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# Remedial Investigation/ Feasibility Study Report

## The Shops at First Street Project Site
## Bellevue, Washington

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## Benenson Bellevue II, L.P.

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**Kennedy/Jenks Consultants**

# REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT

## THE SHOPS AT FIRST STREET PROJECT SITE
## BELLEVUE, WASHINGTON

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# TABLE OF CONTENTS

PAGE NUMBER

# TABLE OF CONTENTS



## APPENDICES

# LIST OF TABLES

# LIST OF FIGURES

# 1.0 INTRODUCTION

This report presents the remedial investigation/feasibility study (RI/FS) performed for a portion of The Shops at First Street development in Bellevue, Washington (project site). The RI/FS was performed in response to the discovery of perchloroethylene (also tetrachloroethene or PCE) in soil during construction work at the project site. This report has been prepared based on information and data gathered by Kennedy/Jenks Consultants and Environmental Management Resources, Inc. (EMR).

## 1.1 REPORT ORGANIZATION

This report is organized as follows:

- Section 1 presents site background information, and an overview of investigations and the Phase I remedial action performed at the project site.

- Section 2 summarizes the RI objectives, methods, and findings. The investigative approach included:
  - Review of geologic and hydrogeologic information for the site vicinity
  - Collection and analysis of soil gas samples
  - Collection and analysis of soil samples from soil borings and a remedial excavation.
  - Collection and analysis of a reconnaissance groundwater sample.
  - Collection of sediment samples from onsite storm sewer catch basins.

- Section 3 presents the FS.

- Section 4 presents the conclusions supported by the findings of the RI/FS.

- Section 5 presents the limitations of the study.

- Section 6 presents references used in preparing this RI/FS.

## 1.2 SITE LOCATION AND FEATURES

The project site is located at 110 108th Avenue NE in Bellevue, Washington. Figure 1 presents a site location map. The project site is located in downtown Bellevue and is surrounded by commercial development. A map showing commercial development immediately adjacent to the project site as of March 1994 is presented in Appendix A (see EMR Figure 2).

The study area for this RI/FS is shown on Figure 2. The study area includes the area surrounding the footprint of a former Bellevue Cleaning Cleaning Village (the Phase I remedial action area), the alignment of existing storm sewer piping to the south of that area, and the storm sewer manhole in the southeast portion of the site (the Phase II remedial action area).

At the time that the RI and Phase I remedial action were performed, that area was an unpaved, graded pad. Construction of the new store in that area ceased and was delayed until completion of the RI. The portion of the study area that extends from the Phase I remedial action area along the alignment of the storm sewer was mostly unpaved during construction.

Ground surface in the site vicinity generally slopes to the south and southwest. The project site elevation ranges from about 142 to 150 feet above Mean Sea Level (MSL). The project site is located on a narrow hill that is part of the Interlake Drift Upland physiographic division of the Seattle area (Glaster and Laprade, 1991). The upland is bordered to the west (approximately 3/4-mile from the site) by Meydenbauer Bay (a bay on the eastern shore of Lake Washington) and to the east by Interstate 5. Mercer Slough, a lowland wetland area, is located approximately one mile to the southeast and Lake Strudevant is located about three-quarters of a mile to the northeast.

## 1.3 SITE BACKGROUND

The Office Depot building, canopy, and former Bellevue Cleaning Village building were constructed in 1961 and 1962. These structures are shown on the map presented as Figure 2 in Appendix A. EMR reviewed the historic Polk Street directories at the Bellevue Public Library and found the Bellevue Cleaning Village listed as a coin-operated laundromat as early as 1967. Dry cleaning operations involving PCE were conducted for a number of years prior to 1993. According to the owner of the cleaning establishment, all equipment related to dry cleaning operations was removed from the premises by June 1993 (EMR, 1994).

Site redevelopment activities began in 1994. Demolition of certain existing structures (including the Bellevue Cleaning Village building) and construction work were undertaken by Turner Construction Company (Turner). During site grading activities on 22 June 1994 at the former location of Bellevue Cleaning Village, soil containing dry cleaning solvent was encountered. Construction was halted by Turner, and EMR initiated investigations to evaluate the nature and extent of soil contamination.

EMR collected a near-surface soil sample (SS-1) from the project site at the location of a former storm drain catch basin (see Figure 3). The sample was analyzed for volatile organics using EPA Method 8240. Analytical results indicated that the sample contained detectable concentrations of three volatile organic compounds (VOCs): PCE (410 mg/kg); 1,1,1-trichloroethane (1,1,1-TCA) (1.9 mg/kg); and trichloroethene (TCE) (0.34 mg/kg). Based on this finding and supplemental boring and sampling performed by EMR, a Phase I remedial action was initiated that consisted of excavating approximately 2,140 cubic yards of soil containing PCE concentrations exceeding 0.5 mg/kg. The Phase I excavation area is shown on Figures 2 and 3. Soil exceeding 0.5 mg/kg of PCE was excavated to a depth of 15 feet to address the MTCA point of compliance requirement for direct human exposure [WAC 173-340-740(6)(c)]. The MTCA Method A soil cleanup level was chosen as the standard for this initial remedial action based a review of the MTCA regulations.

The soil was excavated by West Pac Environmental, Inc., and was disposed of at the Rabanco Regional Landfill located in Roosevelt, Washington. Notice of these actions was provided to the Washington State Department of Ecology (Ecology) in a letter to Ecology from Kennedy/Jenks Consultants dated 16 August 1994.

Kennedy/Jenks Consultants was retained to perform an RI/FS of the study area, and to document the selection and implementation of independent remedial actions at the project site.

# 2.0 REMEDIAL INVESTIGATION

## 2.1 INVESTIGATIVE OBJECTIVE

The objective of the RI was to obtain sufficient investigative data to characterize the distribution of hazardous substances present at the project site, and evaluate the potential threat to human health and the environment.

The RI field work focused on evaluation of VOCs in the subsurface, based on the Phase I Environmental Site Assessment performed by EMR (Appendix A). EMR's property transaction assessment indicates that the RI study area has been paved or covered by structures since 1962, and that the only identified activity performed onsite involving hazardous substance handling or usage was the dry cleaning operation.

Specific objectives of the focused RI included:

- Adequately characterize the nature and extent of soil exposure to VOCs by obtaining data regarding the lateral and vertical distribution of VOC concentrations in the subsurface.

- Obtain reasonably available information regarding local geologic and hydrogeologic conditions.

- Obtain information on potential impacts to the groundwater in the uppermost (water table) aquifer beneath the site.

- Obtain information on other potential points of release along the storm sewer system at the site

## 2.2 INVESTIGATIVE METHODS

The following methods were used to acquire information and data during the RI:

- Review of geologic and hydrogeologic information including environmental site assessment reports, available from public sources.
- Collection and analysis of soil gas samples.
- Collection and analysis of soil samples from soil borings and the Phase I remedial excavation.
- Collection and analysis of groundwater samples from a temporary monitoring well installed in the water table aquifer.
- Collection and analysis of sediment samples from storm sewer catch basins.

These methods are discussed in the following subsections.

### 2.2.1 Performance Monitoring Soil Sampling and Analysis

Performance monitoring soil samples (PX-1 through PX-16) were collected during the Phase I remedial excavation activities. Performance monitoring sampling locations are shown on Figure 3. These samples were analyzed to determine the lateral extent of excavation and to document VOC concentrations in soils left in-place. PCE was the only VOC that was consistently detected in the performance monitoring soil samples collected during the Phase I remedial action.

Sixteen performance samples were collected from the Phase I remedial action. Twelve of these samples were final performance monitoring samples collected from the sidewalls and bottom of the completed excavation. Due to the depth of the excavation and safety considerations, samples were collected directly from an excavator bucket and placed in glass sample jars.

Eight sidewall samples and four bottom samples were collected and analyzed for final performance monitoring. Field monitoring suggested that PCE spread downward and laterally from the presumed sources (i.e., the former Bellevue Cleaning Village floor drain and parking lot catch basin). Based on this finding, performance monitoring sidewall samples were collected from low points along the excavation sidewalls [i.e., 10 to 12 feet below ground surface (bgs)] to ensure that the lateral limits of the excavation to 15 feet bgs were adequate.

Upon collection, all samples were labeled, placed in a chilled cooler, and transported to the analytical laboratory under chain-of-custody at the end of each field day. Samples were submitted to North Coast Analytical, Inc., of Redmond, Washington for 24-hour turnaround analyses using EPA Method 8240.

### 2.2.2 Subsurface Sampling and Analysis

The nature and extent of soil exposure to the VOCs in the study area was characterized by drilling and sampling 26 soil borings to depths ranging from 15 to 100 feet bgs. Boring locations are shown on Figures 2 and 4.

Seven phases of drilling and subsurface sampling were performed. Table 1 lists the borings completed during each phase, the objective of the investigative activity, the dates of drilling, and the consultant responsible for the work.

Drilling for Phases 1 through 6 was performed using a truck-mounted hollow stem auger drill rig. Soil samples were collected during drilling for logging and chemical analysis. Soil samples were typically collected at 5-foot vertical intervals beginning at 5 or 15 feet bgs. In borings located within or immediately adjacent to the Phase I remedial excavation area, the initial sample was collected at 15 feet bgs. In other soil borings, sampling typically began at 5 feet bgs. Drilling for Phase 7 was performed using air rotary drilling methods. Soil samples collected during air rotary drilling were for logging purposes only. These samples were periodically collected directly from the cyclone separator and the discharge from the cyclone was visually monitored on an ongoing basis to identify changes in lithology.

EMR drilled and sampled eight borings that were designated as B-1 through B-8. Soil samples were selected by EMR for analysis based on the results of field screening, using a photoionization detector (PID). Soil samples collected by EMR were transported to North Coast Analytical, Inc., in Redmond, Washington for analysis on a 24-hour turnaround basis, using EPA Method 8240.

Kennedy/Jenks Consultants drilled and sampled 18 borings that were designated as BB-1 through BB-18. Borings BB-1 through BB-8 were sited based on the results of EMR's site characterization work. The depths of these borings, as well as the locations and depths of BB-9 through BB-14, were determined based on field observations and sample analytical results obtained on a rapid turnaround basis from a mobile onsite laboratory. The locations of boring BB-15 through BB-18 were selected based on the results of soil gas sampling and analysis along the alignment of the storm sewer alignment south of the initial remedial excavation.

Relatively undisturbed soil samples were collected by lowering a precleaned split-barrel sampler down the inside of the hollow stem auger. The sampler was driven 18 inches (or to refusal) with standard 140-pound hammer dropping 30 inches. Hammer blow counts were recorded every 6 inches over the sampled interval. The split-barrel sampler was fitted with precleaned 2.5-inch diameter, 6-inch long brass sleeves. After driving each sample, the sampler was retrieved from the borehole and split open to access the sample sleeves. The exposed soil at each end of each sample sleeve submitted for chemical analysis was immediately covered with polytetrafluoroethylene (PTFE) sheeting and fitted with plastic caps sealed with tape. Appropriately sealed and labeled samples were stored in chilled coolers for transport to the analytical laboratory.

Chain-of-custody records were completed in the field and transferred with the samples to the analytical laboratory.

Soil samples were screened in the field for organic vapor emissions using a Foxboro Organic Vapor Analyzer Model No. 128 (OVA) equipped with a flame ionization detector (FID). This screening was accomplished by extruding the sample core into a plastic bag, after which the sample was disaggregated. After the sample was allowed to volatize for approximately 5 minutes, the OVA probe was inserted into the bag's headspace. The OVA readings in volumetric parts per million (ppmv) were recorded on the boring logs.

After the target depth was reached in borings BB-1 through BB-14 (i.e., typically 60 feet bgs), soil samples collected from that boring were transported to an onsite mobile laboratory. Samples were analyzed in order, from the deepest to the most shallow. If the deepest sample from a boring contained detectable concentrations of PCE, an attempt was made to advance the boring an additional 10 to 15 feet, with samples collected at 5-foot vertical intervals. The additional samples were then submitted to the mobile laboratory for analysis. This procedure was repeated until the three deepest samples from each boring contained a reported PCE concentration of less than 0.10 mg/kg of PCE or until drilling refusal was encountered.

The boring for the temporary monitoring well (TMW-1) was drilled about 35 feet west of the storm sewer manhole located adjacent to boring BB-15. This boring was drilled to a total depth of about 110 feet bgs. A temporary 2-inch diameter schedule 40 PVC monitoring well was installed to a total depth of 109 feet bgs. The temporary well casing was screened from about 99 to 109 feet bgs. The static water level of the uppermost saturated zone was measured at 103.5 feet bgs. The temporary monitoring well was developed by surging and bailing to remove fines from within the well casing.

One groundwater sample (TMW-1) and one field transfer blank (TMW-21) were collected using a disposable PVC bailer. The sample was submitted for analysis of VOC under a rapid laboratory turnaround.

Upon receipt of analytical results the temporary monitoring well was formally abandoned in accordance with Construction and Maintenance of Wells (WAC 173-160).

Sample lithology was described on field boring logs using the Unified Soil Classification System (USCS). Kennedy/Jenks Consultants' Standard Procedures for hollow stem auger drilling and borehole logging are presented in Appendix B. Boring logs are presented in Appendix C. Additional details regarding drilling and sampling of TMW-1 are presented in Appendix E (*Supplemental Subsurface Investigation*, dated 17 November 1995, by Kennedy/Jenks Consultants).

Onsite mobile laboratory analyses of soil samples were performed using EPA Method 8021 and a combination of EPA Methods 8010 and 8020. For samples from borings BB-1 through BB-8, the analytes quantified and reported using EPA Method 8021 were PCE, TCE, dichloroethene (DCE; sum of trans- and cis-isomers), 1,1,1-trichloroethane (1,1,1-TCA), and 1,1,2-TCA. This target compound list was selected for the following reasons.

- Numerous soil samples were analyzed by EMR using EPA Method 8240, and PCE was the only VOC that was consistently detected. TCE and 1,1,1-TCA were detected by EMR in one shallow soil sample (SS-1).

- The reduced method run-time for the target compound list allowed for faster field decisions.

For soil samples from borings BB-9 through BB-18, the target compound list was augmented to include a greater number of chlorinated alkanes and alkenes, as well as common aromatic fuel constituents (BTEX). The analyte list was augmented to detect other VOCs that might be present beyond the immediate vicinity of the Phase I remedial excavation area.

The groundwater sample from TMW-1 was submitted for analysis at a fixed base laboratory. Sample TMW-1 was analyzed for VOCs using EPA Method 8240.

Laboratory analytical reports and chain-of-custody forms for soil samples are presented in Appendix D. The analytical laboratory report for sample TMW-1 is presented in Appendix E.

### 2.2.3 Soil Gas Sampling and Analysis

Following the excavation of soil containing PCE from the principal identified source area beneath and immediately west of the western portion of the former Bellevue Cleaning Village building, a soil gas survey was performed in the study area to attempt to identify other areas where VOCs might have been released into the subsurface.

The soil gas survey consisted of collecting and analyzing soil gas samples from 32 locations. Because the sources of releases in the Phase I remedial excavation appeared to be a floor drain and storm drain catch basin, soil gas sampling focused on the downstream storm sewer system piping alignment. Soil gas sampling locations are shown on Figure 2.

The soil gas survey was performed by Transglobal Environmental Geosciences, Inc. (TEG). Soil gas probes were driven into the soil using a roto-hammer. The highly compacted nature of the soils restricted probe penetrations to between 3 and 6 feet bgs. Prior to sampling at each location, at least 60 cubic centimeters (cc) of soil gas were evacuated from the probe. Soil gas samples were then collected in a 20-cc sample syringe. The sample was carried over to the mobile laboratory for immediate direct injection into a gas chromatograph.

The validity of each soil gas sample was assessed qualitatively based on a review of the FID and electron capture detector (ECD) baseline traces. A flat baseline was regarded as an indication that the injected sample had likely been compromised by air leakage during sampling. A baseline with a methane peak and numerous other small peaks characteristic of soil gas was interpreted to be indicative of a representative soil gas sample. If an injected sample exhibited a flat baseline, the sampling probe was either removed and redriven, or driven deeper at its original location and resampled.

Soil gas probes were cleaned between locations, and internal tubing and connections that contacted the samples were replaced between sampling.

### 2.3.4 Storm Sewer Catch Basin Sediment Sampling

located east of the study area.

Sediment samples were collected from six storm sewer catch basins. These samples were collected in order to assess other potential sources of PCE release to the storm sewer system that may have contributed to conditions observed at BB-15. Site development drawings provided by Turner Construction were used to assess which catch basins were connected to the manhole. Five of the samples were from catch basins upstream of the manhole (SED-1 through SED-5) and one sample was from downstream of the manhole (SED-6).

Catch basins sediments were collected by scraping away the upper two inches of sediment in the bottom of the catch basin to expose the underlying (and presumably older) sediments. The underlying sediments were collected using a stainless steel spoon connected to a 6 foot extension. The sediments were placed directly into glass sample containers, packed tightly to reduce headspace, and sealed with polytetrafluorethylene (PTFE) lined screw caps.

