used the 90th percentile values reported for males from Group A (Salmon), Group D (Sole), and All Shellfish.

This table includes non-consumers - however, for reported "salmon" and "all shellfish" consumption, all respondents reported eating these food items.
It is important to remember that the rates are presented in g/kg/day in Table T-5. When ATSDR calculates estimated doses this value is converted to grams/day and then divided by 1,000 to get kg/day, which is the value used in our equation in the Excel file.

Comment 17: Please provide some discussion as to what these tables represent and what it means to a fish consumer in Sinclair inlet.

Response: Additional dose and exposure perspective has been provided in Appendix C.

Comment 18: The statement regarding "commercial and recreational" wells within 4 miles could not be verified from the referenced document.

Response: ATSDR revised this section using more updated information from the Washington Department of Ecology's well logs database – web address: http://apps.ecy.wa.gov/welllog/

Comment 19: The second and third sentence could be misleading as written. As noted elsewhere in the report, numerous storm drain lines remain in use at BNC for the purpose of conveying surface water runoff to Sinclair Inlet.

Response: Correction Made

Comment 20: The Navy concurs that the Suquamish Tribe consumption study defines a very protective consumption rate. Calculating the potential risk using these numbers is conservative and appears appropriate for the PHA. It should be noted, however, that a professional peer review of the study should be conducted before routinely using the data for CERCLA risk assessments.

Response: ATSDR does not conduct CERCLA risk assessments. We use site specific values to assist us in estimating doses and can compare that information to any relevant comparison values as part of a weight-of-evidence approach for public health assessments. ATSDR sponsored the Suquamish Tribe consumption survey to provide information regarding a specific population as a way of gathering information where information was lacking.

Comment 21: Are there enough Brown Rockfish present in the embayment to support an increased consumption rate? Are Brown Rockfish consumed now, due to the possible presence of biological contamination?

Response: According to WADEC, it is possible that low population fish could be seeded to increase the availability of the resource. ATSDR is not aware of any recent inventories of rockfish in Sinclair Inlet. According to the Suquamish Tribe Consumption Survey, ingestion rates of Brown Rockfish by the Suquamish Tribe are relatively low, but they are consumed occasionally.

Comment 22: This summary does not include the 5-10 to 15' borings completed along with the surface samples. This data was used in the OU D RI to calculate potential risk to current and future construction workers. This exposure pathway should be included in the report.

Response: ATSDR only considered surface soil when evaluating residential or visitor exposures because ATSDR does not evaluate occupational exposures which are covered under Occupational Safety and Health Administration. Workers would be protected under OSHA rules and regulations. OSHA requirements should be health-protective for the construction worker scenarios.

Comment 23: The Navy anticipates installation of the OU D remedy prior to finalizing the potential transfer of property to the City of Bremerton. The remedy includes institutional controls prohibiting the use of the property for residential purposes.

Response: ATSDR has modified the relevant text to the Final PHA accordingly.

Comment 24: Estimating a timeline to have the fishing/harvesting restrictions lifted from Sinclair Inlet will require input from Washington Department of Health / Kitsap County Health Department regarding the presence of biological contamination.

Response: ATSDR notes the comment.

Comment 25: Children do access the ISA for ship porting and departure ceremonies and are generally accompanied by an adult. This statement may need to be revised slightly.

Response: Revision to text has been made.

Comment 26: OU B Marine monitoring includes sediment and English Sole only. There are no shellfish collected as part of the long-term monitoring.

Response: Correction has been made

Comment 27: The OU D ROD was signed in May 2005 and the Navy anticipates completing remedial action in 2005. Please include ROD citation, and list in reference section.

Response: The citation for the OU D ROD has been included.

Comment 28: Investigation Results: The subsection on sediments does not address PCBs. Elevated PCB sediment concentrations are directly related to elevated PCB concentrations in bottom fish tissue. PCB concentrations in fish tissue are the primary CERCLA health risk driving the OU B Marine remedial action.

