KING COUNTY AND SEATTLE PUBLIC UTILITIES SOURCE CONTROL PROGRAM FOR THE LOWER DUWAMISH WATERWAY

June 2004 Progress Report

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INTRODUCTION

This report describes the status of source control activities completed by King County and Seattle Public Utilities (SPU) from January 2003 through May 2004 as part of the Lower Duwamish Waterway superfund cleanup. During this time, work focused on the upland areas draining to the Diagonal Ave S CSO/SD, which discharges to the Diagonal/Duwamish early action site. King County and SPU source control activities include:

- Inspecting local businesses in the Lower Duwamish service area to ensure that businesses are implementing appropriate pollution prevention practices and complying with local stormwater, industrial pretreatment, and hazardous waste regulations.
- Installing sediment traps in the storm drain system, collecting key manhole samples from the sanitary sewer, and collecting sediment samples from catch basins on business sites and in public rights-of way to assist in tracing chemicals to their source.
- Analyzing a variety of consumer products to identify sources of elevated chemicals of concern to the waterway.

Background

To support Lower Duwamish Waterway (LDW) sediment remediation efforts, King County and SPU are working together to reduce the amount of pollution discharged to public storm drains and sanitary/combined sewers that discharge to the waterway. The purpose of this source control program is to reduce the potential for waterway sediment to recontaminate following cleanup. King County and SPU are key members of the Lower Duwamish Source Control Working Group because each manages a portion of the public stormwater and wastewater systems that discharge to the Lower Duwamish Waterway.

King County operates the large interceptor pipes that convey municipal and industrial wastewater to the treatment plant located at West Point and the storm drain system in unincorporated King County. Seattle operates the local sanitary/combined sewers that collect wastewater and route it to the King County interceptor system and the storm drains within the City of Seattle. The sanitary/combined sewer and storm drain service areas that discharge to the Lower Duwamish Waterway are shown in Figure 1. The sanitary/combined sewer and storm drains serve an area of about 19,800 and 9,100 acres, respectively.

As shown in Figure 2, a number of both public and private outfalls discharge to the LDW. Outfalls can generally be divided into the following categories.

- Public storm drains. Public storm drain systems collect and convey stormwater runoff from roadways and upland properties to the waterway.
- Private storm drains. Waterfront properties are generally served by private onsite drainage systems that discharge directly to the waterway. These systems are generally smaller than public storm drains and are owned and maintained by the private property owner.
- Combined sewer overflows (CSO). CSOs are located on the combined sewer system to release excess flows that occur during large storm events. Combined sewers collect both stormwater runoff and municipal/industrial wastewater. During large storm events, the

capacity of the collection pipes can be exceeded due to the large amount of stormwater runoff entering the system. Overflow points are provided to prevent stormwater and wastewater from backing up and flooding roadways and local properties. CSOs can discharge directly to the waterway via a dedicated outfall pipe or via a nearby storm drain system.

- Emergency overflows. Like CSOs, emergency overflows are relief points in the sanitary/combined sewer system. However, emergency overflows are not related to storm events. Instead, these overflows function to relieve backups that occur as a result of a pump station failure or obstruction in the conveyance system.
- Unknown outfalls. A number of piped outfalls of unknown origin discharge to the LDW. These outfalls are probably mostly private storm drains that serve waterfront properties, but may also include other systems such as industrial discharges.

Diagonal/Duwamish Project Area

As shown in Figure 3, the combined sewer service area in the Diagonal/Duwamish basin encompasses about 4,900 acres and the storm drain basin covers about 2,600 acres. Both systems share the same outfall. There are 7 separate combined sewer overflow points in the system, Seattle operates 6 and King County operates one overflow. Overflow locations within the Diagonal system are shown on Figure 3.

Locations on Figure 3 where the combined sewer service and storm drain service systems overlap are known as partially separated areas. In these areas, stormwater runoff can discharge to either the separated storm drain system or the combined system, depending how the individual storm drain inlets are plumbed.

Land use in the Diagonal service area is a mix of residential, commercial, and industrial properties. As shown in Figure 4, the western portion of the basin is predominately industrial and the eastern side is mostly residential. Commercial areas are generally located along the major transportation corridors, (e.g., Rainier Ave S and Beacon Ave S). Land use in the basin is summarized in Table 1.

Table 1. Land use in the Diagonal Ave S CSO/SD basin.

Land Use	Storm drain service area (Ac)	Combined sewer service area (Ac)
Industrial	490	657
Commercial	233	412
Public right-of-way	991	1,432
Single-family residential	487	1,369
Multi-family residential	102	314
Schools	45	116
Open space	124	349
Vacant	128	251
Total	2,600	4,900[a]

a. Includes the overlapping portion of the storm drain service area.

MULTI-AGENCY INSPECTION PROGRAM

King County Industrial Waste and SPU are co-leads in the joint King County-Seattle program to inspect businesses in areas that discharge to the LDW through either the city-owned storm drain system or the combined sanitary/storm sewer system. Early action sites are the highest priority and within each early action site, inspections focus first on the separated storm drain basin followed by the combined sewer service area. The goal is to complete the business inspections before sediment cleanup begins. Separated storm drain basins are prioritized because storm drains discharge to the LDW on a regular basis (i.e., everytime it rains), whereas combined sewer overflows discharge much less frequently, typically only during large storm events. During this reporting period (March 2003 to May 2004), inspections focused in areas discharging to the Diagonal/Duwamish early action site.

The following agencies are participating on this project:

- King County Industrial Waste (KCIW): Wastewater Treatment Division.
- Seattle Public Utilities (SPU)
- King County Local Hazardous Waste Management: Water and Land Resources Division (KCHW)
- King County Local Hazardous Waste Management: Seattle-King County Public Health (KCPH)

Inspectors that worked on the project are listed in Table 2.

Table 2. King County and SPU inspectors.

SPU	KCIW	KCHW	KCPH
Tasha Bassett	Barbara Badger	Donna Galstad	Diane Agasid
Ellen Stewart	Lydia Eng	Sue Hamilton	Larry Brown
Tanya Treat	Arnaud Girard	Steve Joyce	Keiko Ii
Savina Uzunow	Dave Haberman	Lisa Niehaus	Mike Kaufmann
Ryean-Marie Woods	Kristin Painter	Ann Peacock	Tracey Mayfield
	Jim Sifford	Emmanuel Rivera	Larry McKenrick
		Dave Waddell	Will Perry

Inspections are being conducted under existing King County and Seattle code authorities. King County has primary authority in the industrial waste and hazardous waste areas and with the exception of the stormwater discharges to the combined sewer, SPU has primary authority to regulate stormwater discharges. Code authority to regulate stormwater discharges to the combined sewer is shared by King County and Seattle. Because of overlapping and different authorities between the City and County regarding discharges to combined areas, project staff developed specific guidance for inspecting businesses in the combined areas. The goal for inspecting stormwater dischargers in combined areas is to minimize discharge of chemicals of concern to the combined sewer by preventing the accidental or deliberate discharge of concentrated products or wastes to the combined sewer.

Cross-Training

KCIW and SPU organized an initial training session to ensure that all inspectors involved in the project were well versed in the inspection procedures and capable of completing all aspects of an inspection (e.g., stormwater, industrial waste, and hazardous waste). The training was attended by more than 30 inspectors from 6 agencies. A training manual with accompanying reference material was provided to each inspector. In addition, a field form was developed to help the inspectors and ensure consistency (see Appendix A). Each of the four county and city agencies involved in the inspection program has designated a lead inspector who is responsible for coordinating the work of the other inspectors in their agency, distributing information, and meeting with the two project co-leads to discuss project procedures.

Business Inspection Process

Inspections are conducted in a specific geographic area. Inspections are initiated as follows:

- Postcards are mailed to all businesses in a given geographical area alerting them that inspectors will be coming to their neighborhood. The business lists used for mailing are purchased from a vendor.
- Inspectors are assigned to geographic subareas and given lists of known businesses in the subareas plus any other information available in county and/or city files including detailed drainage maps. With this information, inspectors conduct a sweep through the area to visually survey all businesses and determine which need to be inspected. In areas served by separated storm drains, inspectors conduct a complete sweep of the entire basin. In areas served by a combined system, inspectors survey only the commercial, industrial, institutional, and mixed use (retail/housing) areas. Residential areas are not surveyed.
- Businesses that do not conduct outside activities and those that do not use hazardous materials or involve industrial processing are not inspected. A list of businesses not inspected is being maintained to record all businesses evaluated as part of this effort.

Often it is not possible to determine if a full inspection is warranted at some businesses from a simple visual survey. In those cases, inspectors conduct an abbreviated inspection, termed a screening visit to assess whether a full inspection is needed. During a screening visit, inspectors talk to businesses about their site activities and based on this conversation determine if a full inspection is needed. If not, the inspector collects a business card and fills out a form documenting basic site information.

Full Inspections

Teams of 1 to 2 inspectors conduct onsite inspections of high-risk businesses. Inspectors check the following issues:

<u>Industrial wastewater</u>. Inspectors look for industrial processes that use water and/or generate wastewater, inspect any pretreatment systems, and note chemicals expected to be discharged. Companies required to have industrial waste permits/authorizations but do not are referred to King County Industrial Waste for permitting.

Wastes/materials disposal. Inspectors review storage, handling, and disposal practices for a long list of waste/materials (e.g., acids, antifreeze, fluorescent light tubes, oils, solvents, phthalate-containing materials, and PCB-containing materials).

Spill Prevention. Inspectors evaluate spill prevention and cleanup practices for inside and outside areas at each facility.

Stormwater. Inspectors check outdoor areas for activities that have a high risk of polluting stormwater. High-risk pollution generating activities include fueling operations, vehicle/equipment maintenance and washing, outside storage (liquids in above ground or portable containers, vehicles/equipment, and non-containerized materials, by-products, or finished products), manufacturing, equipment/vehicle/building/ship maintenance and repair, painting or finishing of vehicles/boats/buildings/equipment, landscape maintenance/construction, and construction activities. In addition, inspectors examine onsite catch basins and other stormwater structures to ensure that these facilities are maintained correctly.

Corrective Actions and Follow-up

Inspectors discuss pollution prevention requirements with company representatives during the inspection and also send a follow up letter that identifies what corrective actions are needed and establishes deadlines for completing those actions. Unless the problem poses an immediate threat to the environment, businesses are typically allowed 30 days to make the necessary improvements. After the deadline, the inspector re-inspects. If the company has not made the necessary improvements at the time of the re-inspection, the inspector refers the problem to the agency with primary authority (SPU for stormwater issues, King County for industrial pretreatment issues, and Ecology for contaminated site issues) enforcement actions.

Businesses with the potential to recontaminate sediment offshore of the Diagonal Ave S CSO/SD following cleanup will be placed on more intensive routine inspection schedules than they would have received prior to the inspection project and may be monitored for specific chemicals of concern.

Data Management

All information collected during inspections is maintained in hard copy files at SPU. Files typically include the following information: original inspection field forms, photo documentation, site maps, copies of all letters sent to the business, copies of industrial waste discharge authorizations, and miscellaneous information provided by the business such as material safety data sheets (MSDS), spill prevention plans, or waste disposal manifests. In addition, information from field inspection forms is entered into an Access database built specifically for this project.

Inspection Results

A total of 780 businesses were inspected between March 1, 2003 and May 31, 2004. Of these, 249 (32 percent) were screening visits and 531 (68 percent) were full site inspections. Inspection locations are shown in Figure 5. A list of all sites inspected is provided in Appendix B, Table B-1. Sixty-five percent of the sites where full inspections were conducted required some type of corrective action (see Table B-2 in Appendix B for details). By June 2004, 82 percent of all sites with corrective actions requested have come into compliance.

Stormwater-related problems were most common, followed by spill prevention/cleanup, hazardous waste, and industrial waste issues. Table 3 summarizes the percentage of total corrective actions by individual program areas.

Table 3. Breakdown of corrective actions requested by program area.

Program Area	Percent of total corrective actions
Stormwater	50
Spill prevention and cleanup	30
Hazardous waste	24
Industrial waste	3

Any problem associated with an outdoor activity (with the exception of spill prevention) that could contaminate stormwater discharged from a particular business is classified as a stormwater problem (e.g., storm drain structure needs cleaning or repair; illicit connection to the storm drain system; general housekeeping of outdoor areas; and outdoor storage, manufacturing, or fueling activities). Spill prevention and cleanup is divided into a separate program area, because this activity pertains to both indoor and outdoor areas and also falls under both King County and City jurisdiction. Spill-related issues that were addressed during the business inspection program generally consisted of having procedures in place for responding to spills, maintaining spill containment and cleanup equipment onsite, and training employees about spill response procedures. The hazardous waste program area generally focuses on issues associated with labeling, storage, documentation, and disposal requirements for small quantity generators. The industrial waste program area deals with the King County Industrial Waste Program and covers permit/authorization, pretreatment prior to discharge, and maintenance of pretreatment facilities.

The most frequently requested corrective actions are shown in Table 4.

Table 4. Most common corrective actions identified in Duwamish Diagonal area.

Corrective Action	Percent of sites with corrective actions
Drainage facility needs cleaning	58
Facility lacks proper spill prevention/cleanup plan/procedures	41
Inadequate spill cleanup materials available onsite	36
Inadequate employee training on spill prevention/cleanup practices	33
Improper storage of hazardous products and waste materials	22
Improper hazardous waste disposal	17
Improper outdoor storage of non-hazardous materials/products	13

A breakdown of all corrective actions requested within each program area (i.e., stormwater, industrial waste, hazardous waste, and spill prevention) is provided in Appendix B (Table B-3) and a list of numbers of corrective actions at each site by program area is provided in Table B-4. A detailed list of corrective actions requested for each site is provided in Table B-5.

Dental Waste Inspections

In addition to the joint King County/SPU inspections, King County Industrial Waste inspectors inspected 16 dental offices in the Diagonal storm drain basin as part of a larger countywide program aimed at bringing all dentists that discharge into the King County sewer system into compliance with local discharge limits for mercury. As of July 1, 2003 dentists were required to either install amalgam separators or meet discharge standards under a separate permit. All offices inspected were in compliance. Fourteen had installed separators, 1 office was an orthodontist (no separator required) and 1 office had applied for and received a permit to meet standards without an amalgam separator. An additional, approximately 20 offices in the Southeast and Northeast Diagonal Basins that will be inspected in July and August of this year.

