SITE INVESTIGATION REPORT
HAZARDOUS WASTE ASSESSMENT
STATE ROUTE 99 - FIRST AVENUE SOUTH BRIDGE PROJECT
SEATTLE, WASHINGTON

For

WASHINGTON DEPARTMENT OF TRANSPORTATION
JOB NO. 04342-075-163
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DAMES & MOORE

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EXECUTIVE SUMMARY

Dames & Moore conducted a site investigation to assess the potential for the presence of contaminants in soil, marine sediments, surface water and groundwater within the limits of the First Avenue South Bridge Project area in Seattle, Washington. The work was performed for Washington Department of Transportation (WSDOT). Subsurface soil, marine sediment, surface water and groundwater samples were collected at locations specified by WSDOT. The samples were analyzed to identify and evaluate the nature and extent of any contamination in the surface and subsurface environment at the project area, to determine the potential impact upon the design and construction of the proposed improvements, and to evaluate any remedial alternatives where exceedance of cleanup standards were found.

Analytical results were compared to the Washington Model Toxic Control Act (MTCA) Method A cleanup standards for nonindustrial and industrial soils (Chapter 173-340-740 and 745 WAC), Marine Sediment Quality Standards (MSQS) (Chapter 173-204-320 WAC), to MTCA Method A cleanup standards for groundwater (Chapter 173-340-720 WAC) and EPA Maximum Contaminant Level (MCL) standards for drinking water.

Based on the data, the following conditions were identified:

SOILS

TPH (oil range) in exceedance of the MTCA standard was detected in the near surface soil at monitoring wells MW-10 (530 mg/kg at 2.5 feet bgs), MW-11 (1,100 mg/kg at 2.5 feet bgs) and MW-14 (1,000 mg/kg at 2.5 feet bgs). The vertical extent appears to be less than 5 feet below ground surface (bgs) and may have been present in the imported soil when the area was filled for development. As such, the TPH may occur as isolated pockets at various locations throughout the area.

In boring MW-12, acetone (810 ug/kg) and methylene chloride (720 ug/kg) were detected in a soil sample collected from 15 feet bgs, which was the soil/water interface at the time of drilling. The methylene chloride concentration exceeds the MTCA standard. A standard for acetone has not been established. Neither of these analytes was detected in groundwater samples. The presence of acetone and methylene chloride is considered dubious and likely results as an analytical laboratory contaminant.

MARINE SEDIMENTS

Mercury (5.2 mg/kg) was detected in a marine sediment sample collected from five feet bgs in the tidal flat beneath the south abutment of the First Avenue South Bridge above MTCA and MSQS cleanup standards (1 mg/kg and 0.41 mg/kg, respectively). The detected concentration is within the documented background levels of mercury in sediments of Elliott Bay.

GROUNDWATER

Arsenic in groundwater collected from monitoring wells MW-2 and MW-7 through MW-11 exceed the MTCA standard. Lead collected from groundwater in monitoring wells MW-8, MW-9 and MW-17 through MW-19 also exceeds the MTCA standard for lead. Lead was detected in MW-3 at the MTCA cleanup standard of 5 ug/l.

Lead was found to range from 2 ug/l (MW-2) to 14 ug/l (MW-17). Arsenic concentrations ranged from 50 ug/l to 130 ug/l in MW-2, which are at or above the MCL for arsenic (50 ug/l).

Vinyl chloride was detected at MW-1 (July 1992) which is located within the former WSDOT landfill. Subsequent sampling events in September 1992 and April 1993 did not detect vinyl chloride.

PROJECT IMPACTS

WSDOT has indicated that dewatering of the utilidor access portals may be necessary during construction activities for the First Avenue South Bridge Project. The data indicate that arsenic, cadmium, copper, lead and zinc may be present in discharge water during the construction dewatering process, especially during initial pumping conditions. Because total lead exceeds the MTCA Method A standard for groundwater, the discharge water cannot be discharged directly to surface water without treatment to reduce total lead to levels acceptable to Washington Department of Ecology (Ecology). However, the water may be discharged to the Metropolitan of Seattle (Metro) sanitary sewer provided Metro's maximum allowable load limits are not exceeded. The condition of elevated lead concentrations may change under continuous pumping conditions, and treatment may not be necessary, allowing direct discharge to the Duwamish Waterway.

Preliminary chemical analytical data indicate loading by lead and copper will exceed the Metro threshold at 6 million gallons per day in the vicinity of MW-18 on the north side of the Duwamish Waterway. Given the lower concentrations of metals in groundwater at MW-12 and MW-19 on the south side of the Duwamish Waterway, the discharge threshold may be increased to 11 million gallons per day, providing the discharge is not concurrent with discharge from the north side of the waterway.

The construction contractor should be held responsible for obtaining a discharge authorization from Metro or a Short Term Modification of Water Quality Standards from Ecology for discharge to surface water. For both these discharge alternatives, daily measurements of dewatering volumes and water quality sampling will likely be required.

1.0 INTRODUCTION

Dames & Moore conducted a site investigation to assess the potential for the presence of contamination in soil, marine sediments, surface water and groundwater within the limits of the State Route 99 - First Avenue South Bridge Project area in Seattle, Washington (See Figure 1). The work was performed for Washington Department of Transportation (WSDOT) by Dames & Moore. This report presents the results of the investigation and summarizes our findings, conclusions and recommendations for the First Avenue South Bridge improvements.

The intent of this investigation was to assess the potential presence of any contamination that may be encountered during project construction. The boring locations were selected by WSDOT after reviewing results of previous work performed by WSDOT and other consultants.

Historical land use and its relationship to the potential of encountering soil and groundwater contamination were reviewed by Shannon and Wilson (1991). The review identified multiple land parcels within the project area which warranted investigation because of past industrial use. WSDOT District Number 1 specified the sampling locations for Dames and Moore to evaluate based upon knowledge of the construction project at the planning and preliminary design stages. Dames and Moore conducted the sampling program in accordance with the State of Washington Model Toxics Control Act (MTCA) cleanup regulations (Chapter 173-340 WAC).

1.1 PURPOSE

The purpose of the site investigation was to identify and evaluate the nature and extent of contamination in the surface and subsurface environment in the project area; determine the potential impact of any contamination upon the design and construction of the proposed improvements; and evaluate any remedial alternatives that may be required. Analytical results from each part of the site investigation were compared to the MTCA Method A cleanup standards for non-industrial and industrial soils. The analytical results for marine sediments were compared to the MTCA Method A cleanup standards for soil (Chapter 173-340-740/745 WAC) and the Marine Sediment Quality Standards (Chapter 173-204-320 WAC). The analytical results from surface water and groundwater sampling were compared to MTCA cleanup standards for groundwater (Chapter 173-340-720 WAC) and EPA Maximum Contaminant Level (MCL) standards for drinking water.

1.2 BACKGROUND

The First Avenue South Bridge site is a transportation corridor that connects First Avenue South and East Marginal Way South on the north side of the Duwamish Waterway with Highway 509 and State Route (SR) 99 to the south. The steel bridge has on- and off-ramps at the north and south ends and is heavily used by vehicular traffic. The bridge has a control tower that operates a lift-bridge system to accommodate commercial boats, barges and private boat passage under the bridge.

WSDOT is redesigning the First Avenue Bridge and its lane approaches to accommodate increased traffic load and to improve safety. As part of the preliminary planning process, Shannon and Wilson (1991) conducted a preliminary assessment for the potential presence of any contamination which may be encountered within the project area. Based on the Shannon and Wilson study and considerations for design information, WSDOT identified specific sampling locations for further assessment. Dames & Moore was contracted by WSDOT in

July 1992 to perform a site investigation for identifying the potential presence of contamination at the specified sampling locations. The investigation was performed during the period between July 1992 and July 1993 in several stages (Dames & Moore, 1993).

1.3 SCOPE OF SERVICES

The scope of services is based on Dames & Moore's contract agreement Y-5191, Task 1.0 - 1.2 with WSDOT, authorized July 9, 1992. Dames & Moore conducted a site assessment for the State Route 99 - First Avenue South Bridge Project. The scope of work performed in support of this project includes the following:

- Drilling and sampling of 18 soil borings;
- Installing, developing and sampling of 17 groundwater monitoring wells;
- Collecting three surface water samples from the wetland area south of West Marginal Way and west of First Avenue South;
- Excavating and sampling of five test pits;
- Drilling and sampling of two hand auger borings in the tidal flat at the south bridge abutment;
- Reviewing of Duwamish Waterway sediment analytical data provided by WSDOT;
- Reviewing data on background concentrations for arsenic and lead within the project area;
- Submitting soil and groundwater samples for laboratory analyses;
- Analyzing data obtained, including evaluation of impacts on proposed design and construction;
- Evaluating of remedial alternatives;
- Monitoring selected monitoring wells on a quarterly basis; and,
- Preparing this report.

The field investigation activities and assessment for the potential presence of contamination. Additional quarterly monitoring of groundwater was conducted in July and November 1993 and the results were summarized in the Dames & Moore *Final Quarterly Monitoring Report* (December 22, 1993).

1.4 LIMITATIONS

The interpretations and conclusions contained in this report are based on the information presented herein, the expertise and experience of Dames & Moore in conducting similar assessments, and current pertinent environmental regulations.

Dames & Moore's work is performed with care, exercising the customary thoroughness and competence of earth science, environmental, and engineering consulting professionals, in accordance with the standard for these professional services at the time and location these services are rendered. It is important to recognize that even the most comprehensive scope of services may fail to detect environmental liability on a particular site. Therefore, Dames & Moore cannot act as insurers and cannot "certify or underwrite" that a site is free of environmental contamination. No expressed or implied representation or warranty is included or intended in our reports except that our work was performed, within the limits prescribed by our client, with the customary thoroughness and competence of our profession.

2.0 HYDROGEOLOGICAL SETTING

2.1 REGIONAL SETTING

The site lies in the Puget Sound trough situated between the Cascade and Olympic Mountain Ranges to the east and west, respectively. Elevations of the site range from mean sea level (msl) to approximately 40 feet above msl. The Duwamish Waterway, which flows west and discharges into Puget Sound at Harbor Island in Seattle, bisects the subject area. The site has grassy areas at the south end of the bridge. A wetland area with a tributary to the Duwamish is situated south of West Marginal Way South between First and Second Avenues South. The project site is drained at the south end by a small creek which flows through the wetland area, is culverted beneath Second Avenue South, and discharges into the Duwamish Waterway. The ground surface at the project site has been modified by human activities, including placement of compacted hydraulic fills and other earthwork activity.

2.2 GEOLOGIC SETTING

The site lies within the Duwamish River Valley (Liesch, et al., 1963). This area has undergone extensive excavation, filling, and construction which has modified the original geology and topography. Hydraulic fill varies in thickness and locally is 50 feet or more in thickness. The site is underlain by fill and unconsolidated sand, silt, clay, gravel and till which overlie consolidated marine sediments. The unconsolidated deposits are reported to be more than over 250 feet in thickness. Based on boring and test pit data, fill material covers much of the project area.

2.3 SOIL LITHOLOGY

The boring and test pit logs from the site investigation indicate a fine-grained material consisting of a clayey silt to silty clay (CL) intermixed with fine, sandy silt (ML), and typically is present in the upper 15 feet of soil. Locally, fill material consisting of wood chips (hog fuel) was encountered in some of the test pits. A fine- to medium-grained silty sand to sandy silt (SM) and sand (SP) underlie the fine-grained soils. Detailed descriptions of the soils encountered are provided on the boring and trench logs presented in Appendices A and B, respectively.

2.4 GROUNDWATER OCCURRENCE

Regionally, groundwater in the unconsolidated deposits extends to approximately 300 feet below ground surface (bgs). Groundwater wells in the Duwamish River Valley obtain water from the valley alluvium or from aquifers in the older unconsolidated deposits beneath the alluvium. Reported water quality indicates moderate to high levels of chloride (83 to 990 ppm) (Liesch et al., 1963). One water well in the Duwamish Valley (T24N, R4E, Section 7) contained flammable gas and hydrogen sulfide.