In addition to the 1994-5 RI sampling, this column should record the 1998-9 “FS Sampling” event for marine sediments conducted as a basis for refining the marine remedy. This sampling event focused on PCBs.

Response: Correction has been made.

Comment 29: Investigative results, groundwater: TCE in MW 402, the subsequent results were 4,500 to 7,600 ppb for MW 402. Were the 8,300 and 11,000 perhaps from a different well? Please provide citation so these numbers can be verified.

Response: Final ROI Report OU B – March 12, 2002: Please refer to 1.5.4.2 Site 7 SI Findings: Page 1-29 and 1-30. "The detection of TCE in MW402 (PS07-MW01) at a concentration of 17,000 µg/L led to three additional rounds of groundwater sampling for the analysis of VOCs. During the additional sampling rounds carbon tetrachloride, 1,1-dichloroethene, 1,1,2-trichloroethane, and PCE were not detected. TCE was detected in MW402 at concentrations ranging from 8,300 to 11,000 µg/L."

Comment 30: Investigation Results: Site 7 is at the former location of Building 99. Building 873 is the subsequent location of the plating shop and is related to Site 7 but is not within the boundaries of Site 7. Building 873 is located within OU B Terrestrial and remedy is for this location is defined in the OU B Terrestrial ROD. The Navy took steps to seal the floor of Building 873. It may be useful to include this under the "Corrective Activities" column along with the statement that Site 7 and Building 873 located within OU B Terrestrial.

Response: ATSDR has revised the text accordingly.

Comment 31: The steam sparging equipment and ancillary piping was removed in summer 2004.

Response: Correction Made.

Comment 32: The entries in the ingestion rate row in this table, indicating Child and Adult, are still reversed. As footnote 2 indicates, the child ingestion rates are presumed to be half the adult rate.

Response: Correction has been made.

Comment 33: Were the numbers used to derive ingestion rates from Table T-3 of the Suquamish study? For salmon, which salmon value was used? Or, was the 90 percentile Group A value used? Was the weight value still presumed to be 79 kg for adults? The IR numbers could not be duplicated using data from the August 2000 version of the Suquamish Fish Consumption study. Which values from which tables were used?

Response: Refer to page 42 (Table T-5) of the Suquamish Consumption Survey for the ingestion rates ATSDR used to calculate estimated dose.

We used the 90th percentile values reported for males from Group A (Salmon), Group D (Sole), and All Shellfish.

This table includes non-consumers - however, for reported "salmon" and "all shellfish" consumption, all respondents reported eating these food items.

It is important to remember that the rates are presented in g/kg/day in Table T-5. When ATSDR calculates estimated doses this value is converted to grams/day and then divided by 1,000 to get kg/day, which is the value used in our equation.

Comment 34: It is helpful to distinguish non-cancer effects. It would clarify tables if a footnote referenced back to Tables 2 or 3, in the body of the report. It is from these Navy & WA Dept. of Fish & Wildlif tables, respectively, that the average chemical concentration values were extracted. A superscript symbol could be used to denote which values came from which source.

Response: Additional perspective has been added regarding non-cancer and cancer health effects. The requested footnote notation was not added because average concentrations are provided in Tables C-2 and C-3 – it should be easy to go back to main document (Tables 2 or 3) and find the corresponding row that represents the value used in estimating the dose.

Comment 35: According to the (revised) risk calculations in Appendix C [see comments below] there is an estimated increased cancer risk and non-cancer risk associated with ingestion of arsenic through fish and shellfish. The text needs to address this within the report.

Response: ATSDR multiplied the ingestion rate for total arsenic by 0.1 to reflect the inorganic fraction ingested. ATSDR has added this information to Table C-1 and the dose estimates should be correct as presented in Appendix C.

Comment 36: “OU-D” is not described until page 6 of the report. Suggest adding a sentence describing what and where OU-D is.

Response: Correction has been made.

