Lower Duwamish Waterway

Cement Kiln Dust: Summary of Existing Information

Prepared for

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List of Acronyms

2LAET	second lowest apparent effects threshold
Al_2O_3	aluminum oxide
bgs	below ground surface
Boeing	The Boeing Company
$CaCO_3$	calcium carbonate
CaO	calcium oxide (also known as lime)
CEC	cation exchange capacity
CKD	cement kiln dust
cm	centimeter
COC	chemical of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSCSL	Confirmed and Suspected Contaminated Sites List
CSGP	Construction Stormwater General Permit
CSL	Cleanup Screening Level
CSO	combined sewer overflow
EAA	Early Action Area
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbons
ESA	Environmental Site Assessment
Fe_2O_3	iron oxide
FS	feasibility study
GW	groundwater
HWG	hazardous waste generator
HWMA	Hazardous Waste Management Activity
HWP	Hazardous Waste Planner
HWTF	Hazardous Waste Transfer Facility
ISGP	Industrial Stormwater General Permit
ISGP-CNE	Industrial Stormwater General Permit, Certificate of No Exposure
ISIS	Integrated Site Information System
K_2SO_4	arcanite
KCl	sylvite
KOH	potassium hydroxide
LAET	lowest apparent effects threshold
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
LSC	Local Source Control
LUST	leaking underground storage tank
MCL	Maximum Contaminant Level
ug/L	micrograms per liter
mg/kg	milligrams per kilogram
MOU	Memorandum of Understanding
MTCA	Model Toxics Control Act
NFA	No Further Action

List of Acronyms (continued)

ng/kg	nanograms per kilogram
NRCES	NRC Environmental Services
PCB	polychlorinated biphenyl
pg/g	pictograms per gram
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RM	river mile
RSVP	Revised Site Visit Program
SAIC	Science Applications International Corporation
SCWG	Source Control Work Group
SD	storm drain
SEA	Ecology Shorelands & Environmental Assistance Program
Seattle DPD	Seattle Department of Planning and Development
SEPA	State Environmental Policy Act
SiO_2	silicon dioxide
SMS	Sediment Management Standards
SO_4	sulfate
SPILLS	Ecology Spills Program
SPPD	South Park Property Development LLC
sq ft	square foot
SQS	Sediment Quality Standard
SVOC	semivolatile organic compound
TEQ	toxic equivalency
TIER2	Toxic Air Pollutants Tier 2 reporter
TOXICS	Ecology Toxics Cleanup Program
TRI	Toxics Release Inventory
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	underground storage tank
VBLS	Vanillin Black Liquor Solids
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbons
WAC	Washington Administrative Code
WARM	Washington Ranking Method
WATQUAL	Ecology Water Quality Program
WQS	Water Quality Standard

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1.0 Introduction

The Lower Duwamish Waterway (LDW) Superfund Site consists of 5 miles of the Duwamish Waterway as measured from the southern tip of Harbor Island, to just south of the Norfolk Combined Sewer Overflow/Storm Drain (CSO/SD) (Figure 1). The LDW flows into Elliott Bay in Seattle, Washington. The LDW was added to the U.S. Environmental Protection Agency (EPA or USEPA) National Priorities List in September 2001 due to the presence of chemical contaminants in sediment. The key parties involved at the LDW site are EPA, the Washington State Department of Ecology (Ecology), and the Lower Duwamish Waterway Group (LDWG), which is composed of the City of Seattle, King County, the Port of Seattle, and The Boeing Company (Boeing). In December 2000, EPA and Ecology signed an agreement with the LDWG to conduct a Remedial Investigation/Feasibility Study (RI/FS) for the LDW site. The Remedial Investigation (RI) was completed in July 2010 (Windward 2010). The Feasibility Study (FS) was completed in October 2012 (AECOM 2012).

Polychlorinated biphenyls (PCBs), arsenic, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and dioxins/furans have been identified as the chemicals of concern (COCs) for human health in LDW sediments. In addition, 41 COCs have been found to pose risks to bottom-dwelling organisms in the LDW (USEPA 2013). EPA has been leading the effort to determine the most effective cleanup strategies for the LDW through the RI/FS process. EPA selected a preferred cleanup alternative and published a Proposed Plan in 2013 (USEPA 2013), and published a final cleanup plan in a Record of Decision dated November 2014 (USEPA 2014). Ecology is leading the effort to investigate adjacent and upland sources of contamination and to develop plans to reduce contaminant migration to waterway sediments.[1]

Ecology has reviewed results from seep and surface water sampling conducted at multiple facilities in the LDW and observed elevated levels of sediment contaminants of concern in some locations. Cement kiln dust (CKD) has been used as fill material at facilities that ultimately discharge to the LDW. The objectives of this report are to delineate the lateral and vertical extent of CKD fill material in the LDW basin, if possible, and to assess whether this material may represent a source of sediment contamination to the LDW.

Section 2.0 provides an overview of the origins and properties of CKD, and how this may relate to LDW sediment contamination. Section 3.0 summarizes the available historical information about the lateral and vertical extent of CKD in the LDW basin. Through review of historical reports, correspondence, and publically-available digitized boring logs, Leidos has identified potential or documented use of CKD as a fill material at 61 parcels (36 sites) in the LDW drainage basin. Section 4.0 lists documents reviewed during preparation of this report.

[1] EPA and Ecology signed an interagency Memorandum of Understanding (MOU) in April 2002 and updated the MOU in April 2004. The MOU divides responsibilities for the site. In November 2014, EPA and Ecology signed a Memorandum of Understanding, which expanded and clarified the MOU to include all offices from EPA Region 10 and Ecology. EPA is the lead agency for the sediment RI/FS, while Ecology is the lead agency for source control issues (EPA and Ecology 2002, 2004, 2014).

2.0 What is Cement Kiln Dust?

CKD is the primary by-product of cement manufacturing. In brief, CKD is a very fine material emitted from the calcining process, which is the heating process used to make cement from various raw materials including limestone and other calcareous materials. Calcining of crushed raw materials is generally conducted at 800° to 900°C. The cement dust produced is a very fine dust, or flue “ash”, which is captured in dust collection systems attached to the rotary calcining kilns. Baghouse filters and electrostatic precipitators are generally used to capture and collect the fine dust from the hot gases of the calcining operation (Riley Group 2005). The cement dust is usually very alkaline (pH 10.5 to 12), and often contains metals that represent the content of the clinker source materials used in the cement manufacture.

Generation of CKD began in the early 1960s, when control of stack emissions at cement plants was implemented (USEPA 1993). All cement kilns generate CKD; the quantities and characteristics of the CKD depend on operational factors and the characteristics of the input material.

2.1 Cement Manufacturing

Cements are used to chemically bind different materials together. Cement is produced by burning mixtures of limestone and other minerals or additives at high temperature in a rotary kiln, followed by cooling, finish mixing, and grinding. The most commonly produced cement type is Portland cement, comprising about 90 percent of all hydraulic cements produced; other types of cement, such as masonry cement, are also produced on a limited basis (USEPA 1993). Portland cement is a hydraulic cement, that is, it sets and hardens by chemical interaction with water.

Cement is made by heating (sintering[2]) a mixture of materials containing lime, silica, alumina, and iron oxide. Typically, these materials include limestone, sand, clay, iron ore, and/or other minerals and mineral processing residues. Heating the raw materials to a high temperature forms a material called "clinker," which is granular and highly variable in size. Clinker is then cooled, and ground with a smaller amount (approximately 3 to 7 percent) of gypsum, or sometimes other materials, to make cement. The CKD generated during calcining[3] is a talcum-like dust, or flue “ash,” captured in dust collection systems attached to the rotary calcining kilns. Baghouse filters, electrostatic precipitators, cyclones, and granular bed filters are air pollution control devices that are generally used in addition to primary settling devices to capture and collect the CKD (USEPA 1993, USGS 2005).

Portland cement is mixed with sand, gravel, water, and other materials to form concrete. Concrete is an artificial rock-like material and is the most widely used building material in the world. As of 1993, about 73 percent of all U.S. cement was used by the ready-mix concrete industry, while 12 percent was used by concrete product producers and 5 percent was used by highway contractors (USEPA 1993).

[2] Sinter – to cause ores or powdery metals to become a coherent mass by heating without melting (sometimes heat or pressure or both).
[3] Calcine – to heat a substance to high temperature but below the melting or fusing point, causing loss of moisture, reduction or oxidation, and the decomposition of carbonates and other compounds.

According to Adaska and Taubert (2008), all or a major portion of CKD is recycled back into the cement kiln as raw feed at many facilities. However, through recycling of CKD into the kiln, chlorine and alkalis tend to accumulate in the gross CKD that is generated (USEPA 1993). These constituents can continue to build up in the kiln system as alkalis (e.g., lithium, potassium, sodium) and alkali salts, which may impair the cement production process. CKD can be returned to the kiln after first treating it for removal of undesirable contaminants (e.g., through leaching, volatilization, or recovery scrubbing). The ability of a cement plant to reuse its CKD may be at least partially dependent on the alkalinity levels of the raw feed material.

2.2 Characteristics of Cement Kiln Dust

CKD is a mixture of sulfates, chlorides, carbonates, and oxides of sodium, potassium, and calcium; quartz, limestone, fly ash, dolomite, feldspars, and iron oxides, glasses of silicon dioxide, aluminum oxide, and cement compounds (Ash Grove 2007). When the fuel source includes waste-derived fuels, CKD may contain lead and traces of other heavy metals, including arsenic, chromium, cadmium, antimony, barium, beryllium, silver, mercury, thallium, selenium, and nickel. Calcium oxide (CaO) may be present in freshly-generated CKD; when mixed with water, calcium oxide will hydrate to form calcium hydroxide (Ash Grove 2007).

CKD consists primarily of calcium carbonate ($CaCO_3$) and silicon dioxide (SiO_2). It is similar to the cement kiln raw feed, but the amount of alkalis, chloride and sulfate is usually considerably higher in the dust. The major oxide requirement of cement clinker is CaO. Therefore limestone or other suitable material that has a high CaO availability (e.g., marl or marble) is used. Usually, most of the materials used in the production of cement are quarried on or very near to the cement plant site. The Lafarge Cement plant on West Marginal Way SW was an exception as it is not located on a quarry and raw materials were brought in by barge (Lafarge 2008).

Cement plants analyze their base material and add the other required oxides (silicon, aluminum, and iron) from other sources. SiO_2 can be supplied by sand, sandstone, ferrous slags, fly ash, or other ash. Aluminum oxide (Al_2O_3) can be supplied by clay, shale, bauxite, or other materials. Iron oxide (Fe_2O_3) can be supplied by iron ore, millscale, and other materials. Sometimes the secondary oxides are provided in the fuels used to heat the kilns. For example, the steel belts in waste tires supply iron oxide, and the ash from burning coal supplies silicates. Preparation of the raw mix for the kiln is a process of constant adjustment based on frequent chemical analysis of the raw materials, the raw mix itself, and the clinker (USEPA 1993; U.S. Geological Survey [USGS] 2005).

Additional detailed information regarding the characteristics of CKD is provided in Appendix A.

2.3 Management of Cement Kiln Dust

2.3.1 Solid Waste Properties

EPA's analysis of CKD chemistry shows that CKD contains toxic constituents, including metals and organic by-products. Constituents identified in dust solids and leachate include arsenic, thallium, antimony, lead, chromium, total-2,3,7,8-substituted dioxins, and total hexachloro-dibenzodioxin. In addition, water-CKD mixtures are often characterized as Resource

Conservation and Recovery Act (RCRA) corrosive waste (see 40 CFR 261.22), with pH levels commonly in excess of 12.5 standard units (USEPA 1993).

Trace Elements

CKD contains metals that represent the content of the clinker source materials used in the calcining operation. Guo and Eckert (1996) state that metals of intermediate volatility such as cadmium and lead concentrate more strongly in CKD than in the clinker.

The U.S. Bureau of Mines analyzed 113 CKD samples collected from 102 cement plants in the early 1980s. The plants sampled represented about 70 percent of those in operation in the U.S. at that time. Trace element concentrations in the CKD samples are summarized below.

Trace Element Concentrations in U.S. Cement Kiln Dust (mg/kg)

Element	Range	Mean	Median
Arsenic	1.3 - 518	24	9.3
Cadmium	<1.5 – 352	21	7.3
Chromium	11 – 172	41	34
Copper	7 -0 206	30	24
Lead	17 – 1,750	253	148
Magnesium	1,980 – 19,100	7,820	6,820
Manganese	63 – 2,410	383	280
Mercury*	<0.13 – 1.0	<0.13	<0.13
Nickel	<12 - 91	22	29
Zinc	32 – 8,660	462	167

Source: Haynes and Kramer 1982
*Mercury was based on only 16 samples.

EPA conducted additional trace element analysis of U.S. cement plant CKD samples for the 1993 Report to Congress (USEPA 1993). In the first part of this study they analyzed fresh CKD as it came from the air pollution control devices at the kilns (termed “as generated”). In the second part of the study they analyzed CKD samples taken from storage or disposal piles (termed “as managed”). The results of those analyses are summarized below.

Trace Metal Concentrations in As-Generated CKD (mg/kg)

Analyte	Number of Samples	Number of Non-Detected Values	Mean	Minimum	Maximum	Median
Antimony	17	1	7.7	1.77	27.2	6.2
Arsenic	17	0	6.9	2.1	20.3	4.9
Barium	17	0	172.1	11.0	779.0	103.0
Beryllium	17	1	0.71	0.158	1.6	0.59
Cadmium	17	0	13.2	0.89	80.7	4.6
Chromium	17	0	26.6	11.5	81.7	18.1
Lead	17	0	388.4	5.1	1,490.0	287.0
Mercury	17	3	1.0	0.005	14.4	0.11

Analyte	Number of Samples	Number of Non-Detected Values	Mean	Minimum	Maximum	Median
Nickel	17	0	19.0	6.9	39.0	15.9
Selenium	17	0	17.5	2.5	109.0	11.3
Silver	17	0	6.9	1.1	22.6	3.7
Thallium	17	0	17.1	0.99	108.0	3.5
Vanadium	17	0	41.6	6.6	204.0	25.9

Source: USEPA 1993

Trace Metal Concentrations in As-Managed CKD (mg/kg)

Analyte	Number of Samples	Number of Non-Detected Values	Mean	Minimum	Maximum	Median
Antimony	14	2	6.5	1.581	10.9	6.6
Arsenic	14	0	7.7	2.1	19.8	6.4
Barium	14	0	144.5	39.8	360.0	136.5
Beryllium	14	2	0.68	0.175	1.5	0.52
Cadmium	14	0	11.8	0.62	27.4	10.1
Chromium	14	0	35.0	9.6	110.0	21.4
Lead	14	0	359.1	40.6	863.0	380.5
Mercury	14	3	0.121	0.009	0.830	0.075
Nickel	14	0	19.4	6.3	54.7	14.9
Selenium	14	0	10.7	1.4	43.9	7.7
Silver	14	2	4.2	0.348	17.2	1.95
Thallium	14	0	4.1	1.1	14.6	2.3
Vanadium	14	0	33.3	7.6	120.0	19.6

Source: USEPA 1993

Ecology, in cooperation with the USGS, summarized 90th percentile background metals concentrations in soils in Washington State and various regions around the state including the Puget Sound region (Ecology 1994). Bergsten (2006) summarized metals concentrations in U.S. soils.

Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Puget Sound 90th percentile[a]	State-Wide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Aluminum	32,600	37,200	71,000	10,000 – 300,000
Arsenic	7	7	5	1 – 5
Beryllium	0.6	2	Not provided	Not provided
Cadmium	1	1	0.06	0.01 – 0.07
Chromium	48	42	100	1 – 1,000
Copper	36	36	30	2 – 100

Analyte	Puget Sound 90th percentile[a]	State-Wide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Iron	58,700	42,100	38,000	7,000 – 550,000
Lead	24	17	10	2 – 200
Manganese	1,200	1,100	600	20 – 3,000
Mercury	0.07	0.07	0.03	0.01 – 0.3
Nickel	48	38	40	5 – 500
Selenium	Not analyzed	Not analyzed	0.3	0.1 – 2
Silver	Not analyzed	Not analyzed	0.05	0.01 – 5
Zinc	85	86	50	10 – 300

Sources: a: Modified from Ecology 1994, b: summary table in Bergsten 2006.

By comparison, the Seattle area CKD fill (as summarized by Riley Group [2005]) contained elevated arsenic, cadmium, and lead. Concentrations of chromium were below the 90^{th} percentile soil background values for the Puget Sound region and the U.S. average values.

Organic Compounds

In its 1993 Report to Congress, EPA stated that it was unlikely that volatile organic compounds (VOCs) would be present in CKD due to the high temperatures at which it is generated. The agency analyzed CKD samples from 11 facilities for VOCs and semivolatile organic compounds (SVOCs). Some VOCs were below detection limits; other VOCs detected were believed to be contaminants introduced during sampling or analysis (e.g., methylene chloride). No SVOCs were detected and USEPA stated that it would not evaluate them further.

For the 1993 Report to Congress, USEPA also analyzed dioxins and furans in as-generated and as-managed CKD samples from 11 facilities. A number of the dioxin and furan target compounds were detected in CKD generated by both hazardous and nonhazardous waste fuel burning facilities, but EPA indicated they were present at very low concentrations. As was the case in the analyses of the as-generated CKD, the majority of the dioxins and dibenzofurans in as-managed CKD samples were detected at concentrations below 100 parts per trillion (ppt), while several samples had homolog concentrations approaching 1 parts per billion (ppb).

2.3.2 Influence of Fuel Type on CKD Contaminant Concentrations

A study by Guo and Eckert (1996) found that measured concentrations of arsenic, beryllium, cadmium, chromium, and lead in waste CKD were higher when a kiln was co-fired with hazardous waste fuels. However, EPA's proposed rule "Standards for the Management of Cement Kiln Dust" stated that based on analysis of available data, "metals levels in CKD are not substantially different, whether generated by kilns that burn hazardous waste or kilns that do not burn hazardous waste." A study of inter-kiln variability and influence of fuel type on stack emissions in Portugal (Zemba et al., 2011) found that use of coal as a fuel rather than coke leads to higher levels of detection for most pollutants (e.g., metals/dioxins/furans) as well as higher concentrations in many cases.

The Seattle Lafarge cement plant tested the effects on air emissions of replacing a portion of its coal fuel with whole tires (RTP Environmental 2009). Their analysis found that emissions of beryllium, cadmium, cobalt, copper, and zinc decreased. No metals emissions increased.

Karstensen (2008) conducted a review of the research on the formation, release, and control of dioxins in cement kilns to evaluate the historical perception that co-processing of hazardous wastes in cement kilns caused increased emissions of dioxins and furans. Early investigations from the 1980s and 1990s found that kilns co-processing hazardous waste had higher emissions compared to those that did not burn hazardous waste, but the testing was often done under worst-case scenario conditions known to favor formation of these compounds. Karstensen's analysis found that proper and responsible use of waste, including organic hazardous waste, to replace parts of the fossil fuel does not seem to increase formation of dioxins or furans. Karstensen concluded that dioxins and furans could be detected in all types of solids samples analyzed: raw meal, pellets and slurry; alternative raw materials such as sand, chalk and different ashes; CKD; clinker; and cement. The concentrations, however, were generally low and similar to soil and sediment.

Karstensen et al. (2010) tested the effects of burning high concentration PCB waste oil in a dry-process cement kiln. Solid process samples of raw meal, coal, clinker, electrostatic precipitator dust, bag house dust and bypass dust were collected every second hour. Chemical analysis and quality testing of the cement and concrete produced during the test showed results within normal ranges; no influence of the PCB-feeding could be identified.

Ideal Cement Company (currently Lafarge) reportedly used slag material from ASARCO smelter operations in its cement manufacturing process. According to records reviewed by Geo Group Northwest, the slag contained arsenic, lead and cadmium (Geo Group Northwest 2003a).

2.3.3 Corrosivity

According to Sreekrishnavilasam and Santagata (2006), many factors determine whether an environment is corrosive, including resistivity, levels of dissolved salts, moisture content, pH, presence of bacteria, and amount of oxygen. These researchers note that no single parameter can be used to accurately forecast the corrosiveness of a particular media, but that a number of parameters can be used as indicators of corrosiveness, and as the basis for determining whether special corrosion mitigation measures, such as cathodic protection, should be taken for buried steel pipes in contact with the media.

Sreekrishnavilasam and Santagata (2006) evaluated the potential corrosivity of fresh and landfilled CKD by measuring four electrochemical characteristics: pH, electrical resistivity (both before and after soaking the samples), soluble sulfate content, and soluble chloride content. Sreekrishnavilasam and Santagata noted that fly ashes and sewage ashes have been reported to be corrosive by other researchers. They based their determination of CKD corrosive potential on previous research on bottom ash. The proposed thresholds for classifying ash as non-corrosive were:

- resistivity > 1,500 Ohm-centimeter (cm)
- pH <5.5
- soluble chloride content < 200 parts per million (ppm)

- soluble sulfate < 1,000 ppm.

Sreekrishnavilasam and Santagata's analyses of these parameters for fresh and landfilled CKD are summarized below.

Corrosivity Parameters of Fresh and Landfilled CKD

CKD Type	Resistivity (Ohm-cm)		pH	Chloride (ppm)	Sulfate (ppm)
	As -compacted	Soaked			
Fresh	255	93	11.55	1406	4908
Landfilled	615	80	12	1840	7383

Source: adapted from Sreekrishnavilasam and Santagata 2006; Note the pH for landfilled CKD in the source table was 1.97, which was believed to be an error and is therefore changed in this table to 12 per the text discussion of the original report.

The measured value of pH (~11.5 to 12) for both CKD types was outside the range (5 to 10) considered problematic for corrosion. However, the extremely low values of resistivity measured indicated that both CKD types are very corrosive. They concluded that "despite the relatively high pH of CKD, the high content of soluble chlorides and sulfates and the high moisture retention capacity of CKD appear likely to produce an environment that will be corrosive to metal structures." However, they suggested that small-scale prototype tests would be required to confirm their assessment. It should be noted that the natural quality of shallow groundwater in the LDW is already characterized by high corrosivity (Hart Crowser 1997a).

2.3.4 Potential for Leaching

Migration of potentially hazardous constituents, including metals, has occurred from CKD waste sites. EPA has documented seven cases of damage to surface water and groundwater, and 21 cases of documented damage to air from CKD waste. By damage, the EPA means that toxic constituents have contaminated groundwater and/or surface water, and/or air above Maximum Contaminant Levels (MCLs) or some other standard. COCs being released to ground and surface waters include arsenic, chromium, and lead, among others. When COC exceedances in groundwater and surface water do occur, the magnitude of the exceedance is generally small, although in certain instances it was as high as two orders of magnitude above the MCLs for drinking water (USEPA 1993).

Hart Crowser (1997a) described the natural groundwater quality in the LDW corridor as follows:

> "Shallow natural groundwater quality in the Duwamish Corridor is characterized by high salinity, conductivity, and corrosivity, and high concentrations of selected metals such as iron and manganese. Other natural water quality considerations include the highly reducing conditions that exist because of the presence of abundant naturally occurring organics and fine-grained sands, and the effect that saline water has on the concentrations of various metals in the groundwater system. Reducing conditions coupled by a lower pH caused by the presence of organics or fine-grained sediment favor preferential dissolution of metals such as iron, manganese, and arsenic… The presence of dissolved natural organics (including humic and fulvic acids) may further enhance the mobility of various metals by forming more soluble organo-metallic complexes."

As noted, however, the alkalinity of CKD causes pH to increase, reducing the mobility of most metals. Also, the chloride in tidally-affected areas of the LDW could influence the leachability of some contaminants, such as cadmium. For example, Van der Sloot et al. (1996) found that wastes with higher chloride levels which had formed cadmium-chloro complexes caused the leachability curve of cadmium to be shifted toward higher pH (i.e., the presence of chloride reduced the solubility of cadmium at lower pH values). CKD can contain chloride concentrations on the order of approximately 0.1 to over 6 percent by weight. Van der Sloot et al. (1996) found that complexation of zinc with chloride was less pronounced than for cadmium.

EPA's 1998 Technical Background Document on Ground Water Controls at CKD Landfills (USEPA 1998) describes factors which are noted to have contributed to the release of CKD constituents into the sub-surface environment. These include:

- Presence of a shallow groundwater flow system with conduit flow characteristics (e.g., karst aquifer or fractured bedrock aquifer);
- CKD disposal below the natural water table or groundwater infiltration into the waste unit;
- Surface runoff or erosion transporting CKD constituents to surface water bodies and/or wetlands, which can serve as a source of groundwater recharge;
- Lack of an impermeable cover to control percolation of rainwater and/or surface water into the waste unit;
- Lack of a bottom liner and/or leachate collection system to control leakage from the waste unit.

EPA's 1993 evaluation of CKD facilities in the Report to Congress (USEPA 1993) stated that the factors that lead to lower potential for groundwater contamination from CKD include: deeper water table, more impermeable underlying soils (e.g., clay, shale), and low recharge rates. EPA stated that the potential for groundwater contamination at a one facility appeared high because the water table was shallow (1 to 3 feet), the underlying soils were a permeable sand, and the net recharge was considered high (15 inches/year). The potential for groundwater contamination at another facility with limestone/siltstone beneath the CKD and a smaller net recharge (6 inches/year) was considered to be lower.

However, as described above, the CKD materials themselves have very low permeabilities (Johnson 1971; Todres et al., 1992; Sreekrishnavilasam and Santagata 2006), and can act as impermeable barriers to groundwater flow and infiltration. For example, Pinnacle GeoScience's (2007) investigation of the Terminal 106W CKD fill site on the LDW found that the CKD fill was not fully saturated even when it was below the static water level. They attributed this to the cementaceous structure of the CKD fill. Others have noted that aging of wastes by weathering changes the mineralogy and increases the abundance of sorbing mineral phases (Van der Sloot et al., 1996), which would lead to reduced mobility of metals.

Sreekrishnavilasam and Santagata (2006) analyzed metals in landfilled CKD and found that average metal concentrations were relatively greater in the deepest sample. The deep sample was taken at a depth of almost 20 meters. They hypothesized that leaching from upper layers over the years (the landfill was 12 years old) may have been responsible for this observed difference. However, these researchers also state that, "given the high pH of the CKD (which reduces the mobility of the ions) and the low values of the hydraulic conductivity measured on the landfilled CKD (1 to 1.8 x 10^{-7} meters/second) (which reduces the probability that extensive ground water percolation occurred), it appears likely that leaching was not too significant."

Bergsten (2006) summarized the importance of the organic matter content of the soil in the immobilization of heavy metals. Organic matter generally has a very high cation exchange capacity (CEC) and a high surface area. This large surface area allows for more adsorption sites to retain heavy metals from solution. Organic material also is often negatively charged and pH dependent. Thus, the more organic material in a soil, generally more heavy metal adsorption and immobilization will take place. As described by Hart Crowser (1997a), naturally occurring groundwater in the LDW corridor is characterized by high organic content. The organic matter can attract and adsorb heavy metal ions, leading to decreased mobility.

2.3.5 Leachate Properties

The species of metals associated with CKD are different from the elemental forms of the metals. In CKD, the metals are bound up in calcium carbonate and silicates (Riley Group 2005). As summarized by Duchesne and Reardon (1998), "CKD is composed of an assemblage of oxidized, anhydrous phases, which include oxides, aluminosilicates sulfates and chlorides. Many of these phases, such as lime (CaO), arcanite (K_2SO_4) and sylvite (KCl), are unstable or highly soluble at earth surface conditions. When CKD contacts water, these phases will either dissolve completely or more stable and less soluble secondary phases will precipitate. Thus the concentration of some constituent elements in CKD leachates will be controlled by the solubility of the secondary precipitates, and the concentration of others will be controlled by their availability to the leachate solutions and by their diffusive flux into solution from the leaching of the primary phases over time."

In CKD leaching tests with a 20:1 ratio of water to solid, Duchesne and Reardon (1998) found that over 20 percent (by mass) of CKD was solubilized, largely as potassium hydroxide (KOH) and K_2SO_4. Molybdenum and chromium also leached at high concentrations[4]. Based on their experimental results, Duchesne and Reardon postulated that the following elements are present in CKD as readily soluble mineral phases or salts, or potentially as volatile condensates on the surfaces of less soluble particles: sodium, chlorine, potassium, sulfate, molybdenum, chromium, and selenium.

Van der Sloot (1990) notes that concern about leaching from alkaline waste products (such as CKD) should be directed towards anionic species (e.g., molybdenum, arsenic, vanadium, selenium, and tin). This is because, in the pH range 9 to 11, the retardation of anions is minimal, whereas the retardation of metals reaches a maximum in this pH interval. Eckert and Guo (1998) state that high pH solutions where CKD is disposed could enhance the dissolution of lead. The lead could then precipitate as the pH drops to the range of ~9 to 11.5 when CKD-affected waters mix with other waters[5]. Because the solubility of most metals is low at higher pH (> ~ 7), most heavy metals would be precipitated in the highly alkaline environment of the cement pore solution.

[4] Note that molybdenum concentrations in this CKD, which originated from a Canadian plant, were significantly greater (202 mg/kg) than concentrations in the U.S. CKD (<50 mg/kg) as reported by Haynes and Kramer (1982).
[5] Note that precipitates form as hydroxides.

In nature, the acid-neutralizing capacity of cementitious wastes will eventually be overcome, although this may take a long time; at this point the heavy metals will begin to leach as the pH drops (Bishop et al., 1986). HydroGeologic's modeling of metals leaching under highly alkaline conditions (from CKD fills) (HydroGeologic 1998) showed one or more metal species reaching receptor wells downgradient at four of the five landfills modeled, but the time frame was on the order of 100 to 160 years. Important points noted by the modelers include:

- Inorganic constituents (e.g., calcium, sodium, sulfate [SO_4]) alter metal complexation reactions; for example, elevated calcium concentrations tend to reduce the adsorption of other cations.
- Adsorption of metal anions tends to decrease with increasing pH, and adsorption of metal cations tends to increase with increasing pH.
- Modeling indicates a general decrease in sorption with increasing pH; however, for each metal, sorption reaches a maximum at a particular pH level, but then drops as pH continues to increase.
- The increased sodium and potassium concentrations from CKD leachate impact adsorption via their effect on the ionic strength, and increased SO_4 may complex barium, lead, and cadmium.

At landfills where metals did reach receptor wells, the highest well concentrations were observed at pH 13 at all observation points with all of the metals except barium. This was due to the decreased sorption seen at the highest pH level. Note that pH levels of CKD fill in the LDW have been measured at around 11 to 12, but none as high as 13 based on literature reviewed to date.

Poon (1989) reviewed evaluation procedures for stabilization/solidification processes used with hazardous wastes. He found that extraction studies of some cement-stabilized heavy metal wastes showed that the amounts present in solution were often lower than the calculated values based on the theoretical solubility products. A variety of mechanisms had been postulated to account for this, including absorption by cement hydrates, substitution, and solid solution in the hydrate structure and formation of various insoluble compounds. He noted that these studies agreed on some conclusions: below pH 7, heavy metals start to solubilize and the solubility is a function of the hydroxides, carbonates, silicates, and other complex forms. Therefore, there is a potential breakthrough point at which a large part of the heavy metals would solubilize if the leaching water turned acidic.

In leaching experiments with cementitious wastes, Halim et al. (2003) also found enhanced leaching of lead at high pH. In cements, lead ions were found bound in a calcium silicate hydrate matrix. Cadmium concentrations, however, decreased with increasing pH due to hydroxide precipitation (Halim et al., 2003). Bishop et al. (1986) note that possible binding of heavy metals, especially chromium and lead, in silicate compounds in cement-stabilized wastes may limit their solubilities because silicates have limited solubility below pH of 9. Also, the solubility of calcium silicates is low up to a pH of about 11. Once the pH rises, the dissolving calcium silicates can release the lead ions.

Mix and Murphy (1984) described the potential leaching of lead from CKD deposited in a quarry and potential impact to surface waters in runoff. The lead deposited on the baghouse dust will be dissolved and leave the quarry in solution because of the high pH in the quarry, but will precipitate as the pH of the runoff falls (presumably due to the addition of acid material rather than to dilution). If it is still present as entrained solids where the runoff enters surface waters, the lead is likely to resolubilize as the pH falls and the carbonate level is simultaneously reduced. If the lead comes in contact with humic acid (from decayed plant and animal matter), it will be complexed and taken out of solution (Mix and Murphy 1984).

High pH in surface waters due to CKD disposal has been documented at U.S. cement plants. For example, according to EPA's 1993 review of CKD sites, the pH of water in a quarry filled with CKD (at the Holnam plant in Mason City, Iowa) reached 12.8 when the natural buffering system that had been sustaining the quarry water at a near neutral pH collapsed (USEPA 1993).

Halim et al. (2004) note that in cement wastes, cadmium precipitates as single compounds in the form of cadmium oxide, hydroxide or carbonate, and forms discrete particles which precipitate on the surface of calcium silicate hydrate or within the cement pores. Lead, however, was dispersed throughout the calcium silicate hydrate matrix. Their research suggests that arsenic may be bound into cement through adsorption or precipitation with silicates or calcium. Chromium was present as a very soluble material in cement, as evidenced by its leachability, but the exact way in which it interacts with cement is unclear. Note that chromium will leach at all pH values.

According to Moon et al. (2008), the leaching of arsenic from soils may be governed by adsorption processes while CKD can immobilize arsenic by precipitation-controlled mechanisms. However, the 2005 Lehigh Cement draft Feasibility Study report (GeoSyntec 2005) found that high pH groundwater associated with the CKD pile at a site in Metaline Falls, Washington, caused naturally occurring arsenic in site soils to go into solution in the groundwater. Downgradient groundwater was characterized by high pH and decreased redox potential. Arsenic concentrations were also elevated even though the CKD at this site did not have elevated arsenic (GeoSyntec 2005). Groundwater with elevated pH and arsenic at that site seeps and flows overland.

Hart Crowser (1997a) noted carbonate-like precipitates in the top 4 to 6 inches of test pits dug at Puget Park. The precipitates were in an organic sandy-silt layer. When analyzed, this precipitate material was similar to CKD but the total metals content was in the low end of the range for CKD. Hart Crowser stated that the precipitates were likely formed by the dissolution and precipitation of carbonate materials associated with the CKD; perched water traveled through the CKD and discharged. Exposure of this discharge to the atmosphere caused much of the dissolved carbonates and iron-containing materials to precipitate.

2.3.6 Beneficial Uses of CKD

Reuse or recycle options for by-products generated as a result of the industrial process are more favorable than incurring the cost of landfilling by-product materials. In the State of Washington, industrial by-products are regulated under Chapter 173-303 WAC (dangerous wastes) which originally included CKD. The following disposal, recycling, or reuse options have been documented for CKD (Ecology 1995):

- Sub base for road construction/use as a road base material;
- Soil stabilization;

- Use as a filler, binder or manufacturing ingredient such as asphalt roofing and paving materials, specialty block manufacturing, glassification, or other manufacturing processes;
- Soil and sludge drying;
- Waste solidification, stabilization or drying of hazardous and solid wastes including contaminated soils, oil sludge, or sewage sludge;
- Construction landfill cover;
- Subtitle D landfill disposal (such as the Dale Strip Pit on Ravensdale [Holnam/aka LaFarge]);
- Sanitary landfill cover;
- Landfill daily cover for Subtitle D solid waste disposal facilities;
- Acidic waste neutralization;
- Land reclamation such as engineered backfill (including backfill for mining pipelines, foundation stabilization, or industrial or residential backfill), settling pond stabilization, or other applications where used as an additive or substitute for Portland cement;
- Lime-alum coagulation in wastewater treatment to neutralize industrial acidic wastes;
- Mineral filler used in manufacture of glass and construction materials;
- Wet scrubber lime solutions and slurries or dry lime scrubbers for coal power plants and waste incinerators; and
- Agricultural use as a soil conditional and fertilizer.

2.4 Regulatory Controls

2.4.1 Applicable Federal Regulations

With passage of the Clean Air Act in 1970, most cement manufacturing plants implemented dust control to collect the fine dust emissions at their urban facilities. This includes the cement manufacturing facilities in the LDW basin. However, based on aerial photographs of the area prior to 1970, many areas in the LDW basin were already receiving CKD as fill by the time the Clean Air Act went into effect (Riley Group 2005).

In 1980, the federal RCRA was amended to exclude several types of special wastes including CKD from regulation as a hazardous waste under RCRA Subtitle C, pending completion of a Report to Congress and a subsequent regulatory determination of whether regulation under Subtitle C is warranted. The Report to Congress was published in December 1993 (USEPA 1993).

Since that time, CKD has remained exempt from federal regulation as a hazardous waste under RCRA Subtitle C, with the exception of kilns that burn hazardous waste as fuel and may be ineligible for the Subtitle C Bevill Exclusion under certain conditions (40 CFR 266.112). According to EPA's website, they are in the process of developing standards for the management of CKD and have published a set of proposed Subtitle D (non-hazardous solid waste) regulations[6].

Under both RCRA and CERCLA, the federal government can respond to situations where the release of CKD or its constituents presents an imminent and substantial danger to human health and the environment. In addition, CKD generated in kilns that burn RCRA hazardous waste is subject to the RCRA Boiler and Industrial Furnace rule (40 CFR 266.112).

2.4.2 State and Local Regulations

CKD waste may also be regulated under state and local laws, but the requirements vary significantly from state to state. For example, California regulates CKD as a non-RCRA hazardous waste, but has suspended enforcement of the management requirements for CKD that fails the State's hazardous waste corrosivity test, pending the results of further study of CKD. Pennsylvania regulates CKD as a residual waste, requiring facilities to comply with site-specific disposal requirements and waste reduction strategies, which are both periodically updated by the State. In contrast, Michigan and Texas both consider CKD an industrial non-hazardous waste. Michigan requires permits, groundwater monitoring, and regular reports of groundwater sampling results, whereas Texas issues non-enforceable guidance (USEPA 1993). In Washington, cleanup of CKD sites is addressed under the Model Toxics Control Act (MTCA), which does not include an exemption for CKD similar to that in RCRA.

[6] http://www.epa.gov/wastes/nonhaz/industrial/special/ckd/

3.0 Cement Kiln Dust Sites in the LDW Basin

Use of CKD fill materials is documented or suspected at 36 sites (62 parcels), comprising approximately 490 acres of land. CKD fill material is not suspected to be present on all 490 acres. The lateral and vertical extent of CKD fill materials could not be determined for most parcels from the information available for review. Property information is listed in Table 1. Ecology Facility/Site Identification Numbers and interactions associated with each property are also listed in Table 1.

Section 3.1 describes the sources of CKD fill material in the LDW basin. Section 3.2 lists available information about sites where sufficient information exists to indicate the use of CKD fill. These sites are shaded in pink on Figure 1. Section 3.3 lists sites where available information indicates that CKD may be present, but additional confirmation is needed. These sites, which are shaded in yellow on Figure 1, were identified through literature reviews and by queries of the GeoMapNW subsurface database[7] for various search terms. The GeoMapNW database queries are discussed in more detail in Appendix B. Section 3.4 describes additional sites near but outside of the LDW basin.

Figure 1 provides an overview of known and suspected CKD sites in the LDW basin. Figures 2, 5, 6, 9, 12, 16, 17, and 19 through 26 provide additional detail for the parcels discussed in Section 3.2 and 3.3 below. These maps also show boring locations identified in the GeoMapNW subsurface database based on a search for cement kiln dust, cement powder or similar (red dots on the maps) or based on a search for ash or similar (orange dots on the maps). Identifiers associated with the dots are the GeoMapNW database IDs for the borings.

3.1 Sources of CKD in the LDW Basin

Industrial development in the LDW basin increased with the economic boom after World War II. Prior to this time, much of the area consisted of low marshy land; as the need for industrial land increased, these low areas were filled with whatever material was suitable, available, and inexpensive to haul from the general vicinity (Riley 2005). Between the 1950s and 1970s, some of these low areas were filled with CKD from the cement manufacturing plants located along the LDW. This material was not regulated and considered to be excellent “clean fill.” Ideal Basic Industries (also known as Holnam Inc. and Lafarge Cement) has been identified as a source of CKD fill material in the LDW (Ecology 2004a). In addition, Ash Grove Cement (also known as Lone Star) produced CKD during this time period.

3.1.1 Lafarge Cement (Formerly Ideal Basic Industries / Holnam Inc.)

The Lafarge Cement plant has been in operation since 1967. Lafarge purchased it from the original owner (Ideal Basic Industries/Holnam, now Holcim) in 1998. Kiln operations were discontinued in 2010. Historically, the Lafarge facility’s Alternate Raw Materials and Alternate Fuels Program converted a variety of recyclable materials (fly ash, granulated blast furnace slag, spent alumina catalyst, and contaminated soils) into cement and incorporated used oil and tire-derived fuel as alternate fuel sources (SAIC 2011a). Johnson (1971) noted that over 100 tons of

[7] http://geomapnw.ess.washington.edu/index.php

CKD were removed per day from the precipitators at the Seattle Plant. Petroleum-contaminated soil containing asphalt and creosote-treated wood from the Jones Stevedoring property were reportedly transported to the Lafarge facility for high temperature thermal destruction treatment (O'Sullivan Omega 1994).

3.1.2 Ash Grove Cement (Formerly Lone Star Cement)

Lone Star Cement produced cement at this location from 1928 to 1984. Limestone, clay, sand, small amounts of iron, vanillin, calcium derivatives and molasses were used in cement production. Vanillin Black Liquor Solids (VBLS) were purchased from Monsanto Chemical. The VBLS had a pH of 12.5. Monsanto Chemical's sale of the VBLS included a clause that the liquid was sold "as-is" and "with all faults". In 1983, Lone Star (facility operator at the time) began recycling CKD into the cement production process to avoid being classified as a hazardous waste generator.

Ash Grove Cement purchased the facility in 1984. Waste CKD and clinker were removed from the property to be used as a soil stabilizer. The location(s) where the CKD and clinker were deposited is unknown (E&E 2008). In 1985, Harper-Owes reported that Ash Grove purchased 25,000 tons of ASARCO slag per year (Harper-Owes 1985). Ash Grove Cement currently produces up to 750,000 tons per year of Type I, II and III Portland cement. Petroleum coke, coal, natural gas, whole tires and internally-generated waste fuels are used to fire the kiln (E&E 2008).

3.2 Known or Documented CKD Fill Sites in the LDW Basin

3.2.1 Puget Park and the McFarland Property

Puget Park and the McFarland Property	
Source Control Area	RM 0.0-1.0 West (Spokane Street to Kellogg Island)
Property No.	15019
Tax Parcel No.	The McFarland Property: 2840700005 Puget Park: 2424039020, 2840700135
Parcel Size	0005: 3.56 acres (155,267) 0135: 1.54 acres (67,023 sq ft) 9020: 17.57 acres (765,349 sq ft)
SW Drainage Basin	SW Idaho Street SD / Duwamish West CSO
Cleanup Site	Puget Park: State Cleanup Site, VCP (former), Independent Cleanup
Areal extent of CKD Fill	100,000 sq ft (Puget Park) 30,000 sq ft (McFarland Property)
Vertical extent of CKD Fill	0 – 20 feet bgs (Puget Park) 0 – 21 feet bgs (McFarland Property)

The Puget Park and the McFarland Property is shown in Figure 2. Parcels 0135 and 9020 of Puget Park and the McFarland Property were filled with CKD in 1969 by Duwamish Excavating Company, owned by John McFarland and his business partner, John Yates. The material was obtained from the Ideal Cement Company (currently Lafarge). A portion of the McFarland property (parcel 0005) was also used for disposal of CKD. The objective was to fill the ravine and develop the property for horseback riding. The dust generated by the operation resulted in numerous complaints by residents and local businesses and the fill permit was revoked by the city of Seattle (Cargill 1995a).

Based on historical geotechnical data and field observations, the lateral extent of CKD fill on the Puget Park property is 100,000 sq ft (referred to as the Puget Park Lobe). The maximum thickness of the fill is 20 feet. Approximately 40,000 cubic yards of CKD fill is present at Puget Park. The lateral extent of CKD fill on the McFarland property is approximately 30,000 sq ft (referred to as the McFarland lobe). The vertical extent of the CKD fill is approximately 21 feet. Approximately 11,000 cubic feet of CKD fill is present on the property (Geo Group Northwest 2003a). The extent of CKD fill is shown on Figure 3.

Several environmental investigations have been conducted at Puget Park and the McFarland property. Summaries of all chemicals detected in environmental media at the properties are included in Tables 2 through 6. Metals concentrations in CKD, soil and calcium carbonate precipitate samples collected from the property exceed Puget Sound, Washington State and U.S. background concentrations. Concentrations also exceeded MTCA cleanup levels and draft soil-to-sediment screening levels (Tables 2 and 3).

Metals Concentrations in Puget Park & McFarland Property CKD/Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Puget Park & McFarland Property	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	9.3 - 440	7	7	5	1 – 5
Cadmium	1.7 - 13	1	1	0.06	0.01 – 0.07
Chromium	10 - 70	48	42	100	1 – 1,000
Lead	12 – 3,600	24	17	10	2 – 200
Mercury	0.13	0.07	0.07	0.03	0.01 – 0.3
Silver	0.78 - 10	Not analyzed	Not analyzed	0.05	0.01 – 5

Metals Concentrations in Puget Park & McFarland Property Calcium Carbonate Precipitate Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Puget Park & McFarland Property	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	2.4 - 270	7	7	5	1 – 5
Cadmium	0.60 - 19	1	1	0.06	0.01 – 0.07
Lead	13 – 5,300	24	17	10	2 – 200

Lead concentrations exceed the lead concentrations in U.S. CKD (17 – 1,750 milligrams per kilogram [mg/kg]) as compiled by Haynes and Kramer (1982). Concentrations of the remaining metals are consistent with the ranges identified by Haynes and Kramer, with the exception of silver. The Haynes and Kramer study did not include a concentration range for silver.

Samples of seep and creek water were collected in June 1998 and 1999 (Table 4). Seep samples were collected upgradient and downgradient from the precipitate chambers. Dissolved lead concentrations were higher in the outflow samples (Geo Group 2003).

Analyte	Concentration Range (ug/L)	Freshwater Chronic WQS (ug/L)	Marine Chronic WQS (ug/L)	Draft GW-to-Sediment Screening Level (ug/L)
Arsenic	2.1 - 66	190	36	370
Lead	0.75 – 200,000	1.9 – 32*	8.1	13
Mercury	0.3 – 0.9	0.012	0.025	0.0074
Selenium	20 - 30	5	71	‘--

* - Dependent on hardness of the sample.

In October 2003, six CKD samples were collected from the Puget Park and McFarland Lobes to determine if dioxins/furans were present in the CKD fill. Most samples were combined and analyzed as composite samples for dioxins/furans. Samples of Puget Creek sediment, the calcium carbonate precipitate, and seep water were also collected. Dioxins/furans were detected in all environmental media that were sampled (Geo Group 2003). The dioxins/furan TEQ for the Puget Creek sediment sample exceeded the LDW background TEQ (Tables 5 and 6).

Remedial actions were performed in 1997 to meet the following goals (Hart Crowser 1997b):

- Eliminate the potential for human contact with CKD and calcium carbonate formations.
- Eliminate potential dust generation and releases to the atmosphere from CKD.
- Control runoff, further sedimentation, and precipitation of the CKD to the environment.
- Maintain and enhance the wooded greenbelt.

During a meeting with Ecology in December 2003, Seattle Parks indicated that plans to construct a leachate collection trench downgradient of the Puget Park Lobe were being developed. Collected water would be discharged to the sanitary sewer (Cargill 2003). In January 2005, Seattle Parks submitted the plans to Ecology for review (Seattle Parks 2005). Records documenting the installation of the leachate collection trench were not found during the file review. It is not known if the trench was installed. Groundwater discharges to Puget Creek, which enters the LDW near SW Idaho Street.

In January 2007, Ecology notified Seattle Parks that additional remedial actions were required at Puget Park. The lateral and vertical extents of arsenic and lead contamination in soil and groundwater had not been determined (Ecology 2007).

Additional information regarding the history and environmental investigations of Puget Park and the McFarland Property is available in *Lower Duwamish Waterway, RM 0.0 to 1.0 West (Spokane Street to Kellogg Island), Summary of Existing Information and Identification of Data Gaps* (SAIC 2012a).

3.2.2 Washington Federal Savings & Loan Property

Washington Federal Savings & Loan Property	
Source Control Area	RM 0.0-1.0 West (Spokane Street to Kellogg Island)
Property No.	15029
Tax Parcel No.	1924049004
Parcel Size	27.71 acres (1,207,186 sq ft)
SW Drainage Basin	SW Idaho Street SD / Duwamish West CSO
Cleanup Site	State Cleanup Site
Areal Extent of CKD Fill	97,000 sq ft, northeastern area 223,000 sq ft, south-central area
Vertical Extent of CKD Fill	Ground surface to 20 – 25 feet bgs, northeastern area Ground surface to 5 – 8 feet bgs, south-central area

The Washington Federal Savings & Loan property is bordered by SW Hudson Street to the north, West Marginal Way SW to the east, additional areas of the West Duwamish Green Belt and South Seattle Community College to the south, and SW Brandon Street to the west. An unimproved dirt road passes from north to south through the property, approximately parallel to West Marginal Way SW (Figure 2).

The property was logged and cleared prior to 1930. Gravel and/or soil were removed from the property along the current West Marginal Way SW. The resulting pit may have been filled with CKD. Between the 1940s and 1970s, A. Abrahamson Brick Co. cleared the property and built access roads to mine clay from the property for brick manufacturing. Ideal Cement (currently Lafarge) filled the area with CKD. Ecology estimated that 100,000 to 350,000 tons of CKD was placed as fill between 1967 and 1971. GeoEngineers estimates that approximately 35,000 cubic yards of CKD fill is present in two areas of the property (Figure 4). No significant land use activity occurred on the property after 1976 (Hong West 1993; GeoEngineers 1993).

Today, the property is wooded. An intermittent stream flows from south to north at the northwest portion of the property. A drainage ditch flows into the stream (Hong West 1993).

On October 25, 2012, the Seattle Department of Planning and Development (Seattle DPD) announced that they were reviewing a Master Use Permit Application to install a stormwater pretreatment system on the property. The purpose of this project is to install a pretreatment facility for pH reduction of site water prior to discharge to the City of Seattle/King County sewer system, as required by King County Industrial Waste. Pretreatment is needed to neutralize high pH leachate from cement kiln dust fill at the property. The proposed work consists of installing an 8-foot by 40-foot skid-mounted pretreatment module on a slab-on-grade concrete foundation. A 75-foot long gravel access road with a concrete entrance will be constructed to access the pretreatment facility. The project includes below grade pump and discharge vaults that are located within an environmental critical area. The State Environmental Policy Act (SEPA) checklist for the proposed project was submitted along with the permit application. Comments were accepted through November 7, 2012 (Seattle DPD 2012, and a Determination of Nonsignificance was issued on January 14, 2013 (Seattle DPD 2013).

Several environmental investigations have been conducted at the Washington Federal Savings & Loan property. Summaries of all chemicals detected in environmental media at the properties are included in Tables 7 through 9. Metals concentrations in CKD, soil and calcium carbonate precipitate samples collected from the property exceed Puget Sound, Washington State U.S. background concentrations. Concentrations also exceeded MTCA cleanup levels and draft soil-to-sediment screening levels (Table 7).

Metals Concentrations in Washington Federal Savings & Loan Property CKD/Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	WFSL Property	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	1.8 - 230	7	7	5	1 – 5
Cadmium	2.2 – 6.8	1	1	0.06	0.01 – 0.07
Chromium	11 - 44	48	42	100	1 – 1,000
Lead	3.8 – 2,400	24	17	10	2 – 200
Silver	0.6 – 3.7	Not analyzed	Not analyzed	0.05	0.01 – 5

Lead concentrations in CKD/soil exceed the lead concentrations in U.S. CKD (17 – 1,750 mg/kg) as compiled by Haynes and Kramer (1982). Concentrations of the remaining metals are consistent with the ranges identified by Haynes and Kramer, with the exception of silver. The Haynes and Kramer study did not include a concentration range for silver.

Lead was detected in one precipitate sample at a concentration of 360 mg/kg, sampled in August 1999 (Table 8). Lead was the only analyte detected in the sample.

Surface water and leachate samples were collected at the property in 1989, 1990, 1993 and 1999. Copper, lead, and mercury concentrations exceeded the Marine Chronic Water Quality Standard (WQS) and silver concentrations exceeded the draft groundwater-to-sediment screening level (Table 9). Mercury concentrations also exceeded the Freshwater Chronic WQS (0.012 micrograms per liter [ug/L]). Hardness data were not available for review for these samples; therefore cadmium, chromium, copper, nickel, silver and zinc results were not compared to the Freshwater Chronic WQS.

At the northeast corner of the property, a French drain has been installed to intercept spring water contaminated by CKD fill. Springs and seeps at the eastern slope of the property are directed to the French drain (Hong West 1993; GeoEngineers 1993).