Key Findings

No significant sources of contaminants to the waterway were found during the business inspections. Instead, as described above, many small problems/corrective actions were identified at numerous businesses throughout the Duwamish Diagonal basin. Key findings related to illicit connections and discharges, unauthorized discharges of industrial wastewater to the sanitary sewer, and presence of elevated levels of contaminants in onsite catch basin samples are described in the following sections.

Illicit Connections and Discharges

Four sites had illicit connections to the public storm drain system that allowed process water/wastewater that would normally discharge to the sanitary sewer to enter the drainage system. Illicit connections found in the Diagonal/Duwamish basin include:

- Indoor wash pad for forklifts, parts, and other heavy machinery
- Drinking water fountain in a warehouse
- Indoor sump in a metal shop
- Conventional clothes wash machine at a dry cleaning facility (plumbed to combined system via catch basin).

The property owners were generally unaware that an illicit discharge existed and assumed that they were legally connected to the sanitary sewer. In all four cases, the illicit connection has since been permanently plugged and the wastewater has either been re-routed to the sanitary sewer or is collected in a container that is emptied to the sanitary sewer. All but one of the four connections were relatively minor. Conditions at the other site are described below:

> Puget Sound Industries: 4429 Airport Way S
> Puget Sound Industries repairs small forklifts and conducts retail sales of forklift and other heavy vehicle parts. Forklifts and forklift parts are pressure washed at an indoor wash pad that was plumbed to a catch basin located in the parking lot. The catch basin discharged to the public storm drain on 7th Ave S. The sediment in the

catch basin was sampled and submitted for laboratory analysis. The sample contained elevated levels of total petroleum hydrocarbons (TPH)-diesel (34,000 mg/kg), TPH-heavy oil (71,000 mg/kg), copper (1,520 mg/kg), lead (1,110 mg/kg), and zinc (2,720 mg/kg). TPH concentrations exceeded the MTCA Method A cleanup level for industrial soil and metals concentrations exceeded the cleanup screening level (CSL) for marine sediment.

The discharge from the wash pad was immediately stopped and the wash pad has since been re-plumbed to the sanitary sewer and an oil/water separator has been installed to pre-treat the washwater. On January 20, 2004 KCIW issued a discharge authorization letter (#10457-01) requiring the company to properly operate and maintain the oil/water separator and meet heavy metals and non-polar fats, oils, and grease discharge limits.

Two illicit discharges to the storm drain system were also found during the inspections. Illicit discharges differ from illicit connections in that there is no plumbed connection to the storm drain system. Instead, wash/wastewater that should be discharged to the sanitary sewer indirectly reaches the storm drain system (e.g., via overland flow or illegal dumping). One discharge consisted of effluent from a sink and storage tank used to leak test outdoor products/equipment. No chemicals were present in the discharge. The other discharge is described below:

<u>Ralph's Concrete and Pumping</u>: 816 Poplar Place S

The concrete holding tanks on concrete pumping trucks are cleaned at this facility. The trucks are filled with water to remove residual concrete, and the water is emptied into temporary settling trays which allow capture of larger solids. Solids are removed and the trays are drained into a concrete lined trench area. Water is pumped from the trench into a series of 55-gallon drums (cut in half and lying on their sides) which provide additional settling. The contents of these drums drain into a concrete vault.

In general, water collected in the vault is recycled back into the concrete trucks. Occasionally, however, there is an excess of water and it is pumped from the vault and discharged to the public right of way adjacent to the site. Water and concrete residual flows down the street and enters either a maintenance hole on Poplar Place S or a catch basin at the intersection of S Charles St and Poplar Place S. Both locations are on the public storm drainage system. SPU issued a Notice of Violation on December 15, 2003 for a discharge and after 2 subsequent violations SPU referred the problem to the Washington State Department of Ecology (Ecology) on May 12, 2004. Ecology is currently working on further enforcement options. Ralph's Concrete and Pumping is in the process of applying for a permit to build a pretreatment facility and obtain a King County Industrial Waste Discharge Permit to discharge to the sanitary sewer.

Industrial Wastewater Discharge Authorizations

All business inspections included a review of wastewater/process water production and disposal. Businesses discharging wastewater to the sanitary sewer without proper authorization from King County were referred to KCIW for additional review and issuance of a discharge authorization, as necessary. KCIW issues four levels of discharge authorizations depending on the type of business, the volume and characteristics of wastewater, and the potential risk to the wastewater collection and treatment system:

- Significant discharge: >25,000 gallons per day or federally regulated facility
- Major discharge: Generally 5,000 – 25,000 gallons per day and facility is not a federally regulated industry
- Minor discharge: Generally 1,000 – 5,000 gallons per day and facility is not a federally regulated industry
- Letter of authorization: Generally <1,000 gallons per day and facility is not a federally regulated industry

Nine of the businesses inspected required approval from King County to discharge wastewater to the sanitary sewer. None of these sites classified as a significant or major discharge. The businesses included:

- Wastewater from the production area at a dishwasher leasing facility.
- Equipment wash pad at a forklift sales and repair facility.
- Wastewater from a plastics and aluminum parts tumbler/deburrer at a small airplane parts manufacturer.
- Washwater from a company that conducts offsite offsite carpet cleaning water damage restoration.
- Contact cooling water from plastic molding operation, water from metal jet cutting facility, and wastewater from a parts tumbler/deburrer at a small parts manufacturer.
- Washwater from pressure washing of containers at a paint manufacturing facility.
- Wastewater from a photographic school and darkroom facility.
- Wastewater from a jet cutting operation at granite and marble fabrication/installation facility.
- Washwater from a hospital laundry service.

All of these sites have since obtained the appropriate authorization from KCIW.

Contaminated Sediment in Onsite Catch Basins

Catch basin sediment samples collected at 7 out of the 36 sites sampled contained elevated levels of contaminants approaching hazardous waste designation thresholds (Table 5). Five of the seven catch basins have been cleaned. Sediment from one catch basin (CB22) is currently being analyzed for additional contaminants to evaluate disposal options. The property owner at the remaining site (CB19) is working on obtaining funds for disposal.

Table 5. Summary of sites containing elevated concentrations of contaminants in catch basin sediment samples.

Sample Number	Address	Contaminant (mg/kg)[a]	Date Verified Cleaned[b]
CB2	4429 Airport WY S	Lead (1,110) TPH[c] (105,000)	December 18, 2003
CB7	2006 Rainier Ave S	Lead (1,220) TPH (22,900)	January 28, 2004
CB15	2901 Rainier Ave S	Lead (476)	May 14, 2004
CB19	5022 Rainier Ave S	Lead (1,530) TCLP Lead (6 mg/L)	In progress
CB22	3711 S Hudson St	1,4-dichlorobenzene (43,000 mg/kg OC)[d] PCBs (267 mg/kg OC)	In progress
CB26	2220 E Union St	Lead (699) TPH (37,700)	May 26, 2004
CB30	910 Boylston Ave	Lead (2,010)	June 2, 2004

a. Unless otherwise noted
b. Sediment may have been cleaned prior to this date
c. TPH is the sum of NWTPH-diesel and NWTPH- heavy oil
d. mg/kg OC = milligrams per kilogram organic carbon normalized

Sample CB2 was collected from a catch basin that was plumbed to an indoor wash pad used to steam clean forklifts, which is the likely source of high levels of metals and oils in the sediment sample. Samples CB7, CB15, CB26, CB30 were collected from parking lots/parking garages at businesses of various types. Sample CB19 was collected from a large, non-standard sump in the parking lot of a car accessory shop. The current business does not engage in vehicle maintenance, however the previous occupant at the site did.

Sample CB22 was collected from an indoor sump at the discharge point from a plastics/metals deburring machine. The elevated levels of PCBs are believed to have originated from the previous tenant. Current operations at this site are not expected to contribute PCBs. Chlorinated solvents, however, were once used in the parts deburrer, which is a possible source of the 1,2-dichlorobenzene.

Surface Water Quality Complaints

As shown in Table 6, between March 2003 and May 2004 the SPU inspectors responded to 41 surface water quality complaints in the Diagonal Ave S CSO/SD basin (27 complaints in the storm drainage basin and 14 complaints in the combined sewer service area). Complaints are registered either from SPU’s hotline number for citizens, or from internal or external agencies. The most common complaint involved automobile related fluids such as gasoline, diesel, and oil (15). The next most common complaint (6) was for paint. The remaining complaints involved a variety of materials including soapy water, drywall, wastewater, and sewage. Thirty-two of these complaints were resolved successfully; investigations are continuing at two sites and seven complaints were not resolved because of lack of information.

Construction Projects in Diagonal Basin

There were 12 major construction sites in the Diagonal Ave S CSO/SD basin that had active grading permits between March 2003 and May 2004 (Table 7). Major sites are defined as those with a cost of greater than $1M reported to the Seattle Department of Planning and Development (DPD). Four sites are located in the storm drain portion of the Diagonal Ave S CSO/SD service area, the largest of which is Sound Transit's Light Rail Central Base located on 6th Avenue S. The remaining 8 sites are located in the combined sewer service area, with the largest site being Seattle Housing Authority's Rainier Vista low income housing construction project on Martin Luther King Jr. Way S.

SOURCE SAMPLING

Source tracing and identification sampling activities are being performed to support the source control efforts. Source tracing sampling is designed to identify sources by strategically collecting samples at key locations within the drainage/combined sewer service areas. Source identification sampling focuses on product testing to determine whether specific products contain chemicals that are a concern for waterway sediments.

Source Tracing

Samples are collected at the following locations to identify sources of the chemicals of concern in the waterway sediment:

- Key manholes in the sanitary/combined sewer
- In-line sediment traps installed in the storm drain system
- Onsite catch basins
- Catch basins in the public right-of-way.

With the exception of the key manhole samples, sediment rather than whole water samples are being collected. Sediment samples offer a number of advantages. First, because sediment is the affected media in the waterway, analysis of sediment source material is key to understanding how pollutants are transported to the waterway. Second, sediment that accumulates in the drainage system provides a measure of pollutant contributions over a longer time period (what has been deposited since the system was last cleaned), whereas water samples provide only a snapshot of a single storm event. Also, unlike whole water samples, sediment samples do not usually present detection limit problems for the analytical laboratory. Contaminants present in the sediment can usually be quantified, which makes it easier to evaluate and interpret the sample results. Finally, sediment samples are generally easier and less expensive to collect than whole water samples.

Key Manhole Samples

King County regularly samples wastewater at key locations in the collection system to provide baseline data for comparisons when tracking down spills at the treatment plants. Twenty-four hour composite samples are collected over a 7-day period twice per year, once during the wet season and once during the dry season. Figure 6 shows sampling stations located within the combined sewer service area discharging to the Lower Duwamish Waterway. Samples are normally analyzed for a suite of metals. In 2003, five sites in the West Point system were chosen to receive additional analyses of semi-volatile organic compounds in order to measure the level of phthalate compounds in sanitary wastewater. Phthalate results are summarized in Table 8. For comparison purposes, Table 8 also presents results from stormwater samples collected from storm drains in Tacoma, SR-520, and the Diagonal Ave S CSO/SD, and wastewater samples collected from the plant influent at the Renton and West Point wastewater treatment plants.

Concentrations of bis(2-ethylhexyl)phthalate (BEHP) in the samples collected at the East Marginal and Duwamish stations (2-14 ug/L) are generally within the range of concentrations observed in stormwater samples (1-16 ug/L). However, BEHP concentrations in the West Marginal samples (21-148 ug/L) are considerably higher than all the other samples, including stormwater and treatment plant influent (5-37 ug/L). The cause of the higher BEHP concentrations at the West Marginal station is unknown. Source investigations have not yet begun in this area. Further investigation will be conducted when source-tracing efforts expand into the west side of the Duwamish.

Phthalates other than BEHP that were detected in the key manhole samples include butylbenzylphthalate (100 percent), diethylphthalate (100 percent), di-*n*-butylphthalate (6 percent), dimethylphthalate (2 percent).

In-line Sediment Traps

In-line sediment traps consist of a small bracket mounted inside the collection system pipe that holds a wide-mouth sample bottle. The traps are installed for a period of 4 to 6 months to passively collect suspended particulate that passes by the site. Traps are installed at 7 sites in the Diagonal Ave CSO/SD basin (Figure 7). Station locations were selected to isolate individual subbasins within the larger storm drain system. Two rounds of samples have been collected to date. Traps were first deployed in February-March, 2003 and removed in August 2003. The traps were re-deployed in October 2003 and left in place until February-March 2004. The third round of traps were installed in February-March 2004 and will be removed in August. It is anticipated that traps will continue to be installed over the next 2-3 years to track changes in suspended particulate quality that may occur as a result of source control activities.

Results from the first 2 rounds of samples are presented in Table 9. There are no standards for sediment trap samples. For the purpose of this analysis, sample results are compared to the sediment management standards. Particulates discharged from storm drain outfalls are transported and deposited over a large area in the waterway and mix with sediment from other sources (e.g., sediment transport processes within the waterway). Therefore, exceedance of a sediment management standard in the in-line sediment samples does not necessarily indicate that the sediment offshore of the outfall will exceed the standards.

Key results are summarized below:

- PCBs are infrequently detected and no samples exceed the sediment management standards.
- With the exception of zinc, metals concentrations are generally low. Zinc exceeded the SQS at 3 stations (ST3, ST5, and ST6) and exceeded the CSL at station ST1.
- BEHP appears to be the chemical that poses the most significant potential to recontaminate waterway sediments. Concentrations exceeded the CSL at all stations except ST5 and ST7. The approximately 300-acre drainage basin upstream of station ST5 is predominately residential. The basin at station ST7 (approximately 200 acres) contains a mixture of residential and industrial properties.
- Polynuclear aromatic hydrocarbon (PAH) concentrations are consistently below the SQS at all trap locations.

Catch Basin Samples

Catch basin samples are grab samples of sediment that has accumulated in the catch basin sump. A catch basin is a storm drain structure that contains a sump to capture sediment and other debris before it can enter the collection system. Because many pollutants present in stormwater runoff tend to adhere to sediment, catch basins can also trap pollutants. The quality of sediment that accumulates in catch basins provides a measure of the quality of the stormwater runoff discharged to the drainage system since the catch basin was last cleaned. Catch basins must be cleaned on a regular basis to maintain their capacity to trap sediment and associated pollutants and prevent these materials from discharging to the downstream receiving water body. To date, 34 onsite and 31 right-of-way CB samples have been collected.