Catch basis sediments were submitted to a fixed based analytical laboratory for analysis of VOCs using EPA Method 8240. Laboratory analytical reports and chain-of-custody forms for sediment samples are presented in Appendix F.

## 2.3 INVESTIGATIVE FINDINGS

### 2.3.1 Lithology

Logs of the 27 borings advanced during this RI are presented in Appendix C. The study area is underlain by a glacial fill composed mainly of very dense sandy silt and silty sand with gravel. The sedimentary deposits encountered to 110 feet bgs (the maximum depth investigated) were unstratified and contained various proportions of poorly sorted, subangular gravel and cobbles.

Predominantly coarse-grained soil zones were encountered in several borings. A coarse sand and gravel zone of undetermined thickness was encountered at a depth of about 20 feet bgs in B-3. This zone, which contained perched water at the time of the investigation, was not encountered in other borings. also found in B-4 - see Section 2.3.2, below

In three borings (BB-12, BB-13, and BB-15), 5- to 15-foot-thick zones consisting of poorly graded sand with silt were encountered. The tops of these zones were encountered at depths ranging from 55 to 83 feet bgs. The sand fraction of the soil consisted of medium to coarse subangular felsic, mafic, and quartzose sand grains. Where encountered, the sand zones were immediately underlain by glacial till. A 10-foot-thick sandy lean clay layer was also encountered in BB-15 and TMW-1 immediately overlying the poorly graded sand with silt. This clay unit was not encountered in any of the other borings.

### 2.3.2 Hydrogeology

Based on an approximate site surface elevation of 146 feet above MSL at TMW-1 , the maximum depth of boring advancement during the RI corresponds to an elevation of about 36 feet above MSL. A zone of perched water was encountered by EMR in B-3 and B-4 at 17.5 to 20 feet bgs. Based on the absence of saturated conditions in any of the other borings drilled during the RI, the perched zone encountered by EMR appears to have been isolated and of relatively small lateral extent.

A review of Ecology files for leaking underground storage tank (LUST) sites in the area of the project site was undertaken to obtain water level information from nearby monitoring wells. Water level data from five LUST sites were reviewed:

- Applegreen Center; 1024 116th Avenue NE
- Unocal Station No. 587; 5 NE Bellevue Way
- Unocal Station No. 4384; 1624 Bellevue Way NE
- Ernst Home Center; 44 Bellevue Way NE
- Bellevue Chrysler Plymouth; 125 116th Avenue NE.

Water table elevations from these data were used to estimate the probable depth to groundwater beneath the project site. This extrapolated groundwater elevation is presented in Figure 5. The data suggest that the water table elevation beneath the study should be about 45 feet above MSL, with annual water level fluctuations of ±3 feet.

The static groundwater level was measured at about 103.5 feet below grade in the temporary monitoring well (TMW-1). This places the static water table elevation at about 42.5 feet above MSL. This observation is consistent with the data review and indicates that TMW-1 encountered the regional water table aquifer.

### 2.3.3 Analytical Results

2.3.3.1 Performance Monitoring Samples. Analytical results for the sixteen performance monitoring samples (PX-1 through PX-16) are summarized in Table 2. Also included on this table are the results from analysis of the initial sample (SS-1) collected by EMR upon discovery of dry cleaning solvent in soil at the project site. Eight of the performance monitoring samples shown on the table (PX-2, PX-3, PX-6, PX-10, PX-12, PX-13, PX-15 and PX-16) were collected from the sidewalls along the lateral limits of the Phase I remedial excavation. Analytical results for PCE for these sidewall samples were below the MTCA Method A soil cleanup level of 0.5 mg/kg that was used during the Phase I remedial action.

Four performance monitoring samples (PX-4, PX-5, PX-8, and PX-11) were collected from the base of the remedial excavation (15 feet bgs) to document PCE concentrations in the underlying soils.

2.3.3.2 Soil Gas Samples. Soil gas sampling points are shown on Figure 2. Table 3 presents a summary of analytical results for soil gas samples collected during the soil gas survey. Laboratory analysis reports for the soil gas samples are presented in Appendix D.

A total of 32 soil gas samples were collected and analyzed. Three chlorinated VOCs were detected in soil gas samples; TCE, PCE, and 1,1,1-TCA. Only PCE was detected at concentrations exceeding 1.0 ppmv.

The following summarizes the findings of the soil gas survey:

- Soil gas samples collected within the footprint of the Phase I remedial action area and adjoining building, but outside the remedial excavation area (SG-10 through SG-24), generally contained little to no detectable PCE. This finding suggests that the PCE release locations previously identified and excavated were the principal source areas for PCE detected in deeper soils underlying the building footprint.

- Soil gas samples collected from up to 50 feet south of the remedial excavation (SG-1 through SG-3) contained slightly elevated PCE concentrations.

- The soil gas samples collected from a probe installed within the remedial excavation to about 6 feet bgs (SG-25) contained relatively high concentrations of PCE in soil vapor (i.e., 8.22 mg/L).

- Several soil gas samples from along the storm sewer alignment contained high PCE concentrations. The sample collected adjacent to the storm sewer manhole (SG-28) contained the highest PCE concentrations detected in the study area, 10.7 mg/L. Two other samples along this alignment also contained greater than 1 mg/L of PCE in soil gas; SG-6 contained 1.04 mg/L and SG-9 contained 1.19 mg/L.

- Where detected in soil gas samples, TCE and 1,1,1-TCA were detected in conjunction with PCE and at smaller concentrations.

2.3.3.3 Subsurface Soil Samples. Table 4 presents a summary of analytical results for subsurface soil samples collected during EMR's site characterization, and Table 5 presents analytical results for Kennedy/Jenks Consultants' subsurface soil sampling. Soil boring locations are shown on Figures 2 and 4.

PCE was the only VOC consistently detected in the subsurface soil samples. Three other chlorinated VOCs (TCE; 1,1,1-TCA; and 1,1,2-TCA) were detected in one soil sample collected from a depth of 15 feet bgs in BB-15. 1,1,2-TCA was not detected in any of the other subsurface soil samples collected during the RI. TCE and 1,1,1-TCA were detected in EMR's initial grab sample at the former storm sewer catch basin (i.e., SS-1). 1,1,1-TCA was not detected in any other subsurface soil sample, and TCE was only detected in one other subsurface soil sample (i.e., BB-12 at 55 feet bgs). PCE was detected in samples from 16 of the 18 borings drilled by Kennedy/Jenks Consultants. The maximum PCE concentration detected during the RI was 4,180 mg/kg (15 feet bgs in BB-15). PCE concentrations exceeding the MTCA Method A cleanup level of 0.5 mg/kg were generally restricted to soils shallower than 55 feet bgs. The only sample from deeper than 55 feet bgs containing a PCE concentration exceeding 0.5 mg/kg was a sample collected from BB-13 at 70 feet bgs.

Residual PCE concentrations in soil beneath the Phase I remedial excavation vicinity (Phase I remedial action area and adjoining building floor) are shown on Figures 6 and 7. Figure 8 illustrates the lateral distribution of PCE concentrations at various depths beneath the remedial excavation area. Concentration contours were computer-generated using the Kriging algorithm in the Surfer Version 4 software package.

PCE was detected at concentrations ranging from 0.2 mg/kg to 0.7 mg/kg in soil samples collected from 70 feet bgs to 100 feet bgs in the soil boring drilled near the storm sewer manhole (BB-15). Analytical results for soil samples from other boring locations along the storm sewer alignment (BB-16 to BB-18) suggest only limited soil exposure to PCE. The maximum PCE concentrations detected in samples from these other borings was 0.11 mg/kg.

<u>2.3.3.4 Groundwater Sampling</u>. No VOCs were detected in either the groundwater sample (TMW-1) or the field transfer blank (TMW-21). The detection limit for each of the chemicals in the VOC analysis was 5.0 µg/L.

<u>2.3.3.5 Storm Sewer Catch Basin Sediment Samples</u>. No VOCs were detected in any of the 6 catch basin sediment samples. The detection limit for each of the chemicals in the VOC analysis was 0.1 mg/kg.

# 3.0 FEASIBILITY STUDY

The Feasibility Study is presented in two sections: the first addresses the selection of cleanup standards and the second presents the rationale for selection of remedial actions for the study area. The terms "study area" and "site" are used interchangeably throughout this section, and are synonymous.

## 3.1 SELECTION OF CLEANUP STANDARDS

This section addresses the selection of cleanup standards for the study area and is presented in seven subsections.

- Section 3.1.1 presents the chemical and medium of concern for the site
- Section 3.1.2 discusses potential receptors and exposure routes
- Section 3.1.3 describes Model Toxics Control Act Cleanup Regulation (MTCA) cleanup methods (A, B, and C)
- Section 3.1.4 presents the points of compliance for attainment of the soil cleanup level
- Section 3.1.5 describes applicable or relevant and appropriate requirements (ARARs) for the site
- Section 3.1.6 provides justification for using the MTCA Method B residential cleanup level at the site
- Section 3.1.7 presents an estimate of the volume of soil in the study area that exceeds the MTCA Method B cleanup level.

### 3.1.1 Chemical and Medium of Concern

PCE is identified as the chemical of concern, and soil is the medium of concern at the site. This determination is based on the following:

- PCE was commonly used as a dry cleaning solvent at the former Bellevue Cleaning Village. The use of PCE coupled with sampling locations where PCE concentrations were detected in the soil strongly suggest that the PCE contamination resulted from historic dry cleaning operations onsite.

- PCE was detected in at least one sample collected from each boring (except for BB-10 and BB-14) drilled and sampled during the RI.

- PCE was detected in 21 of 32 soil gas samples collected and analyzed during the RI.

- Other potential chemicals of concern detected in samples collected during the RI (TCE; 1,1,1-TCA; and 1,1,2-TCA) were detected in a few soil gas samples. Reported concentrations in soil of TCE (detected in three soil samples); 1,1,1-TCA (detected in two samples); and 1,1,2-TCA (detected in one sample), were well below the MTCA Method A cleanup levels.

- Potential exposure of surface water or air to PCE detected in the subsurface in the study area was limited by the site development features such as pavement, structures, and drainage control.

- PCE concentrations in soil that exceed the MTCA Method B soil cleanup level based on direct contact with contaminated soil appear to be limited to about the uppermost 10 to 20 feet of the unsaturated zone.

- Neither PCE nor other VOCs were detected in the groundwater sample collected during the RI.

- The depth to groundwater (103.5 feet) and the low permeability of the vadose soils combine to protect groundwater from residual PCE in the unsaturated zone.

### 3.1.2 Potential Receptors

Soil containing PCE above the MTCA Method B cleanup level (19.6 mg/kg) was detected in two locations. The first location was in the vicinity of the former dry cleaners. The second location was in the vicinity of an onsite manhole (see Figure 2). Soil containing PCE above the MTCA Method B cleanup level in the vicinity of the former dry cleaners was excavated to a depth of 15 feet and disposed of offsite at a permitted facility during an interim remedial action (Welch, 3 August 1994, personal communication). Performance monitoring soil samples from the remedial excavation confirmed that soils exceeding the Method B cleanup levels were completely removed. Based on field OVA readings and analytical data, soil containing PCE at concentrations exceeding the MTCA Method B cleanup level in the vicinity of the manhole appears to be situated between about 10 and 20 feet bgs.

MTCA considers human exposure via direct contact (i.e., ingestion, inhalation, and dermal contact) to chemicals of concern in soil below 15 feet to be unlikely [WAC 173-340-740(6)(c)]. Therefore, exposure to chemicals of concern in study area soil via direct contact would be unlikely for present or future onsite or offsite human receptors.

Permanent surface water features are not present in or adjacent to the study area. Runoff from the study area is collected in a subsurface storm sewer and routed to the municipal storm sewer line beneath 108th Avenue.

The groundwater sample collected from boring TMW-1 did not contain PCE or other VOCs at concentrations equaling or exceeding the analytical method detection limit (5.0 ug/L). TMW-1 was located about 35 feet west of the manhole. Soil samples collected adjacent to the manhole (BB-15) contained the highest concentrations of PCE detected at the site. Based on this finding, exposure of human or ecological receptors due to migration of PCE through the subsurface at the site is considered unlikely.

In summary, no potential receptors can be reasonably exposed to PCE contained in soil at the site.

### 3.1.3 Cleanup Levels

MTCA outlines three basic approaches for establishing cleanup levels: Methods A, B, and C. Method A cleanup levels are established at concentrations at least as stringent as concentrations specified in WAC 173-340 Tables 1, 2, and 3 and in applicable state and federal laws. Methods B and C describe risk assessment procedures [WAC 173-340-700(4)(c)] for residential and industrial locations.

WAC 173-340-700(3)(a) and -704 authorize Method A cleanup levels for some cleanup actions. Method A is appropriate for routine cleanups involving relatively few hazardous substances, and for sites where numerical standards are available for indicator hazardous substances. A cleanup action is routine [WAC 173-340-130(7)(a)] if:

- It involves an obvious and limited choice among cleanup methods
- It uses a cleanup method that is reliable and has proven to be capable of meeting cleanup standards
- Cleanup standards for each hazardous substance addressed by the cleanup are obvious and undisputed, and allow an adequate margin of safety for the protection of human health and the environment
- Ecology has experience with similar actions

- The action does not require an environmental impact statement.

Cleanup of groundwater is not normally considered a routine cleanup action [WAC 173-340-130(7)(c)]. For other chemicals not addressed by WAC 173-340 Tables 1, 2, and 3 or ARARs, concentrations must not exceed natural background levels or the practical quantitation limit (PQL).

Method B is the standard method for determining cleanup levels for soil, groundwater, surface water, and air. Cleanup levels for individual hazardous substances are established using applicable state and federal laws or the risk assessment equations specified in WAC 173-340-720 through -750.

Method C is a conditional method for establishing cleanup levels. Method C provides cleanup levels that protect human health and the environment for specified site uses. Method C can be used where the cleanup action can be shown to comply with applicable state and federal laws, to utilize all practical methods of treatment, and to implement institutional controls.

Method C can be used under the following conditions [WAC 173-340-706(1)]:

- Where Method A or B cleanup levels are below background concentrations

- When the use of Method A or B has the potential for creating significantly greater risks to human health and the environment than the attainment of Method C

- When the attainment of cleanup levels under Method A or B is technically not possible

- When the site is classified as an industrial site that meets the criteria for establishing the soil cleanup levels described in WAC 173-340-745.

Method C cleanup levels, based on the risk assessment equations in WAC 173-340-720 through -750, must be as stringent as cleanup levels established under applicable state or federal laws and must be estimated to result in no significant adverse effects on the protection and propagation of aquatic and terrestrial life.

### 3.1.4 Points of Compliance

The point of compliance is the point (or points) where soil cleanup levels established for the site are to be achieved.

Human exposure to PCE in this study area via direct contact with contaminated soil is the potential exposure route of concern (see Section 3.1.2). This potential route of exposure has been eliminated by the remedial excavation to 15 feet in the area outside of the former dry cleaner. The remaining area of relatively shallow PCE contamination in the area of BB-15 will be remediated in order to eliminate potential exposures due to direct contact.

### 3.1.5 Potential ARARs

MTCA requires that all cleanup actions comply with ARARs [WAC 173-340-710(1)(a)]. MTCA presents the definitions for ARARs [WAC 173-340-710(2) and (3)] as follows:

- Applicable requirements include "... those cleanup standards, standards of control, and other environmental protection requirements, criteria, or limitations promulgated under state or federal law that specifically address a hazardous substance, cleanup action, location, or other circumstance at the site."

- Relevant and appropriate requirements include "... those cleanup standards, standards of control, and other environmental requirements, criteria, or limitations established under state or federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site."

ARARs can be chemical-, action-, or location-specific. Chemical-specific ARARs are typically health- or risk-based numerical values that result in acceptable concentrations of chemical concentrations that may be detected in or discharged to the environment. Table 6 presents the chemical-specific ARAR concentration for PCE in soil (i.e., 19.6 mg/kg).

Action-specific ARARs regulate technologies or activities that involve handling or treating hazardous wastes. Action-specific ARARs are typically technology- or activity-based requirements or limitations. Location-specific ARARs address restrictions on activities or permissible chemical concentrations in a particular location (EPA 1988b). Table 7 describes the potential action-specific ARARs for the site.

No location-specific ARARs were identified for the study area.

### 3.1.6 Justification for Method B Cleanup Level

The Method B cleanup level (cleanup level) for PCE is appropriate for the site because the site meets the criteria for Method B. Evaluation of potential remedial actions indicates that a limited, but reliable and proven, set of remedial methods are available (see Section 3.2.1). Ecology has experience with sites having soil contaminated by dry cleaning solvent and has developed cleanup standards for them (WAC 173-340-740 Table 2). Typically, remedial actions at these sites do not require an environmental impact statement.

### 3.1.7 Estimate of the Volume of Soil That May Require Remediation

Vicinity of Former Dry Cleaners. Approximately 2,140 cubic yards ($yd^3$) of soil containing PCE were removed from the vicinity of the former dry cleaners during the initial (Phase I) remedial action at the site.