Additional information regarding the history and environmental investigations of the Washington Federal Savings & Loan property is available in *Lower Duwamish Waterway, RM 0.0 to 1.0 West (Spokane Street to Kellogg Island), Summary of Existing Information and Identification of Data Gaps* (SAIC 2012a).

3.2.3 Port of Seattle Terminal 107

Port of Seattle Terminal 107	
Source Control Area	RM 0.0-1.0 West (Spokane Street to Kellogg Island)
Property No.	15027
Tax Parcel No.	0213000046, 1924049103, 2840201235, 7666703705, 7666703710
Parcel Size	0046: 0.10 acre (4,440 sq ft) 1235: 0.08 acre (3,506 sq ft) 3705: 0.02 acre (980 sq ft) 3710: 0.01 acre (460 sq ft) 9103: 59.66 acres (2,598,796 sq ft)
SW Drainage Basin	LDW Direct / Duwamish West CSO
Cleanup Site	No
Areal extent of CKD Fill	Unknown
Vertical extent of CKD Fill	Ground surface to 4 feet bgs, southern end

Terminal 107 is comprised of five parcels that are adjacent to the LDW, including most of the tidelands between Kellogg Island and the western bank of the LDW between river mile (RM) 0.5 and 1.0 West, and it includes Kellogg Island (Figure 2). The Duwamish Bike Way and West Marginal Way SW are west of the property. Herring's House Park is north of the property and Lafarge Cement is to the south. The street address for Terminal 107 is 5402 West Marginal Way SW (SoundEarth 2011a). The Port of Seattle historically used 4700 West Marginal Way SW as the address for Terminal 107 (Port of Seattle 1976).

Extensive fill material is present at Terminal 107. Fill activities were performed from the 1880s through the 1920s and from the 1950s through 1976. The maximum thickness of fill encountered at the terminal is 50 feet. Fill material on Kellogg Island consists of fine to medium sand. Fill materials on the upland portion of the terminal consist of sand, gravel, clay, brick fragments, and CKD. The CKD is present on the southern, upland portion of the terminal (parcel 9103), near Lafarge Cement (SoundEarth 2011a) (Figure 2). Johnson (1971) and anecdotal accounts from sediment investigations in the area indicate that CKD is present along the upland bank from the southern portion of the terminal to the northern tip of Kellogg Island. The shoreline of Terminal 107 is over 8,500 linear feet and consists of exposed soil and vegetated slopes. The photograph below illustrates bank soil conditions at Terminal 107.

Western Shoreline at Upland Terminal 107 (2005)

Bank soil samples collected in 2011 from the CKD fill contained arsenic, lead, and zinc at concentrations exceeding the Washington State Sediment Quality Standard (SQS) and Cleanup Screening Level (CSL) (Washington Administrative Code [WAC] 173-204); however, metals concentrations in sediment samples collected adjacent to the fill area did not exceed the SQS/CSL (Table 10). Metals concentrations in the bank soil samples exceed Puget Sound, Washington State and U.S. background concentrations. No other areas of the shoreline have been investigated.

Metals Concentrations in Terminal 107 CKD/Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Terminal 107 Property	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	190 - 324	7	7	5	1 – 5
Lead	640 – 1,610	24	17	10	2 – 200
Zinc	440 – 2,480	85	86	50	10 – 300

Concentrations of lead and zinc are consistent with the ranges identified by Haynes and Kramer (1982).

Additional information regarding the history and environmental investigations of the Terminal 107 property is available in *Lower Duwamish Waterway, RM 0.0 to 1.0 West (Spokane Street to Kellogg Island), Summary of Existing Information and Identification of Data Gaps* (SAIC 2012a).

3.2.4 Port of Seattle Terminal 115

Port of Seattle Terminal 115	
Source Control Area	RM 1.6-2.1 West (Terminal 115)
Property No.	18014
Tax Parcel No.	5367202503, 5367202505
Parcel Size	2503: 0.75 acre (32,494 sq ft) 2505: 98.7 acres (4,299,853 sq ft)
SW Drainage Basin	LDW Direct
Cleanup Site	Port of Seattle N Terminal 115: State Cleanup Site, VCP (former) Crowley Marine Services Terminal 115: LUST Site
Areal extent of CKD Fill	Unknown
Vertical extent of CKD Fill	Unknown

Terminal 115 is adjacent to the LDW and consists of a 98.7-acre parcel (2505) and a 0.75-acre parcel (2503), both owned by the Port of Seattle (Figure 5). CKD fill is not believed to be present on parcel 2503. Parcel 2505 is bordered by the LDW to the east, Glacier Northwest to the north, West Marginal Way SW to the west, and SW Michigan Street to the south.

Much of Terminal 115 is built on the historical Foss Island and reclaimed land. Filling activities occurred from the 1930s through 1971. A program to reclaim and expand Terminal 115 was started in November 1969, which involved extensive filling, dredging, and excavation of the portion of the LDW south and west of Foss Island and Turning Basin No. 1 (currently the area west of Berth 1 at the Terminal 115 property). Thickness of the fill above the pre-1969 riverbed varies across the property (SoundEarth 2011b):

- Less than 10 feet of fill is present in the southern area of the terminal.
- 10 to 20 feet of fill is present in the areas including and immediately adjacent to the former Foss Island.
- 0 to 25 feet of fill is present in the Terminal 115 North area; fill thickness is greatest adjacent to the LDW.

Gravel, sand, silt, concrete, bricks, coal, wood, garbage, and other miscellaneous materials were used as fill during the reclamation and expansion of Terminal 115 (Troost and Booth 2008, as cited in SoundEarth 2011b). CKD and unwanted dredge material were used as fill material north of Boeing Plant 1 and west of Foss Island (Port of Seattle 1987; Shannon & Wilson 1991), which is approximately the central area of present-day Terminal 115 (SAIC 2011b). Figures illustrating the fill history are included in the Terminal 115 Environmental Conditions Report (SoundEarth 2011b).

Several environmental investigations have been performed at Terminal 115 to address petroleum hydrocarbon contamination. Metals were not detected or were not analyzed in soil samples. Arsenic, cadmium, and lead have been detected in groundwater at concentrations exceeding MTCA cleanup levels and the draft groundwater-to-sediment screening levels (Table 11). However, metals were not identified as sediment COCs in the LDW sediment samples collected adjacent to the LDW source control area.

Analyte	Concentration Range (ug/L)	MTCA Cleanup Level (ug/L)	Draft GW-to-Sediment Screening Level (ug/L)
Arsenic	3.6 - 64	0.058	370
Cadmium	4.5	5.0	3.4
Chromium	39	50	320
Lead	5 - 108	15	13

Additional information regarding the history and environmental investigations of Terminal 115 property is available in *Lower Duwamish Waterway, RM 1.6 to 2.1 West (Terminal 115), Summary of Existing Information and Identification of Data Gaps* (SAIC 2011b).

3.2.5 Seaport Petroleum Property

Seaport Petroleum	
Source Control Area	RM 2.1 West (1st Avenue S Storm Drain)
Property No.	19020
Tax Parcel No.	3024049166 (7800 Detroit Avenue SW) 3024049181 (No address listed)
Parcel Size	9166: 2.72 acres (118,293 sq ft) 9181: 0.72 acre (31,200 sq ft)
SW Drainage Basin	1st Avenue S SD
Cleanup Site	West Coast Equipment 2: Independent Cleanup
Areal extent of CKD Fill	Approximately 149,000 sq ft (extent of property)
Vertical extent of CKD Fill	0.5 to 8 ft bgs

The Seaport Petroleum property (formerly West Coast Equipment 2) is comprised of parcels 9166 and 9181 (Figure 6). The property is bordered by Eastern Supply to the north, Detroit Avenue SW on the west, 1st Avenue S on the east, and SW Kenyon Street to the south.

CKD was imported to the property in the mid-1960s, when the property was owned by Eastern Supply, and was used as fill material (GeoEngineers 1996). A total of approximately 60,000 cubic yards of CKD and approximately 300 cubic yards of slag are present on the site (James P. Hurley 1995). Approximately 60 cubic yards of CKD were brought to the property from Birmingham Steel (currently the Riverside Mill property[8]) (Cargill 1995b). Sand, gravel, and slag were periodically imported to the property and placed over the CKD as surfacing material. The CKD is located at approximately 4 to 6 feet below ground surface (bgs); slag and gravel are found above the CKD layer. Native silt is found below the CKD (SAIC 2012b).

A Washington Ranking Method (WARM) score of 3 was assigned to West Coast Equipment 2 in July 1996 (Ecology 1996a).

Several environmental investigations were conducted at the property between 1990 and 1996. Summaries of all chemicals detected in environmental media at the property are included in

[8] 3800 West Marginal Way SW 98106 (Spokane Street to Kellogg Island source control area)

Tables 12 and 13. Metals concentrations in CKD and soil samples collected from the property exceed Puget Sound, Washington State and U.S. background concentrations. Concentrations also exceeded MTCA cleanup levels and draft soil-to-sediment screening levels (Table 12).

Metals Concentrations in Seaport Petroleum Property CKD/Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Seaport Petroleum	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	2.2 - 400	7	7	5	1 – 5
Cadmium	0.27 - 12	1	1	0.06	0.01 – 0.07
Chromium	4.1 – 2,700	48	42	100	1 – 1,000
Lead	11 – 4,600	24	17	10	2 – 200
Mercury	0.11 – 0.17	0.07	0.07	0.03	0.01 – 0.3
Silver	1.7 – 9.5	Not analyzed	Not analyzed	0.05	0.01 – 5
Zinc	100 – 1,200	85	86	50	10 – 300

Chromium and lead concentrations exceed the concentrations (chromium: 11 – 172 mg/kg and lead: 17 – 1,750 mg/kg) in U.S. CKD as compiled by Haynes and Kramer (1982). Concentrations of the remaining metals are consistent with the ranges identified by Haynes and Kramer, with the exception of silver. The Haynes and Kramer study did not include a concentration range for silver.

In groundwater, arsenic, chromium, and lead were detected at concentrations above the MTCA groundwater cleanup levels. Chromium and lead concentrations exceeded the draft groundwater-to-sediment screening levels (Table 13).

Analyte	Concentration Range (ug/L)	MTCA Cleanup Level (ug/L)	Draft GW-to-Sediment Screening Level (ug/L)
Arsenic	7 - 150	0.058	370
Chromium	68 - 330	50	320
Lead	20 - 96	15	13

Isolation and monitoring was proposed for the CKD containing concentrations of metals exceeding the MTCA soil cleanup levels in the southern portion of the property, near test pits TP-4, TP-5, TP-9, and TP-10 (GeoEngineers 1996).

Additional information regarding the history and environmental investigations of the Seaport Petroleum property is available in *Lower Duwamish Waterway, RM 2.1 West (1st Avenue South Storm Drain), Summary of Existing Information and Identification of Data Gaps* (SAIC 2012b).

3.2.6 Intermountain Supply (Former Recycle America)

Intermountain Supply/Former Recycle America	
Source Control Area	RM 2.1 West (1^{st} Avenue S Storm Drain)
Property No.	19009
Tax Parcel No.	3124049001
Parcel Size	3.09 acres (134,650 sq ft)
SW Drainage Basin	1^{st} Avenue S SD / 8^{th} Avenue CSO
Cleanup Site	No
Areal extent of CKD Fill	Approximately 134,650 sq ft, extends to parcel 3124049004 (Kenyon Street Property)
Vertical extent of CKD Fill	Ground surface to 7.5 ft bgs

Intermountain Supply currently occupies parcel 3124049001 at 7901 1st Avenue S. This property is located south of Seaport Petroleum and S Kenyon Street, east of the Kenyon Street Property, north of several parcels currently operated by Waste Management, and east of 1st Avenue S and SR 509 (Figure 6). Recycle America is a former tenant at the property.

The site is almost entirely paved with asphalt. CKD fill material is present across the site from near the surface to about 5 feet below grade (EPI 2006). The CKD extends beyond the property boundary (Figure 7). The Riley Group estimated that approximately 20,000 cubic yards of CKD fill was placed at the property during industrial development of the area between 1969 and 1977 (Riley Group 2005). Historical photos show that a white, fine-grained fill material was deposited in various areas of the property. Dark gray silt was generally observed underlying the CKD to a depth of about 11 feet bgs. The silt was underlain by dark gray, well-graded sand from a depth of about 11 to 15 feet bgs. Depth to water is about 4 to 9 feet bgs, depending on the time of year. Shallow groundwater flows generally toward the northeast, with a hydraulic gradient from 0.004 foot/foot to 0.011 foot/foot (EPI 2006).

Several environmental investigations were conducted at the property between 1997 and 2004. Summaries of all chemicals detected in environmental media at the properties are included in Tables 14 and 15. Metals concentrations in CKD and soil samples (Table 14) collected from the property exceed Puget Sound, Washington State and U.S. background concentrations. Concentrations also exceeded MTCA cleanup levels and draft soil-to-sediment screening levels (Table 14).

Metals Concentrations in Intermountain Supply Property CKD/Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Intermountain Supply	Puget Sound 90^{th} percentile[a]	Statewide 90^{th} percentile[a]	U.S. Average[b]	U.S. Common[b]
Arsenic	2.0 - 143	7	7	5	1 – 5
Cadmium	1.4 – 8.6	1	1	0.06	0.01 – 0.07
Chromium	7.6 - 35	48	42	100	1 – 1,000
Lead	1.7 – 2,210	24	17	10	2 – 200

Lead concentrations exceed the lead concentrations (17 – 1,750 mg/kg) in U.S. CKD as compiled by Haynes and Kramer (1982). Concentrations of the remaining metals are consistent with the ranges identified by Haynes and Kramer, with the exception of silver. The Haynes and Kramer study did not include a concentration range for silver.

Antimony, arsenic, cadmium, lead, and mercury exceeded MTCA groundwater cleanup levels in at least one sample (Table 15). In addition, cadmium, lead, and mercury also exceeded groundwater-to-sediment cleanup levels. The most frequent exceedances were for arsenic and lead.

Analyte	Concentration Range (ug/L)	MTCA Cleanup Level (ug/L)	Draft GW-to-Sediment Screening Level (ug/L)
Antimony	8.0	6.4	--
Arsenic	5 - 91	0.058	370
Cadmium	31	5.0	3.4
Chromium	3 - 37	50	320
Copper	27	640	120
Lead	3 - 28	15	13
Mercury	0.2 – 3.2	2.0	0.0074

Additional information regarding the history and environmental investigations of the Intermountain Supply property is available in *Lower Duwamish Waterway, RM 2.1 West (1st Avenue South Storm Drain), Summary of Existing Information and Identification of Data Gaps* (SAIC 2012b).

3.2.7 Kenyon Street Property

Kenyon Street Property	
Source Control Area	RM 2.1 West (1st Avenue S Storm Drain)
Property No.	19013
Tax Parcel No.	3124049004, 3124049009
Parcel Size	9004: 2.9 acres (126,456 sq ft) 9009: 0.14 acres (5,882 sq ft)
SW Drainage Basin	1st Avenue S SD / 8th Avenue CSO
Cleanup Site	State Cleanup Site, VCP (former)
Areal extent of CKD Fill	~101,000 sq ft
Vertical extent of CKD Fill	Ground surface to 2 – 12 feet bgs, depth increases to the south

The Kenyon Street Property is located at 149 SW Kenyon Street (Figure 6). To the north of the property is SW Kenyon Street and Seaport Petroleum, to the east is Intermountain Supply (formerly Recycle America), and to the south and southeast are parcels operated by Waste Management. To the west are a residential property and a series of parcels owned by Prentice Holdings LLC. A hill and a greenbelt area rise upwards to the west.

The general soil profile at the property consists of fill (CKD, crushed glass, or other materials) to depths of 2 to 12 feet bgs, a thin layer of black organic silt underlying the fill material in parts of the facility, and native, tan to black silty sand to a total depth of 16 feet bgs (SES 2007). A surficial layer of CKD was observed over the northwest portion of the site (Figure 8). The organic layer is believed to be a remnant of a wetland that existed prior to original filling and development of the property. CKD was used to fill the wetland. Groundwater was typically encountered at 6 to 13 feet bgs, and generally flows in an easterly direction (SES 2007).

In 2006 to 2007, as part of a planned redevelopment of the property, an assessment of environmental conditions was conducted for GPH-AHF, LLC (SES 2007). Results of the subsurface investigation conducted at the property indicate that CKD was used as fill material at this location in the early 1970s. The CKD fill layer contains arsenic, cadmium, and lead concentrations typical of the CKD material found at other locations in the LDW basin. The property is currently listed on Ecology's Confirmed and Suspected Contaminated Sites List (CSCSL) as Dr Concrete Recycle for confirmed contamination of soil and surface water with priority pollutant metals, and confirmed contamination of soil with arsenic. The current status is listed as "Cleanup Started."

A summary of all chemicals detected in environmental media at the property is provided in Tables 16 through 18. Metals concentrations in CKD and soil samples collected from the property exceed Puget Sound, Washington State and U.S. background concentrations. Concentrations also exceeded MTCA cleanup levels and draft soil-to-sediment screening levels (Table 16).

Metals Concentrations in Kenyon Street Property CKD/Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Kenyon Street Property	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	3.0 - 327	7	7	5	1 – 5
Cadmium	1.9 – 9.1	1	1	0.06	0.01 – 0.07
Chromium	7.7 - 40	48	42	100	1 – 1,000
Lead	3.5 – 2,550	24	17	10	2 – 200
Silver	1.2 – 4.8	Not analyzed	Not analyzed	0.05	0.01 – 5

Lead concentrations exceed the lead concentrations in U.S. CKD (17 – 1,750 mg/kg) as compiled by Haynes and Kramer (1982). Concentrations of the remaining metals are consistent with the ranges identified by Haynes and Kramer, with the exception of silver. The Haynes and Kramer study did not include a concentration range for silver.

Monitoring wells MW-01, MW-02, MW-03, MW-06, and MW-07 were screened below the CKD layer, while well MW-04 was screened within the CKD layer. CKD was not encountered during the installation of MW-05 or MW-08. Depth to groundwater was measured in July 2007, and ranged from 4.8 feet bgs in MW-08 to 8.0 feet in MW-06 (SES 2007). Arsenic, chromium and lead concentrations exceeded MTCA cleanup levels and draft groundwater-to-sediment screening levels (Table 17).

Analyte	Concentration Range (ug/L)	MTCA Cleanup Level (ug/L)	Draft GW-to-Sediment Screening Level (ug/L)
Arsenic	11 - 100	0.058	370
Cadmium	1.1 – 3.0	5.0	3.4
Chromium	1.1 – 71	50	320
Lead	1.4 – 30	15	13

Groundwater sampling and testing was conducted between September 2006 and February 2008 (SES 2008). Data from the February 2008 sampling was not available for review.

Three stormwater samples were collected in February 2007 (Table 18). Arsenic, barium, chromium and lead were detected in all three samples at low concentrations. Arsenic concentrations ranged from 1.4 to 1.6 ug/L, and did not exceed the Freshwater Chronic WQS (190 ug/L). Since hardness was not analyzed, the chromium and lead results cannot be compared to the Freshwater Chronic WQS. Chromium concentrations ranged from 1.9 to 2.2 ug/L and lead concentrations ranged from 3.3 to 4.5 ug/L (SES 2007).

Additional information regarding the history and environmental investigations of the Kenyon Street Property is available in *Lower Duwamish Waterway, RM 2.1 West (1st Avenue South Storm Drain), Summary of Existing Information and Identification of Data Gaps* (SAIC 2012b).

3.2.8 City of Seattle South Transfer Station Property (Former S Kenyon Street Bus Yard)

City of Seattle South Transfer Station	
Source Control Area	RM 2.1 West (1st Avenue S Storm Drain)
Property No.	19025
Tax Parcel No.	2924049104; 2924049006; 2924049099; 7328401175
Parcel Size	9104: 2.39 acres 9006: 4.26 acres 9099: 1.82 acres 1175: 0.65 acre Total: 9.12 acres
SW Drainage Basin	1st Avenue S SD / 8th Avenue CSO
Cleanup Site	No
Areal extent of CKD Fill	~73,400 sq ft
Vertical extent of CKD Fill	Ground surface to 11 feet bgs

Contiguous parcels 9104, 9006, 9099, and 1175 are owned by the City of Seattle/SPU (Figure 9). The 9.12 acre property was recently developed into SPU's South Transfer Station. The facility is bordered to the south by S Kenyon Street, to the west by SR 509, and to the east by SR 99. The property is also referred to as the former S Kenyon Street Bus Yard.

In March 2009, an RI was completed for the property located on parcels 9104, 9006, 9009, and 1175. Subsurface soil in Area 3 (Figure 10) consisted of a 6-inch to 11-foot layer of fill material that had high levels of arsenic, cadmium, and lead and was later identified as CKD (AMEC

2009a). The CKD was used to fill a ravine that traversed the southwestern portion of Area 3. Timeframe for the use of CKD was estimated between 1969 and 1974 (AMEC 2009a, 2009b).

Several samples were collected from the CKD fill and analyzed for metals in 2008 (Table 19). Metals concentrations in CKD and soil samples collected from the property exceed Puget Sound, Washington State and U.S. background concentrations. Arsenic, cadmium, and lead concentrations exceeded MTCA cleanup levels for soil. Cadmium, lead and silver concentrations exceeded the draft soil-to-sediment screening levels.

Metals Concentrations in South Transfer Station CKD Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	South Transfer Station	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	130 - 440	7	7	5	1 – 5
Cadmium	3.2 – 9.7	1	1	0.06	0.01 – 0.07
Lead	8.1 – 3,700	24	17	10	2 – 200
Silver	3.7	Not analyzed	Not analyzed	0.05	0.01 – 5

Lead concentrations exceed the lead concentrations in U.S. CKD (17 – 1,750 mg/kg) as compiled by Haynes and Kramer (1982). Concentrations of the remaining metals are consistent with the ranges identified by Haynes and Kramer, with the exception of silver. The Haynes and Kramer study did not include a concentration range for silver.

Wells MW-6 and MW-9 are screened in the CKD fill. The pH levels in groundwater samples collected from these wells were as a high as 12.32, which may be attributable to CKD fill (AMEC 2009a). Arsenic and lead concentrations exceeded MTCA cleanup levels. Lead concentrations also exceeded the draft groundwater-to-sediment screening level (Table 20).

Analyte	Concentration Range (ug/L)	MTCA Cleanup Level (ug/L)	Draft GW-to-Sediment Screening Level (ug/L)
MW-6 & MW-9 (screened in CKD)			
Arsenic	15 - 180	0.058	370
Lead	21 - 180	15	13
Downgradient wells			
Arsenic	3.0 - 56	0.058	370
Lead	1.0 – 28	15	13

Additional information regarding the history and environmental investigations of the South Transfer Station is available in *Lower Duwamish Waterway, RM 2.1 West (1st Avenue South Storm Drain), Summary of Existing Information and Identification of Data Gaps* (SAIC 2012b).

3.2.9 Former South Park Landfill

Former South Park Landfill	
Source Control Area	RM 2.1 West (1st Avenue S Storm Drain)
Property No.	19023
Tax Parcel No.: Current Operator	3224049005: vacant 3224049007: Kenyon Business Park 3224049077: TH Seafood (former Formula Corp) 3224049045: Meeco Manufacturing 3224049068: WG Clark Construction 3224049084: Airport Towing 7328400005: South Recycle & Disposal Station 7328400740: Former Glitsa American 7883600005: Hudson Bay Insulation 7883600350: Coast Crane
Parcel Size	3224049005: 21.00 acres (914,648 sq ft) 3224049007: 6.49 acres (282,819 sq ft) 3224049077: 0.72 acre (31, 303 sq ft) 3224049045: 2.77 acres (120,863 sq ft) 3224049068: 0.44 acre (19,150 sq ft) 3224049084: 0.62 acre (27,155 sq ft) 7328400005: 10.29 acres (448,078 sq ft) 7328400740: 1.17 acres (51,000 sq ft) 7883600005: 1.33 acres (57,774 sq ft) 7883600350: 2.38 acres (103,621 sq ft)
SW Drainage Basin	1st Avenue S SD
Cleanup Site	South Park Landfill: State Cleanup Site, VCP (former) South Recycle & Disposal Station: Independent Cleanup Former Glitsa American: LUST Site Coast Crane: State Cleanup Site
Areal extent of CKD Fill	Unknown
Vertical extent of CKD Fill	Unknown

The former South Park Landfill is owned by South Park Property Development LLC (SPPD). The property is bordered by 5th Avenue S to the east, the Kenyon Business Park and South Recycle and Disposal Station to the north, S Sullivan Street to the south, and Occidental Avenue S to the west (Figure 9).

The parcels listed in the above table are within the footprint of the former South Park Landfill. Disposal of sawdust and mixed municipal waste occurred from the 1930s through 1966, and fill material until the landfill closed in 1978. The landfill accepted residential and commercial wastes, and the burn portion of the landfill accepted ignitable material such as wood waste and construction debris (AESI 1998, Farallon 2009).

CKD may have been used as landfill cover in some areas of the former South Park Landfill. The fill layer is not laterally continuous. As illustrated on Figure 9, potential or confirmed CKD fill has been observed in soil samples collected from parcels 3224049007 (Kenyon Business Park), 7328400005 (South Recycle & Disposal Station), 7883600005 (Hudson Bay Insulation), and 7883600350 (Coast Crane) (Earth Consultants 1980, Farallon 2009, PNG 1995). The pH of stormwater runoff from parcel 3224049084 (Airport Towing) indicates the presence of CKD; pH values between 11 and 12 have been recorded (SCWG 2009). A large area of white fill material is visible in a 1936 aerial photograph of the South Park Landfill area (Figure 11). The fill material extends to parcel 3224049084 (Airport Towing) and parcel 3224049045 (Meeco Manufacturing). The RI/FS work plan indicates that the fill material is sawdust or other fill material (Farallon 2009).

Several environmental investigations have been performed at the properties that are within the footprint of the former South Park Landfill. Highest concentrations of chemicals detected in soil, groundwater and surface water were compiled in the RI/FS work plan (Farallon 2009). The Ecology Integrated Site Information System (ISIS) database lists the status of the former South Park Landfill as “Cleanup Started”.

Metals Concentrations in Former South Park Landfill Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	South Transfer Station	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	180	7	7	5	1 – 5
Beryllium	0.58	0.6	2	Not provided	Not provided
Cadmium	34	1	1	0.06	0.01 – 0.07
Chromium	260	48	42	100	1 – 1,000
Copper	4,300	36	36	30	2 – 100
Lead	6,800	24	17	10	2 – 200
Mercury	5.1	0.07	0.07	0.03	0.01 – 0.3
Nickel	770	48	38	40	5 – 500
Silver	80	Not analyzed	Not analyzed	0.05	0.01 – 5
Zinc	7,900	85	86	50	10 – 300

Concentrations of arsenic, cadmium, copper, lead, and mercury exceed MTCA cleanup levels and the draft soil-to-sediment screening levels. Silver and zinc concentrations exceeded the draft soil-to-sediment screening levels. Copper, lead, mercury and nickel concentrations exceed the concentration ranges in U.S. CKD as compiled by Haynes and Kramer (1982). Concentrations of the remaining metals are consistent with the ranges identified by Haynes and Kramer, with the exceptions of beryllium and silver. The Haynes and Kramer study did not include concentration ranges for beryllium and silver.

In groundwater, metals concentrations have exceeded MTCA cleanup levels and the draft groundwater-to-sediment screening levels.

Analyte	Concentration Range (ug/L)	MTCA Cleanup Level (ug/L)	Draft GW-to-Sediment Screening Level (ug/L)
Arsenic	55 - 1,100	0.058	370

Analyte	Concentration Range (ug/L)	MTCA Cleanup Level (ug/L)	Draft GW-to-Sediment Screening Level (ug/L)
Cadmium	9	5.0	3.4
Chromium	53 - 130	50	320
Copper	31 - 120	--	39
Lead	13 - 290	15	13
Mercury	0.1 - 0.4	2	0.0074
Zinc	170 - 200		38

Additional information regarding the history and environmental investigations of the former South Park Landfill is available in *Lower Duwamish Waterway, RM 2.1 West (1st Avenue South Storm Drain), Summary of Existing Information and Identification of Data Gaps* (SAIC 2012b) and *Lower Duwamish Waterway, RM 2.2 to 3.4 West (Riverside Drive), Summary of Existing Information and Identification of Data Gaps* (SAIC 2012c).

3.2.10 Halfon Candy, McKinstry Co. S Barton, and King Electrical Manufacturing

Halfon Candy	
Source Control Area	RM 3.8-4.2 West (Sea King Industrial Park)
Property No.	23019
Tax Parcel No.	2433700076
Parcel Size	0.95 acre (41,425 sq ft)
SW Drainage Basin	S 96th Street SD / 8th Avenue CSO
Cleanup Site	State Cleanup Site
Areal extent of CKD Fill	Unknown, at least 20,000 sq ft
Vertical extent of CKD Fill	Ground surface to 4-6 feet bgs

King Electrical Manufacturing	
Source Control Area	RM 3.8-4.2 West (Sea King Industrial Park)
Property No.	23023
Tax Parcel No.	2433700068
Parcel Size	0105: 2.00 acres (86,940 sq ft) 0068: 0.95 acre (41,423 sq ft)
SW Drainage Basin	S 96th Street SD / 8th Avenue CSO
Cleanup Site	No
Areal extent of CKD Fill	Unknown
Vertical extent of CKD Fill	Unknown

McKinstry Co S Barton	
Source Control Area	RM 3.8-4.2 West (Sea King Industrial Park)
Property No.	23026
Tax Parcel No.	2433700070
Parcel Size	0.93 acres (40,710 sq ft)
SW Drainage Basin	S 96th Street SD / 8th Avenue CSO
Cleanup Site	No
Areal extent of CKD Fill	Unknown
Vertical extent of CKD Fill	Unknown

The CKD fill location map in Johnson (1971) indicates that CKD fill is present on parcels 2433700068, 2433700070, 2433700076. These three parcels are located at the southwest corner of the intersection between S Barton Street and 10th Avenue S (Figure 12).

Prior to construction of a warehouse in 1978, six geotechnical borings were advanced on the western half of the Halfon Candy Company property. CKD was present from the ground surface to 4 - 6 feet bgs. The eastern half of the property was not investigated.

On June 28, 2007, SPU investigated the possibility of contamination in and around a water meter box at the Halfon Candy property. SPU collected water samples and submitted the samples to a lab for analysis of pH and TPH. TPH concentrations were not detected in the sample and pH registered at 8.9. The sample was reanalyzed for metals. Concentrations of arsenic, iron, and lead exceeded MTCA Method A cleanup levels for groundwater. The elevated metals concentrations in groundwater could be attributed to CKD leachate (Zand 2007).

Additional information regarding the history and environmental investigations at these properties is available in *Lower Duwamish Waterway, RM 3.8 to 4.2 West (Sea King Industrial Park), Summary of Existing Information and Identification of Data Gaps* (SAIC 2013).

3.2.11 Former Markey Machinery Property

Former Markey Machinery Property	
Source Control Area	RM 3.8-4.2 West (Sea King Industrial Park)
Property No.	23040
Tax Parcel No.	5624200150
Parcel Size	4.43 acres (193,122 sq ft)
SW Drainage Basin	S 96th Street SD / 8th Avenue CSO
Cleanup Site	State Cleanup Site (former)
Areal extent of CKD Fill	193,122 sq ft
Vertical extent of CKD Fill	Ground surface to 10 feet bgs

The former Markey Machinery property is bordered by S 96th Street to the south, 10th Avenue S to the west, S 95th Street Wetland to the north, and Cascade Pipe and Supply to the east (Figure 12). Simplex Grinnell, NRC Environmental Services (NRCES), and Sherwin Williams currently operate at the property.

In April 1989, an Environmental Site Assessment (ESA) was conducted at the Markey Property to evaluate the use of CKD as fill material. Approximately 50,000 cubic yards of CKD was deposited at the property between 1977 and 1978. At the time of the assessment, a container storage yard was present to the south and west, a drainage ditch (referred to as the 96th Street Ditch and as Hamm Creek) was present north of the property, and stockpiled commercial topsoil was present to the east of the facility (GeoEngineers 1989).

Between 1999 and 2000, all CKD within 100 feet (buffer zone) of Hamm Creek and surrounding street right-of-ways was removed from the property. The CKD was placed on the balance of the site and the remaining exposed CKD was capped with soil, asphalt, and concrete (Figure 13). Stormwater conveyance systems were installed in the capped areas to channelize surface runoff to the clean buffer zone and ultimately Hamm Creek (Seattle Commercial 2001). Seattle Commercial Development filed a restrictive covenant agreement with King County Assessor on June 7, 2001 (Ecology 2001).

Ecology reviewed independent remedial actions conducted at the Markey property and determined the release of lead and arsenic (from CKD fill) into soil no longer posed a threat to human health or the environment. On August 10, 2001, Ecology issued a No Further Action (NFA) decision for the site. The NFA required that Seattle Commercial Development monitor leachate and surface water for five years and file a restrictive covenant on the property (Ecology 2001).

Metals concentrations in CKD and soil samples collected from the property exceed Puget Sound, Washington State and U.S. background concentrations. Arsenic, cadmium, and lead concentrations exceeded MTCA cleanup levels for soil. Cadmium, lead and silver concentrations exceeded the draft soil-to-sediment screening levels (Table 21).

Metals Concentrations in Former Markey Machinery Property CKD/Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Former Markey Machinery Property	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	2 - 210	7	7	5	1 – 5
Cadmium	2 - 4	1	1	0.06	0.01 – 0.07
Chromium	20 – 110	48	42	100	1 – 1,000
Copper	11 - 430	36	36	30	2 – 100
Lead	3 – 9,500	24	17	10	2 – 200
Zinc	31 – 2,500	85	86	50	10 – 300

Lead concentrations exceed the lead concentrations in U.S. CKD (17 – 1,750 mg/kg) as compiled by Haynes and Kramer (1982). Concentrations of the remaining metals are consistent with the ranges identified by Haynes and Kramer.

Groundwater and surface water were monitored at the site bi-monthly during the first year and quarterly for the next four years. Monitoring started in October 2001 and ended in August 2006. Ecology removed the facility from the Hazardous Sites List on September 21, 2009 (Ecology 2012). Groundwater monitoring data were not available for review. Surface water data from

1988 through 1996 are provided in Table 22. More recent surface water data were not available for review.

A cross-section from the Hart Crowser 1996 Remedial Action report shows that fill extends to the west as far as 8th Avenue S and east to parcel 5624200130 and possibly 14th Avenue S (Figure 14) (Hart Crowser 1996). CKD may be a component of the fill. Possible CKD fill was observed in a maintenance hole in S 96th Street (location D1) between 8th and 10th Avenue S (KTA 2012).

Additional information regarding the history and environmental investigations at the property is available in *Lower Duwamish Waterway, RM 3.8 to 4.2 West (Sea King Industrial Park), Summary of Existing Information and Identification of Data Gaps* (SAIC 2013).

3.2.12 Beckwith & Kuffel

Beckwith & Kuffel	
Source Control Area	RM 3.8-4.2 West (Sea King Industrial Park)
Property No.	23051
Tax Parcel No.	5624200351
Parcel Size	2.30 acres (100,188 sq ft)
SW Drainage Basin	S 96th Street SD / 8th Avenue CSO
Cleanup Site	VCP, LUST Site
Areal Extent of CKD fill	~17,700 sq ft
Vertical Extent of CKD fill	Variable, ~2 to 5 feet thick between 4 and 10 feet bgs

Beckwith & Kuffel operates on parcel 0351 (Figure 12). The facility is bordered by S 96th Street to the north, a strip mall to the east, Wooldridge Boats to the south, and an asphalt plant to the west.

A 1969 aerial photograph shows standing water across most of the property. Anecdotal evidence indicates that the property was swampland prior to its development in 1977 (Shannon & Wilson 2014). A 19,550 sq ft building is present on the property. Clarklift of Washington and FMH Materials Handling Solutions historically operated at the property.

CKD fill material is present in the northeastern portion of the property from approximately 4 to 10 feet bgs. The CKD fill is generally 2 feet thick, except near well MW-1 where approximately 5 feet of CKD fill was observed. Asphalt and the building footprint cover most of the area of CKD fill except for a small area along the northern property boundary. The CKD fill may extend beyond the property boundary (Figure 15). An approximately 5-foot-thick layer of peat is present beneath the CKD fill. Depth to water is approximately 3 feet bgs. Groundwater flow direction is towards the northeast (Shannon & Wilson 2014).

USTs were removed from the property in 1990. Environmental investigations were conducted at the property between 2012 and 2014. Summaries of all chemicals detected in environmental media at the properties are included in Tables 23 and 24.

Metals concentrations in CKD and soil samples collected from the property exceed Puget Sound, Washington State and U.S. background concentrations. Arsenic, cadmium, and lead concentrations exceeded MTCA cleanup levels for soil. Cadmium and lead concentrations exceeded the draft soil-to-sediment screening levels (Table 23).

Metals Concentrations in Beckwith & Kuffel CKD/Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Beckwith & Kuffel Property	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	188 – 375	7	7	5	1 – 5
Cadmium	10.9	1	1	0.06	0.01 – 0.07
Chromium	30	48	42	100	1 – 1,000
Copper	NA	36	36	30	2 – 100
Lead	5.35 – 3,280	24	17	10	2 – 200
Zinc	NA	85	86	50	10 – 300

Lead concentrations exceed the lead concentrations in U.S. CKD (17 – 1,750 mg/kg) as compiled by Haynes and Kramer (1982). Concentrations of the remaining metals are consistent with the ranges identified by Haynes and Kramer. The pH of CKD samples were 11.5 and 12. Leaching tests indicated that concentrations of arsenic and lead would not exceed the Characteristic Dangerous Waste criteria under WAC 173-303-090 (Shannon & Wilson 2014).

Groundwater sample results at the Beckwith & Kuffel property are summarized in Table 24. Concentrations of arsenic exceeded the MTCA Method B cleanup level, but did not exceed the draft groundwater-to-sediment screening level. Concentrations of lead exceeded the MTCA Method A cleanup level and the draft groundwater-to-sediment screening level.

Analyte	Concentration Range (ug/L)	MTCA Cleanup Level (ug/L)	Draft GW-to-Sediment Screening Level (ug/L)
Arsenic	2.48 – 10.8	0.058	370
Lead	1.54 – 1,910	15	13

Analyses were not performed to evaluate concentrations of other metals in groundwater. The pH of groundwater in the area of the CKD fill is as high as 13.3, but is more acidic outside the area of CKD fill (Shannon & Wilson 2014).

3.2.13 Duwamish Yacht Club and Delta Marine

Duwamish Yacht Club and Delta Marine	
Source Control Area	RM 3.8-4.2 West (Sea King Industrial Park)
Property No.	23011, 23012
Tax Parcel No.	0001600061 (Duwamish Yacht Club) 0001600029, 0001600062 (Delta Marine)
Parcel Size	0029: 5.00 acres (217, 797 sq ft) 0061: 4.40 acres (191,606 sq ft)

Duwamish Yacht Club and Delta Marine	
	0062: 2.09 acres (90,867 sq ft)
SW Drainage Basin	S 96th Street SD / LDW Direct / 8th Avenue CSO
Cleanup Site	No
Areal Extent of CKD fill	Unknown
Vertical Extent of CKD fill	Unknown

The Duwamish Yacht Club operates on parcel 0061 (Figure 16). The facility is bordered by Delta Marine to the south, the LDW to the east, the 93rd Street Business Park to the west, and KRS Marine to the north.

Delta Marine operates on parcels 0029, 0062, 5624200005, 5624200021, and 5624200006 (Figure 16). The facility is bordered by Hamm Creek to the south, West Marginal Place S and the 93rd Street Business Park to the west, the Duwamish Yacht Club and 93rd Street Business Park to the north, and the LDW to the east.

San Juan Concrete Products Company leased parcel 0029 between January 1963 and August 1965 (Rainier Bank 1978). In the mid-1960s, CKD was deposited on parcels 0029 and 0061 by San Juan Concrete Products Company. Between 1965 and 1974, parcels 0029 and 0062 (along with Duwamish Yacht Club parcel 0061) were used as a junkyard. Heavy machinery, iron barrels, tanks, and debris were present. The large junkyard may have extended west to West Marginal Way S (Duwamish Marina 1977; SDR 1994). CKD may have been deposited on parcel 0062, based on the similar historical uses for this parcel and parcels 0029 and 0061 (Figure 16).

The CKD was capped, and dredged material from the LDW was used as fill on the property (Greenleaf 2007). No environmental investigations have been performed to delineate the areal or vertical extent of CKD fill at these parcels.

Additional information regarding the history and environmental investigations at these parcels is available in *Lower Duwamish Waterway, RM 3.8 to 4.2 West (Sea King Industrial Park), Summary of Existing Information and Identification of Data Gaps* (SAIC 2013).

3.2.14 Port of Seattle Terminal 106 W

Port of Seattle Terminal 106 W	
Source Control Area	RM 0.0-0.1 East (Spokane Street to Ash Grove Cement)
Property No.	01003
Tax Parcel No.	7666700390
Parcel Size	31.30 acres (1,363,428 sq ft)
SW Drainage Basin	LDW Direct
Cleanup Site	No
Areal extent of CKD Fill	119,000 sq ft
Vertical extent of CKD Fill	12 – 23 feet bgs

CKD and other materials were used to fill the historical intertidal area at this location. Development began prior to 1936. The cement plant to the north of the property (currently Ash

Grove Cement) was presumably the source of the CKD fill (Figures 17 and 18). Boring logs indicate that there are discontinuous lenses of CKD fill interspersed with layers of silt. The silt layers appear to be natural alluvial deposits from the LDW. Structural fill was placed in 1952 prior to the construction of the present-day building. The top of the CKD fill layer is at approximately 12 feet bgs. Thickness of the fill varies from 2 to 11 feet. The bottom of the CKD fill layer is at 23 feet bgs (Pinnacle GeoScience 2007).

Samples were collected from the CKD fill in 2007. The pH values of the CKD samples were between 8.02 and 12.2. The pH values from the interbedded silt samples were between 8.04 and 11.5 (Pinnacle GeoScience 2007). Metals concentrations in CKD and soil samples collected from the property exceed Puget Sound, Washington State and United States background concentrations. Concentrations of arsenic and lead exceeded MTCA Method A cleanup levels in soil and groundwater samples collected from the CKD fill area (Pinnacle GeoSciences 2007).

Metals Concentrations in Port of Seattle Terminal 106 W CKD/Soil Samples Compared to Background Metals Concentrations in Puget Sound, Washington State, and United States (mg/kg)

Analyte	Terminal 106W	Puget Sound 90th percentile[a]	Statewide 90th percentile[a]	U.S. Average[b]	U.S. Common Range[b]
Arsenic	9.68 – 17.0	7	7	5	1 – 5
Lead	42.5 – 1,080	24	17	10	2 – 200

Concentrations of arsenic and lead are consistent with the ranges identified by Haynes and Kramer (1982).

Additional information regarding the history and environmental investigations at Terminal 106W is available in *Property Review, Container-Care International, Inc., Port of Seattle – Terminal 106W/Terminal 108* (SAIC 2003) and *Lower Duwamish Waterway, Source Control Action Plan for the Duwamish/Diagonal Way Early Action Cleanup* (Ecology 2004b).

3.3 Suspected or Potential CKD Fill Sites in the LDW Basin

Suspected or potential CKD sites were identified using soil boring information from the GeoMapNW subsurface database, documents reviewed during the preparation of this report, and LDW Data Gaps Reports and Source Control Action Plans.

3.3.1 Potential CKD Sites Based on GeoMapNW Subsurface Database

Soil boring information from GeoMapNW indicates that CKD fill may be present at the following properties/parcels (Table 1).

West side of LDW

- Residential property, parcel 7891600335 (Figure 19)
- South Seattle Community College, parcel 6171900005 (Figure 20)
- Alaska Marine Lines, parcel 1924049026 (Figure 5)
- The Overlook at Westridge, parcel 3024049024 (Figure 21)
- Former Gravel Pit, parcel 0523049012 (Figure 22)

East side of LDW

- RR Row, parcel 3957900075 (Figure 23)
- Mallory & Church, parcel 7376600035 (Figure 24)
- Former Safelite Auto Glass, parcels 7886100450 and 7886100472 (Figure 24)
- Model Werks, parcel 7886100430 (Figure 24)
- Western Peterbilt, parcel 7886100670 (Figure 24)
- Atlas Supply, parcel 7666203975 (Figure 24)
- International Truck Leasing, parcel 7886100290 (Figure 24)

The above parcels, with the exception of the RR Row property and possibly the former Safelite Auto Glass and Model Werks properties, may be part of the City of Seattle refuse dumps identified in *Duwamish Ground Water Studies, Waste Disposal Practices and Dredge and Fill History* by Harper-Owes (1985). The refuse dumps received general refuse, dredge material and served as the Industrial District dump. Harper-Owes (1985) reported that excess transformers and a variety of wastes were deposited at the southern dump sites. CKD may have been used as a landfill cover. If this is the case, CKD may be present across the entire area bounded by S Charlestown Street, Airport Way S, S Industrial Way or S Dakota Street, and 6th Avenue S (Figure 24). The former refuse dumps were identified by Harper-Owes as Nos. 12 a, b, and c.

3.3.2 Potential CKD Sites Based on Document Reviews

Documents reviewed during the preparation of this report indicated that CKD fill materials may be present at the following properties.

Riverside Mill Property

The Riverside Mill Property is located at 3800 West Marginal Way SW, immediately south of Terminal 5 (Figure 19). Approximately 60 cubic yards of CKD from Birmingham Steel (historical operator) were imported from this facility to the Seaport Petroleum Property (Cargill 1995). There was a slag dump and a waste storage pile for flame trap sludge (Harper-Owes 1985).

Sound Delivery Service

An Ecology memorandum from January 1990 indicates that CKD fill is present on the Sound Delivery Service property (Figure 25). Leachate from the fill had pH levels between 8 and 12 (Ecology 1990).

Port of Seattle Terminal 106 E, Warehouse W-6

Potential CKD waste piles at the north end of the Warehouse W-6 property of Terminal 106 E (Figure 23) were identified in *Duwamish Ground Water Studies Waste Disposal Practices and Dredge and Fill History* (Harper-Owes 1985). The waste piles are identified as No. 14 by Harper-Owes (1985).

Northwest Corporate Park

A potential CKD waste pit at the Northwest Corporate Park (Figure 26) was identified in *Duwamish Ground Water Studies Waste Disposal Practices and Dredge and Fill History* (Harper-Owes 1985). The waste pit is identified as No. 20 by Harper-Owes (1985).

3.4 Known and Suspected CKD Fill Sites Outside the LDW Basin

3.4.1 Port of Seattle Terminal 5

Witness testimony documented in the Duwamish Marina lease arbitration indicates that cement tailings presented “environmental cleanup issues” during the expansion of Terminal 5 in 1994 (SDR 1994). Terminal 5 is listed on the CSCSL. The ISIS database indicates that groundwater and sediments are contaminated by metals. The site status is “cleanup started”. CKD sites at Terminal 5 are identified by Nos. 10 and 11 by Harper-Owes (1985).

3.4.2 Harbor Island

A potential CKD waste pile on Harbor Island is identified in *Duwamish Ground Water Studies Waste Disposal Practices and Dredge and Fill History* (Harper-Owes 1985). The waste pile is identified as No. 6.

3.4.3 Fostoria Business Park

Fostoria Business Park	
Tax Parcel No.	2613200084, 2613200085, 8700200010, 8700200020
Parcel Size	0010: 1.45 acres (63,110 sq ft) 0020: 1.76 acres (76,746 sq ft) 0084: 5.01 acres (218,235 sq ft) 0085: 1.54 acres (67,082 sq ft)
Cleanup Site	American Tire Wholesalers: VCP (former) Fostoria Park Industrial Center: Independent Remedial Action Program (former)
Areal extent of CKD Fill	140,000 sq ft
Vertical extent of CKD Fill	Unknown

Fostoria Business Park is a commercial and light industrial business park in Tukwila. In about 1974, CKD was used as fill to create the current site grade. At the time that the CKD was placed on the site, all four parcels had a single owner, but were later sold to different owners. Initial investigations at Fostoria Business Park were performed across all parcels, but later investigations and compliance monitoring programs were performed independently by each property owner. Subsequently, Ecology identified the sites within Fostoria Business Park as:

- ***Fostoria Park Industrial Center*** (Parcel No. 2613200084) has three buildings (A, B & C). There is CKD under a portion of two of buildings (A & C). This property is owned by North Stream Properties Inc. (a.k.a. North Stream Development).

- ***Fostoria Park Buildings D & E*** (Parcels Nos. 8700200010 and 8700200020) has two buildings (D & E). Both buildings sit entirely on CKD. The properties are owned by Fostoria Park Association LLC. Historically, these parcels were a single parcel (Parcel No. 2613200086).
- ***American Tire Wholesalers*** (Parcel No. 2613200085) has one building (former American Tire Wholesalers, World Tire, Johnson Estate property, Total Door Supply, Inc.). There is CKD under a small portion of the northeast part of the building. The property is currently owned by Havenbury Holdings.

Information regarding Fostoria Park Industrial Center was available for review. Ecology granted an interim NFA for the site in June 1999 with the conditions that the property owner maintain the Restrictive Covenant filed on the property and conduct compliance groundwater monitoring (Ecology 1999).

Groundwater compliance monitoring results at the Fostoria Park Industrial Center are summarized in Table 25. Two groundwater monitoring wells were installed at the Fostoria Park Industrial Center for compliance monitoring in 1996. Both wells were screened in the CKD fill. In 1999, well MW-1001 was abandoned due to the experiencing artesian conditions (Ecology 2000). Well MW-1002 was monitored for the duration of the compliance monitoring program from 1996 to 2003. Concentrations of arsenic, lead, copper, and zinc decreased during the seven year program. Total lead concentrations in well MW-1002 occasionally exceeded the groundwater-to-sediment screening level; however dissolved lead concentrations were below screening levels. Dissolved lead concentrations were not detected in groundwater after 2001 (Hart Crowser 2004). In August 2004, Ecology granted an NFA for the site, stating the compliance monitoring was satisfactorily completed (Ecology 2004c).

Ecology reviewed groundwater monitoring data from Fostoria Park Buildings D & E and American Tire Wholesalers in 2004. Ecology concluded that metal partitioning from soil to groundwater had diminished to trace levels and were below Surface Water WQS for fresh water (Madakor 2004).