Shallow groundwater was encountered in all installed monitoring wells at the site. The depth to groundwater was measured after the monitoring wells were developed and before they were purged for sampling. Static groundwater levels were measured from the top of the well casing using an electronic water level indicator. Static groundwater levels are in the range of approximately 2 to 12 feet bgs. Table 1 summarizes the water level measurements and elevations.

Based on measurements of groundwater levels, shallow groundwater flow is apparently toward the Duwamish Waterway. Figure 3 presents the groundwater contour map based on measurements of groundwater levels in selected monitoring wells during April 1993. The saturated thickness of the aquifer in the study area was not determined.

3.0 FIELD INVESTIGATION

Field work consisted of drilling, logging and sampling 18 soil borings of which 17 were converted to monitoring wells; excavating five test pits; hand-auguring two shallow soil borings in tidal flat sediments; and collecting three surface water samples from the wetland area south of West Marginal Way South and west of First Avenue South. Locations of the soil borings and monitoring wells are shown in Figure 2; test pit, tidal flat and surface water sample locations are shown in Figure 4. Figures 5, 6 and 7 identifies the test pits, tidal flat samples, and surface water sample locations, respectively.

In July 1992, 15 soil borings were drilled, of which 14 were subsequently developed as monitoring wells. Seven monitoring wells were resampled in September 1992 to confirm analytical results from the July 1992 sampling. In April 1993, the seven monitoring wells were resampled to evaluate any periodic changes in the groundwater. Three new soil borings were drilled, logged, sampled (soil), and then converted to monitoring wells and sampled (groundwater). Soil samples were collected from the tidal flat along the south bank of the Duwamish Waterway at the First Avenue South bridge. Five test pits were excavated and soil sampled in the vicinity of monitoring well MW-14. Surface water samples were collected from the wetland area south of West Marginal Way South and west of First Avenue South. Details of these field activities and the field protocol are described in Sections 3.1 through 3.3.

3.1 SOIL SAMPLING

3.1.1 Soil Borings and Monitoring Well Installation

Eighteen soil borings were drilled, of which 17 were completed as groundwater monitoring wells (MW-1 through MW-3, and MW-6 through MW-19) at the approximate locations indicated in Figure 2. As planned, boring B-4 was not converted to a monitoring well; it was backfilled with bentonite chips to the ground surface. Boring B-5 was not drilled, as it was found to be located within a wetland area.

Drilling was performed by Hokkaido Drilling Company, Graham, Washington (July 1992) and GeoBoring and Development Company, Incorporated, Puyallup, Washington (April 1993). A Dames & Moore geologist observed the drilling, maintained geologic logs, collected soil samples and field-screened each sample for organic vapors using a photoionization detector (PID). Drilling was accomplished with a hollow stem auger drilling rig using nine-inch outside diameter augers. Boreholes were drilled to depths between 14 to 25 feet bgs. Soil boring logs are presented in Appendix A.

Soil samples were collected as relatively undisturbed samples using a split-spoon sampler lined with stainless steel sample rings. The split-spoon sampler was advanced by a 300-pound hammer dropped 30 inches. Soil samples were collected at approximately two and one-half foot intervals to the groundwater interface, below which samples were collected at five-foot intervals. Sampling sleeves with soil samples were capped with teflon tape and plastic caps. The end caps were sealed using duct tape.

All samples were labeled according to job number, client, date and time of collection, sample number and sampler's initials. Samples were shipped under chain of custody and also stored in a cooler containing ice until their delivery to the analytical laboratory. Copies of the chain-of-custody accompany the analytical results presented in Appendix C.

Monitoring wells were constructed within the borehole with two-inch diameter, flush-threaded, 0.020-inch slotted, schedule 40 PVC well screen, and two-inch diameter, flush-threaded, schedule 40 PVC blank riser pipe. Monitoring wells generally were completed with 5 to 15 feet of well screen. Silica sand pack (8/12 and 10/20 Colorado silica sand) was placed at the screen interval to three feet above the screen, except in MW-19. Silica sand was placed 1.5 feet above the screen in MW-19 because of the shallow condition of the well. The annulus above the sand pack was completed with hydrated bentonite chips. The monitoring wells were completed with a surface seal of concrete and a flush-mounted, watertight, cast iron well cover or above-ground monument. Monitoring well completion diagrams are provided on the boring logs in Appendix A. The top of casing elevation at each well was surveyed by WSDOT and is presented in Table 1.

Drilling augers were cleaned with a high-pressure steam cleaner before the start of drilling and between each borehole. Soil sampling equipment was washed with a water and Alconox solution, then rinsed with distilled water followed by a rinse with ethanol, and triple rinsed with distilled water between samples.

3.1.2 Test Pits

A total of five test pits (TP-1 through TP-5) were excavated in the vicinity of monitoring well MW-14 to delineate the extent of TPH in soil. Test pit locations are shown in Figures 4 and 5. Soil samples were collected between two and five feet bgs as indicated in the test pit logs (Appendix B). Soil was excavated with a backhoe and samples were collected from the backhoe bucket using a decontaminated stainless steel spoon. Soil was temporarily stockpiled at the site in a secured manner. One soil sample was collected from each of the three stockpiles (SP-1-E, SP-2-S, SP-3-W). Stockpiled soils were approximately disposed after analytical testing was accomplished. The samples were placed into laboratory-provided containers, sealed, labeled as described in Section 3.1.1 and placed in an ice-cooled chest for transport to the analytical laboratory. Chain-of-custody was maintained to the analytical laboratory. The decontamination procedure for the sampling equipment was the same as that described in section 3.1.1.

3.1.3 Sediment Sampling

Sediment samples (TF-1-1, TF-1-5, TF-2-1, and TF-2-5) were collected from tidal flat sediments occurring along the south bank of the Duwamish Waterway west of the First Avenue Bridge (Figures 4 and 6). The samples were obtained from approximately one and five feet bgs using a hand auger. Sediments were retrieved from the hand auger with a stainless steel spoon and placed into laboratory provided containers. The sample containers were labeled, sealed and stored, and transported under chain-of-custody, as described in Section 3.1.2. The sampling equipment was decontaminated as described in Section 3.1.1.

3.2 GROUNDWATER SAMPLING

July and September 1992

Groundwater samples were collected from MW-1 through MW-3 and MW-6 through MW-16 in July 1992 and in September 1992 from MW-1, MW-2, and MW-7 through MW-12. Prior to sampling, the wells were purged until three to five well-volumes of water were removed and pH, specific conductivity, and temperature measurements were consistent. Monitoring wells were purged by hand with dedicated bailers in July 1992 and pumped using a centrifugal pump in September 1992. Pump hoses were replaced with dedicated PVC tubing at each well. Groundwater samples were collected with a dedicated disposable teflon bailer and transferred into containers provided by the laboratory. Samples to be analyzed for dissolved metals were filtered in the field using an in-line 45-micron filter during the July 1992 sampling event. During the September 1992 sampling event, filtration of the samples was conducted at the analytical laboratory.

April 1993

Groundwater samples were collected from MW-1, MW-2, MW-7 through MW-12, and MW-17 through MW-19 during the April 1993 sampling event. Before sampling, each well was purged using a centrifugal pump until five well volumes of water were removed and pH, specific conductivity and temperature readings were stable. Groundwater samples were collected with a disposable teflon bailer and transferred into containers provided by the laboratory. Analysis of samples for metals was preceded by filtration at the analytical laboratory.

3.3 SURFACE WATER SAMPLING

Surface water samples (WA2-1, WA2-2, and WA2-3) were collected at three locations in the wetland area located south of West Marginal Way between SR-99 and Second Avenue South (Figures 4 and 7). Prior to collecting samples, the sampling tool was decontaminated following the procedure described in Section 3.1.1. Samples were collected using a polyethylene dipper to retrieve samples that were then transferred into jars provided by the analytical laboratory. Samples were labeled, stored and a chain-of-custody form completed as described in Section 3.1.2. The samples were then transported to the analytical laboratory.

3.4 LIMITED HISTORICAL REVIEW/WETLAND INVESTIGATION

Dames & Moore conducted a limited search of literature and inspection of aerial photographs to determine if lead and arsenic are naturally occurring in the soil at the site. This was done because of measured lead and arsenic concentrations in soil and groundwater identified in the site investigation.

- presence of buried river channels that may be potential pathways for groundwater migration and contaminant transport; and,

- occurrence of background levels of arsenic and lead in soil and groundwater in the Duwamish Waterway area.

Dames & Moore reviewed and interpreted selected historical aerial photographs for information regarding land use in the vicinity of the wetland south of West Marginal Way. Aerial photographs of the site vicinity from

Suzzalo Library at the University of Washington were reviewed for the years 1944, 1961, 1965, and 1970. A summary of the aerial photograph review is provided below.

1944 Photograph

Development of property along the Duwamish Waterway appears more extensive downstream of the bridge to the northwest than upstream along the Duwamish to the southeast. The wetland area appears vegetated without a visible stream channel. The area of MW-3 and MW-9 is developed.

1961 Photograph

The wetland region was visible at the south end of the First Avenue Bridge. The wetland area was traversed by a meandering channel which extends from southeast to northwest, and most likely discharged into the Duwamish Waterway. The stream channel flowed northwest toward West Marginal Way; however, any discharge point into the Duwamish north of West Marginal Way is not visible.

1965 Photograph

The southern bank of the Duwamish Waterway directly below and to the east of the bridge appears to have been filled and graded (Alaska Marine Lines site). The area directly west of the bridge at the south end appears to have been vegetated. The wetland region also appears to have been vegetated, with more vegetation visible than in the 1961 photograph. A distinct stream channel in the wetland area is not evident.

1970 Photograph

There were buildings situated on the identified fill area below the south end of the bridge. The meandering channel through the wetland region is clearly visible; however, the stream abuts against Second Avenue South where its course is not visible.

Background Levels of Metals

The occurrence of widespread contamination in the vicinity of bays and rivers surrounding Elliott Bay has been documented in several reports (PTI Environmental Services and Tetra Tech, 1988). Discharges from industrial and municipal wastewater, stormwater, sewer overflows, and uncontrolled spills have introduced toxic chemicals into the surface water and sediments in the Duwamish Waterway. The Elliott Bay Toxics Action Program was initiated as a result of EPA and Ecology published findings identifying concentration of toxic chemicals in sediments in the vicinity of the Duwamish River. Concentrations of various metals in surface sediments of Elliott Bay, Duwamish River, and Port Susan along Puget Sound ranged as follows: arsenic from 2.37 to 584 mg/kg; lead from 7.2 to 71,100 mg/kg; and, mercury from 0.012 to 28.8 mg/kg. The elevated concentrations of arsenic and lead in groundwater, and of mercury in tidal flat sediments may be attributable to long term presence of industrial and municipal contaminants and/or to other sources.

Soils in the Puget Sound area have background concentration levels of arsenic at less than 15 mg/kg, as reported by the National Oceanic and Atmospheric Administration, or less than 100 mg/kg as reported in another source (Dexter, et al. 1981). One soil sample collected at the site, MW-10 (2.5 feet bgs) had a concentration of arsenic

(24 mg/kg) elevated above the reported background soil concentration (15 mg/kg). Background lead concentrations in soils in the Puget Sound area are reportedly 15 mg/kg (Dexter et al., 1981). Several soil samples had reported concentrations of lead greater than the reported background level.

4.0 LABORATORY ANALYTICAL PROGRAM

Soil, sediment, surface water and groundwater samples were analyzed by Alden Analytical Incorporated located in Seattle, Washington. Analytical results are discussed in Section 5.0. Laboratory analytical data and chain-of-custody forms are presented in Appendix C. A summary of the analyses conducted for the analytical program is provided in Table 2. The results of analyses are summarized in Tables 3 through 11.

4.1 SOIL

In July 1992, soil samples obtained from monitoring wells MW-1 through MW-3, MW-6 through MW-16, and borehole B-4 were analyzed for presence of TPH using Washington analytical method WTPH Hydrocarbon Identification (HCID). WTPH-HCID is a qualitative analytical method designed by Ecology to identify hydrocarbon contamination in soil when the contamination at a site is unknown or when multiple types of fuels are suspected. Where petroleum hydrocarbons are identified, the samples are then quantitatively analyzed using the appropriate Washington analytical methods (WTPH-D for diesel and WTPH-418.1 for oil). Soil samples from MW-10, MW-11, MW-14, and MW-15 were analyzed by WTPH-D and WTPH-418.1.