Like storm drain sediment traps, there are currently no standards that apply specifically to catch basin sediment. For this analysis, results are compared to the sediment management standards and the MTCA Method A cleanup levels for industrial soil. If catch basin sediment samples are below the sediment management standards, there is little chance of recontamination. However, an exceedance of a sediment management standard does not necessarily indicate that the sediment offshore of the outfall will exceed the standards, because particulates discharged from storm drains will mix with sediment in the waterway. TPH results are compared to the MTCA cleanup levels to aid in assessing disposal options for sediment once it is removed from the catch basin.

Onsite Catch Basins

Onsite catch basin samples have been collected at sites of interest identified during the business inspections or simply at sites where sufficient sediment was available for chemical analysis. Approximately 80 percent of the onsite samples were collected from sites where contamination problems were suspected either due to the nature of the onsite activities or because specific problems were observed during the inspection. In most cases, samples were collected immediately after the inspection and before the owner implemented the corrective actions identified during the inspection. The intent is to collect onsite CB samples before and after source controls are in place (and before and after catch basins are cleaned) to evaluate the effectiveness of source control in reducing the amount of contaminants discharged to the waterway.

Sampling locations are shown in Figure 8 and sample results are shown in Table 10. Although there are no standards for catch basin sediments, for the purpose of this analysis, sample results are compared to the sediment management standards and MTCA Method A cleanup standards for industrial soil (for TPH only). Key findings are summarized below:

- Copper (30-1,520 mg/kg) and lead (10-2,010 mg/kg) exceeded the sediment standards in 3 (9 percent) and 6 (18 percent) of the samples collected, respectively. All of the copper exceedances were above the CSL level. For lead, five of the samples exceeded the CSL and one exceeded only the SQS. Most exceedances occurred in samples collected from automotive-related facilities (e.g., auto repair, gas station, and vehicle wash facilities). Other sites where samples exceeded standards included a manufacturing and a medical facility.
- Mercury (<0.06-1.82 mg/kg) was detected in about 65 percent of the samples, but exceeded the sediment management standards in only 7 of the samples (21 percent).
- Zinc (55-2,720 mg/kg) exceeded the CSL in 6 samples (18 percent) and exceeded the SQS in 17 samples (50 percent)
- PAH concentrations are consistently below the SQS standards. However, TPH-oil (52-71,000 mg/kg) exceeded the MTCA Method A cleanup level in 76 percent of the

samples. The highest concentration was measured at a vehicle steam-cleaning pad. TPH-diesel concentrations (15-34,000 mg/kg) were consistently lower than the oil levels and exceeded the MTCA cleanup level in about 35 percent of the samples.

- PCBs were detected in about half the samples, but only one sample exceeded the CSL and one sample exceeded the SQS.
- BEHP (10-2,700 mg/kg OC) exceeded the sediment management standards in all but 6 of the 34 samples collected. Most samples exceeded the CSL; 2 samples exceeded only the SQS. With the exception of the sample collected from the steam cleaning pad (2,700 mg/kg OC), the concentration of BEHP in most samples ranged from about 100-1,000 mg/kg OC.

Right-of Way Samples

Right-of-way samples were collected from catch basins located in a wide variety of roadways to evaluate whether contaminant levels are related to traffic density. Sample locations are shown in Figure 8 and results are presented in Table 11. Zinc, TPH-oil, and BEHP are the contaminants that most frequently exceeded the sediment management standards. Key findings are summarized below:

- With the exception of zinc, metals concentrations rarely exceed the sediment management standards. None of the samples exceeded the SQS for copper and only one sample (0.87 mg/kg) exceeded the SQS for mercury. Mercury was detected in less than half of the samples. Lead concentrations exceeded the CSL in 3 samples. Zinc exceeded the SQS in 9 samples, but none of the samples exceeded the CSL.
- PAH concentrations are consistently below the SQS standards. However, TPH-oil (500-11,000 mg/kg) exceeded the MTCA Method A cleanup level for industrial soil in about 60 percent of the samples. One sample collected from an industrial roadway exceeded the MTCA cleanup level for TPH-diesel.
- PCBs were detected in about half the samples, but none of the samples exceeded the sediment management standards.
- Over 60 percent of the right-of-way samples exceeded either the CSL or the SQS for BEHP. The highest BEHP concentration (460 mg/kg OC) occurred in a sample collected from an industrial roadway. BEHP concentrations were generally lower in samples collected from low to medium traffic roadways (15-110 mg/kg OC) compared to the higher traffic arterials (33-280 mg/kg OC). BEHP concentrations in freeway samples (18-277 mg/kg OC) were within the range observed in the high traffic arterial samples (23-280 mg/kg OC).

Source Sediment Comparisons

Source to source comparisons are complicated by the limited number of samples collected and possible biases introduced by the different sampling strategies employed for each source type. For example, onsite catch basin samples were collected primarily where problems were suspected either because of the kinds of activities conducted onsite or because of specific problems identified during business inspections. General observations and comparisons are described below:

- Contaminant concentrations were generally higher in samples collected from onsite catch basins compared to right-of-way samples. For example, BEHP concentrations in most of the right-of-way samples ranged from about 15-300 mg/kg OC compared to 12-1,000 mg/kg OC in the onsite samples. As shown in Table 12, exceedances of sediment management standards for metals were also more frequent in the onsite samples.

Table 12. Summary of exceedances of sediment management standards for metals in storm drain sediment samples.

Metal	Onsite catch basins	Right-of-way catch basins	Sediment traps
Copper	9%	0%	0%
Lead	18%	10%	0%
Mercury	21%	3%	0%
Zinc	68%	29%	40%

- None of the sediment samples collected from onsite and right-of-way catch basin samples and inline sediment traps exceeded the sediment management standards for PCBs and PAHs. Therefore, it is unlikely that these chemicals will be a problem in waterway sediment following cleanup.
- BEHP poses the most serious concern for recontamination in waterway sediment after cleanup. Concentrations frequently exceeded the sediment management standards in all of the samples collected (82 percent, 65 percent, and 80 percent in the onsite catch basins, right-of-way catch basins, and inline sediment traps, respectively.

Phthalate Source Study

Phthalates, particularly bis(2-ethylhexyl)phthalate (BEHP), are contaminants of concern in the majority of the early action sites in the Lower Duwamish Waterway. Because they are a regional concern extending beyond the Duwamish Waterway, King County and SPU joined with the City of Tacoma to conduct joint testing of various products and materials to help identify the source of these chemicals. The City of Tacoma had previously submitted a sampling and analysis plan for product testing to the U.S. Environmental Protection Agency (EPA) as part of the Thea Foss Superfund investigation (Tacoma 2003). To benefit from the additional resources afforded by participation of the King County Environmental Laboratory, the joint task force added other materials for testing beyond those cited in the original plan.

The intent is to use this information about the phthalate content of common consumer products in conjunction with the source tracing efforts to identify specific sources of phthalates to the storm drains and the sanitary sewer. In addition, project staff hoped to identify specific products low in phthalates that they could recommend as replacement products to businesses and residents.

Background

Phthalates are a class of industrial compounds commonly used as softeners in plastics, as solvents, as oil in vacuum pumps and electric capacitors and transformers, and as carriers for fragrances and pesticides. They have also been reported in personal care products (Houlihan et.

al., 2002). Bis(2-ethylhexyl)phthalate (BEHP) is the most prevalent phthalate in the Duwamish sediments, and is a contaminant of concern at the majority of the early action sites, including the Duwamish Diagonal site. Butyl benzyl phthalate is also a contaminant of concern at this site.

BEHP is the most frequently detected phthalate in stormwater and catch basin samples (USEPA 1983; Herrera 1998; Tacoma 1990; Tacoma 1999; Tacoma 2002). However, until recently, phthalates have not been the focus of source control efforts, primarily because phthalates, particularly BEHP have long been considered a laboratory contaminant. As a result, information on the particular types of businesses that discharge BEHP is scarce, as is information on the type of products that contain substantial amounts of BEHP. To assist in identifying sources of BEHP and other phthalates staff at King County and Seattle Public Utilities joined with staff from the City of Tacoma to test a variety of products and materials.

Products Tested

Prior to selecting the additional materials, project staff reviewed available literature on phthalate sources, talked with representatives from a number of agencies, and reviewed data from EPA (TRI Explorer database) and the Washington State Department of Ecology (Toxic Release Inventory Information Display System or TRIIDS). The review indicated that phthalates are a component of many consumer products and therefore could be a significant non-point source to the waterway.

The additional products selected for testing include those that are commonly used in either Tacoma's Thea Foss Waterway and/or the Lower Duwamish Waterway and that literature reviews suggested might be high in phthalates. Testing focused on products that have not been analyzed for phthalate content. Products such as cosmetics that have already been analyzed were not tested. The goal was to analyze at least three brands or samples for each product type. Products tested by each lab are listed in Table 13.

Table 13. Products tested.

King County Environmental Lab	Tacoma Laboratory
Carwash soap (and liquid wax)	Atmospheric dust
Windshield washer fluid (and defoggers)	Tires
Dish soap (commercial and household)	Cigarette butts
Boat effluents (graywater or bilge)	Break pad dust
Oils (new and used)	Plastic bottles
Armor All (or equivalent)	Vehicle undercoating
Tire dressing (cleaner)	Asphalt binder
Inks and dyes (including printing inks)	Roofing tar
Asphalt sealer	Plastic wrap/packaging peanuts

Methods

The focus on the study was on BEHP, one of the contaminants of concern in the Lower Duwamish Superfund Site. However, other phthalates were also analyzed, as were polynuclear aromatic hydrocarbons (PAHs).

The source study materials and overall approach were presented previously to the EPA in a sample and analysis plan prepared by the City of Tacoma (2003). The joint task force has added additional materials to test above those cited in the plan to account for the different sewerage/stormwater conveyance systems and industry base of the Duwamish Waterway basin versus the Thea Foss Waterway basin.

Both King County and Tacoma laboratories used EPA Method 8270C (GC/MS) to analyze product materials. Because the focus of the testing was on identifying products high in phthalates, the target detection limits for the analysis was set at 1 to 10 ppm (1-10 mg/L in liquid products and 1-10 mg/kg in solid products). The laboratories adhered to standard EPA protocols as much as possible, which included implementing standard quality assurance practices such as analysis of method blanks, spikes, and surrogates.

The specific target parameters are listed in Table 14.

Table 14. Chemical parameters analyzed in product samples.

Phthalates	PAHs
Benzyl butyl phthalate	2-Methylnaphthalene
Bis(2-ethylhexyl)phthalate	Acenaphthene
Di-*n*-butyl phthalate	Acenaphthylene
Di-*n*-octyl phthalate	Anthracene
Diethyl phthalate	Benzo(*a*)anthracene
Dimethyl phthalate	Benzo(*a*)pyrene
	Benzo(*b*)fluoranthene
	Benzo(*g*,*h*,*i*)perylene
	Benzo(*k*)fluoranthene
	Chrysene
	Dibenzo(*a*,*h*)anthracene
	Fluoranthene
	Fluorene
	Indeno(1,2,3-*cd*)pyrene

The King County Laboratory and the Tacoma Laboratory each analyzed samples from one matrix type. Tacoma tested solids while King County tested liquids. In addition to phthalates and PAHs, the laboratories also recorded the top five most frequently detected tentatively identified compounds (TIC).

The Tacoma laboratory also developed a method to measure atmospheric deposition by analyzing material collected from the roof of the Tacoma Dome. A wetted cotton rag was divided into two portions, one being used for a field blank and the other to wipe the Dome's surface. A 16 square foot area on the northeast section of the Dome was wiped clean using the sampling rag and an analysis was performed on both samples. The sampling procedure was repeated after the Tacoma Dome was cleaned by a professional service to determine whether phthalates were present in the rubberized vinyl roofing material.

Results

Both labs have completed an initial round of analyses. Results are presented in Tables 15 and 16. Both solids and liquids analyses presented challenges for the labs. Solids products were shredded and ground prior to extraction. Interference from other organic compounds present in the product matrix created difficulties for the liquid products. Samples were diluted to minimize matrix interferences. However, the additional dilution resulted in samples being flagged because of high levels of phthalates in the blank samples.

Liquid products

As shown in Table 17, BEHP, the primary chemical of concern in waterway sediment was detected above the analytical detection limit in only 4 liquid samples.

Table 17. BEHP detected in liquid product samples.

Product	BEHP (µg/L)
Used oil from commercial lube shop	77,000
Used synthetic oil[a]	75,000
Boat grey water	52
Automated carwash rinsate	8

a. Collected from a single vehicle after 3 months of use. One quart of fresh non-synthetic oil added during the 3-month period.

Table 18 lists the products that also contained higher levels of other phthalates, primarily diethyl phthalate and benzyl butyl phthalate.

Table 18. Other phthalates detected in liquid product samples.

Product	Diethyl Phthalate (µg/L)	Butyl Benzyl Phthalate (µg/L)
Tire dressing	176,000	30,000U
Tire dressing	700,000	30,000U
Tire dressing	701,000	30,000U
Automated car wash product	1,320,000	6,000U
Used synthetic oil	50,000U	581,000
Unused motor oil	50,000U	3,390,000

On an unrelated project, the King County Local Hazardous Waste Program analyzed BEHP concentrations in a variety of cutting oils used at machine shops throughout King County. BEHP concentrations ranged from 1,300 µg/L to 420,000 µg/L.

Solid Products

Solid products contained considerably more phthalates than liquid products. Levels of BEHP were significantly above detection levels in serpentine belts (up to 900,000 µg/kg), used cigarette butts (up to 67,000 µg/kg), packing peanuts (670,000 µg/kg), brake pads (up to 170,000 µg/kg) and brake pad dust (52,000 µg/kg), and tires (up to 47,000 µg/kg). Results varied between brands of brake pads and tires. BEHP was not present above the analytical detection level in new cigarette butts, plastic bottles, asphalt, or asphalt sealer.