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Figures

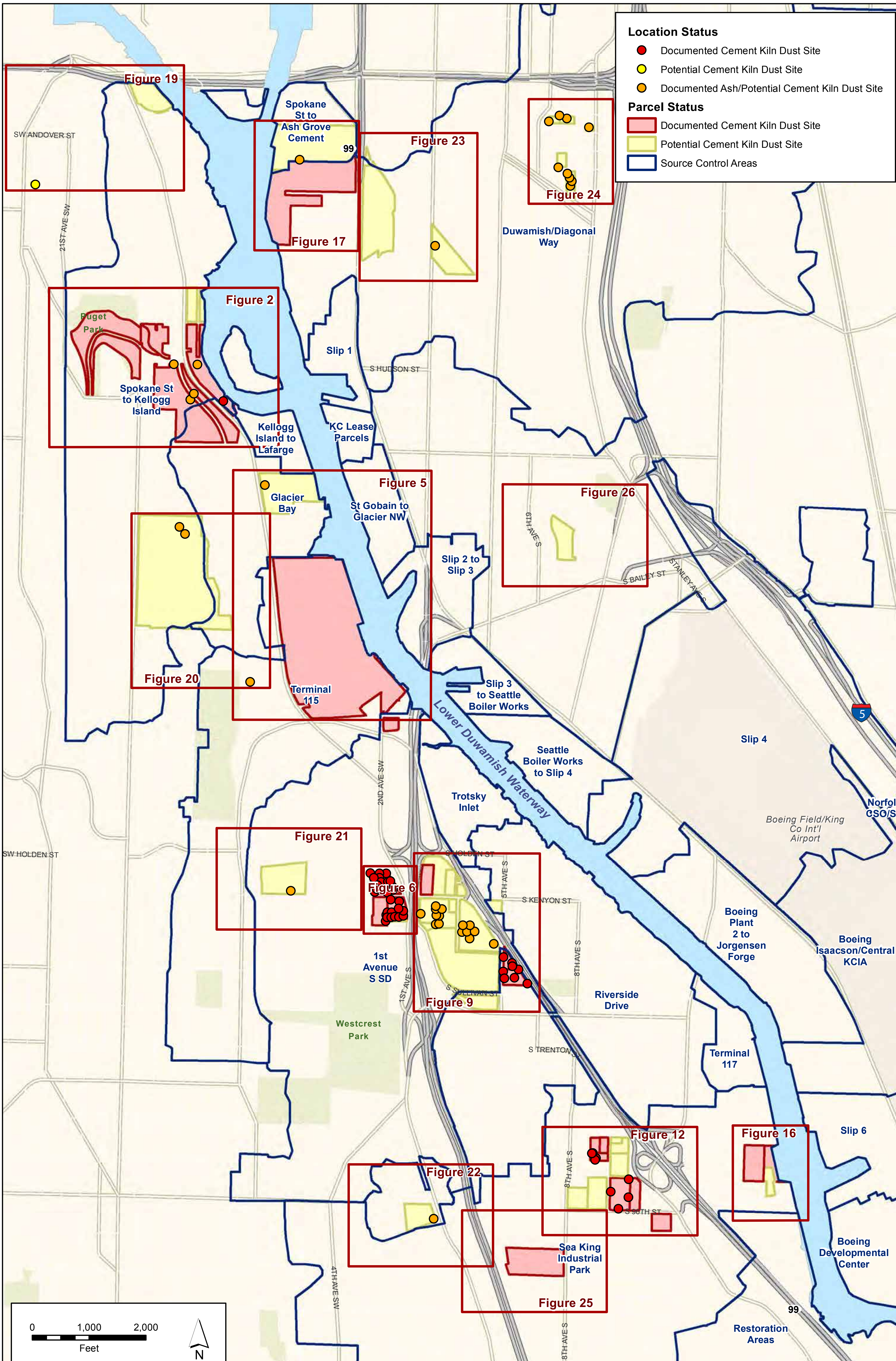

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Figure 1. Overview of Known and Potential Cement Kiln Dust Locations within the LDW Basin

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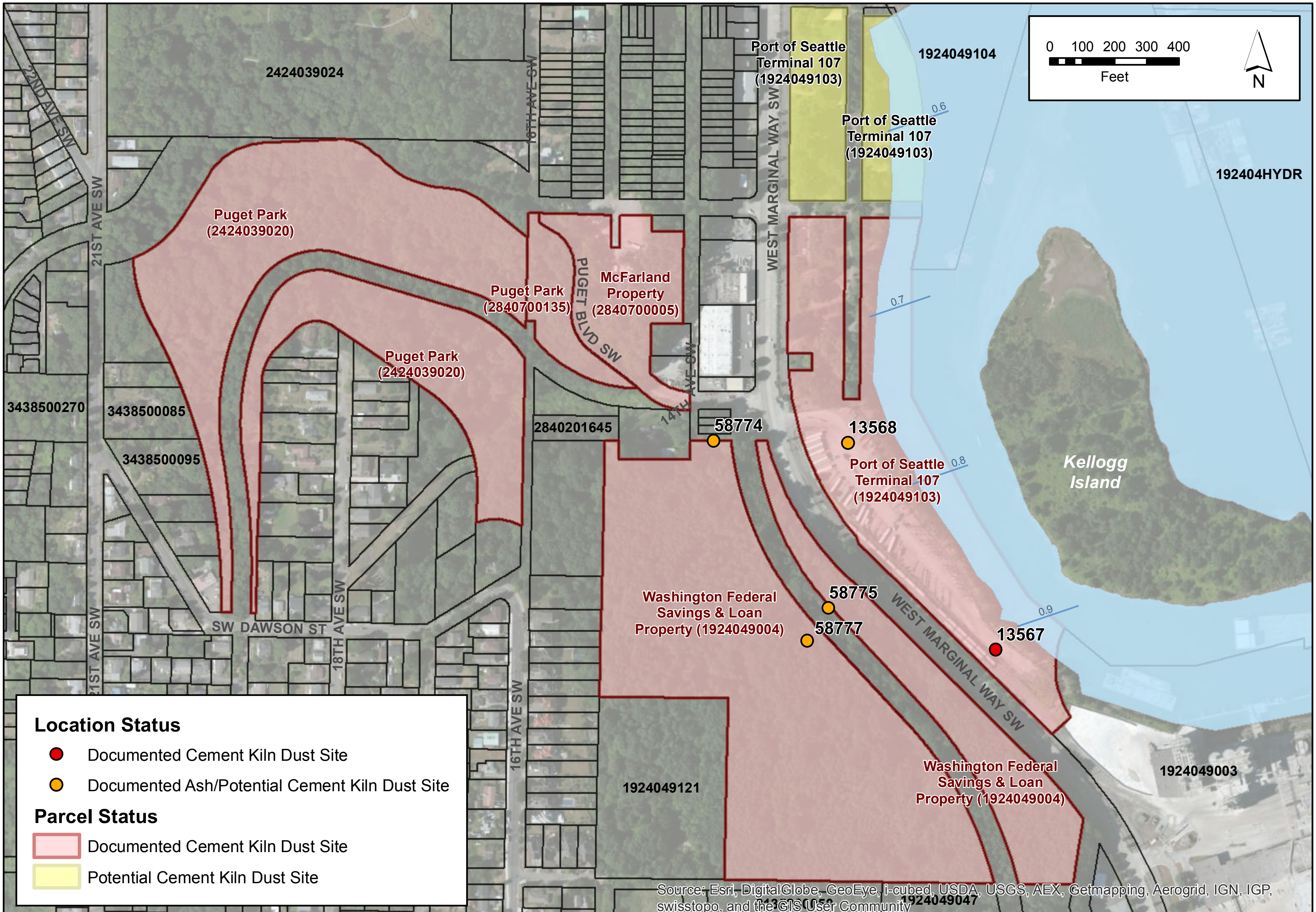

Source: GeoMap NW

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Figure 2. Cement Kiln Dust Locations: Puget Park, the McFarland Property, and Washington Federal Savings and Loan Property

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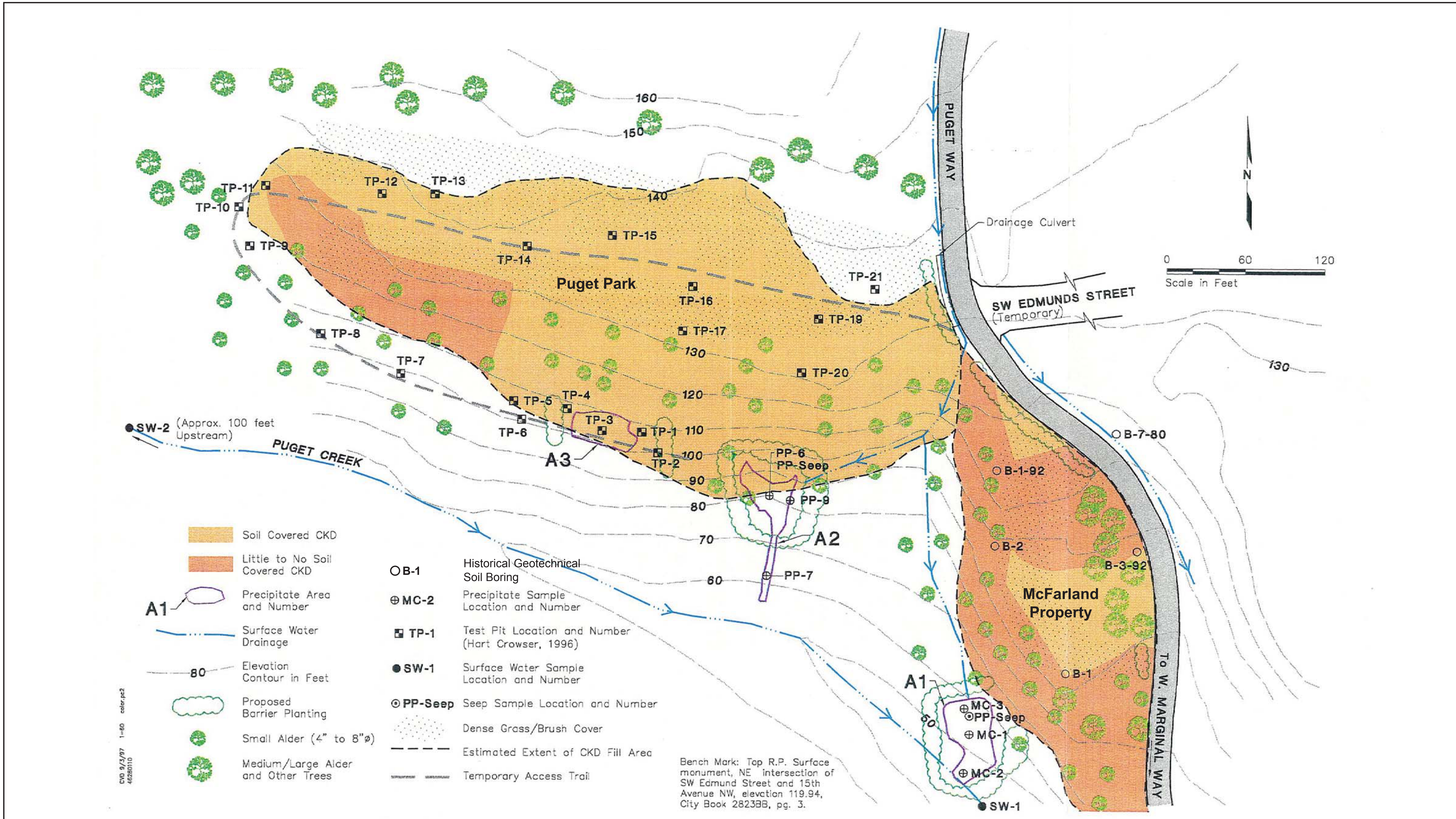

Source: Hart Crowser 1996

Figure 3. Extent of Cement Kiln Dust: Puget Park and the McFarland Property

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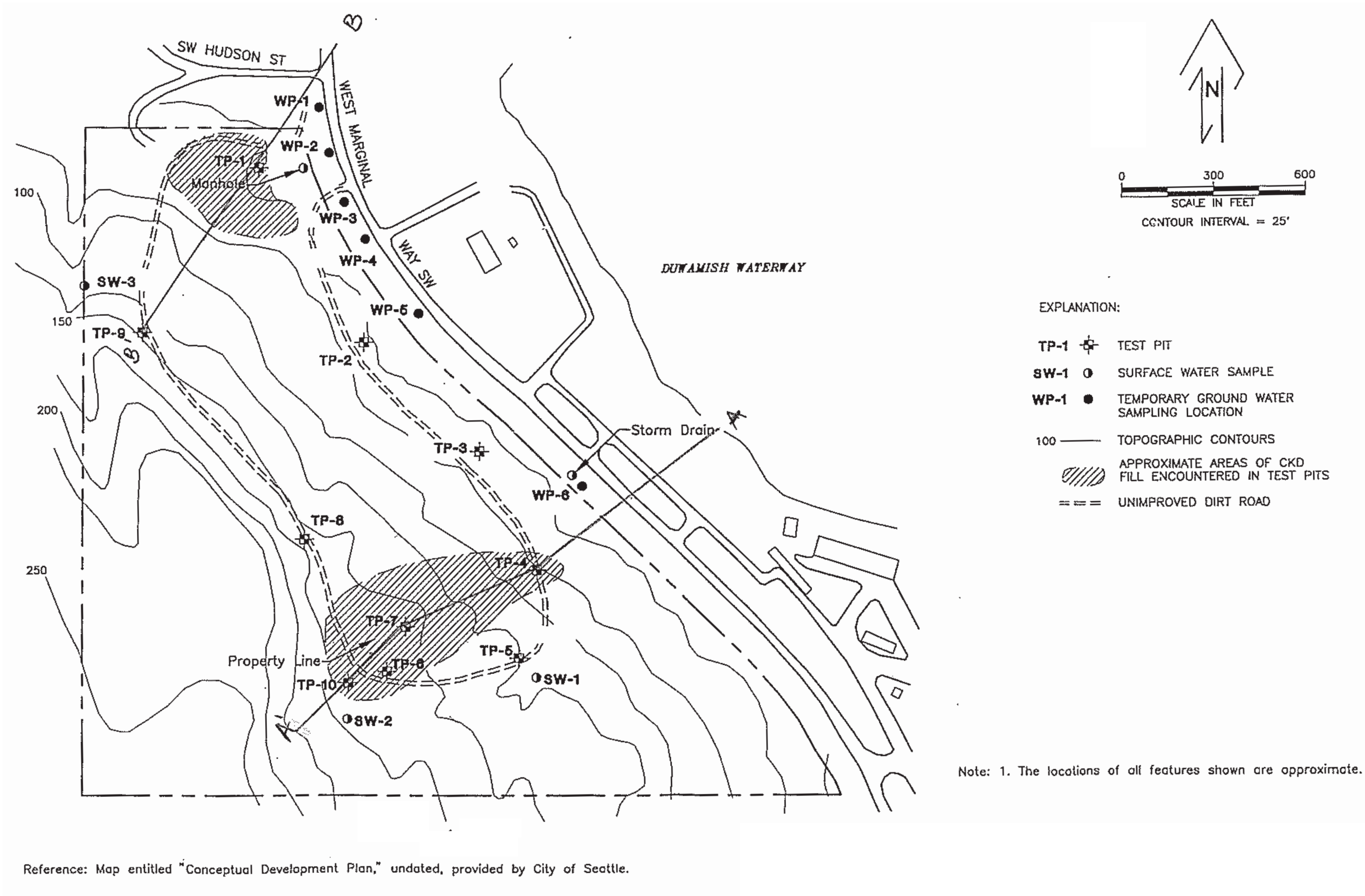
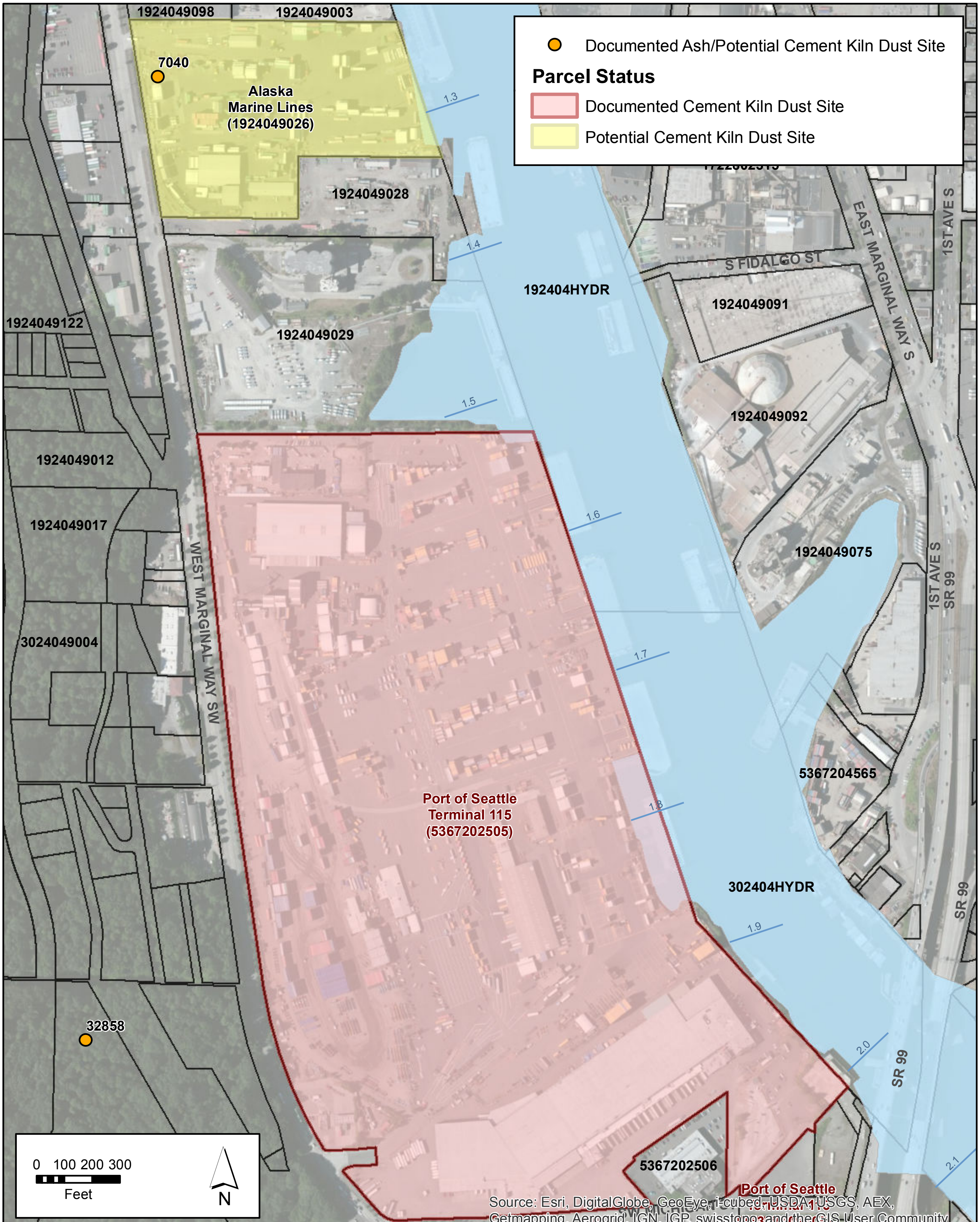


Source: GeoEngineers 2003

Figure 4. Extent of Cement Kiln Dust: Washington Federal Savings and Loan Property



Source: GeoMap NW

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Figure 5. Cement Kiln Dust Locations: Terminal 115

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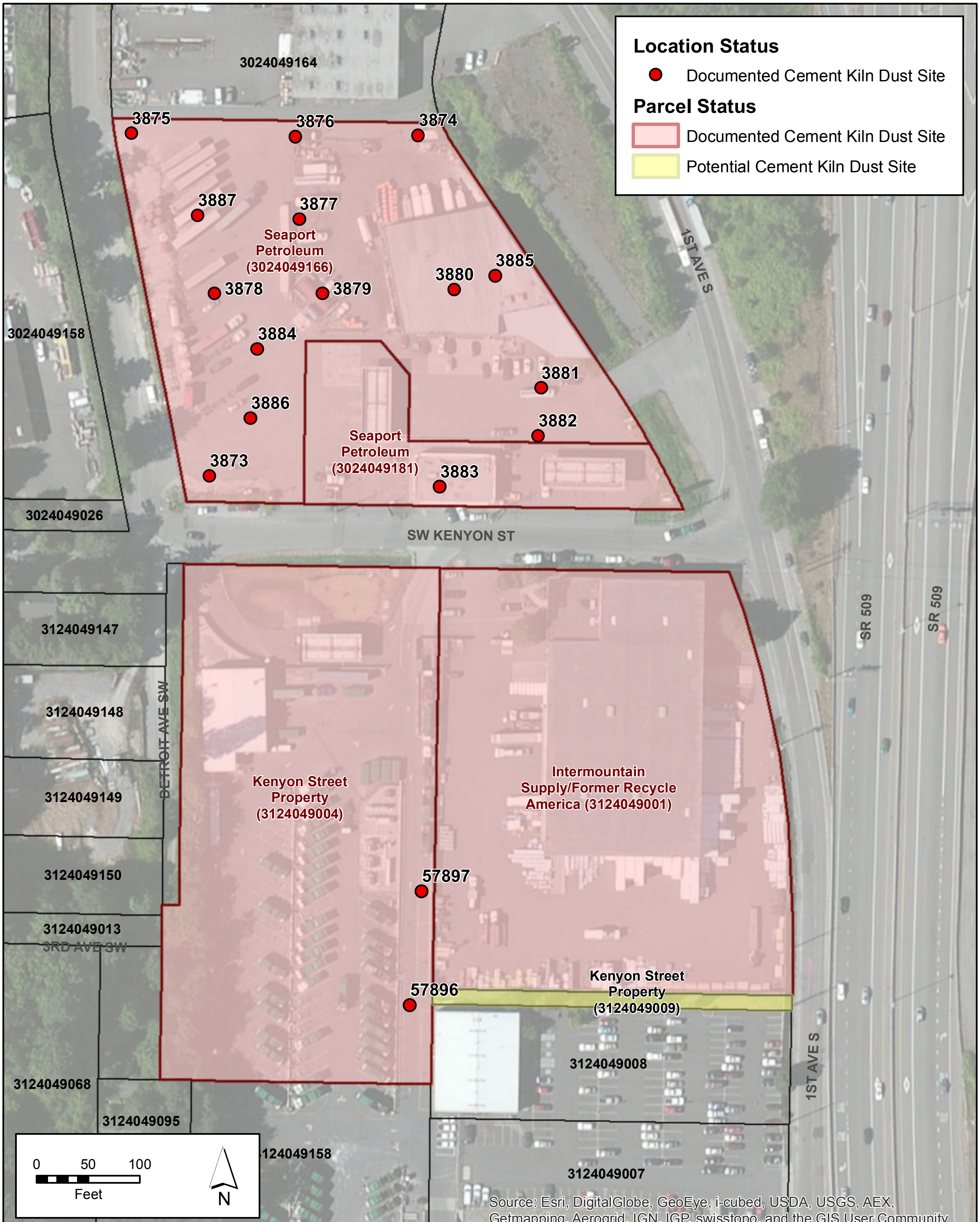

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Figure 6. Cement Kiln Dust Locations: Seaport Petroleum, Intermountain Supply and Kenyon Street Property

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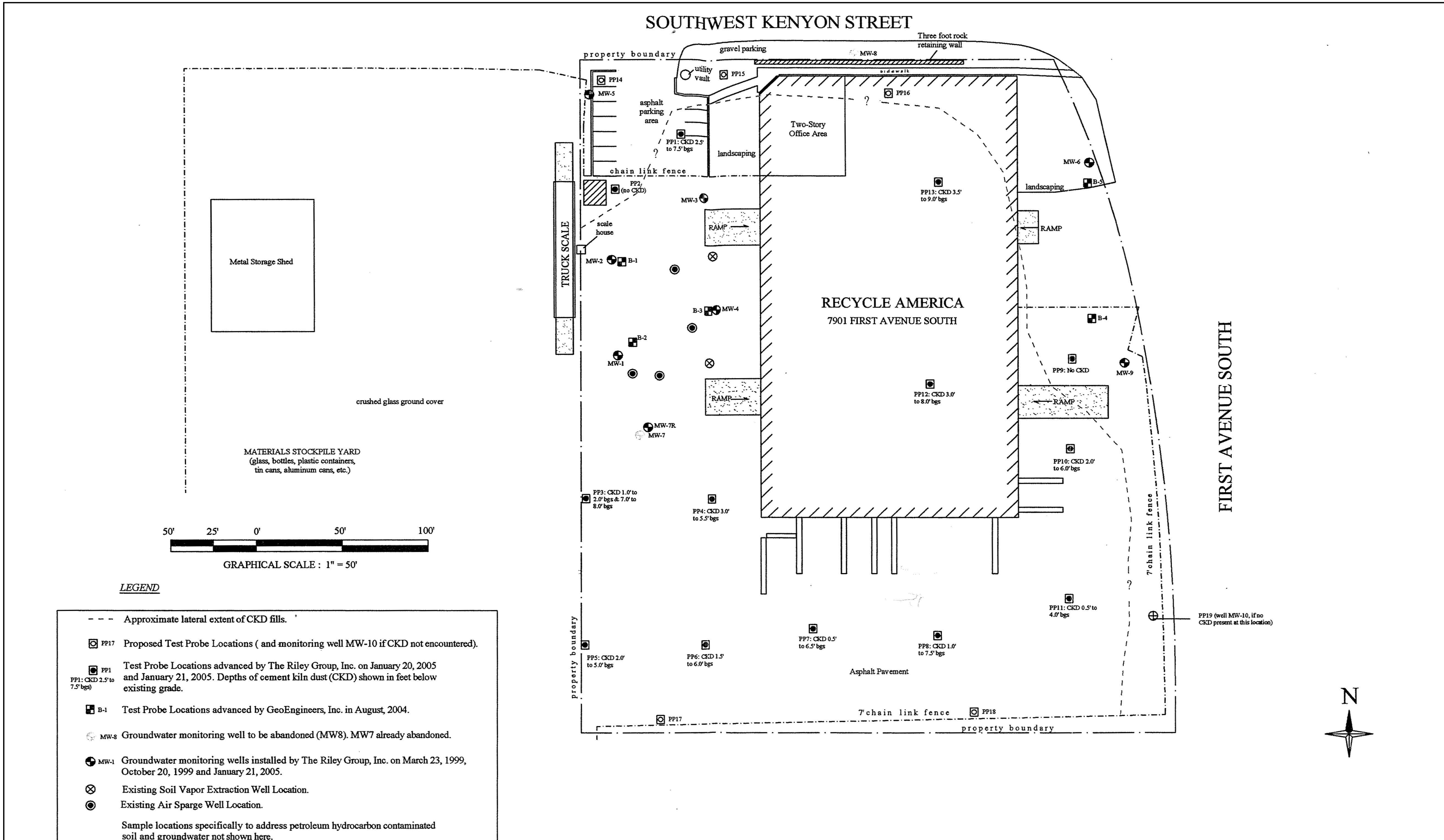

Source: Riley Group 2005

Figure 7. Extent of Cement Kiln Dust Fill: Intermountain Supply Property

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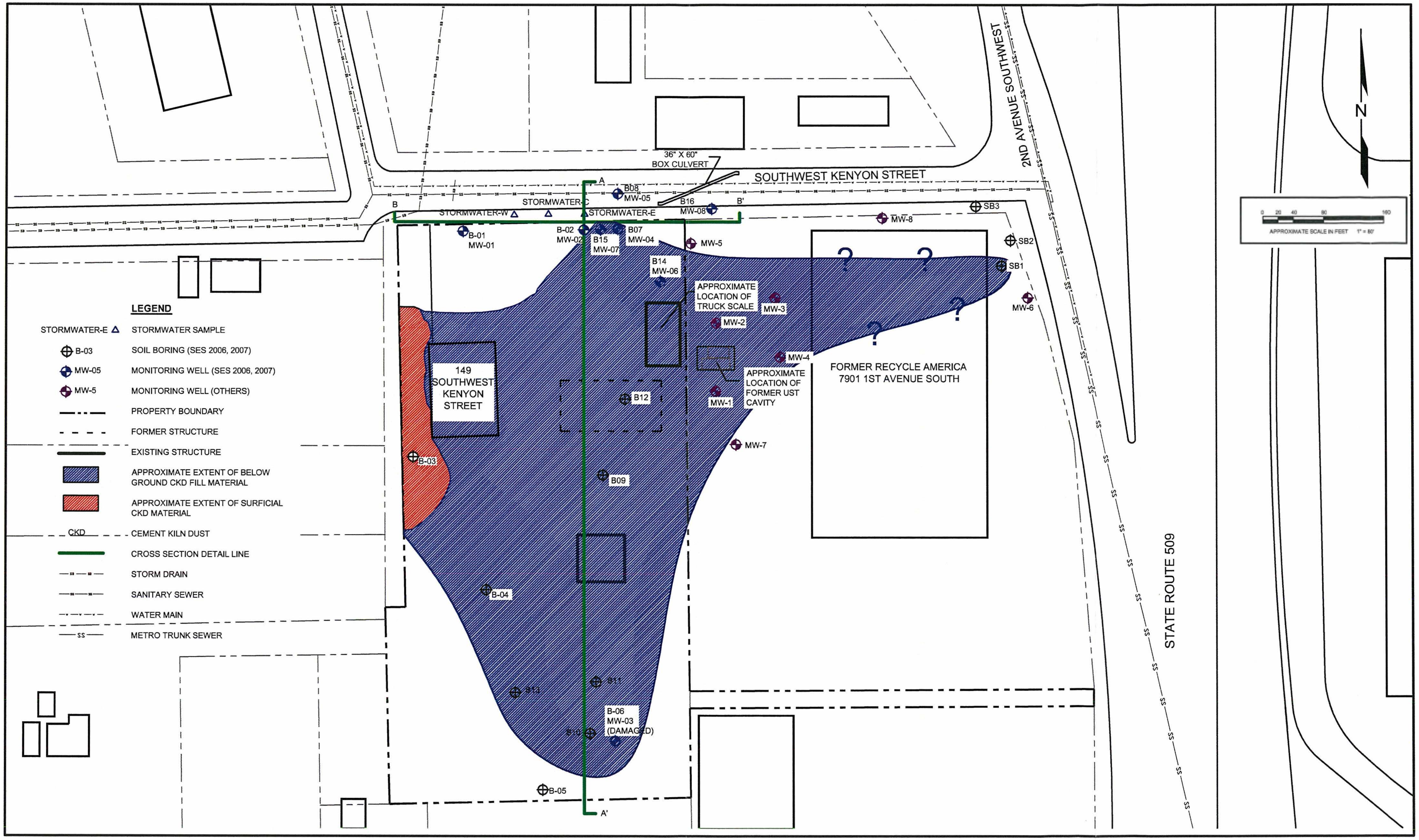

Source: SES 2007

Figure 8. Extent of Kiln Dust Fill: Kenyon Street Property

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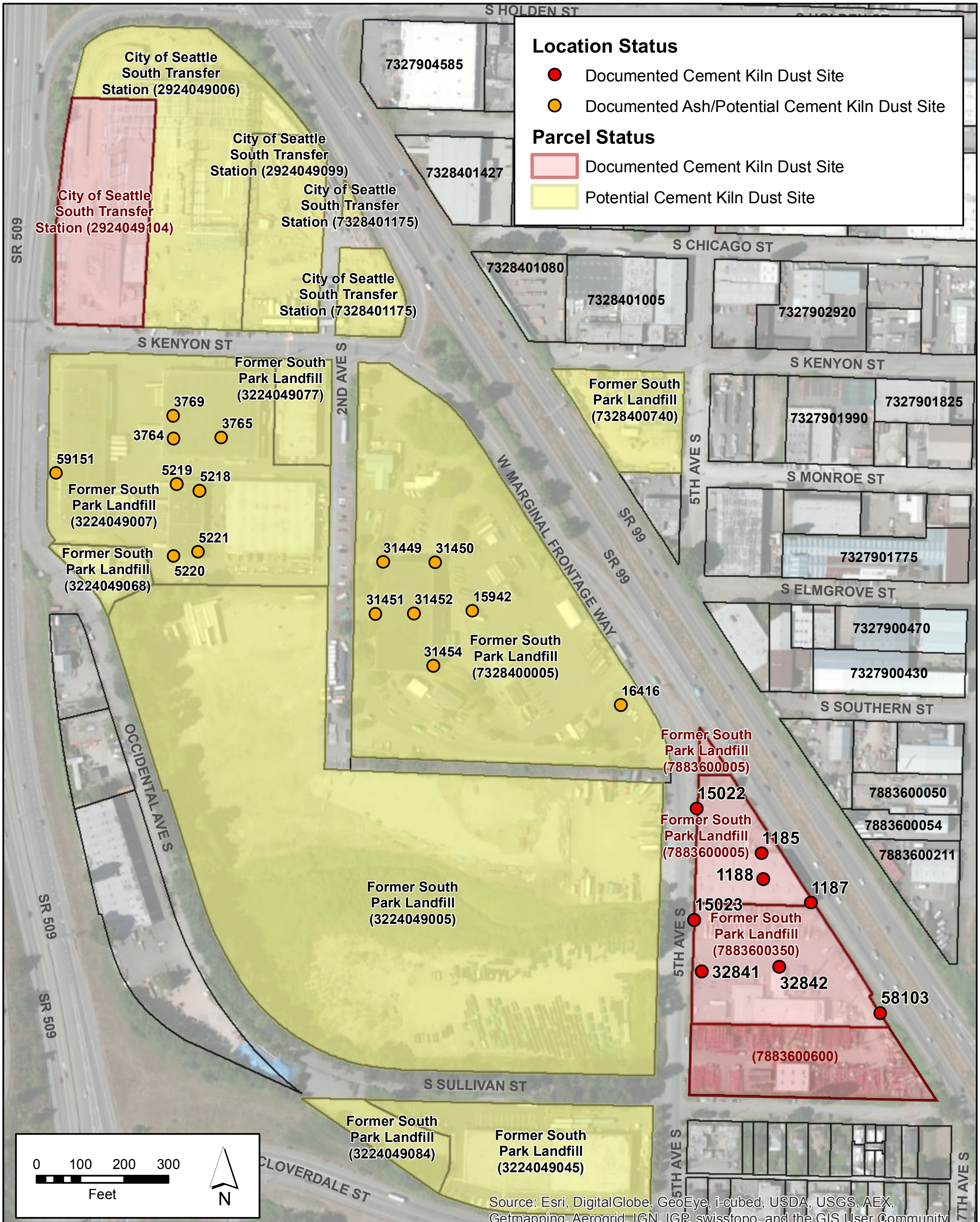

Source: GeoMap NW

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Figure 9. Cement Kiln Dust Locations: City of Seattle South Transfer Station Property and former South Park Landfill

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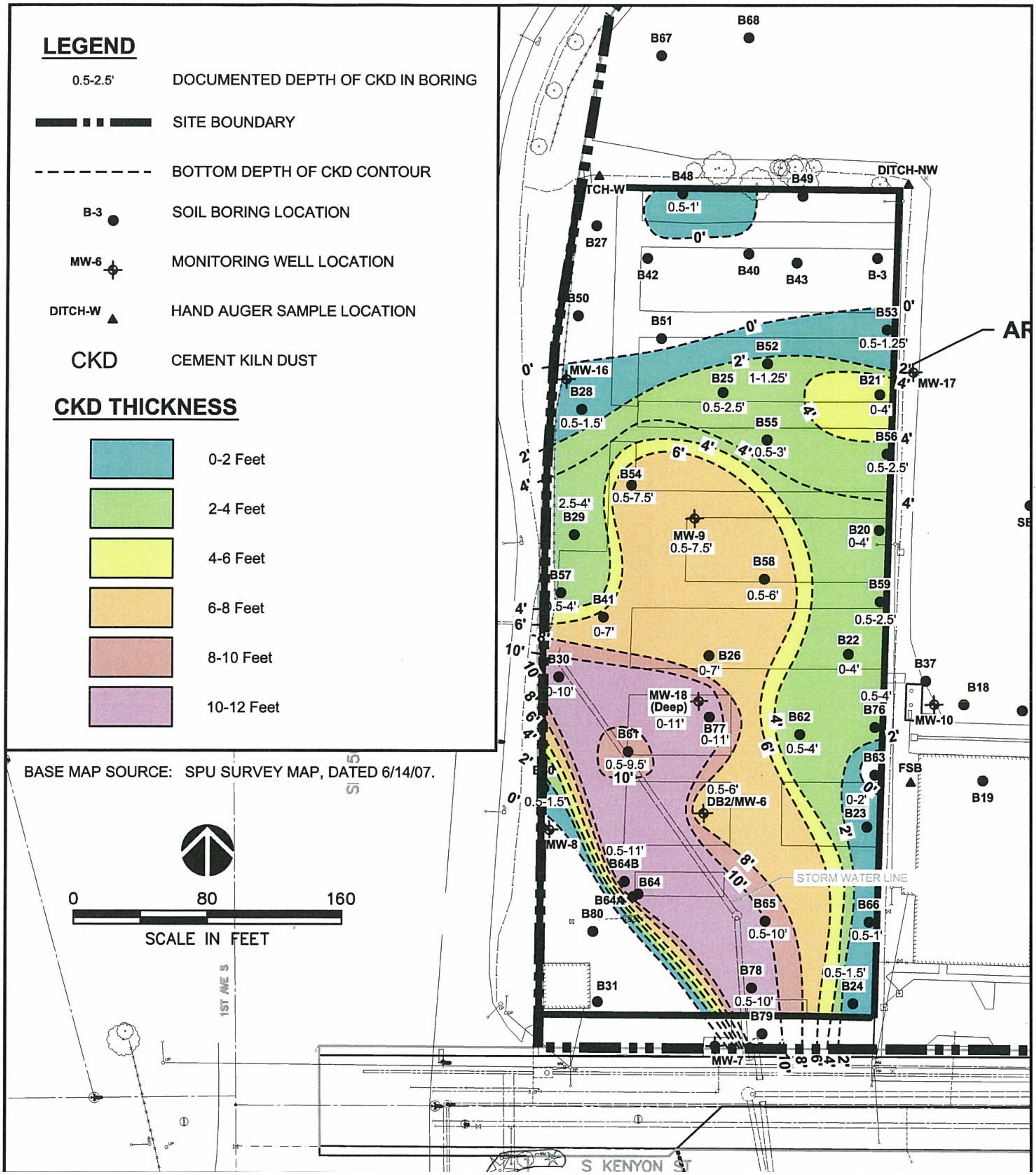
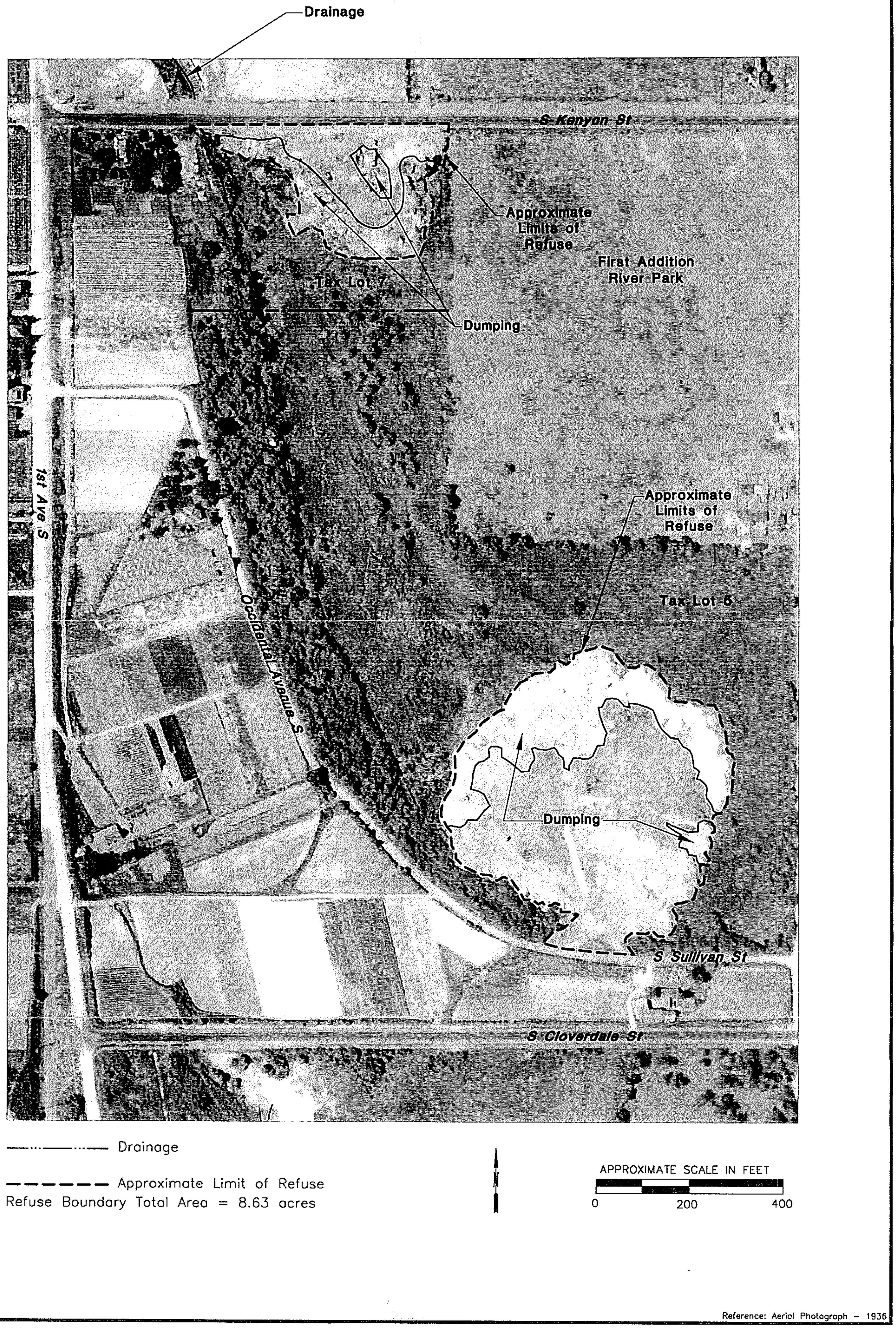


Source: AMEC 2009

Figure 10: Extent of Cement Kiln Dust: City of Seattle South Transfer Station Property



Source: AESI 1998

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Figure 11. Potential CKD Fill, Former South Park Landfill (1936)

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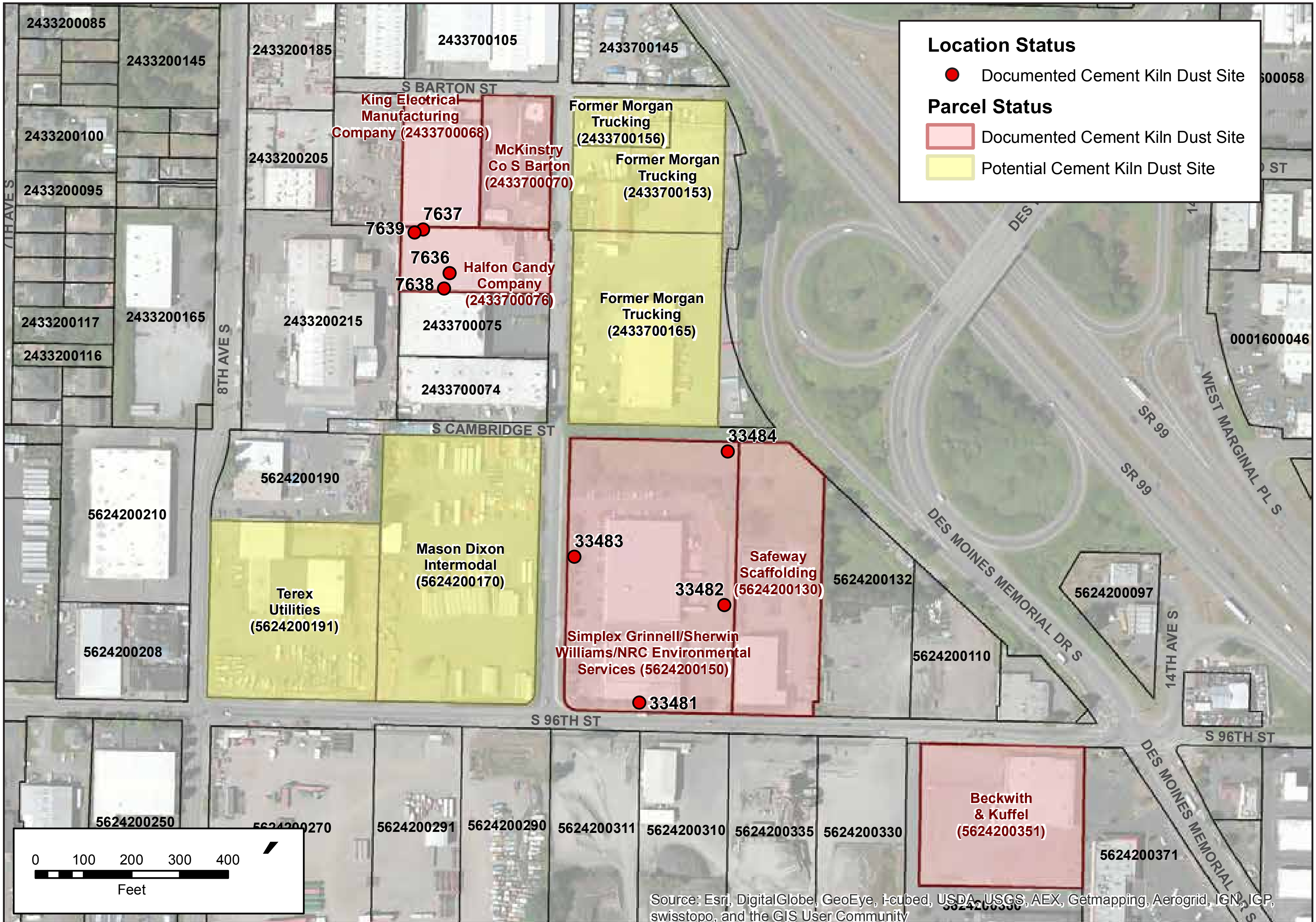

Source: GeoMap NW

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Figure 12. Cement Kiln Dust Locations: S 96th Street in the LDW Basin

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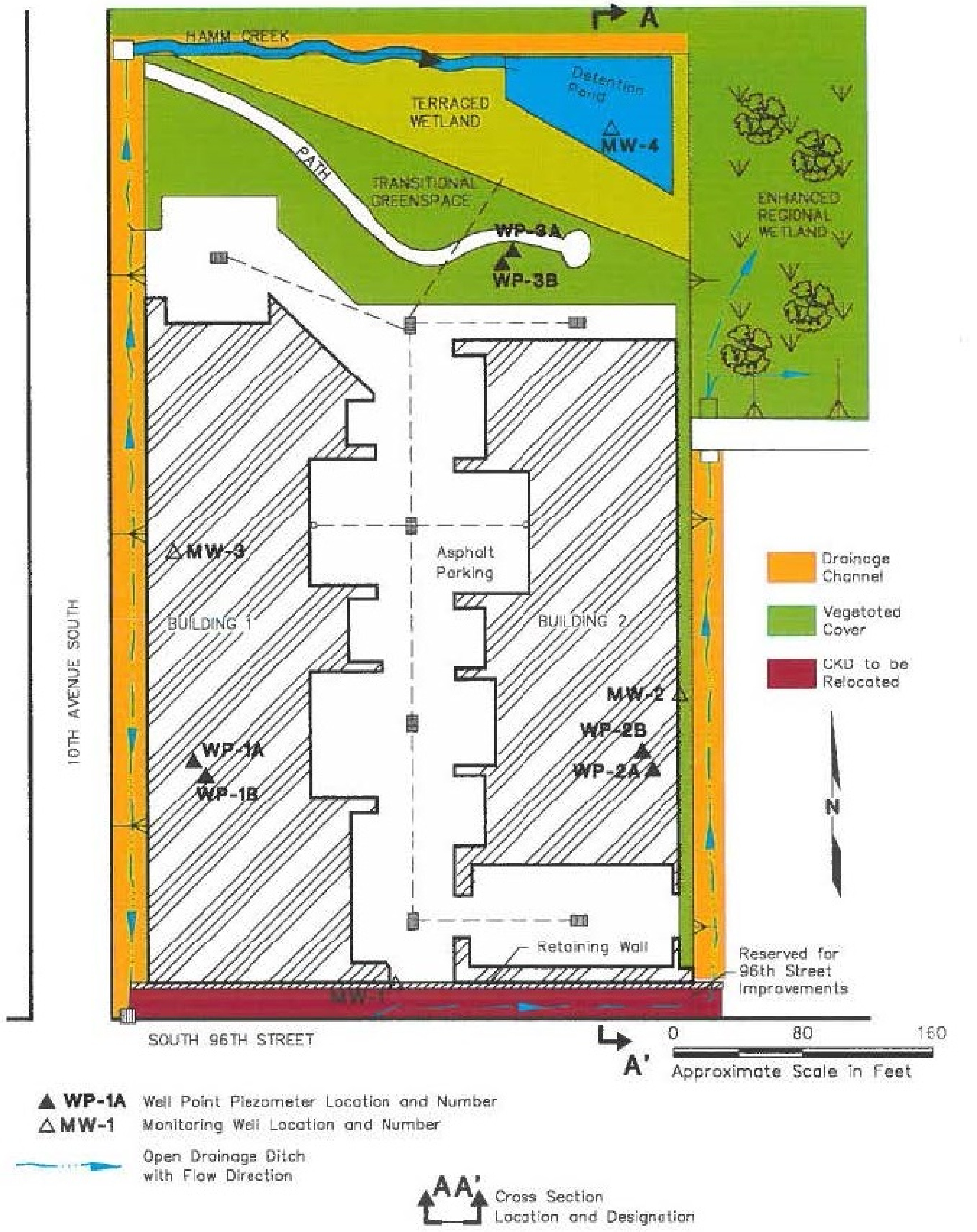

Source: Hart Corwser 1996

Figure 13. CKD Removal, Former Markey Machinery Property

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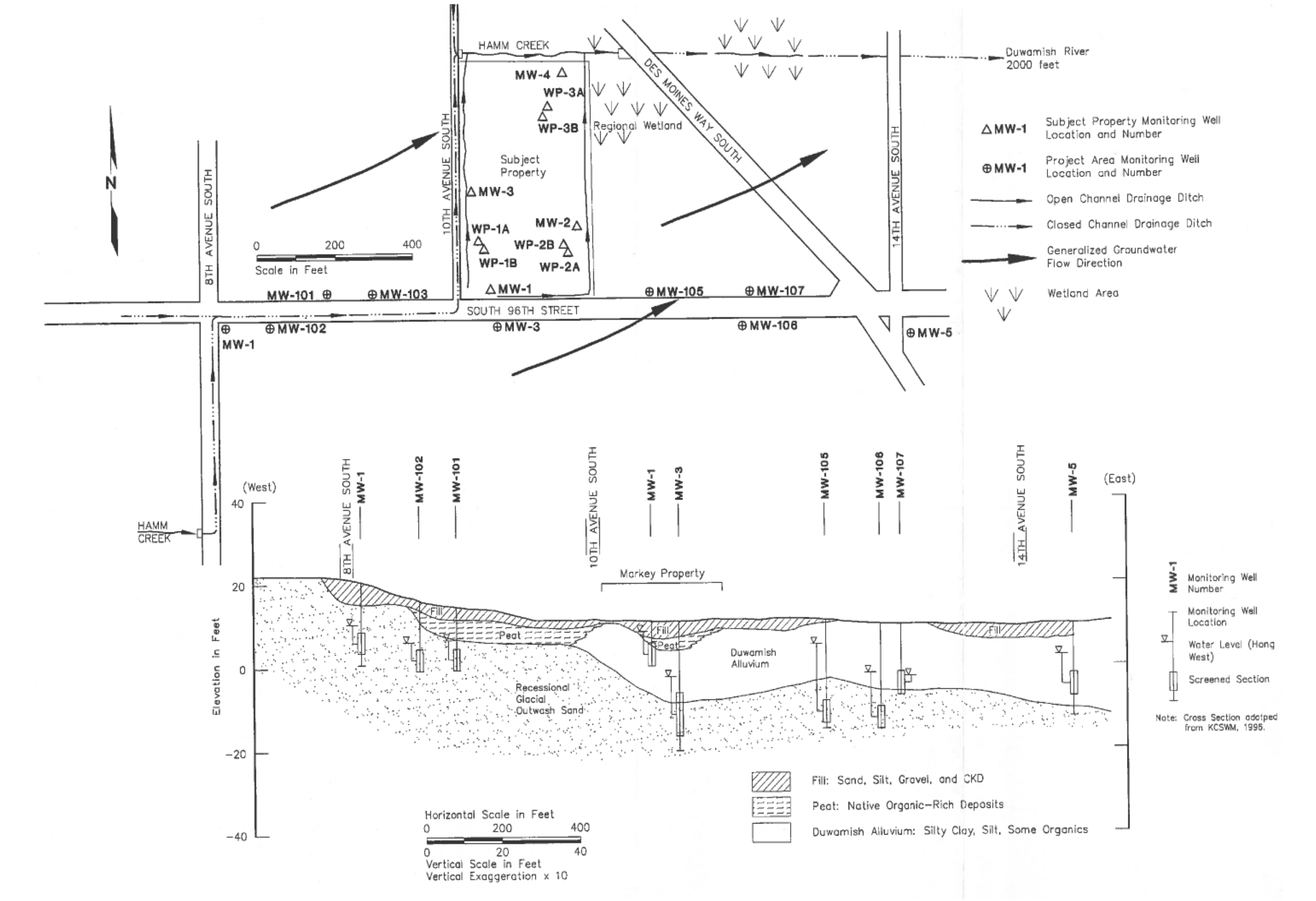
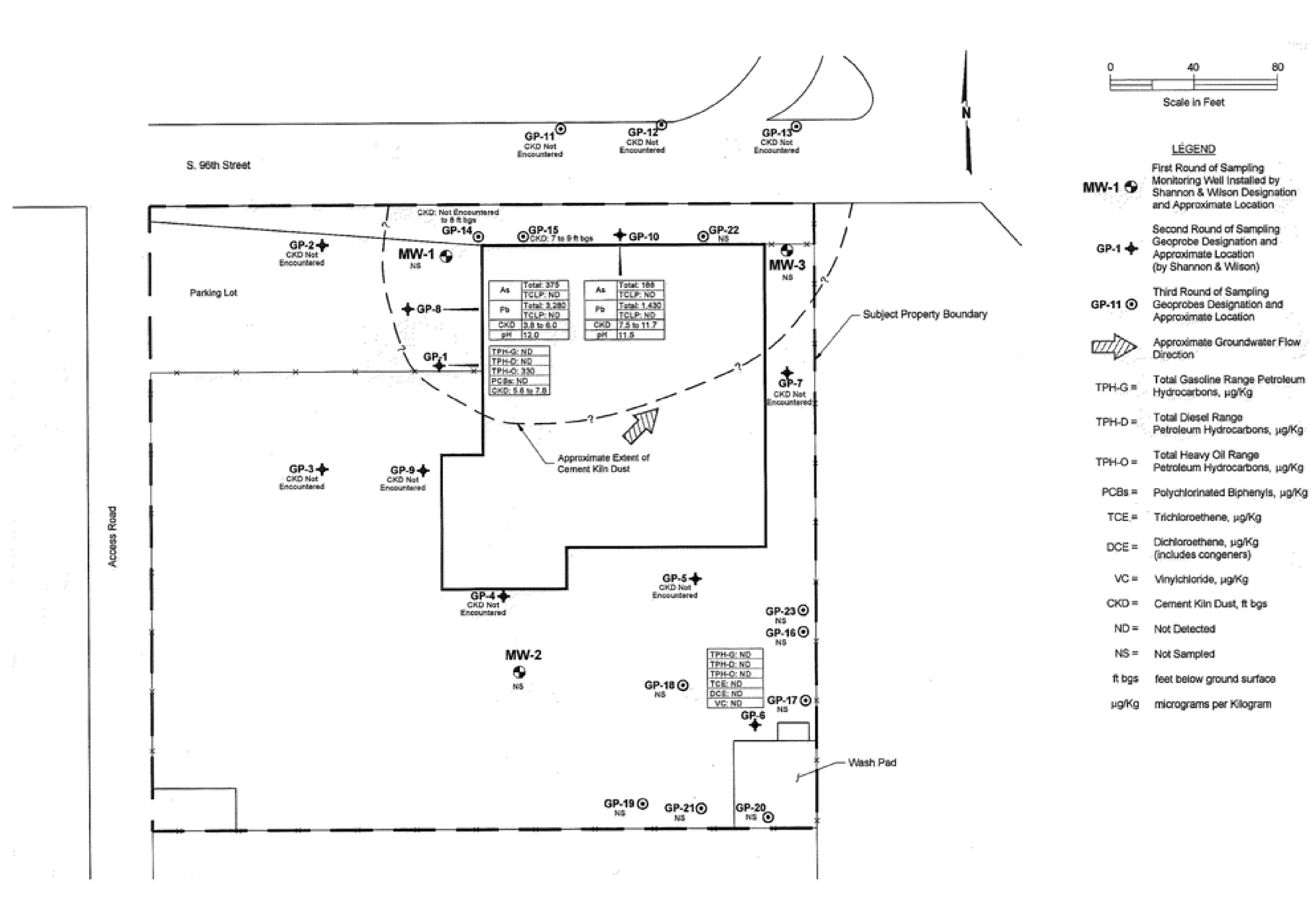


Source: Hart Crowser 1996

Figure 14. Hydrogeologic Cross-Section of S 96th Street



Source: Shannon & Wilson 2014

Figure 15. Extent of Cement Kiln Dust Fill: Beckwith & Kuffel Property

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Figure 16. Cement Kiln Dust Locations: Duwamish Yacht Club and Delta Marine

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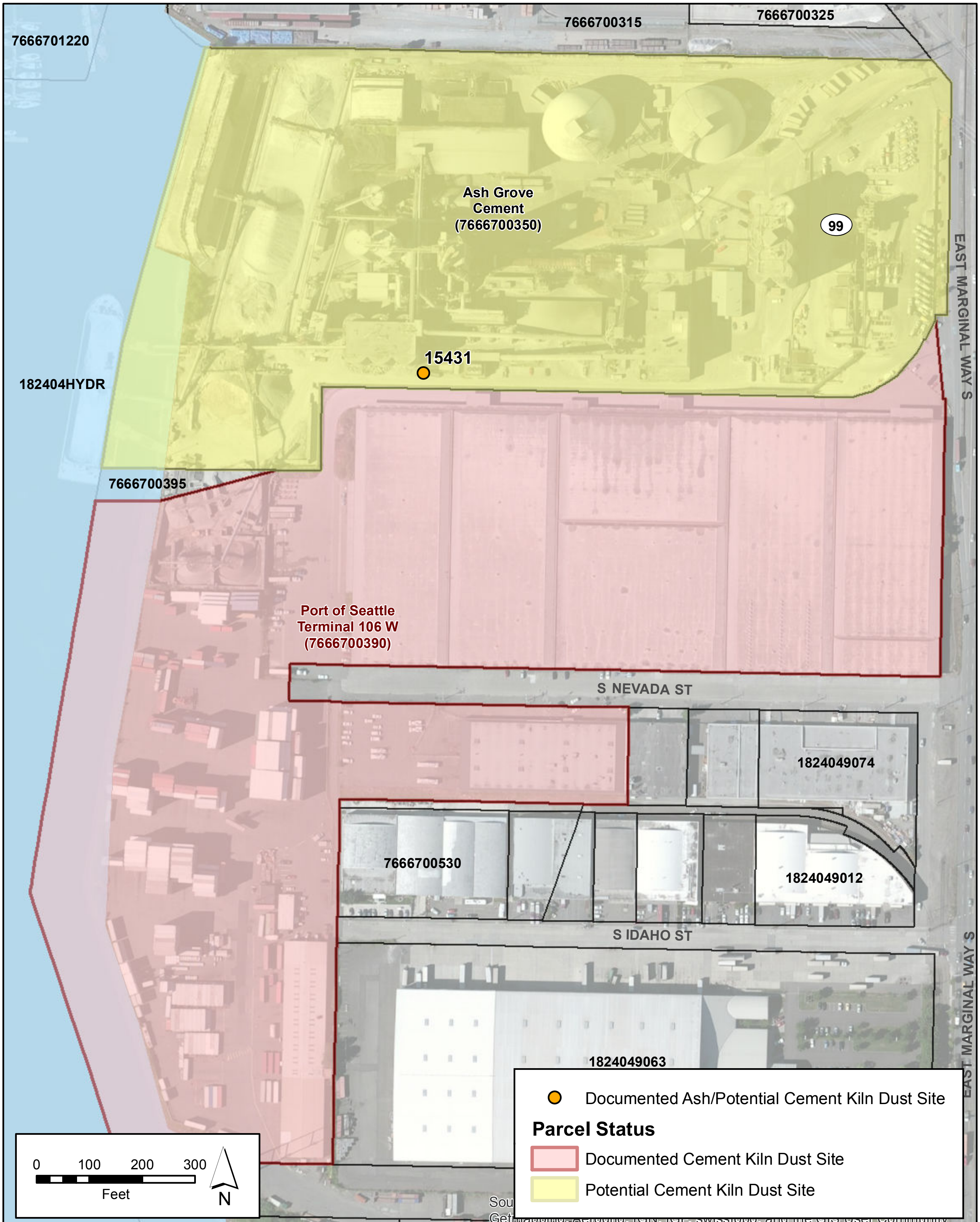

Source: GeoMap NW

Figure 17. Cement Kiln Dust Locations: Ash Grove Cement and Port of Seattle Terminal 106 W

Explanation

- **BH-1** ● Geotechnical exploration by PanGeo in 2005.
- **CKD-1** ○ Exploration to evaluate CKD conditions.
- **T1-1** ○ Exploration to evaluate underground storage tank conditions.
- **Tank 3** ▬ Underground storage tank size and location and surrounding patch (typical).