Samples from MW-1, MW-2, MW-8, and MW-12 were sampled and analyzed for volatile organic compounds (VOCs) using EPA Method 8240 and the soil samples from MW-8 were analyzed for polychlorinated biphenyls (PCBs) using EPA Method 8080. Soil collected from MW-1 through MW-4 and MW-6 through MW-16 were analyzed for presence of priority pollutant metals.

Soil samples collected during April 1993 from MW-17, MW-18, and MW-19 were analyzed for presence of TPH, VOCs, and priority pollutant metals. During the same sampling period soil samples were collected from five test pits (TP-1 through TP-5) excavated in the vicinity of MW-14 and analyzed for TPH as oil (WTPH-418.1). Samples were also collected from the excavated soil stockpiles (SP-1-E, SP-2-S, and SP-3-W) and were analyzed for TPH-418.1, VOCs and priority pollutant metals.

4.2 SEDIMENT

4.2.1 Tidal Flats

During the April 1993 sampling event, four sediment samples were collected from the tidal flat region along the south bank of the Duwamish Waterway at the First Avenue South bridge. Sediment (tidal flat) samples were analyzed for presence of WTPH-HCID, VOCs, and priority pollutant metals.

4.2.2 Duwamish River Sediments

Dames & Moore reviewed the laboratory reports provided by WSDOT of ten samples collected from sediments along the Duwamish River at the First Avenue South Bridge. The analytical tests were performed by Sound Analytical Service, Inc (Appendix D) and the samples were tested for:

- Toxicity Characteristic Leaching Procedure (TCLP) for volatile and semi-volatile organic compounds (EPA Method 1311)
- TCLP for metals (EPA Method 6010)
- Volatile organic compounds (EPA Method 8240)
- Semi-volatile organic compounds (EPA Method 8220)
- Total Petroleum Hydrocarbon identification using Washington method WTPH-HCID
- PCB (EPA Method 8080)
- Total metals

4.3 GROUNDWATER

Groundwater samples collected during July 1992 from MW-1, MW-2, MW-3, and MW-6 through MW-16 were analyzed for TPH (EPA Method 8015 Modified) and priority pollutant metals. Groundwater samples from five monitoring wells (MW-1, MW-2, MW-3, MW-8, and MW-12) were also analyzed for VOCs (EPA Method 624). One groundwater sample (MW-8) was analyzed for PCBs.

In September 1992, groundwater samples collected from MW-1 and MW-12 were analyzed for VOCs. MW-2 and MW-7 through MW-11 were analyzed for dissolved lead and arsenic. In April 1993, groundwater samples collected from MW-1, MW-12, and MW-17 through MW-19 were analyzed for VOCs (EPA 624). Samples collected from MW-2 and MW-7 through MW-11 were analyzed for dissolved arsenic and lead. In addition, groundwater samples collected from MW-17 through MW-19 were analyzed for TPH (EPA Method 8015 Modified) and priority pollutant metals.

4.4 SURFACE WATER

Surface water samples collected in April 1993 were analyzed for TPH (EPA Method 8015 Modified), VOC (EPA 624), and priority pollutant metals.

5.0 FINDINGS

The summary of findings discussed below is based on the field observations, laboratory results, and the results of the limited historical aerial photograph review and the literature search for evaluating background levels of metals in soil and groundwater in the Duwamish Waterway area. The analytical results were compared to the Washington Model Toxic Control Act (MTCA) Method A cleanup standards for soil (Chapter 173-340-740 WAC) and for groundwater (Chapter 173-340-720 WAC). In addition, the results were compared to the Marine Sediment Quality Standards (Chapter 173-204-320 WAC) and to EPA Maximum Contaminant Level (MCL) standards for drinking water (USEPA, 1993) and Washington State Water Quality Standards (Chapter 173-201-047).

The analytical results and soil and water standards are presented in Tables 3 through 11. The concentrations that exceed the standards are shown in bold on the tables. Laboratory analytical data are presented in Appendices C and D.

5.1 SOIL ANALYTICAL DATA

The soil samples were analyzed for TPH, VOCs, PCB, and priority pollutant metals as discussed in Section 4.0. Tables 3 through 6 indicate that these contaminants were primarily either not detected or were below MTCA Method A standards for non-industrial and industrial soils, except as indicated below:

OK • Heavy oil hydrocarbons were detected in soil 2.5 feet below ground surface (bgs) at monitoring well locations MW-10 (530 mg/kg), MW-11 (1,100 mg/kg) and MW-14 (1,000 mg/kg). The MTCA Method A standard for heavy oil in soil is 200 mg/kg. Five test pits were excavated in the vicinity of MW-14 to delineate the heavy oil extent in soil. However, the extent of heavy oil was not delineated in the vicinity of MW-10 and MW-11. ↳ now 2,000 ppm TPH, so OK

OK • Diesel range petroleum hydrocarbons were detected in soil at 2.5 feet bgs in MW-10 (73 mg/kg) and MW-11 (110 mg/kg), and in MW-15 (26 mg/kg). Diesel was also detected at 5 feet bgs in MW-11 (28 mg/kg). The MTCA Method A standard for residential and industrial sites for diesel in soil is 200 mg/kg. The presence of diesel in soil is below the MTCA Method A standard.

OK • Soils from five test pits in the vicinity of MW-14 were stockpiled and sampled at three locations (SP-1-E, SP-2-S, and SP-3-W). Heavy oil hydrocarbons were detected in the stockpile samples at levels ranging between 150 mg/kg to 510 mg/kg. ↳ still under 2,000 ppm TPH

OK • The presence of volatile organic compounds (VOCs) was assessed using EPA method 8240. VOCs were not detected in soil, except for acetone (810 ug/kg) and methylene chloride (720 ug/kg) in samples at 15 feet bgs in monitoring well MW-12, as indicated in Table 2. The MTCA Method A standard for methylene chloride is 500 ug/kg. A MTCA standard for acetone has not been established. ↳ located N. of Duwamish

5.2 DUWAMISH WATERWAY SEDIMENTS ANALYTICAL DATA

TPH and VOCs in sediments were either non-detectable or well below MTCA Method A soil cleanup standards as presented on Table 7 and 8. Marine Quality Sediment Standards for Chemical Criteria developed by Ecology and presented on Tables 7 and 8 do not provide TPH and VOCs standards except for semi-volatile compounds. Priority pollutant metals detected were below the standards, except for mercury (5.2 mg/kg) in tidal flat sample TF-2 at five feet bgs. The MTCA standard for mercury is 1 mg/kg and MSQS for mercury is 0.41 mg/kg. Background concentrations of mercury in sediments of Elliott Bay, including the Duwamish Waterway, ranges between 0.012 to 28.8 mg/kg (PTI et al., 1988). The detected concentrations of mercury are considered to be within the lower range of background concentrations.

5.3 GROUNDWATER ANALYTICAL DATA

Arsenic was detected above MTCA Method A cleanup standard in groundwater sample from monitoring wells MW-2, and MW-7 through MW-11 at concentrations ranging between 3 ug/l (MW-7) and 130 ug/l (MW-2). Reported concentrations for metals in groundwater are generally dissolved concentrations, except where indicated on Table 10. The highest arsenic concentrations were detected in MW-2 (50 ug/l in July 1992; 130 ug/l in September 1992; 62 ug/l in April 1993) located in the former WSDOT landfill. Arsenic concentrations in the other monitoring well samples were less than 20 ug/l. The MTCA Cleanup standard for arsenic in groundwater is 5 ug/l. The Maximum Contaminant Level (MCL) for arsenic in drinking water is 50 ug/l.

Lead was detected at or above MTCA Method A cleanup standard in groundwater samples from monitoring wells MW-3 and MW-9, and MW-17 through MW-19 at concentrations ranging between 5 ug/l and 14 ug/l. The highest concentrations of lead were detected in MW-17 (14 ug/l), MW-18 (10 ug/l) and MW-19 (13 ug/l). The MTCA Cleanup standard for lead in groundwater is 5 ug/l. The Maximum Contaminant Level (MCL) for lead in drinking water is 15 ug/l.

Groundwater collected from monitoring wells MW-1 through MW-3, MW-8 and MW-12 in July 1992 and from MW-17 through MW-19, which were installed in April 1993, was analyzed for volatile organic compounds (VOCs). Vinyl chloride was detected in groundwater at MW-1 (2.7 ug/l) within the former WSDOT landfill in July 1992. However, it was not detected in any of the subsequent groundwater samples collected in September 1992 and April 1993. MTCA Method A standard for vinyl chloride in groundwater is 0.2 ug/l. No other VOCs were detected in groundwater collected from measured monitoring wells.

Total petroleum hydrocarbons (TPH) identified as diesel/oil were detected in groundwater of all monitoring wells except MW-1 and MW-19. Detectable concentrations ranged from 0.14 mg/l (MW-7) to 1.1 mg/l (MW-8) however most concentrations ranged between 0.14 mg/l and 0.58 mg/l. MTCA Method A standard for diesel or oil in groundwater is 1 mg/l.

Dames & Moore also assessed the groundwater quality at the utilidor crossing (Figure 2). Monitoring wells within the utilidor area included MW-12, MW-18, and MW-19. Proposed construction activities at the utilidor crossing includes the discharge of water generated by proposed dewatering activities. The findings were as follows:

- TPH was detected in groundwater samples collected from monitoring wells MW-12 (0.35 mg/l) and MW-18 (0.28 mg/l) as indicated in Table 9. TPH was not detected in groundwater at MW-19. The MTCA Method A standard for TPH in groundwater is 1 mg/l.

- VOCs were not detected in groundwater as indicated in Table 9.

- Total zinc was detected in monitoring well MW-18 (39 ug/l) and MW-19 (23 ug/l) in April 1993. Dissolved zinc was detected in MW-18 (34 ug/l) in April 1993 and in MW-12 (20 ug/l) in July 1992. There is no MTCA standard for zinc. The secondary MCL for zinc in groundwater is 5,000 ug/l. Secondary MCLs are primarily provided to establish taste and appearance standards for drinking water quality.

- Total arsenic was detected in groundwater from MW-18 (3 ug/l) and MW-19 (2 ug/l). Dissolved arsenic was not detected in these monitoring wells. MTCA Method A standard for arsenic in groundwater is 5 ug/l. The MCL for arsenic is 50 ug/l.

- Total lead was detected in MW-18 (10 ug/l) and MW-19 (13 ug/l). Dissolved lead was not detected. MTCA Method A standard for lead in groundwater is 5 ug/l. The MCL for lead is 15 ug/l.

- Total and dissolved cadmium were detected at a concentration of 0.5 ug/l in groundwater from MW-18. Total cadmium was also detected in MW-19 (0.4 ug/l). MTCA Method A and MCL standard for cadmium in groundwater is 5 ug/l.

- Total copper was detected in groundwater in MW-18 (25 ug/l). There is no MTCA standard for copper in groundwater. The MCL for copper is 1300 ug/l.

5.4 SURFACE WATER ANALYTICAL DATA

As indicated in Table 11, TPH, VOCs and priority pollutant metals were detected below MTCA Method A cleanup standards for groundwater and MCLs for all surface water samples.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The following is a summary of the conclusions and recommendations for the study site, and are based on the field data, analytical results, engineering analyses, and findings of this investigation.

6.1 SOILS

TPH above MTCA cleanup standards for non-industrial and industrial soils were detected in near surface soils in the vicinity of MW-10, MW-11 and MW-14 at concentrations in the range of 530 to 1,100 mg/kg. Dames & Moore further assessed the extent of TPH in the vicinity of MW-14. TPH at MW-14 was found to have a limited aerial extent as discussed in Section 5.1, and appears to be confined in the upper five feet of soil over an area of approximately 4,900 square feet. The presence of TPH concentrations appears to be sparse occurrences in the near surface levels (0-2.5 ft. bgs) of the site. The limited occurrences of detected concentrations indicates the presence of TPH is apparently limited to the incidental presence of TPH, rather than to continuous occurrences.