Manhole. During the RI, soil boring BB-15 was drilled and sampled adjacent to the manhole. PCE concentrations exceeding the MTCA Method B cleanup level were detected only in the sample collected from 15 feet bgs. The lateral extent of PCE concentrations exceeding 19.6 mg/kg was not evaluated directly by drilling and sampling. Therefore, it was assumed that the configuration of soil exceeding the Method B cleanup level for PCE is a cylinder with a radius of about 20 feet from the manhole extending from about 10 feet below grade to about 20 feet below grade. Based on available data and this assumption, a conservative estimate of approximately 465 $yd^3$ of soil contain PCE above the cleanup level.

## 3.2 RATIONALE FOR SELECTING THE REMEDIAL ACTION

This section presents the rationale for selecting remedial actions that address the soil containing PCE at concentrations exceeding the cleanup level. Section 3.2.1 identifies and evaluates potential remedial methods. Section 3.2.2 describes the definition of remediation areas within the study area to develop remedial alternatives and identifies remedial alternatives that are applicable to the site conditions. A preliminary analysis of these alternatives is presented in Section 3.2.3, and a detailed analysis is presented in Section 3.2.4. Section 3.2.5 offers a comparative analysis using the criteria presented in the detailed analysis, and Section 3.2.6 concludes with the recommended remedial alternative.

### 3.2.1 Identification and Evaluation of Potential Remedial Methods

This section identifies and evaluates potentially applicable remedial methods based on effectiveness, ability to be implemented, and cost. Remedial methods passing this evaluation are then ranked according to the MTCA hierarchy of preferred remedial methods.

3.2.1.1 Identify and Evaluate Remedial Methods. General response actions, remedial technologies, and process options that may be appropriate for addressing the site conditions were identified (EPA 1985 and 1987a). General response actions are broad categories of remedial methods that can address the cleanup of a specific matrix. Remedial technologies are different techniques within the general response actions. Process options are specific processes within each remedial technology category. For example, aboveground treatment is a general response action. Physical/chemical treatment is a remedial technology within the aboveground treatment category, and soil washing is a process option within the physical/chemical remedial technology class.

Process options were screened for their effectiveness, ability to be implemented, and relative cost.

Effectiveness involves the following considerations:

- Ability to process the anticipated volume of soil
- Ability to meet cleanup standards
- Ability to protect human health and the environment during construction and implementation.

The second criterion in evaluating process options (i.e., ability to be implemented) includes technical and administrative considerations. This criterion focuses on the ability to technically address PCE in soil at concentrations detected during the RI. It also evaluates the permits necessary for onsite and offsite activities and discharges, and the availability of offsite facilities, services, and materials.

Cost is the final criterion in evaluating process options. Cost is based on engineering judgments rather than detailed estimates. Process options that are judged to be similar in effectiveness and ability to be implemented, yet costing several times more than other process options in the same technology category, were eliminated from further consideration.

Process options that are not appropriate for site conditions, planned future site uses, or for PCE contained in soil at concentrations detected during the RI were eliminated from further consideration. In addition, process options that are innovative but not yet proven remedial methods, were also eliminated. If more than one process option in a remedial technology group was identified as potentially appropriate for the site, one process option was selected to represent that technology group. Table 8 presents the identification and evaluation of general response actions, remedial technologies, and process options for soil.

3.2.1.2 MTCA Hierarchy of Preferred Remedial Methods. MTCA requires that the process options used minimize the amount of untreated hazardous substances remaining at a site and that attention be given to permanent solutions and a hierarchy of preferred remedial methods [WAC 173-340-360(3)-(5)]. The MTCA preference for process options, in descending order, is:

1) Reuse or recycling

2) Destruction or detoxification

3) Separation or volume reduction followed by reuse, recycling, destruction, or detoxification of the residual hazardous substance

4) Immobilization of hazardous substances

5) Onsite or offsite disposal at an engineered facility designed to minimize the future release of hazardous substances, and in accordance with applicable state and federal laws

6) Isolation or containment with attendant engineering controls

7) Institutional controls and monitoring.

Table 9 summarizes the results of the process option evaluation, as detailed in Table 8. Table 9 also lists the MTCA preference for each process option.

No soil process options in MTCA preference categories 1, 2, or 4 survived the evaluation process. PCE was not detected in samples collected at the site in a form or concentration that would permit reuse or destruction without first separating the chemical from the soil. Typically, immobilization techniques are not appropriate for organics.

In situ vapor extraction and thermal desorption would separate the chemical from the soil for destruction or further treatment. These process options meet the MTCA expectation to use treatment technologies when practicable, and to destroy or remove hazardous substances to concentrations below cleanup levels [WAC 173-340-360(9)(a) and (b).

Process options shown in Table 9 also include lower preference methods: offsite disposal and institutional controls. MTCA recognizes the need for engineering controls, such as containment, for sites that contain large volumes of material with relative low levels of hazardous substances where treatment is impracticable [WAC 173-340-360(9)(c)].

### 3.2.2 Identification and Description of Remedial Alternatives

This section identifies alternatives that may be appropriate for remediating the site. Section 3.2.2.1 describes the remediation area approach used at the site to develop remedial alternatives. Section 3.2.2.2 presents site-specific descriptions of the remedial process options that are combined into site alternatives. Section 3.2.2.3 identifies the alternatives for the site, and Section 3.2.2.4 presents descriptions of the remedial alternatives. Approximately 2,140 $yd^3$ of soil were excavated from the vicinity of the former dry cleaners during the Phase I remedial action based on an assumed cleanup level of 0.5 mg/kg. Accordingly, soil exceeding the selected cleanup level of 19.6 mg/kg was completely removed from this area during the action.

3.2.2.1 Remediation Area. The only area requiring remediation of PCE-contaminated soil is the vicinity of the storm sewer manhole.

As noted above, a Phase I remedial action has already been undertaken at the location of the former dry cleaners. This action involved excavating PCE-contaminated soil, backfilling with imported clean material, and leaving relatively low concentrations of PCE in soil.

3.2.2.2 Description of Process Options Selected for Developing Remedial Alternatives. This section presents site-specific descriptions of the process options shown in Table 9.

In Situ Vapor Extraction. Vapor extraction removes VOCs from the soil. Perforated pipes are placed in the soil, and a blower creates a pressure gradient that causes the VOCs to move through the soil and into the pipes. Extracted soil gas is processed in a liquid-vapor separator that condenses the moisture and routes the VOCs to an activated carbon treatment system. The wastewater is then taken offsite for treatment.

Thermal Desorption. Thermal treatment strips VOCs from the soil with applications of temperatures that are relatively low (400°-1,100°F) when compared with those used for incineration. Soil is fed into an auger-type heat exchanger, where the addition of heat promotes soil moisture and VOCs to vaporize and escape from the soil. The vaporized VOCs are swept through a baghouse to control particulate emissions, and into a thermal oxidizer for destruction. The throughput for an onsite unit is estimated to be about 20 tons per hour.

Offsite Disposal. Trucks transport soil containing PCE above the cleanup level to a permitted offsite facility for disposal. To completely remove soil containing PCE concentrations exceeding the MTCA Method B cleanup level, approximately 465 $yd^3$ would need to be excavated in the vicinity of the manhole and disposed of offsite. About twenty-five to thirty-five trucks (assuming 1.5 tons per $yd^3$ and 20 to 30 tons per truckload) would be required. Transportation to, and disposal at, the permitted solid waste landfill at Roosevelt, Washington is assumed for cost estimating purposes.

Asphalt Cap. An asphalt cap consists of 3 inches of appropriate base material, covered with 3 inches of asphalt. Capping also includes the installation of a stormwater collection system and annual inspections and repairs to maintain the integrity of the cap.

Although this FS evaluates asphalt, other caps (e.g., concrete) would provide equivalent protection to human health and the environment. However, asphalt provides adequate protection of human health, is cost-effective, and is a common paving material for parking areas.

Excavation. Backhoes, excavators, and front-end loaders could be used to excavate soil for disposal or treatment in the vicinity of the manhole. Approximately 465 $yd^3$ would be excavated for treatment or disposal in the vicinity of the manhole. Approximately 800 $yd^3$ of clean soil would be removed, stockpiled, and used for backfill.

3.2.2.3 Development of Alternatives. This section identifies alternatives that could be appropriate for each remediation area. These alternatives are identified using the requirements and expectations described in MTCA (WAC 173-340-360), which include:

- Meeting threshold requirements for remedial alternatives (see Section 3.2.3)
- Using permanent solutions to the maximum extent practicable
- Providing for a reasonable restoration time frame
- Addressing public concerns raised during the public comment on the Draft Cleanup Action Plan.

In addition to these requirements, Ecology has expectations for cleanup actions [WAC 173-340-360(9)]. These expectations include:

- Using treatment technologies whenever practicable
- Minimizing the need for long-term management of contaminated materials by destroying, detoxifying, or removing hazardous substances that are above cleanup levels
- Recognizing the need to use engineering controls, such as containment, for sites with large volumes of relatively low levels of hazardous substances
- Using institutional controls to supplement engineering controls
- Minimizing contact of precipitation and runon with contaminated material
- Consolidating hazardous substances to the maximum extent practicable, if the hazardous substances remain onsite

- Preventing or minimizing releases to surface water and not depending solely on dilution to demonstrate compliance with the cleanup standards

- Not undertaking cleanup actions that will result in a greater overall threat to human health and the environment when compared to other alternatives.

MTCA recognizes that treatment may not be practicable for all sites. Treatment is required, wherever practicable, for sites containing liquid wastes, areas contaminated with high concentrations of hazardous substances, highly mobile materials, or discrete areas of hazardous substances that lend themselves to treatment [WAC 173-340-360(9)(a)]. MTCA also recognizes that engineering controls, such as containment, are appropriate for sites that contain large volumes of materials with relatively low levels of hazardous substances where treatment is impracticable [WAC 173-340-360(9)(c)].

The following alternatives are proposed for the site:

- An alternative involving offsite disposal of soil containing PCE above the cleanup level. This alternative meets the MTCA expectation to minimize the need for long-term management of contaminated materials.

- Two alternatives that meet the MTCA expectations to use treatment whenever practicable and to minimize the need for long-term management of contaminated materials.

- One treatment alternative involves excavating soil containing PCE above the cleanup level, thermally treating it onsite, and backfilling the excavation with the treated soil.

- The second treatment alternative involves in situ vapor extraction in areas of soil containing PCE above the cleanup level and capturing the chemical in activated carbon units for destruction at an offsite permitted facility.

Because the cleanup level would be achieved in soil throughout the site for the offsite disposal alternatives and both treatment alternatives, engineering or institutional controls would not be included.

All alternatives meet the MTCA expectation to avoid cleanup actions that result in greater overall threat to human health and the environment. Consolidation is not practicable at the site because PCE is widely dispersed in the soil at relatively low concentrations or is located at depths where consolidation is not practicable.

MTCA requirements for meeting threshold requirements, using permanent solutions to the maximum extent practicable, providing for a reasonable restoration time frame, and addressing public comments are addressed in Sections 3.2.3 and 3.2.4.

3.2.2.4 Description of Alternatives. This section describes the three remedial alternatives identified in Section 3.2.2.3.

Alternative 1: Offsite Disposal

This alternative would involve excavation and segregation of clean soil, and soil containing PCE above the cleanup level. Clean soil would be stockpiled for backfill material. Soil containing PCE above the cleanup level would be loaded into trucks, covered, and transported to a permitted offsite disposal facility. Imported material and stockpiled clean material would be used to backfill the excavation.

This alternative would not include institutional controls.

Alternative 2: Thermal Treatment

This alternative pertains to both remediation areas. This alternative would involve excavation and segregation of clean soil, and soil containing PCE above the cleanup level. While clean soil would be stockpiled for backfill material, soil containing PCE above the cleanup level would be thermally treated onsite. The treated soil and the stockpiled clean material would be used to backfill the excavation.

This alternative would not include institutional controls.

Alternative 3: In Situ Vapor Extraction

In this alternative, an in situ vapor extraction system would be constructed and operated. Subsurface soil samples would be collected after treatment to evaluate compliance with cleanup levels. This alternative would not include institutional controls

### 3.2.3 Preliminary Analysis of Alternatives

MTCA has threshold criteria that alternatives must meet for a remedial action to be considered a "cleanup" under MTCA [WAC 173-340-360(2)]. An alternative is not available for selection if it does not meet these threshold requirements. This section presents the evaluation of potential alternatives using these criteria to assess whether the alternatives analyzed in Section 3.2.4 would be available for selection.

The MTCA threshold criteria are described in Section 3.2.3.1. These criteria are used to evaluate the alternatives in Section 3.2.3.2.

3.2.3.1 Description of MTCA Threshold Criteria. To meet the threshold criteria, remedial alternatives must:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable state and federal laws

- Provide for compliance monitoring.

A cleanup is presumed to be protective of human health and the environment at the site if it achieves the PCE cleanup level of 19.6 mg/kg in soil shallower than 15 feet below ground surface. Compliance with cleanup standards involves achieving cleanup levels, establishing the point of compliance, and complying with applicable federal and state laws.

Compliance monitoring assesses the protection of human health and the environment during construction and the operation and maintenance period of a cleanup action. Compliance monitoring confirms that the remedial action has met cleanup standards and verifies its long-term effectiveness.

Compliance with the threshold requirements does not mean that hazardous substances cannot remain onsite untreated. MTCA recognizes that containment can comply with cleanup standards, provided that compliance monitoring is included to ensure the long-term integrity of the containment system.

Tables 6 and 7 identify potential ARARs for the site. Tables 10 and 11 present an evaluation of the ability of each alternative to meet these potential ARARs.

3.2.3.2 <u>Preliminary Analysis of Alternatives</u>. Three alternatives were developed to address the site conditions. Table 12 summarizes the evaluation of these alternatives with MTCA's threshold criteria. In the evaluations, compliance with cleanup standards only includes a discussion of the point of compliance because the other threshold criteria include descriptions of the remaining components of the cleanup standards (i.e., cleanup levels and compliance with ARARs).

MTCA requires that alternatives meet the threshold criteria, at a minimum, to be eligible for selection as a cleanup action. Based on the evaluation presented in Table 12, all alternatives meet the threshold criteria. Alternatives 1 (Offsite Disposal), 2 (Thermal Treatment), and 3 (In Situ Vapor Extraction) can achieve the cleanup level either through offsite disposal or treatment, meet all ARARs, have an acceptable point of compliance, and provide for compliance monitoring throughout remediation.

### 3.2.4 Detailed Analysis of Alternatives

In addition to meeting the threshold criteria, MTCA requires (WAC 173-340-360) that cleanup actions:

- Use permanent solutions to the maximum extent practicable
- Provide for a reasonable restoration time frame
- Consider public concerns raised during the public comment period.

Permanent solutions are actions through which cleanup standards can be met without further remedial activities being required at or off the site [WAC 173-340-360(5)(b)]. Permanent solutions must prevent or minimize future releases of hazardous substances; provide for a net reduction in the amount of hazardous substances being released from the source area; and not rely on institutional controls and monitoring, offsite disposal, or dispersion and dilution if active remedial measures are technically possible [WAC 173-340-360(5)(e)].

Ecology recognizes that permanent solutions may not be practicable for all sites. The following criteria are used to determine whether a cleanup action is permanent to the maximum extent practicable.

3.2.4.1 <u>Overall Protection of Human Health and the Environment</u>. This criterion evaluates: the degree to which existing risks are reduced, the time required to reduce the risks and achieve cleanup standards, onsite and offsite risks resulting from implementation of the alternative, the degree the cleanup action may surpass the specific standards in WAC 173-340-700 through 760, and improvement of the overall environmental quality. Since the overall protection of human health and the environment was evaluated for each alternative in Section 3.2.3.2, it is not evaluated further in this section.

3.2.4.2 Compliance with ARARs. This criterion evaluates how each alternative complies with federal and state ARARs. Section 3.2.3.2 (Table 12), and Tables 10 and 11 present evaluations of ARARs for each alternative.

3.2.4.3 Long-Term Effectiveness. Long-term effectiveness evaluates: the degree of certainty that the alternative will be successful, long-term reliability, the magnitude of residual risk, and the effectiveness of controls required to manage treatment residues or remaining wastes.

3.2.4.4 Short-Term Effectiveness. Short-term effectiveness describes the protection of human health and the environment during remediation and the degree of risk prior to achieving cleanup standards.

3.2.4.5 Permanent Reduction of Toxicity, Mobility, and Volume of the Hazardous Substance. This criterion evaluates the ability of an alternative to permanently and significantly reduce toxicity, mobility, or volume of the contaminated material. This criterion includes an evaluation of the adequacy of the alternative in destroying the hazardous substance, reduction or elimination of the hazardous substance releases and source of releases, degree of irreversibility of the waste treatment process, and the characteristics and quantity of treatment residuals generated.

3.2.4.6 Ability to be Implemented. Ability to be implemented considers: whether the alternative is technically possible; the availability of necessary offsite facilities, services and materials; administrative and regulatory requirements; scheduling, size, and complexity; monitoring requirements; access for construction, operations, and monitoring; and integration with existing facility operations and other current or potential remedial actions.