Approximate Scale: 1-inch = 100 feet
The locations of all features are approximate.
1936 Aerial Photograph from Walker & Associates.
2002 Aerial Photograph from Google Earth.

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Figure 18. Extent of Cement Kiln Dust: Port of Seattle Terminal 106 W

Source: Pinnacle GeoSciences 2007

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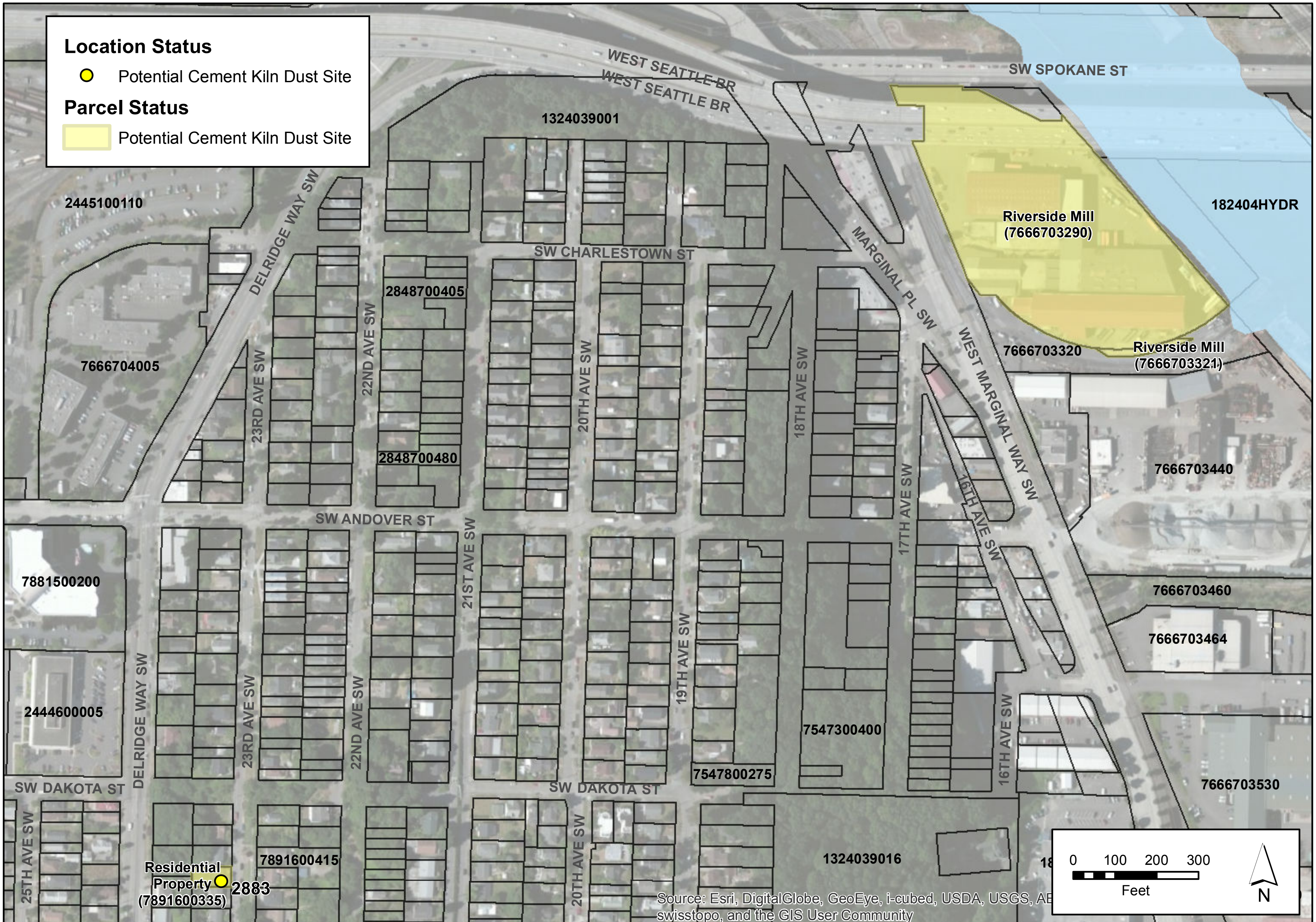

Source: GeoMap NW

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Figure 19. Cement Kiln Dust Locations: Riverside Mill and Residential Property

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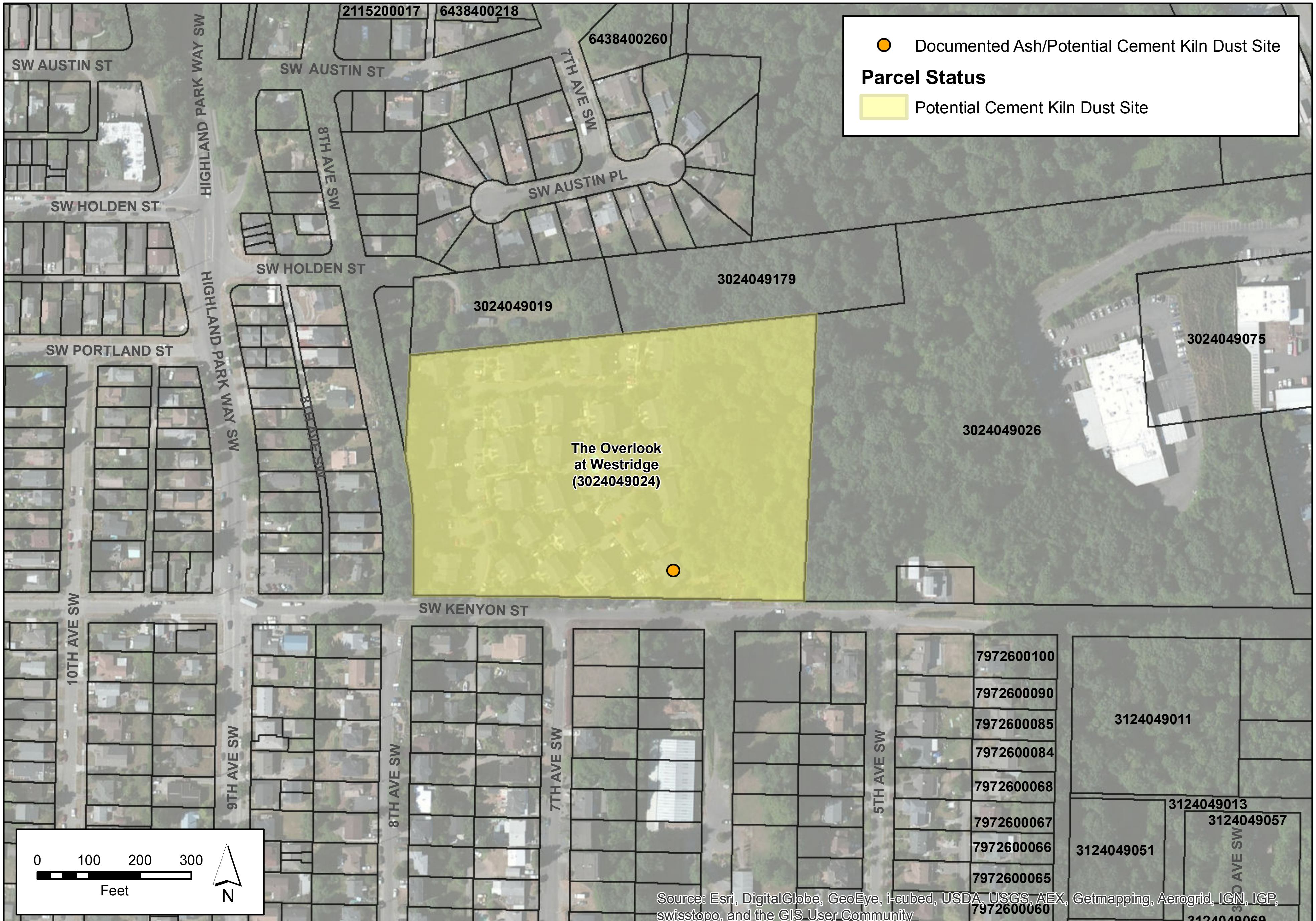
Source: GeoMap NW

Figure 20. Cement Kiln Dust Locations: South Seattle Community College



Source: GeoMap NW

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Figure 21. Cement Kiln Dust Locations: The Overlook at Westridge

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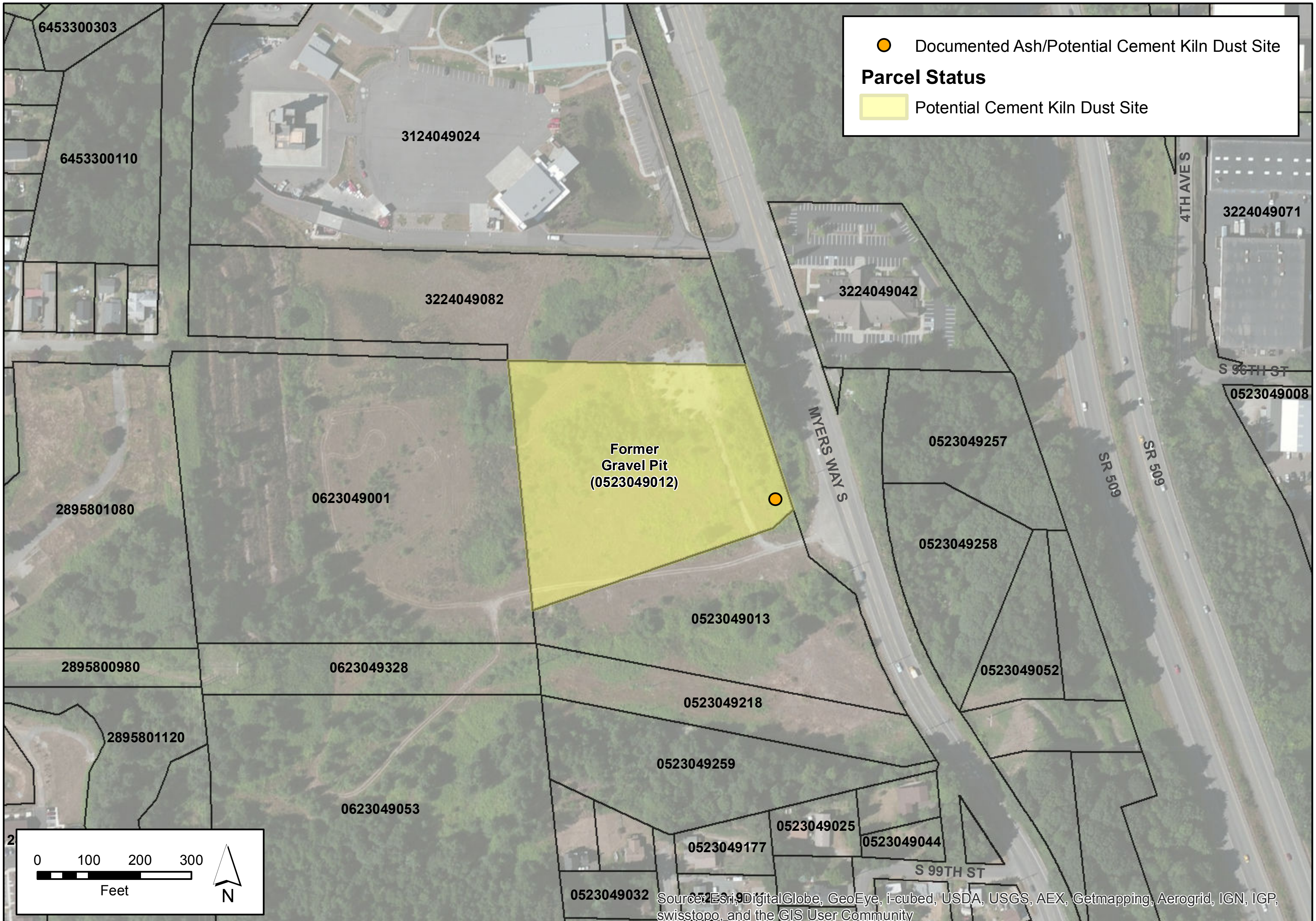

Source: GeoMap NW

Figure 22. Cement Kiln Dust Locations: Fromer Gravel Pit

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Source: GeoMap NW

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Figure 23. Cement Kiln Dust Locations: Port of Seattle Terminal 106 E and RR Row

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Source: GeoMap NW

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Figure 24. Cement Kiln Dust Locations: City of Seattle Former Refuse Dump Sites

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Source: GeoMap NW

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Figure 25. Cement Kiln Dust Locations: Sound Delivery Service Property

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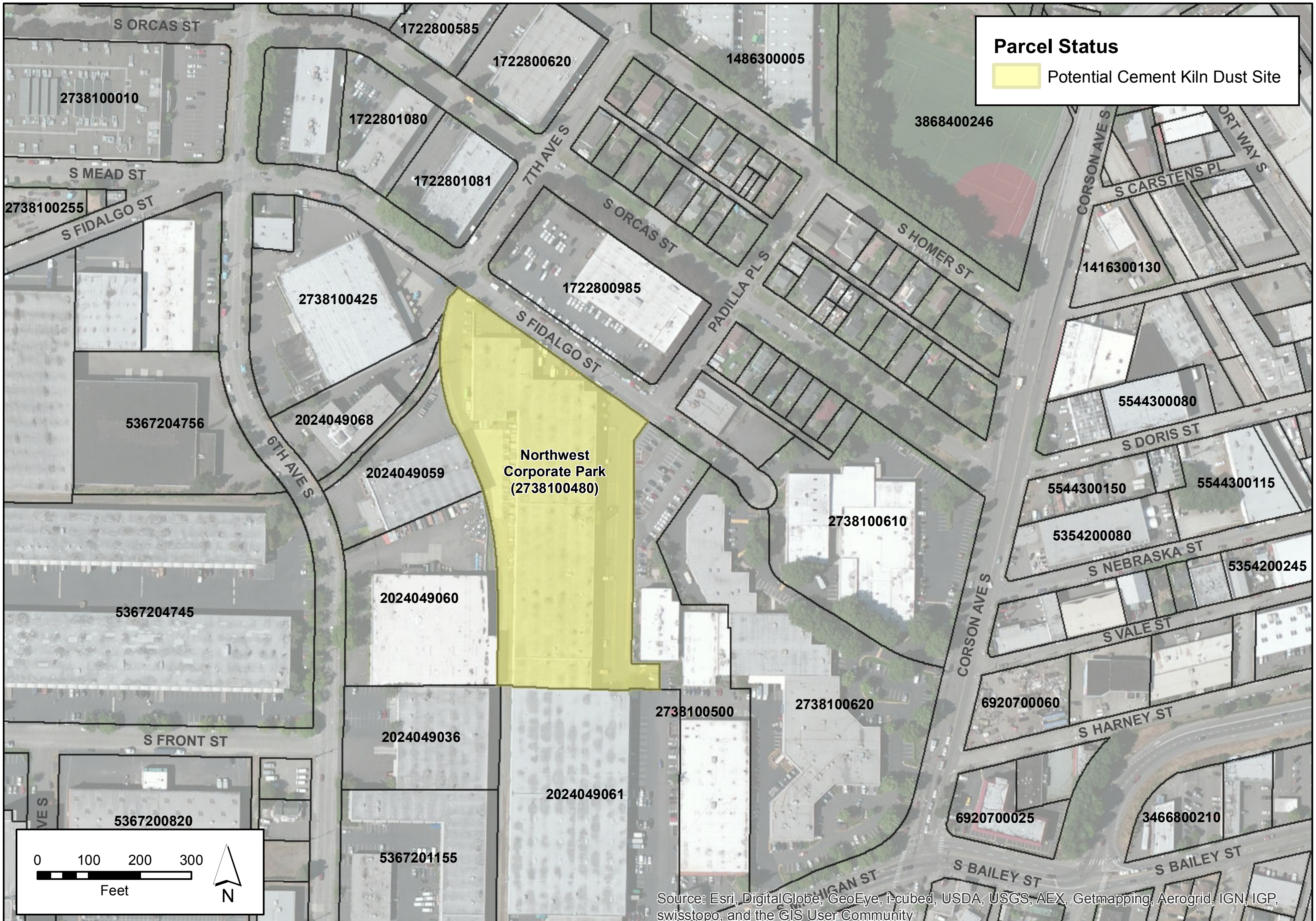

Source: GeoMap NW

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Figure 26. Cement Kiln Dust Locations: Northwest Corporate Park

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Tables

Table 1
Documented and Potential Cement Kiln Dust Sites
Lower Duwamish Drainage Basin

Facility Name	Parcel	Address	Zip	Source Control Area	Acreage (acres, sq ft)	Property Owner	Extent of CKD Fill	Facility/Site ID & Alternate Names	Ecology Interactions
Documented CKD Sites									
Puget Park	2424039020	4767 16th Avenue SW	98106	Spokane Street to Kellogg Island	17.57 acres (765,349 sq ft)	City of Seattle Parks Department	Areal: 100,000 sq ft Vertical: 0 - 20 ft bgs	2479: Puget Park	State Cleanup Site, VCP (former), Independent Cleanup
	2840700135	None			1.54 acres (67,023 sq ft)			6149702: Upper Hudson Street Site	State Cleanup Site, VCP (former), HWG (former)
McFarland Property	2840700005	4818 15th Avenue SW	98106	Spokane Street to Kellogg Island	3.56 acres (155,267)	Thomas S. McFarland	Areal: 30,000 sq ft Vertical: 0 - 21 ft bgs	None	None
Washington Federal Savings & Loan Property	1924049004	SW Hudson Street & West Marginal Way	98106	Spokane Street to Kellogg Island	27.71 acres (1,207,186 sq ft)	Surplus Items Inc.	Areal: 97,000 sq ft, northeastern area; 223,000 sq ft, south-central area Vertical: Ground surface to 20 – 25 ft bgs, northeastern area; Ground surface to 5 – 8 ft bgs, south-central area	13875: Surplus Items Inc.	State Cleanup Site
Port of Seattle Terminal 107	1924049103	5402 West Marginal Way SW	98106	Spokane Street to Kellogg Island	59.66 acres (2,598,796 sq ft)	Port of Seattle	Areal: Unknown, ~57,500 sq ft Vertical: Ground surface to 4 ft bgs, southern end	15472775: 4800 W Marginal, 96168526: Vacant UST 2482 Marginal Way SW	15472775: HWG (former), 96168526: UST (former)
Port of Seattle Terminal 115	5367202505	6000 to 6720 West Marginal Way SW	98106	Terminal 115	98.7 acres (4,299,853 sq ft)	Port of Seattle	Areal: Unknown Vertical: Unknown, ~10 to feet of fill	2177: Port of Seattle N Terminal 115, 15700: Port of Seattle Terminal 115 Berth 1, 4040072: Seattle Port Terminal 115, 15163955: Northland Services Inc., 82536515: Seafreeze Ltd Terminal 115, 98422914: Crowley Marine Services Inc. Terminal 115	2177: State Cleanup Site (former), VCP (former), TOXICS Enforcement Final, HWG, HWP (former), TIER2 (former), TRI (former), 15700, 4040072: 401CZM Project Site, SEA Non Enforcement Final, 15163955: ISGP, WATQUAL Enforcement & Non Enforcement Final, HWG, HWP, HWTF, TIER2, 82536515: ISGP-CNE, HWG, TIER2, UST (former), 98422914: UST, LUST, HWG (former), HWP (former)
Seaport Petroleum	3024049166	7800 Detroit Avenue SW	98106	1st Avenue S SD	2.72 acres (118,293 sq ft)	Seaport WE4ST LLC	Areal: ~149,000 sq ft Vertical: 0.5 - 8 ft bgs	12494: West Coast Equipment 2, 4982711: Seaport Petroleum Detroit Ave	12494: Independent Cleanup, 4982711: ISGP, LSC, TOXICS Enforcement Final, UST, HWMA, TIER2, HWG (former)
	3024049181	None	98106		0.72 acre (31,200 sq ft)	DJP Enterprise Inc			
Intermountain Supply/Former Recycle America	3124049001	7901 1st Avenue S		1st Avenue S SD	3.09 acres (134,650 sq ft)	LMN, LLC	Areal: ~134,650 sq ft Vertical: Ground surface to 7.5 ft bgs	55695661: Recycle America	HWG (former)
Kenyon Street Property	3124049004	149 SW Kenyon Street	98106	1st Avenue S SD	2.9 acres (126,456 sq ft)	Kenyon Street Partners	Areal: ~101,000 sq ft Vertical: Ground surface to 2 – 12 feet bgs, depth increases to the south	4504516: Dr Concrete Recycle	State Cleanup Site, LSC, VCP (former)
	3124049009	8111 1st Avenue SW			0.14 acres (5,882 sq ft)				
City of Seattle South Transfer Station	2924049104	110 S Kenyon Street		1st Avenue S SD	2.39 acres (104,108 sq ft)	City of Seattle	Areal: ~73,400 sq ft Vertical: Ground surface to 11 feet bgs	3453: South Transfer Station	ISGP, CSGP
	2924049006	130 S Kenyon Street			4.26 acres (185,566 sq ft)		Potential for CKD		
	2924049099	150 S Kenyon Street			1.82 acres (79,279 sq ft)		Potential for CKD		
	7328401175	200 S Kenyon Street			0.65 acre (28,314 sq ft)		Potential for CKD		

Table 1
Documented and Potential Cement Kiln Dust Sites
Lower Duwamish Drainage Basin

Facility Name	Parcel	Address	Zip	Source Control Area	Acreage (acres, sq ft)	Property Owner	Extent of CKD Fill	Facility/Site ID & Alternate Names	Ecology Interactions
Former South Park Landfill	3224049005	8100 2nd Avenue S	98108	1st Avenue S SD	21.00 acres (914,648 sq ft)	South Park Property Development LLC	Unknown	2180: South Park Landfill	State Cleanup Site, VCP (former), TOXICS Enforcement Final, CSGP
Kenyon Street Business Park	3224049007	121 S Kenyon Street	98108		6.49 acres (282,819 sq ft)	Harsch Investment Properties LLC			
Formula Corp	3224049077	7901 2nd Avenue S	98108		0.72 acre (31, 303 sq ft)	7901 2nd Ave S LLC			
MEECO Manufacturing	3224049045	426 S Cloverdale Street	98108		2.77 acres (120,863 sq ft)	Lenci Frank Corp		71378133: MEECO/Tri Emerald, 56766158: Cascade Diesel/Frontier Door/Emerson Power Products	71378133: ISGP, LSC, RSVP, TIER2, 56766158: LSC, HWG (former), HWP (former)
Former Airport Towing	3224049084	300 S Sullivan Street	98108	1st Avenue S SD	0.62 acre (27,155 sq ft)	Gordian Development	Unknown	14644: Former Airport Towing	LSC
South Recycle & Disposal Station	7328400005	8100 2nd Avenue S	98108		10.29 acres (448,078 sq ft)	City of Seattle Public Utilities		2175: Seattle S Transfer Sta, 3665320: South Recycle & Disposal Station 5th Ave, 91256919: South Recycle & Disposal Station	2175: Independent Cleanup, ISGP (former), 3665320: Energy Recovery, Storage & Handling
Former Glitsa American	7328400740	327 S Kenyon Street	98108		1.17 acres (51,000 sq ft)	Tenor Company LLC		63168342: Former Glitsa American	LUST, ISGP, UST (former), TIER2 (former), HWG (former)
Long Painting	7883600005	8230 5th Avenue S	98108		1.33 acres (57,774 sq ft)	JYS4 LLC		76764554: Hudson Bay Insulation	LSC, HWG (former)
Coast Crane	7883600350	8250 5th Avenue S	98108		2.38 acres (103,621 sq ft)	Ness Manitowoc Property LLC		2430: Coast Crane	State Cleanup Site, HWG, VCP (former), UST (former)
	7883600350	500 S Sullivan Street	98108		1.90 acres (82,754 sq ft)	White Sands LLC			
WG Clark Construction	3224049068	7958 Occidental Avenue S	98108		0.44 acre (19,150 sq ft)	WG Clark Construction			
King Electrical Manufacturing Company	2433700068	821 S Barton Street		Sea King Industrial Park	0.95 acre (41,423 sq ft)	Robert & Shirley Wilson	Unknown	2404488	ISGP-CNE, WATQUAL Enforcement Final, HWG, RSVP
McKinstry Co S Barton	2433700070	855 S Barton Street		Sea King Industrial Park	0.93 acre (40,710 sq ft)	Robert & Shirley Wilson	Unknown	36919863	UST, HWG (former)
Halfon Candy Company	2433700076	9229 10th Avenue S	98108	Sea King Industrial Park	0.95 acre (41,425 sq ft)	Nell Halfon	Areal: Unknown, at least 20,000 sq ft Vertical: Ground surface to 4-6 feet bgs	1557860	State Cleanup Site, RSVP, LSC
Simplex Grinnell/Sherwin Williams/NRC Environmental Services	5624200150	9520 10th Avenue S	98108	Sea King Industrial Park	4.43 acres (193,122 sq ft)	Seattle Commercial Development	Areal: 193,122 sq ft Vertical: Ground surface to 10 ft bgs	2263: Markey Property Parcel 4	State Cleanup Site (former), VCP (former)
Beckwith & Kuffel	5624200351	1313 S 96th Street	98108	Sea King Industrial Park	2.30 acres (100,188 sq ft)	Starship Properties LLC	Areal: ~17,700 sq ft Vertical: Variable, ~2 to 5 feet thick between 4 and 10 feet bgs	3533187: Beckwith & Kuffel Inc, Clarklift of Washington Alaska Inc, Darr FMH, FMH Material Handling Solutions	VCP, LUST, HWMA, WATQUAL Enforcement Final, UST (former), HWG (former), HWP (former), ISGP (former)
Duwamish Yacht Club/Delta Marine	0001600029	1818 S 96th Street	98108	Sea King Industrial Park	5.00 acres (217, 797 sq ft)	Desimone Trust, managed by BNY Mellon	Unknown	22978975: Delta Marine Industries Inc.	22978975: Boatyard General Permit, 401CZM Project Site, SEA Non Enforcement Final, Air Quality Local Authority Reg, HWP, HWG, TIER2, TRI (former)
	0001600061	1801 S 93rd Street	98108		4.40 acres (191,606 sq ft)			3989: Duwamish Yacht Club	401CZM Project Site
	0001600062	1801 S 93rd Street	98108		2.09 acres (90,867 sq ft)				
Port of Seattle Terminal 106 W	7666700390	1 S Idaho Street		EAA-1	31.30 acres (1,363,428 sq ft)	Port of Seattle	Areal: 119,000 sq ft Vertical: 12 - 23 ft bgs	8271889	UST

Table 1
Documented and Potential Cement Kiln Dust Sites
Lower Duwamish Drainage Basin

Facility Name	Parcel	Address	Zip	Source Control Area	Acreage (acres, sq ft)	Property Owner	Extent of CKD Fill	Facility/Site ID & Alternate Names	Ecology Interactions
Fostoria Business Park Fostoria Park Industrial Center	2613200084	4495 S 134th Place, Tukwila	98168		5.01 acres (218,235 sq ft)	North Stream Development	Unknown	2411: Fostoria Park Industrial Center	Independent Remedial Action Program (former), HWG (former)
American Tire Wholesalers	2613200085	4435 S 134th Place, Tukwila	98168		1.54 acres (67,082 sq ft)	Havenbury Holdings	Unknown	2290: American Tire Wholesalers	VCP (former), UST (former)
Fostoria Park Buildings D & E	8700200010	4487 S 134th Place, Tukwila	98168		1.45 acres (63,110 sq ft)	Fostoria Park Association LLC	Unknown	11794419: Fostoria Park Buildings D & E	VCP (former)
	8700200020		98168		1.76 acres (76,746 sq ft)	Fostoria Park Association LLC	Unknown		
Potential CKD Sites									
Sound Delivery Service	0523049010	9999 8th Avenue S	98108	Sea King Industrial Park	10.71 acres (466,575 sq ft)	Southpark Properties III LLC	Unknown	26432659	HWG (former)
Terminal 5 (American Presidential Lines)								2061: SW Harbor Project Terminal 5	State Cleanup Site, Sediments
Riverside Mill	7666703290	3800 West Marginal Way SW		Spokane Street to Kellogg Island	6.23 acres (271,281 sq ft)	Riverside Mill LLC	Unknown	2093: Seattle Steel Industrial Fasteners	UST, LUST (former), Independent Remedial Action Program (former), HWG (former)
	7666703321	3835 West Marginal Way SW			0.09 acres (3,727 sq ft)				
Residential Property	7891600335	4115 23rd Avenue SW	98106	Spokane Street to Kellogg Island/Duwamish West CSO	0.11 acre (5,000 sq ft)	Private property		None	None
South Seattle Community College	6171900005	6000 16th Avenue SW	98106	Spokane Street to Kellogg Island	59.59 acres (2,595,802 sq ft)	Seattle Community College		43445813	UST, LSC, HWG, LUST (former), HWP (former)
Alaska Marine Lines	1924049026	5600 West Marginal Way SW	98106	Glacier Bay	13.76 acres (599,490 sq ft)	5600 W Marginal Way SW Seattle LLC		17126	SPILLS Enforcement Final
The Overlook at Westridge	3024049024	600 SW Kenyon Street	98106	1st Avenue S SD	9.16 acres (399,009 sq ft)	John McKenna		None	None
Former Morgan Trucking	2433700153	9302 10th Avenue S	98108	Sea King Industrial Park	1.54 acres (66,940 sq ft)	Ream Family Limited Partner		42665774	ISGP, HWMA, HWG (former), UST (former)
	2433700154	9302 10th Avenue S	98108		1.54 acres (66,940 sq ft)				
	2433700155	9302 10th Avenue S	98108		1.54 acres (66,940 sq ft)				
	2433700156	9302 10th Avenue S	98108		0.46 acre (20,000 sq ft)				
	2433700165	9228 10th Avenue S	98108		2.85 acres (124,310 sq ft)				
Mason Dixon Intermodal	5624200170	9515 10th Avenue S	98108	Sea King Industrial Park	4.28 acres (186,563 sq ft)	South Park Industrial Properties LLC		3546421	HWG (former), HWMA (former)
Terex Utilities	5624200191	9426 8th Avenue S	98108	Sea King Industrial Park	2.95 acres (128,647 sq ft)	South Park Industrial Properties LLC		3291: Terex Utilities, 27446996: Fruehauf Trailer Services	3291: ISGP (former), 27446996: State Cleanup Site, UST, LUST (former), HWG (former)
Former Gravel Pit	0523049012	9800 Myers Way S	98108	Sea King Industrial Park	4.51 acres (196,456 sq ft)	City of Seattle		None	None
RR Row	3957900075		98108	EAA-1	6.90 acres (300,656 sq ft)	Union Pacific Railroad		None	None
Mallory & Church	7376600035	676 S Industrial Way	98108	EAA-1	0.83 acre (36,130 sq ft)	DAE II LLC		None	None
Former Safelite Auto Glass	7886100450	665 S Dakota Street	98108	EAA-1	0.57 acre (24,826 sq ft)	Imagine Venture Group LLC		None	None
	7886100472	665 S Dakota Street	98108	EAA-1	0.06 acre (2,720 sq ft)	Robert Johnson			
Model Werks	7886100430	655 S Andover Street	98108	EAA-1	0.88 acre (38,408 sq ft)	Dakota Street LLC		2178: Flint Ink Corp Seattle, Sinclair & Valentine Co Inc	Independent Remedial Action Program (former), UST (former), HWG (former), HWP (former), TIER2 (former)
Western Peterbilt	7886100670	3801 Airport Way S	98108	EAA-1	0.24 acre (10,240 sq ft)	RBC Partnership		None	None

Table 1
Documented and Potential Cement Kiln Dust Sites
Lower Duwamish Drainage Basin

Facility Name	Parcel	Address	Zip	Source Control Area	Acreage (acres, sq ft)	Property Owner	Extent of CKD Fill	Facility/Site ID & Alternate Names	Ecology Interactions
Atlas Supply	7666203975	611 S Charlestown Street	98108	EAA-1	0.57 acre (24,780 sq ft)	Sunset Properties II LLC		1550	LSC, RSVP
International Truck Leasing	7886100290	3801 7th Avenue S	98108	EAA-1	0.71 acre (30,720 sq ft)	Team B LLC		75219382: Eagle Harbor Construction, Coastal Tank, Coastal Tank Cleaning Inc., Jackson Property	LSC,VCP (former), HWG (former), HWP (former), TIER2(former)
Port of Seattle Terminal 106 E	7666207536	4200 East Marginal Way S	98134	EAA-1	17.99 acres (783,522 sq ft)	AMB US Logistics Fund LP		6768: Prologis, Argo Yard Roadway Project	CSGP, LSC
Northwest Corporate Park	2738100480	703 S Fidalgo Street	98108		4.57 acres (198,900 sq ft)	CSHV NWCP Seattle LLC		None	None

Ecology Interaction Notes

CSGP - Construction Stormwater General Permit
HWG - Hazardous Waste Generator
HWMA - Hazardous Waste Management Activity
HWP - Hazardous Waste Planner
HWTF - Hazardous Waste Transfer Facility
ISGP - Industrial Stormwater General Permit
ISGP-CNE - Industrial Stormwater General Permit, Certificate of No Exposure
LSC - Local Source Control
LUST - Leaking Underground Storage Tank
RSVP - Revised Site Visit Program
SEA - Ecology Shorelands & Environmental Assistance Program
SPILLS - Ecology Spills Program
TIER2 - Toxic Air Pollutants Tier 2 reporter
TOXICS - Ecology Toxics Cleanup Program
TRI - Toxics Release Inventory
UST - underground storage tank
VCP - Voluntary Cleanup Program
WATQUAL - Ecology Water Quality Program
(former) - indicates that an end date is listed in the Facility/Site Database for this interaction.

Table 2
Chemicals Detected in Cement Kiln Dust Soil Samples
The McFarland Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	CKD Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
RZA AGRA 1994a	6/21/1994	8+63-11W	0.5	Arsenic	440	0.67	590	657
RZA AGRA 1994a	6/21/1994	9+49-10W	0.5	Arsenic	390	0.67	590	582
RZA AGRA 1994a	6/21/1994	10+19	1.5	Arsenic	370	0.67	590	552
RZA AGRA 1994a	6/21/1994	9+35-15E	0.4	Arsenic	360	0.67	590	537
RZA AGRA 1994a	6/21/1994	9+25	1.5	Arsenic	330	0.67	590	493
RZA AGRA 1994a	6/21/1994	9+25	4.0	Arsenic	330	0.67	590	493
RZA AGRA 1994a	6/21/1994	9+08-26W	0.3	Arsenic	320	0.67	590	478
RZA AGRA 1994a	6/21/1994	8+50	2.5	Arsenic	230	0.67	590	343
RZA AGRA 1994a	6/21/1994	Mayer - 2	2.5	Arsenic	150	0.67	590	224
RZA AGRA 1994a	6/21/1994	7+75	4.0	Arsenic	150	0.67	590	224
RZA AGRA 1994a	6/21/1994	Mayer - 3	3.0	Arsenic	140	0.67	590	209
RZA AGRA 1994a	6/21/1994	7+50	0.5	Arsenic	130	0.67	590	194
RZA AGRA 1994a	6/21/1994	8+10-13W	0.4	Arsenic	120	0.67	590	179
RZA AGRA 1994a	6/21/1994	Mayer - 4	1.5	Arsenic	14	0.67	590	21
RZA AGRA 1994a	6/21/1994	7+00	4.0	Arsenic	12	0.67	590	18
RZA AGRA 1994a	6/21/1994	Mayer - 5	1.5	Arsenic	9.3	0.67	590	14
RZA AGRA 1994a	6/21/1994	Mayer - 4	1.5	Barium	160	16,000		<1
RZA AGRA 1994a	6/21/1994	7+75	4.0	Barium	130	16,000		<1
RZA AGRA 1994a	6/21/1994	10+19	1.5	Barium	120	16,000		<1
RZA AGRA 1994a	6/21/1994	8+63-11W	0.5	Barium	120	16,000		<1
RZA AGRA 1994a	6/21/1994	9+08-26W	0.3	Barium	120	16,000		<1
RZA AGRA 1994a	6/21/1994	9+49-10W	0.5	Barium	120	16,000		<1
RZA AGRA 1994a	6/21/1994	9+25	1.5	Barium	110	16,000		<1
RZA AGRA 1994a	6/21/1994	9+25	4.0	Barium	110	16,000		<1
RZA AGRA 1994a	6/21/1994	9+35-15E	0.4	Barium	110	16,000		<1
RZA AGRA 1994a	6/21/1994	8+50	2.5	Barium	93	16,000		<1
RZA AGRA 1994a	6/21/1994	8+10-13W	0.4	Barium	86	16,000		<1
RZA AGRA 1994a	6/21/1994	Mayer - 2	2.5	Barium	74	16,000		<1
RZA AGRA 1994a	6/21/1994	7+00	4.0	Barium	66	16,000		<1
RZA AGRA 1994a	6/21/1994	7+50	0.5	Barium	57	16,000		<1
RZA AGRA 1994a	6/21/1994	Mayer - 5	1.5	Barium	46	16,000		<1

Table 2
Chemicals Detected in Cement Kiln Dust Soil Samples
The McFarland Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	CKD Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
RZA AGRA 1994a	6/21/1994	Mayer - 3	3.0	Barium	39	16,000		<1
RZA AGRA 1994a	6/21/1994	8+63-11W	0.5	Cadmium	13	2.0	1.7	7.6
RZA AGRA 1994a	6/21/1994	9+49-10W	0.5	Cadmium	12	2.0	1.7	7.1
RZA AGRA 1994a	6/21/1994	9+25	1.5	Cadmium	10	2.0	1.7	5.9
RZA AGRA 1994a	6/21/1994	9+35-15E	0.4	Cadmium	9.6	2.0	1.7	5.6
RZA AGRA 1994a	6/21/1994	10+19	1.5	Cadmium	8.8	2.0	1.7	5.2
RZA AGRA 1994a	6/21/1994	9+25	4.0	Cadmium	8.6	2.0	1.7	5.1
RZA AGRA 1994a	6/21/1994	9+08-26W	0.3	Cadmium	8.4	2.0	1.7	4.9
RZA AGRA 1994a	6/21/1994	8+50	2.5	Cadmium	7.3	2.0	1.7	4.3
RZA AGRA 1994a	6/21/1994	7+75	4.0	Cadmium	5.4	2.0	1.7	3.2
RZA AGRA 1994a	6/21/1994	7+50	0.5	Cadmium	5.2	2.0	1.7	3.1
RZA AGRA 1994a	6/21/1994	8+10-13W	0.4	Cadmium	4.7	2.0	1.7	2.8
RZA AGRA 1994a	6/21/1994	Mayer - 4	1.5	Cadmium	3.2	2.0	1.7	1.9
RZA AGRA 1994a	6/21/1994	Mayer - 3	3.0	Cadmium	3.2	2.0	1.7	1.9
RZA AGRA 1994a	6/21/1994	Mayer - 2	2.5	Cadmium	3.1	2.0	1.7	1.8
RZA AGRA 1994a	6/21/1994	7+00	4.0	Cadmium	2.1	2.0	1.7	1.2
RZA AGRA 1994a	6/21/1994	Mayer - 5	1.5	Cadmium	1.7	2.0	1.7	1.0
RZA AGRA 1994a	6/21/1994	Mayer - 4	1.5	Chromium	70	2,000	270	<1
RZA AGRA 1994a	6/21/1994	7+00	4.0	Chromium	35	2,000	270	<1
RZA AGRA 1994a	6/21/1994	Mayer - 5	1.5	Chromium	29	2,000	270	<1
RZA AGRA 1994a	6/21/1994	8+10-13W	0.4	Chromium	27	2,000	270	<1
RZA AGRA 1994a	6/21/1994	7+75	4.0	Chromium	21	2,000	270	<1
RZA AGRA 1994a	6/21/1994	8+63-11W	0.5	Chromium	15	2,000	270	<1
RZA AGRA 1994a	6/21/1994	8+50	2.5	Chromium	14	2,000	270	<1
RZA AGRA 1994a	6/21/1994	Mayer - 3	3.0	Chromium	14	2,000	270	<1
RZA AGRA 1994a	6/21/1994	9+08-26W	0.3	Chromium	13	2,000	270	<1
RZA AGRA 1994a	6/21/1994	7+50	0.5	Chromium	13	2,000	270	<1
RZA AGRA 1994a	6/21/1994	Mayer - 2	2.5	Chromium	13	2,000	270	<1
RZA AGRA 1994a	6/21/1994	9+35-15E	0.4	Chromium	12	2,000	270	<1
RZA AGRA 1994a	6/21/1994	9+49-10W	0.5	Chromium	12	2,000	270	<1
RZA AGRA 1994a	6/21/1994	9+25	4.0	Chromium	12	2,000	270	<1

Table 2
Chemicals Detected in Cement Kiln Dust Soil Samples
The McFarland Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	CKD Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
RZA AGRA 1994a	6/21/1994	10+19	1.5	Chromium	11	2,000	270	<1
RZA AGRA 1994a	6/21/1994	9+25	1.5	Chromium	10	2,000	270	<1
RZA AGRA 1994a	6/21/1994	8+63-11W	0.5	Lead	3,600	250	67	54
RZA AGRA 1994a	6/21/1994	9+49-10W	0.5	Lead	3,500	250	67	52
RZA AGRA 1994a	6/21/1994	9+35-15E	0.4	Lead	3,100	250	67	46
RZA AGRA 1994a	6/21/1994	9+25	1.5	Lead	3,000	250	67	45
RZA AGRA 1994a	6/21/1994	9+25	4.0	Lead	2,600	250	67	39
RZA AGRA 1994a	6/21/1994	10+19	1.5	Lead	2,500	250	67	37
RZA AGRA 1994a	6/21/1994	9+08-26W	0.3	Lead	2,200	250	67	33
RZA AGRA 1994a	6/21/1994	8+50	2.5	Lead	1,800	250	67	27
RZA AGRA 1994a	6/21/1994	7+75	4.0	Lead	1,400	250	67	21
RZA AGRA 1994a	6/21/1994	7+50	0.5	Lead	980	250	67	15
RZA AGRA 1994a	6/21/1994	8+10-13W	0.4	Lead	920	250	67	14
RZA AGRA 1994a	6/21/1994	Mayer - 2	2.5	Lead	890	250	67	13
RZA AGRA 1994a	6/21/1994	Mayer - 3	3.0	Lead	880	250	67	13
RZA AGRA 1994a	6/21/1994	Mayer - 5	1.5	Lead	34	250	67	<1
RZA AGRA 1994a	6/21/1994	7+00	4.0	Lead	13	250	67	<1
RZA AGRA 1994a	6/21/1994	Mayer - 4	1.5	Lead	12	250	67	<1
RZA AGRA 1994a	6/21/1994	7+50	0.5	Mercury	0.13	2.0	0.03	4.3
RZA AGRA 1994a	6/21/1994	8+63-11W	0.5	Silver	10	400	0.61	16
RZA AGRA 1994a	6/21/1994	9+49-10W	0.5	Silver	9.8	400	0.61	16
RZA AGRA 1994a	6/21/1994	9+35-15E	0.4	Silver	9.0	400	0.61	15
RZA AGRA 1994a	6/21/1994	9+25	1.5	Silver	8.5	400	0.61	14
RZA AGRA 1994a	6/21/1994	10+19	1.5	Silver	8.3	400	0.61	14
RZA AGRA 1994a	6/21/1994	9+25	4.0	Silver	8.3	400	0.61	14
RZA AGRA 1994a	6/21/1994	9+08-26W	0.3	Silver	7.6	400	0.61	12
RZA AGRA 1994a	6/21/1994	7+75	4.0	Silver	6.4	400	0.61	10
RZA AGRA 1994a	6/21/1994	8+50	2.5	Silver	6.1	400	0.61	10
RZA AGRA 1994a	6/21/1994	Mayer - 3	3.0	Silver	4.4	400	0.61	7.2
RZA AGRA 1994a	6/21/1994	7+50	0.5	Silver	4.1	400	0.61	6.7
RZA AGRA 1994a	6/21/1994	Mayer - 2	2.5	Silver	3.9	400	0.61	6.4

Table 2
Chemicals Detected in Cement Kiln Dust Soil Samples
The McFarland Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	CKD Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
RZA AGRA 1994a	6/21/1994	8+10-13W	0.4	Silver	3.8	400	0.61	6.2
RZA AGRA 1994a	6/21/1994	Mayer - 4	1.5	Silver	0.91	400	0.61	1.5
RZA AGRA 1994a	6/21/1994	7+00	4.0	Silver	0.80	400	0.61	1.3
RZA AGRA 1994a	6/21/1994	Mayer - 5	1.5	Silver	0.78	400	0.61	1.3

ft bgs - Feet below ground surface
mg/kg - Milligrams per kilogram
MTCA - Model Toxics Control Act
CKD - cement kiln dust
CSL - Cleanup Screening Level from Washington Sediment Management Standards

a - The lower of MTCA Method A or B cleanup levels was selected, from CLARC database.
b - Based on CSL. Where two screening levels are listed for a single chemical, the higher screening levels are for soil samples collected from the vadose zone and the lower screening levels are for soil samples collected from the saturated zone (SAIC 2006).
Groundwater elevation data are not available for this site. The saturated CSL screening levels were assumed for all CKD soil samples.
Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Soil-to-Sediment Screening Level, whichever is lower.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:
RZA AGRA (RZA AGRA, Inc.). 1994a. Limited Environmental Assessment of Mayer Hudson Street Project (Draft).
Prepared for Gordon, Thomas, Honeywell, Malanca, Peterson & Daheim. July 18, 1994.

