REVISED
SITE CHARACTERIZATION REPORT
ROY STREET FACILITY

Prepared for:

CITY OF SEATTLE
DEPARTMENT OF PARKS & RECREATION
Seattle, Washington

Prepared by:

REMEDIATION TECHNOLOGIES, INC.
Seattle, Washington

RETEC Project No. 3-1274-160

Prepared by: _____

Reviewed by: _____

FEBRUARY 1995

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

The Department of Parks and Recreation of the City of Seattle owns and operates a maintenance facility at 802 Roy Street. Two underground storage tanks (USTs) were removed from the Site in March of 1993 following the discovery of hydrocarbon contamination in adjacent soil. Since then, the Site has been the subject of further investigations. In addition, a soil removal action took place in the fall of 1993. Presented herein is a description of the various activities that have occurred to characterize the Site and reduce the level of contamination.

Work associated with removal of the USTs and subsequent investigations may be divided into the following tasks beginning with removal of the underground storage tanks. The dates and lead group involved in each activity are provided for reference.

- March 1993 — Underground Storage Tank Excavation (E.P. Johnson)
- March 1993 — Preliminary Site Assessment (E.P. Johnson)
- June 1993 — Initial Site Investigation (RETEC, Inc.)
- September 1993 — Contaminated Soil Excavation (Seattle Parks)
- October 1993 — Supplementary Site Investigation (RETEC, Inc.)

This report complies with WAC 173-340-450 regulations regarding releases from USTs as outlined by the Washington Department of Ecology (Ecology). In addition, the report supersedes a previous site characterization report (RETEC, 1993) issued before completion of the contaminated soil excavation and the supplementary site investigation.

2.1 Site Description

The Seattle Parks facility (Site) is located at 802 Roy Street, near the south end of Lake Union (Figure 2-1). It lies on the Southwest 1/4 of the Southeast 1/4 of Section 30, Township 25 North, Range 4 East in the City of Seattle, Washington. The Site is bordered by Aloha Street to the north, Roy Street to the south, 8th Avenue to the west, and an alley to the east. The general topography at the Site slopes northeasterly towards Lake Union.

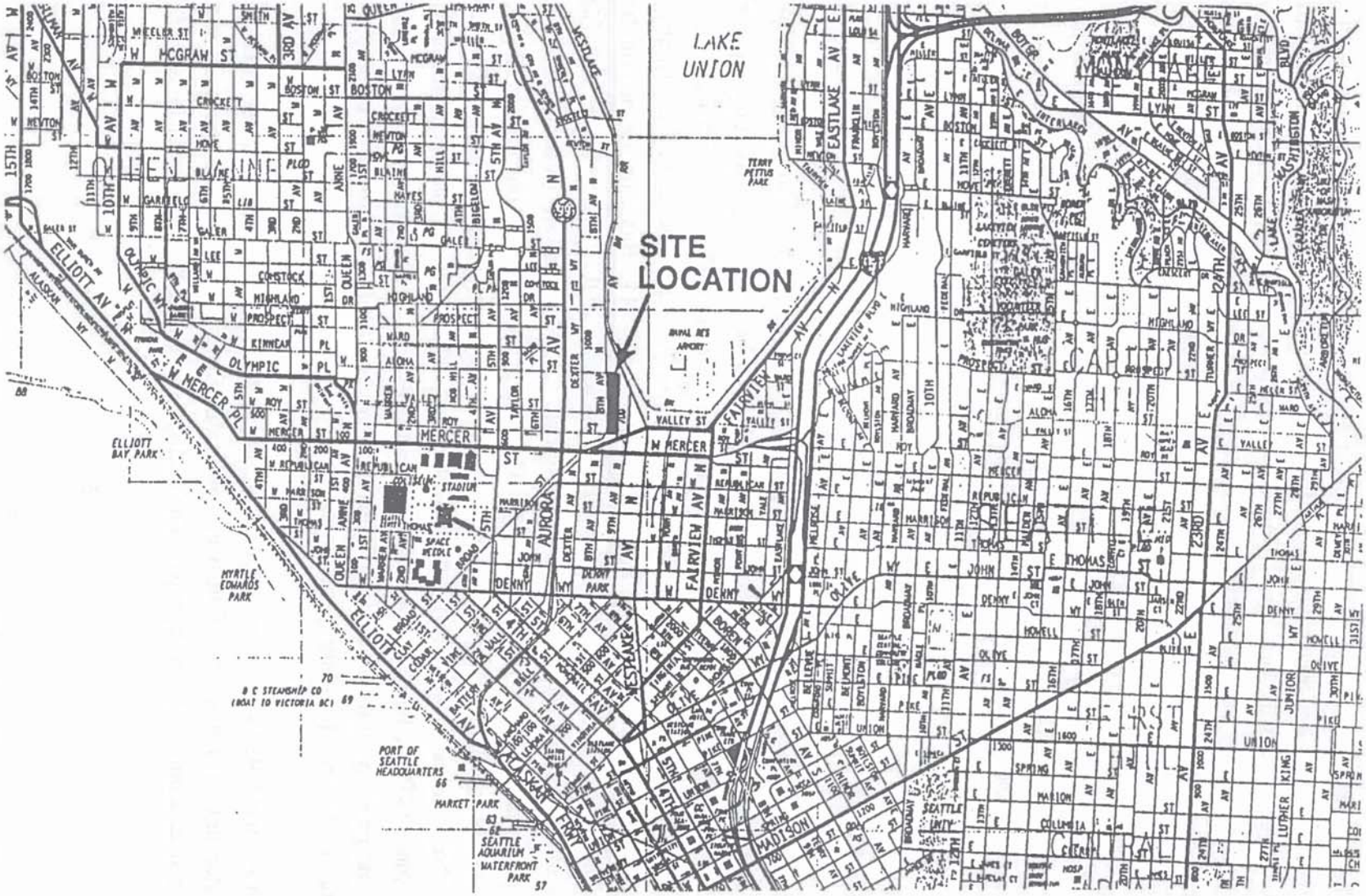
The Site (Figure 2-2) occupies approximately one acre of property that includes an administrative office building and adjoining service shop, a truck bay area on the west side of the main building, and a ten stall vehicle parking area on the east side of the building. A large vehicle parking area is located adjacent to the north end of the service shop building. The entire parking area was covered with asphalt or concrete before the USTs were removed.

2.2 Site History

Prior to construction of the building, the Site was covered by fill from the Denny Regrade and from other unknown sources. The fill consists of sands, silts, clays, gravels, concrete, household debris and discarded construction materials. Once the area was filled, it was leveled and graded flat for use as commercial property. The building that is currently at the Site was built by Puget Power and Light Company before 1944. Based on information from previous investigations and city drawings, it was determined that Puget Power and Light Company installed two USTs (2,700 and 550 gallons). These tanks are identified on a 1955 drawing prepared by Puget Power and Light Company. After 1955, but before 1967, the property was bought by Seattle City Light. A 1967 drawing prepared by Seattle City Light indicates plans to install a 4,000 gallon diesel tank. Seattle City Light moved out of the building and in October 1975 the building was leased by Seattle Parks. Seattle Parks then purchased the building and property from Seattle City Light in November 1991. Seattle Parks is the current owner and resident of the building and property.

In August 1992, Seattle Parks notified Ecology of a leak in a fuel pump dispenser at the maintenance shop. Fueling operations were suspended in October 1992 after discovering fuel odors in soil adjacent to the fuel pumps. The fuel system reportedly tested tight in May 1992.

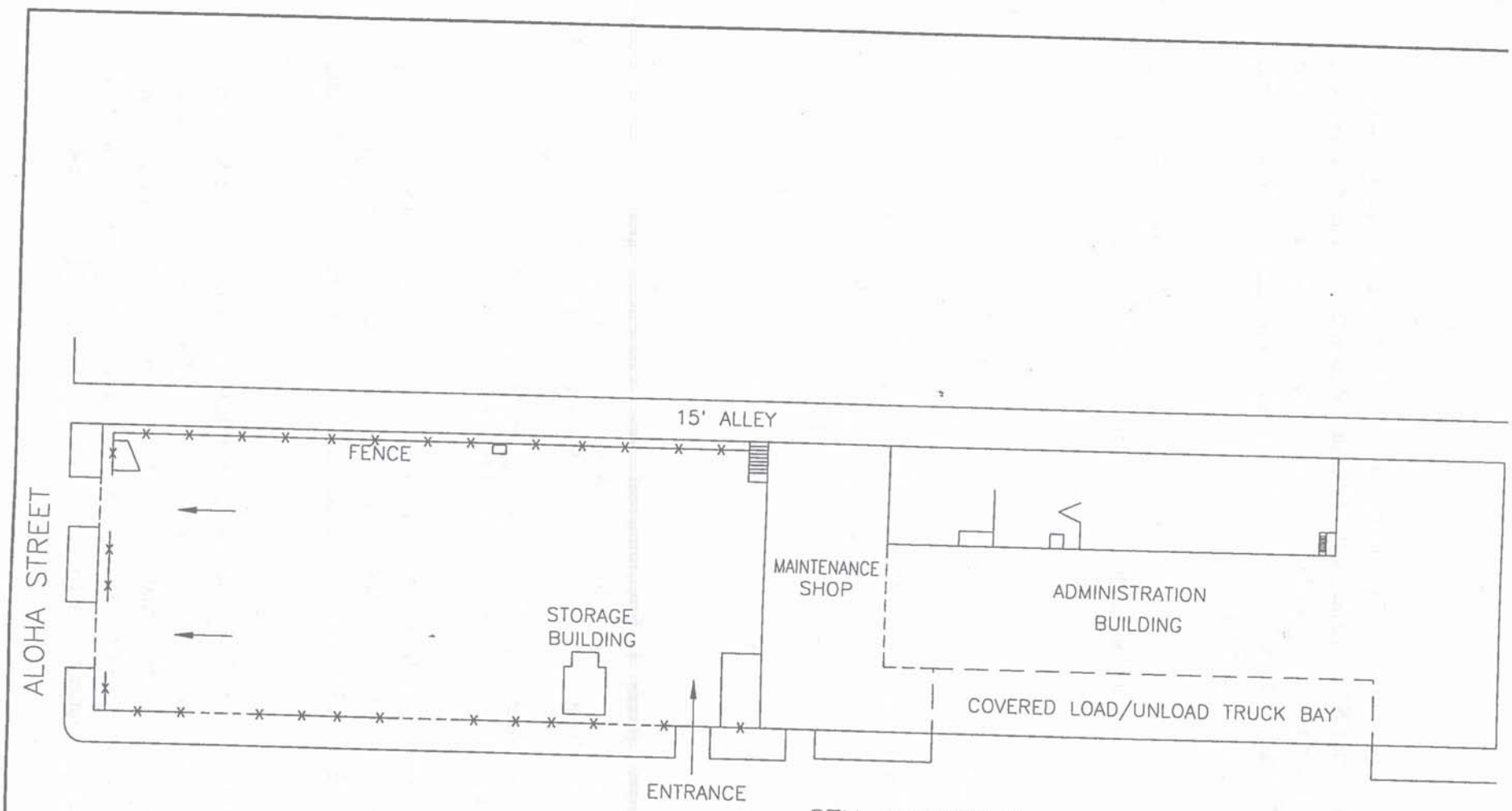
REIEC



SITE LOCATION MAP
ROY STREET FACILITY
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