An assessment of the extent in the vicinity of MW-10 and MW-11 requires off-site exploratory trenches and disruption of activities on the off-site property (Alaska Marine Lines). TPH-affected soil (oil range hydrocarbons) in the vicinity of MW-10 and MW-11 appears to occur in surficial soils (2.5 feet bgs) at levels ranging from 530 to 1100 mg/kg. TPH in soils was non-detectable below 7.5 feet in the area.

6.2 GROUNDWATER

The concentration of vinyl chloride reported in the groundwater sample from MW-1 (2.7 ug/l) within the former WSDOT landfill in July 1992 is greater than the MTCA Method A standard for vinyl chloride (0.2 ug/l). Vinyl

chloride was not detected in groundwater at MW-2 which also lies within the landfill. Vinyl chloride was not detected in groundwater at MW-1 in subsequent sampling events in September 1992 and April 1993. Based on the analytical results, it appears that the reported vinyl chloride concentration in the sample was an anomaly that may be related to laboratory contamination.

The MTCA Method A standard for arsenic and lead in groundwater is 5.0 ug/l. Arsenic in groundwater in monitoring wells MW-2 and MW-7 through MW-11, and MW-17 exceed the MTCA standard. Detectable arsenic concentrations ranged between 3 ug/l and 130 ug/l. Lead in groundwater in monitoring wells MW-9 and MW-17 through MW-19 exceed the MTCA standard. Lead in MW-3 was detected at the MTCA standard. Detectable lead was found to range between 2 ug/l and 14 ug/l. An association between arsenic and lead in soil and groundwater could not be made.

Metals (arsenic, cadmium, copper, lead, and zinc) were detected in groundwater samples collected from the monitoring wells in the vicinity of the proposed new utilidor access portals (MW-12, MW-18, and MW-19) as indicated in Table 10. Lead in MW-18 (10 ug/l) and MW-19 (13 ug/l) exceeded the MTCA Method A standard (5 ug/l). The data indicates that these metals may be present in discharge water during the construction dewatering process. Because total lead exceeds the MTCA Method A standard for groundwater, the discharge water cannot be discharged to surface water without pretreatment to reduce lead to levels acceptable to Ecology. However, the water may be discharged to the Metro sanitary sewer provided Metro's maximum allowable load limits are not exceeded, as outlined below.

Based on previous agreements between Metro and WSDOT and the concentrations of total metals detected in groundwater samples from monitoring wells MW-12, MW-18 and MW-19, Dames & Moore has estimated the maximum quantity of water which could be discharged to Metro's sanitary sewer system assuming the discharge water quality is the same as that measured for this study. Table 12 lists Metro's discharge standard of maximum concentrations, and maximum daily discharge in pounds for various metals. Table 12 also shows the average metals concentration detected in groundwater by well location, and the calculated maximum volume of water that can be discharged to the sanitary sewer before the daily maximum discharge rate is exceeded. Based on the average concentrations detected in groundwater at the monitoring wells, the maximum daily volume of discharge is calculated to be six million gallons per day (MGD).

6.3 SEDIMENTS

Mercury (5.2 mg/kg) detected in a marine sediment sample collected from five feet bgs in the tidal flat beneath the south abutment of the First Avenue South Bridge exceeds the MTCA standard for mercury (1 mg/kg) and MSQS for mercury (0.41 mg/kg). However, background levels of mercury in sediments of Elliott Bay, including the Duwamish Waterway, ranges between 0.012 to 28.8 mg/kg (PTI et al., 1988). The level of mercury detected in the tidal flat sample is considered within the lower range of background concentrations. Therefore, treatment for mercury removal is considered unnecessary.

WSDOT should also consider the following in its design plans, preparation of bid documents, and construction of the First Avenue South Bridge improvements:

* Prepare to handle any excavated soil containing visible TPH contamination by stockpiling in a secured area, and using as part of underpavement requirements during the new road construction.

- Prepare to discharge groundwater from dewatering under permit to the Metro sanitary sewer or to the Dewamish Waterway. Treatment to remove lead may be required, depending on continiuous pumping conditions.

1.DOT	Ingrid answer questions have letter and report re-typed Ingrid provide 12 copies give Ingrid addresses of DOT copies Ingrid distribute DTM copies
2.GEAE	meet with Joanne check calcs. find blower/rental price check w/mark re: PNE for GE provide written plan for vapor extraction
3.MEB	call A. Payne - set up meeting discuss E/con change order from info I sent Andy discuss final budget give Andy copy of Schedules for TL and MEB

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Bruce A. Liesch, Charles E. Price and Kenneth L. Walters. 1963. Geology and Ground-water Resources of Northwestern King County, Washington, Unites States Geological Survey, Ground-water Branch.

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Dames & Moore. 1993. Memorandum, Site Investigation Status, First Avenue South Bridge Project. Job No. 04342-075-163. Dated July 13, 1993.

Dames & Moore. 1993. Interim Report, Summary of Chemical Analysis for EIS Report, Preliminary Hazardous Waste Assessment, SR-99 - First Avenue South Bridge Project, Seattle, Washington. Job No. 04342-075-163. Dated August 20, 1993.

Dexter et al. 1981. National Oceanic and Atmospheric Administration Technical Memorandum OMPA-13 (Table VIII-1),.

Metropolitan of Seattle. Discharge Loading Factors

PTI Environmental Services and Tetra Tech, Inc. 1988. Elliott Bay Action Program: Analysis of Toxic Problem Areas, prepared for U.S. Environmental Protection Agency, Region X, Seattle, Washington.

Shannon & Wilson, Inc. June 1991. Hazardous Waste and Waste Discipline Report for First Avenue South Bridge.

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Washington Department of Ecology. April 1991. Sediment Management Standards, Washington Administrative Code, Chapter 173-204-320.

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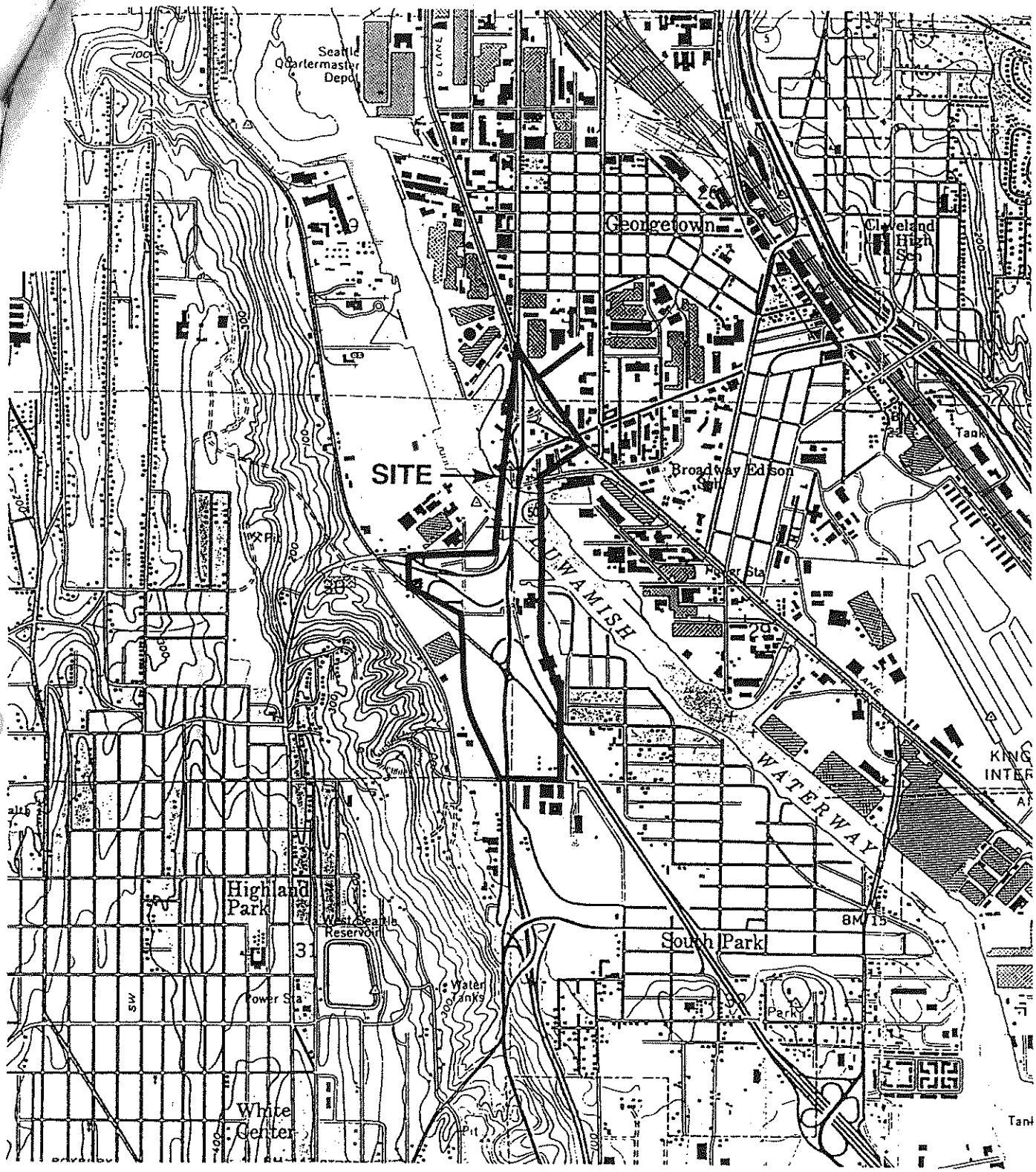
Washington Department of Ecology. April 1991. Marine Sediment Quality Standards, Washington Administrative Code, Chapter 173-204-320.

Washington Department of Ecology. December 1992. Water Quality Standards, Washington Administrative Code, Chapter 173-201-047.



0 2000 4000

Approximate Scale in Feet

BASE MAP: USGS 7.5' Quadrangle, Seattle South, WA.