In addition, di-*n*-butylphthalate was found in used cigarette butts (200,000 µg/kg), some brake pads (17,000-22,000 µg/kg), and certain automobile serpentine belts (950-1,900 µg/kg). Di-*n*-butylphthalate was not found in the one new cigarette butt that was tested.

Butyl benzyl phthalate was found in packing peanuts (670,000 µg/kg) and in small amounts in used car brake pad dust (1,500 µg/kg). Diethyl phthalate was found in some brake pads (1,800-2,000 µg/kg) and some serpentine belts (2,100-3,100 µg/kg).

Tacoma Dome sampling

Sampling took place on May 13, 2003 (before cleaning) and July 3, 2003 (after cleaning). The roof wipe samples collected before the Dome roof was cleaned indicated that material deposited on the roof surface contained approximately 600 µg/square foot of BEHP. Samples collect shortly after the roof was cleaned yielded a BEHP concentration of approximately 42 µg/square foot of roof surface, which indicates that about 7 percent of the BEHP in the sample collected before cleaning was contributed from the roof surface rather than atmospheric deposition of phthalates. The Dome surface had last been washed 2 years prior to this sampling event. The rain record indicates that 1.89 inches of rain fell during the prior 30 days to the May sampling and no measurable rain occurred 6 days prior to sampling.

Conclusions

The low or non-detected levels of BEHP in almost all of the cleaning and maintenance products tested indicate that businesses in the Duwamish do not need to make significant changes in the products that they are using for vehicle maintenance/cleaning activities. Results also suggest that we need to look elsewhere for more substantial sources of phthalates. One possible source of some phthalates is cutting oils used at machine shops.

High levels of phthalates, particularly BEHP in brake pads, serpentine belts, and tires indicate that these materials may be a source of phthalates to the waterway via deposition of worn product particles on roadway surfaces and subsequent washoff in stormwater runoff. Automotive sources of BEHP should also be considered given that two of the three used motor oil samples contained significant concentrations of BEHP, but none of the unused/new oil samples contained BEHP above analytical detection limits. The literature review also suggests that some vehicle fuel products, such as diesel, contain BEHP that may be released into the atmosphere in the exhaust (California Air Resources Board, 1997). This theory is supported by results from the sampling of the Tacoma Dome roof. The next step will be to test for the presence of phthalates in the air in the Duwamish basin and to continue with source tracing using sediment traps and catch basin sampling.

NEXT STEPS

King County and SPU intend to continue the joint business inspection and source tracing efforts to support the Lower Duwamish Waterway Superfund investigation. Some modifications have been made to take advantage of lessons learned during the past year and a half. In addition, SPU and KCIW are discussing an outreach program to reach businesses in the Duwamish/Diagonal Basin. No decision has been made on the type of outreach, but possibilities being discussed include educational seminars and posters mailed to all businesses inspected. The intent is to provide ongoing reminders to businesses of how their practices can affect the Duwamish Waterway.

Business Inspections

The joint business inspection program has been successful in reaching businesses that discharge to the LDW via the publicly owned storm drain or the combined sewer systems. King County and SPU will have a continuing presence in the Duwamish/Diagonal area, focusing on higher priority businesses and will also expand into other areas to support ongoing and future early action area cleanups.

Duwamish Diagonal

The first complete sweep of businesses in the Diagonal Ave S CSO/SD basin has been completed. Inspectors are currently conducting follow up inspections at sites where corrective actions were required. As this follow up work is completed, the inspectors will begin post-correction inspections at select businesses that were first inspected more than a year ago, checking to see that any corrections made are still in place and best management practices are still being employed. Businesses that did not require corrections will be placed on a schedule of routine inspections according to normal agency practices.

Other Areas in the LDW

Within the next month King County and SPU will begin joint inspections in the separated storm drain system that drains to Slip 4 (470 Ac). SPU and KCIW are currently working with management at King County Airport to identify businesses needing inspections and to select locations for sediment traps. The airport has agreed to mail informational letters to all tenants and to provide inspectors with official badges.

The larger combined sewer service area (6,200 Ac) that discharges to Slip 4 via an emergency overflow at a King County pump station will not be inspected because the pump station that has not overflowed in the last 20 years. The smaller combined sewer service area that discharges to Slip 4 via an emergency overflow at a City of Seattle pump station (approximately 35 Ac) overlaps with the separated storm drain area and will therefore be covered by the inspections to be conducted in the Slip 4 storm drain basin.

After Slip 4, inspectors will move the following locations in the LDW (in order of priority):

- Early action site at river mile 3.8 in the vicinity of the former Slip 5.
- Trotsky early action site.

Once inspections are completed at the Trotsky early action site, inspectors will move north to the East Waterway where the Port of Seattle is conducting a sediment cleanup action. Although the East Waterway is not in the Lower Duwamish Waterway Superfund site, it is undergoing cleanup now, is adjacent to the Superfund site, and has many of the same contaminants of concern and similar land use patterns. King County and SPU propose to inspect the separated storm drain basin (mostly on Harbor Island) and the combined sewer service area that discharge to the East Waterway to support the Port's cleanup effort.

Source Sampling

Source Tracing

Source tracing efforts will continue to focus on catch basin and in-line sediment sampling to track sources of contaminants to the waterway sediment. In addition, King County will continue to analyze phthalates in its routine key manhole samples. With inspections moving into Slip 4, the next phase involves installing sediment traps at key locations in the storm drains discharging to Slip 4. It is anticipated that sediment traps will be installed by September 2004. Onsite and right-of-way catch basin sampling will be coordinated with the business inspection effort.

Phthalate Source Study

The phthalate source study will be continued with future work focusing on evaluating whether atmospheric deposition is a significant source of phthalates to the waterway sediment via either direct deposition on the waterway or via stormwater runoff. King County and SPU intend to collect air samples at 2 to 3 locations in the Duwamish Diagonal basin. Because source sampling results indicate that automobiles may be a source of phthalates, at least one sampling location will be located adjacent to a major roadway or highway. A background station in a residential area will also be sampled. The County and SPU are currently investigating sampling methodology and analytical methods to develop a sampling plan for this effort.

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TABLES

Table 7. Construction Projects with Grading in Diagonal Ave S CSO/SD Basin
All Permits Active March 2003 - May 2004

Project	Basin	Permit Date Start	Permit Date End	Address					DCLU Proj Cost	Project Description
RAINIER VISTA	CSO	6/11/2003	9/16/2005	4500		M L KING JR	WY	S	$31,078,597	CONSTRUCT AND OCCUPY LOW INCOME HOUSING, MIXED USE BLDG
2300290	SD	6/19/2003	12/19/2004	00833		DAVIS	PL	S	$2,824,774	CONSTRUCT & OCCUPY TWO TWO-STORY APT
2207892	SD	2/6/2004	8/6/2005	00500		17TH	AV		$25,881,161	CONSTRUCTION ADDITION & SUBSTANTUAL ALTERATIONS TO SHELL & CORE
2207429	CSO	3/12/2003	9/12/2004	02702		16TH	AV	S	$1,367,000	CONST OF A 160FT DEEP TEST SHAFT FOR SOUND TRANSIT
2204942	CSO	4/24/2003	10/24/2004	02821	S	WALDEN	ST		$3,770,000	DEMOLISH APPROX. 19000 SQUARE FEET OF EXISTING
2301643	CSO	7/8/2003	1/8/2005	04721		RAINIER	AV	S	$1,880,000	ADDITIONS AND ALTERATIONS TO SEATTLE PUBLIC LIBRARY "COLUMBIA"
2305679	CSO	10/8/2003	4/8/2005	03621		33RD	AV	S	$1,500,000	DEMO 3 BLDGS AND 5,000 CY GRADING FOR MIXED USE BLDG
2400238	CSO	5/20/2004	11/20/2005	03642		33RD	AV	S	$2,000,000	EXC AND SHORING FOR 7-STORY MIXED USE BUILDING
2107959	SD	9/23/2003	3/23/2005	03407		AIRPORT	WY	S	$28,286,087	CONSTRUCT A 4-STORY O&M FACILITY FOR SOUND TRANSIT
2206223	CSO	6/20/2003	12/20/2004	00316		BROADWAY			$5,012,399	DEMOLISH BLDGS302, 316 & 322 BROADWAY AND CONSTRUCT CHILD CARE CTR
2304932	SD	1/22/2004	7/22/2005	00801	S	DEARBORN	ST		$1,189,095	CONSTRUCT OFFICE/VEHICLE STORAGE BLDG.& OCCUPY
2301344	CSO	9/30/2003	3/30/2005	00917	E	YESLER	WY		$2,178,900	CONSTRUCT COMMUNITY/CHILD CARE CENTER FOR SEATTLE

Table 9. Diagonal Sediment Trap Results (2/03-3/04).

	SQS	CSL	ST1 E Marginal/S Oregon	ST2 Airport Way/6th Ave S	ST2 Grab in pipe	ST 2 (bottle #1)	ST2 (bottle #2)	ST3 S Forest	ST3 S Forest	ST5 S College/Rainier Ave	ST6 S Bush Pl/Rainier Ave	ST7 S Dakota/6th Ave S
Date deployed			02/01/03	02/01/03				02/01/03	10/13/03	02/01/03	02/01/03	10/13/03
Date removed			08/21/03	08/21/03	08/21/03	03/11/04	03/11/04	08/21/03	03/11/04	08/21/03	08/21/03	02/18/04
TOC (percent)			17	4.5	2.1	4.6	3.5	6.7	1.8	13	12	6.9
Metals (mg/kg DW)												
As	57	93	10 U	7 U	30 U	50 U	8 U	9 U	7 U	6 U	8 U	**9**
Cu	390	390	**298**	**89.9**	**78**	**146**	**34.1**	**138**	**69**	**136**	**231**	**62.6**
Pb	450	530	**244**	**76**	**100**	**210**	**39**	**128**	**102**	**175**	**200**	**61**
Hg	0.41	0.59	**0.3**	0.06 U	0.02 U	0.4 U	0.07 U	**0.07**	0.07 U	**0.10**	**0.25**	0.06 U
Zn	410	960	1,050	**282**	**159**	**735**	**162**	**653**	**433**	**479**	**944**	**262**
LPAH (mg/kg OC)												
Acenapthene	16	57	11 U	2 U	2 U	5 U	3 U	2 U	4 U	1 U	9 U	1 J
Acenaphthylene	66	66	11 U	2 U	2 U	5 U	3 U	2 U	4 U	1 U	9 U	1 U
Anthracene	220	1,200	11 U	**6**	2 U	5 U	3 U	**3**	4 U	1 U	9 U	1 U
Fluorene	23	79	11 U	**2**	2 U	5 U	3 U	2 U	4 U	1 U	9 U	1 J
Naphthalene	99	170	11 U	2 U	2 U	5 U	3 U	**9**	4 U	1 U	9 U	1 U
Phenanthrene	100	4,480	**19**	**36**	**6**	**22**	**12**	**16**	**11**	**4**	**49**	**4**
HPAH (mg/kg OC)												
Benzo(a)anthracene	110	270	11 U	**24**	**5**	**18**	**8**	**11**	**6**	**3**	**27**	**2**
Dibenzo(a,h)anthracene	12	33	11 U	2 U	2 U	5 U	**3**	2 U	4 U	1 U	**9**	1 U
Chrysene	110	460	**18**	**29**	**6**	**30**	**12**	**15**	**11**	**4**	**42**	**3**
Fluoranthene	160	1,200	**35**	**60**	**10**	**65**	**25**	**24**	**22**	**8**	**76**	**6**
Benzo(b)fluoranthene[a]	230	450	**14**	**40**	**6**	**24**	**9**	**6**	**7**	**6**	**39**	**2**
Benzo(k)fluoranthene			**14**	**40**	**5**	**24**	**9**	**5**	**7**	**4**	**39**	**2**
Benzo(g,h,i)perylene	31	78	11 U	**3**	2 U	**10**	**5**	2 U	**5**	**2**	**14**	**1** J
Benzo(a)pyrene	99	210	**11**	**24**	**4**	**20**	**9**	2 U	**6**	**4**	**28**	**2**
Pyrene	1,000	1,400	**32**	**53**	**10**	**30**	**13**	**24**	**11**	**7**	**68**	**4**
Indeno(1,2,3-c,d)pyrene	34	88	11 U	**5**	**2**	**10**	**6**	2 U	**4** J	**4**	**16**	**1** J
Phthalates (mg/kg OC)												
Bis(2-ethylhexyl)phthalate	47	78	**394**	**400** E	**133**	**283**	**40**	**269** E	**256**	**68**	**350**	**35**
Butylbenzylphthalate	4.9	64	**17**	**27**	2 U	10	**4**	**30**	**7**	**3**	**28**	**3**
Diethylphthalate	61	110	11 U	2 U	2 U	5 U	3 U	2 U	4 U	1 U	9 U	1 U
Dimethylphthalate	53	53	11 U	**2**	2 U	5 U	3 U	**2**	**15**	**2**	**9**	1 U
Di-n-butylphthalate	220	1,700	11 U	**2**	2 U	5 U	**3**	2 U	4 U	**6**	9 U	1 U
Di-n-octylphthalate	58	4,500	**21**	**8**	2 U	**19**	**4**	**58** M	**23**	**3**	**31**	**3**
PCBs (mg/kg OC)	12	64										
Aroclor 1016			0.12 U	0.53 U	0.90 U	0.43 U	0.57 U	0.30 U	1.11 U	0.15 U	0.16 U	0.28 U
Aroclor 1242			0.12 U	0.53 U	0.90 U	0.43 U	0.57 U	0.30 U	1.11 U	0.15 U	0.16 U	0.28 U
Aroclor 1248			0.12 U	0.53 U	0.90 U	1.48 P	1.71 P	0.30 U	1.11 U	0.15 U	0.16 U	0.28 U
Aroclor 1254			**0.50**	**2.13**	**1.71**	**0.98**	**0.60** J	**1.94**	**2.78**	**1.00**	**0.70**	**1.42**
Aroclor 1260			0.12 U	0.53 U	0.90 U	0.67	0.40 J	0.30 U	**1.28** J	0.15 U	0.16 U	0.28 U
Aroclor 1221			0.24 U	1.09 U	1.81 U	0.43 U	0.57 U	0.58 U	1.11 U	0.30 U	0.32 U	0.28 U
Aroclor 1232			0.12 U	0.53 U	0.90 U	0.43 U	0.57 U	0.30 U	1.11 U	0.15 U	0.16 U	0.28 U
TPH (mg/kg)		***MTCA A***										
Diesel		2,000	620	88	50	370	87 U	560	380	600		
Motor Oil		2,000	1,100	230	110	2,400	570	1,400	1,200	1,200		

Exceeds CSL or MTCA Level A Cleanup

Exceeds SQS

a. SMS for total benzofluoranthenes

Table 10. Diagonal Ave S CSO/SD: Onsite CB sediment samples.