FIGURE
2-1

PLTS_028040



N

0 40 80 160

APPROXIMATE SCALE IN FEET

REF DWG	DESC.			
0				
0	LT.	5/20/94	INITIAL ISSUE	GJL
NO	DRWN	DATE	REVISION	

ROY STREET PROJECT

3-1274-160

SCALE 1" = 80'

SITE PLAN
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

REMEDIATION TECHNOLOGIES, INC.

PLTS_028041

Shortly after the suspension of fueling operations, Seattle Parks commissioned soil-gas and geophysical surveys from SCS Engineers of Bellevue, Washington. The surveys were intended to assess the magnitude and distribution of hydrocarbon contamination in soil and identify the location of underground tanks. The surveys were conducted in April 1992, and SCS's report is reproduced in Appendix A.

In March 1993, E.P. Johnson (Pasco, WA) was retained by Seattle Parks to remove the 2,700 and 550 gallon USTs. This and subsequent work aimed at characterizing and remediating the Site are the subject of this report.

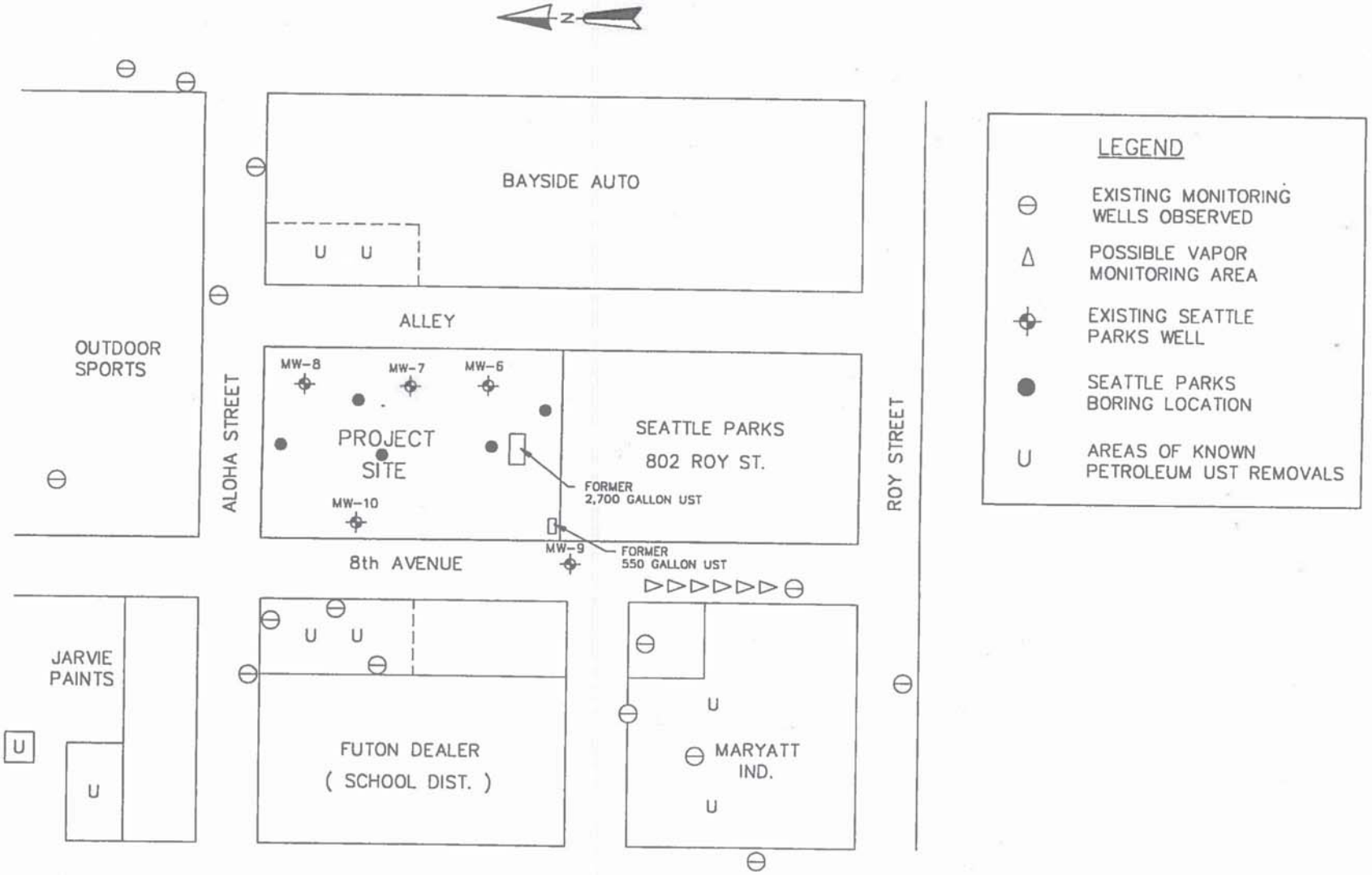
2.3 Area Water Quality

Groundwater quality in the area of the Roy Street facility has been impacted by known releases from adjacent facilities. Several investigations have been completed in the vicinity of the Site. The three investigation reports reviewed by RETEC were:

- "Summary Report Environmental Testing Seattle Facility" completed for Maryatt Industries by Dalton, Olmsted and Fuglevand Inc. dated December 9, 1992
- "Preliminary Phase I Environmental Site Assessment and Subsurface Investigation" for the Westlake Terminals Site completed by Earth Consultants, Inc. dated September 15, 1992
- "Site Characterization for the Seattle School District Building" completed by Hart Crowser dated July 24, 1989

These reports were reviewed for information on upgradient groundwater quality in the Roy Street area. Summaries of these investigations are presented below. The locations of numerous monitoring wells, USTs, and former USTs near the Seattle Parks facility are provided in Figure 2-3 for reference.

The Maryatt Site located at 771 Valley Street is directly upgradient of the Roy Street facility. Past practices on the Site resulted in the release of hazardous substances. Constituents associated with petroleum fuels were detected in five of the six wells at the Site with the highest concentrations detected in the area of the former USTs. Gasoline, diesel, and heavier range hydrocarbons were detected. Benzene concentrations at the Site were as high as 0.48 ppm.



REF DWG	DESC.						
0							
0	E.F.	5/20/94	INITIAL ISSUE	G.H.	5/20/94		
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE

ROY STREET PROJECT

3-1274-160

SCALE NONE

CAD FILE 12745045

SITE VICINITY MAP
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 2-3 REV. 0

PLTS_028043

TPH as gasoline and diesel were also detected at concentrations up to 4.2 ppm and 26 ppm respectively. Chlorinated solvents were detected in three wells at the Site.

The Jarvie Paint Site is located at 760 Aloha Street to the northwest of the Roy Street facility. Information obtained during a site assessment indicated that solvents and metals were used in the process of making various paints. The solvents were stored in USTs located on the west side of the property near Dexter Avenue North. Evidence of soil staining with solvents was observed on the property in 1977 by a Metro inspector. Evidence that solvents leaked or were dumped into the storm sewer system running along 8th Street was also documented. In addition, volatile organics were detected in the sewer. The potential for soil and groundwater contamination beneath Jarvie Paint is considered high. However, no soil or groundwater data was available for review.

The Seattle School District is located at 800 8th Street directly upgradient of the Roy Street facility. The primary sources of contamination at this Site appear to be petroleum hydrocarbons released from USTs previously located on site. Of the 5 groundwater samples collected from the Site, no BTEX compounds were detected in the samples. Acetone was observed in two of the wells at 5.7 ppb and 2.9 ppb. Carbon disulfide and cis-1,2-dichloroethene were observed in one of the wells at 9.1 ppb and 1.8 ppb, respectively. TPH concentrations were measured at 2.0 ppm and 1.0 ppm in two wells at the Site.

The foregoing summary of investigations conducted on properties adjacent to the Seattle Park's Roy Street facility highlights the potential for off-site sources of groundwater contamination.