Figure 1

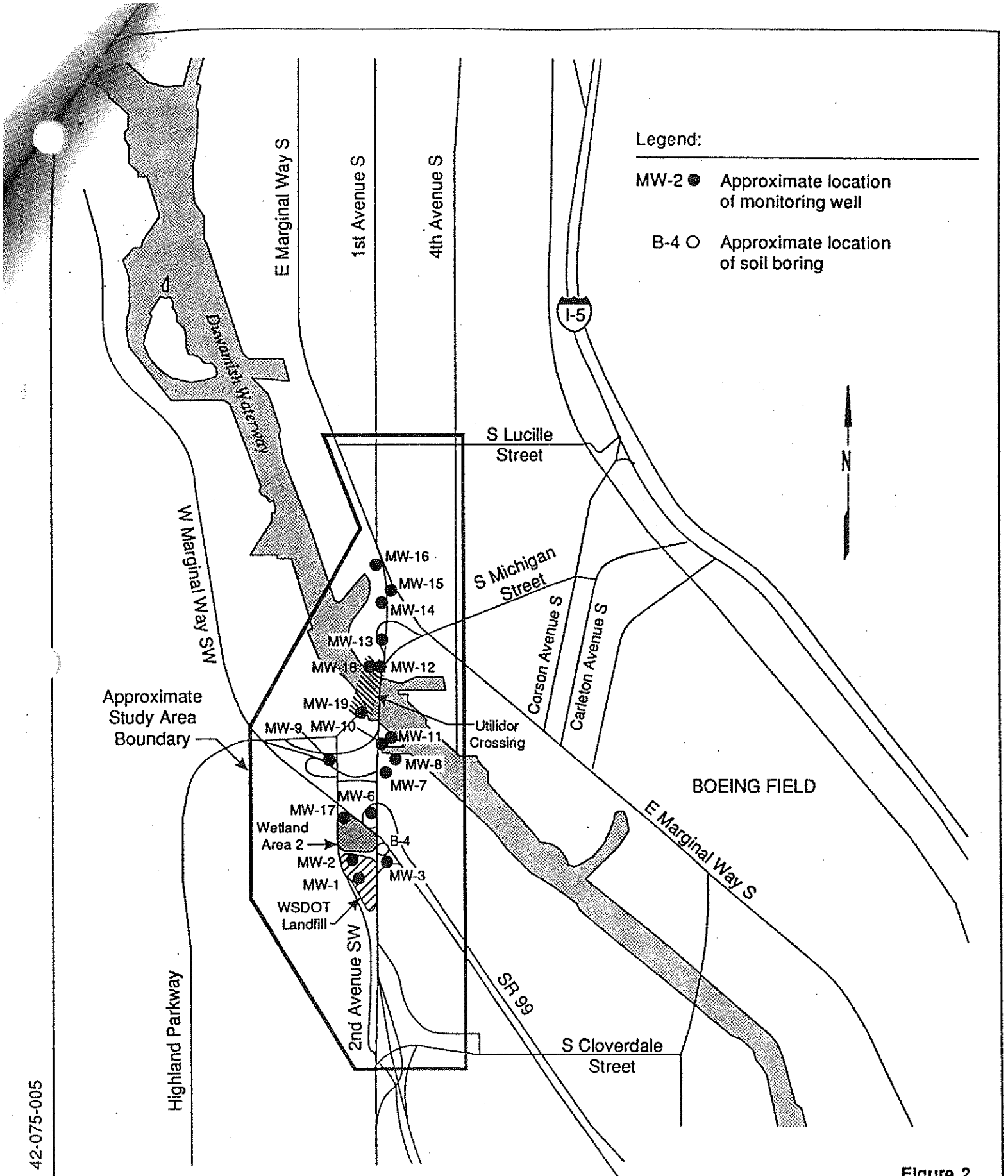
Site Location Map

First Avenue South Bridge

Washington State Department of Transportation

Dames & Moore

United States Environmental Protection Agency. May 1993. Drinking Water Regulations and Health Advisories.