Table 3
Chemicals Detected in Calcium Carbonate Precipitate Samples
Puget Park and the McFarland Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Carbonate Precipitate Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
Hart Crowser 1996	8/29/1996	PP-4	NA	Arsenic	270	0.67	590	403
Hart Crowser 1996	8/29/1996	PP-5	NA	Arsenic	100	0.67	590	149
Hart Crowser 1996	8/29/1996	MC-1	NA	Arsenic	35	0.67	590	52
Hart Crowser 1996	8/29/1996	PP-9	NA	Arsenic	35	0.67	590	52
Hart Crowser 1996	8/29/1996	PP-3	NA	Arsenic	16	0.67	590	24
Hart Crowser 1996	8/29/1996	PP-6	NA	Arsenic	10	0.67	590	15
Hart Crowser 1996	8/29/1996	PP-7	NA	Arsenic	10	0.67	590	15
Hart Crowser 1996	8/29/1996	PP-1	NA	Arsenic	9.0	0.67	590	13
Hart Crowser 1996	8/29/1996	PP-8	NA	Arsenic	6.2	0.67	590	9.3
Hart Crowser 1996	8/29/1996	MC-2	NA	Arsenic	5.2	0.67	590	8
Hart Crowser 1996	8/29/1996	PP-2	NA	Arsenic	2.9	0.67	590	4.3
Hart Crowser 1996	8/29/1996	MC-3	NA	Arsenic	2.4	0.67	590	4
Hart Crowser 1996	8/29/1996	PP-5	NA	Cadmium	19	2.0	1.7	11
Hart Crowser 1996	8/29/1996	PP-9	NA	Cadmium	1.9	2.0	1.7	1.1
Hart Crowser 1996	8/29/1996	PP-7	NA	Cadmium	0.88	2.0	1.7	<1
Hart Crowser 1996	8/29/1996	PP-1	NA	Cadmium	0.7	2.0	1.7	<1
Hart Crowser 1996	8/29/1996	PP-2	NA	Cadmium	0.60	2.0	1.7	<1
Hart Crowser 1996	8/29/1996	PP-5	NA	Lead	5,300	250	67	791
Hart Crowser 1996	8/29/1996	PP-9	NA	Lead	1,600	250	67	24
Hart Crowser 1996	8/29/1996	PP-3	NA	Lead	1,500	250	67	22
Hart Crowser 1996	8/29/1996	PP-6	NA	Lead	1,300	250	67	19
Hart Crowser 1996	8/29/1996	MC-1	NA	Lead	410	250	67	6
Hart Crowser 1996	8/29/1996	PP-7	NA	Lead	280	250	67	4.2
Hart Crowser 1996	8/29/1996	PP-4	NA	Lead	250	250	67	3.7
Hart Crowser 1996	8/29/1996	MC-3	NA	Lead	130	250	67	2
Hart Crowser 1996	8/29/1996	PP-2	NA	Lead	95	250	67	1.4
Hart Crowser 1996	8/29/1996	PP-1	NA	Lead	51	250	67	<1
Hart Crowser 1996	8/29/1996	PP-8	NA	Lead	38	250	67	<1
Hart Crowser 1996	8/29/1996	MC-2	NA	Lead	13	250	67	<1

Table 3
Chemicals Detected in Calcium Carbonate Precipitate Samples
Puget Park and the McFarland Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Carbonate Precipitate Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor

mg/kg - Milligrams per kilogram
MTCA - Model Toxics Control Act
CSL - Cleanup Screening Level from Washington Sediment Management Standards
TEQ - toxic equivalency
NA - Not available

a - The lower of MTCA Method A or B cleanup levels for soil was selected, from CLARC database.
b - Based on CSL for soil. Where two screening levels are listed for a single chemical, the higher screening levels are for soil samples collected from the vadose zone and the lower screening levels are for soil samples collected from the saturated zone (SAIC 2006).
Perched water was observed at 2 to 4 inches bgs. The saturated CSL screening levels were assumed for all carbonate precipitate samples.
Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Soil-to-Sediment Screening Level, whichever is lower.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:
Hart Crowser (Hart Crowser, Inc.). 1996. Draft Remedial Evaluation Report, Hudson Street Site, West Seattle, Washington. September 27, 1996. Prepared for Joint Defense Team.

Table 4
Chemicals Detected in Seep and Creek Water Samples
Puget Park

Source	Sample Location	Date Sampled	Chemical	Seep and Creek Water Conc'n (ug/L)	Freshwater Chronic WQS[a] (ug/L)	Freshwater Chronic WQS Exceedance Factor	Marine Chronic WQS[a] (ug/L)	Chronic WQS Exceedance Factor	GW-to-Sediment Screening Level[c] (ug/L)	Exceedance Factor
Seattle Parks 1993	1A	5/14/1993	Arsenic	66	190	<1	36	1.8	370	<1
Seattle Parks 1993	2A	5/14/1993	Arsenic	59	190	<1	36	1.6	370	<1
Geo Group 2003a	A3-Out	6/25/1999	Arsenic	29 T	190	<1	36	<1	370	<1
Geo Group 2003a	A3-SE	6/25/1999	Arsenic	21 Ds	190	<1	36	<1	370	<1
Geo Group 2003a	A3-Out	6/30/1998	Arsenic	10 T	190	<1	36	<1	370	<1
Geo Group 2003a	A3-Out	6/30/1998	Arsenic	10 Ds	190	<1	36	<1	370	<1
Geo Group 2003a	A3-Out	6/25/1999	Arsenic	8.8 Ds	190	<1	36	<1	370	<1
Geo Group 2003a	A1-Out	6/25/1999	Arsenic	6.7 T	190	<1	36	<1	370	<1
Geo Group 2003a	A3-SE	6/30/1998	Arsenic	6.3 T	190	<1	36	<1	370	<1
Geo Group 2003a	A3-In	6/30/1998	Arsenic	6.1 T	190	<1	36	<1	370	<1
Geo Group 2003a	A3-In	6/25/1999	Arsenic	5.4 Ds	190	<1	36	<1	370	<1
Geo Group 2003a	A3-In	6/25/1999	Arsenic	5.0 T	190	<1	36	<1	370	<1
Geo Group 2003a	A1-Out	6/30/1998	Arsenic	4.4 T	190	<1	36	<1	370	<1
Geo Group 2003a	A1-Out	6/30/1998	Arsenic	4.3 Ds	190	<1	36	<1	370	<1
Geo Group 2003a	A3-SE	6/25/1999	Arsenic	4.0 T	190	<1	36	<1	370	<1
Geo Group 2003a	A3-SE	6/30/1998	Arsenic	3.8 Ds	190	<1	36	<1	370	<1
Geo Group 2003a	A3-In	6/30/1998	Arsenic	3.3 Ds	190	<1	36	<1	370	<1
Geo Group 2003a	Stream 3	6/30/1998	Arsenic	3.1 Ds	190	<1	36	<1	370	<1
Geo Group 2003a	Stream 2	6/30/1998	Arsenic	2.6 T	190	<1	36	<1	370	<1
Geo Group 2003a	Stream 3	6/30/1998	Arsenic	2.5 T	190	<1	36	<1	370	<1
Geo Group 2003a	Stream 3	6/25/1999	Arsenic	2.5 T	190	<1	36	<1	370	<1
Geo Group 2003a	Stream 2	6/30/1998	Arsenic	2.4 Ds	190	<1	36	<1	370	<1
Geo Group 2003a	Stream 2	6/25/1999	Arsenic	2.1 T	190	<1	36	<1	370	<1
Geo Group 2003a	A1-Out	6/25/1999	Lead	200,000 T	3.1	64,516	8.1	24,691	13	15,385
Hart Crowser 1996	PP-Seep	8/29/1996	Lead	1,300 T	32	41	8.1	160	13	100
Hart Crowser 1996	PP-Seep-2	10/4/1996	Lead	1,300 T	27	48	8.1	160	13	100
Hart Crowser 1996	PP-Seep-2	10/4/1996	Lead	1,100 Ds	27	41	8.1	136	13	85
Hart Crowser 1996	PP-Seep	8/29/1996	Lead	1,000 Ds	32	31	8.1	123	13	77
Geo Group 2003a	A3-SE	6/30/1998	Lead	540 T	25	22	8.1	67	13	42
Geo Group 2003a	A3-Out	6/25/1999	Lead	340 T	5	68	8.1	42	13	26
Geo Group 2003a	A3-SE	6/25/1999	Lead	270 T	21	13	8.1	33	13	21
Geo Group 2003a	A3-In	6/30/1998	Lead	93 T	15	6.2	8.1	11	13	7.2
Geo Group 2003a	A3-SE	6/25/1999	Lead	58 Ds	21	2.8	8.1	7.2	13	4.5
Geo Group 2003a	A3-In	6/25/1999	Lead	56 T	15	3.7	8.1	6.9	13	4.3
Geo Group 2003a	A3-Out	6/30/1998	Lead	26 T	3.9	6.7	8.1	3.2	13	2.0

Table 4
Chemicals Detected in Seep and Creek Water Samples
Puget Park

Source	Sample Location	Date Sampled	Chemical	Seep and Creek Water Conc'n (ug/L)	Freshwater Chronic WQS[a] (ug/L)	Freshwater Chronic WQS Exceedance Factor	Marine Chronic WQS[a] (ug/L)	Chronic WQS Exceedance Factor	GW-to-Sediment Screening Level[c] (ug/L)	Exceedance Factor
Geo Group 2003a	A3-Out	6/30/1998	Lead	12 Ds	3.9	3.1	8.1	1.5	13	<1
Geo Group 2003a	A1-Out	6/30/1998	Lead	5.7 T	1.9	3.0	8.1	<1	13	<1
Geo Group 2003a	A1-Out	6/25/1999	Lead	3.8 Ds	3.1	1.2	8.1	<1	13	<1
Hart Crowser 1997a	SW-1	7/25/1997	Lead	3.7 T	5.9	<1	8.1	<1	13	<1
Geo Group 2003a	A3-In	6/25/1999	Lead	2.9 Ds	13	<1	8.1	<1	13	<1
Geo Group 2003a	A1-Out	6/30/1998	Lead	2.2 Ds	1.9	1.2	8.1	<1	13	<1
Geo Group 2003a	A3-Out	6/25/1999	Lead	1.4 Ds	5.0	<1	8.1	<1	13	<1
Geo Group 2003a	Stream 3	6/30/1998	Lead	0.75 T	5.6	<1	8.1	<1	13	<1
Seattle Parks 1993	1A	5/14/1993	Mercury	0.9	0.012	75	0.025	36	0.0074	122
Seattle Parks 1993	2A	5/14/1993	Mercury	0.3	0.012	25	0.025	12	0.0074	41
Seattle Parks 1993	2A	5/14/1993	Selenium	30	5.0	6.0	71	<1		
Seattle Parks 1993	1A	5/14/1993	Selenium	20	5.0	4.0	71	<1		

ug/L - Microgram per liter
WQS - Water Quality Standards
GW - Groundwater
CSL - Cleanup Screening Level from Washington Sediment Management Standards
Ds - Dissolved metal
T - Total metal

a - The lower of the ARARs for Surface Water Aquatic Life (Marine/Chronic) were selected from CLARC database, lead WQS is based on water hardness
b - The lower of the ARARs for Surface Water Aquatic Life (Marine/Acute) were selected from CLARC database
c - Based on CSL (SAIC 2006).
Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentrations to the minimum screening level available in the WA State CLARC database and Groundwater-to-Sediment Screening Level.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Sources:

Geo Group (Geo Group Northwest, Inc.). 2003a. Summary Report of Previous Environmental Work, Puget Park (SW Hudson Street Site), Seattle, Washington. Prepared for Seattle Department of Parks and Recreation. October 20, 2003.
Hart Crowser (Hart Crowser, Inc.). 1996. Draft Remedial Evaluation Report, Hudson Street Site, West Seattle, Washington. September 27, 1996. Prepared for Joint Defense Team.
Hart Crowser. 1997a. Remedial Evaluation Report, Hudson Street Site, West Seattle, Washington. Prepared for Joint Defense Team. September 5, 1997.
Seattle Parks (Seattle Department of Parks and Recreation). 1993. Letter from Marrell D. Livesay, Seattle Parks, to Mary O'Herron, Ecology. Re: Puget Park information requested by Gail Coburn. July 13, 1993.

Table 5
Dioxins/Furans Detected in Cement Kiln Dust Samples
Puget Park and the McFarland Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	CKD Conc'n (pg/g)	TEQ (pg/g)
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	1,2,3,6,7,8- HxCDD	0.53 J	0.053
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	1,2,3,4,6,7,8-HpCDD	7.9	0.079
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	OCDD	69.2	0.0692
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	1,2,3,4,7,8-HxCDF	0.42 J	0.042
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	1,2,3,4,6,7,8-HpCDF	2.0 J	0.02
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	OCDF	3.30 J	0.0033
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total TCDD	0.89	
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total PeCDD	0.42	
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total HxCDD	3.3	
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total HpCDD	21.3	
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total PeCDF	3.0	
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total HxCDF	3.7	
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total HpCDF	4.5	
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total PCDD (Dioxin)	95.11	0.6
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total PCDF (Furans)	35.6	0.55
Geo Group 2003b	10/6/2003 to10/8/2003	SCRN- 1,3,4,5,6 (Composite)	3.5 - 5	Total TEQ (Dioxin +Furan)	130.71	1.10

ft bgs - Feet below ground surface
pg/g - Picograms/gram
MTCA - Model Toxics Control Act
CKD - Cement kiln dust
TEQ - toxic equivalency
J - Estimated value

Cleanup levels and screening values are not available for comparison to CKD concentrations or TEQs.
Table presents detected chemicals only.

Source:

Geo Group (Geo Group Northwest, Inc.). 2003b. Results from Limited Screening for Dioxin, Puget Park (SW Hudson Street Site), Seattle, Washington. Prepared for Seattle Department of Parks and Recreation. November 6, 2003.

Table 6
Dioxins/Furans Detected in Puget Creek Sediment, Calcium Carbonate Precipitate and Seep Water
Puget Park and the McFarland Property

Source	Sample Date	Sample Location	Chemical	Sediment/ Precipitate Conc'n (pg/g DW)	TEQ (pg/g DW)	LDW Background TEQ (pg/g DW)	Exceedance Factor
Geo Group 2003b	10/8/2003	SCRN-7	1,2,3,4,6,7,8-HpCDD	251	2.51	1.6	1.6
Geo Group 2003b	10/8/2003	SCRN-7	1,2,3,4,6,7,8-HpCDF	26.4	0.264	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	1,2,3,4,7,8,9-HpCDF	1.0 J	0.01	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	1,2,3,4,7,8-HxCDF	0.36 J	0.036	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	1,2,3,6,7,8- HxCDD	2.3 J	0.23	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	1,2,3,6,7,8-HxCDF	0.24 J	0.024	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	1,2,3,7,8,9-HxCDD	1.10 J	0.11	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	2,3,4,6,7,8-HxCDF	0.29 J	0.029	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	OCDD	2,270	2.27	1.6	1.4
Geo Group 2003b	10/8/2003	SCRN-7	OCDF	104	0.104	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-8	OCDF	1.9	0.0019	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	Total HpCDD	493		1.6	
Geo Group 2003b	10/8/2003	SCRN-7	Total HpCDF	88.9		1.6	
Geo Group 2003b	10/8/2003	SCRN-7	Total HxCDD	20.2		1.6	
Geo Group 2003b	10/8/2003	SCRN-7	Total HxDCF	14.3 X		1.6	
Geo Group 2003b	10/8/2003	SCRN-7	Total PCDD (Dioxin)	2,783.63	5.4	1.6	3.4
Geo Group 2003b	10/8/2003	SCRN-8	Total PCDD (Dioxin)	49	0.4	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	Total PCDF (Furans)	209.78	0.8	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-8	Total PCDF (Furans)	33.4	1.1	1.6	<1
Geo Group 2003b	10/8/2003	SCRN-7	Total PeCDD	0.43		1.6	
Geo Group 2003b	10/8/2003	SCRN-7	Total PeCDF	0.98 X		1.6	
Geo Group 2003b	10/8/2003	SCRN-7	Total TCDF	1.6 X		1.6	
Geo Group 2003b	10/8/2003	SCRN-7	Total TEQ (Dioxin +Furan)	2,993.41	6.2	1.6	3.9
Geo Group 2003b	10/8/2003	SCRN-8	Total TEQ (Dioxin +Furan)	82.4	1.5	1.6	<1

Source	Sample Date	Sample Location	Chemical	Water Conc'n (pg/L)	TEQ (pg/L)
Geo Group 2003b	10/8/2003	SCRN-9	Total PCDD (Dioxin)	21.3	2.9
Geo Group 2003b	10/8/2003	SCRN-9	Total PCDF (Furans)	2.6	1.25
Geo Group 2003b	10/8/2003	SCRN-9	Total TEQ (Dioxin +Furan)	23.9	4.1

Table 6
Dioxins/Furans Detected in Puget Creek Sediment, Calcium Carbonate Precipitate and Seep Water
Puget Park and the McFarland Property

Source	Sample Date	Sample Location	Chemical	Sediment/ Precipitate Conc'n (pg/g DW)	TEQ (pg/g DW)	LDW Background TEQ (pg/g DW)	Exceedance Factor

pg/g - Picograms/gram
DW - Dry weight
pg/L - Picograms per liter
LDW - Lower Duwamish Waterway
TEQ - toxic equivalency
J - Estimated value
X - Result influenced by the presence of a diphenyl ether peak that is at least 10 percent of the total analyte peak.

SCRN-7 - Puget Creek sediment sample
SCRN-8 - calcium carbonate precipitate sample
SCRN-9 - seep water sample

Table presents detected chemicals only.
Organic chemicals were not normalized for organic carbon content during testing.
Chemical concentrations are compared to the 95 percent upper confidence limit on the mean of the natural background concentration for dioxins/furans (AECOM 2010). Sediment Management Standards are not available for comparison.
Exceedance factors are the ratio of the detected concentrations to the LDW background TEQ.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:
Geo Group (Geo Group Northwest, Inc.). 2003b. Results from Limited Screening for Dioxin, Puget Park (SW Hudson Street Site), Seattle, Washington. Prepared for Seattle Department of Parks and Recreation. November 6, 2003.

Table 7
Chemicals Detected in Soil and Cement Kiln Dust Samples
Washington Federal Savings & Loan Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor	Notes
GeoEngineers 1993	3/3/1993	TP-4	1.5	Arsenic	230	0.67	590	343	CKD
GeoEngineers 1993	3/3/1993	TP-10	2.0	Arsenic	190	0.67	590	284	CKD
GeoEngineers 1993	3/3/1993	TP-6	2.0	Arsenic	160	0.67	590	239	CKD
GeoEngineers 1993	3/3/1993	TP-7	2.5	Arsenic	140	0.67	590	209	CKD
GeoEngineers 1993	3/3/1993	TP-1	2.0	Arsenic	93	0.67	590	139	CKD
GeoEngineers 1993	3/3/1993	TP-3	1.5	Arsenic	19	0.67	590	28	Soil
GeoEngineers 1993	3/3/1993	TP-5	2.0	Arsenic	3.8	0.67	590	5.7	Soil
GeoEngineers 1993	3/3/1993	TP-9	1.5	Arsenic	3.2	0.67	590	4.8	Soil
GeoEngineers 1993	3/3/1993	TP-8	2.5	Arsenic	3.1	0.67	590	4.6	Soil
GeoEngineers 1993	3/3/1993	TP-2	2.0	Arsenic	1.8	0.67	590	2.7	Soil
GeoEngineers 1993	3/3/1993	TP-10	2.0	Barium	340	16,000		<1	CKD
GeoEngineers 1993	3/3/1993	TP-3	1.5	Barium	150	16,000		<1	Soil
GeoEngineers 1993	3/3/1993	TP-4	1.5	Barium	100	16,000		<1	CKD
GeoEngineers 1993	3/3/1993	TP-7	2.5	Barium	100	16,000		<1	CKD
GeoEngineers 1993	3/3/1993	TP-9	1.5	Barium	87	16,000		<1	Soil
GeoEngineers 1993	3/3/1993	TP-1	2.0	Barium	80	16,000		<1	CKD
GeoEngineers 1993	3/3/1993	TP-8	2.5	Barium	72	16,000		<1	Soil
GeoEngineers 1993	3/3/1993	TP-5	2.0	Barium	65	16,000		<1	Soil
GeoEngineers 1993	3/3/1993	TP-2	2.0	Barium	47	16,000		<1	Soil
GeoEngineers 1993	3/3/1993	TP-6	2.0	Barium	23	16,000		<1	CKD
GeoEngineers 1993	3/3/1993	TP-4	1.5	Cadmium	6.8	2.0	1.7	4.0	CKD
GeoEngineers 1993	3/3/1993	TP-1	2.0	Cadmium	3.6	2.0	1.7	2.1	CKD
GeoEngineers 1993	3/3/1993	TP-10	2.0	Cadmium	3.0	2.0	1.7	1.8	CKD
GeoEngineers 1993	3/3/1993	TP-6	2.0	Cadmium	3.0	2.0	1.7	1.8	CKD
GeoEngineers 1993	3/3/1993	TP-7	2.5	Cadmium	2.2	2.0	1.7	1.3	CKD
GeoEngineers 1993	3/3/1993	TP-9	1.5	Chromium	44	2,000	270	<1	Soil
GeoEngineers 1993	3/3/1993	TP-8	2.5	Chromium	38	2,000	270	<1	Soil
GeoEngineers 1993	3/3/1993	TP-5	2.0	Chromium	36	2,000	270	<1	Soil
GeoEngineers 1993	3/3/1993	TP-3	1.5	Chromium	34	2,000	270	<1	Soil
GeoEngineers 1993	3/3/1993	TP-2	2.0	Chromium	24	2,000	270	<1	Soil
GeoEngineers 1993	3/3/1993	TP-6	2.0	Chromium	14	2,000	270	<1	CKD

Table 7
Chemicals Detected in Soil and Cement Kiln Dust Samples
Washington Federal Savings & Loan Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor	Notes
GeoEngineers 1993	3/3/1993	TP-1	2.0	Chromium	12	2,000	270	<1	CKD
GeoEngineers 1993	3/3/1993	TP-10	2.0	Chromium	12	2,000	270	<1	CKD
GeoEngineers 1993	3/3/1993	TP-4	1.5	Chromium	12	2,000	270	<1	CKD
GeoEngineers 1993	3/3/1993	TP-7	2.5	Chromium	11	2,000	270	<1	CKD
GeoEngineers 1993	3/3/1993	TP-4	1.5	Lead	2,400	250	67	36	CKD
GeoEngineers 1993	3/3/1993	TP-1	2.0	Lead	1,200	250	67	18	CKD
GeoEngineers 1993	3/3/1993	TP-10	2.0	Lead	1,100	250	67	16	CKD
GeoEngineers 1993	3/3/1993	TP-7	2.5	Lead	750	250	67	11	CKD
GeoEngineers 1993	3/3/1993	TP-6	2.0	Lead	670	250	67	10	CKD
GeoEngineers 1993	3/3/1993	TP-3	1.5	Lead	120	250	67	1.8	Soil
GeoEngineers 1993	3/3/1993	TP-9	1.5	Lead	5.5	250	67	<1	Soil
GeoEngineers 1993	3/3/1993	TP-5	2.0	Lead	4.5	250	67	<1	Soil
GeoEngineers 1993	3/3/1993	TP-8	2.5	Lead	4.1	250	67	<1	Soil
GeoEngineers 1993	3/3/1993	TP-2	2.0	Lead	3.8	250	67	<1	Soil
GeoEngineers 1993	3/3/1993	TP-4	1.5	Silver	3.7	400	0.61	6.1	CKD
GeoEngineers 1993	3/3/1993	TP-10	2.0	Silver	0.98	400	0.61	1.6	CKD
GeoEngineers 1993	3/3/1993	TP-1	2.0	Silver	0.97	400	0.61	1.6	CKD
GeoEngineers 1993	3/3/1993	TP-7	2.5	Silver	0.76	400	0.61	1.2	CKD
GeoEngineers 1993	3/3/1993	TP-6	2.0	Silver	0.6	400	0.61	<1	CKD

ft bgs - Feet below ground surface
mg/kg - Milligrams per kilogram
MTCA - Model Toxics Control Act
CSL - Cleanup Screening Level from Washington Sediment Management Standards
CKD - cement kiln dust

a - The lower of MTCA Method A or B cleanup levels was selected, from CLARC database.
b - Based on CSL. Where two screening levels are listed for a single chemical, the higher screening levels are for soil samples collected from the vadose zone and the lower screening levels are for soil samples collected from the saturated zone (SAIC 2006).
Groundwater elevation data are not available for this site. The saturated CSL screening levels were assumed for all CKD soil samples.
Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Soil-to-Sediment Screening Level, whichever is lower.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:
GeoEngineers (GeoEngineers Inc.). 1993. Report of Geoenvironmental Services, Parcel Number 109-002 Seattle, Washington. Prepared for The City of Seattle. April 27, 1993.

Table 8
Chemicals Detected in Calcium Carbonate Precipitate Samples
Washington Federal Savings & Loan Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Calcium Carbonate Precipitate Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
Wendlick 1999	8/4/1999	Vertical Drain Line Build Up	NA	Lead	360	250	67	5.4

mg/kg - Milligrams per kilogram
CSL - Cleanup Screening Level from Washington Sediment Management Standards
MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or B cleanup levels for soil was selected, from CLARC database.
b - Based on CSL for soil. Where two screening levels are listed for a single chemical, the higher screening levels are for soil samples collected from the vadose zone and the lower screening levels are for soil samples collected from the saturated zone (SAIC 2006).
Groundwater elevation data are not available for this site. The saturated CSL screening levels were assumed for all carbon precipitate samples.
Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Soil-to-Sediment Screening Level, whichever is lower.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:
Wendlick. 1999. Letter from Joseph Wendlick, to Michael J Romano, Centurion Development Services. Re: Results of Analyses on Two (2) Groundwater Leachate samples and One (1) Calcium Carbonate Precipitate Sample Collected on 4-6 August 1999 at Property Situated at SW Hudson Street and West Marginal Way. August 26, 1999.

Table 9
Chemicals Detected in Surface Water and Leachate Samples
Washington Federal Savings & Loan Property

Source	Sample Date	Sample Location	Chemical	Surface Water Conc'n (ug/L)	Freshwater Chronic WQS[a] (ug/L)	Freshwater Chronic WQS Exceedance Factor	Marine Chronic WQS[a] (ug/L)	Chronic WQS Exceedance Factor	GW-to-Sediment Screening Level[c] (ug/L)	Exceedance Factor
Environmental Control 1990b	2/1/1990	002617	Aluminum	1,200						
Environmental Control 1990b	2/1/1990	002616	Aluminum	490						
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Aluminum	270						
Environmental Control 1990b	2/1/1990	002614	Aluminum	200						
Environmental Control 1990a	5/19/1989	907830 Catch Basin Water	Aluminum	200						
Environmental Control 1990a	5/19/1989	907828 Zd Drain Water	Aluminum	130						
Environmental Control 1990a	5/19/1989	907827 Clear Water - embankment	Aluminum	120						
Environmental Control 1990b	2/1/1990	002615	Aluminum	120						
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Arsenic	20	190	<1	36	<1	370	<1
Ecology 1989b	3/30/1989	CKD-1	Arsenic	4.0	190	<1	36	<1	370	<1
Ecology 1989b	3/30/1989	CKD-2	Arsenic	2.0	190	<1	36	<1	370	<1
Ecology 1989b	3/30/1989	CKD-3	Arsenic	1.0	190	<1	36	<1	370	<1
Environmental Control 1990a	5/19/1989	907827 Clear Water - embankment	Barium	260						
Environmental Control 1990a	5/19/1989	907830 Catch Basin Water	Barium	260						
Environmental Control 1990b	2/1/1990	002614	Barium	176						
GeoEngineers 1993	3/3/1993	Leachate Collection System Manhole	Barium	130						
Environmental Control 1990b	2/1/1990	002616	Barium	73						
Environmental Control 1990a	5/19/1989	907828 Zd Drain Water	Barium	60						
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Barium	60						
GeoEngineers 1993	3/3/1993	SW-1	Barium	36						
GeoEngineers 1993	3/3/1993	SW-2	Barium	31						
Environmental Control 1990b	2/1/1990	002617	Barium	29						
GeoEngineers 1993	3/3/1993	Leachate Seep next to Storm Drain	Barium	28						
GeoEngineers 1993	3/3/1993	SW-3	Barium	21						
Environmental Control 1990b	2/1/1990	002615	Barium	12						
Ecology 1989b	3/30/1989	CKD-1	Cadmium	2.0			8.80	<1	3.40	<1
Environmental Control 1990b	2/1/1990	002614	Chromium	80					320	<1
Ecology 1989b	3/30/1989	CKD-2	Chromium	40					320	<1
Environmental Control 1990b	2/1/1990	002616	Chromium	29					320	<1
Ecology 1989b	3/30/1989	CKD-1	Chromium	20					320	<1
Environmental Control 1990b	2/1/1990	002617	Chromium	14					320	<1
Environmental Control 1990b	2/1/1990	002615	Chromium	12					320	<1
Environmental Control 1990a	5/19/1989	907827 Clear Water - embankment	Chromium	10					320	<1
Ecology 1989b	3/30/1989	CKD-3	Chromium	10					320	<1
Environmental Control 1990a	5/19/1989	907830 Catch Basin Water	Chromium	10					320	<1

Table 9
Chemicals Detected in Surface Water and Leachate Samples
Washington Federal Savings & Loan Property

Source	Sample Date	Sample Location	Chemical	Surface Water Conc'n (ug/L)	Freshwater Chronic WQS[a] (ug/L)	Freshwater Chronic WQS Exceedance Factor	Marine Chronic WQS[a] (ug/L)	Chronic WQS Exceedance Factor	GW-to-Sediment Screening Level[c] (ug/L)	Exceedance Factor
Environmental Control 1990b	2/1/1990	002614	Cobalt	9.0						
Environmental Control 1990b	2/1/1990	002615	Cobalt	7.0						
Environmental Control 1990b	2/1/1990	002616	Cobalt	7.0						
Environmental Control 1990b	2/1/1990	002617	Cobalt	5.0						
Environmental Control 1990b	2/1/1990	002614	Copper	26			2.40	11	120	<1
Environmental Control 1990a	5/19/1989	907827 Clear Water - embankment	Copper	20			2.40	8.3	120	<1
Environmental Control 1990a	5/19/1989	907828 Zd Drain Water	Copper	20			2.40	8.3	120	<1
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Copper	20			2.40	8.3	120	<1
Environmental Control 1990b	2/1/1990	002617	Copper	16			2.40	6.7	120	<1
Environmental Control 1990b	2/1/1990	002615	Copper	11			2.40	4.6	120	<1
Environmental Control 1990a	5/19/1989	907830 Catch Basin Water	Copper	10			2.40	4.2	120	<1
Environmental Control 1990b	2/1/1990	002616	Copper	4.0			2.40	1.7	120	<1
Environmental Control 1990b	2/1/1990	002617	Iron	1,200						
Environmental Control 1990b	2/1/1990	002616	Iron	520						
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Iron	90						
Environmental Control 1990b	2/1/1990	002614	Iron	30						
Environmental Control 1990b	2/1/1990	002615	Iron	30						
Environmental Control 1990a	5/19/1989	907830 Catch Basin Water	Iron	20						
Ecology 1989b	3/30/1989	CKD-1	Lead	1,100			8.1	136	13	85
Ecology 1989b	3/30/1989	CKD-2	Lead	940			8.1	116	13	72
Environmental Control 1990a	5/19/1989	907827 Clear Water - embankment	Lead	900			8.1	111	13	69
Environmental Control 1990a	5/19/1989	907830 Catch Basin Water	Lead	800			8.1	99	13	62
Wendlick 1999	8/6/1999	Leachate Sample #1	Lead	790			8.1	98	13	61
Wendlick 1999	8/6/1999	Leachate Sample #2	Lead	760			8.1	94	13	58
Ecology 1989b	3/30/1989	CKD-3	Lead	670			8.1	83	13	52
Environmental Control 1990b	2/1/1990	002614	Lead	450			8.1	56	13	35
GeoEngineers 1993	3/3/1993	Leachate Collection System Manhole	Lead	46			8.1	5.7	13	3.5
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Lead	30			8.1	3.7	13	2.3
Environmental Control 1990b	2/1/1990	002617	Manganese	38						
Environmental Control 1990b	2/1/1990	002616	Manganese	25						
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Manganese	20						
Environmental Control 1990b	2/1/1990	002614	Manganese	15						
Environmental Control 1990b	2/1/1990	002615	Manganese	4.0						
Ecology 1989b	3/30/1989	CKD-3	Mercury	1.4	0.012	117	0.025	56	0.0074	189
Ecology 1989b	3/30/1989	CKD-2	Mercury	0.9	0.012	75	0.025	36	0.0074	122

Table 9
Chemicals Detected in Surface Water and Leachate Samples
Washington Federal Savings & Loan Property

Source	Sample Date	Sample Location	Chemical	Surface Water Conc'n (ug/L)	Freshwater Chronic WQS[a] (ug/L)	Freshwater Chronic WQS Exceedance Factor	Marine Chronic WQS[a] (ug/L)	Chronic WQS Exceedance Factor	GW-to-Sediment Screening Level[c] (ug/L)	Exceedance Factor
Ecology 1989b	3/30/1989	CKD-1	Mercury	0.3	0.012	25	0.025	12	0.0074	41
Environmental Control 1990a	5/19/1989	907828 Zd Drain Water	Molybdenum	70						
Environmental Control 1990b	2/1/1990	002615	Molybdenum	70						
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Molybdenum	70						
Environmental Control 1990b	2/1/1990	002614	Molybdenum	40						
Environmental Control 1990a	5/19/1989	907827 Clear Water - embankment	Molybdenum	30						
Environmental Control 1990b	2/1/1990	002616	Molybdenum	20						
Environmental Control 1990a	5/19/1989	907830 Catch Basin Water	Molybdenum	20						
Ecology 1989b	3/30/1989	CKD-1	Nickel	40						
Ecology 1989b	3/30/1989	CKD-3	Nickel	40						
Ecology 1989b	3/30/1989	CKD-2	Nickel	10						
Environmental Control 1990b	2/1/1990	002614	Silver	30					1.50	20
Environmental Control 1990b	2/1/1990	002616	Silver	10					1.50	6.7
Environmental Control 1990a	5/19/1989	907827 Clear Water - embankment	Strontium	29,000						
Environmental Control 1990a	5/19/1989	907830 Catch Basin Water	Strontium	28,000						
Environmental Control 1990b	2/1/1990	002614	Strontium	11,200						
Environmental Control 1990a	5/19/1989	907828 Zd Drain Water	Strontium	1,600						
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Strontium	1,600						
Environmental Control 1990b	2/1/1990	002616	Strontium	926						
Environmental Control 1990b	2/1/1990	002615	Strontium	411						
Environmental Control 1990b	2/1/1990	002617	Strontium	124						
Environmental Control 1990b	2/1/1990	002616	Tin	50						
Environmental Control 1990b	2/1/1990	002614	Tin	40						
Environmental Control 1990b	2/1/1990	002615	Tin	30						
Environmental Control 1990b	2/1/1990	002617	Tin	20						
Environmental Control 1990b	2/1/1990	002615	Vanadium	7.0						
Environmental Control 1990b	2/1/1990	002614	Vanadium	6.0						
Environmental Control 1990b	2/1/1990	002616	Vanadium	6.0						
Environmental Control 1990b	2/1/1990	002617	Vanadium	4.0						
Environmental Control 1990b	2/1/1990	002614	Yittrium	10						
Environmental Control 1990b	2/1/1990	002616	Yittrium	4.0						
Environmental Control 1990b	2/1/1990	002615	Yittrium	2.0						
Environmental Control 1990b	2/1/1990	002617	Yittrium	2.0						
Environmental Control 1990a	5/19/1989	907830 Catch Basin Water	Zinc	20			81	<1	76	<1
Environmental Control 1990b	2/1/1990	002617	Zinc	16			81	<1	76	<1

Table 9
Chemicals Detected in Surface Water and Leachate Samples
Washington Federal Savings & Loan Property

Source	Sample Date	Sample Location	Chemical	Surface Water Conc'n (ug/L)	Freshwater Chronic WQS[a] (ug/L)	Freshwater Chronic WQS Exceedance Factor	Marine Chronic WQS[a] (ug/L)	Chronic WQS Exceedance Factor	GW-to-Sediment Screening Level[c] (ug/L)	Exceedance Factor
Environmental Control 1990b	2/1/1990	002616	Zinc	11			81	<1	76	<1
Environmental Control 1990a	5/19/1989	907827 Clear Water - embankment	Zinc	10			81	<1	76	<1
Environmental Control 1990b	2/1/1990	002614	Zinc	9.0			81	<1	76	<1
Environmental Control 1990a	5/19/1989	907829 Zd Drain Water	Zinc	8.0			81	<1	76	<1
Environmental Control 1990b	2/1/1990	002615	Zinc	4.0			81	<1	76	<1
Environmental Control 1990a	5/19/1989	907828 Zd Drain Water	Zinc	3.0			81	<1	76	<1

ug/L - Microgram per liter
WQS - Water Quality Standards
GW - Groundwater
CSL - Cleanup Screening Level from Washington Sediment Management Standards

a - The lower of the ARARS for Surface Water Aquatic Life (Marine/Chronic) were selected from CLARC database
b - The lower of the ARARS for Surface Water Aquatic Life (Marine/Acute) were selected from CLARC database
c - Based on CSL (SAIC 2006).
Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentrations to the minimum screening level available in the WA State CLARC database and Groundwater-to-Sediment Screening Level.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.
Hardness was not analyzed for samples collected on the Washington Federal Savings & Loan Property.
Freshwater Chronic Water Quality Standards were not calculated for cadmium, copper, lead, nickel, silver, and zinc

Sources:

Ecology. 1989b. Daily Project Record, South of S.W. Hudson Street – CKD Dump. March 30, 1989.
Environmental Control (Environmental Control Science, Inc.). 1990a. Letter from Carl Mangold, Environmental Control Science, Inc. to William Riley, Appraisal Associates, Inc. Re: West Marginal Way Property (Washington Federal Savings & Loan, Assoc., Seattle). January 29, 1990.
Environmental Control. 1990b. Letter from Carl Mangold, Environmental Control Science, Inc., to George Corley, Washington Federal Savings & Loan Assoc. Re: West Marginal Way Property. February 15, 1990.
GeoEngineers (GeoEngineers Inc.). 1993. Report of Geoenvironmental Services, Parcel Number 109-002 Seattle, Washington. Prepared for The City of Seattle. April 27, 1993.
Wendlick. 1999. Letter from Joseph Wendlick, to Michael J Romano, Centurion Development Services. Re: Results of Analyses on Two (2) Groundwater Leachate samples and One (1) Calcium Carbonate Precipitate Sample Collected on 4-6 August 1999 at Property Situated at SW Hudson Street and West Marginal Way. August 26, 1999.

Table 10
Chemicals Detected Above Screening Levels in Bank Soil Samples
Port of Seattle Terminal 107

Source	Sample Location	Date Sampled	Chemical	Conc'n (mg/kg)	SQS	CSL	Units	SQS Exceedance Factor	CSL Exceedance Factor	LDW Background	Units	LDW Background Exceedance Factor
Hart Crowser 2012	T107-BS-5	5/10/2011	Arsenic	324	57	93	mg/kg	5.7	3.5	7.3	mg/kg	44
Hart Crowser 2012	T107-BS-4	5/10/2011	Arsenic	313	57	93	mg/kg	5.5	3.4	7.3	mg/kg	43
Hart Crowser 2012	T107-BS-2	5/10/2011	Arsenic	310	57	93	mg/kg	5.4	3.3	7.3	mg/kg	42
Hart Crowser 2012	T107-BS-1	5/10/2011	Arsenic	197	57	93	mg/kg	3.5	2.1	7.3	mg/kg	27
Hart Crowser 2012	T107-BS-3	5/10/2011	Arsenic	190	57	93	mg/kg	3.3	2.0	7.3	mg/kg	26
Hart Crowser 2012	RM-BS-4	5/12/2011	Arsenic	43	57	93	mg/kg	<1	<1	7.3	mg/kg	5.9
Hart Crowser 2012	RM-BS-5	5/12/2011	Arsenic	8.5	57	93	mg/kg	<1	<1	7.3	mg/kg	1.2
Hart Crowser 2012	T107-BS-5	5/10/2011	Lead	1610	450	530	mg/kg	3.6	3.0			
Hart Crowser 2012	T107-BS-2	5/10/2011	Lead	1140	450	530	mg/kg	2.5	2.2			
Hart Crowser 2012	T107-BS-4	5/10/2011	Lead	970	450	530	mg/kg	2.2	1.8			
Hart Crowser 2012	T107-BS-1	5/10/2011	Lead	730	450	530	mg/kg	1.6	1.4			
Hart Crowser 2012	T107-BS-3	5/10/2011	Lead	640	450	530	mg/kg	1.4	1.2			
Hart Crowser 2012	RM-BS-1	5/12/2011	Mercury	1.1	0.41	1	mg/kg	2.6	1.8			
Hart Crowser 2012	T107-BS-5	5/10/2011	Zinc	2480	410	960	mg/kg	6.0	2.6			
Hart Crowser 2012	T107-BS-4	5/10/2011	Zinc	1440	410	960	mg/kg	3.5	1.5			
Hart Crowser 2012	T107-BS-2	5/10/2011	Zinc	1280	410	960	mg/kg	3.1	1.3			
Hart Crowser 2012	T107-BS-3	5/10/2011	Zinc	603	410	960	mg/kg	1.5	<1			
Hart Crowser 2012	T107-BS-1	5/10/2011	Zinc	440	410	960	mg/kg	1.1	<1			
Source	**Sample Location**	**Date Sampled**	**Chemical**	**Conc'n (ug/kg)**	**LAET**	**2LAET**	**Units**	**LAET Exceedance Factor**	**2LAET Exceedance Factor**	**LDW Background**	**Units**	**LDW Background Exceedance Factor**
Hart Crowser 2012	T107-BS-3	5/10/2011	Dioxin/Furans TEQ (ng/kg)	1.87						1.6	ng/kg	1.2
Hart Crowser 2012	RM-BS-5	5/12/2011	Total PCBs	78	130	1,000	mg/kg	<1	<1	6.5	ug/kg	12
Hart Crowser 2012	RM-BS-1	5/12/2011	Total PCBs	47	130	1,000	mg/kg	<1	<1	6.5	ug/kg	7.2
Hart Crowser 2012	RM-BS-4	5/12/2011	Total PCBs	47	130	1,000	mg/kg	<1	<1	6.5	ug/kg	7.2
Hart Crowser 2012	RM-BS-2	5/12/2011	Total PCBs	16	130	1,000	mg/kg	<1	<1	6.5	ug/kg	2.5

Table 10
Chemicals Detected Above Screening Levels in Bank Soil Samples
Port of Seattle Terminal 107

mg/kg - Milligram per kilogram
ug/kg - Micrograms per kilogram
ng/kg - Nanograms per kilogram
SMS - Sediment Management Standard (Washington Administrative Code 173-204)
SQS - SMS Sediment Quality Standard
CSL - SMS Cleanup Screening Level
LAET - Lowest Apparent Effects Threshold
2LAET - Second LAET
cPAHs - Carginogenic polycyclic aromatic hydrocarbons
PCB - Polychlorinated biphenyl
LDW - Lower Duwamish Waterway
TEQ - Toxic Equivalency

Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentrations to the SQS/CSL, LAET/2LAET or LDW Background.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:
Hart Crowser (Hart Crowser, Inc.). 2012. Lower Duwamish Waterway, Bank Sampling Summary Report, Seattle, Washington.
Prepared for Washington State Department of Ecology. March 13, 2012.

Table 11
Chemicals Detected in Groundwater
Terminal 115

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
Seafreeze Facility Area							
Port of Seattle 1996	10/23/1995	MW-11	Lead	108	15	13	8.3
Port of Seattle 1996	4/25/1995	MW-8	Lead	66	15	13	5.1
Port of Seattle 1996	4/25/1995	MW-11	Lead	61	15	13	4.7
Port of Seattle 1996	7/28/1995	MW-11	Lead	58	15	13	4.5
EMCON 1995b	11/4/1994	MW-10	Lead	54 D	15	13	4.2
Port of Seattle 1997	2/25/1997	MW-11	Lead	41 D	15	13	3.2
Port of Seattle 1996	10/23/1995	MW-8	Lead	40	15	13	3.1
EMCON 1995b	11/4/1994	MW-10	Lead	39	15	13	3.0
Port of Seattle 1997	2/25/1997	MW-11	Lead	34 D	15	13	2.6
Port of Seattle 1996	10/23/1995	MW-9	Lead	27	15	13	2.1
Port of Seattle 1996	10/23/1995	MW-10	Lead	25	15	13	1.9
Port of Seattle 1996	7/28/1995	MW-10	Lead	22	15	13	1.7
Port of Seattle 1996	7/28/1995	MW-8	Lead	22	15	13	1.7
Port of Seattle 1996	4/25/1995	MW-10	Lead	20	15	13	1.5
Port of Seattle 1996	4/25/1995	MW-9	Lead	19	15	13	1.5
Port of Seattle 1996	2/7/1996	MW-8	Lead	17	15	13	1.3
Port of Seattle 1996	2/7/1996	MW-9	Lead	16	15	13	1.2
EMCON 1995b	11/4/1994	MW-11	Lead	15	15	13	1.2
EMCON 1995b	11/4/1994	MW-9	Lead	13	15	13	1.0
EMCON 1995b	11/4/1994	MW-8	Lead	12	15	13	<1
Port of Seattle 1996	2/7/1996	MW-8	Lead	12	15	13	<1
Port of Seattle 1996	2/7/1996	MW-11	Lead	11	15	13	<1
Port of Seattle 1996	2/7/1996	MW-10	Lead	9.0	15	13	<1
Port of Seattle 1996	7/28/1995	MW-9	Lead	7.0	15	13	<1
Port of Seattle 1997	2/25/1997	MW-9	Lead	5.0 D	15	13	<1
Southwest Tank Yard/Cardlock Facility/Shultz Distributing							
Onsite Environmental 2009b	12/4/2009	MW-15	Arsenic	64	0.058	370	1,103
Onsite Environmental 2009a	10/7/2009	MW-15	Arsenic	42	0.058	370	724
Onsite Environmental 2009b	12/4/2009	MW-19	Arsenic	16	0.058	370	276
Onsite Environmental 2009b	12/4/2009	MW-19	Arsenic	14	0.058	370	241
Onsite Environmental 2009a	10/7/2009	MW-19	Arsenic	5.5	0.058	370	94.8
Onsite Environmental 2009a	10/7/2009	MW-19	Arsenic	5.0	0.058	370	86.2
Onsite Environmental 2009a	10/7/2009	MW-21	Arsenic	3.6	0.058	370	62.1
Onsite Environmental 2009a	10/7/2009	MW-16	Barium	200	3,200		<1
Onsite Environmental 2009b	12/4/2009	MW-16	Barium	200	3,200		<1
Onsite Environmental 2009b	12/4/2009	MW-15	Barium	69	3,200		<1
Onsite Environmental 2009b	12/4/2009	MW-21	Barium	61	3,200		<1
Onsite Environmental 2009b	12/4/2009	MW-17	Barium	55	3,200		<1
Onsite Environmental 2009a	10/7/2009	MW-17	Barium	46	3,200		<1
Onsite Environmental 2009b	12/4/2009	MW-19	Barium	35	3,200		<1
Onsite Environmental 2009a	10/7/2009	MW-15	Barium	31	3,200		<1
Onsite Environmental 2009a	10/7/2009	MW-21	Barium	26	3,200		<1
Onsite Environmental 2009b	12/4/2009	MW-19	Barium	0.037	3,200		<1

Table 11
Chemicals Detected in Groundwater
Terminal 115

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
Onsite Environmental 2009b	12/4/2009	MW-15	Cadmium	4.5	5.0	3.4	1.3
Onsite Environmental 2009b	12/4/2009	MW-15	Chromium	39	50	320	<1
Onsite Environmental 2009b	12/4/2009	MW-15	Lead	56	15	13	4.3
Onsite Environmental 2009a	10/7/2009	MW-15	Lead	9.8	15	13	<1
Onsite Environmental 2009b	12/4/2009	MW-15	Selenium	5.9	80		<1

ug/L - Micrograms per liter

CSL - Cleanup Screening Level from Washington Sediment Management Standards

D - Duplicate sample

MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or B cleanup levels was selected, from CLARC database.

b - Based on CSL (SAIC 2006).

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Groundwater-to-Sediment Screening Level, whichever is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Sources:

EMCON (EMCON Northwest, Inc.). 1995b. Soil and Groundwater Assessment Report, Port of Seattle, Terminal 115, Seattle, Washington. Prepared for Port of Seattle. February 21, 1995.

OnSite Environmental (OnSite Environmental Inc.). 2009a. Analytical Data for Project T115_SW Tank, Laboratory Reference No. 0910-074. October 23, 2009.

OnSite Environmental. 2009b. Analytical Data for Project Terminal 115 SW Corner; D4840, Laboratory Reference No. 0912-041. December 14, 2009.

Port of Seattle. 1996. Annual Report, UST 1996 Compliance Monitoring, Terminal 115, Seattle, Washington. July 15, 1996.

Port of Seattle. 1997. Annual Report, UST 1997 Compliance Monitoring, Terminal 115, Seattle, Washington. October 29, 1997.