Source	Sample ID	Location	Cu (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Zn (mg/kg)	TPH-Diesel (mg/kg)	TPH-Oil (mg/kg)	PCBs (mg/kg OC)	BEHP[a] (ug/kg DW)	BEHP[a] (mg/kg OC)
Auto repair	CB7	2006 Rainier Ave S	647	1,220	0.1	1,150	9,900	13,000	0.28	140,000	824
	CB9	820 S Charlestown	177	105	0.06 U	294	50 U	300	3.59	2,200	81
	CB13	1410 Airport Way S	95.7	127	0.09	432	51	300	20.9	4,500	136
	CB19	5022 Rainier Ave S	405	1,530	1.82	1,170	3,500	13,000	2.63	53,000	482
Gas station	CB10	852 Rainier Ave. S	86.6	96	0.07	250	930	2,000	0.11 U	1,500	10
	CB23	4800 Beacon Ave S	86.6	73	0.07 U	501	800	3,900	0.24 U	3,400	40
	CB26	2220 E Union St	184	699	1.7	1,470	8,700	29,000	3.62	64,000	246
	CB27a	2220 E Union St	92.1	109	0.1	396	5,200	22,000	1.66	33,000	388
	CB29	700 12th Ave	261	164	0.09 U	668	5,000	21,000	0.26	63,000	558
Grocery stores	CB15	2901 Rainier Ave S	142	476	0.06 U	98.3	380	3,900	0.48 U	380	10
	CB18	5041 Wilson Ave S	79.9	55	0.22	359	970	6,100	0.21 U	20,000	225
	CB25	3820 Rainier Ave S	187	152	0.2	912	2,900	15,000	0.24	120,000	750
Vehicle/equip wash	CB2	4429 Airport WY S	1,520	1,110	0.5	2,720	34,000	71,000	0.53 U	200,000 B	2,667 B
	CB21	3151 Rainier Ave S	194	97	0.06 U	305	1,900	4,900	0.40 U	17,000	354
Transportation	CB3	635 S Edmunds St	29.6	10	0.05 U	54.9	15	52	8.30 U	130	28
	CB8	5200 E Marginal Wy	275	205	0.10	603	2,000	4,500	10.87	71,000	772
Misc retail	CB16	4801 Rainier Ave S	56.1	63	0.1	237	1,400	6,800	1.06	11,000	229
	CB20	4580 Beacon Ave S	184	277	1.16	754	2,100	7,800	1.94	99,000	990
	CB12	3701 7th Ave S	181	97	0.1	603	41	270	0.61	6,600	99
	CB28	1018 E Seneca St	254	327	0.2	677	440	3,100	0.13	14,000	103
Manufacturing	CB1	3414 4th Av S	161	125	0.3	1,100	NA	NA	0.62	19,000 B	100 B
	CB22	3711 S Hudson St	520	151	0.16	433	190	920	267	410	34
	CB31	3901 9th Ave S	186	231	0.12	590	200	670	3.47	460	12
Restaurant	CB27b	950 E Madison St	137	88	0.1 U	537	6,600	9,400	0.47 U	140,000	596
	CB32	3820 Rainier Ave S	194	131	0.2 U	874	770	3,000	0.10 U	34,000	164
Other	CB4	828 S Poplar Place	135	47	0.08 U	360	1,800	6,300	1.12 U	32,000	941
	CB5	828 S Poplar Place	147	51	0.2 U	412	2,600	9,200	0.27 U	67,000	447
	CB11	5005 3rd Ave S	325	445	0.68	3,940	370	2,100	4.11	6,200	100
	CB24	3515 S Alaska ST	172	299	0.2	699	730	5,700	0.92 U	12,000	156
	CB30	910 Boylston Ave	79.4	2,010	0.84	257	620	2,800	3.15	11,000	134
Transportation	CB33	3820 6 Ave. S	118	82	0.09	924	900	3,100	0.51	9,900	87
	CB34	12100 E Marginal Wy	98.7	110	0.07 U	833	430	2,400	0.21 U	4,200	45
	CB35	12100 E Marginal Wy	78.6	87	0.1	382	4,000	2,700	0.22 U	11,000	123
	CB36	12100 E Marginal Wy	201	152	0.07 U	420	5,300	14,000	0.19 U	24,000	226
Thea Foss basin (Tacoma)											
Auto repair/supplies (7)			Mean							58,371	
			Range							(2,600 - 340,000)	
Fast food (2)			Mean							74,000	
			Range							(48,000 - 100,000)	
Vehicle/equip wash (1)										24,000	
Misc retail (3)			Mean							14,100	
			Range							(1,800 - 35,000)	
Manufacturing (6)			Mean							106,083	
			Range							(9,100 - 580,000)	
SQS			390	450	0.41	410	NA	NA	12	NA	47
CSL			390	530	0.59	410	NA	NA	65	NA	78
MTCA Level A			NA	250	2	NA	2,000	2,000	NA	NA	NA

SQS
Exceeds CSL or MTCA Level A Cleanup Level (TPH)
a. Bis(2-ethylhexy)phthalate
NA = not applicable/not analyzed

Table 11. Right-of-Way CB Sediment Samples.

Road Type	Station ID	Cu (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Zn (mg/kg)	TPH-Diesel (mg/kg)	TPH-Oil (mg/kg)	PCBs (mg/kg OC)	BEHP[a] (ug/kg DW)	BEHP[a] (mg/kg OC)
Diagonal basin										
Industrial	RCB1	112	1,370	0.87	364	3,500	4,000	6.70	46,000	460
	RCB16	154	105	0.19	698	1,400	8,000	4.13	14,000	197
	RCB29	134	106	0.26	334	130	480	1.53	1,400	32
Freeway	RCB30	46.2	20	0.06 U	171	130	630	0.63 U	3,200	107
	RCB31	185	157	0.07	552	150	660	4.74	1,100	18
	RCB32	97.5	126	0.09 U	305	150	690	1.82	21,000	277
High traffic arterial	RCB2	40.1	121	0.07 U	137	270	1,600	0.55	2,900	53
	RCB3	48.8	78	0.07 U	179	200	1,400	0.37 U	2,400	46
	RCB7	55.1	374	0.06 U	142	210	1,600	0.83 U	2,100	88
	RCB11	117	92	0.07 U	243	540	3,000	0.27 U	3,200	23
	RCB10	183	109	0.1 U	589	630	4,600	1.16	28,000	280
	RCB12	112	77	0.1 U	384	540	3,000	0.51	5,600	96
	RCB13	172	163	0.17	567	1,200	7,800	1.67	17,000	177
	RCB15	157	145	0.2	781	1,400	9,100	3.68	18,000	219
	RCB17	137	146	0.15	534	1,400	7,200	3.04	12,000	158
	RCB18	229	137	0.13	575	1,700	8,500	2.51	14,000	141
	RCB19	71.9	64	0.05 U	252	470	2,600	1.48	5,900	137
	RCB20	164	206	0.2	759	1,800	11,000	1.31	24,000	168
	RCB21	38.4	39	0.07 U	132	390	2,500	0.31 U	4,300	70
	RCB27	159	111	0.06 U	335	560	2,400	0.37	12,000	201
Medium traffic	RCB6	46.4	46	0.06 U	176	380	2,800	0.40 U	4,000	85
	RCB9	42.5	53	0.04 U	151	160	1,900	0.43 U	970	21
	RCB26	40.2	136	0.06 U	84.7	1,800	4,500	0.29 U	1,300	20
	RCB24	41.4	316	0.31	226	400	1,400	0.34	1,100	15
	RCB25	53.1	25	0.07 U	120	290	1,200	0.34 U	1,900	34
Low traffic res	RCB4	167	245	0.30	851	460	1,600	0.18 U	3,600	30
	RCB5	66.6	197	0.32	362	260	2,400	0.18	2,400	22
	RCB22	97.2	65	0.06 U	176	230	1,500	0.45 U	3,100	66
	RCB28	76.9	131	0.2	313	140	910	0.29	4,100	33
	RCB23	81.6	180	0.12	277	690	2,500	0.22	8,700	81
Low traffic mix	RCB8	75.3	54	0.07 U	223	320	3,000	0.24	8,600	110
Thea Foss (Tacoma)										
Residential									4,825	
(8 samples)									(2,000 - 10,000)	
Commercial									21,000	
(5 samples)									(2,100 - 67,000)	
Industrial									13,250	
(14 samples)									(2,300 - 34,000)	
SQS		390	450	0.41	410	NA	NA	12	NA	47
CSL		390	530	0.59	410	NA	NA	65	NA	78
MTCA Level A		NA	250	2	NA	2,000	2,000	NA	NA	NA

a. Bis(2-ethylhexyl)phthalate

Exceeds SQS

Exceeds CSL or MTCA Level A Cleanup Level (TPH)

Table 15. Duwamish source tracing: Liquid product testing results.

	Drinking water through Barista maker	Dishwasher soap, McDonalds	Dish soap, Ultra Joy with aromatic release	Dish soap, Ultra Palmolive (antibacterial)	All purpose Cleaner, Simple Green (concentrated)	Boat tap water	Boat grey water	Tire Dresser Black Magic Tire Wet	Tire Dressing 1
Phthalates (µg/L)									
Bis(2-ethylhexyl)phthalate	0.45 U	4,800 U	3,600 U	5,900 U	6,000 U	1.90 U	52	10,000 U	10,000 U
Benzyl butyl phthalate	0.29 U	6,000 U	6,000 U	6,000 U	6,000 U	0.31 U	20	30,000 U	30,000 U
Di-n-butyl phthalate	1.88	10,000 U	10,000 U	10,000 U	10,000 U	0.52 U	116	50,000 U	50,000 U
Di-n-octyl phthalate	0.29 U	6,000 U	6,000 U	6,000 U	6,000 U	0.31 U	3.6 U	30,000 U	30,000 U
Diethyl phthalate	1.05	10,000 U	10,000 U	19,000 <RDL	10,000 U	0.52 U	6.0 U	176,000	700,000
Dimethyl phthalate	0.19 U	4,000 U	40,000 U	4,000 U	4,000 U	0.21 U	2.4 U	20,000 U	20,000 U
PAHs (µg/L)									
Acenaphthene									
Acenaphthylene									
Anthracene									
Benzo(a)anthracene									
Benzo(a)pyrene									
Benzo(b)fluoranthene									
Benzo(g,h,i)perylene									
Benzo(k)fluoranthene									
Chrysene									
Dibenzo(a,h)anthracene									
Fluoranthene									
Fluorene									
Indeno(1,2,3-cd)pyrene									
Naphthalene									
Phenanthrene							4.4		
Pyrene									

Table 15. Duwamish source tracing: Liquid product testing results.

	Tire Dressing 2	Automated car wash rinsate from Elephant Car wash	Car wax/soap, Turtle Wax 2 in 1 Wash Plus Wax	Car care product Armorall Protectant	Car Wash Soap, Mother's California Gold Car Wash	Automated car wash product, Harmony Presoak 180 (elephant wash)	Automated car wash product, Harmony Triple Coat	RainX	Clear Shield Windshield Fluid
Phthalates (µg/L)									
Bis(2-ethylhexyl)phthalate	10,000 U	7.98	5,100 U	3,900 U	9,600 U	2,000 U	302,000 U	10,000 U	5,100 U
Benzyl butyl phthalate	30,000 U	0.32 U	6,000 U	6,000 U	6,000 U	6,000 U	6,000 U	30,000 U	6,000 U
Di-n-butyl phthalate	50,000 U	0.53 U	10,000 U	10,000 U	10,000 U	10,000 U	10,000 U	50,000 U	10,000 U
Di-n-octyl phthalate	30,000 U	0.32 U	6,000 U	6,000 U	6,000 U	6,000 U	6,000 U	30,000 U	6,000 U
Diethyl phthalate	701,000	1.53	10,000 U	10,000 U	10,000 U	10,000 U	1,320,000	50,000 U	10,000 U
Dimethyl phthalate	20,000 U	0.21 U	4,000 U	4,000 U	4,000 U	4,000 U	4,000 U	20,000 U	4,000 U
PAHs (µg/L)									
Acenaphthene									
Acenaphthylene									
Anthracene									
Benzo(a)anthracene									
Benzo(a)pyrene									
Benzo(b)fluoranthene									
Benzo(g,h,i)perylene									
Benzo(k)fluoranthene									
Chrysene									
Dibenzo(a,h)anthracene									
Fluoranthene									
Fluorene									
Indeno(1,2,3-cd)pyrene									
Naphthalene									
Phenanthrene			6,100						
Pyrene									

Table 15. Duwamish source tracing: Liquid product testing results.

	Asphalt Sealer		Rainwater exposed to asphalt sealer		Driveway Sealer, Henry 132 Driveway Coating		New Penzoil Oil Synthetic		Used Penzoil Oil Synthetic		Car Engine Oil Mobil 1 5W-30		Car Engine Oil Valvoline SAE 20W-50		Spent automotive oils	
Phthalates (µg/L)																
Bis(2-ethylhexyl)phthalate	10,000	U	1,200	U	10,000	U	10,000	U	75,000	<RDL	10,000	U	10,000	U	10,000	U
Benzyl butyl phthalate	6,000	U	300	U	6,000	U	30,000	U	581,000		3,390,000		30,000	U	30,000	U
Di-n-butyl phthalate	10,000	U	500	U	10,000	U	50,000	U	50,000	U	50,000	U	50,000	U	50,000	U
Di-n-octyl phthalate	6,000	U	300	U	6,000	U	30,000	U	30,000	U	30,000	U	30,000	U	30,000	U
Diethyl phthalate	10,000	U	500	U	10,000	U	50,000	U	50,000	U	50,000	U	50,000	U	50,000	U
Dimethyl phthalate	4,000	U	200	U	4,000	U	20,000	U	20,000	U	20,000	U	20,000	U	20,000	U
PAHs (µg/L)																
Acenaphthene					871,000											
Acenaphthylene																
Anthracene					1,180,000				46,000							
Benzo(a)anthracene					1,260,000				98,000							
Benzo(a)pyrene					1,320,000											
Benzo(b)fluoranthene					1,500,000											
Benzo(g,h,i)perylene					787,000											
Benzo(k)fluoranthene					508,000											
Chrysene	9,000				1,150,000				65,000							
Dibenzo(a,h)anthracene					143,000											
Fluoranthene					5,360,000				56,000							
Fluorene					749,000											
Indeno(1,2,3-cd)pyrene					824,000											
Naphthalene	35,400				1,640,000				194,000						110,000	
Phenanthrene					5,930,000				104,000							
Pyrene					3,490,000				118,000							

Table 15. Duwamish source tracing: Liquid product testing results.