3.0 FIELD ACTIVITIES

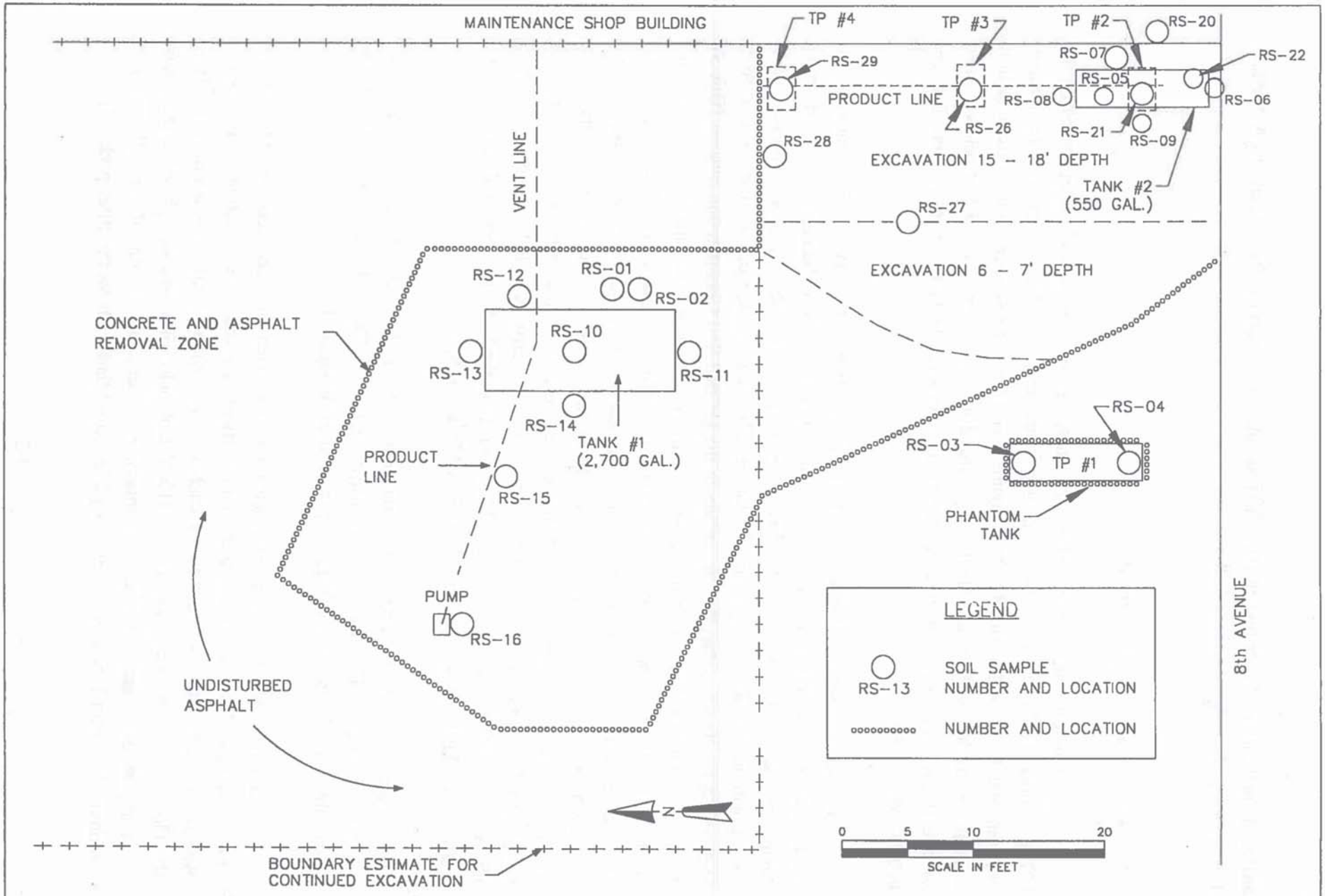
Presented in this section is a summary of field activities conducted at the Seattle Parks facility. These activities may be divided into the following tasks beginning with removal of the underground storage tank. The dates and lead group involved in each activity are provided for reference.

- March 1993 — Underground Storage Tank Excavation (E.P. Johnson)
- March 1993 — Preliminary Site Assessment (E.P. Johnson)
- June 1993 — Initial Site Investigation (RETEC, Inc.)
- September 1993 — Contaminated Soil Excavation (Seattle Parks)
- October 1993 — Supplementary Site Investigation (RETEC, Inc.)

3.1 Underground Storage Tank Excavation

Two USTs were removed from the Roy Street Facility in March of 1993 (Tanks # 1 and 2, Figure 3-1). A suspected third tank (Phantom Tank, Figure 3-1) was determined not to exist. No evidence of free petroleum product was observed during the tank removal operations. After removal of the tank, approximately 325 tons of petroleum contaminated soil were excavated from the affected area and thermally treated off-site. The excavation was not backfilled at the conclusion of the tank removal operation.

Twenty-two samples of soil were collected from the excavation and analyzed for various constituents. The samples were collected from the bottom and sidewalls of the excavation. The samples were retrieved by hand from the bucket of the excavator. The bucket and sampling tools were decontaminated between samples using tri-sodium phosphate (TSP) and deionized water. The locations of sampling points are shown in Figure 3-1. The samples were analyzed primarily for TPH as gasoline (EPA Method 8015, modified) and volatile aromatics (benzene, toluene, ethylbenzene and xylenes, BTEX) by EPA Method 8020. Selected samples were also



REF DWG	DESC.
0	
0	I.T. 5/20/94 INITIAL ISSUE
NO	DRWN DATE REVISION

ROY STREET PROJECT

3-1274-160

SCALE 1" = 10'

G.H. | CHKD | DATE | APPVD | DATE

CAD FILE 12745055

UNDERGROUND STORAGE TANK EXCAVATION
SAMPLE LOCATIONS
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

RETEC
REMEDIATION
TECHNOLOGIES INC

DRAWING NO. FIGURE 3-1 REV. 0

PLTS_028046

analyzed for lead (EPA Method 6010), TPH as substances heavier than diesel (EPA Method 418.1) and PCBs (EPA Method 8080).

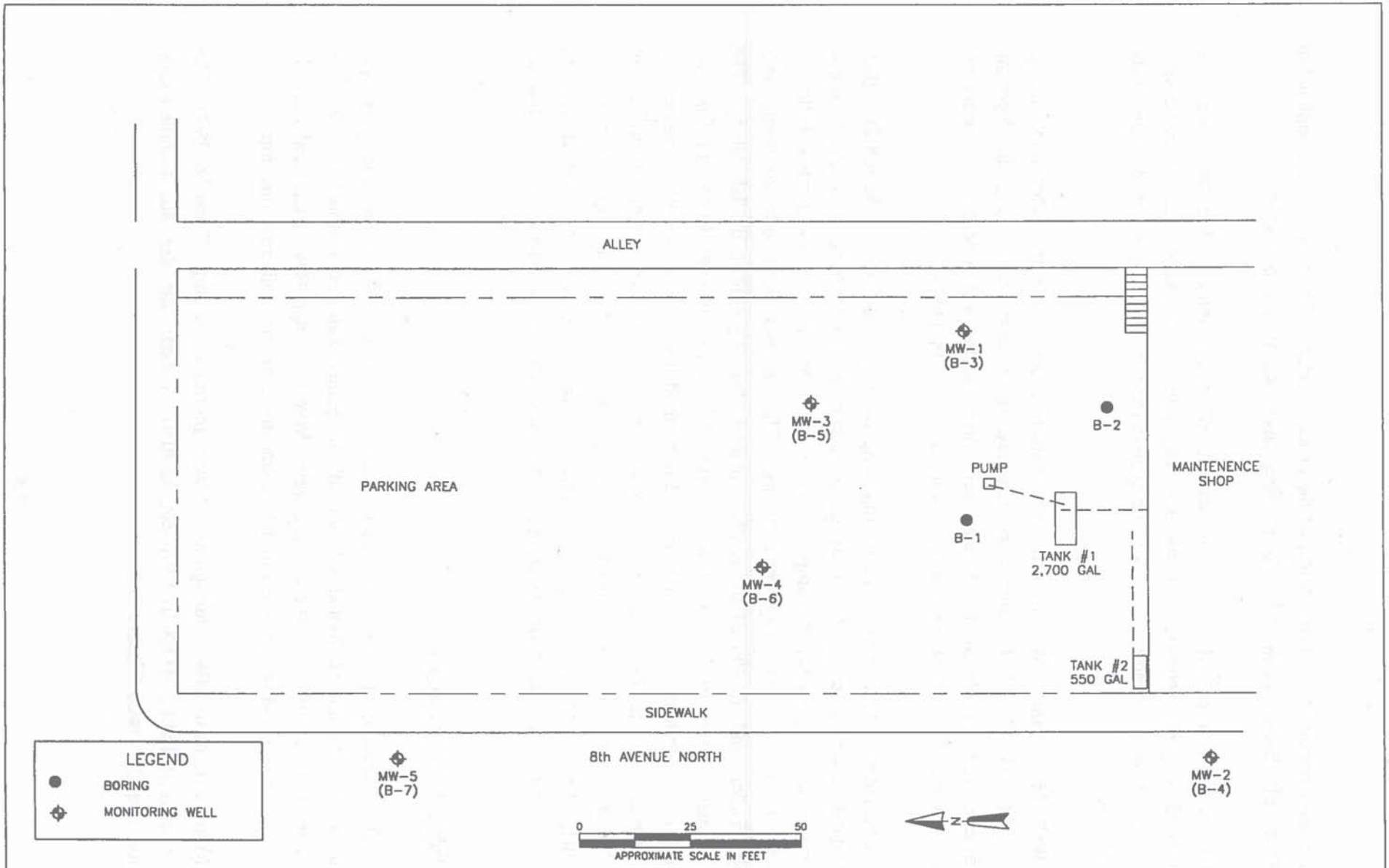
3.2 Preliminary Site Assessment

E.P. Johnson conducted a preliminary site assessment immediately after removing the USTs to obtain information on the remaining contamination. Seven borings were installed between March 12 and March 18, 1993 (Figure 3-2). The borings were installed using hollow stem auger drilling equipment. The borings ranged in depth from 24 to 39 feet below ground surface (bgs). All borings were extended below the water table to determine whether free product was present.

Soil samples were collected from the borings at five-foot intervals. The sampling was performed using a split-spoon sampler (18-inches long, 2-inch diameter). All sampling equipment used in the investigation was decontaminated between samples to prevent cross contamination. In addition, augers and downhole drilling equipment were steam-cleaned between borings. All soils were classified according to the Unified Soil Classification System (USCS); descriptions included the soil name, color, texture, consistency or compaction, and moisture content. Boring logs and soil descriptions are contained in Appendix B. The samples were placed directly into precleaned glass jars, and any excess soil was stored in plastic bags for soil-gas screening with a PID. All samples were placed directly into an iced cooler. Standard chain of custody procedures were followed during the preparation and transportation of the soil samples to the laboratory. The samples were analyzed primarily for TPH as gasoline and diesel (EPA Method 8015, modified), and BTEX (EPA Method 8020). Selected samples were analyzed for TPH heavier than diesel by EPA Method 418.1.