Table 12
Chemicals Detected in Soil
Seaport Petroleum Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
KM&S 1995	2/1/1995	TPE4-1	4.0	Arsenic	400	0.67	590	597
KM&S 1995	2/1/1995	TPE2-1	4.0	Arsenic	360	0.67	590	537
KM&S 1995	2/1/1995	TPE1-1	4.0	Arsenic	290	0.67	590	433
KM&S 1995	2/1/1995	TPE5-1	4.0	Arsenic	200	0.67	590	299
GeoEngineers 1996	1/31/1996	TP4, #2	3.0 (CKD)	Arsenic	200	0.67	590	299
GeoEngineers 1996	1/31/1996	TP9, #2	2.5 (CKD)	Arsenic	160	0.67	590	239
GeoEngineers 1996	1/31/1996	TP5, #2	3.0 (CKD)	Arsenic	140	0.67	590	209
GeoEngineers 1996	1/31/1996	TP6, #2	2.0 (CKD)	Arsenic	130	0.67	590	194
GeoEngineers 1996	1/31/1996	TP2, #2	3.0 (CKD)	Arsenic	120	0.67	590	179
GeoEngineers 1996	1/30/1996	B3, #1	0 (slag/native)	Arsenic	100	0.67	590	149
GeoEngineers 1996	1/31/1996	TP10, #2	2.5 (CKD)	Arsenic	94	0.67	590	140
GeoEngineers 1996	1/31/1996	TP7, #2	3.0 (CKD)	Arsenic	94	0.67	590	140
GeoEngineers 1996	1/31/1996	TP3, #2	4.5 (CKD)	Arsenic	93	0.67	590	139
GeoEngineers 1996	1/30/1996	B2, #2	2.5 (CKD)	Arsenic	67	0.67	590	100
GeoEngineers 1996	2/2/1996	TP8, #2	2.5 (CKD)	Arsenic	67	0.67	590	100
KM&S 1995	2/1/1995	TPE1-2	0.5	Arsenic	64	0.67	590	96
KM&S 1995	2/1/1995	TPE2-2	0.5	Arsenic	52	0.67	590	78
GeoEngineers 1996	1/30/1996	TP2, #1	0.5 (slag)	Arsenic	50	0.67	590	75
GeoEngineers 1996	1/30/1996	TP1, #1	0.5 (slag)	Arsenic	45	0.67	590	67
KM&S 1995	2/1/1995	TPE4-2	0.5	Arsenic	34	0.67	590	51
GeoEngineers 1996	1/30/1996	TP1, #2	2.0 (CKD)	Arsenic	32	0.67	590	48
GeoEngineers 1996	1/31/1996	TP5, #3	6.5 (CKD)	Arsenic	32	0.67	590	48
KM&S 1995	2/1/1995	TPE5-2	0.5	Arsenic	28	0.67	590	42
GeoEngineers 1996	1/31/1996	TP7, #1	0.5 (native)	Arsenic	18	0.67	590	27
GeoEngineers 1996	1/31/1996	TP3, #1	0.5 (slag/native)	Arsenic	17	0.67	590	25
GeoEngineers 1996	2/2/1996	TP8, #1	0.5 (slag/native)	Arsenic	15	0.67	590	22
GeoEngineers 1996	1/31/1996	TP1, #4	9.0 (native)	Arsenic	11	0.67	590	16
GeoEngineers 1996	1/31/1996	TP9, #4	9.5 (native)	Arsenic	7.6	0.67	590	11

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GeoEngineers 1996	1/31/1996	TP7, #4	12.5 (native)	Arsenic	6.7	0.67	590	10
GeoEngineers 1996	1/31/1996	TP6, #4	12 (native)	Arsenic	5.6	0.67	590	8.4
GeoEngineers 1996	1/31/1996	TP2, #4	12 (native)	Arsenic	5.5	0.67	590	8.2
GeoEngineers 1996	2/2/1996	TP8, #4	9.5 (native)	Arsenic	3.5	0.67	590	5.2
GeoEngineers 1996	1/31/1996	TP3, #4	10.25 (native)	Arsenic	2.7	0.67	590	4.0
GeoEngineers 1996	1/31/1996	TP4, #4	10.75 (native)	Arsenic	2.3	0.67	590	3.4
GeoEngineers 1996	1/30/1996	B2, #1	0 (slag/native)	Barium	450	41		11
GeoEngineers 1996	1/31/1996	TP10, #1	0.5 (slag/native)	Barium	280	41		6.8
GeoEngineers 1996	1/31/1996	TP5, #1	0.5 (slag/native)	Barium	270	41		6.6
GeoEngineers 1996	1/31/1996	TP4, #1	0.5 (slag/native)	Barium	220	41		5.4
GeoEngineers 1996	1/31/1996	TP9, #1	0.5 (slag/native)	Barium	220	41		5.4
GeoEngineers 1996	1/30/1996	TP1, #1	0.5 (slag)	Barium	180	41		4.4
GeoEngineers 1996	1/30/1996	TP2, #1	0.5 (slag)	Barium	140	41		3.4
GeoEngineers 1996	1/31/1996	TP3, #2	4.5 (CKD)	Barium	65	41		1.6
GeoEngineers 1996	1/30/1996	B3, #3	5.0 (CKD)	Barium	58	41		1.4
GeoEngineers 1996	1/30/1996	B2, #2	2.5 (CKD)	Barium	57	41		1.4
GeoEngineers 1996	1/31/1996	TP5, #3	6.5 (CKD)	Barium	53	41		1.3
GeoEngineers 1996	1/31/1996	TP2, #2	3.0 (CKD)	Barium	50	41		1.2
GeoEngineers 1996	1/30/1996	B3, #5	10 (native)	Barium	47	41		1.1
GeoEngineers 1996	1/31/1996	TP9, #2	2.5 (CKD)	Barium	45	41		1.1
GeoEngineers 1996	2/2/1996	TP3, #3	7.0 (native)	Barium	40	41		<1.0
GeoEngineers 1996	2/2/1996	TP6, #3	6.5 (native)	Barium	39	41		<1.0
GeoEngineers 1996	1/31/1996	TP5, #2	3.0 (CKD)	Barium	30	41		<1.0
GeoEngineers 1996	1/31/1996	TP4, #2	3.0 (CKD)	Barium	29	41		<1.0
GeoEngineers 1996	2/2/1996	TP7, #3	7.5 (native)	Barium	29	41		<1.0
GeoEngineers 1996	2/2/1996	TP8, #2	2.5 (CKD)	Barium	29	41		<1.0
GeoEngineers 1996	2/2/1996	TP4, #3	6.5 (native)	Barium	28	41		<1.0
GeoEngineers 1996	1/31/1996	TP6, #2	2.0 (CKD)	Barium	27	41		<1.0

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GeoEngineers 1996	1/31/1996	TP7, #2	3.0 (CKD)	Barium	26	41		<1.0
GeoEngineers 1996	1/30/1996	TP1, #2	2.0 (CKD)	Barium	25	41		<1.0
GeoEngineers 1996	1/31/1996	TP3, #1	0.5 (slag/native)	Barium	25	41		<1.0
GeoEngineers 1996	1/31/1996	TP10, #3	6.5 (native)	Barium	24	41		<1.0
GeoEngineers 1996	1/31/1996	TP1, #3	5.0 (native)	Barium	23	41		<1.0
GeoEngineers 1996	1/31/1996	TP6, #1	0.5 (slag/native)	Barium	23	41		<1.0
GeoEngineers 1996	2/2/1996	TP9, #3	6.5 (native)	Barium	21	41		<1.0
GeoEngineers 1996	2/2/1996	TP8, #1	0.5 (slag/native)	Barium	18	41		<1.0
GeoEngineers 1996	2/2/1996	TP2, #3	6.5 (native)	Barium	17	41		<1.0
GeoEngineers 1996	1/30/1996	B2, #5	10 (native)	Barium	16	41		<1.0
GeoEngineers 1996	1/31/1996	TP10, #2	2.5 (CKD)	Barium	15	41		<1.0
GeoEngineers 1996	2/2/1996	TP8, #3	6.5 (native)	Barium	15	41		<1.0
GeoEngineers 1996	1/30/1996	B3, #1	0 (slag/native)	Barium	13	41		<1.0
GeoEngineers 1996	1/31/1996	TP7, #1	0.5 (native)	Barium	13	41		<1.0
KM&S 1995	2/1/1995	TPE4-1	4.0	Cadmium	12	2.0	1.7	7.1
KM&S 1995	2/1/1995	TPE5-1	4.0	Cadmium	10	2.0	1.7	5.9
KM&S 1995	2/1/1995	TPE2-1	4.0	Cadmium	8.6	2.0	1.7	5.1
GeoEngineers 1996	1/31/1996	TP6, #2	2.0 (CKD)	Cadmium	6.6	2.0	1.7	3.9
KM&S 1995	2/1/1995	TPE1-1	4.0	Cadmium	5.9	2.0	1.7	3.5
KM&S 1995	2/1/1995	TPE5-2	0.5	Cadmium	5.7	2.0	1.7	3.4
GeoEngineers 1996	1/30/1996	B3, #1	0 (slag/native)	Cadmium	4.4	2.0	1.7	2.6
GeoEngineers 1996	2/2/1996	TP8, #2	2.5 (CKD)	Cadmium	3.7	2.0	1.7	2.2
GeoEngineers 1996	1/31/1996	TP3, #2	4.5 (CKD)	Cadmium	3.6	2.0	1.7	2.1
GeoEngineers 1996	1/31/1996	TP9, #2	2.5 (CKD)	Cadmium	3.5	2.0	1.7	2.1
GeoEngineers 1996	1/31/1996	TP5, #2	3.0 (CKD)	Cadmium	3.4	2.0	1.7	2.0
GeoEngineers 1996	1/31/1996	TP4, #2	3.0 (CKD)	Cadmium	3.3	2.0	1.7	1.9
GeoEngineers 1996	1/31/1996	TP7, #2	3.0 (CKD)	Cadmium	3.2	2.0	1.7	1.9
GeoEngineers 1996	1/31/1996	TP10, #2	2.5 (CKD)	Cadmium	3.0	2.0	1.7	1.8

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KM&S 1995	2/1/1995	TPE4-2	0.5	Cadmium	2.9	2.0	1.7	1.7
GeoEngineers 1996	1/31/1996	TP2, #2	3.0 (CKD)	Cadmium	2.8	2.0	1.7	1.6
KM&S 1995	2/1/1995	TPE1-2	0.5	Cadmium	1.9	2.0	1.7	1.1
KM&S 1995	2/1/1995	TPE2-2	0.5	Cadmium	1.9	2.0	1.7	1.1
GeoEngineers 1996	1/30/1996	TP1, #1	0.5 (slag)	Cadmium	1.2	2.0	1.7	<1
GeoEngineers 1996	1/30/1996	B2, #1	0 (slag/native)	Cadmium	1.1	2.0	1.7	<1
GeoEngineers 1996	1/30/1996	TP2, #1	0.5 (slag)	Cadmium	0.86	2.0	1.7	<1
GeoEngineers 1996	1/31/1996	TP4, #1	0.5 (slag/native)	Cadmium	0.82	2.0	1.7	<1
GeoEngineers 1996	1/31/1996	TP9, #1	0.5 (slag/native)	Cadmium	0.65	2.0	1.7	<1
GeoEngineers 1996	1/30/1996	B2, #2	2.5 (CKD)	Cadmium	0.59	2.0	1.7	<1
GeoEngineers 1996	1/30/1996	TP1, #2	2.0 (CKD)	Cadmium	0.59	2.0	1.7	<1
GeoEngineers 1996	1/31/1996	TP5, #1	0.5 (slag/native)	Cadmium	0.50	2.0	1.7	<1
GeoEngineers 1996	1/31/1996	TP10, #1	0.5 (slag/native)	Cadmium	0.49	2.0	1.7	<1
GeoEngineers 1996	1/30/1996	B3, #3	5.0 (CKD)	Cadmium	0.29	2.0	1.7	<1
GeoEngineers 1996	1/31/1996	TP3, #1	0.5 (slag/native)	Cadmium	0.29	2.0	1.7	<1
GeoEngineers 1996	1/31/1996	TP5, #3	6.5 (CKD)	Cadmium	0.29	2.0	1.7	<1
GeoEngineers 1996	2/2/1996	TP8, #1	0.5 (slag/native)	Cadmium	0.27	2.0	1.7	<1
KM&S 1995	2/1/1995	TPE2-2	0.5	Chromium	2,700		270	10
KM&S 1995	2/1/1995	TPE5-2	0.5	Chromium	2,200		270	8.1
GeoEngineers 1996	1/31/1996	TP9, #1	0.5 (slag/native)	Chromium	2,000		270	7.4
GeoEngineers 1996	1/31/1996	TP10, #1	0.5 (slag/native)	Chromium	1,900		270	7.0
GeoEngineers 1996	1/31/1996	TP5, #1	0.5 (slag/native)	Chromium	1,900		270	7.0
GeoEngineers 1996	1/31/1996	TP4, #1	0.5 (slag/native)	Chromium	1,700		270	6.3
KM&S 1995	2/1/1995	TPE1-2	0.5	Chromium	1,200		270	4.4
KM&S 1995	2/1/1995	TPE4-2	0.5	Chromium	940		270	3.5
GeoEngineers 1996	1/30/1996	TP2, #1	0.5 (slag)	Chromium	790		270	2.9
GeoEngineers 1996	1/30/1996	TP1, #1	0.5 (slag)	Chromium	320		270	1.2
KM&S 1995	2/1/1995	TPE1-1	4.0	Chromium	270		270	1.0

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GeoEngineers 1996	1/31/1996	TP5, #3	6.5 (CKD)	Chromium	70		270	<1
KM&S 1995	2/1/1995	TPE4-1	4.0	Chromium	53		270	<1
GeoEngineers 1996	1/30/1996	B2, #1	0 (slag/native)	Chromium	41		270	<1
GeoEngineers 1996	1/31/1996	TP6, #1	0.5 (slag/native)	Chromium	38		270	<1
GeoEngineers 1996	1/30/1996	B2, #2	2.5 (CKD)	Chromium	27		270	<1
GeoEngineers 1996	1/31/1996	TP5, #2	3.0 (CKD)	Chromium	23		270	<1
GeoEngineers 1996	1/31/1996	TP3, #1	0.5 (slag/native)	Chromium	21		270	<1
GeoEngineers 1996	1/30/1996	B3, #1	0 (slag/native)	Chromium	20		270	<1
KM&S 1995	2/1/1995	TPE5-1	4.0	Chromium	17		270	<1
KM&S 1995	2/1/1995	TPE2-1	4.0	Chromium	14		270	<1
GeoEngineers 1996	1/30/1996	B3, #3	5.0 (CKD)	Chromium	14		270	<1
GeoEngineers 1996	1/30/1996	B3, #5	10 (native)	Chromium	12		270	<1
GeoEngineers 1996	1/30/1996	TP1, #2	2.0 (CKD)	Chromium	12		270	<1
GeoEngineers 1996	2/2/1996	TP4, #3	6.5 (native)	Chromium	11		270	<1
GeoEngineers 1996	1/31/1996	TP6, #2	2.0 (CKD)	Chromium	11		270	<1
GeoEngineers 1996	1/31/1996	TP1, #3	5.0 (native)	Chromium	10		270	<1
GeoEngineers 1996	1/31/1996	TP2, #2	3.0 (CKD)	Chromium	10		270	<1
GeoEngineers 1996	1/31/1996	TP4, #2	3.0 (CKD)	Chromium	10		270	<1
GeoEngineers 1996	2/2/1996	TP6, #3	6.5 (native)	Chromium	10		270	<1
GeoEngineers 1996	1/31/1996	TP9, #2	2.5 (CKD)	Chromium	9.2		270	<1
GeoEngineers 1996	2/2/1996	TP3, #3	7.0 (native)	Chromium	9.1		270	<1
GeoEngineers 1996	1/31/1996	TP3, #2	4.5 (CKD)	Chromium	8.8		270	<1
GeoEngineers 1996	1/31/1996	TP10, #2	2.5 (CKD)	Chromium	8.7		270	<1
GeoEngineers 1996	2/2/1996	TP7, #3	7.5 (native)	Chromium	8.4		270	<1
GeoEngineers 1996	1/30/1996	B2, #5	10 (native)	Chromium	8.1		270	<1
GeoEngineers 1996	1/31/1996	TP7, #2	3.0 (CKD)	Chromium	7.5		270	<1
GeoEngineers 1996	1/31/1996	TP10, #3	6.5 (native)	Chromium	7.4		270	<1
GeoEngineers 1996	2/2/1996	TP2, #3	6.5 (native)	Chromium	7.2		270	<1

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GeoEngineers 1996	2/2/1996	TP8, #2	2.5 (CKD)	Chromium	6.8		270	<1
GeoEngineers 1996	2/2/1996	TP8, #1	0.5 (slag/native)	Chromium	6.2		270	<1
GeoEngineers 1996	2/2/1996	TP8, #3	6.5 (native)	Chromium	6.1		270	<1
GeoEngineers 1996	2/2/1996	TP9, #3	6.5 (native)	Chromium	5.9		270	<1
GeoEngineers 1996	1/31/1996	TP7, #1	0.5 (native)	Chromium	4.1		270	<1
GeoEngineers 1996	1/31/1996	TP9, #1	0.5 (slag/native)	Diesel-range hydrocarbons	3,400	2,000		1.7
GeoEngineers 1996	1/31/1996	TP10, #1	0.5 (slag/native)	Diesel-range hydrocarbons	2,800	2,000		1.4
GeoEngineers 1996	1/31/1996	TP9, #2	2.5 (CKD)	Diesel-range hydrocarbons	890	2,000		<1
GeoEngineers 1996	1/31/1996	TP8, #2	2.5 (CKD)	Diesel-range hydrocarbons	560	2,000		<1
GeoEngineers 1996	1/30/1996	B2, #1	0 (slag/native)	Diesel-range hydrocarbons	330	2,000		<1
GeoEngineers 1996	1/31/1996	TP1, #2	2.0 (CKD)	Diesel-range hydrocarbons	270	2,000		<1
GeoEngineers 1996	1/31/1996	TP8, #1	0.5 (slag/native)	Diesel-range hydrocarbons	250	2,000		<1
GeoEngineers 1996	1/31/1996	TP6, #2	2.0 (CKD)	Diesel-range hydrocarbons	220	2,000		<1
GeoEngineers 1996	1/31/1996	TP3, #1	0.5 (slag/native)	Diesel-range hydrocarbons	190	2,000		<1
GeoEngineers 1996	1/31/1996	TP4, #1	0.5 (slag/native)	Diesel-range hydrocarbons	190	2,000		<1
GeoEngineers 1996	1/31/1996	TP2, #1	0.5 (slag)	Diesel-range hydrocarbons	70	2,000		<1
GeoEngineers 1996	1/31/1996	TP6, #1	0.5 (slag/native)	Diesel-range hydrocarbons	52	2,000		<1
GeoEngineers 1996	1/31/1996	TP1, #1	0.5 (slag)	Diesel-range hydrocarbons	46	2,000		<1
GeoEngineers 1996	2/2/1996	TP8, #2	2.5 (CKD)	Gasoline-range hydrocarbons[c]	210	30		7.0
GeoEngineers 1996	1/31/1996	TP5, #3	6.5 (CKD)	Lead	4,600	250	67	69
KM&S 1995	2/1/1995	TPE4-1	4.0	Lead	2,400	250	67	36
GeoEngineers 1996	1/30/1996	B3, #1	0 (slag/native)	Lead	2,200	250	67	33
KM&S 1995	2/1/1995	TPE2-1	4.0	Lead	1,900	250	67	28
KM&S 1995	2/1/1995	TPE1-1	4.0	Lead	1,100	250	67	16
KM&S 1995	2/1/1995	TPE5-1	4.0	Lead	1,100	250	67	16
GeoEngineers 1996	1/31/1996	TP4, #2	3.0 (CKD)	Lead	870	250	67	13
GeoEngineers 1996	1/31/1996	TP9, #2	2.5 (CKD)	Lead	830	250	67	12
GeoEngineers 1996	1/31/1996	TP5, #2	3.0 (CKD)	Lead	740	250	67	11

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GeoEngineers 1996	1/31/1996	TP2, #2	3.0 (CKD)	Lead	720	250	67	11
GeoEngineers 1996	1/31/1996	TP3, #2	4.5 (CKD)	Lead	720	250	67	11
GeoEngineers 1996	1/31/1996	TP10, #2	2.5 (CKD)	Lead	650	250	67	10
GeoEngineers 1996	1/31/1996	TP6, #2	2.0 (CKD)	Lead	640	250	67	10
GeoEngineers 1996	1/31/1996	TP7, #2	3.0 (CKD)	Lead	610	250	67	9.1
KM&S 1995	2/1/1995	TPE5-2	0.5	Lead	480	250	67	7.2
GeoEngineers 1996	2/2/1996	TP8, #2	2.5 (CKD)	Lead	410	250	67	6.1
GeoEngineers 1996	1/30/1996	TP2, #1	0.5 (slag)	Lead	360	250	67	5.4
GeoEngineers 1996	1/30/1996	B2, #1	0 (slag/native)	Lead	220	250	67	3.3
GeoEngineers 1996	1/30/1996	TP1, #1	0.5 (slag)	Lead	200	250	67	3.0
GeoEngineers 1996	1/30/1996	B2, #2	2.5 (CKD)	Lead	150	250	67	2.2
GeoEngineers 1996	1/31/1996	TP9, #1	0.5 (slag/native)	Lead	140	250	67	2.1
GeoEngineers 1996	1/31/1996	TP5, #1	0.5 (slag/native)	Lead	120	250	67	1.8
GeoEngineers 1996	1/31/1996	TP4, #1	0.5 (slag/native)	Lead	98	250	67	1.5
KM&S 1995	2/1/1995	TPE1-2	0.5	Lead	93	250	67	1.4
KM&S 1995	2/1/1995	TPE4-2	0.5	Lead	86	250	67	1.3
GeoEngineers 1996	1/31/1996	TP10, #1	0.5 (slag/native)	Lead	71	250	67	1.1
GeoEngineers 1996	2/2/1996	TP8, #1	0.5 (slag/native)	Lead	68	250	67	1.0
GeoEngineers 1996	1/30/1996	TP1, #2	2.0 (CKD)	Lead	65	250	67	<1
KM&S 1995	2/1/1995	TPE2-2	0.5	Lead	55	250	67	<1
GeoEngineers 1996	1/31/1996	TP3, #1	0.5 (slag/native)	Lead	53	250	67	<1
GeoEngineers 1996	1/31/1996	TP6, #1	0.5 (slag/native)	Lead	34	250	67	<1
GeoEngineers 1996	1/31/1996	TP7, #1	0.5 (native)	Lead	28	250	67	<1
GeoEngineers 1996	1/31/1996	TP9, #4	9.5 (native)	Lead	25	250	67	<1
GeoEngineers 1996	1/31/1996	TP1, #4	9.0 (native)	Lead	22	250	67	<1
GeoEngineers 1996	1/31/1996	TP7, #4	12.5 (native)	Lead	18	250	67	<1
GeoEngineers 1996	1/31/1996	TP2, #4	12 (native)	Lead	15	250	67	<1
GeoEngineers 1996	1/31/1996	TP6, #4	12 (native)	Lead	15	250	67	<1

Table 12
Chemicals Detected in Soil
Seaport Petroleum Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
GeoEngineers 1996	1/30/1996	B3, #3	5.0 (CKD)	Lead	13	250	67	<1
GeoEngineers 1996	2/2/1996	TP8, #4	9.5 (native)	Lead	13	250	67	<1
GeoEngineers 1996	1/31/1996	TP3, #4	10.25 (native)	Lead	11	250	67	<1
GeoEngineers 1996	1/31/1996	TP4, #4	10.75 (native)	Lead	11	250	67	<1
GeoEngineers 1996	1/31/1996	TP4, #1	0.5 (slag/native)	Mercury	0.17	2.0	0.030	5.7
KM&S 1995	2/1/1995	TPE1-2	0.5	Mercury	0.13	2.0	0.030	4.3
GeoEngineers 1996	1/30/1996	B2, #1	0 (slag/native)	Mercury	0.11	2.0	0.030	3.7
GeoEngineers 1996	1/31/1996	TP9, #1	0.5 (slag/native)	Oil-range hydrocarbons	5,500	2,000		2.8
GeoEngineers 1996	1/31/1996	TP10, #1	0.5 (slag/native)	Oil-range hydrocarbons	4,200	2,000		2.1
GeoEngineers 1996	1/30/1996	B2, #1	0 (slag/native)	Oil-range hydrocarbons	1,500	2,000		<1
GeoEngineers 1996	1/31/1996	TP3, #1	0.5 (slag/native)	Oil-range hydrocarbons	1,400	2,000		<1
GeoEngineers 1996	1/31/1996	TP8, #1	0.5 (slag/native)	Oil-range hydrocarbons	1,300	2,000		<1
GeoEngineers 1996	1/31/1996	TP4, #1	0.5 (slag/native)	Oil-range hydrocarbons	1,000	2,000		<1
GeoEngineers 1996	1/31/1996	TP8, #2	2.5 (CKD)	Oil-range hydrocarbons	720	2,000		<1
GeoEngineers 1996	1/31/1996	TP1, #2	2.0 (CKD)	Oil-range hydrocarbons	500	2,000		<1
GeoEngineers 1996	1/31/1996	TP2, #1	0.5 (slag)	Oil-range hydrocarbons	340	2,000		<1
GeoEngineers 1996	1/31/1996	TP1, #1	0.5 (slag)	Oil-range hydrocarbons	260	2,000		<1
GeoEngineers 1996	1/31/1996	TP6, #1	0.5 (slag/native)	Oil-range hydrocarbons	220	2,000		<1
GeoEngineers 1996	1/31/1996	TP6, #2	2.0 (CKD)	Oil-range hydrocarbons	38	2,000		<1
GeoEngineers 1996	1/31/1996	TP3, #2	4.5 (CKD)	Silver	9.5		0.61	16
GeoEngineers 1996	1/31/1996	TP7, #2	3.0 (CKD)	Silver	8.8		0.61	14
GeoEngineers 1996	1/31/1996	TP5, #2	3.0 (CKD)	Silver	8.3		0.61	14
GeoEngineers 1996	2/2/1996	TP8, #2	2.5 (CKD)	Silver	8.2		0.61	13
GeoEngineers 1996	1/31/1996	TP2, #2	3.0 (CKD)	Silver	8.0		0.61	13
GeoEngineers 1996	1/31/1996	TP10, #2	2.5 (CKD)	Silver	7.8		0.61	13
GeoEngineers 1996	1/31/1996	TP4, #2	3.0 (CKD)	Silver	7.5		0.61	12
GeoEngineers 1996	1/30/1996	B3, #1	0 (slag/native)	Silver	6.8		0.61	11
GeoEngineers 1996	1/31/1996	TP6, #2	2.0 (CKD)	Silver	6.3		0.61	10

Table 12
Chemicals Detected in Soil
Seaport Petroleum Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
GeoEngineers 1996	1/31/1996	TP3, #1	0.5 (slag/native)	Silver	5.6		0.61	9.2
GeoEngineers 1996	1/30/1996	B2, #2	2.5 (CKD)	Silver	5.2		0.61	8.5
GeoEngineers 1996	1/31/1996	TP10, #1	0.5 (slag/native)	Silver	5.2		0.61	8.5
GeoEngineers 1996	1/31/1996	TP4, #1	0.5 (slag/native)	Silver	4.8		0.61	7.9
GeoEngineers 1996	1/31/1996	TP6, #1	0.5 (slag/native)	Silver	4.8		0.61	7.9
GeoEngineers 1996	2/2/1996	TP8, #1	0.5 (slag/native)	Silver	4.8		0.61	7.9
GeoEngineers 1996	1/31/1996	TP9, #1	0.5 (slag/native)	Silver	4.6		0.61	7.5
GeoEngineers 1996	1/30/1996	TP1, #1	0.5 (slag)	Silver	3.9		0.61	6.4
GeoEngineers 1996	1/30/1996	TP2, #1	0.5 (slag)	Silver	3.8		0.61	6.2
GeoEngineers 1996	1/31/1996	TP7, #1	0.5 (native)	Silver	3.5		0.61	5.7
GeoEngineers 1996	1/31/1996	TP5, #3	6.5 (CKD)	Silver	3.4		0.61	5.6
GeoEngineers 1996	1/30/1996	TP1, #2	2.0 (CKD)	Silver	1.7		0.61	2.8
GeoEngineers 1996	1/31/1996	TP5, #1	0.5 (slag/native)	Silver	1.7		0.61	2.8
GeoEngineers 1996	1/30/1996	B2, #1	0 (slag/native)	Silver	1.6		0.61	2.6
GeoEngineers 1996	2/2/1996	TP6, #3	6.5 (native)	Silver	1.5		0.61	2.5
GeoEngineers 1996	2/2/1996	TP7, #3	7.5 (native)	Silver	1.4		0.61	2.3
GeoEngineers 1996	2/2/1996	TP4, #3	6.5 (native)	Silver	1.1		0.61	1.8
GeoEngineers 1996	1/31/1996	TP9, #2	2.5 (CKD)	Silver	10		0.61	16
GeoEngineers 1996	2/2/1996	TP3, #3	7.0 (native)	Silver	1.7		0.61	2.8
GeoEngineers 1996	1/31/1996	TP5, #2	3.0 (CKD)	TCLP Chromium (mg/L)	0.12			<1
GeoEngineers 1996	1/31/1996	TP5, #2	3.0 (CKD)	TCLP Silver (mg/L)	0.023			<1
KM&S 1995	2/1/1995	TPE4-1	4.0	Zinc	1,200	24,000	38	32
KM&S 1995	2/1/1995	TPE2-1	4.0	Zinc	960	24,000	38	25
KM&S 1995	2/1/1995	TPE1-1	4.0	Zinc	750	24,000	38	20
KM&S 1995	2/1/1995	TPE5-1	4.0	Zinc	690	24,000	38	18
KM&S 1995	2/1/1995	TPE5-2	0.5	Zinc	490	24,000	38	13
KM&S 1995	2/1/1995	TPE4-2	0.5	Zinc	260	24,000	38	6.8
KM&S 1995	2/1/1995	TPE1-2	0.5	Zinc	120	24,000	38	3.2

Table 12
Chemicals Detected in Soil
Seaport Petroleum Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
KM&S 1995	2/1/1995	TPE2-2	0.5	Zinc	100	24,000	38	2.6

ft bgs - feet below ground surface

mg/kg - Milligrams per kilogram

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or Method B cleanup level was selected, from CLARC database.

b - Screening levels based on CSL and assuming saturated zone soils (SAIC 2006).

c - MTCA Method A cleanup level for TPH gasoline range organics with benzene present

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or the Soil-to-Sediment Screening Level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Sources:

GeoEngineers (GeoEngineers, Inc.). 1996. Report: Site Characterization, West Coast Equipment Site, Seattle, Washington. Prepared by GeoEngineers for Mr. Bob Cash and Mr. Randall Thomas. April 15, 1996.

KM&S (Kidder Mathews & Segner Inc). 1995. Letter from Craig Hogan, KM&S, to Daniel Cargill, Ecology, Re: Information on Phase I Environmental Site Assessment for property located at 7746 Detroit Avenue SW. November 9, 1995.

Table 13
Chemicals Detected in Groundwater
Seaport Petroleum Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
GeoEngineers 1996	2/2/1996	MW-3	2-Butanone (methyl ethyl ketone)	11	4,800		<1
GeoEngineers 1996	2/2/1996	MW-3	Acetone	80	7,200		<1
GeoEngineers 1996	2/2/1996	MW-9	Acetone	20	7,200		<1
GeoEngineers 1996	2/2/1996	MW-9	Arsenic (dissolved)	120	0.058	370	2069
GeoEngineers 1996	2/2/1996	MW-3	Arsenic (dissolved)	39	0.058	370	672
GeoEngineers 1996	2/2/1996	MW-2	Arsenic (dissolved)	7.0	0.058	370	121
GeoEngineers 1996	2/2/1996	MW-9	Arsenic (total)	150	0.058	370	2586
GeoEngineers 1996	2/2/1996	MW-2	Arsenic (total)	65	0.058	370	1121
GeoEngineers 1996	2/2/1996	MW-3	Arsenic (total)	53	0.058	370	914
GeoEngineers 1996	2/2/1996	MW-9	Barium (dissolved)	150	3,200		<1
GeoEngineers 1996	2/2/1996	MW-2	Barium (total)	430	3,200		<1
GeoEngineers 1996	2/2/1996	MW-9	Barium (total)	360	3,200		<1
GeoEngineers 1996	2/2/1996	MW-3	Barium (total)	76	3,200		<1
GeoEngineers 1996	2/2/1996	MW-3	Benzene	0.85	0.80		1.1
GeoEngineers 1996	2/2/1996	MW-9	Chromium (dissolved)	68	50	320	1.4
GeoEngineers 1996	2/2/1996	MW-2	Chromium (total)	330	50	320	6.6
GeoEngineers 1996	2/2/1996	MW-9	Chromium (total)	180	50	320	3.6
GeoEngineers 1996	2/2/1996	MW-3	Chromium (total)	160	50	320	3.2
GeoEngineers 1996	2/2/1996	MW-3	Diesel-range hydrocarbons	930	500		1.9
GeoEngineers 1996	2/2/1996	MW-2	Diesel-range hydrocarbons	680	500		1.4
GeoEngineers 1996	2/2/1996	MW-9	Diesel-range hydrocarbons	590	500		1.2
GeoEngineers 1996	2/2/1996	MW03	Ethylbenzene	0.85	700		<1
GeoEngineers 1996	2/2/1996	MW-9	Lead (dissolved)	20	15	13	1.5
GeoEngineers 1996	2/2/1996	MW-3	Lead (total)	96	15	13	7.4
GeoEngineers 1996	2/2/1996	MW-2	Lead (total)	41	15	13	3.2
GeoEngineers 1996	2/2/1996	MW-9	Lead (total)	25	15	13	1.9
GeoEngineers 1996	2/2/1996	MW-3	Oil-range hydrocarbons	770	500		1.5
GeoEngineers 1996	2/2/1996	MW-3	Toluene	0.88	640		<1
GeoEngineers 1996	2/2/1996	MW-3	Xylenes	1.5	1,000		<1

ug/L - Micrograms per liter

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or Method B cleanup level was selected, from CLARC database.

b - Based on CSL (SAIC 2006)

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Groundwater-to-Sediment screening level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:

GeoEngineers (GeoEngineers, Inc.). 1996. Report: Site Characterization, West Coast Equipment Site, Seattle, Washington. Prepared by GeoEngineers for Mr. Bob Cash and Mr. Randall Thomas. April 15, 1996.

Table 14
Chemicals Detected in Soil
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Maximum Exceedance Factor
Riley 2005c	Aug 2004	B-3	2 - 3	Arsenic	143	0.67	590	213
Riley 2005c	Aug 2004	B-1	2 - 3	Arsenic	44	0.67	590	66
Riley 2005c	Aug 2004	B-2	2.5 - 3.5	Arsenic	39	0.67	590	58
Riley 2005c	Aug 2004	B-1	5 - 6	Arsenic	37	0.67	590	55
Riley 2005c	Aug 2004	B-1	8.5 - 9.5	Arsenic	7.1	0.67	590	11
Riley 2005c	Aug 2004	B-5	5 - 6	Arsenic	4.3	0.67	590	6.5
Riley 2005c	Aug 2004	B-4	3 - 4	Arsenic	3.9	0.67	590	5.8
Riley 2005c	Aug 2004	B-3	4.5 - 5.5	Arsenic	3.7	0.67	590	5.5
Riley 2005c	Aug 2004	B-2	6.5 - 7.5	Arsenic	2.9	0.67	590	4.4
Riley 2005c	Aug 2004	B-4	6.5 - 7.5	Arsenic	2.1	0.67	590	3.1
Riley 2005c	Aug 2004	B-5	2 - 3	Arsenic	2.0	0.67	590	3.0
Riley 2005c	Aug 2004	B-2	9 - 10	Arsenic	1.3	0.67	590	1.9
Riley 1998b	9/2/1997	B2	12 (excavation floor)	Benzene	180	0.03		6,000
Riley 1998b	9/2/1997	SS2	8.0 (sidewall)	Benzene	84	0.03		2,800
Riley 1998b	9/2/1997	B3	12 (excavation floor)	Benzene	82	0.03		2,733
Riley 1998b	9/2/1997	ES1	8.0 (sidewall)	Benzene	56	0.03		1,867
Riley 1998b	9/2/1997	STP4	stockpile	Benzene	8.6	0.03		287
Riley 2005d	12/3/2004	B2	13	Benzene	0.45	0.03		15
Riley 2004c	5/31/1997	SB7	7.0	Benzene	0.42	0.03		14
Riley 2005d	12/3/2004	B10	6.0 (CKD)	Benzene	0.12	0.03		4.0
Riley 2005d	12/3/2004	B3	13	Benzene	0.061	0.03		2.0
Riley 2005d	12/3/2004	B5	6.0 (CKD)	Benzene	0.059	0.03		2.0
Riley 2005d	12/3/2004	B8	13	Benzene	0.032	0.03		1.1
Riley 2005c	Aug 2004	B-3	2 - 3	Cadmium	8.6	2.0	1.7	5.0
Riley 2005c	Aug 2004	B-1	2 - 3	Cadmium	2.9	2.0	1.7	1.7
Riley 2005c	Aug 2004	B-1	5 - 6	Cadmium	2.5	2.0	1.7	1.5

Table 14
Chemicals Detected in Soil
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Maximum Exceedance Factor
Riley 2005c	Aug 2004	B-2	2.5 - 3.5	Cadmium	1.5	2.0	1.7	<1
Riley 2005c	Aug 2004	B-5	2 - 3	Cadmium	1.4	2.0	1.7	<1
Riley 2005c	Aug 2004	B-2	6.5 - 7.5	Chromium, total	35		270	<1
Riley 2005c	Aug 2004	B-5	2 - 3	Chromium, total	17		270	<1
Riley 2005c	Aug 2004	B-1	8.5 - 9.5	Chromium, total	15		270	<1
Riley 2005c	Aug 2004	B-3	2 - 3	Chromium, total	14		270	<1
Riley 2005c	Aug 2004	B-5	5 - 6	Chromium, total	13		270	<1
Riley 2005c	Aug 2004	B-4	3 - 4	Chromium, total	13		270	<1
Riley 2005c	Aug 2004	B-1	5 - 6	Chromium, total	12		270	<1
Riley 2005c	Aug 2004	B-4	6.5 - 7.5	Chromium, total	11		270	<1
Riley 2005c	Aug 2004	B-2	2.5 - 3.5	Chromium, total	11		270	<1
Riley 2005c	Aug 2004	B-1	2 - 3	Chromium, total	11		270	<1
Riley 2005c	Aug 2004	B-3	4.5 - 5.5	Chromium, total	7.6		270	<1
Riley 2005c	Aug 2004	B-2	9 - 10	Chromium, total	6.6		270	<1
Riley 2005d	12/3/2004	B2	13	Diesel-range hydrocarbons	3,000	2,000		1.5
Riley 1998b	9/2/1997	STP4	stockpile	Diesel-range hydrocarbons	1,700	2,000		<1
Riley 1998b	9/2/1997	ES1	8.0 (sidewall)	Diesel-range hydrocarbons	1,300	2,000		<1
Riley 1998b	9/2/1997	B2	12 (excavation floor)	Diesel-range hydrocarbons	1,200	2,000		<1
Riley 1998b	9/2/1997	B3	12 (excavation floor)	Diesel-range hydrocarbons	1,000	2,000		<1
Riley 1998b	9/2/1997	SS2	8.0 (sidewall)	Diesel-range hydrocarbons	960	2,000		<1
Riley 2004c	5/31/1997	SB4	6.5	Diesel-range hydrocarbons	560	2,000		<1
Riley 1998b	9/2/1997	WS2	7.0 (sidewall)	Diesel-range hydrocarbons	400	2,000		<1
Riley 2004c	5/31/1997	SB6	6.5	Diesel-range hydrocarbons	340	2,000		<1
Riley 2004c	5/31/1997	SB1	5.0	Diesel-range hydrocarbons	100	2,000		<1
Riley 1998b	9/2/1997	B2	12 (excavation floor)	Ethylbenzene	330	6.0		55
Riley 1998b	9/2/1997	SS2	8.0 (sidewall)	Ethylbenzene	190	6.0		32

Table 14
Chemicals Detected in Soil
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Maximum Exceedance Factor
Riley 1998b	9/2/1997	B3	12 (excavation floor)	Ethylbenzene	180	6.0		30
Riley 1998b	9/2/1997	ES1	8.0 (sidewall)	Ethylbenzene	130	6.0		22
Riley 1998b	9/2/1997	STP4	stockpile	Ethylbenzene	41	6.0		6.8
Riley 1998b	9/2/1997	WS2	7.0 (sidewall)	Ethylbenzene	13	6.0		2.2
Riley 2005d	12/3/2004	B2	13	Ethylbenzene	1.5	6.0		<1
Riley 2004c	5/31/1997	SB7	7.0	Ethylbenzene	0.99	6.0		<1
Riley 2005d	12/3/2004	B8	13	Ethylbenzene	0.86	6.0		<1
Riley 1998b	9/2/1997	B2	12 (excavation floor)	Gasoline-range hydrocarbons[e]	17,000	30		567
Riley 1998b	9/2/1997	SS2	8.0 (sidewall)	Gasoline-range hydrocarbons[e]	9,000	30		300
Riley 1998b	9/2/1997	B3	12 (excavation floor)	Gasoline-range hydrocarbons[e]	8,800	30		293
Riley 1998b	9/2/1997	ES1	8.0 (sidewall)	Gasoline-range hydrocarbons[e]	6,100	30		203
Riley 1998b	9/2/1997	STP4	stockpile	Gasoline-range hydrocarbons[e]	2,600	30		87
Riley 1998b	9/2/1997	WS2	7.0 (sidewall)	Gasoline-range hydrocarbons[e]	1,100	30		37
Riley 2005d	12/3/2004	B2	13	Gasoline-range hydrocarbons[e]	190	30		6.3
Riley 2004c	5/31/1997	SB1	5.0	Gasoline-range hydrocarbons[e]	85	30		2.8
Riley 2005c	Aug 2004	B-3	2 - 3	Lead	2,210	250	67	33
Riley 2005c	Aug 2004	B-1	2 - 3	Lead	888	250	67	13
Riley 2005c	Aug 2004	B-1	5 - 6	Lead	719	250	67	11
Riley 2005c	Aug 2004	B-2	2.5 - 3.5	Lead	423	250	67	6.3
Riley 2005c	Aug 2004	B-2	6.5 - 7.5	Lead	52	250	67	<1
Riley 2005c	Aug 2004	B-5	5 - 6	Lead	11	250	67	<1
Riley 2005c	Aug 2004	B-4	3 - 4	Lead	4.2	250	67	<1
Riley 2005c	Aug 2004	B-1	8.5 - 9.5	Lead	4.0	250	67	<1
Riley 2005c	Aug 2004	B-3	4.5 - 5.5	Lead	2.9	250	67	<1
Riley 2005c	Aug 2004	B-5	2 - 3	Lead	2.5	250	67	<1
Riley 2005c	Aug 2004	B-4	6.5 - 7.5	Lead	1.7	250	67	<1

Table 14
Chemicals Detected in Soil
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Maximum Exceedance Factor
Riley 2005c	Aug 2004	B-2	9 - 10	Lead	0.93	250	67	<1
Riley 2004c	5/31/1997	SB6	6.5	Oil-range hydrocarbons	2,700	2,000		1.4
Riley 2004c	5/31/1997	SB4	6.5	Oil-range hydrocarbons	1,700	2,000		<1
Riley 2005d	12/3/2004	B7	6.0 (CKD)	Oil-range hydrocarbons	170	2,000		<1
Riley 2005d	12/3/2004	B12	6.0 (CKD)	Oil-range hydrocarbons	97	2,000		<1
Riley 1998b	9/2/1997	B2	12 (excavation floor)	Toluene	590	7.0		84
Riley 1998b	9/2/1997	SS2	8.0 (sidewall)	Toluene	520	7.0		74
Riley 1998b	9/2/1997	B3	12 (excavation floor)	Toluene	450	7.0		64
Riley 1998b	9/2/1997	ES1	8.0 (sidewall)	Toluene	420	7.0		60
Riley 1998b	9/2/1997	STP4	stockpile	Toluene	110	7.0		16
Riley 1998b	9/2/1997	WS2	7.0 (sidewall)	Toluene	9.7	7.0		1.4
Riley 2004c	5/31/1997	SB7	7.0	Toluene	3.1	7.0		0.44
Riley 1998b	9/15/1997	SS4	8.0 (sidewall)	Total EPH[c]	1,242	2,000		<1
Riley 1998b	9/15/1997	WS2	7.0 (sidewall)	Total EPH[c]	528	2,000		<1
Riley 1998b	9/15/1997	ES4	8.0 (sidewall)	Total EPH[c]	250	2,000		<1
Riley 1998b	9/15/1997	B5	13 (excavation floor)	Total EPH[c]	56	2,000		<1
Riley 1998b	9/15/1997	SS4	8.0 (sidewall)	Total VPH[d]	1,890	30		63
Riley 1998b	9/15/1997	ES4	8.0 (sidewall)	Total VPH[d]	484	30		16
Riley 1998b	9/15/1997	WS2	7.0 (sidewall)	Total VPH[d]	406	30		14
Riley 1998b	9/15/1997	B5	13 (excavation floor)	Total VPH[d]	26	30		<1
Riley 1998b	9/15/1997	B4	13 (excavation floor)	Total VPH[d]	17	30		<1
Riley 1998b	9/2/1997	B2	12 (excavation floor)	Xylenes	1,030	9.0		114
Riley 1998b	9/2/1997	SS2	8.0 (sidewall)	Xylenes	820	9.0		91
Riley 1998b	9/2/1997	B3	12 (excavation floor)	Xylenes	720	9.0		80
Riley 1998b	9/2/1997	ES1	8.0 (sidewall)	Xylenes	640	9.0		71
Riley 1998b	9/2/1997	STP4	stockpile	Xylenes	264	9.0		29

Table 14
Chemicals Detected in Soil
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Maximum Exceedance Factor
Riley 1998b	9/2/1997	WS2	7.0 (sidewall)	Xylenes	71	9.0		7.9
Riley 2005d	12/3/2004	B2	13	Xylenes	15	9.0		1.6
Riley 2004c	5/31/1997	SB7	7.0	Xylenes	6.4	9.0		<1
Riley 2005d	12/3/2004	B8	13	Xylenes	1.9	9.0		<1
Riley 2004c	5/31/1997	SB1	5.0	Xylenes	1.4	9.0		<1

ft bgs - feet below ground surface

mg/kg - Milligrams per kilogram

CSL - Cleanup Screening Level from Washington Sediment Management Standards

EPH - extractable petroleum hydrocarbons

MTCA - Model Toxics Control Act

VPH - volatile petroleum hydrocarbons

[ ] Sample location was excavated during remediation activities.

a - The lower of MTCA Method A or Method B cleanup level was selected, from CLARC database.

b - Screening levels based on CSL and assuming saturated zone soils (SAIC 2006).

c - Total EPH was compared to the MTCA cleanup level for TPH-Diesel

d - Total VPH was compared to the MTCA cleanup level for TPH-Gasoline

e - MTCA Method A cleanup level for TPH gasoline range organics with benzene present

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or the Soil-to-Sediment Screening Level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Sources:

Riley (Riley Environmental, LLC). 1998b. Letter from Todd Fisher, Riley Environmental, to Dick Sutterlin, Recycle America, Re: UST Removal & Independent Cleanup Action Letter Report, Recycle America Facility, 7901 First Avenue South. November 3, 1998.

Riley (The Riley Group, Inc.). 2004c. Letter from Paul Riley, The Riley Group, Inc., Michael Kuntz, Washington State Department of Ecology,

Table 14
Chemicals Detected in Soil
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Maximum Exceedance Factor

Re: Independent Remedial Action Review #NW1261, Recycle America Facility, 7901 First Avenue South, Seattle, Washington 98108. August 4, 2004.

Riley. 2005c. Letter from Paul Riley, The Riley Group, Inc., to Michael Kuntz, Ecology, Re: Limited Phase II Findings for Metals Technical Memorandum, Recycle America Facility, 7901 First Avenue South, Seattle, Washington. February 1, 2005.

Riley. 2005d. Letter from Paul Riley, The Riley Group, Inc., to Michael Kuntz, Ecology, Re: Underground Storage Tank Independent Cleanup Action Report, Recycle America Facility, 7901 First Avenue South, Seattle, Washington 98108. NW1261. February 18, 2005.

Table 15
Chemicals Detected in Groundwater
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
EPI 2006	5/18/2005	MW-11	Antimony (dissolved)	8.0	6.4		1.3
EPI 2006	5/18/2005	MW-11	Antimony (total)	9.0	6.4		1.4
EPI 2006	2/14/2006	MW-7R	Arsenic (dissolved)	91	0.058	370	1569
Riley 2005c	8/18/2004	MW-3	Arsenic (dissolved)	68	0.058	370	1172
Riley 2005c	8/18/2004	MW-4	Arsenic (dissolved)	59	0.058	370	1017
Riley 2005c	8/18/2004	MW-7	Arsenic (dissolved)	58	0.058	370	1000
EPI 2006	2/14/2006	MW-1	Arsenic (dissolved)	35	0.058	370	603
EPI 2006	5/18/2005	MW-11	Arsenic (dissolved)	35	0.058	370	603
EPI 2006	5/18/2005	MW-3	Arsenic (dissolved)	34	0.058	370	586
EPI 2006	2/14/2006	MW-3	Arsenic (dissolved)	31	0.058	370	534
EPI 2006	8/30/2005	MW-7R	Arsenic (dissolved)	31	0.058	370	534
Riley 2005c	8/18/2004	MW-5	Arsenic (dissolved)	31	0.058	370	534
EPI 2006	2/14/2006	MW-5	Arsenic (dissolved)	30	0.058	370	517
Riley 2005c	Aug 2004	MW-4	Arsenic (dissolved)	30	0.058	370	517
EPI 2006	2/14/2006	MW-10	Arsenic (dissolved)	29	0.058	370	500
EPI 2006	8/30/2005	MW-11	Arsenic (dissolved)	29	0.058	370	500
EPI 2006	5/18/2005	MW-7R	Arsenic (dissolved)	28	0.058	370	483
Riley 2005c	8/18/2004	MW-2	Arsenic (dissolved)	27	0.058	370	466
EPI 2006	8/30/2005	MW-3	Arsenic (dissolved)	26	0.058	370	448
EPI 2006	8/30/2005	MW-5	Arsenic (dissolved)	24	0.058	370	414
Riley 2005c	Aug 2004	MW-2	Arsenic (dissolved)	24	0.058	370	410
EPI 2006	5/18/2005	MW-4	Arsenic (dissolved)	23	0.058	370	397
Riley 2005c	8/18/2004	MW-1	Arsenic (dissolved)	23	0.058	370	397
EPI 2006	5/18/2005	MW-1	Arsenic (dissolved)	22	0.058	370	379
EPI 2006	8/30/2005	MW-1	Arsenic (dissolved)	22	0.058	370	379
EPI 2006	11/22/2005	MW-7R	Arsenic (dissolved)	21	0.058	370	362
EPI 2006	8/31/2005	MW-6	Arsenic (dissolved)	20	0.058	370	345
EPI 2006	2/14/2006	MW-9	Arsenic (dissolved)	20	0.058	370	345
EPI 2006	11/22/2005	MW-11	Arsenic (dissolved)	20	0.058	370	345
Riley 2005c	8/18/2004	MW-8	Arsenic (dissolved)	19	0.058	370	328
EPI 2006	11/22/2005	MW-3	Arsenic (dissolved)	18	0.058	370	310
EPI 2006	8/30/2005	MW-4	Arsenic (dissolved)	18	0.058	370	310
EPI 2006	11/22/2005	MW-1	Arsenic (dissolved)	16	0.058	370	276
EPI 2006	5/18/2005	MW-5	Arsenic (dissolved)	15	0.058	370	259
EPI 2006	11/22/2005	MW-10	Arsenic (dissolved)	15	0.058	370	259
EPI 2006	2/14/2006	MW-11	Arsenic (dissolved)	15	0.058	370	259
EPI 2006	11/22/2005	MW-5	Arsenic (dissolved)	14	0.058	370	241
EPI 2006	8/31/2005	MW-9	Arsenic (dissolved)	13	0.058	370	224
EPI 2006	5/18/2005	MW-2	Arsenic (dissolved)	12	0.058	370	207
EPI 2006	8/31/2005	MW-10	Arsenic (dissolved)	11	0.058	370	190
Riley 2005c	Aug 2004	MW-1	Arsenic (dissolved)	9.9	0.058	370	171
EPI 2006	11/22/2005	MW-4	Arsenic (dissolved)	9.0	0.058	370	155
EPI 2006	5/18/2005	MW-9	Arsenic (dissolved)	9.0	0.058	370	155

Table 15
Chemicals Detected in Groundwater
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
EPI 2006	5/18/2005	MW-10	Arsenic (dissolved)	7.0	0.058	370	121
EPI 2006	11/22/2005	MW-9	Arsenic (dissolved)	5.0	0.058	370	86
EPI 2006	5/18/2005	MW-7R	Arsenic (total)	40	0.058	370	690
EPI 2006	5/18/2005	MW-11	Arsenic (total)	36	0.058	370	621
EPI 2006	5/18/2005	MW-3	Arsenic (total)	35	0.058	370	603
EPI 2006	5/18/2005	MW-1	Arsenic (total)	30	0.058	370	517
EPI 2006	5/18/2005	MW-5	Arsenic (total)	29	0.058	370	500
EPI 2006	5/18/2005	MW-4	Arsenic (total)	26	0.058	370	448
EPI 2006	11/22/2005	MW-3	Arsenic (total)	23	0.058	370	397
EPI 2006	11/22/2005	MW-7R	Arsenic (total)	22	0.058	370	379
EPI 2006	11/22/2005	MW-11	Arsenic (total)	22	0.058	370	379
EPI 2006	5/18/2005	MW-10	Arsenic (total)	20	0.058	370	345
EPI 2006	11/22/2005	MW-1	Arsenic (total)	19	0.058	370	328
EPI 2006	11/22/2005	MW-10	Arsenic (total)	18	0.058	370	310
EPI 2006	11/22/2005	MW-6	Arsenic (total)	17	0.058	370	293
EPI 2006	5/18/2005	MW-9	Arsenic (total)	15	0.058	370	259
EPI 2006	11/22/2005	MW-5	Arsenic (total)	14	0.058	370	241
EPI 2006	5/18/2005	MW-2	Arsenic (total)	13	0.058	370	224
EPI 2006	11/22/2005	MW-4	Arsenic (total)	11	0.058	370	190
EPI 2006	11/22/2005	MW-9	Arsenic (total)	10	0.058	370	172
EPI 2006	11/22/2005	MW-2	Arsenic (total)	9.0	0.058	370	155
Riley 2000a	11/10/1999	MW-1	Benzene	13,000	0.80		16,250
Riley 2000b	3/7/2000	MW-1	Benzene	6,100	0.80		7,625
Riley 1999a	3/23/1999	MW-2	Benzene	6,000	0.80		7,500
Riley 2000a	11/10/1999	MW-4	Benzene	2,800	0.80		3,500
Riley 2004a	7/27/2001	MW-1	Benzene	2,200	0.80		2,750
Riley 2004a	5/1/2001	MW-1	Benzene	1,500	0.80		1,875
Riley 1999a	3/23/1999	MW-3	Benzene	1,200	0.80		1,500
Riley 2000b	3/7/2000	MW-4	Benzene	510	0.80		638
Riley 2005i	7/9/1999	MW-1	Benzene	410	0.80		513
Riley 2005i	7/9/1999	MW-4	Benzene	320	0.80		400
Riley 2005i	7/9/1999	MW-2	Benzene	310	0.80		388
Riley 2000a	11/10/1999	MW-2	Benzene	110	0.80		138
Riley 2000b	3/7/2000	MW-2	Benzene	59	0.80		74
Riley 2005i	7/9/1999	MW-3	Benzene	54	0.80		68
Riley 1999a	3/23/1999	MW-4	Benzene	51	0.80		64
Riley 2004a	7/27/2001	MW-4	Benzene	13	0.80		16
Riley 2004a	5/1/2001	MW-2	Benzene	10	0.80		13
Riley 2005a	12/10/2004	MW-1	Benzene	8.6	0.80		11
Riley 2000b	3/7/2000	MW-3	Benzene	7.0	0.80		8.8
Riley 2004a	6/30/2003	MW-4	Benzene	6.8	0.80		8.5
Riley 2004a	6/11/2002	MW-4	Benzene	4.2	0.80		5.3
Riley 2004a	5/1/2001	MW-4	Benzene	4.0	0.80		5.0