	Spent automotive oils		Tristar Extender (ink product)		Polycon Blue Crude M31 (ink product)		Inxvelope Extender (ink product)		Inxvelope dense black (ink product)	
Phthalates (µg/L)										
Bis(2-ethylhexyl)phthalate	77,000	<RDL	6,300	U	15,000	U	11,000	U	8,500	U
Benzyl butyl phthalate	30,000	U	6,000	U	6,000	U	6,000	U	6,000	U
Di-n-butyl phthalate	50,000	U	10,000	U	10,000	U	10,000	U	10,000	U
Di-n-octyl phthalate	30,000	U	6,000	U	6,000	U	6,000	U	6,000	U
Diethyl phthalate	50,000	U	10,000	U	10,000	U	10,000	U	10,000	U
Dimethyl phthalate	20,000	U	4,000	U	4,000	U	4,000	U	4,000	U
PAHs (µg/L)										
Acenaphthene										
Acenaphthylene										
Anthracene										
Benzo(a)anthracene	<RDL									
Benzo(a)pyrene										
Benzo(b)fluoranthene										
Benzo(g,h,i)perylene										
Benzo(k)fluoranthene										
Chrysene										
Dibenzo(a,h)anthracene										
Fluoranthene	36,000									
Fluorene										
Indeno(1,2,3-cd)pyrene										
Naphthalene	357,000									
Phenanthrene	106,000									
Pyrene	85,000								21,800	

Table 16. Duwamish Source Tracing: Solid product testing results.

Source	Ford-Motorcraft Serp Belt-new	New Cigarette butt Marlbro light 100	Used Cigarette butt-Muni	Used Cigarette butt-TDome	Plastic Bottles - Tacoma Recycling	Packing Peanuts-Tacoma Recycling	Crafco Asph Sealer
BEP Phase 2 - ID #	021	022	023	024	025	026	027
Date Collected	1/12/2004	1/12/2004	1/12/2004	1/12/2004	1/9/2004	1/9/2004	1/12/2004
Conventionals							
Total solids (percent)	**98.9**	**92.1**	**89.8**	**90.4**	**99.6**	**100**	**98.8**
Phthalates (ug/kg DW)							
Bis(2-ethylhexyl)phthalate	**3,900**	5,400 U	**67,000** 10x	49,000 U 10x	810 U	**18,000**	16,000
Butylbenzylphthalate	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	**670,000**	16,000
Diethylphthalate	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Dimethylphthalate	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Di-n-butylphthalate	970 U	5,400 U	**200,000** 10x	**210,000** 10x	810 U	9,500 U	16,000
Di-n-octyl phthalate	970 U	5,400 UJ	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
LPAHs (ug/kg DW)							
2-Methylnaphthalene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Acenaphthene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Acenaphthylene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Anthracene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Fluorene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Naphthalene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Phenanthrene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
HPAHs in ug/kg							
Benzo(a)anthracene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Benzo(a)pyrene	970 U	5,400 UJ	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Benzo(g,h,i)perylene	970 U	5,400 UJ	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Benzo(b,k)fluoranthenes	970 U	5,400 UJ	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Chrysene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Dibenzo(a,h)anthracene	970 U	5,400 UJ	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Fluoranthene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Indeno(1,2,3-c,d)pyrene	970 U	5,400 UJ	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000
Pyrene	970 U	5,400 U	49,000 U 10x	49,000 U 10x	810 U	9,500 U	16,000

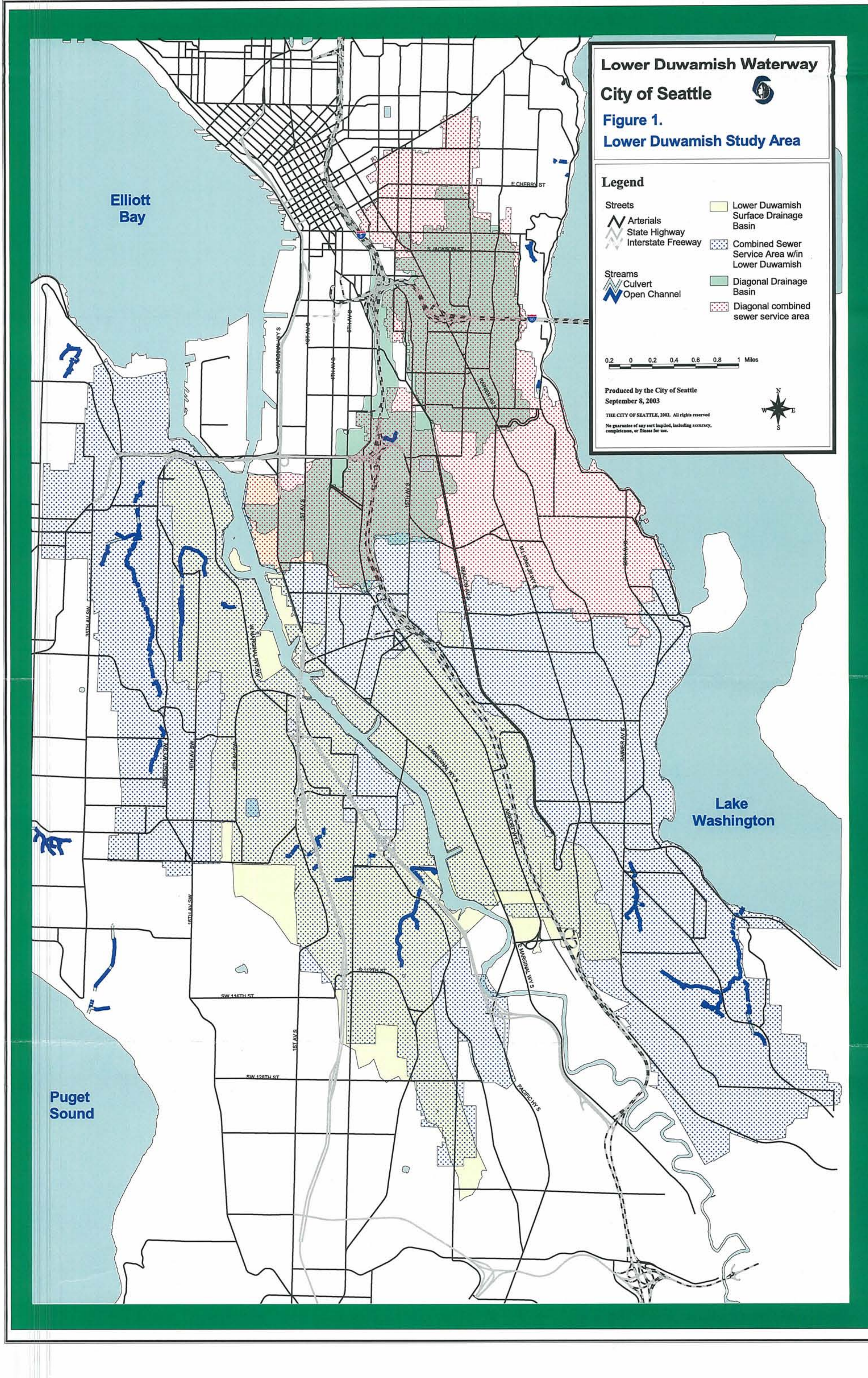
The analyte was not detected at or above the reported value
The analyte was not detected at or above the reported estimated result
The analyte was positively identified. The associated value is an estimate
The analyte was quantitated based on the Internal Standard Phenanthrene-d10
Indicates the value is based on a 1:10 dilution

Table 16. Duwamish Source Tracing: Solid product testing results.

Source	alt	US Oil Liquid Asphalt- NC800		US Oil Asphalt Cement	
BEP Phase 2 - ID #		028		029	
Date Collected		1/12/2004		1/12/2004	
Conventionals					
Total solids (percent)		**83**		**100**	
Phthalates (ug/kg DW)					
Bis(2-ethylhexyl)phthalate	U	19,000	UJ	20,000	UJ
Butylbenzylphthalate	U	19,000	UJ	20,000	UJ
Diethylphthalate	U	19,000	U	20,000	U
Dimethylphthalate	U	19,000	U	20,000	U
Di-n-butylphthalate	U	19,000	U	20,000	U
Di-n-octyl phthalate	UJ	19,000	UJ	20,000	UJ
LPAHs (ug/kg DW)					
2-Methylnaphthalene	U	**630,000**		20,000	U
Acenaphthene	U	19,000	U	20,000	U
Acenaphthylene	U	19,000	U	20,000	U
Anthracene	U	19,000	U	20,000	U
Fluorene	U	**19,000**		20,000	U
Naphthalene	U	**240,000**		20,000	U
Phenanthrene	U	19,000	U	20,000	U
HPAHs in ug/kg					
Benzo(a)anthracene	U	19,000	UJ	20,000	UJ
Benzo(a)pyrene	UJ	19,000	UJ	20,000	UJ
Benzo(g,h,i)perylene	UJ	**19,000**	J	20,000	UJ
Benzo(b,k)fluoranthenes	BJ	19,000	UJ	20,000	UJ
Chrysene	U	**22,000**	J	20,000	UJ
Dibenzo(a,h)anthracene	UJ	19,000	UJ	20,000	UJ
Fluoranthene	U	19,000	U	20,000	U
Indeno(1,2,3-c,d)pyrene	UJ	19,000	UJ	20,000	UJ
Pyrene	U	19,000	UP	20,000	UP

The analyte was not detected at or above
The analyte was not detected at or above
The analyte was positively identified. The
The analyte was quantitated based on the
Indicates the value is based on a 1:10 dilu

FIGURES


Lower Duwamish Waterway
City of Seattle
Figure 1.
Lower Duwamish Study Area
Legend
Streets
Arterials
State Highway
Interstate Freeway
Streams
Culvert
Open Channel
Lower Duwamish Surface Drainage Basin
Combined Sewer Service Area w/in Lower Duwamish
Diagonal Drainage Basin
Diagonal combined sewer service area
0.2 0 0.2 0.4 0.6 0.8 1 Miles
Produced by the City of Seattle
September 8, 2003
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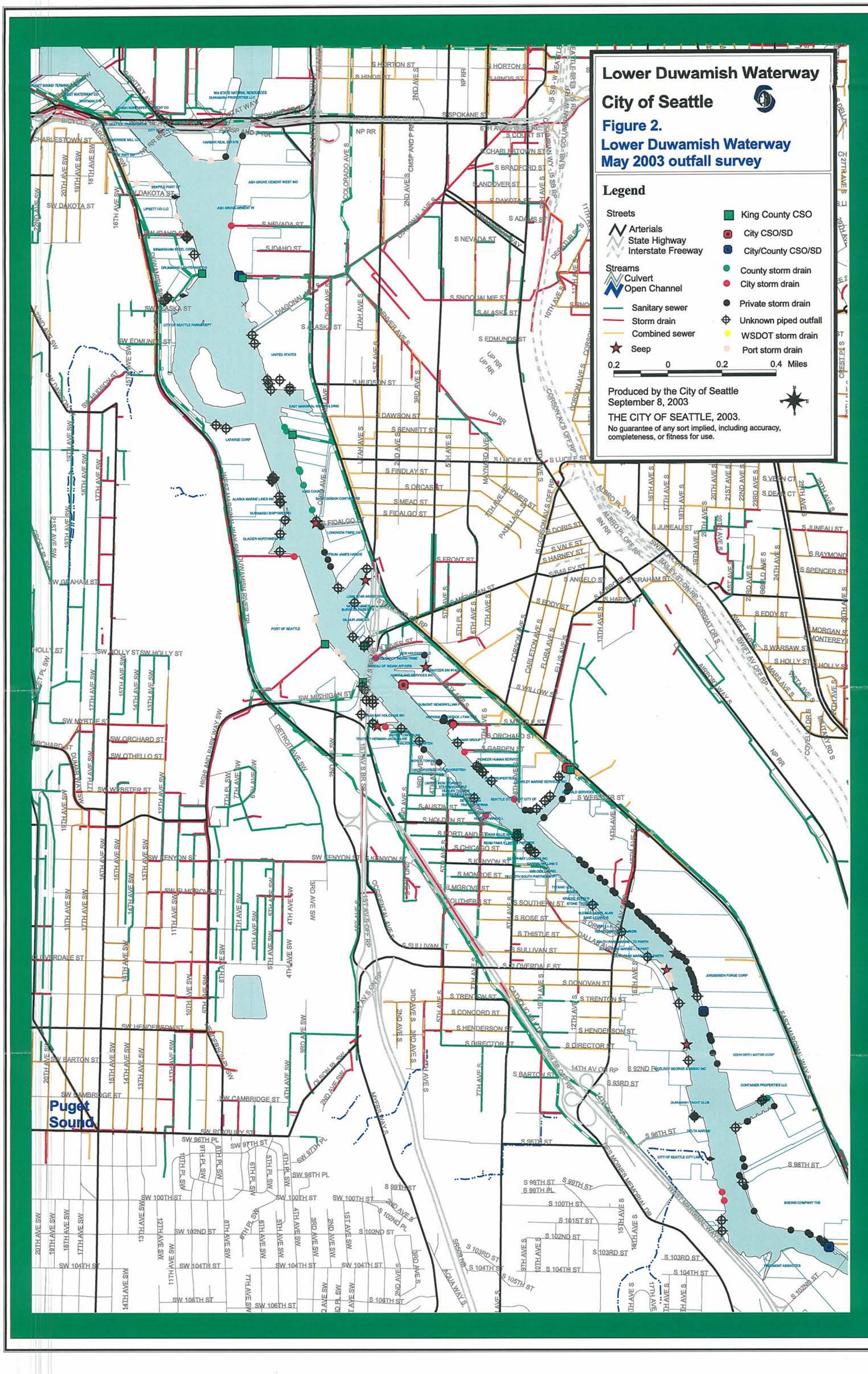
N
E
S
W
Elliott Bay
Lake Washington
Puget Sound
E CHERRY ST
S JACKSON ST
SW 116TH ST
SW 128TH ST
1ST AV S
PACIFIC HY S
E MARGINAL WY S