Five of the seven borings were completed as monitoring wells (Figure 3-2). The other two borings (B-1 and B-2) were backfilled with bentonite. The wells were screened across the water table. Well construction logs are provided in Appendix B.

The monitoring wells were constructed utilizing 4-inch-diameter schedule 40 PVC casing and well screen. The well screens consisted of between 10- and 20-foot sections of PVC screen with 0.020 inch slots. The bottom of each well was capped with a 4-inch-diameter flush-threaded end cap. A filter pack of clean #10/20 Colorado silica sand was placed in the annular space around the screen and extended a minimum 2-feet above the top of the well screen. A minimum 2-foot-thick bentonite seal was placed immediately above the filter pack. The



REF DWG	DESC.							
0								
0	LT.	1/7/94	INITIAL ISSUE	G.H.				
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE	

ROY STREET PROJECT

3-1274-160

SCALE 1" = 25'

CAD FILE 12745095

PRELIMINARY SITE ASSESSMENT
BORING AND WELL LOCATIONS
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 3-2 REV. 0

PLTS_028048

bentonite seal extended to within 1.5 feet of the ground surface. The wells were completed at the surface with 12-inch-diameter by 12-inch-deep steel locking well protectors.

Water levels in the wells were measured just before development. The static water level was measured using an electronic level indicator. The water-level indicator was cleaned between wells to prevent cross-contamination. No free hydrocarbon product was observed in any of the monitoring wells.

Wells MW-1 and MW-5 were developed using a 3-stage electric submersible pump. Approximately 55-gallons of water were removed from each well during development. Development water was placed in DOT-approved drums, labeled and covered. The pump and hose were decontaminated between wells to avoid cross-contamination.

Subsequent to development, all 5 monitoring wells were sampled on March 22, 1993. Approximately 3 well-volumes of groundwater were purged from each well before sampling to allow collection of representative samples. All purge water from the monitoring wells was containerized on site in DOT approved drums. The samples were collected using clean disposable bailers and transferred to sample containers for shipment to the laboratory. The water was analyzed for TPH as gasoline and diesel (EPA Method 8015, modified), TPH heavier than diesel (EPA Method 418.1) and BTEX (EPA Method 8020). Each sample container was clearly labeled with the date and time of collection, project name, sample identification, sampler's name, and analysis required. Sample containers were stored in coolers on ice immediately after collection and kept cool during transfer to the laboratory. Strict chain of custody procedures were maintained throughout the transportation and handling of the samples.

3.3 Initial Site Investigation

RETEC conducted a brief site investigation which consisted of reviewing existing information and obtaining additional data on soil and groundwater contamination at the Site. Groundwater was sampled from the existing wells (MW-1 through MW-5) and analyzed. In addition, two trenches were excavated to help delineate remaining soil contamination.

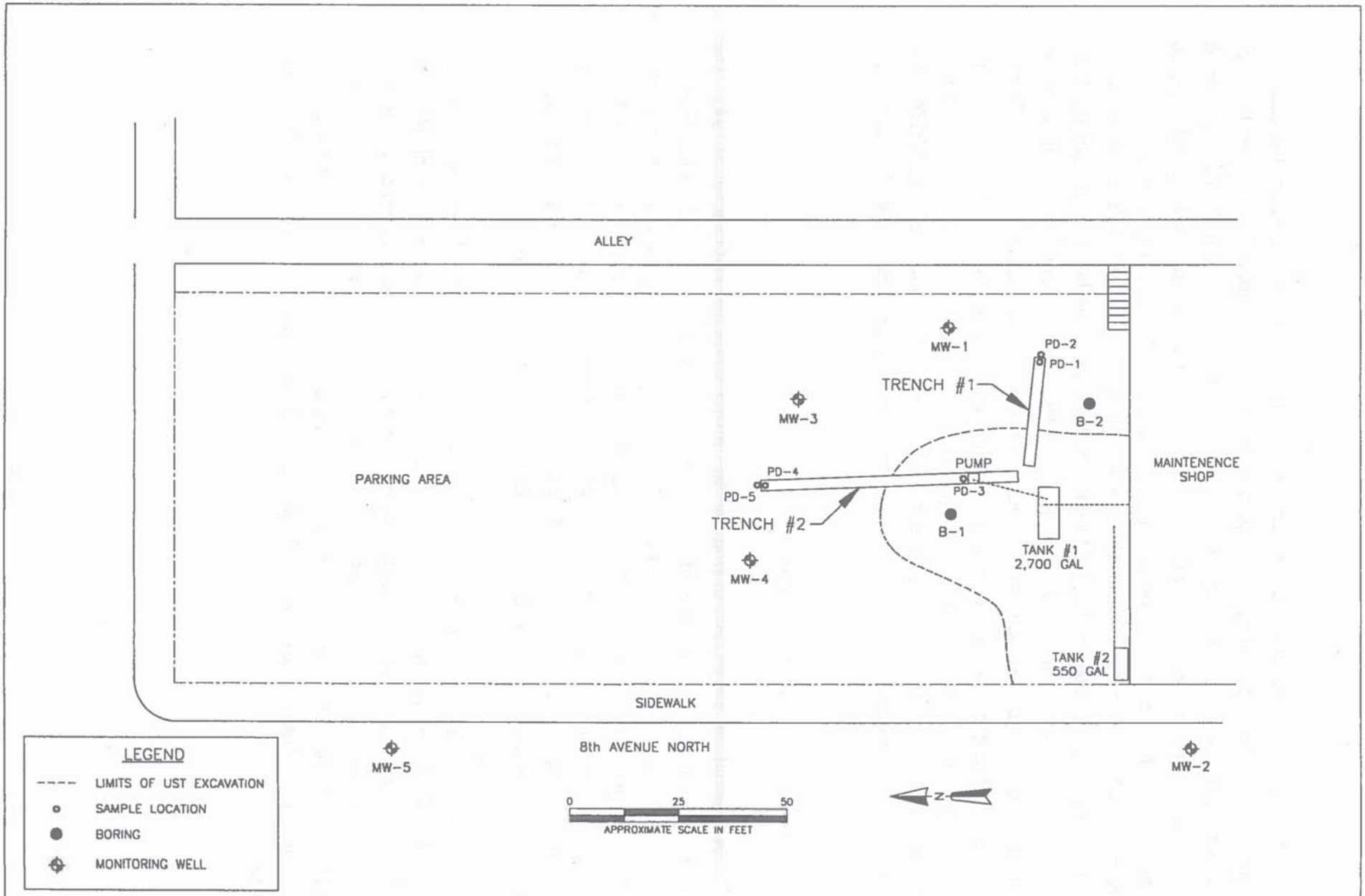
Monitoring wells MW-1 through MW-5 were resampled on June 17 and 18, 1993. The samples were analyzed for BTEX by EPA Method 8020. Standard sampling and documentation procedures were followed (Section 3.2).

Two trenches were dug on June 28 and 29, 1993 to further delineate the extent of contamination to the north and east of the previous excavation (Figure 3-3). The trenches were advanced until contamination diminished to low levels or physical barriers prevented continuation. Soil was obtained from the excavator bucket at frequent intervals and screened in the field for the presence of organic vapors. Results of the screening were used to select samples for laboratory analysis. Screening was performed using a OVM/Datalogger Model 580B Photo Ionization Detector (PID). Operation and calibration of the PID and methods of soil vapor screening were performed in strict accordance with manufacturers instructions. Calibration of the PID was performed using background air as a zeroing gas and 100 ppm isobutylene as the span gas. The screening procedure consisted of placing soil in a plastic bag and analyzing out-gassed vapors directly in the bag. Five samples of soil were collected from the trenches and analyzed for TPH as gasoline (EPA Method 8015, modified) and BTEX (EPA Method 8020). Standard sampling and documentation procedures were followed (Section 3.2).

3.4 Contaminated Soil Excavation

Additional soil was excavated from the Site during September and October of 1993. The decision to excavate soil was made after considering the available data and various remedial options. The excavation was performed by E.P. Johnson under the supervision of Seattle Parks. RETEC was primarily responsible for on-site sampling and testing. The testing was performed to assist Seattle Parks in guiding the excavation. Sample locations and the extent of the excavation are identified in Figure 3-4. Thirteen samples of soil were analyzed for TPH as gasoline (EPA Method 8015, modified) and BTEX (EPA Method 8020).

Approximately 2,870 tons of soil were excavated. The first 2,290 tons were recycled into cement (Holnam, Inc. Seattle). The remaining material was land-disposed at the Roosevelt landfill (Rabanco). The sidewalls of the excavation were nearly vertical and the average depth to the base of the excavation was between 20 and 25 feet bgs. Excavation was ceased when it became evident that remaining contamination was localized near the surface of the water table (12-18 feet bgs). The excavation was backfilled and compacted with clean imported fill and then paved.