Table 15
Chemicals Detected in Groundwater
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
Riley 2004a	1/28/2004	MW-4	Benzene	2.8	0.80		3.5
Riley 2004a	6/30/2003	MW-2	Benzene	2.8	0.80		3.5
Riley 2004a	1/14/2003	MW-4	Benzene	2.7	0.80		3.4
Riley 2004a	6/11/2002	MW-1	Benzene	2.2	0.80		2.8
Riley 2005i	7/27/2001	MW-2	Benzene	2.0	0.80		2.5
Riley 2004a	6/30/2003	MW-1	Benzene	1.5	0.80		1.9
Riley 2005a	12/10/2004	MW-4	Benzene	1.4	0.80		1.8
Riley 2004a	1/14/2003	MW-1	Benzene	1.3	0.80		1.6
Riley 2004f	9/23/2004	MW-1	Benzene	1.1	0.80		1.4
EPI 2006	8/31/2005	MW-6	Cadmium (dissolved)	31	5.0	3.4	9.1
EPI 2006	5/18/2005	MW-3	Chromium (dissolved)	23	50	320	<1
EPI 2006	8/31/2005	MW-6	Chromium III (dissolved)	37	24,000		<1
EPI 2006	11/22/2005	MW-3	Chromium III (dissolved)	13	24,000		<1
EPI 2006	8/31/2005	MW-10	Chromium III (dissolved)	7.0	24,000		<1
EPI 2006	11/22/2005	MW-3	Chromium III (total)	17	24,000		<1
EPI 2006	5/18/2005	MW-3	Chromium, total	23	50	320	<1
Riley 2005c	Aug 2004	MW-2	Chromium, total	5.5	50	320	<1
Riley 2005c	Aug 2004	MW-1	Chromium, total	3.6	50	320	<1
Riley 2005c	Aug 2004	MW-3	Chromium, total	3.3	50	320	<1
EPI 2006	5/18/2005	MW-2	Copper (total)	27	640	120	<1
Riley 2000a	11/3/1999	MW-7	Diesel-range hydrocarbons	5,000	500		10
Riley 2000a	11/10/1999	MW-1	Diesel-range hydrocarbons	2,900	500		5.8
Riley 2000a	11/3/1999	MW-5	Diesel-range hydrocarbons	2,400	500		4.8
Riley 2005i	3/7/2000	MW-7	Diesel-range hydrocarbons	2,000	500		4.0
Riley 1999a	3/23/1999	MW-2	Diesel-range hydrocarbons	1,400	500		2.8
Riley 2000b	3/7/2000	MW-1	Diesel-range hydrocarbons	1,100	500		2.2
Riley 2005a	12/10/2004	MW-7	Diesel-range hydrocarbons	1,000	500		2.0
Riley 2004a	5/1/2001	MW-7	Diesel-range hydrocarbons	720	500		1.4
Riley 2000a	11/10/1999	MW-4	Diesel-range hydrocarbons	690	500		1.4
Riley 2004a	5/1/2001	MW-1	Diesel-range hydrocarbons	560	500		1.1
Riley 2005i	7/9/1999	MW-1	Diesel-range hydrocarbons	510	500		1.0
Riley 1999a	3/23/1999	MW-1	Diesel-range hydrocarbons	400	500		<1
Riley 2005i	7/9/1999	MW-4	Diesel-range hydrocarbons	380	500		<1
Riley 1999a	3/23/1999	MW-3	Diesel-range hydrocarbons	360	500		<1
Riley 2005a	12/10/2004	MW-1	Diesel-range hydrocarbons	340	500		<1
Riley 1999a	3/23/1999	MW-4	Diesel-range hydrocarbons	320	500		<1
Riley 2005i	7/9/1999	MW-2	Diesel-range hydrocarbons	250	500		<1
Riley 2004f	8/18/2004	MW-4	Diesel-range hydrocarbons	170	500		<1
Riley 2004f	8/18/2004	MW-2	Diesel-range hydrocarbons	140	500		<1
Riley 2000a	11/10/1999	MW-1	Ethylbenzene	1,100	700		1.6
Riley 2000b	3/7/2000	MW-1	Ethylbenzene	820	700		1.2
Riley 2004a	7/27/2001	MW-1	Ethylbenzene	720	700		1.0
Riley 2004a	5/1/2001	MW-1	Ethylbenzene	490	700		<1

Table 15
Chemicals Detected in Groundwater
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
Riley 1999a	3/23/1999	MW-2	Ethylbenzene	340	700		<1
Riley 2000a	11/10/1999	MW-4	Ethylbenzene	160	700		<1
Riley 2005i	7/9/1999	MW-2	Ethylbenzene	100	700		<1
Riley 2005i	7/9/1999	MW-1	Ethylbenzene	95	700		<1
Riley 2000b	3/7/2000	MW-4	Ethylbenzene	56	700		<1
Riley 2004a	6/11/2002	MW-1	Ethylbenzene	20	700		<1
Riley 2000a	11/10/1999	MW-2	Ethylbenzene	20	700		<1
Riley 2005i	7/9/1999	MW-4	Ethylbenzene	16	700		<1
Riley 2000b	3/7/2000	MW-2	Ethylbenzene	12	700		<1
Riley 1999a	3/23/1999	MW-3	Ethylbenzene	9.0	700		<1
Riley 2005a	12/10/2004	MW-1	Ethylbenzene	8.6	700		<1
Riley 1999a	3/23/1999	MW-4	Ethylbenzene	6.0	700		<1
Riley 2004a	7/27/2001	MW-4	Ethylbenzene	5.0	700		<1
Riley 1999a	3/23/1999	MW-1	Ethylbenzene	5.0	700		<1
Riley 2005i	7/9/1999	MW-3	Ethylbenzene	3.6	700		<1
Riley 2004a	5/1/2001	MW-2	Ethylbenzene	3.0	700		<1
Riley 2004a	6/11/2002	MW-4	Ethylbenzene	1.2	700		<1
Riley 2004a	7/27/2001	MW-2	Ethylbenzene	1.0	700		<1
Riley 2004a	5/1/2001	MW-4	Ethylbenzene	1.0	700		<1
Riley 2000a	11/10/1999	MW-1	Gasoline-range hydrocarbons	16,000	800		20
Riley 2000b	3/7/2000	MW-1	Gasoline-range hydrocarbons	5,500	800		6.9
Riley 1999a	3/23/1999	MW-2	Gasoline-range hydrocarbons	5,400	800		6.8
Riley 2004a	7/27/2001	MW-1	Gasoline-range hydrocarbons	3,100	800		3.9
Riley 2004a	5/1/2001	MW-1	Gasoline-range hydrocarbons	2,000	800		2.5
Riley 2005i	7/9/1999	MW-2	Gasoline-range hydrocarbons	1,200	800		1.5
Riley 2000a	11/10/1999	MW-4	Gasoline-range hydrocarbons	890	800		1.1
Riley 2005i	7/9/1999	MW-1	Gasoline-range hydrocarbons	820	800		1.0
Riley 1999a	3/23/1999	MW-1	Gasoline-range hydrocarbons	740	800		<1
Riley 2000b	3/7/2000	MW-4	Gasoline-range hydrocarbons	280	800		<1
Riley 2000a	11/10/1999	MW-2	Gasoline-range hydrocarbons	260	800		<1
Riley 2004a	6/11/2002	MW-1	Gasoline-range hydrocarbons	250	800		<1
Riley 2004a	1/14/2003	MW-1	Gasoline-range hydrocarbons	190	800		<1
Riley 2000b	3/7/2000	MW-2	Gasoline-range hydrocarbons	180	800		<1
Riley 2005i	7/9/1999	MW-4	Gasoline-range hydrocarbons	160	800		<1
Riley 2005i	5/1/2001	MW-2	Gasoline-range hydrocarbons	140	800		<1
Riley 2005a	12/10/2004	MW-1	Gasoline-range hydrocarbons	120	800		<1
Riley 1999a	3/23/1999	MW-4	Gasoline-range hydrocarbons	78	800		<1
Riley 1999a	3/23/1999	MW-3	Gasoline-range hydrocarbons	68	800		<1
Riley 2005i	5/1/2001	MW-4	Gasoline-range hydrocarbons	52	800		<1
EPI 2006	8/31/2005	MW-10	Lead (dissolved)	28	15	13	2.2
EPI 2006	2/14/2006	MW-5	Lead (dissolved)	10	15	13	<1
EPI 2006	8/31/2005	MW-6	Lead (dissolved)	10	15	13	<1
EPI 2006	8/30/2005	MW-2	Lead (dissolved)	9.0	15	13	<1

Table 15
Chemicals Detected in Groundwater
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Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
EPI 2006	8/30/2005	MW-5	Lead (dissolved)	9.0	15	13	<1
EPI 2006	5/18/2005	MW-2	Lead (dissolved)	6.0	15	13	<1
EPI 2006	8/30/2005	MW-3	Lead (dissolved)	4.0	15	13	<1
EPI 2006	2/14/2006	MW-7R	Lead (dissolved)	4.0	15	13	<1
EPI 2006	2/14/2006	MW-2	Lead (dissolved)	3.0	15	13	<1
EPI 2006	5/18/2005	MW-3	Lead (total)	16	15	13	1.2
EPI 2006	5/18/2005	MW-7R	Lead (total)	15	15	13	1.2
EPI 2006	5/18/2005	MW-2	Lead (total)	8.0	15	13	<1
EPI 2006	11/22/2005	MW-7R	Lead (total)	8.0	15	13	<1
EPI 2006	11/22/2005	MW-6	Lead (total)	6.0	15	13	<1
EPI 2006	5/18/2005	MW-1	Lead (total)	5.0	15	13	<1
EPI 2006	11/22/2005	MW-3	Lead (total)	5.0	15	13	<1
EPI 2006	5/18/2005	MW-4	Lead (total)	4.0	15	13	<1
EPI 2006	5/18/2005	MW-5	Lead (total)	4.0	15	13	<1
EPI 2006	5/18/2005	MW-11	Mercury (dissolved)	1.1	2.0	0.0074	149
EPI 2006	5/18/2005	MW-11	Mercury (total)	3.2	2.0	0.0074	432
EPI 2006	5/18/2005	MW-2	Mercury (total)	0.40	2.0	0.0074	54
EPI 2006	5/18/2005	MW-10	Mercury (total)	0.20	2.0	0.0074	27
EPI 2006	5/18/2005	MW-2	Nickel (dissolved)	180	320		<1
EPI 2006	5/18/2005	MW-2	Nickel (total)	200	320		<1
Riley 2005a	12/10/2004	MW-7	Oil-range hydrocarbons	17,000	500		34
Riley 2004a	6/11/2002	MW-7	Oil-range hydrocarbons	3,800	500		7.6
Riley 2004a	6/30/2003	MW-7	Oil-range hydrocarbons	3,700	500		7.4
Riley 2004a	1/14/2003	MW-7	Oil-range hydrocarbons	2,900	500		5.8
Riley 2004a	1/28/2004	MW-7	Oil-range hydrocarbons	1,700	500		3.4
Riley 2004a	1/28/2004	MW-4	Oil-range hydrocarbons	1,300	500		2.6
Riley 1999a	3/23/1999	MW-2	Oil-range hydrocarbons	830	500		1.7
Riley 2005a	12/10/2004	MW-4	Oil-range hydrocarbons	810	500		1.6
Riley 2005i	7/9/1999	MW-1	Oil-range hydrocarbons	700	500		1.4
Riley 2005i	7/9/1999	MW-4	Oil-range hydrocarbons	650	500		1.3
Riley 2005i	7/9/1999	MW-2	Oil-range hydrocarbons	540	500		1.1
Riley 2005i	7/9/1999	MW-3	Oil-range hydrocarbons	530	500		1.1
Riley 1999a	3/23/1999	MW-1	Oil-range hydrocarbons	520	500		1.0
EPI 2006	5/18/2005	MW-2	Thallium (dissolved)	4.0			
EPI 2006	5/18/2005	MW-2	Thallium (total)	4.0			
Riley 2000a	11/10/1999	MW-1	Toluene	2,600	640		4.1
Riley 2005i	7/9/1999	MW-2	Toluene	840	640		1.3
Riley 1999a	3/23/1999	MW-2	Toluene	840	640		1.3
Riley 2000b	3/7/2000	MW-1	Toluene	130	640		<1
Riley 2005i	7/9/1999	MW-1	Toluene	34	640		<1
Riley 2004a	7/27/2001	MW-1	Toluene	15	640		<1
Riley 2004a	5/1/2001	MW-1	Toluene	8.0	640		<1
Riley 1999a	3/23/1999	MW-3	Toluene	8.0	640		<1

Table 15
Chemicals Detected in Groundwater
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
Riley 2005i	7/9/1999	MW-4	Toluene	5.9	640		<1
Riley 2000a	11/10/1999	MW-2	Toluene	5.0	640		<1
Riley 2000b	3/7/2000	MW-2	Toluene	3.0	640		<1
Riley 2000b	3/7/2000	MW-4	Toluene	3.0	640		<1
EPI 2006	5/18/2005	MW-11	Trichloroethylene	3.0	2.4		1.3
Riley 2000a	11/10/1999	MW-1	Xylenes	1,800	1,600		1.1
Riley 1999a	3/23/1999	MW-2	Xylenes	590	1,600		<1
Riley 2000b	3/7/2000	MW-1	Xylenes	540	1,600		<1
Riley 1999a	3/23/1999	MW-1	Xylenes	140	1,600		<1
Riley 2004a	7/27/2001	MW-1	Xylenes	76	1,600		<1
Riley 2005i	7/9/1999	MW-2	Xylenes	65	1,600		<1
Riley 2005i	7/9/1999	MW-1	Xylenes	47	1,600		<1
Riley 2004a	5/1/2001	MW-1	Xylenes	25	1,600		<1
Riley 2000a	11/10/1999	MW-2	Xylenes	24	1,600		<1
Riley 2000b	3/7/2000	MW-4	Xylenes	21	1,600		<1
Riley 2000b	3/7/2000	MW-2	Xylenes	11	1,600		<1
Riley 2005i	7/9/1999	MW-4	Xylenes	6.3	1,600		<1

ug/L - Micrograms per liter

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

Before groundwater remediation

a - MTCA Method A cleanup level

b - Based on CSL (SAIC 2006)

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Groundwater-to-Sediment screening level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Sources:

EPI (Environmental Partners Inc.). 2006. Supplemental Investigation Report, Former Recycle America Facility, 7901 1st Avenue South, Seattle, Washington. Prepared for Holert Family Trust and Intermountain Supply. December 21, 2006.

Riley. 1999a (The Riley Group, Inc.). Phase II Groundwater Investigation Report, Recycle America Facility, 7901 First Avenue South, Seattle, Washington 98108. Prepared by The Riley Group, Inc. for Mr. Richard R. Sutterlin, Trustee. May 20, 1999.

Riley. 2000a. Supplemental Phase II Subsurface Investigation Letter Report, Recycle America Facility, 7901 First Avenue South, Seattle, Washington 98108. Prepared by The Riley Group, Inc. for Holert Trust (c.o. Mr. Richard Sutterlin). February 16, 2000.

Riley. 2000b. Corrective Action Plan & Remedial Design Report, Recycle America Facility, 7901 First Avenue South, Seattle, Washington 98108. Prepared by The Riley Group, Inc. for Holert Trust, c.o. Mr. Richard Sutterlin. August 25, 2000.

Riley. 2004a. Letter from Thomas Nanevicz, The Rile Group, Inc., to Holert Trust, c.o. Mr. Richard Sutterlin, Re: Groundwater

Table 15
Chemicals Detected in Groundwater
Intermountain Supply/Former Recycle America

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor

Monitoring Well Sampling Event – First Quarter 2004, Recycle America Facility, 7901 First Avenue South, Seattle, Washington 98108. February 26, 2004.

Riley. 2004f. Letter from Paul Riley, The Riley Group, Inc., to Holert Trust, c.o. Mr. Richard Sutterlin, Re: Groundwater Monitoring Well Sampling Event – Third Quarter 2004, Recycle America Facility, 7901 First Avenue South. October 11, 2004.

Riley. 2005a. Letter from Paul Riley, The Riley Group, Inc., to Holert Trust, c.o. Mr. Richard Sutterlin, Re: Groundwater Monitoring Well Sampling Event – Fourth Quarter 2004, Recycle America Facility, 7901 First Avenue South, Seattle, Washington 98108. January 14, 2005.

Riley. 2005c. Letter from Paul Riley, The Riley Group, Inc., to Michael Kuntz, Ecology, Re: Limited Phase II Findings for Metals Technical Memorandum, Recycle America Facility, 7901 First Avenue South, Seattle, Washington. February 1, 2005.

Riley. 2005i. Letter from Thomas Nanevicz and Paul Riley, The Riley Group, to Holert Trust, c/o Mr. Richard Sutterlin, Re: Groundwater Monitoring Well Sampling Event – Second Quarter 2005, Recycle America Facility, 7901 First Avenue South. April 29, 2005.

Table 16
Chemicals Detected in Soil
Kenyon Street Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
SES 2007	9/28/2006	B-04	4.0	Arsenic	327	0.67	590	488
SES 2007	9/28/2006	B-03	3.0	Arsenic	326	0.67	590	487
SES 2007	9/28/2006	B-06	8.0	Arsenic	326	0.67	590	487
SES 2007	9/28/2006	B-02	4.0	Arsenic	143	0.67	590	213
SES 2007	2/8/2007	B-12	7.5	Arsenic	110	0.67	590	164
SES 2007	9/28/2006	B-01	2.0	Arsenic	95	0.67	590	142
SES 2007	2/5/2007	B-09	8.0	Arsenic	30	0.67	590	45
SES 2007	2/5/2007	B-07	6.0	Arsenic	8.7	0.67	590	13
SES 2007	2/8/2007	B-10	10.5	Arsenic	6.6	0.67	590	9.9
SES 2007	2/8/2007	B-11	11.0	Arsenic	5.7	0.67	590	8.6
SES 2007	9/28/2006	B-04	11.0	Arsenic	5.7	0.67	590	8.5
SES 2007	2/5/2007	B-08	5.5	Arsenic	5.2	0.67	590	7.7
SES 2007	9/28/2006	B-04	14.5	Arsenic	4.3	0.67	590	6.3
SES 2007	2/8/2007	B-13	11.0	Arsenic	3.0	0.67	590	4.5
SES 2007	2/8/2007	B-12	7.5	Barium	103	16,000		<1
SES 2007	2/5/2007	B-09	8.0	Barium	101	16,000		<1
SES 2007	9/28/2006	B-04	11.0	Barium	75	16,000		<1
SES 2007	2/5/2007	B-07	6.0	Barium	70	16,000		<1
SES 2007	9/28/2006	B-04	4.0	Barium	66	16,000		<1
SES 2007	9/28/2006	B-06	8.0	Barium	64	16,000		<1
SES 2007	9/28/2006	B-01	2.0	Barium	62	16,000		<1
SES 2007	2/8/2007	B-11	11.0	Barium	59	16,000		<1
SES 2007	2/8/2007	B-10	10.5	Barium	53	16,000		<1
SES 2007	2/8/2007	B-13	11.0	Barium	51	16,000		<1
SES 2007	9/28/2006	B-03	3.0	Barium	42	16,000		<1
SES 2007	2/5/2007	B-08	5.5	Barium	39	16,000		<1
SES 2007	9/28/2006	B-04	14.5	Barium	31	16,000		<1

Table 16
Chemicals Detected in Soil
Kenyon Street Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
SES 2007	9/28/2006	B-02	4.0	Barium	17	16,000		<1
SES 2007	9/28/2006	B-06	8.0	Cadmium	9.1	2.0	1.7	5.3
SES 2007	9/28/2006	B-03	3.0	Cadmium	8.0	2.0	1.7	4.7
SES 2007	9/28/2006	B-04	4.0	Cadmium	6.8	2.0	1.7	4.0
SES 2007	2/5/2007	B-09	8.0	Cadmium	5.3	2.0	1.7	3.1
SES 2007	9/28/2006	B-02	4.0	Cadmium	4.4	2.0	1.7	2.6
SES 2007	2/5/2007	B-07	6.0	Cadmium	3.7	2.0	1.7	2.2
SES 2007	2/8/2007	B-12	7.5	Cadmium	2.3	2.0	1.7	1.3
SES 2007	9/28/2006	B-01	2.0	Cadmium	1.9	2.0	1.7	1.1
SES 2007	2/5/2007	B-09	8.0	Chromium	40		270	<1
SES 2007	9/28/2006	B-04	11.0	Chromium	22		270	<1
SES 2007	2/8/2007	B-12	7.5	Chromium	21		270	<1
SES 2007	9/28/2006	B-06	8.0	Chromium	17		270	<1
SES 2007	2/8/2007	B-13	11.0	Chromium	16		270	<1
SES 2007	9/28/2006	B-03	3.0	Chromium	16		270	<1
SES 2007	9/28/2006	B-01	2.0	Chromium	16		270	<1
SES 2007	9/28/2006	B-04	4.0	Chromium	15		270	<1
SES 2007	2/8/2007	B-11	11.0	Chromium	14		270	<1
SES 2007	9/28/2006	B-02	4.0	Chromium	13		270	<1
SES 2007	9/28/2006	B-04	14.5	Chromium	11		270	<1
SES 2007	2/8/2007	B-10	10.5	Chromium	10		270	<1
SES 2007	2/5/2007	B-07	6.0	Chromium	8.9		270	<1
SES 2007	2/5/2007	B-08	5.5	Chromium	7.7		270	<1
SES 2007	9/28/2006	B-06	8.0	Lead	2,550	250	67	38
SES 2007	9/28/2006	B-03	3.0	Lead	2,350	250	67	35
SES 2007	2/5/2007	B-09	8.0	Lead	2,100	250	67	31
SES 2007	9/28/2006	B-04	4.0	Lead	1,830	250	67	27

Table 16
Chemicals Detected in Soil
Kenyon Street Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor
SES 2007	9/28/2006	B-02	4.0	Lead	1,320	250	67	20
SES 2007	2/8/2007	B-12	7.5	Lead	613	250	67	9.1
SES 2007	9/28/2006	B-01	2.0	Lead	546	250	67	8.1
SES 2007	2/5/2007	B-07	6.0	Lead	48	250	67	<1
SES 2007	2/8/2007	B-10	10.5	Lead	21	250	67	<1
SES 2007	9/28/2006	B-04	11.0	Lead	17	250	67	<1
SES 2007	9/28/2006	B-04	14.5	Lead	4.9	250	67	<1
SES 2007	2/8/2007	B-11	11.0	Lead	4.2	250	67	<1
SES 2007	2/5/2007	B-08	5.5	Lead	3.8	250	67	<1
SES 2007	2/8/2007	B-13	11.0	Lead	3.5	250	67	<1
SES 2007	9/28/2006	B-06	8.0	Selenium	3.6	400		<1
SES 2007	9/28/2006	B-04	4.0	Selenium	3.6	400		<1
SES 2007	9/28/2006	B-03	3.0	Selenium	3.1	400		<1
SES 2007	9/28/2006	B-02	4.0	Selenium	2.1	400		<1
SES 2007	2/8/2007	B-12	7.5	Selenium	1.6	400		<1
SES 2007	2/5/2007	B-09	8.0	Selenium	1.1	400		<1
SES 2007	9/28/2006	B-06	8.0	Silver	4.8	400	0.61	7.8
SES 2007	9/28/2006	B-04	4.0	Silver	3.9	400	0.61	6.4
SES 2007	9/28/2006	B-03	3.0	Silver	3.7	400	0.61	6.0
SES 2007	2/5/2007	B-09	8.0	Silver	2.3	400	0.61	3.7
SES 2007	9/28/2006	B-02	4.0	Silver	1.9	400	0.61	3.0
SES 2007	9/28/2006	B-01	2.0	Silver	1.2	400	0.61	1.9

ft bgs - feet below ground surface

mg/kg - Milligrams per kilogram

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

Table 16
Chemicals Detected in Soil
Kenyon Street Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	Exceedance Factor

a - The lower of MTCA Method A or Method B cleanup level was selected, from CLARC database.

b - Screening levels based on CSL and assuming saturated zone soils (SAIC 2006).

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or the Soil-to-Sediment Screening Level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:

SES (Sound Environmental Strategies). 2007. Independent Remedial Action Plan, Kenyon Street Property, 149 Southwest Kenyon Street, Seattle, Washington. Prepared for GPA-AHF, LLC. September 21, 2007.

Table 17
Chemicals Detected in Groundwater
Kenyon Street Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
SES 2007	10/4/2006	MW-02	Arsenic	100	0.058	370	1724
SES 2007	2/12/2007	MW-04	Arsenic	99	0.058	370	1712
SES 2007	7/5/2007	MW-07	Arsenic	99	0.058	370	1703
SES 2007	7/5/2007	MW-04	Arsenic	85	0.058	370	1459
SES 2008	11/1/2007	MW-07	Arsenic	78	0.058	370	1343
SES 2007	4/20/2007	MW-04	Arsenic	56	0.058	370	962
SES 2007	7/5/2007	MW-02	Arsenic	56	0.058	370	959
SES 2008	11/1/2007	MW-02	Arsenic	41	0.058	370	703
SES 2007	7/5/2007	MW-06	Arsenic	36	0.058	370	628
SES 2008	11/1/2007	MW-06	Arsenic	28	0.058	370	474
SES 2007	7/5/2007	MW-05	Arsenic	23	0.058	370	402
SES 2007	10/4/2006	MW-01	Arsenic	23	0.058	370	391
SES 2007	10/4/2006	MW-03	Arsenic	21	0.058	370	362
SES 2008	11/1/2007	MW-05	Arsenic	17	0.058	370	286
SES 2008	11/1/2007	MW-01	Arsenic	15	0.058	370	264
SES 2007	7/5/2007	MW-08	Arsenic	15	0.058	370	252
SES 2007	2/12/2007	MW-05	Arsenic	14	0.058	370	236
SES 2008	11/1/2007	MW-08	Arsenic	13	0.058	370	222
SES 2007	4/20/2007	MW-05	Arsenic	11	0.058	370	186
SES 2007	10/4/2006	MW-02	Barium	66	3,200		<1
SES 2007	10/4/2006	MW-01	Barium	32	3,200		<1
SES 2007	7/5/2007	MW-04	Barium	30	3,200		<1
SES 2008	11/1/2007	MW-02	Barium	27	3,200		<1
SES 2008	11/1/2007	MW-01	Barium	27	3,200		<1
SES 2007	4/20/2007	MW-04	Barium	16	3,200		<1
SES 2008	11/1/2007	MW-07	Barium	16	3,200		<1
SES 2007	2/12/2007	MW-05	Barium	15	3,200		<1
SES 2007	7/5/2007	MW-02	Barium	13	3,200		<1
SES 2007	10/4/2006	MW-03	Barium	13	3,200		<1
SES 2007	2/12/2007	MW-04	Barium	13	3,200		<1
SES 2008	11/1/2007	MW-06	Barium	11	3,200		<1
SES 2007	7/5/2007	MW-06	Barium	10	3,200		<1
SES 2007	7/5/2007	MW-07	Barium	9.3	3,200		<1
SES 2007	4/20/2007	MW-05	Barium	6.2	3,200		<1
SES 2007	7/5/2007	MW-05	Barium	4.1	3,200		<1
SES 2007	7/5/2007	MW-08	Barium	3.5	3,200		<1
SES 2008	11/1/2007	MW-08	Barium	2.9	3,200		<1
SES 2008	11/1/2007	MW-05	Barium	2.0	3,200		<1
SES 2007	10/4/2006	MW-02	Cadmium	3.0	5.0	3.4	<1
SES 2008	11/1/2007	MW-07	Cadmium	1.1	5.0	3.4	<1
SES 2008	11/1/2007	MW-02	Cadmium	1.1	5.0	3.4	<1
SES 2007	10/4/2006	MW-03	Chromium[c]	71	50	320	1.4
SES 2007	10/4/2006	MW-02	Chromium[c]	44	50	320	<1

Table 17
Chemicals Detected in Groundwater
Kenyon Street Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
SES 2007	10/4/2006	MW-01	Chromium[c]	35	50	320	<1
SES 2007	7/5/2007	MW-05	Chromium[c]	17	50	320	<1
SES 2008	11/1/2007	MW-02	Chromium[c]	17	50	320	<1
SES 2007	7/5/2007	MW-02	Chromium[c]	17	50	320	<1
SES 2007	7/5/2007	MW-04	Chromium[c]	17	50	320	<1
SES 2007	7/5/2007	MW-07	Chromium[c]	14	50	320	<1
SES 2008	11/1/2007	MW-07	Chromium[c]	14	50	320	<1
SES 2007	7/5/2007	MW-06	Chromium[c]	12	50	320	<1
SES 2007	2/12/2007	MW-04	Chromium[c]	12	50	320	<1
SES 2007	2/12/2007	MW-05	Chromium[c]	11	50	320	<1
SES 2007	7/5/2007	MW-08	Chromium[c]	8.7	50	320	<1
SES 2008	11/1/2007	MW-06	Chromium[c]	5.1	50	320	<1
SES 2007	4/20/2007	MW-04	Chromium[c]	3.8	50	320	<1
SES 2008	11/1/2007	MW-01	Chromium[c]	3.5	50	320	<1
SES 2008	11/1/2007	MW-05	Chromium[c]	1.1	50	320	<1
SES 2007	10/4/2006	MW-02	Lead	30	15	13	2.3
SES 2007	10/4/2006	MW-01	Lead	17	15	13	1.3
SES 2008	11/1/2007	MW-07	Lead	10	15	13	<1
SES 2008	11/1/2007	MW-02	Lead	8.0	15	13	<1
SES 2008	11/1/2007	MW-01	Lead	3.0	15	13	<1
SES 2007	7/5/2007	MW-02	Lead	2.7	15	13	<1
SES 2007	2/12/2007	MW-04	Lead	2.0	15	13	<1
SES 2007	7/5/2007	MW-04	Lead	1.8	15	13	<1
SES 2007	7/5/2007	MW-06	Lead	1.8	15	13	<1
SES 2008	11/1/2007	MW-06	Lead	1.5	15	13	<1
SES 2007	7/5/2007	MW-07	Lead	1.4	15	13	<1
SES 2007	7/5/2007	MW-06	Selenium	6.1	80		<1
SES 2007	10/4/2006	MW-03	Selenium	4.5	80		<1
SES 2008	11/1/2007	MW-06	Selenium	3.0	80		<1
SES 2007	2/12/2007	MW-04	Selenium	2.3	80		<1
SES 2007	10/4/2006	MW-02	Selenium	2.0	80		<1
SES 2007	7/5/2007	MW-04	Selenium	1.9	80		<1
SES 2008	11/1/2007	MW-07	Selenium	1.6	80		<1
SES 2007	10/4/2006	MW-01	Selenium	1.5	80		<1
SES 2008	11/1/2007	MW-02	Selenium	1.4	80		<1
SES 2007	7/5/2007	MW-07	Selenium	1.2	80		<1
SES 2007	7/5/2007	MW-02	Selenium	1.1	80		<1

Table 17
Chemicals Detected in Groundwater
Kenyon Street Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor

ug/L - Micrograms per liter

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or Method B cleanup level was selected, from CLARC database.

b - Based on CSL (SAIC 2006)

c - MTCA Method A cleanup level for Chromium Total

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Groundwater-to-Sediment Screening Level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Sources:

SES (Sound Environmental Strategies). 2007. Independent Remedial Action Plan, Kenyon Street Property, 149 Southwest Kenyon Street, Seattle, Washington. Prepared for GPA-AHF, LLC. September 21, 2007.

SES. 2008. Groundwater Monitoring Report, Fourth Quarter 2007. Kenyon Street Property, 149 Southwest Kenyon Street, Seattle, Washington. January 10, 2008.

Table 18
Chemicals Detected in Stormwater
Kenyon Street Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	Exceedance Factor
SES 2007	2/6/2007	Stormwater-W	Arsenic	1.6	0.058	370	27
SES 2007	2/6/2007	Stormwater-E	Arsenic	1.5	0.058	370	27
SES 2007	2/6/2007	Stormwater-C	Arsenic	1.4	0.058	370	25
SES 2007	2/6/2007	Stormwater-E	Barium	21	3,200		<1
SES 2007	2/6/2007	Stormwater-W	Barium	21	3,200		<1
SES 2007	2/6/2007	Stormwater-C	Barium	20	3,200		<1
SES 2007	2/6/2007	Stormwater-E	Chromium[c]	2.2	50	320	<1
SES 2007	2/6/2007	Stormwater-C	Chromium[c]	2.1	50	320	<1
SES 2007	2/6/2007	Stormwater-W	Chromium[c]	1.9	50	320	<1
SES 2007	2/6/2007	Stormwater-W	Lead	4.5	15	13	<1
SES 2007	2/6/2007	Stormwater-E	Lead	3.3	15	13	<1
SES 2007	2/6/2007	Stormwater-C	Lead	3.3	15	13	<1

ug/L - Micrograms per liter

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or Method B cleanup level was selected, from CLARC database.

b - Based on CSL (SAIC 2006)

c - MTCA Method A cleanup level for Chromium Total

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Groundwater-to-Sediment Screening Level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Sources:

SES (Sound Environmental Strategies). 2007. Independent Remedial Action Plan, Kenyon Street Property, 149 Southwest Kenyon Street, Seattle, Washington. Prepared for GPA-AHF, LLC. September 21, 2007.

Table 19
Chemicals Detected in CKD
City of Seattle South Transfer Station

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	MTCA Exceedance Factor	Soil-to-Sediment Screening Exceedance Factor
AMEC 2009	7/25/2008	B30	7.5	Arsenic	440	0.67	590	657	<1
AMEC 2009	7/25/2008	B30	7.5	Arsenic	320	0.67	590	478	<1
AMEC 2009	7/24/2008	B22	3.5	Arsenic	310	0.67	590	463	<1
AMEC 2009	7/25/2008	B24	1.5	Arsenic	250	0.67	590	373	<1
AMEC 2009	10/15/2008	B66	0.5	Arsenic	210	0.67	590	313	<1
AMEC 2009	7/24/2008	B26	4.0	Arsenic	200	0.67	590	299	<1
AMEC 2009	2/29/2008	DB-2/MW-6	2.5	Arsenic	160	0.67	590	239	<1
AMEC 2009	10/17/2008	B48	0.5	Arsenic	150	0.67	590	224	<1
AMEC 2009	7/24/2008	B23	1.5	Arsenic	130	0.67	590	194	<1
AMEC 2009	2/29/2008	DB-2/MW-6	2.5	Barium	40	16,000		<1	
AMEC 2009	7/25/2008	B30	7.5	Cadmium	9.7	2.0	1.7	4.9	5.7
AMEC 2009	7/24/2008	B22	3.5	Cadmium	6.8	2.0	1.7	3.4	4.0
AMEC 2009	7/25/2008	B30	7.5	Cadmium	6.6	2.0	1.7	3.3	3.9
AMEC 2009	2/29/2008	DB-2/MW-6	2.5	Cadmium	5.5	2.0	1.7	2.8	3.2
AMEC 2009	7/24/2008	B26	4.0	Cadmium	5.3	2.0	1.7	2.7	3.1
AMEC 2009	10/17/2008	B48	0.5	Cadmium	5.2	2.0	1.7	2.6	3.1
AMEC 2009	7/25/2008	B24	1.5	Cadmium	4.4	2.0	1.7	2.2	2.6
AMEC 2009	10/15/2008	B66	0.5	Cadmium	3.4	2.0	1.7	1.7	2.0
AMEC 2009	7/24/2008	B23	1.5	Cadmium	3.2	2.0	1.7	1.6	1.9
AMEC 2009	7/25/2008	B30	7.5	Lead	3700	250	67	15	55
AMEC 2009	7/25/2008	B30	7.5	Lead	2700	250	67	11	40
AMEC 2009	7/24/2008	B22	3.5	Lead	2200	250	67	8.8	33
AMEC 2009	2/29/2008	DB-2/MW-6	2.5	Lead	1700	250	67	6.8	25
AMEC 2009	10/17/2008	B48	0.5	Lead	1600	250	67	6.4	24
AMEC 2009	7/24/2008	B26	4.0	Lead	1500	250	67	6.0	22
AMEC 2009	7/25/2008	B24	1.5	Lead	1400	250	67	5.6	21
AMEC 2009	10/15/2008	B66	0.5	Lead	1200	250	67	4.8	18

Table 19
Chemicals Detected in CKD
City of Seattle South Transfer Station

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	MTCA Exceedance Factor	Soil-to-Sediment Screening Exceedance Factor
AMEC 2009	7/24/2008	B23	1.5	Lead	1100	250	67	4.4	16
AMEC 2009	10/16/2008	B61	10.0	Lead	110	250	67	<1	1.6
AMEC 2009	7/24/2008	B21	4.0	Lead	12	250	67	<1	<1
AMEC 2009	7/25/2008	B30	10.5	Lead	8.1	250	67	<1	<1
AMEC 2009	2/29/2008	DB-2/MW-6	2.5	Silver	3.7	400	0.61	<1	6.1

ft bgs - Feet below ground surface

mg/kg - Milligrams per kilogram

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or B cleanup levels was selected, from CLARC database.

b - Based on CSL. Where two screening levels are listed for a single chemical, the higher screening levels are for soil samples collected from the vadose zone and the lower screening levels are for soil samples collected from the saturated zone (SAIC 2006).

Groundwater elevation data are not available for this site. The saturated CSL screening levels were assumed for all CKD soil samples.

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Soil-to-Sediment Screening Level, whichever is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:

AMEC (AMEC Earth & Environmental, Inc.). 2009. Remedial Investigation Report, South Kenyon Street Bus Yard, 110, 130, 150, and 200 South Kenyon Street, Seattle, WA. Prepared for City of Seattle Attorney's Office. March 31, 2009.

Table 20
Chemicals Detected in Groundwater
City of Seattle South Transfer Station

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	MTCA Exceedance Factor	GW-to-Sediment Screening Exceedance Factor
AMEC 2009	7/25/2008	MW-9	Arsenic	180	0.058	370	3103	<1
AMEC 2009	7/25/2008	MW-9	Arsenic	170	0.058	370	2931	<1
AMEC 2009	7/25/2008	MW-6	Arsenic	140 T	0.058	370	2414	<1
AMEC 2009	7/25/2008	MW-6	Arsenic	140 D	0.058	370	2414	<1
AMEC 2009	7/25/2008	MW-6	Arsenic	140 T	0.058	370	2414	<1
AMEC 2009	7/25/2008	MW-6	Arsenic	130 D	0.058	370	2241	<1
AMEC 2009	10/13/2008	MW-9	Arsenic	130	0.058	370	2241	<1
AMEC 2009	10/13/2008	MW-9	Arsenic	130	0.058	370	2241	<1
AMEC 2009	10/13/2008	MW-9	Arsenic	130	0.058	370	2241	<1
AMEC 2009	10/13/2008	MW-9	Arsenic	130	0.058	370	2241	<1
AMEC 2009	10/13/2008	MW-6	Arsenic	120 T	0.058	370	2069	<1
AMEC 2009	10/13/2008	MW-6	Arsenic	110 D	0.058	370	1897	<1
AMEC 2009	10/13/2008	MW-6	Arsenic	100 D	0.058	370	1724	<1
AMEC 2009	10/13/2008	MW-6	Arsenic	100 T	0.058	370	1724	<1
AMEC 2009	2/22/2008	MW-6	Arsenic	15 D	0.058	370	259	<1
AMEC 2009	2/22/2008	MW-6	Barium	1,000 D	3,200		<1	
AMEC 2009	10/13/2008	MW-6	Lead	180	15	13	12	14
AMEC 2009	7/25/2008	MW-6	Lead	130	15	13	8.7	10
AMEC 2009	7/25/2008	MW-6	Lead	130	15	13	8.7	10
AMEC 2009	10/13/2008	MW-6	Lead	83	15	13	5.5	6.4
AMEC 2009	10/13/2008	MW-6	Lead	52	15	13	3.5	4.0
AMEC 2009	7/25/2008	MW-9	Lead	50	15	13	3.3	3.8
AMEC 2009	7/25/2008	MW-6	Lead	40	15	13	2.7	3.1
AMEC 2009	7/25/2008	MW-6	Lead	34 D	15	13	2.3	2.6
AMEC 2009	10/13/2008	MW-6	Lead	34	15	13	2.3	2.6
AMEC 2009	10/13/2008	MW-9	Lead	26	15	13	1.7	2.0
AMEC 2009	10/13/2008	MW-9	Lead	26	15	13	1.7	2.0
AMEC 2009	10/13/2008	MW-9	Lead	26	15	13	1.7	2.0
AMEC 2009	10/13/2008	MW-9	Lead	25	15	13	1.7	1.9
AMEC 2009	7/25/2008	MW-9	Lead	21	15	13	1.4	1.6
AMEC 2009	2/22/2008	MW-6	Selenium	5.8 D	80		<1	

ug/L - Micrograms per liter

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or Method B cleanup level was selected, from CLARC database.

b - Based on CSL (SAIC 2006)

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Groundwater-to-Sediment Screening Level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:

AMEC (AMEC Earth & Environmental, Inc.). 2009. Remedial Investigation Report, South Kenyon Street Bus Yard, 110, 130, 150, and 200 South Kenyon Street, Seattle, WA. Prepared for City of Seattle Attorney's Office. March 31, 2009.

Table 21
Chemicals Detected in Soil
Simplex Grinnell/Sherwin Williams/NRC Environmental (Former Markey Machinery Property)

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	MTCA Exceedance Factor	Soil-to-Sediment Screening Level Exceedance Factor
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Anthracene	0.52	24,000	1.20	<1	<1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Aroclor 1248	0.23	0.50	0.065	<1	3.5
GeoEngineers 1990	Jan-90	14	1.2	Aroclor 1254	0.58	0.50	0.065	1.2	8.9
GeoEngineers 1990	Jan-90	2	0.0	Aroclor 1254	0.38	0.50	0.065	<1	5.8
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Aroclor 1254	0.32	0.50	0.065	<1	4.9
GeoEngineers 1990	Jan-90	8	0.4	Aroclor 1254	0.31	0.50	0.065	<1	4.8
GeoEngineers 1990	Jan-90	12	2.7	Aroclor 1254	0.26	0.50	0.065	<1	4.0
GeoEngineers 1990	Jan-90	9	0.4	Aroclor 1254	0.17	0.50	0.065	<1	2.6
GeoEngineers 1990	Jan-90	10	0.9	Aroclor 1254	0.17	0.50	0.065	<1	2.6
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Aroclor 1260	1.3	0.50	0.065	2.60	20
GeoEngineers 1990	Jan-90	14	1.2	Aroclor 1260	1.1	0.50	0.065	2.20	17
GeoEngineers 1990	Jan-90	2	0.0	Aroclor 1260	0.78	0.50	0.065	1.6	12
GeoEngineers 1990	Jan-90	8	0.4	Aroclor 1260	0.65	0.50	0.065	1.30	10
GeoEngineers 1990	Jan-90	12	2.7	Aroclor 1260	0.42	0.50	0.065	<1	6.5
GeoEngineers 1990	Jan-90	10	0.9	Aroclor 1260	0.40	0.50	0.065	<1	6.2
GeoEngineers 1990	Jan-90	9	0.4	Aroclor 1260	0.36	0.50	0.065	<1	5.5
GeoEngineers 1989a	4/17/1989	TP-23		Arsenic	210	0.67	590	313	<1
Hart Crowser 1996	1994	B-3	1 to 8	Arsenic	205	0.67	590	306	<1
GeoEngineers 1989a	4/17/1989	TP-27		Arsenic	190	0.67	590	284	<1
GeoEngineers 1989a	4/18/1989	TP-31		Arsenic	170	0.67	590	254	<1
GeoEngineers 1989a	4/18/1989	TP-34		Arsenic	150	0.67	590	224	<1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Arsenic	89	0.67	590	133	<1
GeoEngineers 1989a	5/26/1988	CKD Composite		Arsenic	5.6	0.67	590	8.4	<1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Barium	230				
GeoEngineers 1989a	4/17/1989	TP-27		Barium	120				
GeoEngineers 1989a	4/18/1989	TP-34		Barium	93				
GeoEngineers 1989a	4/17/1989	TP-23		Barium	83				
GeoEngineers 1989a	4/18/1989	TP-31		Barium	69				
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Benzo(a)anthracene	0.22	1.37	0.27	<1	<1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Benzo(g,h,i)perylene	0.24		0.078		3.1
GeoEngineers 1989a	4/17/1989	TP-27		Cadmium	4	2.0	1.7	1.9	2.2
GeoEngineers 1989a	4/17/1989	TP-23		Cadmium	3.5	2.0	1.7	1.8	2.1
GeoEngineers 1989a	4/18/1989	TP-34		Cadmium	3	2.0	1.7	1.6	1.8
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Cadmium	2	2.0	1.7	1.2	1.4
GeoEngineers 1989a	4/18/1989	TP-31		Cadmium	2	2.0	1.7	<1	<1

Table 21
Chemicals Detected in Soil
Simplex Grinnell/Sherwin Williams/NRC Environmental (Former Markey Machinery Property)

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	MTCA Exceedance Factor	Soil-to-Sediment Screening Level Exceedance Factor
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Chromium	110		270		<1
GeoEngineers 1989a	4/17/1989	TP-23		Chromium	30		270		<1
GeoEngineers 1989a	4/17/1989	TP-27		Chromium	29		270		<1
GeoEngineers 1989a	4/18/1989	TP-34		Chromium	29		270		<1
GeoEngineers 1989a	4/18/1989	TP-31		Chromium	28		270		<1
GeoEngineers 1989a	5/26/1988	CKD Composite		Chromium	27.1		270		<1
Hart Crowser 1996	1994	B-3	1 to 8	Chromium	18.3		270		<1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Chrysene	0.22	137	0.46	<1	<1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Copper	430	3,200	39	<1	11
GeoEngineers 1989a	4/18/1989	TP-34		Copper	100	3,200	39	<1	2.6
GeoEngineers 1989a	4/17/1989	TP-23		Copper	89	3,200	39	<1	2.3
GeoEngineers 1989a	4/17/1989	TP-27		Copper	85	3,200	39	<1	2.2
GeoEngineers 1989a	4/18/1989	TP-31		Copper	80	3,200	39	<1	2.1
GeoEngineers 1989a	5/26/1988	CKD Composite		Copper	42	3,200	39	<1	1.1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Fluoranthene	0.42	3,200	1.2	<1	<1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Lead	9,500	250	67	38	142
GeoEngineers 1989a	4/17/1989	TP-27		Lead	1,730	250	67	6.9	26
GeoEngineers 1989a	4/17/1989	TP-23		Lead	1300	250	67	5.2	19
Hart Crowser 1996	1994	B-3	1 to 8	Lead	1,107	250	67	4.4	17
GeoEngineers 1989a	4/18/1989	TP-34		Lead	1,080	250	67	4.3	16
GeoEngineers 1989a	4/18/1989	TP-31		Lead	960	250	67	3.8	14
GeoEngineers 1989a	5/26/1988	CKD Composite		Lead	60	250	67	<1	<1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Methylene chloride	0.29	0.02		15	
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Nickel	65				
GeoEngineers 1989a	5/26/1988	CKD Composite		Nickel	33				
GeoEngineers 1989a	4/17/1989	TP-23		Nickel	14				
GeoEngineers 1989a	4/17/1989	TP-27		Nickel	9.6				
GeoEngineers 1989a	4/18/1989	TP-31		Nickel	9.6				
GeoEngineers 1989a	4/18/1989	TP-34		Nickel	8.5				
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		PCBs, total	1.9	0.5	0.065	3.8	29
GeoEngineers 1990	Jan-90	14	1.2	PCBs, total	1.68	0.5	0.065	3.4	26
GeoEngineers 1990	Jan-90	2	0.0	PCBs, total	1.16	0.5	0.065	2.3	18
GeoEngineers 1990	Jan-90	8	0.4	PCBs, total	0.96	0.5	0.065	1.9	15
GeoEngineers 1990	Jan-90	12	2.7	PCBs, total	0.68	0.5	0.065	1.4	10
GeoEngineers 1990	Jan-90	10	0.9	PCBs, total	0.57	0.5	0.065	1.1	8.8

Table 21
Chemicals Detected in Soil
Simplex Grinnell/Sherwin Williams/NRC Environmental (Former Markey Machinery Property)

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	MTCA Exceedance Factor	Soil-to-Sediment Screening Level Exceedance Factor
GeoEngineers 1990	Jan-90	9	0.4	PCBs, total	0.53	0.5	0.065	1.1	8.2
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Phenanthrene	0.26		0.49		<1
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Pyrene	0.44	2,400	1.4	<1	<1
GeoEngineers 1989a	4/17/1989	TP-9		Total petroleum hydrocarbons	940	2,000		<1	
GeoEngineers 1990	Jan-90	2	0.0	Total petroleum hydrocarbons	900	2,000		<1	
GeoEngineers 1990	Jan-90	8	0.4	Total petroleum hydrocarbons	600	2,000		<1	
GeoEngineers 1989a	4/17/1989	TP-6		Total petroleum hydrocarbons	570	2,000		<1	
GeoEngineers 1990	Jan-90	9	0.4	Total petroleum hydrocarbons	470	2,000		<1	
GeoEngineers 1989a	4/17/1989	TP-12		Total petroleum hydrocarbons	310	2,000		<1	
GeoEngineers 1989a	4/17/1989	TP-3		Total petroleum hydrocarbons	290	2,000		<1	
GeoEngineers 1990	Jan-90	10	0.9	Total petroleum hydrocarbons	240	2,000		<1	
GeoEngineers 1990	Jan-90	12	2.7	Total petroleum hydrocarbons	100	2,000		<1	
GeoEngineers 1990	Jan-90	14	1.2	Total petroleum hydrocarbons	84	2,000		<1	
GeoEngineers 1989a	4/17/1989	Upper Fill-Composite		Zinc	890	24,000	38	<1	23
GeoEngineers 1989a	4/18/1989	TP-31		Zinc	720	24,000	38	<1	19
GeoEngineers 1989a	4/17/1989	TP-27		Zinc	690	24,000	38	<1	18
GeoEngineers 1989a	4/17/1989	TP-23		Zinc	540	24,000	38	<1	14
GeoEngineers 1989a	4/18/1989	TP-34		Zinc	530	24,000	38	<1	14
GeoEngineers 1989a	5/26/1988	CKD Composite		Zinc	67	24,000	38	<1	1.8
10th Avenue S Ditch									
Hart Crowser 1996	8/15/1996	SED-1		Arsenic	14	0.67	590	21	<1
Hart Crowser 1996	8/15/1996	SED-1		Chromium	15		270		<1
Hart Crowser 1996	8/15/1996	SED-1		Copper	43	3,200	39	<1	1.1
Hart Crowser 1996	8/15/1996	SED-1		Lead	110	250	67	<1	1.6
Hart Crowser 1996	8/15/1996	SED-1		Zinc	160	24,000	38	<1	4.2
Hamm Creek									
Hart Crowser 1996	8/15/1996	SED-5		Arsenic	18	0.67	590	27	<1
Hart Crowser 1996	8/15/1996	SED-2		Arsenic	16	0.67	590	24	<1
Hart Crowser 1996	8/15/1996	SED-3		Arsenic	12	0.67	590	18	<1
Hart Crowser 1996	8/15/1996	SED-4		Arsenic	12	0.67	590	18	<1
Hart Crowser 1996	8/15/1996	SED-5		Chromium	91		270		<1
Hart Crowser 1996	8/15/1996	SED-4		Chromium	61		270		<1
Hart Crowser 1996	8/15/1996	SED-3		Chromium	50		270		<1
Hart Crowser 1996	8/15/1996	SED-2		Chromium	30		270		<1
Hart Crowser 1996	8/15/1996	SED-5		Copper	270	3,200	39	<1	6.9

Table 21
Chemicals Detected in Soil
Simplex Grinnell/Sherwin Williams/NRC Environmental (Former Markey Machinery Property)

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	MTCA Exceedance Factor	Soil-to-Sediment Screening Level Exceedance Factor
Hart Crowser 1996	8/15/1996	SED-4		Copper	90	3,200	39	<1	2.3
Hart Crowser 1996	8/15/1996	SED-3		Copper	69	3,200	39	<1	1.8
Hart Crowser 1996	8/15/1996	SED-2		Copper	42	3,200	39	<1	1.1
Hart Crowser 1996	8/15/1996	SED-5		Lead	270	250	67	1.1	4.0
Hart Crowser 1996	8/15/1996	SED-4		Lead	240	250	67	<1	3.6
Hart Crowser 1996	8/15/1996	SED-3		Lead	160	250	67	<1	2.4
Hart Crowser 1996	8/15/1996	SED-2		Lead	79	250	67	<1	1.2
Hart Crowser 1996	8/15/1996	SED-5		Zinc	2500	24,000	38	<1	66
Hart Crowser 1996	8/15/1996	SED-3		Zinc	1300	24,000	38	<1	34
Hart Crowser 1996	8/15/1996	SED-4		Zinc	1,200	24,000	38	<1	32
Hart Crowser 1996	8/15/1996	SED-2		Zinc	760	24,000	38	<1	20
Wetland									
Hart Crowser 1996	8/15/1996	SED-6		Arsenic	14	0.67	590	21	<1
Hart Crowser 1996	8/15/1996	SED-7		Arsenic	11	0.67	590	16	<1
Hart Crowser 1996	8/15/1996	SED-8		Arsenic	9.0	0.67	590	13	<1
Hart Crowser 1996	8/15/1996	SED-6		Chromium	35		270		<1
Hart Crowser 1996	8/15/1996	SED-7		Chromium	34		270		<1
Hart Crowser 1996	8/15/1996	SED-8		Chromium	22		270		<1
Hart Crowser 1996	8/15/1996	SED-6		Copper	62	3,200	39	<1	1.6
Hart Crowser 1996	8/15/1996	SED-8		Copper	42	3,200	39	<1	1.1
Hart Crowser 1996	8/15/1996	SED-7		Copper	36	3,200	39	<1	<1
Hart Crowser 1996	8/15/1996	SED-6		Lead	110	250	67	<1	1.6
Hart Crowser 1996	8/15/1996	SED-7		Lead	37	250	67	<1	<1
Hart Crowser 1996	8/15/1996	SED-8		Lead	31	250	67	<1	<1
Hart Crowser 1996	8/15/1996	SED-6		Zinc	420	24,000	38	<1	11
Hart Crowser 1996	8/15/1996	SED-7		Zinc	290	24,000	38	<1	7.6
Hart Crowser 1996	8/15/1996	SED-8		Zinc	77	24,000	38	<1	2.0
East Ditch									
Hart Crowser 1996	8/15/1996	SED-9		Arsenic	8.6	0.7	590	13	<1
Hart Crowser 1996	8/15/1996	SED-10		Arsenic	2.0	0.67	590	3.0	<1
Hart Crowser 1996	8/15/1996	SED-9		Chromium	23		270		<1
Hart Crowser 1996	8/15/1996	SED-10		Chromium	20		270		<1
Hart Crowser 1996	8/15/1996	SED-9		Copper	49	3,200	39	<1	1.3
Hart Crowser 1996	8/15/1996	SED-10		Copper	11	3,200	39	<1	<1
Hart Crowser 1996	8/15/1996	SED-9		Lead	100	250	67	<1	1.5

Table 21
Chemicals Detected in Soil
Simplex Grinnell/Sherwin Williams/NRC Environmental (Former Markey Machinery Property)

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	MTCA Exceedance Factor	Soil-to-Sediment Screening Level Exceedance Factor
Hart Crowser 1996	8/15/1996	SED-10		Lead	3.0	250	67	<1	<1
Hart Crowser 1996	8/15/1996	SED-9		Zinc	66	24,000	38	<1	1.7
Hart Crowser 1996	8/15/1996	SED-10		Zinc	31	24,000	38	<1	<1

ft bgs - Feet below ground surface
mg/kg - Milligrams per kilogram
C - Composite sample
CSL - Cleanup Screening Level from Washington Sediment Management Standards
MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or B cleanup levels was selected, from CLARC database.
b - Based on CSL. Where two screening levels are listed for a single chemical, the higher screening levels are for soil samples collected from the vadose zone and the lower screening levels are for soil samples collected from the saturated zone (SAIC 2006).
Depth to groundwater is approximately 2 ft bgs.
Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Soil-to-Sediment Screening Level.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Sources:
GeoEngineers (GeoEngineers, Inc.). 1989a. Environmental Site Assessment, Cement Kiln Dust Landfill, Markey Machinery Property, Seattle, Washington for Helsell, Fetterman, Martin, Todd & Hokanson. August 16, 1989.
GeoEngineers. 1990. Environmental Sampling Report, Upper Fill, Proposed Parcel 4, South 96th Street and 10th Avenue South for Helsell, Fetterman, Martin, Todd & Hokanson. June 13, 1990.
Hart Crowser (Hart Crowser, Inc.). 1996. Environmental Study and Remedial Action Evaluation Holnam - Markey Property, Seattle, Washington, Prepared for Holnam Inc. October 28, 1996.