Job No. 42-075-005

Figure 2

Monitoring Well and Boring Location Map

First Avenue South Bridge
Washington State Department of Transportation

Dames & Moore

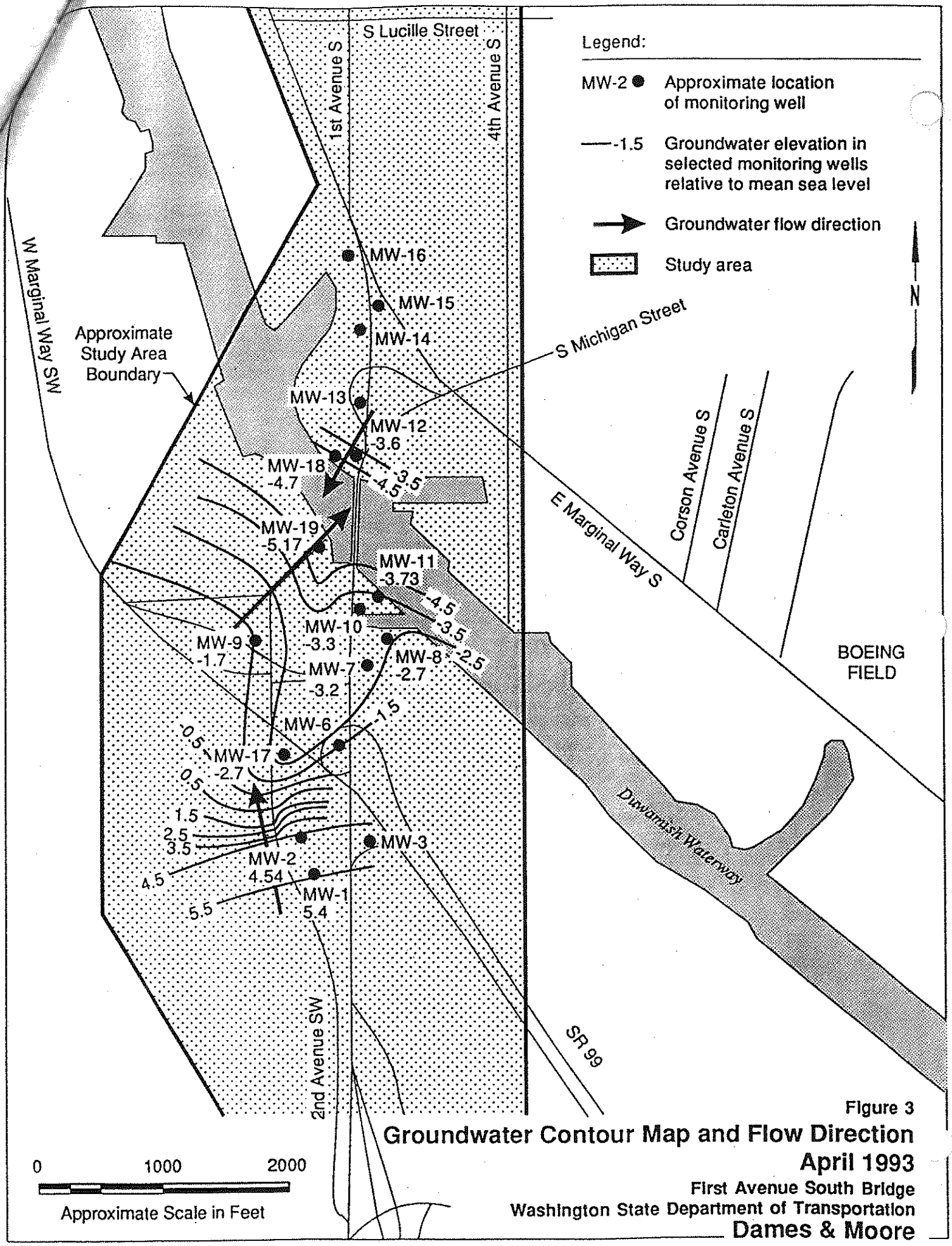


Figure 3

Groundwater Contour Map and Flow Direction
April 1993

First Avenue South Bridge
Washington State Department of Transportation

Dames & Moore

Job No. 04342-075-005

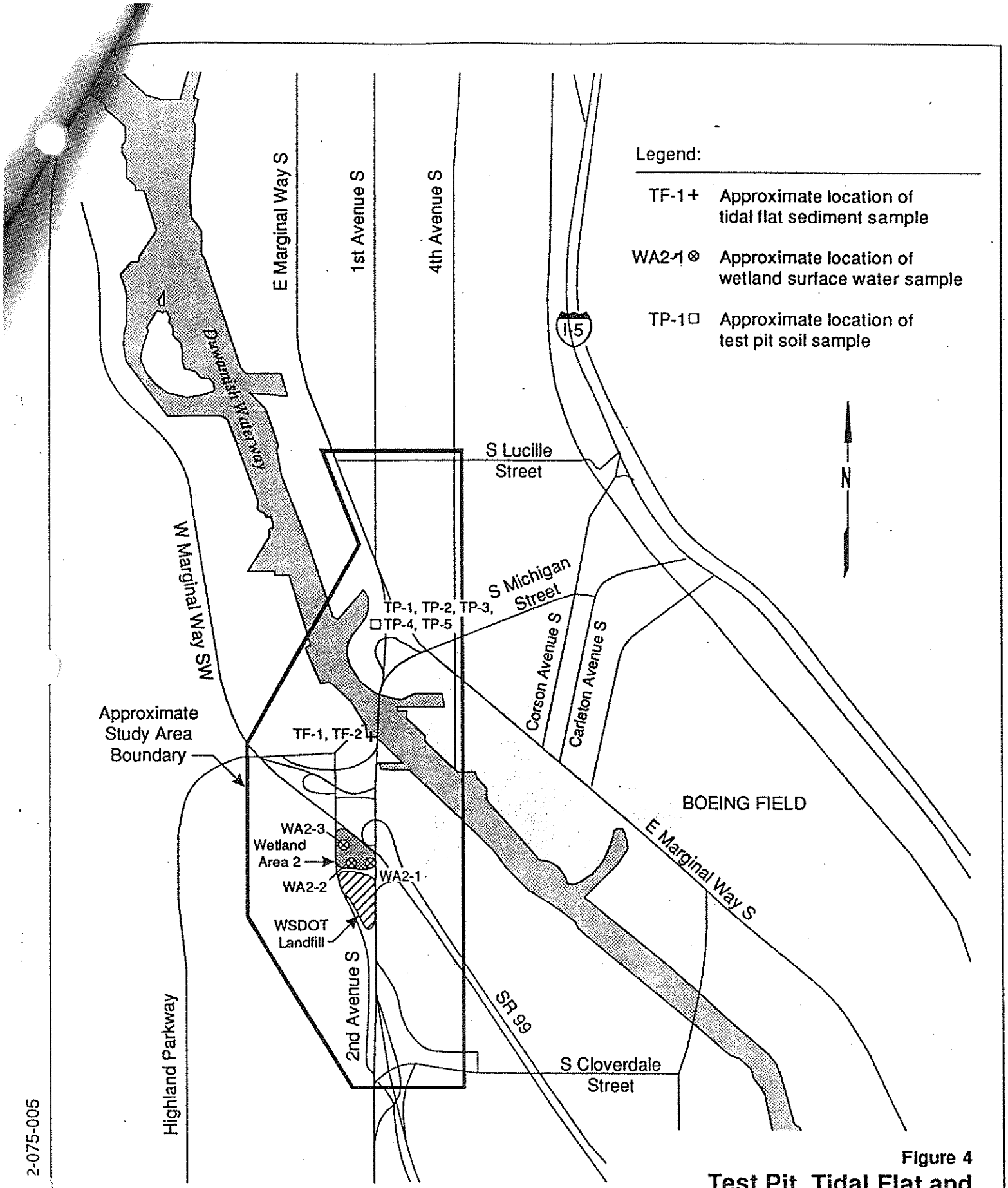


Figure 4

Test Pit, Tidal Flat and Wetland Sample Vicinity Map

First Avenue South Bridge
Washington State Department of Transportation

Dames & Moore

Job No. 2-075-005

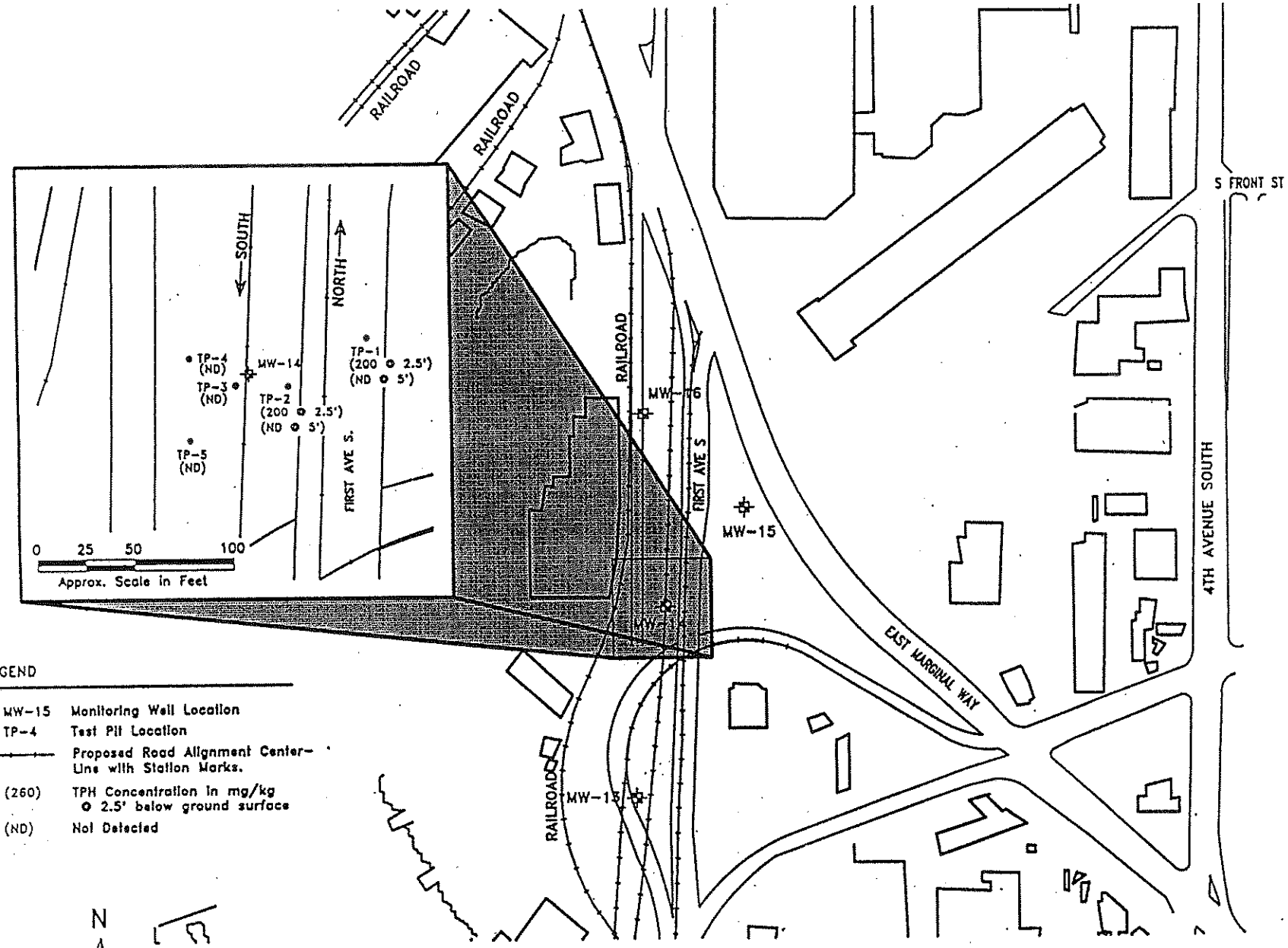


Figure 5
Test Pit Sample Location Map
First Avenue South Bridge
Washington Dept. of Transportation

Job No. 04342-075-005

Dames & Moore

based-g plot1 7/20/93

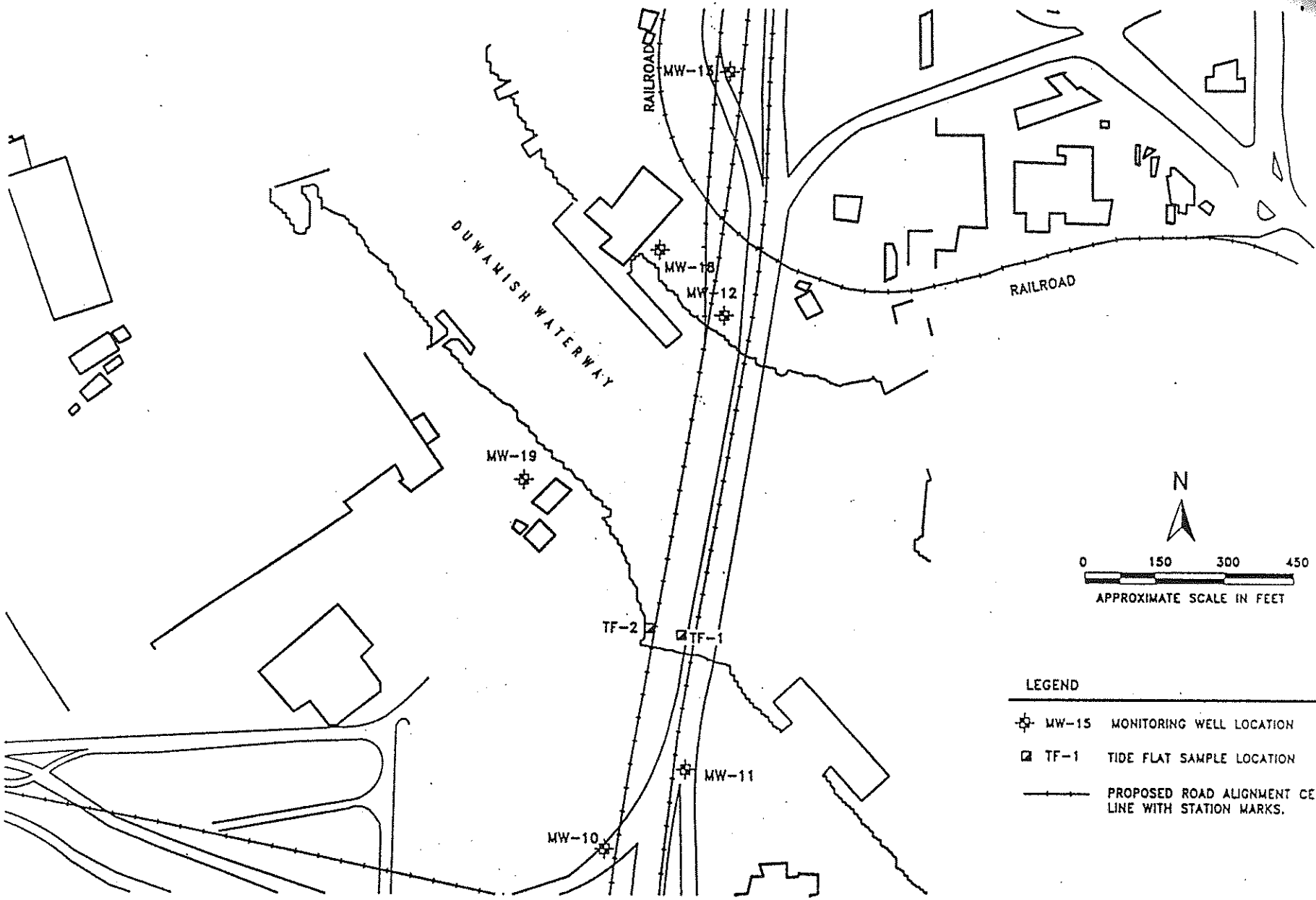


Figure 6
Tidal Flat Sample Location Map
First Avenue South Bridge
Washington Dept. of Transportation

Job No. 04342-075-005

Dames & Moore

basemap plot2 7/30/93

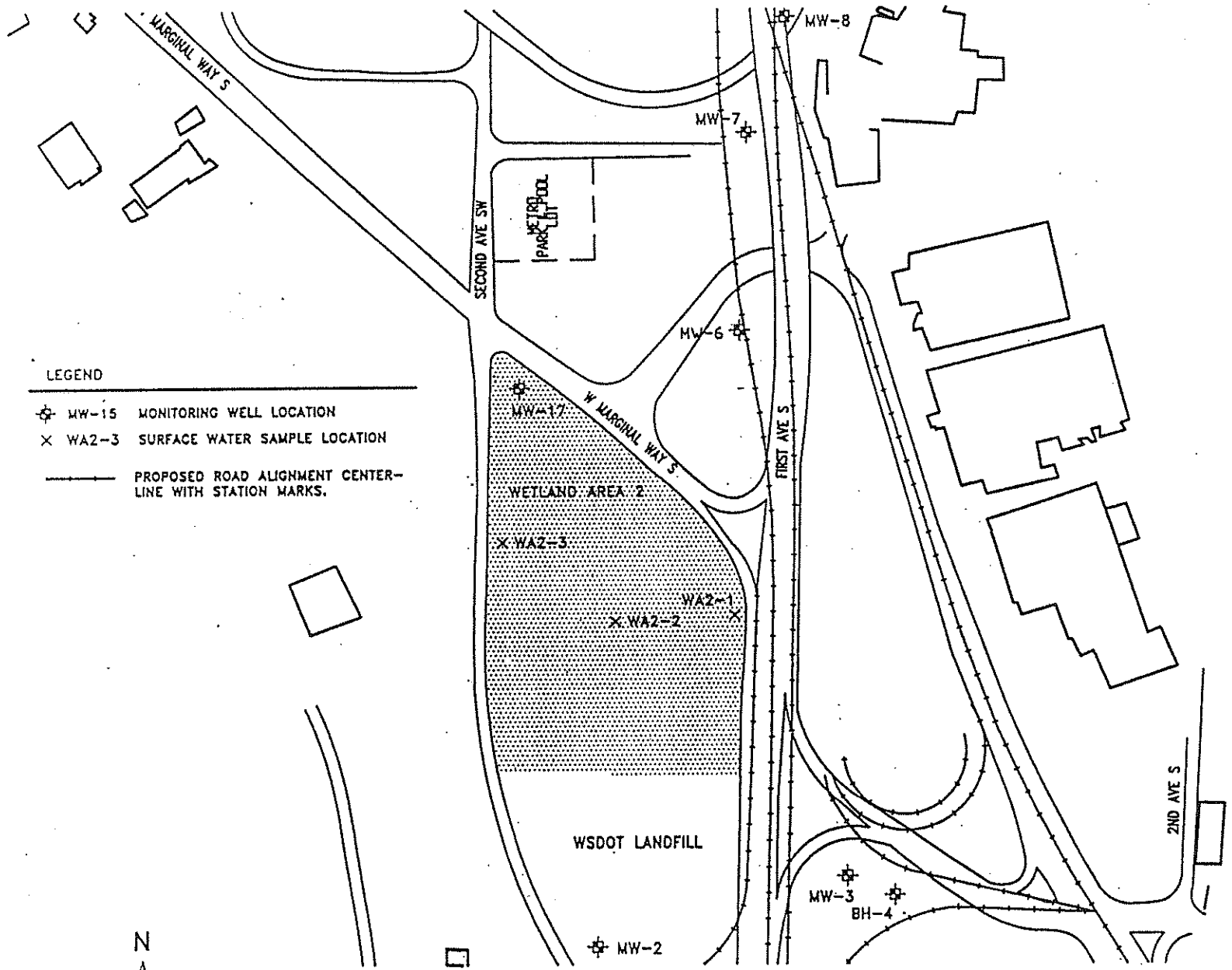


Figure 7
Surface Water Sample Location Map
First Avenue South Bridge
Washington Dept. of Transportation

Job No. 04342-075-005

Dames & Moore

Table 1
Groundwater Levels

All measurements are in feet.

MW Number	Date	Ground Surface Elevation[1] (MSL)	Top of Casing Elevation[1] (MSL)	Depth to Water from Top of Casing	Total Depth of Water	Water Elevation (MSL)
1	7/20/92	7.24	6.74	5.47	8.30	1.27
	9/17/92	7.24	6.74	6.9	6.80	-0.16
	4/13/93[2]	7.24	10.79	5.39	12.19	5.40
2	7/20/92	8.22	7.95	6.56	2.15	1.39
	9/17/92	8.22	7.95	8.17	1.13	-0.22
	4/14/93	8.22	7.95	3.41	5.13	4.54
7	7/21/92	8.03	7.53	10.43	6.81	-2.90
	9/18/92	8.03	7.53	12.7	5.80	-5.17
	4/14/93	8.03	7.53	10.69	7.01	-3.16
8	7/21/92	7.27	6.89	9.34	5.43	-2.45
	9/18/92	7.27	6.89	10.5	4.70	-3.61
	4/14/93	7.27	6.89	9.63	4.96	-2.74
9	7/21/92	12.31	11.75	13.13	3.82	-1.38
	9/18/92	12.31	11.75	14.4	3.00	-2.65
	4/14/93	12.31	11.75	13.45	3.26	-1.70
10	7/21/92	7.64	7.15	10.26	7.00	-3.11
	9/21/92	7.64	7.15	13.12	4.75	-5.97
	4/13/93	7.64	7.15	10.45	6.75	-3.30
11	7/21/09	5.56	4.86	8.66	5.28	-3.80
	9/21/92	5.56	4.86	9.46	4.79	-4.60
	4/13/93	5.56	4.86	8.59	5.16	-3.73
12	7/22/92	3.34	2.95	8.28	9.72	-5.33
	9/21/92	3.34	2.95	5.58	13.34	-2.63
	4/13/93	3.34	2.95	6.51	11.81	-3.56
17	4/29/93	9.58	9.23	11.91	12.49	-2.68
18	4/29/93	2.88	2.64	7.31	14.73	-4.67
19	4/29/93	2.58	2.28	7.35	7.36	-5.07

Notes:

[1] - Well survey data and elevation reference provided by WSDOT.
[2] - Well head raised 4.05 feet.
MSL - Mean Sea Level.