REF DWG	DESC.							
1	E.F.	7/28/93	MINOR CHANGES	D.S.	7/28/93			
0	L.T.	1/7/94	INITIAL ISSUE	C.H.				
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE	

ROY STREET PROJECT

3-1274-160

SCALE 1" = 25'

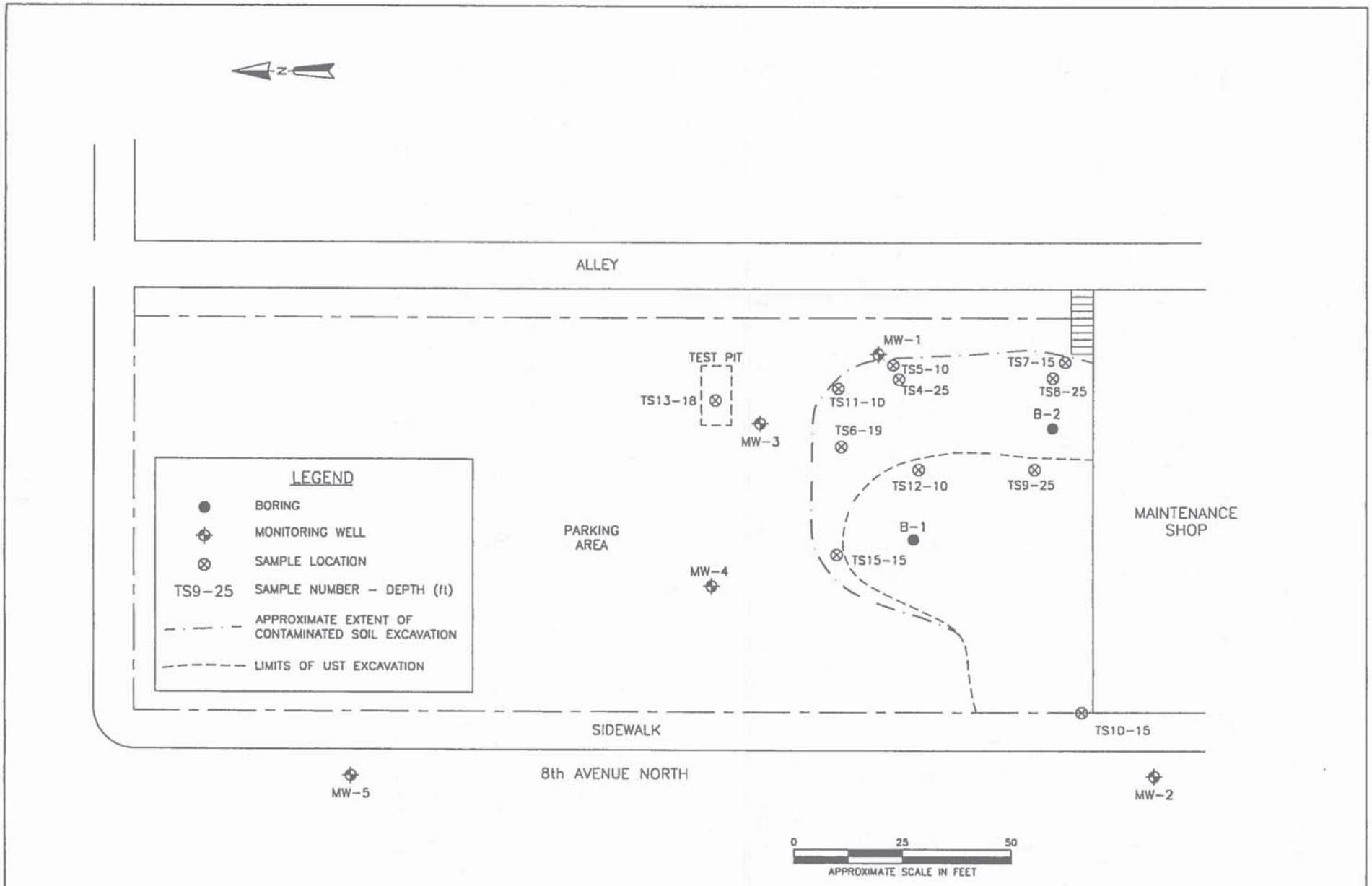
CAD FILE 1274S08S

INITIAL SITE INVESTIGATION
TRENCH AND SAMPLE LOCATIONS
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 3-3 REV. 0

PLTS_028051



REF DWG	DESC.						
0	LT.	10/12/93	LOCATION OF ABANDONED WELLS & MONITORING WELLS DATA	G.H.			
0	LT.	5/20/94	INITIAL ISSUE	G.H.			
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE

ROY STREET PROJECT

3-1274-160

SCALE 1" = 25'

CAD FILE 12745255

CONTAMINATED SOIL EXCAVATION
SAMPLE LOCATIONS
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 3-4 REV. 0

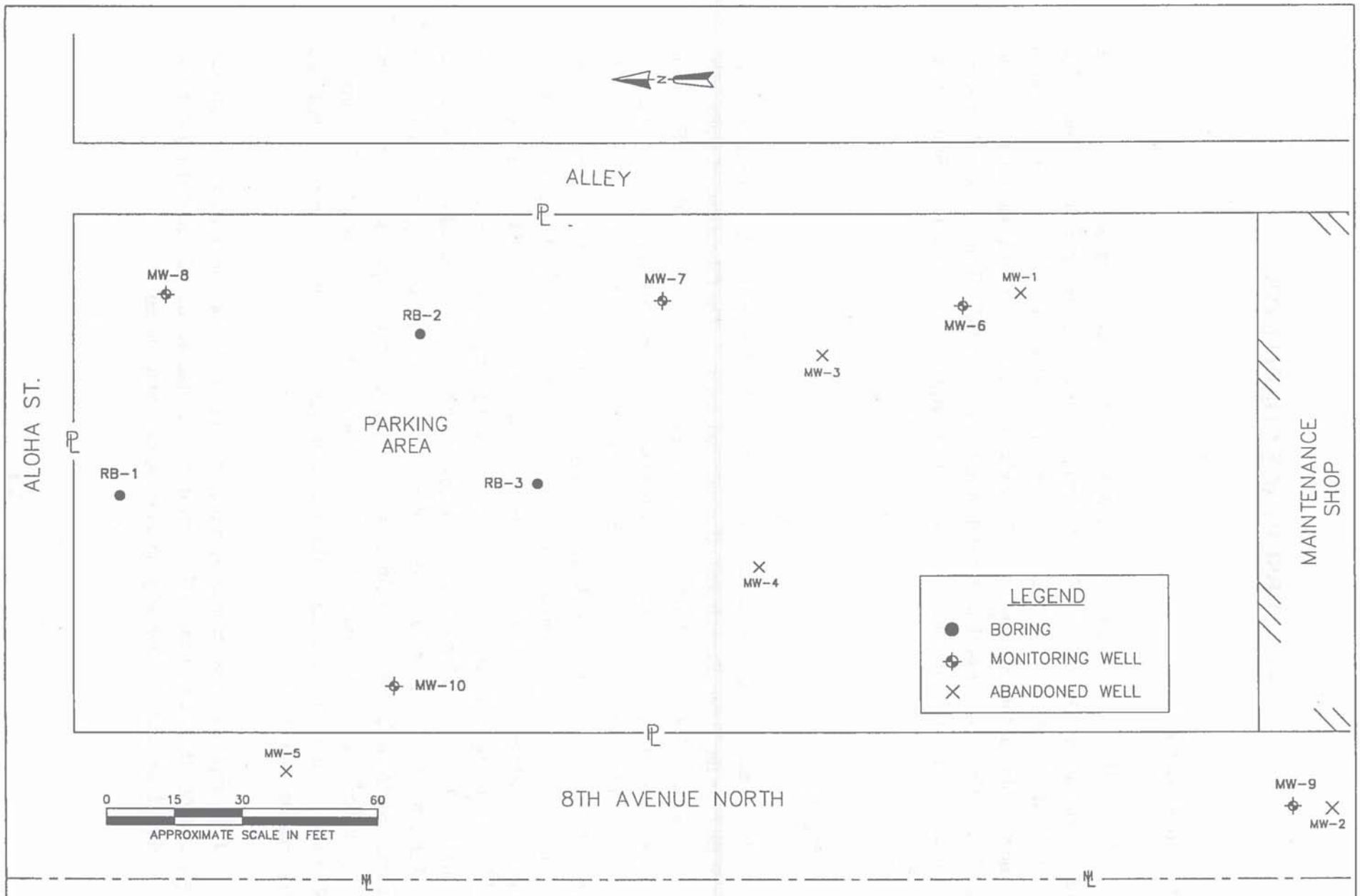
PLTS_028052

3.5 Supplementary Site Investigation

Observations made while excavating contaminated soil suggested that a semiconfining layer or aquitard existed at approximately 20 ft bgs (See Section 4.0). The usefulness and applicability of the existing monitoring wells (MW-1 through MW-5) was called into question by this finding because the well-screens for these wells extended far below this layer. The boring logs for these wells were prepared by the driller, are of poor quality, and are considered of little value in characterizing subsurface conditions at the Site (Appendix B). It was determined that supplementary information was required to better characterize soil and groundwater in the affected area.

The supplementary investigation consisted of abandoning the five previously installed wells to eliminate the conduit between the lower and upper portions of the aquifer. (Note: Any contaminant migration from the upper to the lower portions of the aquifer is considered very unlikely since there appeared to be an upward vertical gradient across the aquitard (See Section 4.0). The wells were abandoned by Geoboring, Inc. on October 12, 1993. Pressure grouting with a bentonite-cement slurry was performed using a tremmie pipe to ensure a seal of high integrity.

RETEC supervised the installation of 8 borings by Geoboring in October, 1993. Five of these borings were completed as wells to replace the previously abandoned wells (Figure 3-5). The borings and wells were installed using standard construction, testing, and well-development methods (Section 3.2 and Appendix B). Soil was generally sampled and characterized at 5-foot intervals which was reduced to 2.5-foot intervals near the water table to prevent puncture of the aquitard. Selected samples of soil were submitted from each boring for analytical testing (TPH as gasoline (EPA Method 8015, modified) and BTEX by EPA Method 8020). Groundwater samples were collected from the new wells (MW-6 through MW-10) in October 1993, January 1994, April 1994, and September 1994 and also tested for TPH as gasoline and BTEX.