Table 22
Chemicals Detected in Surface Water
Former Markey Machinery Property (Simplex Grinnell/Sherwin Williams/NRC Environmental)

Source	Sample Date	Sample Location	Chemical	Surface Water Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	Chronic Surface Fresh Water Quality Standard (ug/L)	MTCA Exceedance Factor	Chronic Surface Fresh Water Quality Standard Exceedance Factor
10th Avenue S Ditch								
Hart Crowser 1996	7/19/1996	SW-2	Arsenic	25	0.098	190	255	<1
Hart Crowser 1996	7/19/1996	SW-1	Arsenic	24	0.098	190	245	<1
Hart Crowser 1996	7/19/1996	SW-1	Arsenic	22	0.098	190	224	<1
Hart Crowser 1996	7/19/1996	SW-2	Arsenic	21	0.098	190	214	<1
Hart Crowser 1996	7/19/1996	SW-1	Chromium	10				
Hart Crowser 1996	7/19/1996	SW-2	Copper	99	2,900	3.5	<1	28
Hart Crowser 1996	7/19/1996	SW-2	Copper	94	2,900	3.5	<1	27
Hart Crowser 1996	7/19/1996	SW-1	Copper	92	2,900	3.5	<1	26
Hart Crowser 1996	7/19/1996	SW-1	Copper	89	2,900	3.5	<1	25
Hart Crowser 1996	7/19/1996	SW-2	Lead	19		0.54		35
Hart Crowser 1996	7/19/1996	SW-1	Lead	15		0.54		28
Hart Crowser 1996	7/19/1996	SW-1	Lead	8.9		0.54		16
Hart Crowser 1996	7/19/1996	SW-2	Lead	8.6		0.54		16
Hart Crowser 1996	7/19/1996	SW-2	Nickel	17				
Hart Crowser 1996	7/19/1996	SW-2	Nickel	16				
Hart Crowser 1996	7/19/1996	SW-1	Nickel	14				
Hart Crowser 1996	7/19/1996	SW-1	Nickel	13				
Hart Crowser 1996	7/19/1996	SW-2	Silver	0.46				
Hart Crowser 1996	7/19/1996	SW-1	Silver	0.24				
Hart Crowser 1996	7/19/1996	SW-2	Silver	0.24				
Hart Crowser 1996	7/19/1996	SW-2	Zinc	37	17,000	32	<1	1.2
Hart Crowser 1996	7/19/1996	SW-1	Zinc	28	17,000	32	<1	<1
Hart Crowser 1996	7/19/1996	SW-1	Zinc	19	17,000	32	<1	<1
Hart Crowser 1996	7/19/1996	SW-2	Zinc	19	17,000	32	<1	<1
S 96th Street Ditch								
GeoEngineers 1989a	5/26/1988	Leachate	Arsenic	10	0.098	190	102	<1
GeoEngineers 1989a	5/26/1988	Leachate	Chromium	91				
GeoEngineers 1989a	5/26/1988	Leachate	Copper	314	2,900	3.5	<1	90
GeoEngineers 1989a	4/24/1989	D	Copper	280	2,900	3.5	<1	80
GeoEngineers 1989a	5/26/1988	Leachate	Lead	297		0.54		550

Table 22
Chemicals Detected in Surface Water
Former Markey Machinery Property (Simplex Grinnell/Sherwin Williams/NRC Environmental)

Source	Sample Date	Sample Location	Chemical	Surface Water Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	Chronic Surface Fresh Water Quality Standard (ug/L)	MTCA Exceedance Factor	Chronic Surface Fresh Water Quality Standard Exceedance Factor
GeoEngineers 1989a	4/24/1989	D	Lead	25		0.54		46
GeoEngineers 1989a	5/26/1988	Leachate	Nickel	149				
GeoEngineers 1989a	5/26/1988	Leachate	Zinc	230	17,000	32	<1	7.2
Hamm Creek								
GeoEngineers 1989a	5/26/1988	Upstream	Arsenic	3.0	0.098	190	31	<1
GeoEngineers 1989a	5/26/1988	Downstream	Arsenic	2.0	0.098	190	20	<1
GeoEngineers 1989a	5/26/1988	Upstream	Cadmium	10	41	0.37	<1	27
GeoEngineers 1989a	5/26/1988	Upstream	Chromium	14				
GeoEngineers 1989a	5/26/1988	Downstream	Copper	9.0	2,900	3.5	<1	2.6
GeoEngineers 1989a	5/26/1988	Upstream	Copper	6	2,900	3.5	<1	1.7
GeoEngineers 1989a	5/26/1988	Downstream	Lead	50		0.54		93
GeoEngineers 1989a	4/21/1989	A	Lead	6.0		0.54		11
GeoEngineers 1989a	5/26/1988	Downstream	Nickel	36				
GeoEngineers 1989a	5/26/1988	Upstream	Nickel	25				
GeoEngineers 1989a	5/26/1988	Upstream	Selenium	10				
GeoEngineers 1989a	5/26/1988	Downstream	Zinc	26	17,000	32	<1	<1
GeoEngineers 1989a	5/26/1988	Upstream	Zinc	22	17,000	32	<1	<1
Wetland								
GeoEngineers 1989a	4/21/1989	C	Copper	80	2,900	3.5	<1	23
GeoEngineers 1989a	4/21/1989	C	Lead	360		0.54		667

ug/L - Micrograms per liter
MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or B cleanup levels was selected, from CLARC database.
Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Chronic Surface Fresh Water Quality Standard.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Sources:

GeoEngineers (GeoEngineers, Inc.). 1989a. Environmental Site Assessment, Cement Kiln Dust Landfill, Markey Machinery Property, Seattle, Washington for Helsell, Fetterman, Martin, Todd & Hokanson. August 16, 1989.

Hart Crowser (Hart Crowser, Inc.). 1996. Environmental Study and Remedial Action Evaluation Holnam - Markey Property, Seattle, Washington, Prepared for Holnam Inc. October 28, 1996.

Table 23
Chemicals Detected in Soil
Beckwith & Kuffel Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	MTCA Exceedance Factor	Soil-to-Sediment Screening Level Exceedance Factor
Shannon & Wilson 2014	11/20/2013	South sidewall	10	1,2-Dichloroethane	0.0501	11		<1	
Shannon & Wilson 2014	2/11/2014	MW-8	9	1,2-Dichloroethene, cis-	0.0535	160		<1	
Shannon & Wilson 2014	8/29/2013	GP-29	3	1,2-Dichloroethene, cis-	0.0295	160		<1	
Shannon & Wilson 2014	8/29/2013	GP-28	4	1,2-Dichloroethene, cis-	0.0265	160		<1	
Shannon & Wilson 2014	8/29/2013	GP-25	4	1,2-Dichloroethene, cis-	0.0179	160		<1	
Shannon & Wilson 2014	4/23/2012	GP-8	5	Arsenic	375	0.67	590	560	<1
Shannon & Wilson 2014	1/27/2012	MW-1	4	Arsenic	301	0.67	590	449	<1
Shannon & Wilson 2014	4/24/2012	GP-10	7.5	Arsenic	188	0.67	590	281	<1
Shannon & Wilson 2014	6/26/2003	B1		Barium	58	41		1.4	
Shannon & Wilson 2014	1/27/2012	MW-1	4	Cadmium	10.9	2	1.7	5.5	6.4
Shannon & Wilson 2014	6/26/2003	B1		Chromium	30		270		<1
Shannon & Wilson 2014	6/26/2003	B2		cPAHs, total	0.013	1.37		<1	
Shannon & Wilson 2014	2004	UST-SNW		Diesel Range Hydrocarbons	1200	2,000		<1	
Shannon & Wilson 2014	2004	UST-N		Diesel Range Hydrocarbons	730	2,000		<1	
Shannon & Wilson 2014	2004	UST-ESW		Diesel Range Hydrocarbons	380	2,000		<1	
Shannon & Wilson 2014	2004	UST-WSW		Diesel Range Hydrocarbons	150	2,000		<1	
Shannon & Wilson 2014	6/26/2003	B6		Diesel Range Hydrocarbons	130	2,000		<1	
Shannon & Wilson 2014	2004	UST-Base		Diesel Range Hydrocarbons	87	2,000		<1	
Shannon & Wilson 2014	6/26/2003	B3		Diesel Range Hydrocarbons	71	2,000		<1	
Shannon & Wilson 2014	2004	UST-NW		Diesel Range Hydrocarbons	63	2,000		<1	
Shannon & Wilson 2014	2004	UST-SSW		Diesel Range Hydrocarbons	38	2,000		<1	
Shannon & Wilson 2014	2004	UST-ESW		Diesel Range Hydrocarbons	35	2,000		<1	
Shannon & Wilson 2014	6/26/2003	B3		Gasoline Range Hydrocarbons	2.0	100		<1	
Shannon & Wilson 2014	2004	UST-N		Heavy Oil Range Hydrocarbons	1,400	2,000		<1	
Shannon & Wilson 2014	4/23/2012	GP-1	8	Heavy Oil Range Hydrocarbons	330	2,000		<1	
Shannon & Wilson 2014	2004	UST-ESW		Heavy Oil Range Hydrocarbons	110	2,000		<1	
Shannon & Wilson 2014	2004	UST-SSW		Heavy Oil Range Hydrocarbons	93	2,000		<1	
Shannon & Wilson 2014	2004	UST-SNW		Heavy Oil Range Hydrocarbons	90	2,000		<1	
Shannon & Wilson 2014	2004	UST-ESW		Heavy Oil Range Hydrocarbons	70	2,000		<1	
Shannon & Wilson 2014	2004	UST-WSW		Heavy Oil Range Hydrocarbons	66	2,000		<1	
Shannon & Wilson 2014	4/23/2012	GP-8	5	Lead	3,280	250	67	13	49
Shannon & Wilson 2014	1/27/2012	MW-1	4	Lead	3,240	250	67	13	48
Shannon & Wilson 2014	4/24/2012	GP-10	7.5	Lead	1,430	250	67	5.7	21
Shannon & Wilson 2014	6/26/2003	B1		Lead	6.0	250	67	<1	<1
Shannon & Wilson 2014	4/23/2012	GP-6	8	Lead	5.35	250	67	<1	<1

Table 23
Chemicals Detected in Soil
Beckwith & Kuffel Property

Source	Sample Date	Sample Location	Sample Depth (ft bgs)	Chemical	Soil Conc'n (mg/kg)	MTCA Cleanup Level[a] (mg/kg)	Soil-to-Sediment Screening Level[b] (mg/kg)	MTCA Exceedance Factor	Soil-to-Sediment Screening Level Exceedance Factor
Shannon & Wilson 2014	11/20/2013	South sidewall	10	Trichloroethene	0.869	0.03		29	
Shannon & Wilson 2014	11/20/2013	North sidewall	14	Trichloroethene	0.686	0.03		23	
Shannon & Wilson 2014	11/20/2013	South sidewall	18	Trichloroethene	0.413	0.03		14	
Shannon & Wilson 2014	2/11/2014	MW-8	14.5	Trichloroethene	0.282	0.03		9.4	
Shannon & Wilson 2014	2/11/2014	MW-7	15	Trichloroethene	0.168	0.03		5.6	
Shannon & Wilson 2014	11/20/2013	East sidewall	8	Trichloroethene	0.157	0.03		5.2	
Shannon & Wilson 2014	2/11/2014	MW-9	14.5	Trichloroethene	0.0783	0.03		2.6	
Shannon & Wilson 2014	8/29/2013	GP-25	4	Trichloroethene	0.0517	0.03		1.7	

ft bgs - Feet below ground surface
mg/kg - Milligrams per kilogram
CSL - Cleanup Screening Level from Washington Sediment Management Standards
MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or B cleanup levels was selected, from CLARC database.
b - Based on CSL. Where two screening levels are listed for a single chemical, the higher screening levels are for soil samples collected from the vadose zone and the lower screening levels are for soil samples collected from the saturated zone (SAIC 2006).
Depth to groundwater is approximately 2 ft bgs.
Table presents detected chemicals only.
Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Soil-to-Sediment Screening Level.
Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:
Shannon & Wilson (Shannon & Wilson, Inc.). 2014. Remedial Investigation/Interim Remedial Action Report, Beckwith & Kuffel Site, Seattle, Washington. October 21, 2014.

Table 24
Chemicals Detected in Groundwater
Beckwith & Kuffel Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	MTCA Exceedance Factor	GW-to-Sediment Screening Exceedance Factor
Shannon & Wilson 2014	7/16/2012	GP-17	1,1-Dichloroethane	1.19	7.68		<1	
Shannon & Wilson 2014	7/16/2012	GP-17	1,1-Dichloroethene	4.12	400		<1	
Shannon & Wilson 2014	9/25/2013	MW-5	1,1-Dichloroethene	3.28	400		<1	
Shannon & Wilson 2014	4/23/2012	GP-6	1,1-Dichloroethene	2.07	400		<1	
Shannon & Wilson 2014	2/14/2014	MW-8	1,1-Dichloroethene	1.97	400		<1	
Shannon & Wilson 2014	2/14/2014	MW-9	1,1-Dichloroethene	1.28	400		<1	
Shannon & Wilson 2014	5/21/2014	MW-9	1,1-Dichloroethene	1.16	400		<1	
Shannon & Wilson 2014	8/22/2014	MW-8	1,1-Dichloroethene	1.05	400		<1	
Shannon & Wilson 2014	4/23/2012	GP-1	1,2,4-Trimethylbenzene	1.58				
Shannon & Wilson 2014	4/23/2012	GP-6	1,2-Dichloroethane	145	0.48		302	
Shannon & Wilson 2014	7/16/2012	GP-17	1,2-Dichloroethane	61.1	0.48		127	
Shannon & Wilson 2014	7/16/2012	GP-18	1,2-Dichloroethane	38.3	0.48		80	
Shannon & Wilson 2014	2/14/2014	MW-7	1,2-Dichloroethane	15.7	0.48		33	
Shannon & Wilson 2014	2/14/2014	MW-8	1,2-Dichloroethane	7.19	0.48		15	
Shannon & Wilson 2014	7/16/2012	GP-16-7	1,2-Dichloroethane	5.08	0.48		11	
Shannon & Wilson 2014	8/22/2014	MW-8	1,2-Dichloroethane	4.87	0.48		10	
Shannon & Wilson 2014	5/21/2014	MW-7	1,2-Dichloroethane	2.79	0.48		5.8	
Shannon & Wilson 2014	7/16/2012	GP-16-19	1,2-Dichloroethane	2.55	0.48		5.3	
Shannon & Wilson 2014	8/21/2014	MW-7	1,2-Dichloroethane	1.76	0.48		3.7	
Shannon & Wilson 2014	2/14/2014	MW-7	1,2-Dichloroethene, cis-	297	16		19	
Shannon & Wilson 2014	5/21/2014	MW-7	1,2-Dichloroethene, cis-	143	16		8.9	
Shannon & Wilson 2014	4/23/2012	GP-6	1,2-Dichloroethene, cis-	57.7	16		3.6	
Shannon & Wilson 2014	9/25/2013	MW-5	1,2-Dichloroethene, cis-	55.5	16		3.5	
Shannon & Wilson 2014	7/16/2012	GP-17	1,2-Dichloroethene, cis-	42.6	16		2.7	
Shannon & Wilson 2014	8/16/2013	OS-1	1,2-Dichloroethene, cis-	38.0	16		2.4	
Shannon & Wilson 2014	7/16/2012	GP-16-19	1,2-Dichloroethene, cis-	34.1	16		2.1	
Shannon & Wilson 2014	2/14/2014	MW-8	1,2-Dichloroethene, cis-	32.0	16		2.0	
Shannon & Wilson 2014	8/21/2014	OS-1	1,2-Dichloroethene, cis-	31.9	16		2.0	
Shannon & Wilson 2014	7/16/2012	GP-18	1,2-Dichloroethene, cis-	30.2	16		1.9	

Table 24
Chemicals Detected in Groundwater
Beckwith & Kuffel Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	MTCA Exceedance Factor	GW-to-Sediment Screening Exceedance Factor
Shannon & Wilson 2014	8/21/2014	MW-7	1,2-Dichloroethene, cis-	30.0	16		1.9	
Shannon & Wilson 2014	5/21/2014	MW-8	1,2-Dichloroethene, cis-	23.1	16		1.4	
Shannon & Wilson 2014	8/21/2014	MW-8	1,2-Dichloroethene, cis-	22.1	16		1.4	
Shannon & Wilson 2014	5/22/2014	OS-1	1,2-Dichloroethene, cis-	16.8	16		1.1	
Shannon & Wilson 2014	2/14/2014	OS-1	1,2-Dichloroethene, cis-	15.3	16		<1	
Shannon & Wilson 2014	2/14/2014	MW-9	1,2-Dichloroethene, cis-	9.62	16		<1	
Shannon & Wilson 2014	7/16/2012	GP-16-7	1,2-Dichloroethene, cis-	7.52	16		<1	
Shannon & Wilson 2014	5/21/2014	MW-9	1,2-Dichloroethene, cis-	6.77	16		<1	
Shannon & Wilson 2014	8/21/2014	MW-9	1,2-Dichloroethene, cis-	6.17	16		<1	
Shannon & Wilson 2014	8/22/2014	MW-6	1,2-Dichloroethene, cis-	2.99	16		<1	
Shannon & Wilson 2014	7/18/2012	GP-23	1,2-Dichloroethene, cis-	2.77	16		<1	
Shannon & Wilson 2014	2/20/2014	MW-6	1,2-Dichloroethene, cis-	2.17	16		<1	
Shannon & Wilson 2014	2/14/2014	MW-7	1,2-Dichloroethene, trans-	3.44	160		<1	
Shannon & Wilson 2014	5/21/2014	MW-7	1,2-Dichloroethene, trans-	1.97	160		<1	
Shannon & Wilson 2014	9/25/2013	MW-5	1,2-Dichloroethene, trans-	1.83	160		<1	
Shannon & Wilson 2014	4/23/2012	GP-6	1,2-Dichloroethene, trans-	1.3	160		<1	
Shannon & Wilson 2014	4/20/2012	MW-3	4-Isopropyltoluene	11.5	--		<1	
Shannon & Wilson 2014	4/20/2012	MW-1	Arsenic, total	10.8	0.058	370	186	<1
Shannon & Wilson 2014	4/20/2012	MW-1	Arsenic, dissolved	6.67	0.058	370	115	<1
Shannon & Wilson 2014	4/20/2012	MW-3	Arsenic, total	5.7	0.058	370	97	<1
Shannon & Wilson 2014	4/20/2012	MW-3	Arsenic, dissolved	2.48	0.058	370	43	<1
Shannon & Wilson 2014	6/26/2003	B1	Chromium	1.74	50	320	<1	<1
Shannon & Wilson 2014	6/26/2003	B9	Diesel Range Hydrocarbons	9,900	500		<1	
Shannon & Wilson 2014	4/23/2012	GP-6	Diesel Range Hydrocarbons	1,710	500		<1	
Shannon & Wilson 2014	6/27/2003	B10	Diesel Range Hydrocarbons	1,600	500		<1	
Shannon & Wilson 2014	9/5/2003	B13	Diesel Range Hydrocarbons	1,600	500		<1	

Table 24
Chemicals Detected in Groundwater
Beckwith & Kuffel Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	MTCA Exceedance Factor	GW-to-Sediment Screening Exceedance Factor
Shannon & Wilson 2014	4/24/2012	GP-10	Diesel Range Hydrocarbons	836	500		<1	
Shannon & Wilson 2014	4/23/2012	GP-1	Diesel Range Hydrocarbons	538	500		<1	
Shannon & Wilson 2014	9/5/2003	B20	Diesel Range Hydrocarbons	420	500		<1	
Shannon & Wilson 2014	6/26/2003	B6	Diesel Range Hydrocarbons	290	500		<1	
Shannon & Wilson 2014	4/23/2012	GP-6	Gasoline Range Hydrocarbons	264	800		<1	
Shannon & Wilson 2014	4/23/2012	GP-1	Gasoline Range Hydrocarbons	63	800		<1	
Shannon & Wilson 2014	4/20/2012	MW-1	Lead, total	1,910	15	13	<1	147
Shannon & Wilson 2014	4/20/2012	MW-1	Lead, dissolved	1,510	15	13	<1	116
Shannon & Wilson 2014	7/18/2012	GP-11	Lead, total	92.7	15	13	<1	7.1
Shannon & Wilson 2014	7/20/2012	GP-13	Lead, total	47.8	15	13	<1	3.7
Shannon & Wilson 2014	4/23/2012	GP-6	Lead, total	36.9	15	13	<1	2.8
Shannon & Wilson 2014	7/19/2012	GP-12	Lead, total	23.2	15	13	<1	1.8
Shannon & Wilson 2014	7/18/2012	GP-11	Lead, dissolved	2.97	15	13	<1	<1
Shannon & Wilson 2014	7/20/2012	GP-13	Lead, dissolved	2.48	15	13	<1	<1
Shannon & Wilson 2014	7/19/2012	GP-12	Lead, dissolved	1.81	15	13	<1	<1
Shannon & Wilson 2014	4/20/2012	MW-3	Lead, total	1.54	15	13	<1	<1
Shannon & Wilson 2014	4/23/2012	GP-1	Naphthalene	2.00	160		<1	
Shannon & Wilson 2014	6/26/2003	B6	Naphthalene	0.4	160		<1	
Shannon & Wilson 2014	6/26/2003	B1	Naphthalene	0.3	160		<1	
Shannon & Wilson 2014	4/23/2012	GP-1	PCBs, total	1.87	0.04	1.5	<1	1.2
Shannon & Wilson 2014	6/26/2003	B9	Toluene	14	640		<1	
Shannon & Wilson 2014	6/27/2003	B10	Toluene	7	640		<1	
Shannon & Wilson 2014	4/24/2012	GP-10	Toluene	1.68	640		<1	
Shannon & Wilson 2014	9/25/2013	MW-5	Trichloroethene	1,320	2.4		550	
Shannon & Wilson 2014	7/16/2012	GP-17	Trichloroethene	1,050	2.4		438	
Shannon & Wilson 2014	2/14/2014	MW-8	Trichloroethene	878	2.4		366	

Table 24
Chemicals Detected in Groundwater
Beckwith & Kuffel Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	MTCA Exceedance Factor	GW-to-Sediment Screening Exceedance Factor
Shannon & Wilson 2014	8/21/2014	MW-8	Trichloroethene	615	2.4		256	
Shannon & Wilson 2014	5/21/2014	MW-8	Trichloroethene	558	2.4		233	
Shannon & Wilson 2014	2/14/2014	MW-9	Trichloroethene	275	2.4		115	
Shannon & Wilson 2014	8/21/2014	MW-9	Trichloroethene	179	2.4		75	
Shannon & Wilson 2014	5/21/2014	MW-9	Trichloroethene	137	2.4		57	
Shannon & Wilson 2014	4/23/2012	GP-6	Trichloroethene	96.6	2.4		40	
Shannon & Wilson 2014	8/22/2014	MW-6	Trichloroethene	88.6	2.4		37	
Shannon & Wilson 2014	2/20/2014	MW-6	Trichloroethene	85	2.4		35	
Shannon & Wilson 2014	7/16/2012	GP-16-19	Trichloroethene	39.1	2.4		16	
Shannon & Wilson 2014	5/21/2014	MW-6	Trichloroethene	18.9	2.4		7.9	
Shannon & Wilson 2014	7/16/2012	GP-20	Trichloroethene	11.9	2.4		5.0	
Shannon & Wilson 2014	8/16/2013	OS-1	Trichloroethene	9.05	2.4		3.8	
Shannon & Wilson 2014	8/21/2014	OS-1	Trichloroethene	7.02	2.4		2.9	
Shannon & Wilson 2014	7/16/2012	GP-19	Trichloroethene	5.42	2.4		2.3	
Shannon & Wilson 2014	5/22/2014	OS-1	Trichloroethene	5.35	2.4		2.2	
Shannon & Wilson 2014	2/14/2014	OS-1	Trichloroethene	5.31	2.4		2.2	
Shannon & Wilson 2014	7/16/2012	GP-18	Trichloroethene	2.27	2.4		<1	
Shannon & Wilson 2014	2/14/2014	MW-7	Trichloroethene	1.94	2.4		<1	
Shannon & Wilson 2014	2/14/2014	MW-7	Vinyl Chloride	95.8	0.2		479	
Shannon & Wilson 2014	5/21/2014	MW-7	Vinyl Chloride	34.5	0.2		173	
Shannon & Wilson 2014	7/16/2012	GP-16-7	Vinyl Chloride	16.0	0.2		80	
Shannon & Wilson 2014	8/16/2013	OS-1	Vinyl Chloride	14.6	0.2		73	
Shannon & Wilson 2014	7/16/2012	GP-18	Vinyl Chloride	11.8	0.2		59	
Shannon & Wilson 2014	8/21/2014	MW-7	Vinyl Chloride	8.19	0.2		41	
Shannon & Wilson 2014	4/23/2012	GP-6	Vinyl Chloride	7.64	0.2		38	
Shannon & Wilson 2014	5/22/2014	OS-1	Vinyl Chloride	7.26	0.2		36	

Table 24
Chemicals Detected in Groundwater
Beckwith & Kuffel Property

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	MTCA Exceedance Factor	GW-to-Sediment Screening Exceedance Factor
Shannon & Wilson 2014	8/21/2014	OS-1	Vinyl Chloride	6.43	0.2		32	
Shannon & Wilson 2014	7/16/2012	GP-17	Vinyl Chloride	3.48	0.2		17	
Shannon & Wilson 2014	6/26/2003	B1	Xylenes	1.0	1,000		<1	

ug/L - Micrograms per liter

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or Method B cleanup level was selected, from CLARC database.

b - Based on CSL (SAIC 2006)

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level or Groundwater-to-Sediment Screening Level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:

Shannon & Wilson (Shannon & Wilson, Inc.). 2014. Remedial Investigation/Interim Remedial Action Report, Beckwith & Kuffel Site, Seattle, Washington. October 21, 2014.

Table 25
Chemicals Detected in Groundwater
Fostoria Business Park

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	MTCA Exceedance Factor	GW-Sediment Screening Level Exceedance Factor
Hart Crowser 2004	6/11/1999	MW-1001	Arsenic, dissolved	9.7	0.058	370	167	<1
Hart Crowser 2004	4/2/1999	MW-1001	Arsenic, dissolved	12	0.058	370	207	<1
Hart Crowser 2004	1/7/1999	MW-1001	Arsenic, dissolved	9.6	0.058	370	166	<1
Hart Crowser 2004	9/11/1996	MW-1001	Arsenic, dissolved	17.4	0.058	370	300	<1
Hart Crowser 2004	5/3/1996	MW-1001	Arsenic, dissolved	30	0.058	370	517	<1
Hart Crowser 2004	6/11/1999	MW-1001	Arsenic, total	10	0.058	370	172	<1
Hart Crowser 2004	4/2/1999	MW-1001	Arsenic, total	11	0.058	370	190	<1
Hart Crowser 2004	1/7/1999	MW-1001	Arsenic, total	10	0.058	370	172	<1
Hart Crowser 2004	9/11/1996	MW-1001	Arsenic, total	30.6	0.058	370	528	<1
Hart Crowser 2004	5/3/1996	MW-1001	Arsenic, total	35	0.058	370	603	<1
Hart Crowser 2004	9/11/1996	MW-1001	Lead, dissolved	2.03	15	13	<1	<1
Hart Crowser 2004	9/11/1996	MW-1001	Lead, total	4.26	15	13	<1	<1
Hart Crowser 2004	11/25/2003	MW-1002	Arsenic, dissolved	38	0.058	370	655	<1
Hart Crowser 2004	8/20/2003	MW-1002	Arsenic, dissolved	120	0.058	370	2069	<1
Hart Crowser 2004	6/2/2003	MW-1002	Arsenic, dissolved	102	0.058	370	1759	<1
Hart Crowser 2004	2/19/2003	MW-1002	Arsenic, dissolved	31	0.058	370	534	<1
Hart Crowser 2004	11/15/2001	MW-1002	Arsenic, dissolved	68	0.058	370	1172	<1
Hart Crowser 2004	8/9/2001	MW-1002	Arsenic, dissolved	36	0.058	370	621	<1
Hart Crowser 2004	5/2/2001	MW-1002	Arsenic, dissolved	88	0.058	370	1517	<1
Hart Crowser 2004	1/31/2001	MW-1002	Arsenic, dissolved	112	0.058	370	1931	<1
Hart Crowser 2004	6/11/1999	MW-1002	Arsenic, dissolved	55	0.058	370	948	<1
Hart Crowser 2004	4/27/1999	MW-1002	Arsenic, dissolved	53	0.058	370	914	<1
Hart Crowser 2004	4/2/1999	MW-1002	Arsenic, dissolved	85	0.058	370	1466	<1
Hart Crowser 2004	1/7/1999	MW-1002	Arsenic, dissolved	73	0.058	370	1259	<1
Hart Crowser 2004	11/25/2003	MW-1002	Arsenic, total	51	0.058	370	879	<1
Hart Crowser 2004	8/20/2003	MW-1002	Arsenic, total	120	0.058	370	2069	<1
Hart Crowser 2004	6/2/2003	MW-1002	Arsenic, total	108	0.058	370	1862	<1

Table 25
Chemicals Detected in Groundwater
Fostoria Business Park

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	MTCA Exceedance Factor	GW-Sediment Screening Level Exceedance Factor
Hart Crowser 2004	2/19/2003	MW-1002	Arsenic, total	39	0.058	370	672	<1
Hart Crowser 2004	11/15/2001	MW-1002	Arsenic, total	45	0.058	370	776	<1
Hart Crowser 2004	8/9/2001	MW-1002	Arsenic, total	40	0.058	370	690	<1
Hart Crowser 2004	5/2/2001	MW-1002	Arsenic, total	98	0.058	370	1690	<1
Hart Crowser 2004	1/31/2001	MW-1002	Arsenic, total	104	0.058	370	1793	<1
Hart Crowser 2004	6/11/1999	MW-1002	Arsenic, total	81	0.058	370	1397	<1
Hart Crowser 2004	4/27/1999	MW-1002	Arsenic, total	60	0.058	370	1034	<1
Hart Crowser 2004	4/2/1999	MW-1002	Arsenic, total	94	0.058	370	1621	<1
Hart Crowser 2004	1/7/1999	MW-1002	Arsenic, total	93	0.058	370	1603	<1
Hart Crowser 2004	4/27/1999	MW-1002	Copper, dissolved	6.8	640	120	<1	<1
Hart Crowser 2004	8/20/2003	MW-1002	Copper, total	3	640	120	<1	<1
Hart Crowser 2004	11/15/2001	MW-1002	Copper, total	6	640	120	<1	<1
Hart Crowser 2004	8/9/2001	MW-1002	Copper, total	2	640	120	<1	<1
Hart Crowser 2004	6/11/1999	MW-1002	Copper, total	3.5	640	120	<1	<1
Hart Crowser 2004	4/27/1999	MW-1002	Copper, total	11	640	120	<1	<1
Hart Crowser 2004	4/2/1999	MW-1002	Copper, total	2.1	640	120	<1	<1
Hart Crowser 2004	8/9/2001	MW-1002	Lead, dissolved	4	15	13	<1	<1
Hart Crowser 2004	4/27/1999	MW-1002	Lead, dissolved	3.6	15	13	<1	<1
Hart Crowser 2004	11/25/2003	MW-1002	Lead, total	3	15	13	<1	<1
Hart Crowser 2004	8/20/2003	MW-1002	Lead, total	5	15	13	<1	<1
Hart Crowser 2004	6/2/2003	MW-1002	Lead, total	30	15	13	2.0	2.3
Hart Crowser 2004	2/19/2003	MW-1002	Lead, total	4	15	13	<1	<1
Hart Crowser 2004	11/15/2001	MW-1002	Lead, total	8	15	13	<1	<1
Hart Crowser 2004	8/9/2001	MW-1002	Lead, total	23	15	13	1.5	1.8
Hart Crowser 2004	6/11/1999	MW-1002	Lead, total	6	15	13	<1	<1
Hart Crowser 2004	4/27/1999	MW-1002	Lead, total	21	15	13	1.4	1.6
Hart Crowser 2004	6/11/1999	MW-1002	Nickel, dissolved	25	320		<1	

Table 25
Chemicals Detected in Groundwater
Fostoria Business Park

Source	Sample Date	Sample Location	Chemical	Conc'n (ug/L)	MTCA Cleanup Level[a] (ug/L)	GW-to-Sediment Screening Level[b] (ug/L)	MTCA Exceedance Factor	GW-Sediment Screening Level Exceedance Factor
Hart Crowser 2004	1/7/1999	MW-1002	Nickel, dissolved	17	320		<1	
Hart Crowser 2004	8/9/2001	MW-1002	Zinc, dissolved	7	4800	76	<1	<1
Hart Crowser 2004	8/20/2003	MW-1002	Zinc, total	8.0	4800	76	<1	<1
Hart Crowser 2004	11/15/2001	MW-1002	Zinc, total	8.0	4800	76	<1	<1
Hart Crowser 2004	8/9/2001	MW-1002	Zinc, total	15.0	4800	76	<1	<1
Hart Crowser 2004	4/27/1999	MW-1002	Zinc, total	14.0	4800	76	<1	<1

ug/L - Micrograms per liter

CSL - Cleanup Screening Level from Washington Sediment Management Standards

MTCA - Model Toxics Control Act

a - The lower of MTCA Method A or B cleanup levels was selected, from CLARC database.

b - Based on CSL (SAIC 2006)

Table presents detected chemicals only.

Exceedance factors are the ratio of the detected concentration to the MTCA Cleanup Level and Groundwater-to-Sediment Screening Level, whichever level is lower.

Chemicals and samples with exceedance factors greater than 1 are shaded light yellow.

Source:

Hart Crowser (Hart Crowser, Inc.). 2004. Results of Quarterly Groundwater Monitoring, 2003, Fostoria Business Park, Tukwila, WA. Prepared for Northstream Development. January 21, 2004.

Appendix A

Additional Background Information on Cement Kiln Dust Characteristics and Properties

CKD Characteristics and Properties

Bulk Chemical Characteristics

CKD from three different types of kiln operations (long-wet, long-dry, and alkali by-pass with precalciner) were characterized for chemical and physical traits by Todres et al. (1992). Each of the plants was equipped with an electrostatic precipitator for dust collection. For comparison, typical Portland cement composition was provided by Adaska and Taubert (2008).

Bulk Constituent Composition of CKD from Different Kiln Types Compared to Portland Cement (percent by weight)				
Constituent	**Long-wet kiln**	**Long-dry kiln**	**Alkali by-pass from preheater/precalciner**	**Typical Type I Portland cement**
SiO_2	15.02	9.64	15.23	20.5
Al_2O_3	3.85	3.39	3.07	5.4
Fe_2O_3	1.88	1.10	2.00	2.6
CaO	41.01	44.91	61.28	63.9
MgO	1.47	1.29	2.13	2.1
SO_3	6.27	6.74	8.67	3.0
Na_2O	0.74	0.27	0.34	< 1
K_2O	2.57	2.40	2.51	< 1
Loss on Ignition (LOI)	25.78	30.24	4.48	0 – 3
Free lime (CaO)	0.85	0.52	27.18	< 2

Source: Adapted from Todres et al. (1992) and Adaska and Taubert (2008)

In the 1993 Report to Congress, USEPA summarized CKD bulk constituents for four types of cement kilns.

Bulk Constituent Composition of CKD from Different Kiln Types (percent by weight)				
Constituent	**Long Dry Kilns, Dry Kilns with Preheaters, and/or Calciners**[a]	**Wet Kilns**[b]	**Rotary Kiln with Cyclone Preheater**[c]	**Rotary Kiln with Grate Preheater**[c]
SiO_2	4.3 – 10.1	4.1 – 7.7	7 – 11	2 – 19
Al_2O_3	1.0 – 3.3	1.3 – 3.3	3 – 6[d]	0.5 – 8[d]
TiO_2	0.07 – 0.2	0.08 – 0.2		
Fe_2O_3	0.7 – 2.3	0.8 – 2.0	1 – 3[d]	0.5 – 4[d]
Mn_2O_3	0.01 – 0.2	0.02 – 0.04		
CaO	11 – 45	15.9 – 38	41 – 51	6 – 26
MgO	0.4 – 2	0.4 – 1.9	0.5 – 2	0 – 2
SO_3	0.1 – 7.7	0.1 – 6.0	0.5 – 4	7 – 41
K_2O	0.2 – 9.7	0.2 – 12.1	0.5 – 4	14 – 40
Cl^-	0.08 – 2.7	4.2 – 6.3	0 – 0.3	0.9 – 4.5
Na_2O	0.07 – 1.2	0.1 – 4.1	0 – 0.5	0.5 – 3

Bulk Constituent Composition of CKD from Different Kiln Types (percent by weight)				
Constituent	**Long Dry Kilns, Dry Kilns with Preheaters, and/or Calciners[a]**	**Wet Kilns[b]**	**Rotary Kiln with Cyclone Preheater[c]**	**Rotary Kiln with Grate Preheater[c]**
LOI	Not available	22 – 25[e]	29 – 38	4 – 24
pH	6.11 – 12.83[f]	11.64 – 12.98[g]	No Data	No Data

Source: USEPA 1993
a Based on 28 tests from 12 facilities.
b Based on 19 tests from 9 facilities.
c No information was provided on the size of the population samples or operational characteristics.
d The responses for the corresponding constituents are aggregated.
e Range based on (1) a Dragon Products Company memorandum (December 6, 1991) from Steve Wallace to John Bangeman regarding typical analyses of several Dragon Products materials; and (2) a typical analysis of Stable Sorb at Keystone Cement Company (February 18, 1991).
f Based on EPA sampling data for TCLP and SPLP leachate tests on as generated CKD from seven facilities. These leachate samples are obtained using an acid solution, so that actual CKD pH values may be higher than indicated here.
g Based on EPA sampling data for TCLP and SPLP tests on as generated CKD from eight facilities. These leachate samples are obtained using an acid solution, so that actual CKD pH values may be higher than indicated here.

In 1970, three samples of CKD were collected from Lafarge Cement and analyzed by a University of Washington engineering student as part of his master's thesis work (Johnson 1971). Mr. Johnson noted that the constituents are shown in the table as oxides, in keeping with cement industry notation, but that the actual chemical form of these elements would be as hydroxides and complex hydrated silicates.

Bulk Constituent Composition of CKD Collected from Lafarge Cement in 1970	
Constituent	**Range of 3 samples (% by weight)**
SiO_2	11.93 – 12.45
Al_2O_3	3.43 – 3.74
Fe_2O_3	1.34 – 1.38
CaO	41.78 – 47.02
MgO	0.74 – 0.79
SO_3	Not measured
Na_2O	1.85 – 2.15*
K_2O	0.69 – 0.91
Loss on Ignition (LOI)	15.3 – 17.84

Source: Johnson 1971
*Not reported for one of the three samples.

Variability

As noted above, chemical composition of raw materials and clinker are continually analyzed in order to produce cement with very specific characteristics. Chemical composition of CKD can vary from batch to batch within the same plant. For example, the monthly change in CKD composition for different batches produced in the Tourah Portland Cement Factory in Egypt in

2006 (El-Dakroury et al. 2011) is shown below. Some constituents varied very little over the course of the year (e.g., Mn_2O_3) while others varied more considerably (e.g., K_2O).

Monthly change of CKD in chemical composition (percent by weight)						
Month	**1/06**	**2/06**	**3/06**	**4/06**	**5/06**	**6/06**
SiO_2	16.46	16.80	15.86	16.18	16.72	16.78
Al_2O_3	5.63	5.60	5.54	5.79	5.70	5.60
Fe_2O_3	1.69	1.56	1.79	1.66	1.95	2.03
CaO	67.11	66.96	66.99	69.27	69.63	71.50
MgO	1.56	1.56	1.66	1.66	1.58	1.58
SO_3	3.37	3.39	3.79	3.30	3.14	2.51
Na_2O	0.39	0.58	0.30	0.18	0.21	0.16
K_2O	3.62	3.77	3.66	2.29	2.14	1.78
TiO_2	0.25	0.24	0.24	0.26	0.26	0.25
P_2O_3	0.08	0.09	0.09	0/09	0.10	0.09
SrO	0.06	0.05	0.05	0.06	0.05	0.07
Mn_2O_3	0.02	0.02	0.03	0.02	0.02	0.02
LOI	34.68	34.98	34.97	34.35	34.00	34.09
Month	**7/06**	**8/06**	**9/06**	**10/06**	**11/06**	**12/06**
SiO_2	15.16	13.76	13.86	14.32	14.03	13.39
Al_2O_3	5.15	5.00	4.98	5.11	4.96	4.71
Fe_2O_3	2.07	1.92	1.96	1.98	1.93	1.79
CaO	67.85	65.77	66.46	66.57	65.17	64.00
MgO	1.41	1.39	1.34	1.40	1.37	1.37
SO_3	4.05	5.38	5.32	4.52	5.19	6.01
Na_2O	0.23	0.30	0.27	0.25	0.62	0.42
K_2O	4.06	6.23	5.91	5.34	6.65	7.81
TiO_2	0.23	0.21	0.23	0.23	0.22	0.21
Monthly change of CKD in chemical composition (percent by weight)						
Month	**7/06**	**8/06**	**9/06**	**10/06**	**11/06**	**12/06**
P_2O_3	0.09	0.09	0.10	0.10	0.09	0.09
SrO	0.06	0.06	0.05	0.05	0.04	0.04
Mn_2O_3	0.02	0.02	0.02	0.02	0.02	0.02
LOI	35.99	35.17	35.41	35.41	NR	NR

pH

CKD generally has a strong alkali content (pH 10.5 to 12.0) (USEPA 1993). The Riley Group (2005) summarized pH concentrations in CKD fills near the Recycle America property in Seattle as ranging from 11 to 12. The pH of a slurry made from the 1970 Marginal Way CKD pile sample was approximately 11.9 (Johnson 1971). Sreekrishnavilasam and Santagata (2006) analyzed the pH of landfilled and fresh CKD. The pH consistently averaged 12 (range 11.5 to 12.5) for both types of CKD.

Particle Size

According to the USEPA 1993 Report to Congress, from 15 to 90 percent of CKD particles have a diameter below 10 micrometers (µm), which is within the respirable range for humans. Particle size is largely influenced by kiln type. Dusts collected from dry kilns are finer than those from wet and semi-wet or semi-dry kilns. Other factors that influence particle size include variability in the raw materials, process technology, fuels, and dust collection methods. The fine-grained nature of CKD makes it easily transportable in air.

Particle Size Distributions of CKD Samples from Three Kiln Types (percent by weight)

Particulate size	Long-wet kiln	Long-dry kiln	Alkali by-pass from preheater/precalciner
>100 µm	5.0	0.0	2.0
<45 µm	85.0	99.2	84.5
<30 µm	77.3	98.8	66.0
<7 µm	43.0	87.2	14.0
<1 µm	12.0	12.0	3.0
<0.6 µm	7.5	5.6	2.0
Median size	9.3 µm	3.0 µm	22.2 µm

Source: Adapted from Todres et al. 1992; summary in Sreekrishnavilasam and Santagata 2006

Sreekrishnavilasam and Santagata (2006) analyzed particle sizes of landfilled and fresh CKD. They found that particle size of landfilled CKD was somewhat coarser than fresh CKD and attributed the difference to possible changes in the microstructure occurring as a result of chemical reactions or to possible contamination from other materials in the fill. The presence of reaction products in the landfilled CKD, some in the form of elongated crystals, and a more networked structure markedly distinguish the landfilled material from the fresh material.

Conductivity/Permeability

The hydraulic conductivity is defined as the ease with which water can move through porous spaces and fractures in soil or rock. Permeability is defined as the measure of how easily water moves through the porous media. The terms permeability and hydraulic conductivity are often used interchangeably.

The hydraulic conductivity of CKD is low compared to typical soil types (USEPA 1993). Compacted CKD conductivities are as low as $1x10^{-10}$ cm/sec, an extremely low value compared to the typical conductivity of a compacted clay landfill liner, which is about 1×10^{-7} cm/sec. Todres et al. (1992) analyzed the permeability of three types of CKD (long-wet rotary kiln, long-dry rotary kiln, and alkali bypass precalciner system) and found reduced permeability with greater density for all three dust types; secondarily, higher free lime provided lower permeability, but the authors did not discuss why this might be so. The permeability of CKD sampled from a waste pile at Puget Park in 1970 that had not been compacted was 8.65×10^{-6} cm/sec (Johnson 1971).

Sreekrishnavilasam and Santagata (2006) analyzed the permeability of landfilled and fresh CKD. These researchers found drainage characteristics of the landfilled CKD that would be described as “practically impervious to low permeability.” Hydraulic conductivity was 10 times smaller in landfilled CKD than fresh CKD. They concluded that compacted CKDs can be considered impervious.

Aging/Weathering

Sreekrishnavilasam and Santagata (2006; also Sreekrishnavilasam et al. 2007) analyzed the oxide composition of landfilled and fresh CKD. The landfilled CKD was approximately 12 years old. Both types of samples were collected from the Lehigh cement plant in Mitchell, Indiana. The oxide composition of fresh and landfilled CKD were consistent, with the primary difference being the availability of free lime. The landfilled CKD had only traces of free lime, which the authors attributed to the likely reaction or carbonation of the free lime during the extended storage time. The fresh CKD particles were found to be irregularly shaped and have a fairly smooth surface, while the landfilled material showed clear evidence of reaction products in the form of fibers (Sreekrishnavilasam et al. 2006).

Composition of Fresh and Landfilled CKDs			
Constituent	**Fresh 1**	**Fresh III**	**Landfilled (mean ± SD)**
CaO	50.4	44.9	46.15 ± 3.98
SiO_2	n.a.	10.5	8.8 ± 1.91
Al_2O_3	2.66	3.49	2.67 ± 0.18
Fe_2O_3	1.09	1.32	1.17 ± 0.22
MgO	0.7	1.0	1.14 ± 0.41
SO_3	3.50	1.89	3.91 ± 0.81
Na_2O	0.18	0.16	0.15 ± 0.09
K_2O	2.16	1.45	1 .74 ± 0.53
CaO (free)	2 – 5*	Trace**	trace
LOI	33.62	34.98	33.74 ± 0.65
pH	12.5	11.5	12 - core samples 11.5 - landfill open front samples

Note. Oxide values expressed in percentages by mass.
* from historic measurements made by the manufacturer
** the low levels of free lime detected in the Fresh III sample were believed to be due to changes in manufacturing process at the cement plant which made the plant more efficient

Huntzinger (2009) analyzed the elemental composition of a sample of landfilled CKD waste pile in Alpena, Michigan. The sample was taken from a depth of approximately 25 feet. The mass fractions of most oxides in the aged CKD were within the ranges typically seen for fresh CKD. The exception was CaO, which was lower than typically seen for fresh CKD (34.5 percent vs. 38-50 percent, respectively). The high percentage of calcite ($CaCO_3$) and the presence of ettringite ($Ca_6Al_2(SO_4)_3(OH)_{12}$-$26H_2O$) indicate that the waste pile from which the CKD core was taken had been exposed to moisture and likely undergone some carbonation after its deposition. Ettringite is a common hydration product found in cements and other materials high in Ca, Al, and SO_3, such as CKD and fly ash.

Peethamparan et al. (2008) analyzed the chemical and physical characteristics of CKD to study hydration behavior and the potential suitability as soil stabilizers. They found that ettringite, gypsum, syngenite, calcium hydroxide, and calcium silicate hydrate were nearly absent in the hydration products formed in CKDs with low initial free lime content. The main constituent of the low free lime hydrated CKDs was calcite, which was originally present in the fresh CKD. In general, high free-lime content (~14–29 percent) CKDs, when reacted with water produced significant amounts of calcium hydroxide, ettringite and syngenite.

Appendix B

GeoMapNW Database Queries

Appendix B

Lower Duwamish Waterway
GeoMapNW Subsurface Database Review

The GeoMap NW subsurface database was created by the Pacific Northwest Center for Geologic Mapping Studies at the University of Washington. The project was funded by the U.S. Geological Survey (USGS) and through agreements with the cities of Bainbridge Island, Bellevue, Kirkland, Mercer Island, Redmond, and Seattle; many departments in King County; the Washington State Department of Transportation (WSDOT), and the Division of Geology and Earth Resources in the Washington State Department of Natural Resources.

Geographical and subsurface geological information from thousands of geotechnical boring logs, water well logs, test pit logs, and direct measurements is contained within the database. The information was provided by WSDOT, Department of Health, Department of Ecology, the USGS, the Columbia Basin Groundwater Management Area, many county Public Utility Districts, and environmental consultants.

To identify areas where cement kiln dust (CKD) may have been used for fill material within the Lower Duwamish Waterway (LDW) drainage basin, Leidos queried the major material listed in the lithology descriptions field for the following search terms:

- Ash
- Cement by-product
- Cement kiln dust
- Cement waste
- Concrete
- Concrete waste
- Fly ash
- Portland cement concrete
- Powder

The query results returned over 9,000 records.[1] Further review of the layer descriptions for each record was performed to identify locations that were likely to represent CKD fill. For example, records with layer descriptions such as “Portland cement concrete (6” thick)” were excluded while records that positively identified CKD, cement/concrete by-products or waste, ash and powder were retained, resulting in 71 “sites”[2] of interest. The locations of the “sites” were then mapped to identify properties within the 24 sources control areas associated with the LDW cleanup site.

[1] Each record represents a single lithological layer/unit at an explored location (typically a soil boring or well boring). There are multiple records for each boring/well in the GeoMapNW database.
[2] The sites include soil borings, test pits, and other geological logs available in the GeoMapNW database.

Once properties of interest were identified, the associated reports, maps and boring logs for documented CKD sites were downloaded from the GeoMapNW database, if available.[3] Leidos reviewed this information, along with other relevant reports available in the LDW document library, to estimate the area and vertical extent of CKD fill at each property. The results of this review are summarized in Table 1 of the *Lower Duwamish Waterway, Cement Kiln Dust: Summary of Existing Information* report (Leidos 2015).

[3] Note that the information is currently available at the Washington State Department of Natural Resources Subsurface Geology Information System website: https://fortress.wa.gov/dnr/geology/