Table 2
Laboratory Tests Summary

	Soil Samples					Water Samples						
ID	WTPH-HCID	WTPH-D	WTPH-418.1	EPA 8240 (VOCs)	Priority Pollutant Metals	EPA 8015 M (TEPH)	Priority Pollutant (dissolved metals)	EPA 624 (VOCs)	Priority Pollutant Metals	EPA 603 (PCBs)	EPA 7060 (dissolved arsenic)	EPA 7241 (dissolved lead)
MW-1	x			x	x	x		x	x			
MW-2	x			x	x	x		x	x		x	x
MW-3	x				x	x		x	x			
B-4	x											
MW-6	x				x	x			x			
MW-7	x				x	x			x		x	x
MW-8	x			x	x	x		x	x	x	x	x
MW-9	x				x	x			x		x	x
MW-10		x			x	x			x		x	x
MW-11		x			x	x			x		x	x
MW-12	x			x	x	x		x	x			
MW-13	x				x	x			x			
MW-14			x		x	x			x			
MW-15		x			x	x			x			
MW-16	x				x	x			x			
MW-17	x			x	x	x	x	x	x			
MW-18	x			x	x	x	x	x	x			
MW-19	x			x	x	x	x	x	x			
TP-1			x									
TP-2			x									
TP-3			x									
TP-4			x									
TP-5			x									
SP-1-E			x	x	x							
SP-2-S			x	x	x							
SP-3-W			x	x	x							
TF-1	x			x	x							
TF-2	x	x		x	x							
WA2-1						x		x	x			
WA2-2						x		x	x			
WA2-3						x		x	x			

Notes:

B - Soil Boring.
MW - Monitoring Well.
TP - Test Pit.
TF - Tidal Flat.
WA2 - Wetland Area 2 Surface Water Sample.

Table 3
Summary of TPH in Borehole/Monitoring Well Soil Samples

All units are shown as mg/kg.

Method	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12	MTCA[1]
WTPH-HCID	ND	ND	ND	ND	ND	ND	ND	ND	D	D	ND	NA
WTPH-D diesel	NA	NA	NA	NA	NA	NA	NA	NA	73 (2.5')	110(2.5')	NA	200.0/200.0
WTPH-418.1 oil	NA	NA	NA	NA	NA	NA	NA	NA	**530 (2.5')**	**1100 (2.5')**	NA	200.0/200.0

Notes:

Numbers in bold indicate a concentration at or above the MTCA Cleanup Levels.

MTCA - Model Toxics Control Act.

[1] - MTCA Method A Soil Cleanup Standards for Non-Industrial/Industrial Sites (WAC 173-340-740/745) amended February 1991.

NA - Not Analyzed.

ND - Not Detected.

D - Detected.

( ) - Sample depth in feet.

Table 3 (continued)
Summary of TPH in Borehole/Monitoring Well Soil Samples

All units are shown as mg/kg.

Method	MW-13	MW-14	MW-15	MW-16	MW-17	MW-18	MW-19	MTCA[1]
WTPH-HCID	ND	D	D	ND	ND	ND	ND	NA
WTPH-D diesel	NA	NA	26 (2.5')	NA	NA	NA	NA	200.0/200.0
WTPH-418.1 oil	NA	**1000 (2.5')**	NA	NA	NA	NA	NA	200.0/200.0

Notes:

Numbers in bold indicate a concentration at or above the MTCA Cleanup Levels.

MTCA - Model Toxics Control Act.

[1] - MTCA Method A Soil Cleanup Standards for Non-Industrial/Industrial Sites (WAC 173-340-740/745).

NA - Not Analyzed.

ND - Not Detected.

D - Detected.

( ) - Sample depth in feet.

Table 4
Summary of VOC/PCB in Borehole/Monitoring Well Soil Samples

All units shown are µg/kg.

Method	Sample ID	MW - 1			MW - 2			MW - 8			MW - 12				MTCA [1]	
	Sample Depth	2.5'	5'	10'	5'	7.5'	12.5'	2.5'	5'	10'	2.5'	5'	10'	15'	Non-Industrial	Industrial
EPA 8240 (VOC)[2]																
Acetone		ND	10	ND	ND	ND	16	ND	ND	13	ND	21	ND	810	NA	NA
Methylene Chloride		ND	ND	ND	ND	ND	ND	59	85	270	ND	ND	ND	**720**	500	500
Ethyl benzene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.5	20,000	20,000
Toluene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
EPA 8080 (PCB)																
Aroclor -1248		NA	NA	NA	NA	NA	NA	ND	ND	ND	NA	NA	NA	NA	1,000	10,000
Aroclor -1254		NA	NA	NA	NA	NA	NA	ND	ND	ND	NA	NA	NA	NA	1,000	10,000
Aroclor -1260		NA	NA	NA	NA	NA	NA	880	ND	ND	NA	NA	NA	NA	1,000	10,000

Notes:

Numbers in bold indicate a concentration at or above the MTCA Cleanup Levels.

MTCA - Model Toxics Control Act.

VOC - Volatile Organic Compounds

PCB- Polychlorinated Biphenyls

NA - Not Analyzed.

ND - Not Detected.

[1] - MTCA Method A Soil Cleanup Standards for Non-Industrial/Industrial Sites (WAC 173-340-740/745).

[2] - All other compounds were not detected.

Table 4 (continued)
Summary of VOC/PCB in Borehole/Monitoring Well Soil Samples

All units shown are µg/kg.

Method	Sample ID	MW - 17					MW-18					MW-19		MTCA [1]	
	Sample Depth	1 (2.5')	2 (5')	3 (7.5')	4 (10')	5 (12.5')	1 (2.5')	2 (5')	3 (7.5')	4 (10')	5 (12.5')	1 (2.5')	2 (5')	Non-Industrial	Industrial
EPA 8240 (VOC)[2]															
Acetone		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
Methylene Chloride		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	500	500
Ethyl benzene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	20,000	20,000
Toluene		54	ND	ND	63	ND	ND	ND	ND	ND	ND	ND	ND		
EPA 8080 (PCB)															
Aroclor -1248		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,000	10,000
Aroclor -1254		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,000	10,000
Aroclor -1260		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,000	10,000

Notes:

Numbers in bold indicate a concentration at or above the MTCA Cleanup Levels.

MTCA - Model Toxics Control Act.

VOC - Volatile Organic Compounds

PCB- Polychlorinated Biphenyls

NA - Not Analyzed.

ND - Not Detected.

1 - MTCA Method A Soil Cleanup Standards for Non-Industrial/Industrial Sites (WAC 173-340-740/745).

2 - All other compounds were not detected.

Table 5 (continued)
Summary of Metals in Borehole/Monitoring Well Soil Samples

All units shown in mg/kg.

Metal	MW-12	MW-13	MW-14	MW-15	MW-16	MW-17	MW-18	MW-19	MTCA[1]	
									Non-Industrial	Industrial
Antimony	ND	ND	ND	ND	ND	6 (3')	ND	ND	NS	NS
Arsenic	4 (5')	7 (10')	12 (2.5')	9 (10')	2 (2.5')	8.3 (6')	7.6 (3')	3 (2')	20.0	200
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
Cadmium	ND	ND	ND	ND	ND	4.3 (4')	2.1 (3')	0.88 (1')	2.0	10
Chromium	17 (5')	18 (15')	16 (5')	21 (10')	12 (10')	57 (4')	16 (3')	8.6 (2')	100.0	500
Copper	22 (5')	31 (10')	29 (10')	70 (2.5')	23 (2.5')	44 (4')	27 (3')	9.6 (2')	NS	NS
Lead	ND	ND	134 (2.5')	85 (2.5')	ND	13 (1')	7.4 (1')	ND	250.0	1,000
Mercury	ND	ND	ND	ND	ND	ND	0.17 (1')	ND	1.0	1
Nickel	ND	13 (10')	13 (10')	19 (2.5')	ND	71 (4')	12 (4')	6.9 (2')	NS	NS
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
Silver	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
Zinc	37 (5')	33 (10')	180 (2.5')	84 (2.5')	35 (2.5')	76 (4')	29 (4')	24 (2')	NS	NS

Notes:

Numbers in bold indicate a concentration at or above the MTCA Cleanup Levels.

MTCA - Model Toxics Control Act.

[1] - MTCA Method A Soil Cleanup Levels for Industrial Sites (WAC 173-340-740/745).

NA - Not Analyzed.

ND - Not Detected.

NS - Standard not established.

( ) - Sample depth in feet, with highest concentration level.

Table 5
Summary of Metals in Borehole/Monitoring Well Soil Samples

All units shown in mg/kg.

Metal	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MTCA[1]	
											Non-Industrial	Industrial
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	16 (2.5')	ND	NS	NS
Arsenic	6 (2.5')	14 (12.5')	15(5')	3 (2.5')	4 (10')	10 (5')	6 (10')	8 (10')	24 (2.5')	17 (2.5')	20.0	200
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
Cadmium	ND	1 (7.5')	ND	ND	ND	1 (10')	ND	ND	ND	ND	2.0	10
Chromium	47 (2.5')	38 (12.5')	20 (10')	14 (10')	51 (5')	53 (10')	21 (2.5')	16 (10')	22 (2.5')	21 (2.5')	100.0	500
Copper	33 (2.5')	52 (12.5')	34 (5')	25 (10')	40 (10')	40 (10')	26 (10')	24 (10')	40 (2.5')	36 (2.5')	NS	NS
Lead	24 (2.5')	27 (12.5')	ND	ND	ND	51 (2.5')	63 (2.5')	ND	653 (2.5')	57 (5')	250.0	1,000
Mercury	ND	ND	ND	ND	ND	ND	ND	0.2 (10')	ND	0.2 (2.5')	1.0	1
Nickel	54 (2.5')	25 (12.5')	15 (5')	ND	73 (5')	66 (10')	12 (2.5')	11 (10')	18 (2.5')	23 (2.5')	NS	NS
Selenium	ND	ND	ND	ND	ND	<2 (5')	ND	ND	ND	ND	NS	NS
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS
Zinc	66 (2.5')	116 (12.5')	51 (10')	40 (2.5')	67 (10')	68 (10')	55 (2.5')	39 (10')	59 (2.5')	71 (2.5')	NS	NS

Notes:

Numbers in bold indicate a concentration at or above the MTCA Cleanup Levels.

MTCA - Model Toxics Control Act.

[1] - MTCA Method A Soil Cleanup Levels for Industrial Sites (WAC 173-340-740/745).

NA - Not Analyzed.

ND - Not Detected.

NS - Standard not established.

( ) - Sample depth in feet, with highest concentration level.

Table 6
Summary of TPH, VOC and Metals in Test Pit Soil Samples

All units are in mg/kg.

Sample ID / Method	TP-1-2.5	TP-1-5.0	TP-2-2.0	TP-2-5.0	TP-3-2.5	TP-3-5.0	TP-4-2.5	MTCA[1] Non-Industrial	MTCA[1] Industrial
WTPH-418.1 modified	**260**	47	**200**	ND	ND	ND	ND	200[2]	200.0[2]
EPA 8240 (VOC)								0.5	0.5*
Priority Pollutant Metals									
Antimony								NS	NS
Arsenic								20	200.0
Beryllium								NS	NS
Cadmium								2.0	10.0
Chromium								100.0	500.0
Copper								NS	NS
Lead								250.0	1000.0
Mercury								1.0	1.0
Nickel								NS	NS
Selenium								NS	NS
Silver								NS	NS
Thallium								NS	NS
Zinc								NS	NS

Notes:

Numbers in bold indicates a concentration at or above the MTCA Cleanup Standard.

[1] - MTCA Method A cleanup guidelines for Industrial Sites (WAC 173-340-740/745).

[2] - MTCA Method A cleanup guidelines for total petroleum hydrocarbons as oil is 200 mg/kg.

[3] - Methylene Chloride.

* - MTCA Method A cleanup guidelines for Industrial Sites for Methylene Chloride is 0.5 mg/kg.