3.2.4.7 <u>Cost</u>. The cost criterion is used to select from among two or more cleanup action alternatives that have an equivalent level of preference (with respect to cleanup technologies and process options). Costs also are used to determine practicability. A cleanup action is not considered practicable if the incremental cost of the cleanup action is substantial and disproportionate to the incremental degree of protection achieved, compared to a lower preference cleanup action.

The detailed analysis of the alternatives using these MTCA criteria is presented in Tables 13 through 17.

Selection of a cleanup alternative must also involve the restoration time frame. The establishment of a restoration time frame should consider:

- Potential risks posed by the site
- Practicability of achieving a shorter restoration time frame
- Current and future use of the site, surrounding areas, and associated resources that are, or could be, affected by releases of hazardous substances
- Availability of alternative water supplies
- Likely effectiveness and reliability of institutional controls
- Ability to control and monitor hazardous substance migration from the site
- Toxicity of the hazardous substances
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site, or under similar site conditions.

Community concerns would be addressed by following the requirements described in WAC 173-340-550(5)(c)(iii). These requirements include:

- Sending written notification of the proposed remedial action to various parties
- Posting a sign at the site indicating what remedial actions are being conducted
- Identifying a party to contact for more information.

### 3.2.5 Comparative Analysis of Alternatives

3.2.5.1 Long-Term Effectiveness. Alternatives 1 (Offsite Disposal), 2 (Thermal Treatment) and 3 (In Situ Vapor Extraction) offer an equivalent degree of long-term effectiveness at the site. Disposal in an engineered landfill (Alternative 1) and treatment (Alternatives 2 and 3) reduce the magnitude of residual risk to an acceptable level (i.e., the cleanup level). In addition, all three alternatives eliminate the need for long-term monitoring and other controls because the cleanup level would be achieved.

3.2.5.2 Short-Term Effectiveness. Alternative 3 (In Situ Vapor Extraction) would have the best degree of short-term effectiveness. This alternative would not involve significant risks to human health or the environment. Vapor extraction wells could be installed with low risk to human health and the environment because established techniques are available for controlling these risks. Treatment residuals would be managed in accordance with applicable state and federal regulations. Remedial workers would be adequately protected with clothing and respirators, if required, during construction and operation of the remedial action.

Alternatives 1 (Offsite Disposal) and 2 (Thermal Treatment) would have the most significant short-term risks compared to the other alternative. Both alternatives involve deep excavations and complex shoring. Exposure to soil containing PCE, falling hazards, and work around moving heavy equipment for protracted periods would present tangible risks to remedial workers. Fugitive dust and vapors could result in exposure of workers and the community to PCE. The open excavations could also pose a threat to the environment due to the potential contamination of stormwater runon and runoff.

Of these two alternatives, Alternative 1 (Offsite Disposal) has the greatest degree of short-term risk because of the amount of truck traffic and noise that may significantly affect the community and the local transportation system. Approximately 700 tons of soil would be removed offsite, requiring 25 to 35 truckloads. These trucks would have the potential for transportation accidents and spills.

Although Alternatives 2 (Thermal Treatment) and 3 (In Situ Vapor Extraction) have short-term risks associated with air emissions, air pollution controls would be implemented to comply with air quality standards.

3.2.5.3 Permanent Reduction of Toxicity, Mobility, and Volume. Alternatives 2 (Thermal Treatment) and 3 (In Situ Vapor Extraction) would treat PCE in the soil to the cleanup level. Of these two alternatives, Alternative 2 would be expected to consistently achieve the cleanup level because direct treatment would more thoroughly treat the soil compared to in situ methods, which may be adversely affected by the geological characteristics of, and chemical distribution at, the site.

Alternative 1 (Offsite Disposaldoes not involve treatment that would reduce the toxicity, mobility, or volume of PCE.

3.2.5.4 Ability to be Implemented. Alternative 3 (In Situ Vapor Extraction) involves installing wells (a common remedial feature that would not be difficult at this site) and is the simplest alternative to physically implement.

Alternatives 1 (Offsite Disposal) and 2 (Thermal Treatment) entail deep excavations that would require significant shoring. These alternatives would be the most difficult to implement. Alternative 2 (Thermal Treatment) involves uncertainties regarding the thermal treatment process. Soil moisture conditions, materials handling problems, and air pollution control system performance deficiencies could adversely affect the process.

Permits for the alternatives are expected to be relatively easy to obtain, although it could take up to three months to obtain the necessary permits. The availability of offsite facilities, services, and materials is adequate for all alternatives. Alternatives 1 (Offsite Disposal), 2 (Thermal Treatment), and 3 (In Situ Vapor Extraction) can be effectively monitored during remedial action implementation.

3.2.5.5 Cost. A summary of costs for the alternatives is presented in Table 17 (detailed cost information is provided in Appendix E).

3.2.5.6 Restoration Time Frame. Alternative 1 (Offsite Disposal) could require 4 to 6 months for implementation. Alternative 2 (Thermal Treatment) could require 6 to 8 months to complete. Alternative 3 (In Situ Vapor Extraction) could take from 6 months to 2 years to complete, depending on the effectiveness of the process.

3.2.5.7 Community Concerns. Community concerns will be addressed as described in Section 3.2.4.

### 3.2.6 Recommended Alternative

The recommended alternative for the site is Alternative 3 (In Situ Vapor Extraction). The alternative meets applicable state and federal laws and offers a high degree of protection to human health and the environment. In situ vapor extraction at this remediation area can be quickly implemented and offers minimal short-term risks to remediation workers and the community (compared to offsite disposal and thermal treatment, which involve deep excavations). In situ vapor extraction is a high-preference process that uses treatment to the maximum extent practicable. This alternative is likely to meet the cleanup level throughout the remediation area, and it does not need a conditional point of compliance.

# 4.0 CONCLUSIONS

The following conclusions are supported by the findings of the RI/FS.

- PCE is the primary chemical of concern identified at the site. Although trace concentrations of trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA) were detected in soil gas samples, neither compound has been detected in soil samples at concentrations exceeding MTCA cleanup levels. Other than the prior dry cleaning operation, no other historic activities that might have led to environmental releases of hazardous substances were identified during EMR's research into past operations in the study area.

- Data suggest that the PCE release is associated with the former dry cleaning operation at the Bellevue Cleaning Village.

- The mode of PCE release into the subsurface appears to have been leakage from the floor drain inside the former dry cleaner building, and from the storm sewer catch basin and manhole located west and southeast of the dry cleaner building, respectively. The manhole is constructed of brick and mortar and is of unknown age.

- Sampling data demonstrate that the shallow soil (i.e., less than 15 feet bgs), containing PCE at concentrations exceeding the MTCA Method B cleanup level, has been removed from the Phase I remedial action area. Therefore, the cleanup in this area has met the MTCA point of compliance requirement for human exposure via direct contact cited in WAC 173-340-740(6)(c).

- Findings of the soil gas sampling effort in the vicinity of the Phase I remedial action area suggest that the PCE contamination identified and excavated during the Phase I remedial action was the principal source area for PCE, and that PCE was not released from other locations in this area.

- Elevated concentrations of PCE in soil at the storm sewer manhole begin near 15 feet bgs, which corresponds to the bottom of the manhole structure.

- The lateral extent of PCE concentrations exceeding 19.6 mg/kg (MTCA Method B soil cleanup level) around the manhole has not been characterized through direct sampling, but is expected to be of limited horizontal distance due to the nature of the release. Soil sampling indicates that the maximum vertical extent of PCE exceeding 19.6 mg/kg in soil beneath the manhole is less than 25 feet bgs.

- There do not appear to have been PCE releases along the storm sewer drain alignment between the Phase I remedial action area and the manhole requiring remediation.

- Groundwater occurs at a depth of about 103.5 feet bgs at the site and the annual water table elevation fluctuations are probably minimal (i.e., less than 3 feet).

- Groundwater sampling and analysis demonstrated that PCE from the storm sewer manhole has not impacted the water table.

- PCE and other chlorinated VOCs were not detected in sediment samples collected from onsite storm drain catch basins outside of the Phase I remedial action area either upstream or downstream of the storm sewer manhole (i.e., Phase I remedial action area).

- Based on the FS, the remedial alternative that best meets the selection criteria near the manhole is soil vapor extraction.

# 5.0 LIMITATIONS OF THE STUDY

This RI/FS is based on the sampling and testing in the study area that is described herein. Kennedy/Jenks Consultants is not responsible for the accuracy of information provided by others cited in this document that has not been independently verified. The RI/FS did not include a comprehensive investigation for all possible substances subject to regulation or potentially detrimental to human health or the environment. Findings are our professional opinion and are not a warranty, guarantee, or positive assertion as to the presence, absence, or extent of hazardous substances in the subsurface in the study area.

# 6.0 REFERENCES


Environmental Management Resources, Inc. (EMR). "Phase I Environmental Site Assessment, Benenson Bellevue Associates II Property, The Shops at First Street Property, 100/110 108th Avenue NE and 10812 Main Street, Bellevue, Washington, 98004." 12 April 1994.

Galster, Richard W., and Laprado, William T. "Geology of Seattle, Washington, United States of America." Bulletin of the Association of Engineering Geologists. Volume XXVIII, No. 3. 1991.

Johnson, P.C., Kemblowski, M.S., and Colthart, J.D. 1990a. "Quantitative Analysis for the Cleanup of Hydrocarbon-Contaminated Soils by In Situ Soil Venting." *Groundwater*, Volume 28, Number 3, May-June 1990.

U.S. Environmental Protection Agency. 1985. Handbook Remedial Action at Waste Disposal Sites (Revised). EPA/625/6-85/006. U.S. EPA, Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency. 1987a. A Compendium of Technologies Used in the Treatment of Hazardous Wastes. EPA/625/8-87/014. U.S. EPA, Center for Environmental Research Information, Cincinnati, OH.

U.S. Environmental Protection Agency. 1987b. Remedial Action Costing Procedures Manual. EPA/600/8-87/049. U.S. EPA, Office of Solid Waste and Emergency Response, Washington, DC.

U.S. Environmental Protection Agency. 1988a. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. EPA/540/G-89/004. OSWER Directive 9355.3-01. U.S. EPA, Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency. 1988b. CERCLA Compliance with Other Laws Manual: Draft Guidance. EPA/540/G-89/006. U.S. EPA, Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency. 1988c. Technology Screening Guide for Treatment of CERCLA Soils and Sludges. EPA/540/2-88/004. U.S. EPA, Office of Solid Waste and Emergency Response, Washington, DC.

U.S. Environmental Protection Agency. 1989. CERCLA Compliance with Other Laws Manual, Part II. Clean Air Act and Other Environmental Statutes and State Requirements. Interim Final. August 1989. U.S EPA, Office of Solid Waste and Emergency Response, Washington, DC.

U.S. Environmental Protection Agency. 1990. Handbook on In Situ Treatment of Hazardous Waste-Contaminated Soils. EPA/540/2-90/002. U.S. EPA, Risk Reduction Engineering Laboratory, Cincinnati, OH.

Welch, D. 3 August 1994. Personal Communication (telephone conversation with Mr. Thom Morin, Kennedy/Jenks Consultants, Federal Way, WA regarding interim remedial action at Benenson site). Mr. David Welch, EMR, Inc., Bellevue, WA.

# Tables

# TABLE 1

## SUMMARY OF DRILLING AND SAMPLING INVESTIGATIVE WORK

| Phase | Borings | Boring Depth(s) (ft bgs) | Objectives | Field Screening Instrument | Laboratory Analytical Methods | Date | Consultant |
|---|---|---|---|---|---|---|---|
| 1 | B-1 to B-5 | 15 to 37 | Preliminary characterization of VOC types and concentration distribution in identified source areas. | PID | EPA 8240 | 28 June 1994 | EMR, Inc. |
| 2 | B-6 | 90 | Obtain information on unsaturated zone thickness. | PID | EPA 8240 | 13 July 1994 | EMR, Inc. |
| 3 | B-7 and B-8 | 60 | Determine vertical extent of detectable VOC concentrations beneath identified release locations. | PID | EPA 8240[a] | 25 July 1994 | EMR, Inc. |
| 4 | BB-1 to BB-8 | 70 to 80 | Characterize lateral and vertical distribution of selected chlorinated VOC concentrations in soil in area of Phase I remedial action excavation. | FID | EPA 8021[b] | 5,6 August 1994 | Kennedy/Jenks Consultants |
| 5 | BB-9 to BB-14 | 60 to 90 | Characterize lateral and vertical extent of detectable concentrations of selected aromatics and chlorinated VOCs in area of Phase I remedial action excavation. | FID | EPA 8021[c] | 10, 11 August 1994 | Kennedy/Jenks Consultants |
| 6 | BB-15 to BB-18 | 20 to 100 | Evaluate possible exposure of soil along storm sewer alignment to selected chlorinated VOCs based on results of soil gas survey; characterize vertical distribution of PCE concentrations beneath storm sewer manhole. | FID | EPA 8010/8020[c] | 15, 16 October 1994 | Kennedy/Jenks Consultants |
| 7 | TMW-1 | 109 | Evaluate possible exposure of uppermost saturated zone to PCE near the area of BB-15 | PID | EPA 8240 | 3 November 1995 | Kennedy/Jenks Consultants |

Notes:

PID = Photoionization detector.
FID = Flame ionization detector.
(a) Samples analyzed for PCE; TCE; DCE; 1,1,1-TCA; and 1,1,2-TCA.
(b) Selected samples were analyzed for halogenated organic compounds only by EPA Method 8240.
(c) Samples analyzed for selected chlorinated alkanes and alkenes, as well as benzene, toluene, total xylenes, and ethylbenzene.

# TABLE 2

## SUMMARY OF ANALYTICAL RESULTS FOR PERFORMANCE MONITORING SOIL SAMPLES
### (Concentrations in mg/kg)

| | Sample | Depth (feet bgs) | Perchloroethylene | Methyl Ethyl Ketone | 1,1,1-Trichloroethane | Trichloroethene |
|---|---|---|---|---|---|---|
| | SS-1 | 2 | 410[a] | <2.0 | 1.9 | 0.34 |
| | PX-1 | 12 | 0.62 | <2.0 | <0.2 | <0.2 |
| S | ***PX-2*** | 12 | 0.36 | <2.0 | <0.2 | <0.2 |
| S | ***PX-3*** | 12 | 0.22 | <2.0 | <0.2 | <0.2 |
| B | ***PX-4*** | 15 | 1.7 | <2.0 | <0.2 | <0.2 |
| B | ***PX-5*** | 15 | <0.20 | <2.0 | <0.2 | <0.2 |
| S | ***PX-6*** | 12 | <0.20 | <2.0 | <0.2 | <0.2 |
| | PX-7 | 12 | 0.52 | <2.0 | <0.2 | <0.2 |
| B | ***PX-8*** | 15 | 1.0 | <2.0 | <0.2 | <0.2 |
| | PX-9 | 12 | 1.5 | <2.0 | <0.2 | <0.2 |
| S | ***PX-10*** | 12 | <0.20 | <2.0 | <0.2 | <0.2 |
| B | ***PX-11*** | 15 | 1.9 | <2.0 | <0.2 | <0.2 |
| S | ***PX-12*** | 12 | <0.20 | <2.0 | <0.2 | <0.2 |
| S | ***PX-13*** | 12 | <0.20 | 2.0 | <0.2 | <0.2 |
| | PX-14 | 12 | 0.85 | <2.0 | <0.2 | <0.2 |
| S | ***PX-15*** | 12 | 0.27 | <2.0 | <0.2 | <0.2 |
| S | ***PX-16*** | 10 | <0.20 | <2.0 | <0.2 | <0.2 |
| | MTCA Method A Soil Cleanup Levels[b] | | 0.50 | NE | 20 | 0.50 |

Notes:

All samples were analyzed for volatile organics using EPA Method 8240. Only compounds detected are reported.

(a) Analyzed at 1:100 dilution.

(b) Model Toxics Control Act [WAC 173-340-740(2)].

NE Indicates no regulatory limit has been established.

Samples in ***BOLD AND ITALICS*** denotes samples collected from limit of soil excavation.