Comment 37: Appendix C Tables: We understand that ATSDR uses the upper bound range of 1 and 10,000. The state of Washington and EPA Region IX often use the upper bound range of 1 and 1,000,000 in regulatory risk assessments. For clarity purposes a short discussion on why ATSDR uses upper bound range of 1 and 10,000 may be appropriate.

Response: ATSDR revised table and added a range in the cell rather than just using the 1 x 10^{-4} value.

Comment 37: In Appendix C: Is it possible for ATSDR to consider the 95th percentile rather than the 90th?

Response: ATSDR’s assumptions are typically made to err on the side of safety and in this case ATSDR used the 90th percentile ingestion rates for adult males only. Since using adult male-only ingestion rates are considerably higher than using the ingestion rates based on the entire population we believe these are very health-protective and are suitable for this evaluation.

Comment 38: . Is it possible to incorporate a 70-year ED in the BNC/PSNS evaluation?

Response: ATSDR used exposure duration of 30 years because the evaluation was based on a hypothetical future use scenario within Sinclair Inlet. As mentioned in the report, advisories have been posted for Sinclair Inlet since 1982. ATSDR believes that the exposure duration assumption of 30 years is sufficient for evaluating potential future exposures and making recommendations about future fish/shellfish monitoring.

Comment 39: Are the conclusions and summary future risk statements in the report (salmon and other migratory species, and possibly some shellfish, are safe to consume at unlimited frequency or with some frequency restrictions) based on cumulative risks? Is it possible to include some kind of estimate of what consumption frequencies would be considered safe, for the fish/shellfish that would require a frequency restriction?

Response: ATSDR's estimates of dose assume cumulative exposures to a given chemical contaminant over a specific time period. ATSDR has added a table that provides additional guidance regarding what would be considered a safe fish/shellfish consumption given the contaminant concentrations observed from recent sampling.

Comment 40: Is it "unsafe" to consume English sole from Sinclair Inlet at any frequency? (English sole is higher in PCB and arsenic concentrations.)

Response: Although English sole typically have the highest contaminant concentrations among the fish and shellfish sampled in Sinclair Inlet, the levels that are commonly found across Sinclair Inlet do not represent a definitive hazard. It is important to keep in mind that although some contaminants exceed their reference value (i.e., RBC), concentrations were not detected in English sole at levels that have been shown to cause health effects in toxicological studies. Although human data are preferred, reference values often must be based on animal studies because relevant human studies are lacking. In the absence of evidence to the contrary, it is usually assumed that humans are more sensitive to the effects of hazardous substance than animals and that certain persons may be particularly sensitive. Therefore, the reference values have uncertainty factors that are built in because often the only available studies are based on animals or human variability.

ATSDR recommends the following approach to use when making decisions about consuming fish from specific locations:

1. Follow all available advisories from your local or state health department. These advisories are provided to ensure the safety of subsistence populations, anglers, and other fish consumers. The fact that an advisory has been issued does not necessarily mean that consuming the fish will make you sick, either immediately or over a period of time. It does, however, indicate that on the basis of the best scientific information available regarding the potential for adverse health effects

people should reduce or avoid consuming the species listed in the advisory for a given location.

2. If you choose not to follow the advisory, you are assuming a greater risk and the potential that repeated exposures to contaminants in the fish could result in adverse health effects in the future. People can take certain precautions to minimize the possibility of exposure to PCBs and other contaminants that tend to accumulate in fatty tissues and organs. These precautions include selecting younger smaller fish, removing the skin and fatty tissue, and avoid eating the liver and other internal organs of the fish.

Comment 41: Why are cancer rates only calculated for English sole consumption for arsenic and PCBs (is it because the tissue concentrations for English sole are the highest and would more directly influence the risk estimate)?

Response: ATSDR presented doses for all the contaminants that are known or suspected carcinogens. This includes arsenic, BEHP, and benzo(a)pyrene, dieldrin, and PCBs. Other compounds were not included because they are not known or believed to cause cancer.