REF DWG	DESC.						
0	I.T.	11/19/93	REVISED WELL & BORING LOCATIONS	G.H.			
0	I.T.	1/7/94	INITIAL ISSUE	G.H.			
NO	ORWN	DATE	REVISION	CHKD	DATE	APPVD	DATE

ROY STREET PROJECT

3-1274-160

SCALE 1" = 30'

CAD FILE 1274523S

SUPPLEMENTARY SITE INVESTIGATION
BORING AND MONITORING WELL LOCATIONS
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 3-5 REV. 0

PLTS_028054

4.0 SUBSURFACE CONDITIONS

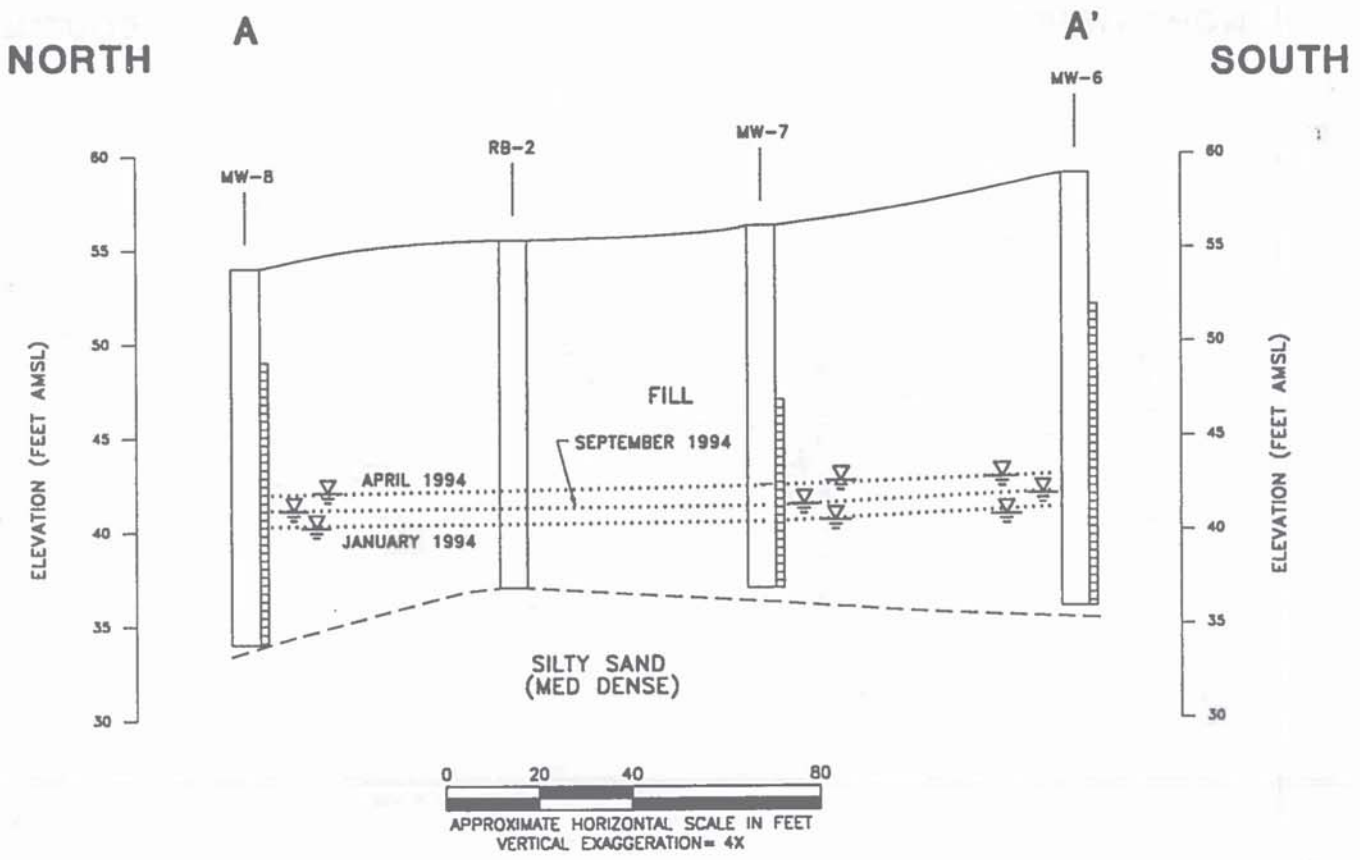
4.1 Regional Geology

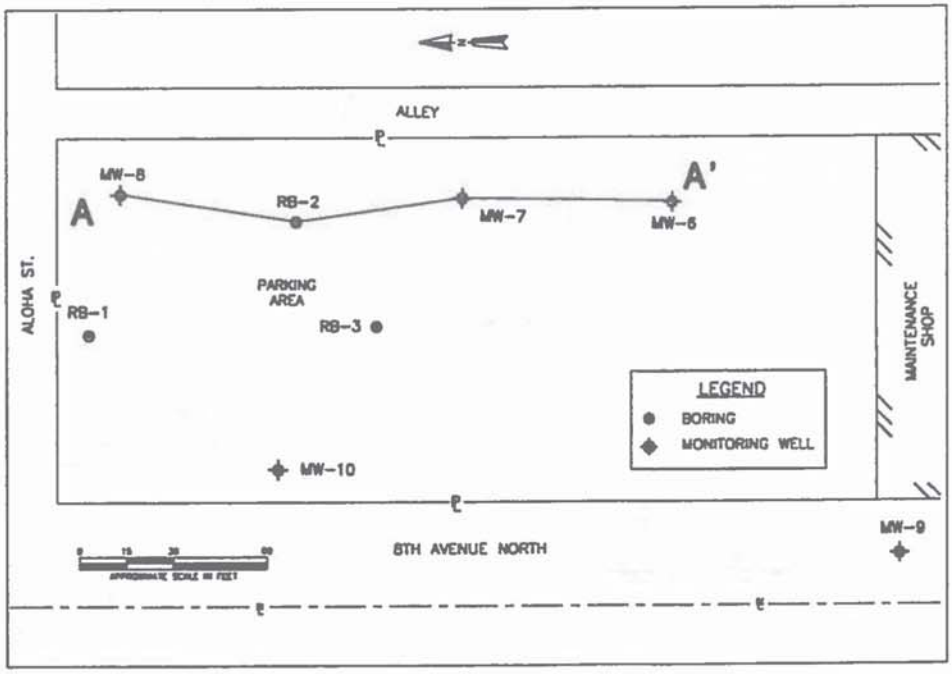
Regionally, the Site lies in the Puget Sound trough, where recent geology is largely the result of glaciation. A till of the Vashon Drift of Pleistocene age underlies the Site. The Vashon Drift till is a mixture of clay, sand, gravel, cobbles and boulders. The variation in thickness within the Site is unknown. Above the till is a layer of sand with some clay and gravel, identified as recessional stratified drift in the Vashon Drift. This recessional stratified drift likely includes the silty sand and gravel noted during investigations at the Seattle Parks facility.

4.2 Site Geology

The original ground surface beneath the Site has been raised by the addition of several feet of fill from the Denny Regrade and other unknown sources. The fill consists of sands, silts, clays, gravels, concrete, household debris and discarded construction materials. The fill is capped at the Site (i.e., north of the maintenance building) by approximately 4 inches of asphalt and associated base material. The fill extends vertically downward to depths varying from 18 to 27 feet bgs. A medium dense layer of silty sand lies immediately beneath the fill. The presence of the silty sand was noted visually during the excavation and during the installation of MW-6. During the excavation, a sample of the material was acquired by hand. A shovel could not be inserted into the layer. In addition, samples chipped from the surface were hard and brittle. This hardened layer of silty sand appears to be only a few feet thick. The layer was less than 2 feet thick at the location for MW-6 where it was penetrated during the first boring installed for this well (See log in Appendix B). Gravelly sands appear to be the dominant material underlying the silty sand based on information from the boring logs for MW-1 through MW-5 and evaluation of the material that heaved upward through the first borehole installed during construction of MW-6.

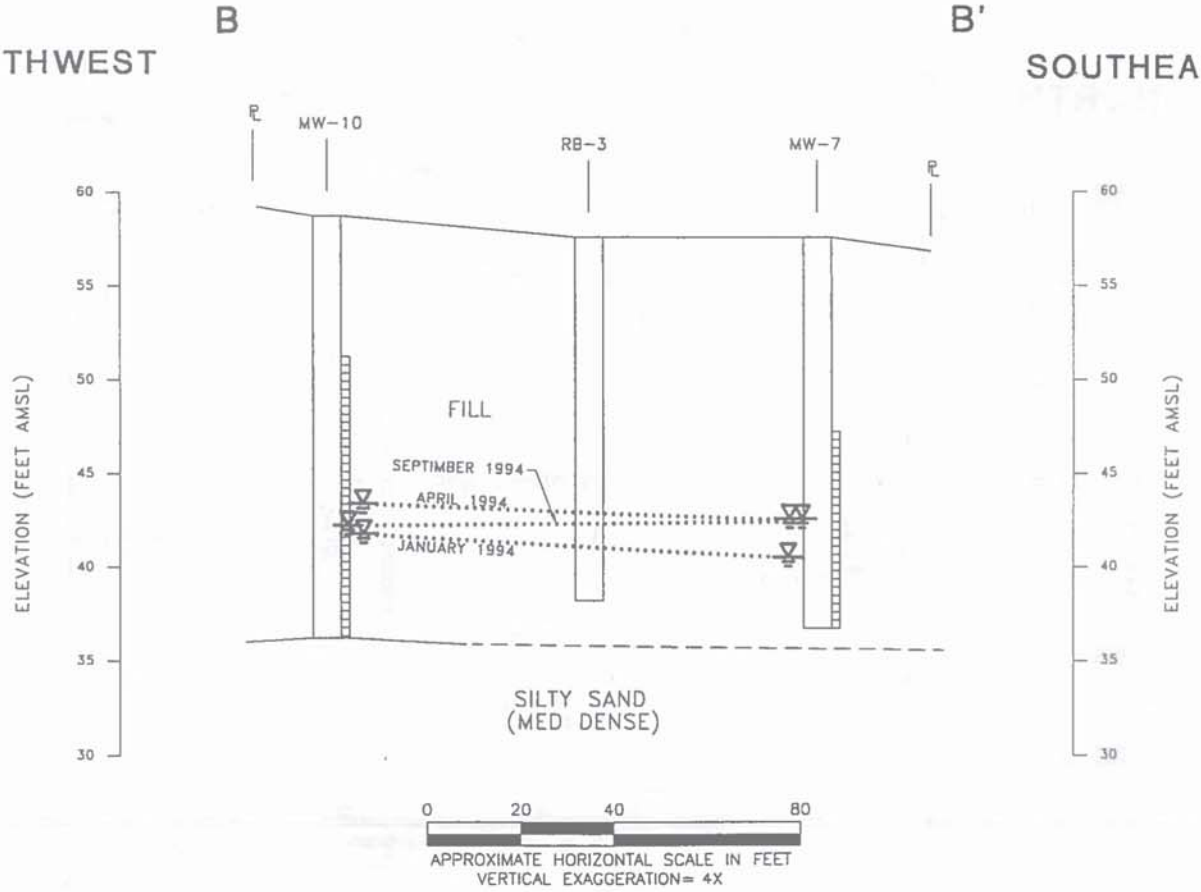
Two simplified cross-sections were prepared (Figures 4-1 and 4-2) using data from the supplementary site investigation. These cross-sections indicate that the contact between the upper fill and the medium dense silty sand dips to the south and east.