B= bottom samples
S= side wall samples

# TABLE 3

## SUMMARY OF ONSITE MOBILE LABORATORY SOIL GAS ANALYTICAL RESULTS

| Sample | Detected Volatile Organic Compounds (parts per million volume) | | |
|---|---|---|---|
| | Perchloroethylene | Trichloroethene | 1,1,1-Trichloroethane |
| SG-1 | 0.01 | ND | ND |
| SG-2 | 0.27 | ND | 0.18 |
| SG-3 | 0.86 | 0.07 | 0.46 |
| SG-4 | 0.01 | ND | ND |
| SG-5 | ND | ND | ND |
| SG-6 | 1.04 | 0.02 | 0.64 |
| SG-7 | 0.04 | ND | ND |
| SG-8 | 0.11 | ND | 0.03 |
| SG-9 | 1.19 | ND | 0.68 |
| SG-10 | 0.07 | ND | ND |
| SG-11 | 0.01 | ND | ND |
| SG-12 | 0.04 | ND | ND |
| SG-13 | ND/ND[a] | ND/ND[a] | ND/ND[a] |
| SG-14 | ND | ND | ND |
| SG-15 | ND | ND | ND |
| SG-16 | 0.01 | ND | ND |
| SG-17 | ND | ND | ND |
| SG-18 | 0.02 | ND | ND |
| SG-19 | ND | ND | ND |
| SG-20 | ND | ND | ND |
| SG-21 | ND | ND | ND |
| SG-22 | ND | ND | ND |
| SG-23 | 0.11 | ND | ND |
| SG-24 | ND | ND | ND |
| SG-25 | 8.22 | ND | 0.07 |
| SG-26 | 0.10/0.13[a] | ND/ND[a] | ND/ND[a] |
| SG-27 | 0.10 | ND | ND |
| SG-28 | 10.7 | 0.16 | 0.19 |
| SG-29 | ND | ND | ND |
| SG-30 | 0.07/0.09[a] | ND/ND[a] | ND/ND[a] |
| SG-31 | 0.39 | ND | 0.01 |
| SG-32 | 0.12/0.10[a] | ND/ND[a] | ND/ND[a] |
| Detection Limits | 0.01 | 0.01 | 0.01 |

Notes:

All samples were analyzed for selected chlorinated solvents using modified EPA Method 8021. Only compounds detected are reported.
ND Indicates not detected above the detection limit.
(a) Laboratory duplicate sample result.

# TABLE 5

## SUMMARY OF ONSITE MOBILE LABORATORY SUBSURFACE SOIL ANALYTICAL RESULTS

| Boring | Depth (ft) | Detected Volatile Organic Compound (mg/kg) |
|---|---|---|
| | | Perchloroethylene (PCE) |
| BB-9 (cont.) | 45 | 0.04 |
| | 55 | ND |
| | 60 | ND |
| BB-10 | 5 | ND |
| | 15 | ND |
| | 25 | 0.03 |
| | 35 | 0.05/ND[a] |
| | 45 | ND |
| | 55 | 0.03 |
| | 62 | ND |
| BB-11 | 5 | ND |
| | 15 | ND |
| | 25 | ND |
| | 35 | 0.02 |
| | 45 | 0.07 |
| | 55 | 0.08/0.07[a] |
| | 60 | 0.06 |
| BB-12 | 5 | ND |
| | 15 | 0.03 |
| | 25 | 0.01 |
| | 35 | 0.08 |
| | 45 | ***0.54*** |
| | 55[c] | 0.39 |
| | 60 | 0.42 |
| | 65 | 0.25 |
| | 70 | 0.26/0.44[a] |
| | 77 | 0.07 |
| | 80 | ND |
| | 85 | ND |
| | 90 | 0.03 |
| BB-13 | 5 | ND |
| | 15 | ND |
| | 25 | ND |
| | 35 | ND |
| | 45 | ND |

# TABLE 5

## SUMMARY OF ONSITE MOBILE LABORATORY SUBSURFACE SOIL ANALYTICAL RESULTS

| Boring | Depth (ft) | Detected Volatile Organic Compound (mg/kg) |
|---|---|---|
| | | Perchloroethylene (PCE) |
| BB-13 (cont.) | 55 | 0.04 |
| | 60 | 0.22 |
| | 70 | 0.61/0.61[a] |
| | 80 | 0.07 |
| | 85 | ND |
| | 90 | ND |
| BB-14 | 5 | ND |
| | 15 | ND |
| | 25 | ND/ND[a] |
| | 35 | 0.03 |
| | 45 | ND |
| | 55 | ND |
| | 60 | ND |
| BB-15 | 15[d] | 4,180 |
| | 25 | 6.96 |
| | 35 | 0.99 |
| | 45 | 0.20 |
| | 55 | 0.07 |
| | 65 | 0.39 |
| | 70 | 0.02 |
| | 75 | 0.07 |
| | 80 | 0.03 |
| | 85 | 0.03 |
| | 90 | 0.04 |
| | 95 | 0.02/0.02[a] |
| | 100 | 0.02 |
| BB-16 | 5 | ND |
| | 15 | ND |
| | 25 | 0.01/0.01[a] |
| | 35 | ND |
| | 40 | ND |
| | 45 | ND |
| BB-17 | 5 | 0.01 |
| | 10 | 0.11 |
| | 15 | 0.08 |

# TABLE 5



## SUMMARY OF ONSITE MOBILE LABORATORY SUBSURFACE SOIL ANALYTICAL RESULTS

| Boring | Depth (ft) | Detected Volatile Organic Compound (mg/kg) |
|---|---|---|
| | | Perchloroethylene (PCE) |
| BB-17 (cont.) | 20 | ND |
| BB-18 | 5 | 0.07 |
| | 10 | 0.02 |
| | 15 | ND |
| | 20 | 0.10 |
| | 25 | 0.01 |
| | 30 | 0.02 |
| | 35 | ND |
| STOCK-1 | 0 | 0.07 |
| STOCK-2 | 0 | 0.02 |
| STOCK-3 | 0 | 0.01 |
| STOCK-4 | 0 | ND |
| STOCK-5 | 0 | 0.02 |
| STOCK-6 | 0 | 0.03/0.03[c] |
| DECON1 | NA | <1.0 μg/L |
| DECON2 | NA | <1.0 μg/L |
| DECON10 | NA | 30 μg/L |
| DECON11 | NA | 33 μg/L |
| Detection Limits | | 0.01 |
| MTCA Method A Cleanup Levels[e] | | 0.50 |

Notes:

All samples were analyzed for selected chlorinated solvents using modified EPA Method 8021. Only compounds detected are reported.

(a) Laboratory duplicate sample results.
(b) Detection limits for borings BB-1 through BB-8.
(c) Trichloroethene was also detected in this sample at a concentration of 0.06 mg/kg.
(d) Other compounds detected in this sample include trichloroethene (0.11 mg/kg), 1,1,1-trichloroethane (0.04 mg/kg), and 1,1,2-trichloroethane (0.89 mg/kg).
(e) Model Toxics Control Act [WAC 173-340-740(2)].
ND Indicates compound not detected at a concentration equal or greater than method detection limit.
Values in bold and italics indicates concentration exceeds MTCA Method A cleanup level.

## TABLE 6

## CHEMICAL OF CONCERN AND CHEMICAL-SPECIFIC ARARs FOR SOIL

| Chemical | WAC 173-340 Method B CLARC Value (mg/kg) | Basis |
|---|---|---|
| Perchloroethylene | 19.6 | Direct exposure to soil |

# TABLE 7

## POTENTIAL ACTION-SPECIFIC ARARs

| Federal Citation | State Citation | Description | Potential Requirement | Justification |
|---|---|---|---|---|
| 29 CFR 1910.120 | WAC 296-62 | General safety and health standards for workers, including requirements for responses involving hazardous substances. | Applicable | Required for protection of remedial action workers. |
| 40 CFR 50.6 and .12<br>40 CFR 60.5 | WAC 173-400<br>WAC 173-460<br>WAC 173-470<br>PSAPCA Regulations I, II, and III | General regulations for air pollution sources; particulate matter emissions standards; control standards for toxic air pollutants. | Applicable | Applicable for remedial processes emitting air pollutants. |
| 40 CFR 262.12, 262.20 through .33, and 262.40 through .43 | WAC 173-303-160, 170, 180, 190, 210, and 220 | Requirements for generators of hazardous and dangerous waste. | Applicable | Required if hazardous or dangerous wastes are transported offsite. |
| 40 CFR 268 | WAC 173-303-140 | Land disposal restrictions. | Applicable | Applicable if dangerous wastes are disposed in offsite landfill. |
| None | WAC 173-304 | Standards for disposal of solid waste. | Applicable | Applicable for disposal of solid waste. |
| 49 CFR 107, 171 through 179 | WAC 446-50 | Transportation regulations for hazardous materials. | Applicable | Applicable for offsite transportation of dangerous or hazardous waste. |
| None | WAC 173-160<br>WAC 173-162 | Regulations for construction and maintenance of new water wells; licensing of drillers. | Applicable | Applicable for new and existing wells. |
| None | WAC 173-340-360 | MTCA rquirements for selection of cleanup actions. | Applicable | Regulations outline requirements for hazardous substance cleanups. |
| None | WAC 173-340-410 | MTCA requirements regarding compliance monitoring during remedial activities. | Applicable | Required for protecting human health and confirming attainment of cleanup standards. |

# TABLE 7

## POTENTIAL ACTION-SPECIFIC ARARs

| Federal Citation | State Citation | Description | Potential Requirement | Justification |
|---|---|---|---|---|
| None | WAC 173-340-440 and -702(4) | MTCA requirements regarding institutional controls to limit activities at a site that may result in exposure to hazardous substances. | Applicable | Applicable if residual concentrations exceed cleanup levels or if conditional points of compliance have been established. |
| None | WAC 173-340-704,-705, and -706 | Use of Methods A, B, and C for determining cleanup levels. | Applicable | Applicable methods for determining cleanup levels. |
| None | WAC 173-340-707 | MTCA analytical methods for evaluating the effectiveness of a cleanup action. | Applicable | Applicable if remedial action requires chemical analyses. |
| None | WAC 173-340-708 | MTCA regulation on human health risk assessment procedures. | Applicable | Required for determining site cleanup levels. |

# TABLE 8

## EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS

| General Response Action | Remedial Technologies | Process Options | Description | Evaluation Comments |
|---|---|---|---|---|
| Containment | Covers | Soil | Clean soil is placed over ground surface to provide a physical barrier to chemicals of concern. | Asphalt selected for further evaluation. |
| | | Clay | Low permeability clay layer overlain with soil over chemically impacted materials provides physical barrier that minimizes potential for contact and infiltration. | Not appropriate for site awaiting development. |
| | | Concrete | Similar to clay cover description with concrete used as low permeability barrier. | Asphalt selected for further evaluation. |
| | | Asphalt | Similar to clay cover description with asphalt used as low permeability barrier. | Potentially implementable. |
| | | RCRA | Multi-media barrier consisting of low-permeability layer, synthetic liner, drainage layer, and vegetative cover. Performs functions similar to those described for clay cap. | Asphalt selected for further evaluation. |
| | Surface Controls | Revegetation | Planting grasses, shrubs, or trees to minimize contact with soil, reduce dust generation, and control surface water runoff. | Not appropriate for chemicals detected at depth. |
| | Dust Suppression | Wet Suppression | Watering ground surface to control dust generation. | Not appropriate for chemicals detected at depth. |
| | | Chemical Stabilization | A suppressant sprayed on the ground binds dust and surface particles into a protective crust that minimizes dust generation. | Not appropriate for chemicals detected at depth. |
| | | Physical Stabilization | Placing a cover (e.g. rock, soil, straw) on exposed surfaces to prevent particles from becoming airborne. | Not appropriate for chemicals detected at depth. |
| | | Vegetative Stabilization | Same as revegetation above. | Not appropriate for chemicals detected at depth. |
| | | Wind Fences/Screens | Fences or screens are installed around site perimeter to block wind and reduce dust generation. | Not appropriate for chemicals detected at depth. |
| Removal | Excavation | Backhoe, Excavators, Loaders, Dozers | Excavate material for subsequent aboveground treatment and/or disposal. | Potentially implementable. |

# TABLE 8

## EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS

| General Response Action | Remedial Technologies | Process Options | Description | Evaluation Comments |
|---|---|---|---|---|
| Aboveground Treatment | Solidification | Pozzolanic Solidification | Siliceous materials are combined with a setting agent (e.g., lime, cement, or gypsum) and soil. Treatment results in a solidified product that resists leaching. | Not appropriate for volatile organics. |
| | | Cement-Based Solidification | Process binds soil with portland cement into leach-resistant matrix. | Not appropriate for volatile organics. |
| | | Organic Polymer Solidification | Urea formaldehyde and several specialty organic polymers are mixed with soil to seal chemicals in a sponge-like polymer matrix. | Not appropriate for volatile organics. |
| | | Thermoplastic Microencapsulation | Mixing of heated dried soil within asphalt bitumen, paraffin, or polyethylene matrix, resulting in a solid mass suitable for land disposal. | Not appropriate for volatile organics. |
| | Physical/Chemical | Soil Washing | Removal of inorganic or organic chemicals by washing excavated soil with a liquid medium (e.g., water). | Vapor extraction selected from this remedial technology group for evaluation. |
| | | Organic Solvent Extraction | Removal of organics, oil, and grease from soil, using an organic solvent as the mass transfer medium and then recovering the solvent by distillation. | Vapor extraction selected from this remedial technology group for evaluation. |
| | | Vapor Extraction | Removal of low molecular weight organics by creating a vacuum pressure gradient in soil that causes volatile organics to transfer from soil to air stream. | Potentially implementable. |
| | | Chemical Dechlorination | Specially synthesized chemical reagents are used to dehalogenate certain classes of chlorinated organics (e.g., PCBs). | Vapor extraction selected from this remedial technology group for evaluation. |
| | Biological/ Bioremediation | Landfarming/ Aerobic | Aerobic degradation of hydrocarbons by spreading a thin layer of soil on the ground and adding microorganisms to degrade or transform chemicals. | Not appropriate for chemical of concern. |
| | | Windrow Composting | Aerobic degradation of hydrocarbons in soil involves spreading soil in large rows and overturning it with a windrow composter at regular intervals to provide adequate aeration. | Not appropriate for chemical of concern. |
| | | Bio-Venting | Combination of vapor extraction and aerobic landfarming process options. Microorganisms use oxygen supplied by a vapor extraction system to enhance degradation. | Not appropriate for chemical of concern. |
| | | Bio-Reactor System | Degradation with the use of a liquid/solids contact reactor. Reactor environment enhances mass transfer rates and contact between chemicals and microorganisms capable of degrading the chemicals. | Not appropriate for chemical of concern. |

# TABLE 8

## EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS

| General Response Action | Remedial Technologies | Process Options | Description | Evaluation Comments |
|---|---|---|---|---|
| Aboveground Treatment (continued) | Thermal | Thermal Desorption | Soils are heated, driving off water and organics with boiling points less than 1,100°F. Organics are incinerated in an afterburner or collected for subsequent treatment. | Potentially implementable. |
| | | Rotary Kiln Incineration | Incineration process (in the presence of oxygen) uses temperatures ranging from 1,500°F to 3,000°F and turbulence caused by rotation to vaporize and destroy organics. | Not appropriate. Other more cost-effective thermal treatment options are available. |
| | | Infrared Thermal Incineration | Thermal destruction of organics in soil using electrically powered silicon carbide rods to heat organics to combustion temperatures. Remaining combustibles are incinerated in an afterburner. | Not appropriate. Other more cost-effective thermal treatment options are available. |
| | | Pyrolysis | Thermal conversion (in an oxygen-deficient atmosphere) of organic material into solid, liquid, and gaseous components. | Not appropriate. Other more cost-effective thermal treatment options are available. |
| | | Fluidized Bed/ Circulating Bed Combustor | A bed of granular sand-like material is fluidized by air injected into the incinerator to create a turbulent atmosphere and improve heat transfer. | Not appropriate. Other more cost-effective thermal treatment options are available. |
| | | Multiple Hearth Incineration | Multiple levels of shifting plates move materials through the combustion chamber. Each hearth has fuel burners mounted on walls that incinerate organics as materials descend to lower hearths in increasingly hotter combustion zones. | Not appropriate. Other more cost-effective thermal treatment options are available. |
| | | Vitrification | Application of heat destroys organics and immobilizes inorganics by incorporating them into a glass or glass-like structure. | Not appropriate. Other more cost-effective thermal treatment options are available. |
| In Situ Treatment | Solidification | Pozzolanic Cement-Based | In situ treatment of soil by the injection and mixing of solidifying agents with soil. Treatment results in a solidified product that resists leaching. | Not appropriate for volatile organics. |
| | Physical/Chemical | Soil Freezing | Freezing surrounding soil to create a physical barrier to chemical migration. | Not appropriate. Only a temporary measure. |
| | | Soil Flushing | In situ extraction of inorganics or organics from soils, accomplished by passing solvents through soil using an injection/recirculation process. | Vapor extraction selected from this remedial technology group for evaluation. |

# TABLE 8

## EVALUATION OF GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGIES, AND PROCESS OPTIONS

| General Response Action | Remedial Technologies | Process Options | Description | Evaluation Comments |
|---|---|---|---|---|
| In Situ Treatment (continued) | Physical/Chemical (continued) | Vapor Extraction | Extraction of volatile organics from subsurface soil by creating a pressure gradient that causes volatile organics to transfer from soil to airstream. | Potentially implementable. |
| | Chemical | Precipitation | Application of specific treatment reagents which aid in the formation of insoluble metal precipitates that reduce chemical mobility. Metals could later resolubilize as conditions change. | Not appropriate for chemicals of concern. |
| | | Oxidation | Oxidation state of chemicals is raised to detoxify a few inorganics and oxidizable organics and to make some organics more amenable to biological degradation. | Not appropriate for chemicals of concern. |
| | | Reduction | Reduction in the oxidation state of a few heavy metals (chromium, lead, mercury) to reduce toxicity or solubility or to transform them to a form that can be more easily handled. | Not appropriate for chemicals of concern. |
| | Biological/ Bioremediation | Aerobic | Application of nutrients, oxygen, and microorganisms to accelerate the natural biodegradation of organic compounds. | Not appropriate. Chemicals are not amenable to aerobic bioremediation. |
| | | Anaerobic | Same as aerobic process with the omission of oxygen application. The anaerobic process degrades organics slower than the aerobic process, but is better suited to chlorinated hydrocarbons. | Innovative; bioremediation of chlorinated organics often results in more toxic compounds (e.g., vinyl chloride). |
| | Thermal | Vitrification | Using high temperatures to melt soil and bind chemicals in a stable non-crystalline solid that resists leaching. Organics are destroyed by pyrolysis. | Not appropriate for chemical of concern. |
| | | Steam-Enhanced Vapor Extraction | Vapor extraction with the addition of steam to increase chemical mobility and removal rate. | Vapor extraction alone expected to be successful at site. |
| | | Radio Frequency Heating | Application of radio frequency waves to heat soil and vaporize volatile organics. Volatiles are then collected for destruction or treatment. | Experimental. More tested and cost-effective methods are available. |
| Disposal | Offsite | Management Unit | Disposal of soil in a permitted offsite management unit. | Potentially implementable. |
| | Onsite | Containment | Containment of soil onsite. | Not appropriate for site awaiting development. |

# TABLE 9

## SUMMARY OF POTENTIAL REMEDIAL PROCESS OPTIONS FOR SOIL

| MTCA Preference[a] | Technology Description | Process Option |
|---|---|---|
| 1 | Reuse or Recycling | None |
| 2 | Destruction or Detoxification | None |
| 3 | Separation Followed by Reuse or Destruction | In Situ Vapor Extraction |
| | | Thermal Desorption |
| 4 | Immobilization | None |
| 5 | Onsite or Offsite disposal | Offsite Landfill |
| 6 | Containment | Caps (asphalt) |

Note:

(a) Source: WAC 173-340-360(4).