** - Estimated value.

NS - Standard not established.

NA - Not analyzed.

Blank indicates not analyzed.

Table 6 (continued)
Summary of TPH, VOC and Metals in Test Pit Soil Samples

All units are in mg/kg.

Sample ID / Method	TP-4-5.0	TP-5-2.5	TP-5-5.0	SP-1-E	SP-2-S	SP-2-S Duplicate	SP-3-W	MTCA[1] Non-Industrial	MTCA[1] Industrial
WTPH-418.1 modified	ND	ND	ND	150	**470**	**510**	**280**	200[2]	200.0[2]
EPA 8240 (VOC)				0.36[3]	0.30[3]	NA	0.31[3]	0.5	0.5*
Priority Pollutant Metals									
Antimony				ND**	ND**	NA	ND**	NS	NS
Arsenic				2.2	11	NA	2.3	20	200.0
Beryllium				ND**	ND**	NA	ND**	NS	NS
Cadmium				1.7	1.5	NA	1.5	2.0	10.0
Chromium				12	9.3	NA	10	100.0	500.0
Copper				12	31	NA	9.7	NS	NS
Lead				7.5	27	NA	ND	250.0	1000.0
Mercury				ND	ND	NA	ND	1.0	1.0
Nickel				9.4	8.3	NA	7.4	NS	NS
Selenium				ND	ND	NA	ND	NS	NS
Silver				ND**	ND**	NA	ND**	NS	NS
Thallium				ND	ND	NA	ND	NS	NS
Zinc				27	75	NA	24	NS	NS

Notes:

Numbers in bold indicates a concentration at or above the MTCA Cleanup Standard.

[1] - MTCA Method A cleanup guidelines for Industrial Sites (WAC 173-340-740/745).

[2] - MTCA Method A cleanup guidelines for total petroleum hydrocarbons as oil is 200 mg/kg.

[3] - Methylene Chloride.

* - MTCA Method A cleanup guidelines for Industrial Sites for Methylene Chloride is 0.5 mg/kg.

** - Estimated value.

NS - Standard not established.

NA - Not analyzed.

Blank indicates not analyzed.

Table 7
Summary of TPH, VOC and Metals in Tidal Flat Soil Samples

All units are in mg/kg.

Sample ID / Method	TF-1-1	TF-1-5	TF-2-1	TF-2-5	MTCA[1]		Marine Sediment Quality Standards[2]
					Non-Industrial	Industrial	
WTPH-HCID							
gasoline	ND	ND	ND	ND	100.0	100.0	NS
diesel	ND	ND	ND	160*	200.0	200.0	NS
oil	ND	ND	ND	ND	200.0	200.0	NS
EPA 8240 (VOC)	ND	ND	0.33[3]	ND	0.5*	0.5*	NS
Priority Pollutant Metals							
Antimony	ND**	ND**	ND**	ND**	NS	NS	NS
Arsenic	3.3	9.6	3.5	11	20.0	200.0	57
Beryllium	ND**	ND**	ND**	ND**	NS	NS	NS
Cadmium	2.2	3.4	1.3	4	2.0	10.0	5.1
Chromium	20	29	12	50	100.0	500.0	260
Copper	30	35	11	45	NS	NS	390
Lead	24	28	13	85	250.0	1000.0	450
Mercury	ND**	0.15	ND**	5.2	1.0	1.0	0.41
Nickel	12	18	5.8	16	NS	NS	NS
Selenium	ND**	ND**	ND**	ND**	NS	NS	NS
Silver	ND**	ND**	ND**	ND**	NS	NS	6.1
Thallium	ND**	ND**	ND**	ND**	NS	NS	NS
Zinc	49	77	25	150	NS	NS	410

Notes:

Numbers in bold indicates a concentration at or above the MTCA Cleanup Standard.

[1] - MTCA Method A Cleanup Guidelines for Industrial Sites (WAC 173-340-740/745).

[2] - Sediment Management Standards (WAC 173-204-320).

[3] - Methylene Chloride.

* - MTCA Method A Cleanup Guidelines for Industrial Soils for Methylene Chloride is 0.5 mg/kg.

** - Estimated value.

NS - Standard not established.

ND - Not Detected.

Table 8 (continued)
Summary of Analytical Results - Duwamish River Sediments

Method	Units	B-2 S-1	B-2 S-2	B-2 S-4	B-2 S-5	B-2 S-6	Action Levels		
							USEPA Regulatory Levels		Marine Sediment Quality Standards
TCLP [1]/Volatiles	(mg/L)	ND	ND	ND	ND	ND	various		NS
TCLP/Semi-volatiles	(mg/L)	ND	ND	ND	ND	ND	various		NS
TCLP Metals	(mg/L)								
Antimony		0.1	ND	0.1	0.2	0.1	NA		NS
Selenium		ND	ND	0.3	0.2	0.2	1.0		NS
							Cleanup Levels [2]		
							Industrial Soil	Residential Soil	
EPA 8240 Volatiles	(mg/kg)	ND	ND	ND	ND	ND	various	various	NS
EPA 8270 Semi-volatiles	(mg/kg)								
Phenanthrene		0.220	0.280	ND	ND	ND	NS	NS	100
Di-n-butylphthalate		2.400	3.700	2.400	3.500	1.400	NS	NS	220
Fluoranthene		0.430	0.200	ND	ND	ND	NS	NS	160
Pyrene		0.630	0.200	ND	ND	ND	NS	NS	1000
Butyl benzyl phthalate		ND	0.640	ND	1.300	ND	NS	NS	4.9
Benzo(a)anthracene		0.330	ND	ND	ND	ND	20.0	1.0	110
Bis(2-ethylhexyl)phthalate		0.660	ND	ND	ND	ND	NS	NS	47
Chrysene		0.360	ND	ND	ND	ND	20.0	1.0	110
Benzo(b)fluoranthene		0.670	0.068	ND	ND	0.072	20.0	1.0	NS
Benzo(a)pyrene		ND	0.330	ND	ND	0.320	20.0	1.0	99
Benzo(g,h,i)perylene		0.200	ND	ND	ND	ND	20.0	1.0	31
WTPH-HCID	(mg/Kg)	ND	ND	ND	ND	ND	100\200 [3]	100\200 [3]	NS
EPA 8080 PCB	(mg/Kg)								
Aroclor 1248		ND	ND	0.6	0.3	0.5	NS	NS	NS
Aroclor 1254		ND	ND	0.6	0.4	0.7	NS	NS	NS
Total PCBs							10 [4]	1 [4]	12
Total Metals	(mg/Kg)								
Arsenic		ND	ND	ND	ND	ND	200	20	57
Barium		88	42	85	88	110	NS	NS	NS
Cadmium		0.90	0.51	1.5	1.2	1.3	10	2	5.1
Chromium		32	17	40	29	35	500	100	260
Lead		170	12	40	34	57	1,000	250	450
Mercury		0.21	0.13	0.35	0.39	0.23	1	1	0.41

Notes:

[1] - Toxicity Characteristic Leaching Procedure.
[2] - Method A, Model Toxics Control Act, WDOE, 1991 (WAC 173-340-740/745).
[3] - 100 mg/Kg - gasoline range, 200 mg/Kg - diesel range and heavier.
[4] - Total concentration of all PCB Aroclors.
- Sediment Management Standards (WAC 173-204-320).
NS - Standard not established.
ND - Analyte not detected.
Numbers in bold indicate a concentration at or above the MTCA Cleanup Standard.

Table 9
Summary of TEPH, PCB and VOC in Groundwater Samples

Method	Units	MW-1			MW-2			MW-3	MW-6	MW-7			MW-8			MTCA[1]
		Jul-92	Sep-92	Apr-93	Jul-92	Sep-92	Apr-93	Jul-92	Jul-92	Jul-92	Sep-92	Apr-93	Jul-92	Sep-92	Apr-93	
EPA 8015M (TEPH)	(mg/l)															
Diesel/Oil					0.49			0.15	0.28	0.14			1.1			1
Diesel		ND														
EPA 608 (PCB)	(µg/l)															0.1
EPA 624 (VOC)	(µg/l)	**2.7[2]**	ND	ND	ND			ND					ND			0.2[3]

Vinyl chloride hit

Notes:

Blank indicates not analyzed.
Numbers in bold indicate a concentration at or above the MTCA Cleanup Standard.
MTCA - Model Toxics Control Act.
[1] - MTCA Method A cleanup level for groundwater WAC 173-340-720.
[2] - Vinyl Chloride.
[3] - MTCA Method A cleanup level for vinyl chloride in groundwater.
** - MTCA Standard varies for each VOC contaminant.
TEPH - Total Extractable Petroleum Hydrocarbons.
PCB - Polychlorinated Biphenyls.
VOC - Volatile Organic Compounds.
ND - Not Detected.

Table 9 (continued)
Summary of TEPH, PCB and VOC in Groundwater Samples

Method	Units	MW-9			MW-10			MW-11			MW-12			MW-13	MTCA[1]
		Jul-92	Sep-92	Apr-93	Jul-92	Sep-92	Apr-93	Jul-92	Sep-92	Apr-93	Jul-92	Sep-92	Apr-93	Jul-92	
EPA 8015M (TEPH) Diesel/Oil Diesel	(mg/l)	0.58			0.30			0.19			0.35			0.33	1
EPA 608 (PCB)	(µg/l)														0.1
EPA 624 (VOC)	(µg/l)										ND	ND	ND		0.2[3]

Notes:

Blank indicates not analyzed.
Numbers in bold indicate a concentration at or above the MTCA Cleanup Standard.
MTCA - Model Toxics Control Act.
[1] - MTCA Method A cleanup level for groundwater WAC 173-340-720.
[2] - Vinyl Chloride.
[3] - MTCA Method A cleanup level for vinyl chloride in groundwater.
** - MTCA Standard varies for each VOC contaminant.
TEPH - Total Extractable Petroleum Hydrocarbons.
PCB - Polychlorinated Biphenyls.
VOC - Volatile Organic Compounds.
ND - Not Detected.

Table 9 (continued)
Summary of TEPH, PCB and VOC in Groundwater Samples

Method	Units	MW-14 Jul-92	MW-15 Jul-92	MW-16 Jul-92	MW-17 Apr-93	MW-18 Apr-93	MW-19 Apr-93	MTCA[1]
EPA 8015M (TEPH)	(mg/l)							
Diesel/Oil		0.53	0.23	0.29	0.33	0.28	ND	1
Diesel								
EPA 608 (PCB)	(µg/l)							0.1
EPA 624 (VOC)	(µg/l)				ND	ND	ND	0.2[3]

Notes:

Blank indicates not analyzed.
Numbers in bold indicate a concentration at or above the MTCA Cleanup Standard.
MTCA - Model Toxics Control Act.
[1] - MTCA Method A cleanup level for groundwater WAC 173-340-720.
[2] - Vinyl Chloride.
[3] - MTCA Method A cleanup level for vinyl chloride in groundwater.
[**] - MTCA Standard varies for each VOC contaminant.
TEPH - Total Extractable Petroleum Hydrocarbons.
PCB - Polychlorinated Biphenyls.
VOC - Volatile Organic Compounds.
ND - Not Detected.

Table 12
Metro Sanitary Sewer Discharge Loading Criteria

Metals	Metro Discharge Criteria		Metals Detected (mg/l)			Daily Maximum Quantity (million gal/day)		
	Daily Limits (mg/l)	Daily Maximums (lbs.)						
		1000	MW-12	MW-18	MW-19	MW-12	MW-18	MW-19
Cadium	0.02	0.09		0.0005	0.0004		22	27
Chromium	0.16	0.73						
Copper	0.26	1.19		0.025			6	
Nickel	0.19	0.87						
Lead	0.25	1.15		0.01	0.013		14	11
Zinc	0.6	2.75	0.02	0.039	0.023	17	8	14
Arsenic	0.1	0.46		0.003	0.002		18	28
Mercury	0.01	0.05						
Silver	0.1	0.46						
Cyanide	0.1	0.46						
H2S	10	NA						

Notes:

Blank indicates metal not detected.
NA - Not Applicable.