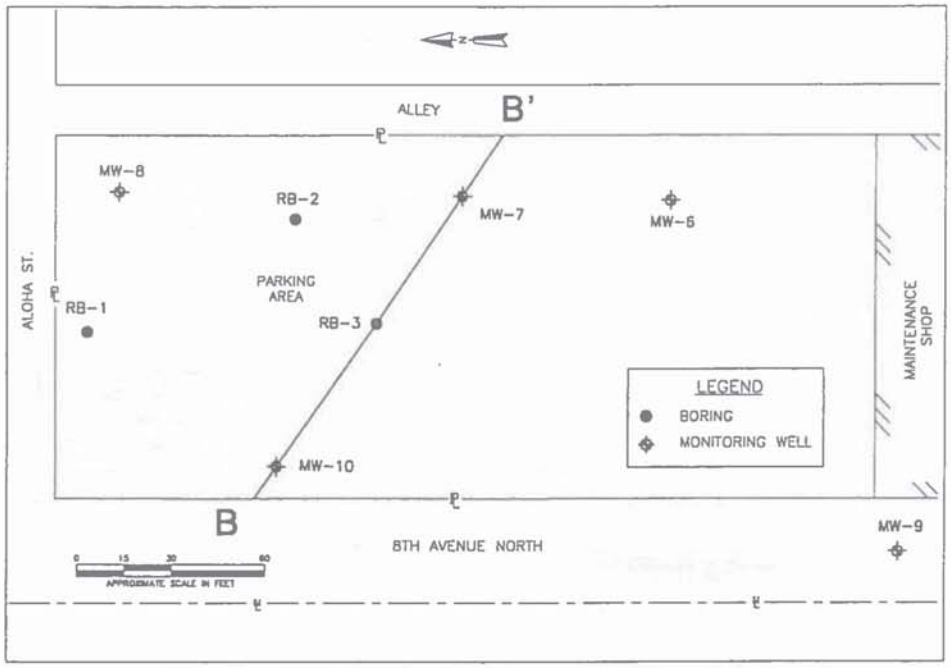




		ROY STREET PROJECT						SCALE	1" = 40'	GEOLOGICAL CROSS-SECTION A-A' SEATTLE DEPARTMENT OF PARKS AND RECREATION	REMEDIATION TECHNOLOGIES INC
		3-1274-160									DRAWING NO. FIGURE 4-1 REV 0
REF DWG	DESC.										
0											
0	LT.	5/20/94	INITIAL ISSUE	G.M.				CAD FILE	127453PS		
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE				

PLTS_028056





		ROY STREET PROJECT			SCALE	1" = 40'	GEOLOGICAL CROSS-SECTION B-B' SEATTLE DEPARTMENT OF PARKS AND RECREATION	REMEDIATION TECHNOLOGIES INC	
		3-1274-160						DRAWING NO.	REV
REF DWG	DESC.							FIGURE 4-2	0
0									
0	I.T.	5/20/94	INITIAL ISSUE	G.H.					
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE		
					CAD FILE	1274SJ05			

PLTS_028057

The lithology of the Site near the presumed aquitard is not well understood but could be a significant consideration in the design of remedial systems for remaining soil and groundwater contamination. If the aquitard is as thin as suggested by available information, wells and trenching systems must be carefully designed not to penetrate the layer.

4.3 Site Hydrogeology

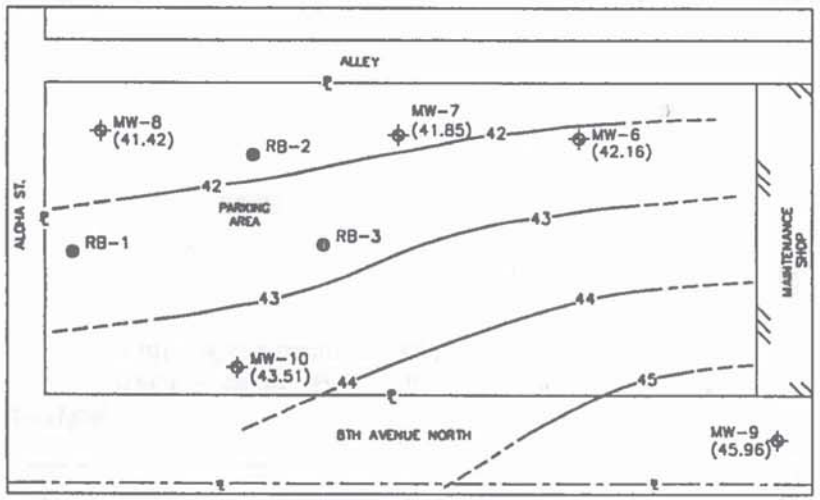
Hydrogeologic conditions at the Site were investigated by installing 5 monitoring wells during the preliminary site assessment and an additional 5 wells during the supplementary site investigation. The original 5 wells were abandoned during the supplementary site investigation because it was suspected that they connected groundwater above and below an observed layer of silty sand identified as a potential aquitard. That this layer could act as an aquitard was suggested by 2 observations. First, groundwater was observed to wet the sidewall of the excavation as work approached the position of MW-1. The wetting occurred far above where any saturated condition was encountered near the base of the excavation. Secondly, sand was noted to heave upwards about 2 feet in the first borehole installed for construction of MW-6 (See Appendix B). Both the heaving and wetting of the excavation wall are indications of a differential between the hydraulic and piezometric heads beneath the aquitard.

Groundwater at the Site occurs under water-table conditions in the fill material. The observed silty sand layer at depth is thought to act as an aquitard. This aquitard would be expected to prevent the migration of contaminants vertically downward because of the limited permeability of the layer and the vertical gradient suggested by heaving sands beneath the layer.

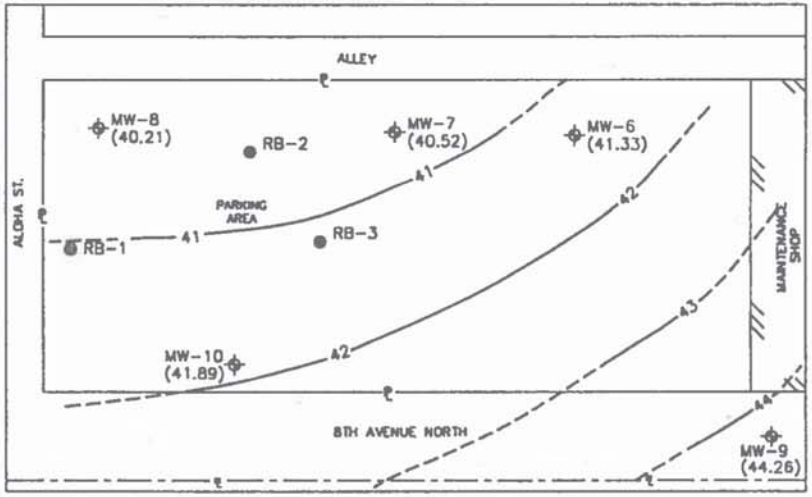
Contour maps are presented in Figure 4-3 using data from several well gaugings (Table 4-1). Water levels at the Site are generally between 12 to 18 feet bgs and appear to vary seasonally. The groundwater flows predominately east northeast towards Lake Union at a gradient which is approximately 0.02 feet per foot.

During completion of the supplementary investigation, RETEC performed slug tests on monitoring wells MW-6 and MW-8 which were completed in the water table aquifer. The tests were carried out to obtain values for the hydraulic conductivity (K) of the screened aquifer in the area. The hydraulic conductivity (also known as coefficient of permeability) is a measure of the ability of the aquifer to transmit a volume of water through a known area and is commonly measured in centimeters per second (cm/s). A slug test consists of removing a known volume of water from a well and measuring the change in the water level over time until

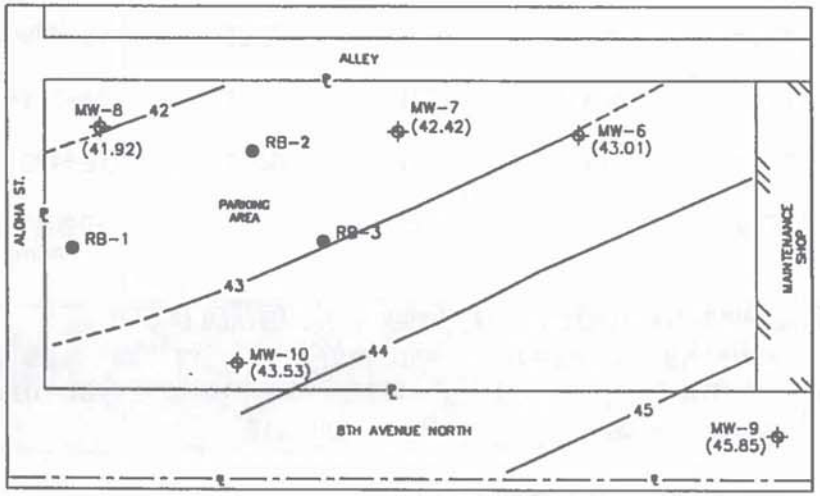
equilibrium is obtained. From time versus water level data plots, the K values were estimated using the method of Bouwer and Rice (1976) for unconfined aquifers. The results of the slug test were 8.47×10^{-7} cm/s for MW-6 and 1.87×10^{-6} cm/s for MW-8. These results are slightly lower than normal for silty sand.