# TABLE 10

## COMPLIANCE OF ALTERNATIVES WITH CHEMICAL-SPECIFIC ARAR

| ARAR | | Alternative | | |
|---|---|---|---|---|
| Citation | Description | 1[a] Offsite Disposal | 2[a] Thermal Treatment | 3[a] In Situ Vapor Extraction |
| Model Toxics Control Act Cleanup Regulation Section VII (WAC 173-340-740) | Specifies cleanup level that protects human health and the environment. | Soil cleanup levels achieved through removal and offsite disposal. | Soil cleanup levels achieved through treatment. | Soil cleanup levels achieved through treatment. |

Notes:

(a) This alternative applies to the former dry cleaners remediation area and the manhole remediation area.

# TABLE 11

## March 1994ALTERNATIVES WITH ACTION-SPECIFIC ARARs

| ARAR | | Alternatives | | |
|---|---|---|---|---|
| Citation | Description | 1[a] Offsite Disposal | 2[a] Thermal Treatment | 3[a] In Situ Vapor Extraction |
| • 29 CFR 1910.120<br>• WAC 296-62 | General safety and health standards for workers, including requirements for responses involving hazardous substances. | Remedial action workers can be adequately protected. | Same as Alternative 1. | Same as Alternative 1. |
| • 40 CFR 50.6 and .12<br>• WAC 173-400<br>• WAC 173-460<br>• WAC 173-470<br>• PSAPCA Regulations I and III | General regulations for air pollution sources; particulate matter emissions standards; control standards for toxic air pollutants. | Fugitive dust during remedial activities can be adequately controlled with water. | Alternative can meet fugitive dust control requirements; baghouse and air pollution system expected to meet requirements. | Alternative can meet fugitive dust control requirements; activated carbon system expected to meet air pollution control requirements. |
| • 40 CFR 262.12, 262.20 through .33, and 262.40 through .43<br>• WAC 173-303-160, 170, 180, 190, 210, and 220 | Requirements for generators of dangerous and hazardous waste. | Alternative can meet requirements. | Alternative can meet requirements for offsite treatment or disposal of treatment residues. | Alternative can meet requirements for offsite treatment or disposal of treatment residues. |
| • 40 CFR 268<br>• WAC 173-303-140<br>• WAC 173-304 | Land disposal restrictions for hazardous or dangerous waste; standards for solid waste. | Alternative can meet solid waste requirements; hazardous/dangerous waste not expected. | Treated byproducts can meet requirements for hazardous/dangerous waste and solid waste. | Treated byproducts can meet requirements for hazardous/dangerous waste and solid waste. |
| • 49 CFR 107, 171 through 179<br>• WAC 446-50 | Transportation regulations for hazardous materials. | Alternative can meet requirements. | Treatment byproducts sent offsite for treatment or disposal can meet requirements. | Treatment byproducts sent offsite for treatment or disposal can meet requirements. |
| • None<br>• WAC 173-160<br>• WAC 173-162 | Regulations for construction and maintenance of new water wells; licensing of drillers. | Cleanup levels achieved; monitoring not required. | Same as Alternative 3. | Same as Alternative 3. |
| • None<br>• WAC 173-340-360 | MTCA requirements regarding selection of cleanup actions. | Offsite disposal is a low-preference remedial method. Meets other requirements. | Treatment is a preferred method, as it meets the requirements and provides a permanent solution. | Same as Alternative 4. |

# TABLE 11

## March 1994ALTERNATIVES WITH ACTION-SPECIFIC ARARs

| ARAR | | Alternatives | | |
|---|---|---|---|---|
| Citation | Description | 1[a] Offsite Disposal | 2[a] Thermal Treatment | 3[a] In Situ Vapor Extraction |
| • None<br>• WAC 173-340-410 | MTCA requirements regarding compliance monitoring during remedial activities. | Meets requirements. | Same as Alternative 3. | Same as Alternative 3. |
| • None<br>• WAC 173-340-440 and -702(4) | MTCA requirements regarding institutional controls to limit activities at a site that may result in exposure to hazardous substances. | None required. | Same as Alternative 3. | Same as Alternative 3. |
| • None<br>• WAC 173-340-704 | Use of Method A for determining cleanup level. | Cleanup level achieved through removal and offsite disposal. | Cleanup level achieved through treatment. | Cleanup level achieved through treatment. |
| • None<br>• WAC 173-340-707 | MTCA analytical methods for evaluating the effectiveness of a cleanup action. | Approved methods will be used. | Same as Alternative 3. | Same as Alternative 3. |

Notes:

(a) This alternative applies to the former dry cleaners remediation area and the manhole remediation area.

# TABLE 12

## ALTERNATIVE EVALUATION WITH MTCA'S THRESHOLD CRITERIA

| Threshold Criteria | 1[a] Offsite Disposal | 2[a] Thermal Treatment | 3[a] In Situ Vapor Extraction |
|---|---|---|---|
| Overall Protection of Human Health and Environment | Reduces risks to acceptable level (i.e., cleanup level) through removal and offsite disposal. Alternative has acceptable time frame for achieving cleanup standards. Moderate to high risks to workers due to deep excavations with substantial shoring requirements and potential for direct exposure. Also, potential spills and accidents during transportation. Overall improvement to environment is high because cleanup standards are achieved. | Reduces risks to acceptable level (i.e., cleanup level) through treatment. Alternative has acceptable time frame for achieving cleanup standards. Moderate to high risks to workers due to deep excavations with substantial shoring requirements and potential for direct exposure. Potential air pollution threats would be controlled. Overall improvement to environment is high because cleanup standards are achieved. | Reduces risks to acceptable level (i.e., cleanup level) through treatment. Alternative may have lengthy time frame because of geologic conditions (i.e., dense glacial till may hinder vapor extraction). Low to moderate risks to workers. Low risks to offsite receptors. Potential air pollution threats would be controlled. Overall improvement to environment is high because cleanup standards are achieved. |
| Point of Compliance | Soil throughout the site for protection of direct exposure. | Soil throughout the site for protection of direct exposure. | Soil throughout the site for protection of direct exposure. |
| Applicable State and Federal Laws[b] | Can achieve ARARs. | Can achieve ARARs. | Can achieve ARARs. |
| Compliance Monitoring | Includes performance monitoring to confirm that soil containing PCE at concentrations above the cleanup level has been removed. | Includes performance monitoring to confirm that soil containing PCE at concentrations above the cleanup level has been excavated and adequately treated. | Includes performance monitoring to confirm that soil containing PCE at concentrations above the cleanup level has been adequately treated. |

Notes:

(a) This alternative applies to the former dry cleaners remediation area and the manhole remediation area.
(b) The alternative's compliance with ARARs is presented in Appendix FS-C.

# TABLE 13

## EVALUATION OF LONG-TERM EFFECTIVENESS FOR REMEDIAL ALTERNATIVES

| Subcriteria | Alternative 1[a] Offsite Disposal | Alternative 2[a] Thermal Treatment | Alternative 3[a] In Situ Vapor Extraction |
|---|---|---|---|
| Degree of certainty that alternative will be successful | Long-term effectiveness concerns would not be significant because soil containing PCE above the cleanup level would be excavated to 15 feet bgs and removed from the site. Permitted disposal facility is expected to adequately manage landfilled soil for the long-term. | No long-term effectiveness concerns are associated with the site because soil containing PCE above the cleanup level would be excavated to 15 feet bgs and treated. PCE remaining in the soil would not pose an unacceptable risk to human health and the environment. | No long-term effectiveness concerns are associated with the site because soil containing PCE above the cleanup level would be below 15 feet. PCE remaining in the soil would not pose an unacceptable risk to human health and the environment. |
| Long-term reliability | Long-term reliability at the site is not a significant concern because soil containing PCE above the cleanup level would be removed. Long-term reliability of a permitted disposal facility is expected to be adequate. | Long-term controls would not be required because the PCE cleanup level would be achieved. | Long-term controls would not be required because the PCE cleanup level would be achieved. |
| Magnitude of residual risk | Concentrations of PCE exceeding direct exposure cleanup level would be deeper than 15 feet. | Concentrations of PCE exceeding direct exposure cleanup level would be deeper than 15 feet. | Concentrations of PCE exceeding direct exposure cleanup level would be deeper than 15 feet. |
| Effectiveness of controls required to manage treatment residues or remaining wastes | Controls not required. | Controls not required. | Controls not required. |

Note:

(a) This alternative applies to the former dry cleaners remediation area and the manhole remediation area.

# TABLE 14

# EVALUATION OF SHORT-TERM EFFECTIVENESS FOR REMEDIAL ALTERNATIVES

| Subcriteria | Alternative | | |
|---|---|---|---|
| | 1[a] Offsite Disposal | 2[a] Thermal Treatment | 3[a] In Situ Vapor Extraction |
| Protection of human health during construction and implementation | Fugitive dust emissions could be generated during soil excavation, transportation, and handling. PCE, adsorbed to dust particles or in vapor phase, could be ingested or inhaled. Potential for contamination of runon/runoff. Appreciable risks to remedial workers because of deep excavations, moving heavy equipment, and direct contact with soil. Offsite tracking of contaminants on construction vehicles could occur. Vehicular traffic could significantly affect the community and adversely affect local transportation system. | Fugitive dust emissions could be generated during soil excavation and handling. PCE, adsorbed to dust particles or in vapor phase, could be ingested or inhaled. Potential for contamination of runon/runoff. Appreciable risks to remedial workers because of deep excavations, moving heavy equipment, and direct contact with soil. Thermal treatment could potentially increase air pollution risks. | Risks involved with this alternative include exposure to PCE in soil cuttings, condensate, and vapor stream. Risks can be readily controlled through routine procedures and use of personal protective equipment. |
| Degree of risk prior to attainment of cleanup standards | Degree of risk can be controlled. Spraying the site with water would minimize generation and release of fugitive emissions. Remediation workers would wear protective clothing and respirators, if required. Special precautions for working in deep excavations and around moving heavy equipment would be emphasized. Surface water controls (e.g., covering stockpiled soil with plastic) would be used. Vehicles would be decontaminated before departing offsite. Restricting daily vehicle trips would lessen impact on community and transportation system, although approximately 29 - 35 truckloads would be required. | Degree of risk can be controlled. Spraying the site with water would minimize generation and release of fugitive emissions. Remediation workers would wear protective clothing and respirators, if required. Special precautions for working in deep excavations and around moving heavy equipment would be emphasized. Surface water controls would be used. Thermal treatment pollution control features expected to meet local air quality standards. | Risks can be controlled. Established techniques are available to minimize impacts from constructing and operating vapor extraction system (e.g., wearing protective clothing and respirators). Containment facility would be constructed for protecting environment against condensate spill. Air pollution control system would be used to meet air quality standards. |

Note:

(a) This alternative applies to the former dry cleaners remediation area and the manhole remediation area.

# TABLE 15

## EVALUATION OF PERMANENT REDUCTION OF TOXICITY, MOBILITY, OR VOLUME FOR REMEDIAL ALTERNATIVES

| Subcriteria | Alternative | | |
|---|---|---|---|
| | 1[a] Offsite Disposal | 2[a] Thermal Treatment | 3[a] In Situ Vapor Extraction |
| Adequacy of alternative in destroying hazardous substances | Does not include treatment. | Thermal desorption and subsequent treatment of PCE at permitted offsite facility expected to virtually destroy (i.e., greater than 99 percent) PCE. | System would be designed to capture (for subsequent treatment) PCE. |
| Reduction or elimination of hazardous substance releases and sources of releases | Does not destroy or treat hazardous materials. However, approximately 465 $yd^3$ of material would be excavated and disposed of at a permitted offsite landfill, thereby eliminating site source. | Thermal desorption would treat soil containing PCE above the cleanup level. | System would treat soil containing PCE above the cleanup level. |
| Irreversibility of waste treatment process | NA[b] | Treatment irreversible. | Treatment irreversible. |
| Characteristics and quantity of treatment residuals generated | NA | PCE captured using carbon adsorption system; subsequent thermal treatment of PCE at permitted offsite facility. | PCE in condensate is subsequently treated at permitted facility. Carbon system thermally regenerated offsite, thereby destroying adsorbed PCE. |

Notes:

(a) This alternative applies to the former dry cleaners remediation area and the manhole remediation area.
(b) NA = Not applicable.

# TABLE 16

## EVALUATION OF ABILITY TO IMPLEMENT REMEDIAL ALTERNATIVES

| Subcriteria | Alternative | | |
|---|---|---|---|
| | 1[a] Offsite Disposal | 2[a] Thermal Treatment | 3[a] In Situ Vapor Extraction |
| Consideration of whether alternative is technically possible | Difficult to excavate in a developed area. | Difficult to excavate to required depth. Other technologies involved in this alternative are common remedial methods that can be readily implemented. | Technologies involved in this alternative are common remedial methods that can be readily implemented. |
| Availability of necessary offsite facilities, services, and materials | Adequate offsite facilities, services, and materials are available. | Adequate offsite facilities, services, and material are available. | Adequate offsite facilities, services, and materials are available. |
| Administrative and regulatory requirements | Requirements include clearing and graing permit and State Environmental Policy Act (SEPA) checklist. | Requirements include clearing and grading permit and SEPA checklist. | Requirements include SEPA checklist. |
| Scheduling, size, and complexity | Deep excavations involve complex shoring requirements. Alternative more suited to summer months because of potential stormwater runon/runoff contamination. | Deep excavations involve complex shoring requirements. Thermal desorption requires modeling/testing to assess air emission characteristics. Alternative more suited to summer months because of potential stormwater runon/runoff contamination and because of increased energy required to treat wet soil. | Cleanup level (19.6 mg/kg) is readily achievable using this technology. |
| Monitoring requirements | Soil samples would be collected and analyzed during remediation to evaluate compliance with cleanup level. | Soil samples would be collected and analyzed during remediation to evaluate compliance with cleanup level. Air samples also would be collected to determine compliance with air quality standards. | Air samples also would be collected to determine compliance with air quality standards and declines in influent PCE concentrations. Once influent concentrations decrease sufficiently, soil samples would be collected and analyzed during remediation to evaluate compliance with cleanup level. |
| Access for construction, operations, and monitoring | Available. | Available. | Available. |

# TABLE 16

## EVALUATION OF ABILITY TO IMPLEMENT REMEDIAL ALTERNATIVES

| Subcriteria | Alternative<br>1[a]<br>Offsite Disposal | <br>2[a]<br>Thermal Treatment | <br>3[a]<br>In Situ Vapor Extraction |
|---|---|---|---|
| Integration with existing facility operations and other current or potential remedial actions | Alternative would adversely affect proposed facility construction schedule and/or activities of site tenants. | Alternative would adversely affect proposed facility construction schedule and/or activities of site tenants. | East to integrate. |

Note:

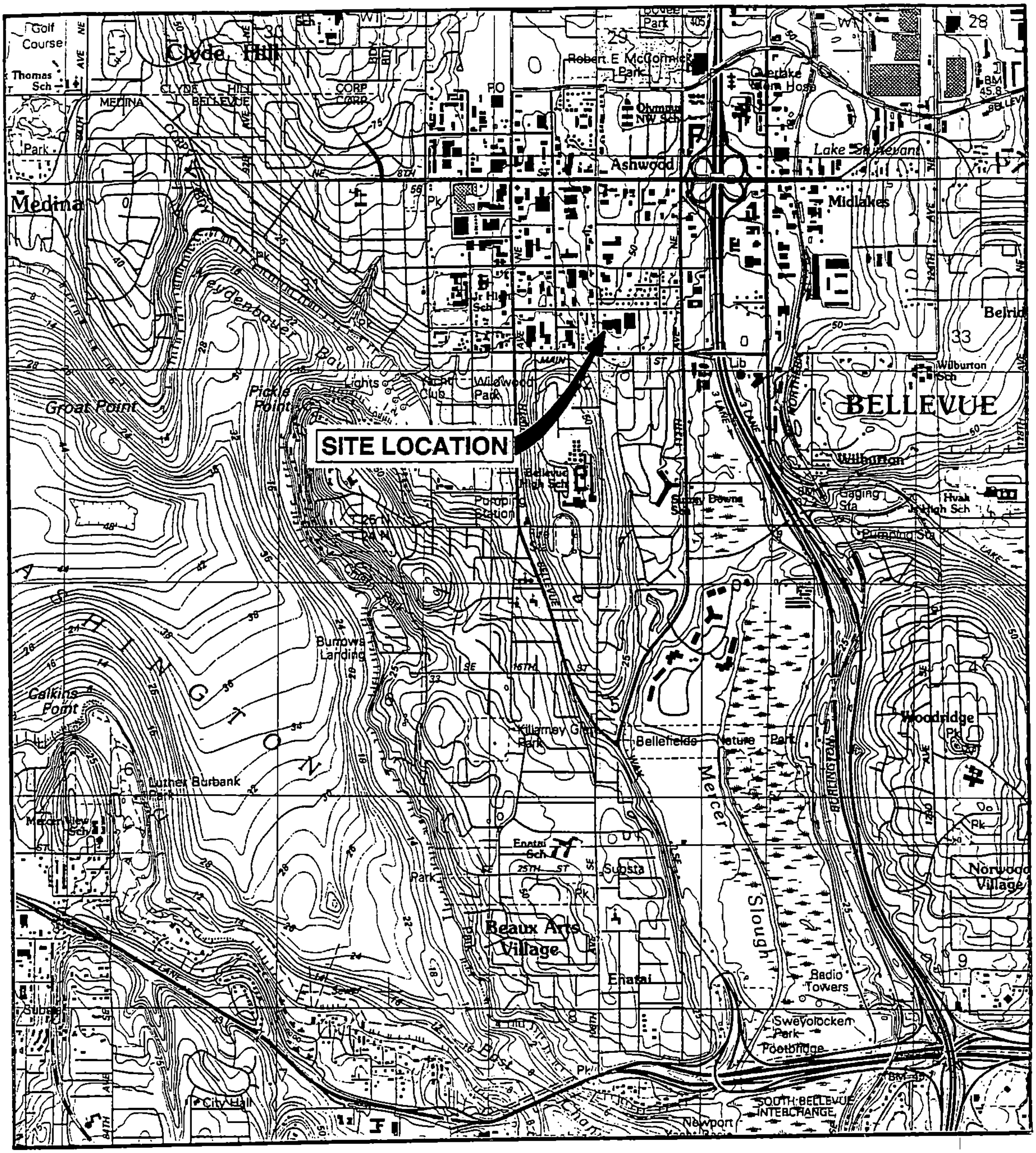
(a) This alternative applies to the former dry cleaners remediation area and the manhole remediation area.

# TABLE 17

## SUMMARY OF COSTS FOR ALTERNATIVES

| Alternative | Description | Total Present Worth ($) |
|---|---|---|
| 1 | Offsite Disposal | 152,000 |
| 2 | Thermal Treatment | 180,000 |
| 3 | In Situ Vapor Extraction | 123,000 |

# Figures




SCALE 1:25,000

0 1000 2000

APPROXIMATE SCALE IN FEET
1 CENTIMETER ON THE MAP REPRESENTS
250 METERS ON THE GROUND
CONTOUR INTERVAL 5 METERS

REFERENCE: USGS 7.5' TOPOGRAPHIC QUADRANGLE
BELLEVUE SOUTH, 1983.

N

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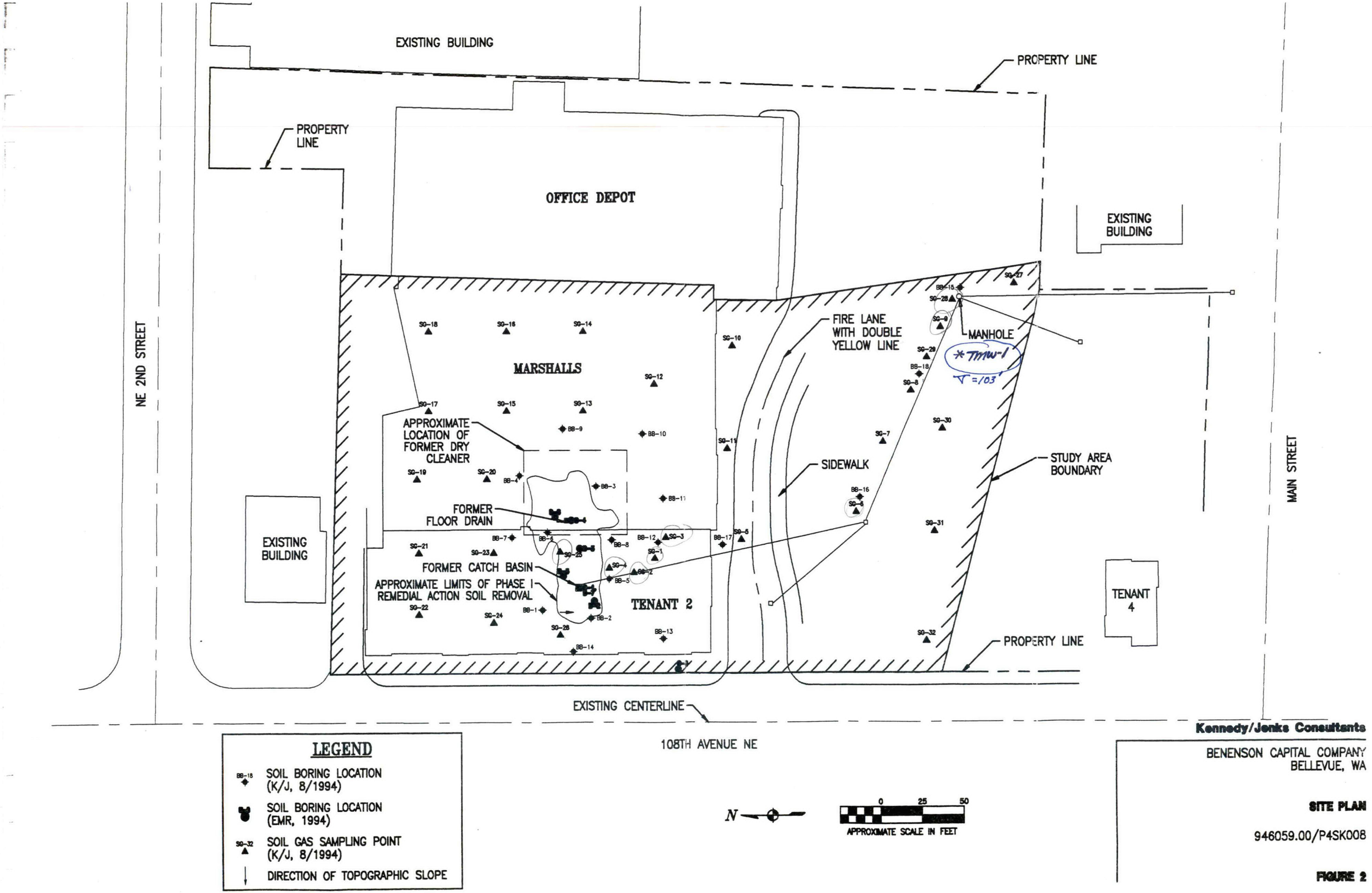
BENENSON CAPITAL COMPANY
BELLEVUE, WA

**SITE LOCATION MAP**

946059.00/P4SK007

**FIGURE 1**

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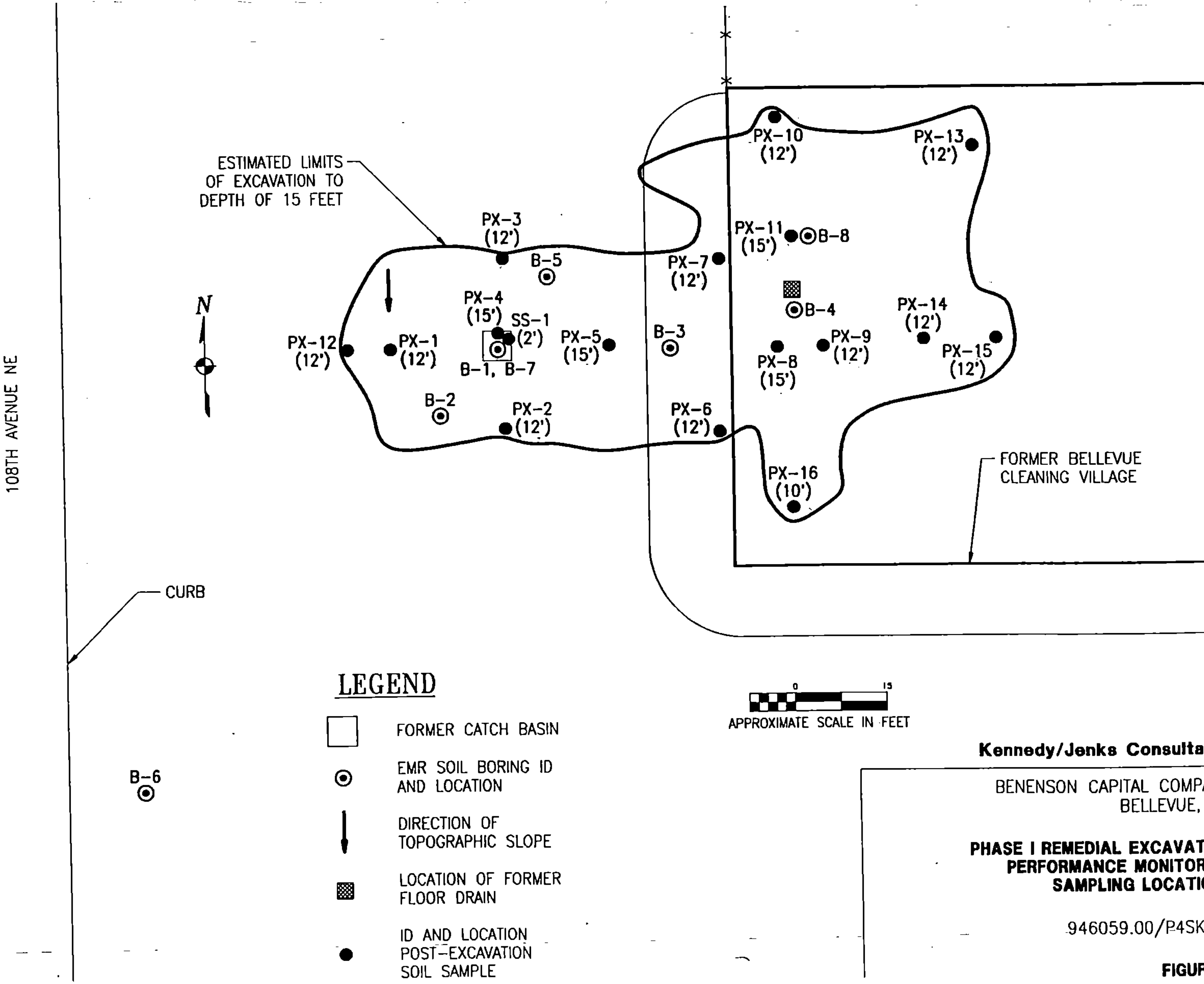
**SITE PLAN**

946059.00/P4SK008

**FIGURE 2**

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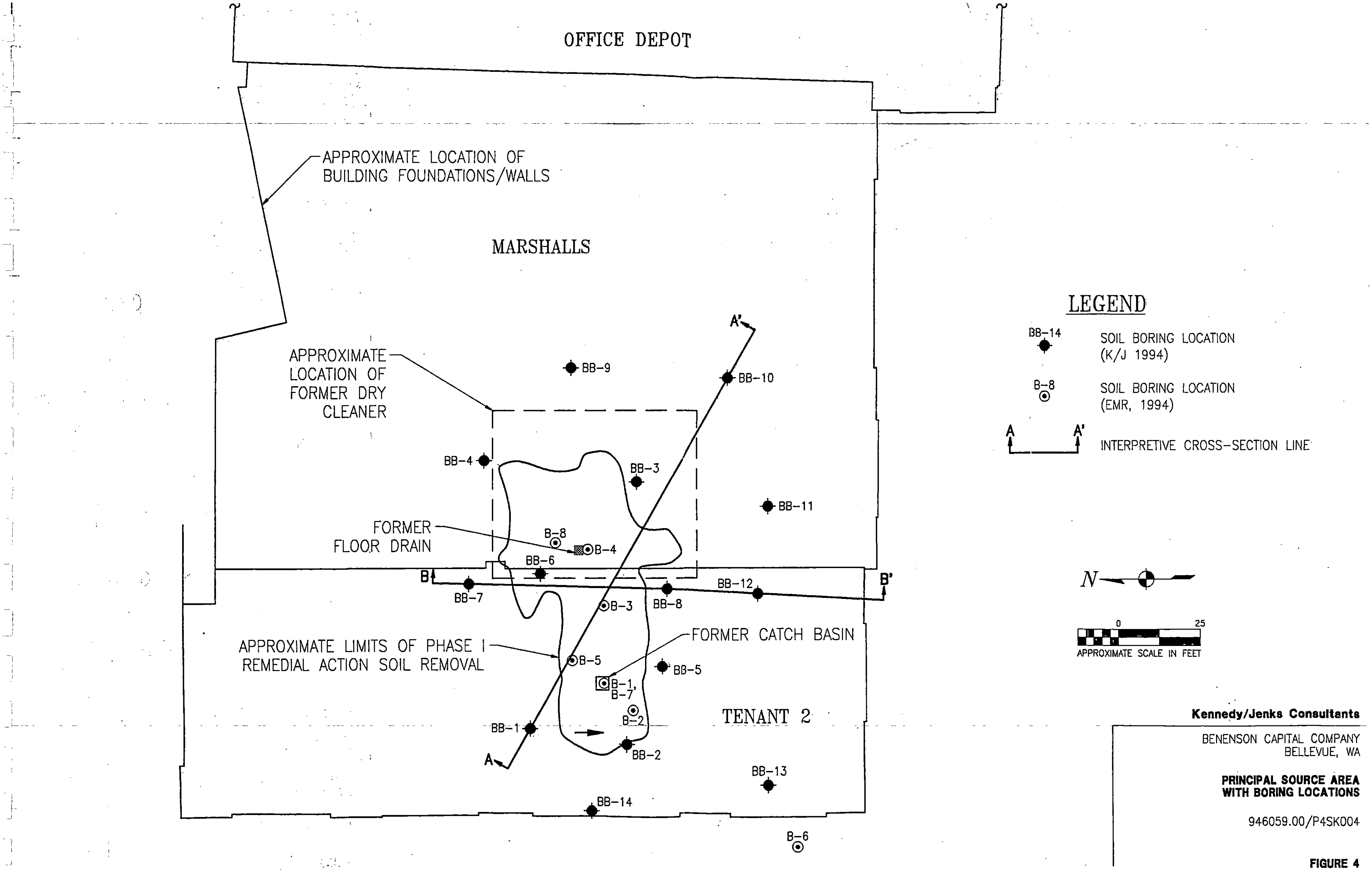
BELLEVUE, WA