Lower Duwamish Waterway
City of Seattle
Figure 2.
Lower Duwamish Waterway
May 2003 outfall survey
Legend
Streets
Arterials
State Highway
Interstate Freeway
Streams
Culvert
Open Channel
Sanitary sewer
Storm drain
Combined sewer
Seep
King County CSO
City CSO/SD
City/County CSO/SD
County storm drain
City storm drain
Private storm drain
Unknown piped outfall
WSDOT storm drain
Port storm drain
0.2 0 0.2 0.4 Miles
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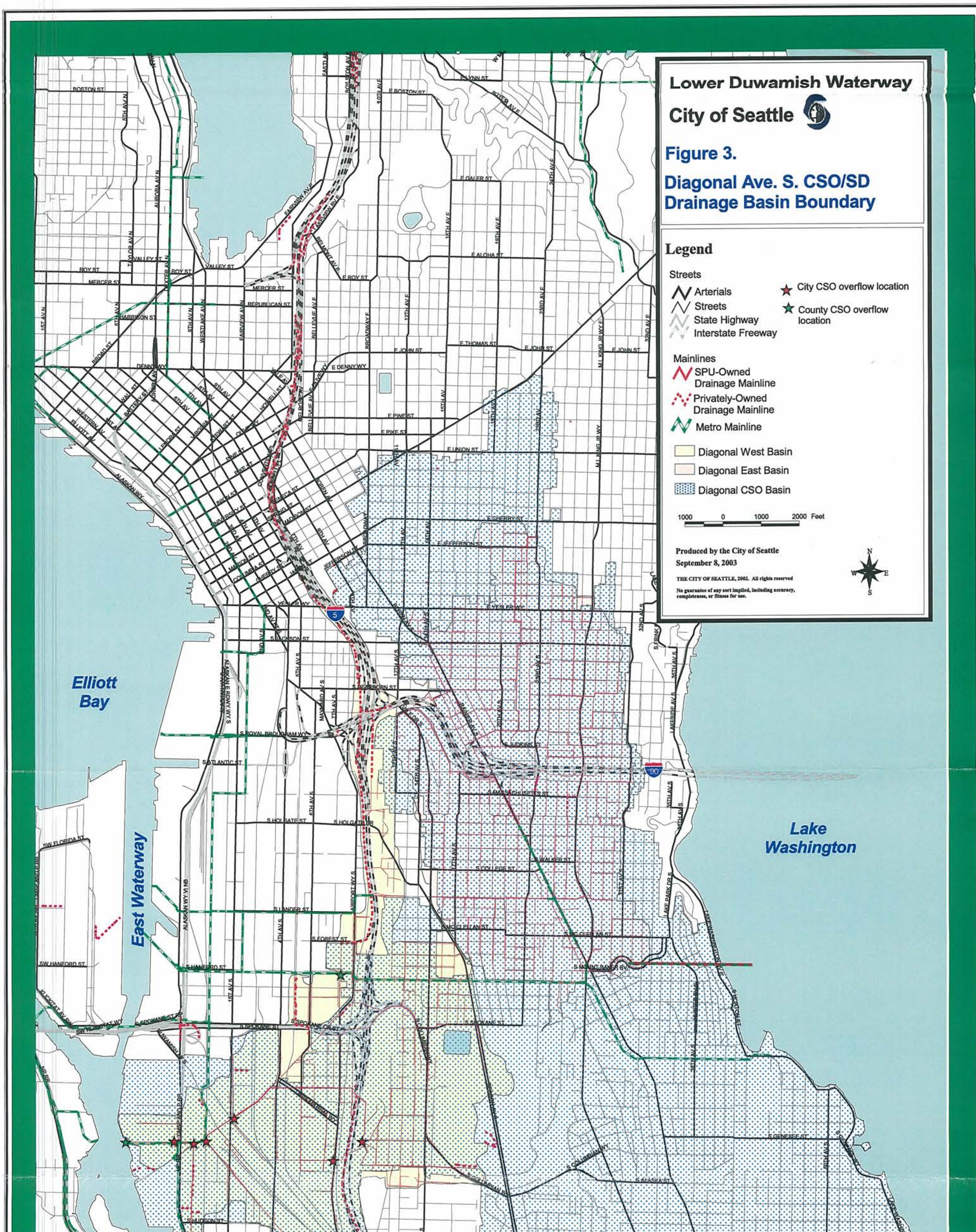
Puget Sound



Lower Duwamish Waterway
City of Seattle
Figure 3.
Diagonal Ave. S. CSO/SD Drainage Basin Boundary
Legend
Streets
Arterials
Streets
State Highway
Interstate Freeway
City CSO overflow location
County CSO overflow location
Mainlines
SPU-Owned Drainage Mainline
Privately-Owned Drainage Mainline
Metro Mainline
Diagonal West Basin
Diagonal East Basin
Diagonal CSO Basin
1000 0 1000 2000 Feet
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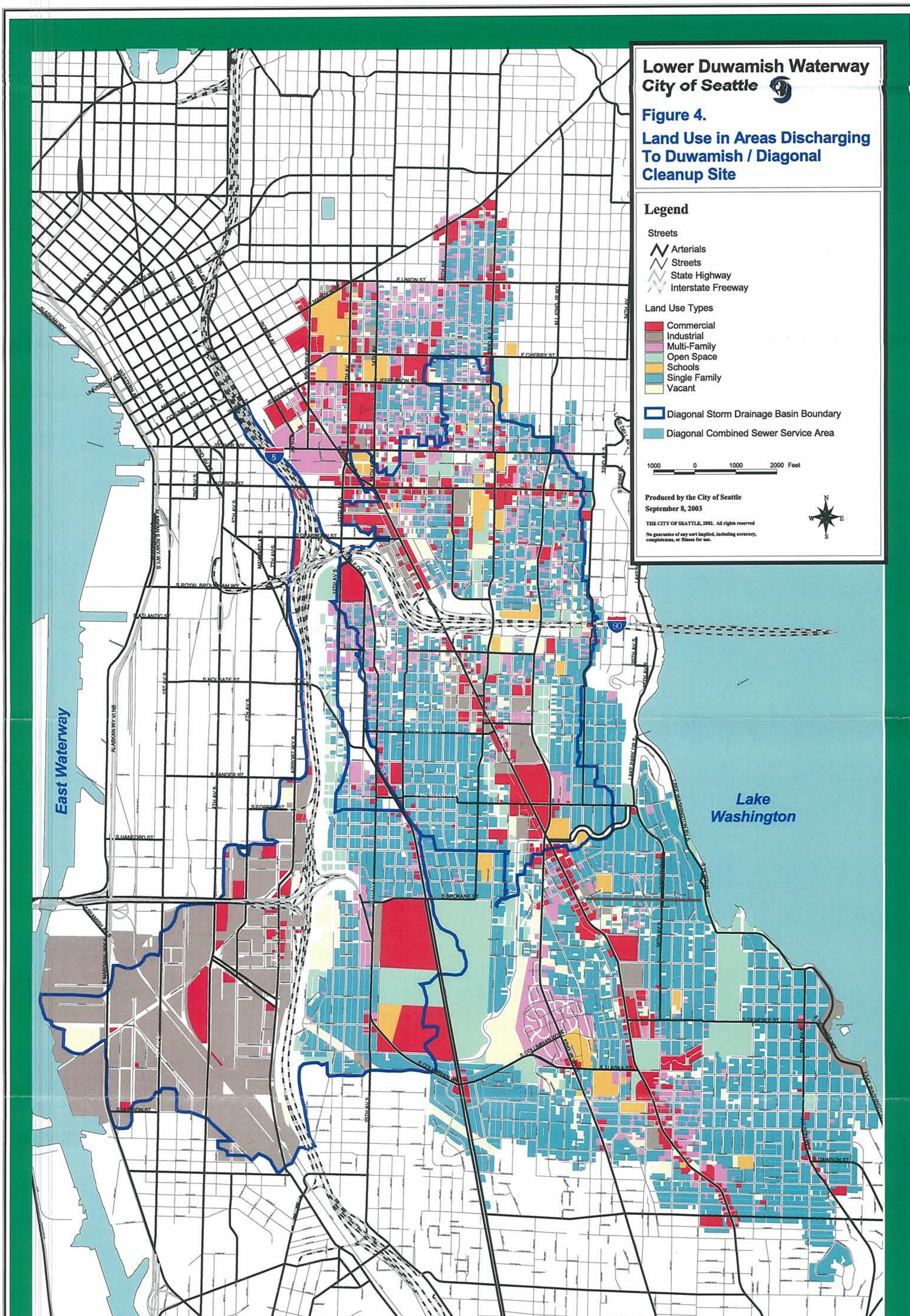
N
E
S
W
Elliott Bay
East Waterway
Lake Washington


Lower Duwamish Waterway
City of Seattle
Figure 4.
Land Use in Areas Discharging To Duwamish / Diagonal Cleanup Site
Legend
Streets
Arterials
Streets
State Highway
Interstate Freeway
Land Use Types
Commercial
Industrial
Multi-Family
Open Space
Schools
Single Family
Vacant
Diagonal Storm Drainage Basin Boundary
Diagonal Combined Sewer Service Area
1000 0 1000 2000 Feet
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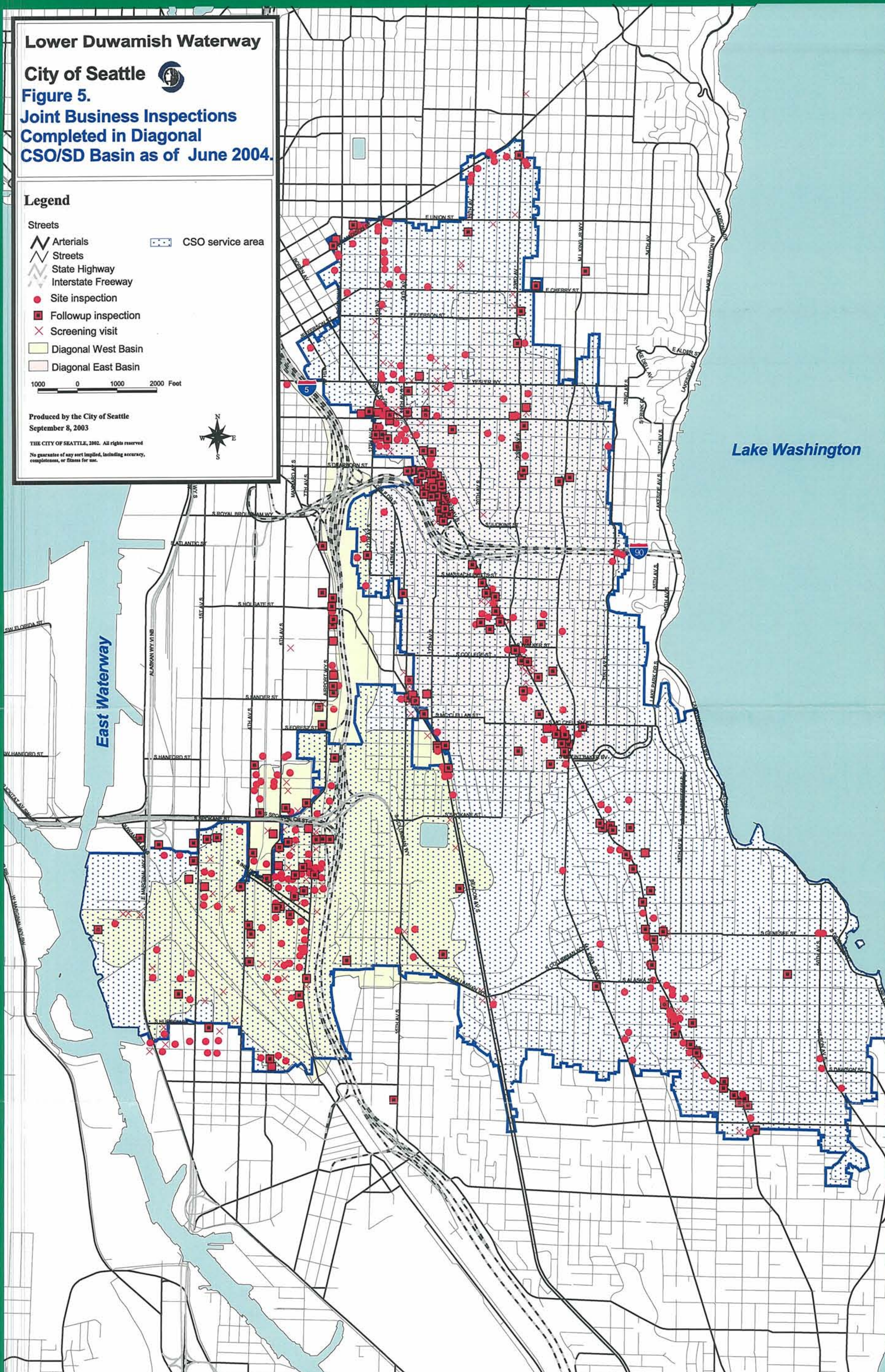
N
W
E
S
East Waterway
Lake Washington