**PHASE I REMEDIAL EXCAVATION PERFORMANCE MONITORING SAMPLING LOCATIONS**

946059.00/P4SK009

**FIGURE 3**

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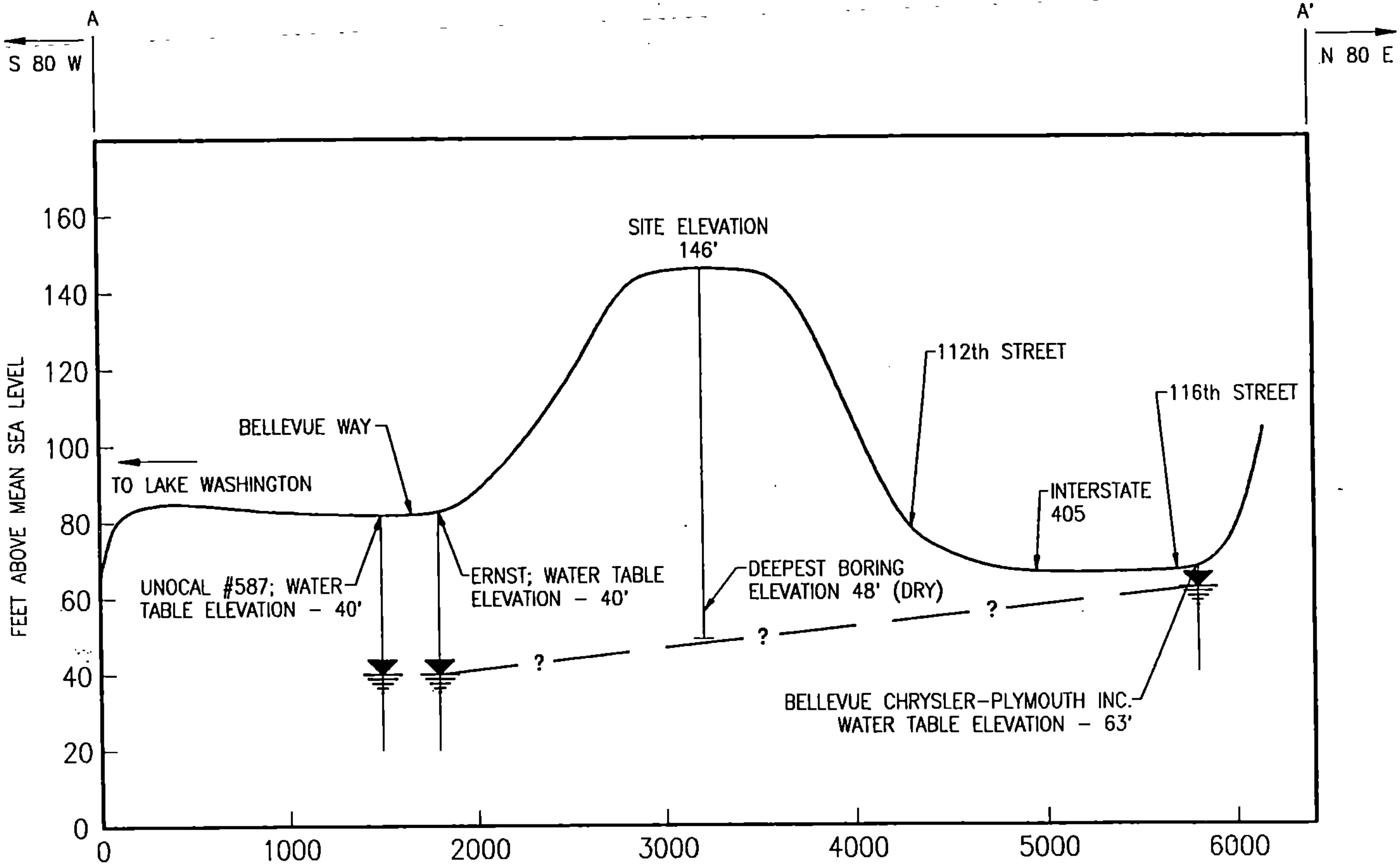
**PRINCIPAL SOURCE AREA WITH BORING LOCATIONS**

946059.00/P4SK004

**FIGURE 4**




HORIZONTAL SCALE: 1"=800'
VERTICAL SCALE: 1"=40'
VERTICAL EXAGGERATION = 20x

**LEGEND**

APPROXIMATE WATER TABLE ELEVATION

INTERPOLATED WATER TABLE

TOPOGRAPHIC SOURCE: USGS 7.5' QUAD., BELLEVUE SOUTH, 1983

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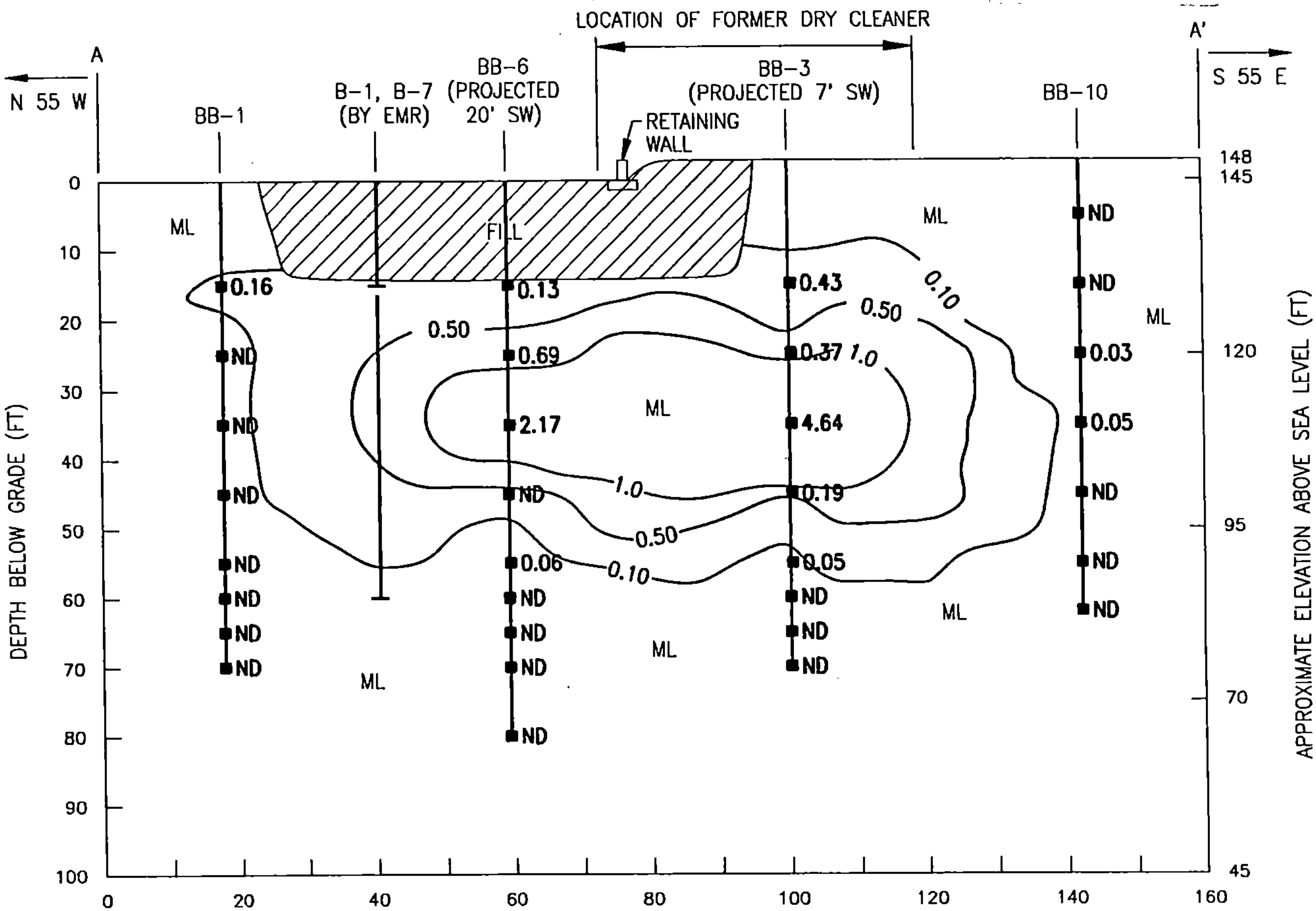
**RELATIONSHIP OF AREA TOPOGRAPHY TO INFERRED WATER TABLE ELEVATION**

946059.00/P4SK006

**FIGURE 5**




HORIZONTAL SCALE: 1"=25'
VERTICAL SCALE: 1"=25'
NO VERTICAL EXAGGERATION

## LEGEND

0.06 / ND / ND — SOIL BORING PROFILE WITH SAMPLE LOCATIONS AND PCE CONCENTRATIONS IN mg/kg (ND INDICATES NOT DETECTED)

0.10 — PCE CONCENTRATION CONTOUR (CONCENTRATION IN mg/kg) CONTOURS DERIVED USING KRIGING TECHNIQUES IN SURFER® VERSION 4

ML – SANDY SILT WITH GRAVEL; GRAY, DAMP TO DRY, VERY HARD; (GLACIAL TILL)

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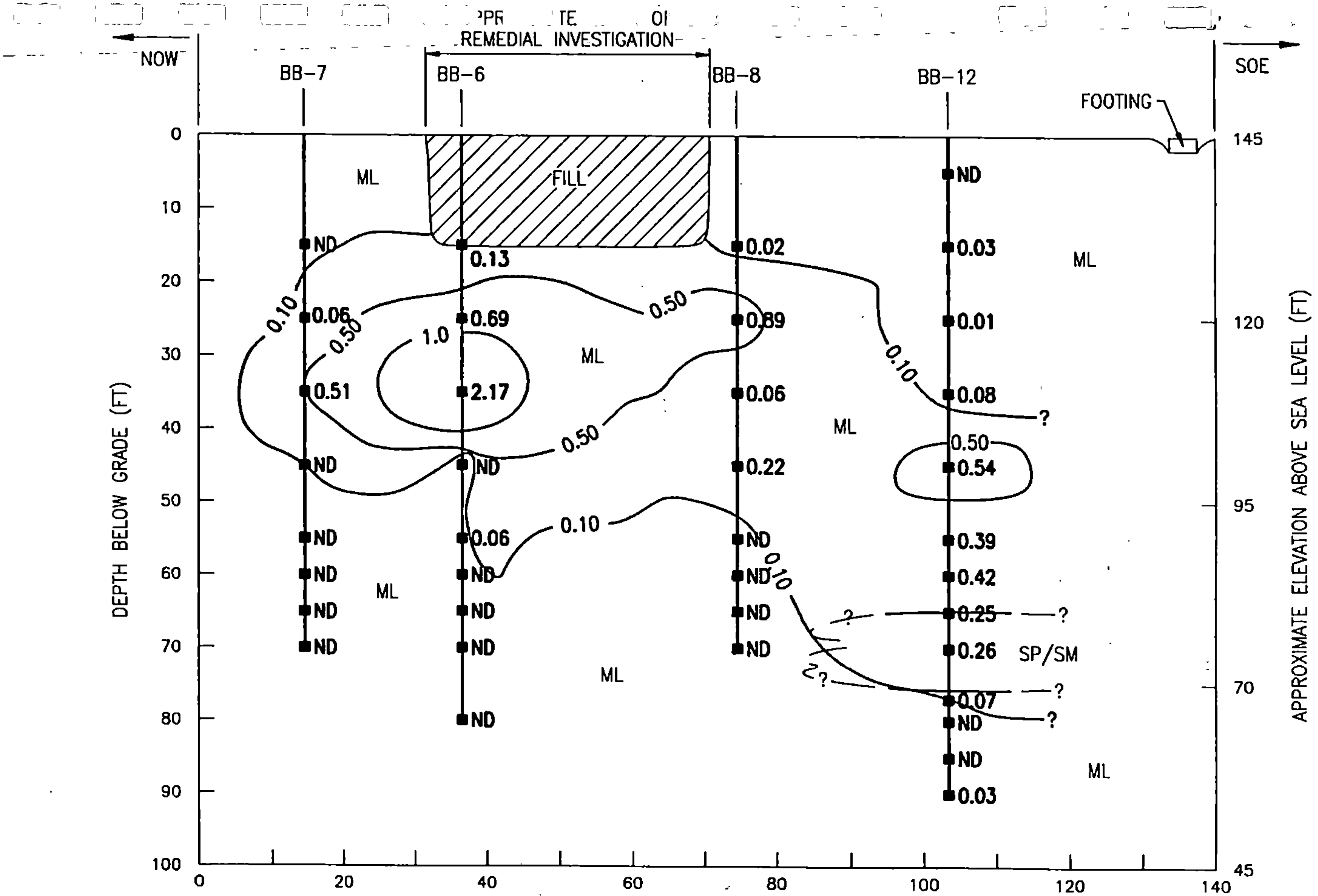
**CROSS-SECTION A-A', ESTIMATED PCE CONCENTRATION DISTRIBUTION**

946059.00/P4SK001

**FIGURE 6**




HORIZONTAL SCALE: 1"=25'
VERTICAL SCALE: 1"=25'
NO VERTICAL EXAGGERATION

## LEGEND

0.06 / ND / ND — SOIL BORING PROFILE WITH SAMPLE LOCATIONS AND PCE CONCENTRATIONS IN mg/kg (ND INDICATES NOT DETECTED)

——— —? LITHOLOGIC CONTACT (DASHED WHERE INFERRED, QUERIED WHERE UNCERTAIN)

—0.10— PCE CONCENTRATION CONTOUR (CONCENTRATION IN mg/kg) CONTOURS DERIVED USING KRIGING TECHNIQUES IN SURFER® VERSION 4

ML – SANDY SILT WITH GRAVEL; GRAY, DAMP TO DRY, VERY HARD; (GLACIAL TILL)

SP/SM – POORLY GRADED SAND WITH SILT; GRAY, DAMP, VERY DENSE;

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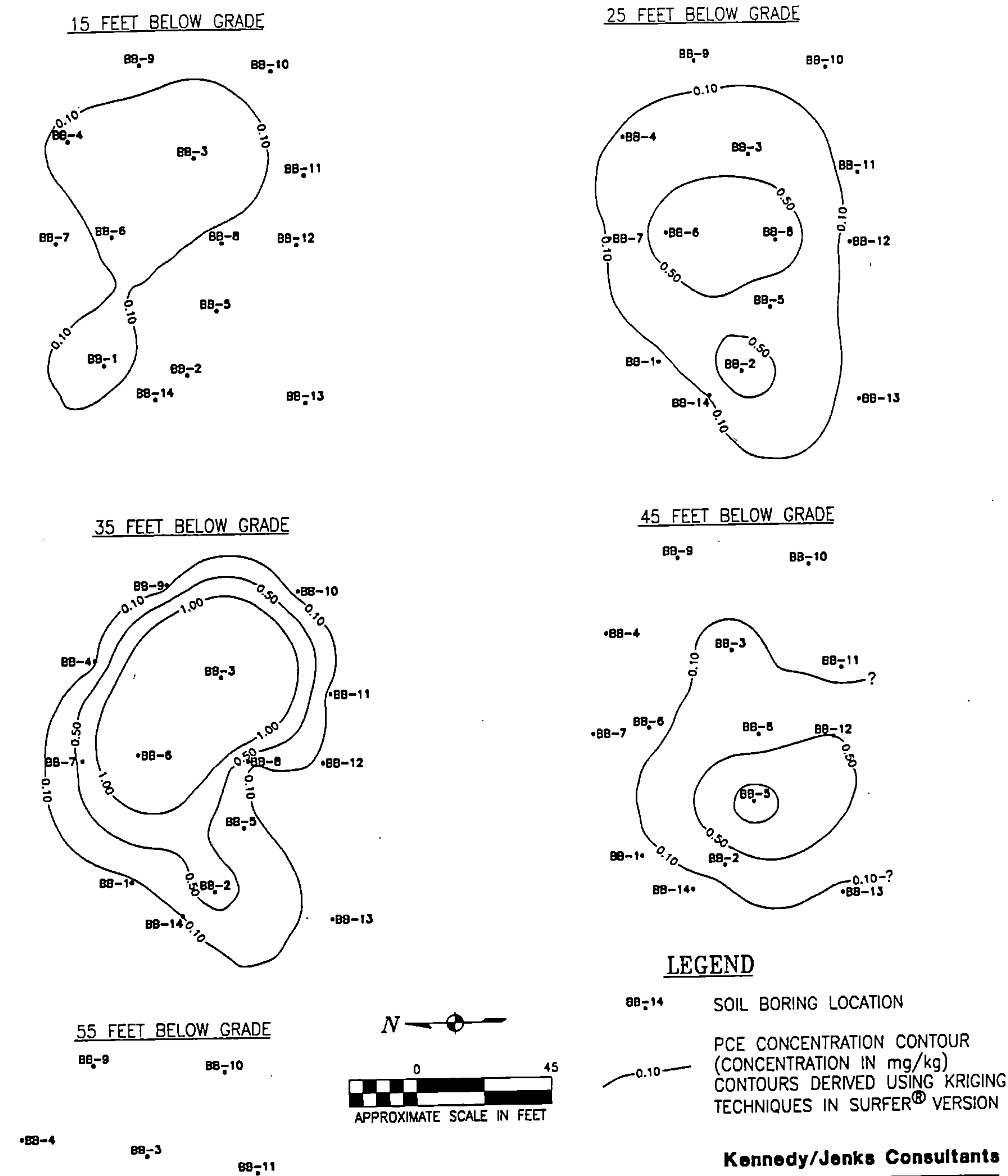
**CROSS-SECTION B-B', ESTIMATED PCE CONCENTRATION DISTRIBUTION**

946059.00/P4SK002

**FIGURE 7**

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**ESTIMATED PCE CONCENTRATION CONTOURS AT VARIOUS DEPTHS**

946059.00/P4SK003

**FIGURE 8**