Lower Duwamish Waterway
City of Seattle
Figure 5.
Joint Business Inspections Completed in Diagonal CSO/SD Basin as of June 2004.
Legend
Streets
Arterials
Streets
State Highway
Interstate Freeway
CSO service area
Site inspection
Followup inspection
Screening visit
Diagonal West Basin
Diagonal East Basin
1000 0 1000 2000 Feet
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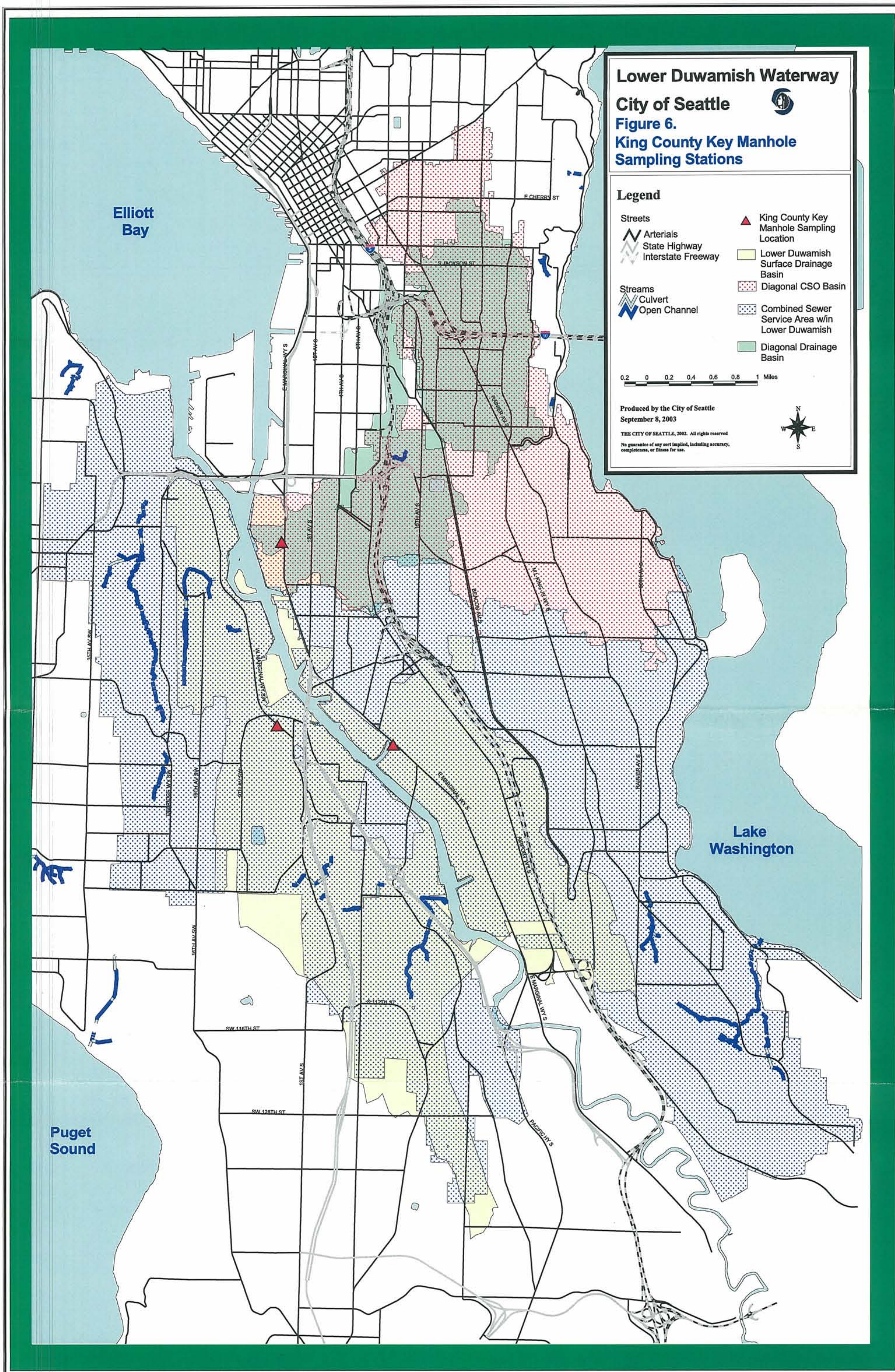
N
S
E
W
Lake Washington
East Waterway
E UNION ST
E CHERRY ST
S DEARBORN ST
S ATLANTIC ST
S HOLGATE ST
S LANDER ST
S FOREST ST
S HANFORD ST
S GENESEE ST
5
90



Lower Duwamish Waterway
City of Seattle
Figure 6.
King County Key Manhole Sampling Stations
Legend
Streets
Arterials
State Highway
Interstate Freeway
Streams
Culvert
Open Channel
King County Key Manhole Sampling Location
Lower Duwamish Surface Drainage Basin
Diagonal CSO Basin
Combined Sewer Service Area w/in Lower Duwamish
Diagonal Drainage Basin
0.2 0 0.2 0.4 0.6 0.8 1 Miles
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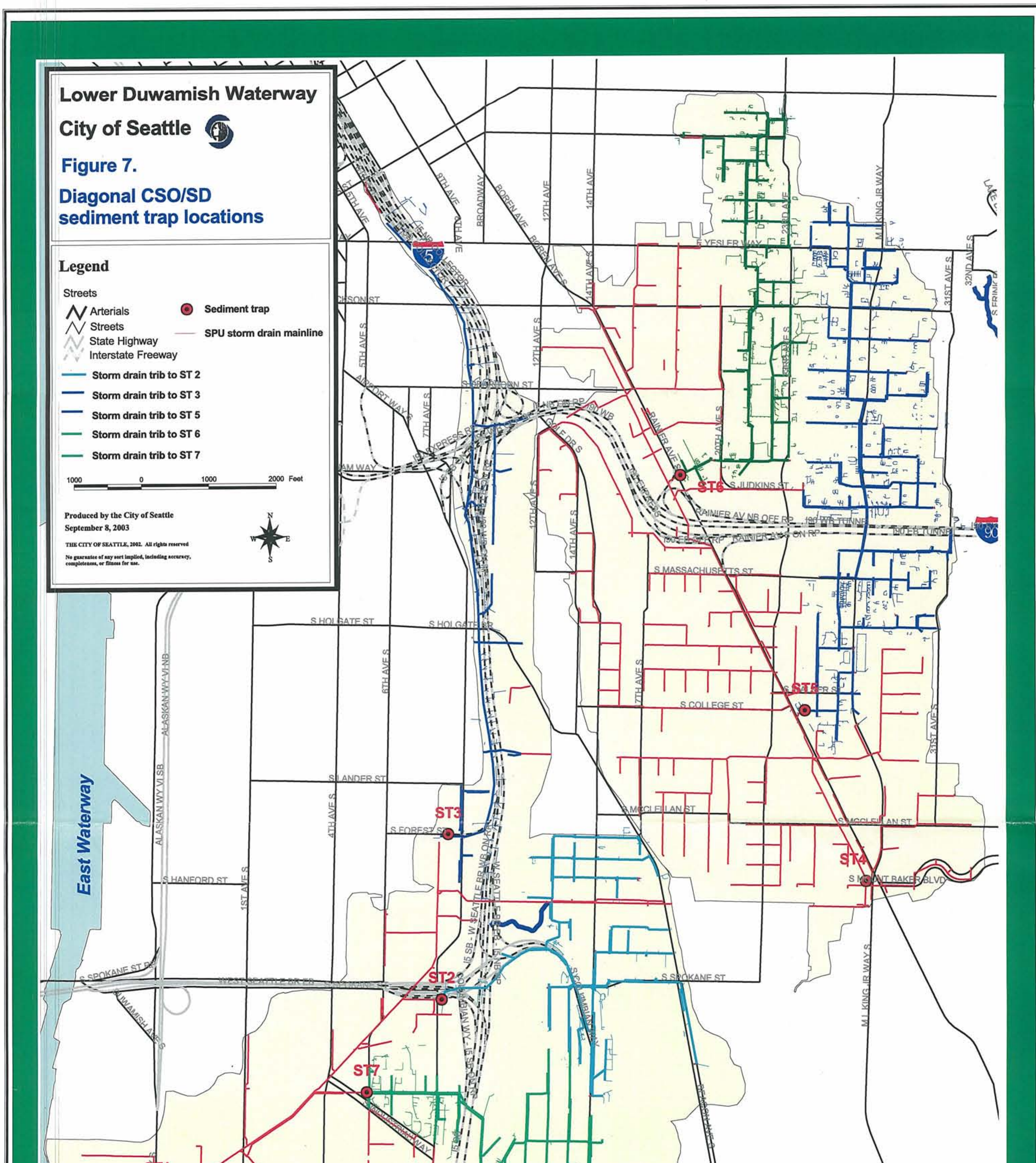
N
W
E
S
Elliott Bay
Lake Washington
Puget Sound
E CHERRY ST
SW 116TH ST
SW 128TH ST
1ST AV S
E MARGINAL WY S
PACIFIC HY S



Lower Duwamish Waterway
City of Seattle
Figure 7.
Diagonal CSO/SD sediment trap locations
Legend
Streets
Arterials
Streets
State Highway
Interstate Freeway
Sediment trap
SPU storm drain mainline
Storm drain trib to ST 2
Storm drain trib to ST 3
Storm drain trib to ST 5
Storm drain trib to ST 6
Storm drain trib to ST 7
1000
0
1000
2000 Feet
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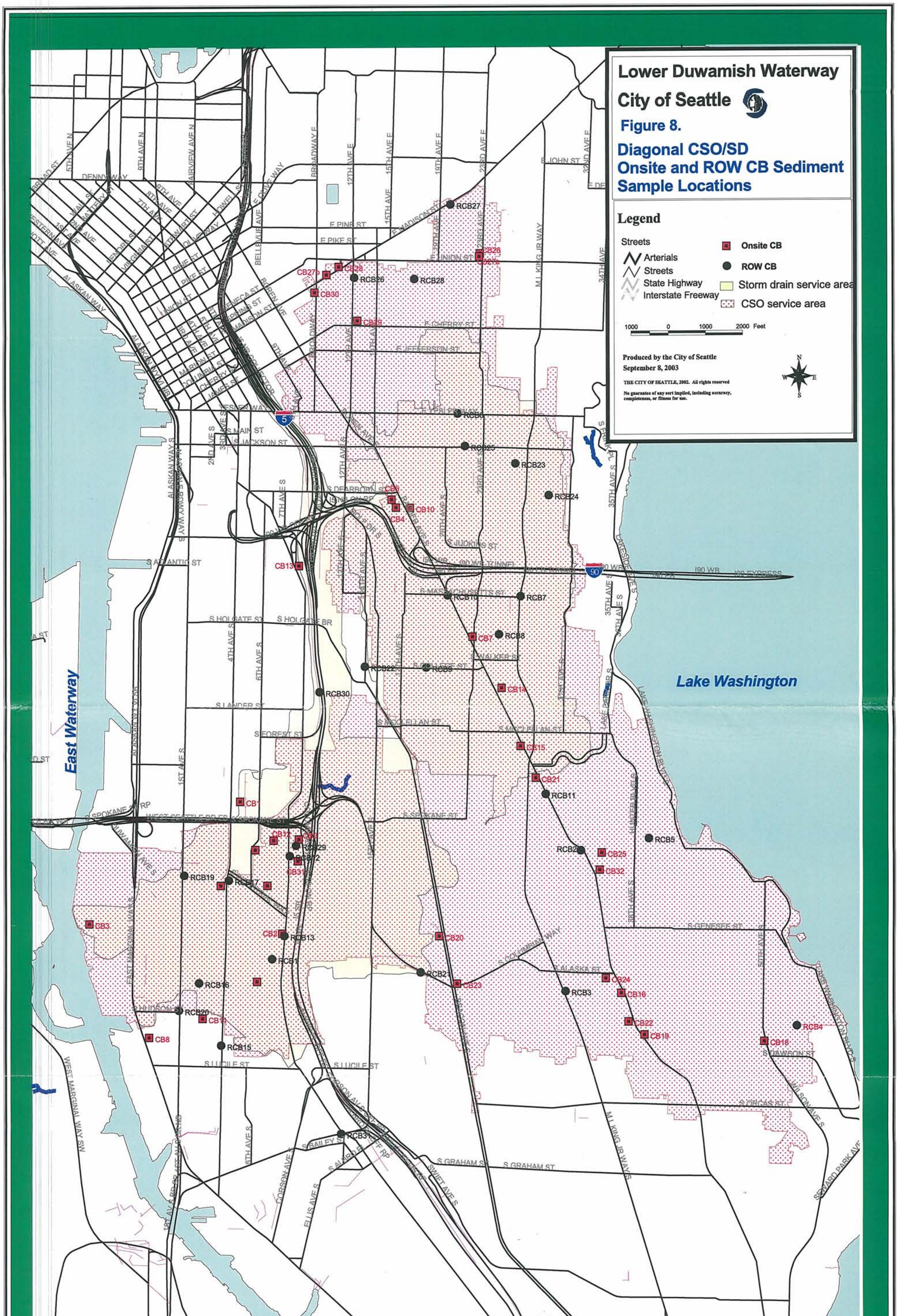
N
W
E
S
ST1
ST2
ST3
ST4
ST5
ST6
ST7
East Waterway
S HOLGATE ST
S LANDER ST
S FOREST ST
S HANFORD ST
S SPOKANE ST
S MASSACHUSETTS ST
S COLLEGE ST
S MCCLELLAN ST
S JUDKINS ST
S MOUNT BAKER BLVD
S COLUMBIAN WAY
S HUDSON ST
S LUCILE ST
S ALASKA
E YESLER WAY
BROADWAY
BOREN AVE
12TH AVE
14TH AVE
17TH AVE S
20TH AVE S
23RD AVE
31ST AVE S
32ND AVE S
M L KING JR WAY S
RAINIER AVE S
1ST AVE S
4TH AVE S
5TH AVE S
6TH AVE S
7TH AVE S
15TH AVE S
AIRPORT WAY S
ALASKAN WY VI SB
ALASKAN WY VI NB
EAST MARGINAL WAY S
WEST SEATTLE BR EB
I90 WB TUNNEL
I90 EB TUNNEL
RAINIER AVE S ON RP
RAINIER AV NB OFF RP



Lower Duwamish Waterway
City of Seattle
Figure 8.
Diagonal CSO/SD
Onsite and ROW CB Sediment
Sample Locations
Legend
Streets
Arterials
Streets
State Highway
Interstate Freeway
Onsite CB
ROW CB
Storm drain service area
CSO service area
1000 0 1000 2000 Feet
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Lake Washington
East Waterway