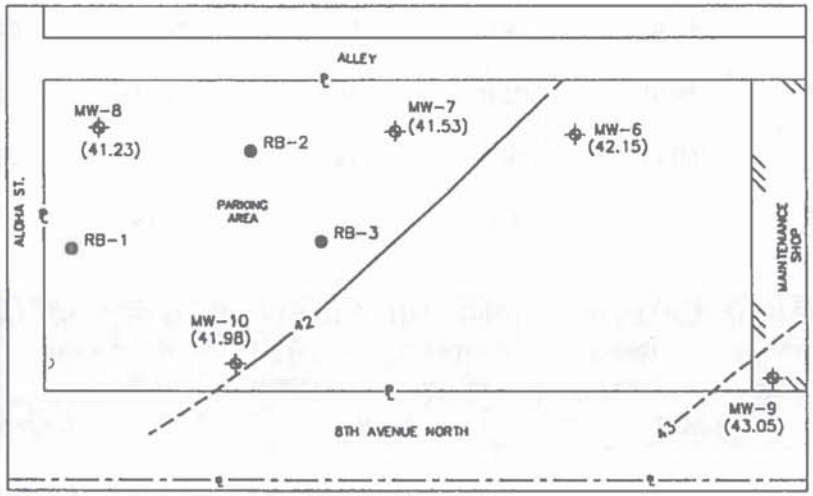
OCTOBER 1993



JANUARY 1994



APRIL 1994



SEPTEMBER 1994

LEGEND

- BORING
- MONITORING WELL
- (42.16) GROUNDWATER ELEVATION (ft amsl)
- —43— GROUNDWATER ELEVATION CONTOUR (ft amsl)

N

0 70 140

APPROXIMATE SCALE IN FEET

REF DWG	DESC.							
0								
0	RJAS T	5/20/94	INITIAL ISSUE	G.H.				
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE	

ROY STREET PROJECT

3-1274-160

SCALE 1" = 70'

CAD FILE 12745355

GROUNDWATER CONTOUR MAP

SEATTLE DEPARTMENT OF PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 4-3 REV. 0

PLTS_028060

REIEC

TABLE 4–1
GROUNDWATER GAUGING DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

GAUGING DATE	MW–6		MW–7		MW–8		MW–9		MW–10	
	Water Level (feet bTOC)	Water Elevation (feet amsl)	Water Level (feet bTOC)	Water Elevation (feet amsl)	Water Level (feet bTOC)	Water Elevation (feet amsl)	Water Level (feet bTOC)	Water Elevation (feet amsl)	Water Level (feet bTOC)	Water Elevation (feet amsl)
Survey Elevation		58.76		55.82		53.72		61.35		58.53
25–Oct–93	16.79	41.97	14.10	41.72	12.35	41.37	15.51	45.84	15.09	43.44
25–Jan–94	17.43	41.33	15.30	40.52	13.51	40.21	17.09	44.26	16.64	41.89
25–Apr–94	15.75	43.01	13.40	42.42	11.80	41.92	15.50	45.85	16.64	41.89
15–Sept–94	16.61	42.15	14.29	41.53	12.49	41.23	18.30	43.05	16.55	41.98

NOTES:

bTOC – below top of casing
amsl – above mean sea level

5.0 ANALYTICAL RESULTS

Soil and groundwater samples were submitted to several laboratories during the course of the project:

- OnSite Environmental, Inc. (Redmond, WA)
- Sound Analytical Services, Inc. (Tacoma, WA)
- Analytical Resources Inc. (Seattle, WA)
- Alden Analytical Laboratories, Inc. (Seattle, WA)

The analytical data for the Site was reviewed by RETEC. Strict chain of custody procedures and documentation were maintained for each sample submitted. Laboratory reports and chain of custody records are contained in Appendices C and D for soil and groundwater, respectively. The analytical results are presented and discussed below.

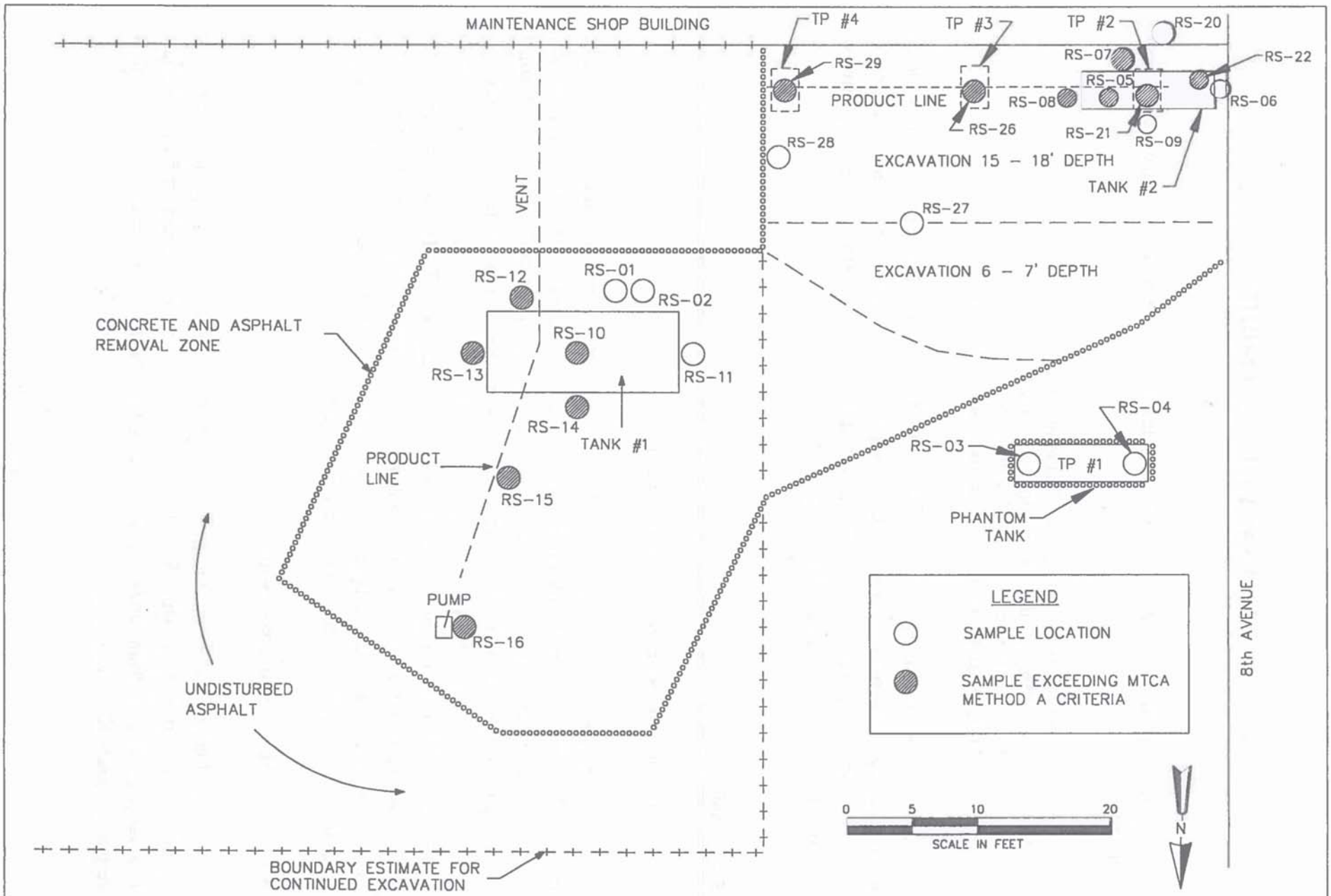
5.1 Soil

5.1.1 Underground Storage Tank Excavation

Soil samples were collected from 22 different locations within the tank excavation area by E.P. Johnson. Figure 5-1 identifies the location of the samples collected and analytical results are presented in Table 5-1. Analytical results for 13 of the samples exceeded Method A criteria for at least one of the following constituents: TPH-g, benzene, toluene, ethylbenzene, and xylenes. Method A criteria were exceeded for TPH-g in all 13 samples. The concentrations ranged from 140 to 3,800 ppm TPH-g for samples near Tank #1. TPH-g was also detected at 15,000 ppm near the pump area north of tank #2. Concentrations of TPH-g ranged from 1,500 to 6,900 ppm near Tank #2. Sample RS-15 near Tank #1 also exceeded the MTCA Method A level for lead (250 ppm) with a concentration of 480 ppm.

5.1.2 Preliminary Site Assessment

E.P. Johnson supervised the installation of seven borings in the vicinity of the tank excavations as indicated on Figure 5-2. Split spoon samples were collected on 5-foot intervals to assist in geological characterization and for analytical testing. A summary of the analytical results is presented in Table 5-2.



REF DWG	DESC.						
0							
0	LT.	1/10/94	INITIAL ISSUE	G.H.			
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE

ROY STREET PROJECT

3-1274-160

SCALE 1" = 10'

CAD FILE 1274S10S

UNDERGROUND STORAGE TANK EXCAVATION
SAMPLE LOCATIONS
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

RETEC
REMEDIATION
TECHNOLOGIES INC

DRAWING NO. FIGURE 5-1 REV. 0

PLTS_028063

TABLE 5-1
UNDERGROUND STORAGE TANK EXCAVATION
SOIL ANALYTICAL DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

SAMPLE ID	SAMPLE DATE	UNITS	WTPH-G GAS Method 8015M	WTPH-D DIESEL Method 8015M	WTPH-OILS OILS Method 418.1	BTEX - Method 8020				LEAD
						BENZENE	TOLUENE	ETHYL-BENZENE	TOTAL XYLENES	Method 6010
MTCA Method A		ppm	100	200		0.5	40	20	20	250
RS-01	01-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA	NA
RS-02	01-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA	NA
RS-03 **		ppm								
RS-04	02-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA	NA
RS-05	03-Mar-93	ppm	1700	NA	NA	< 0.25	1.5	8.3	29.2	32
RS-06	03-Mar-93	ppm	88	NA	NA	< 0.05	< 0.05	< 0.05	0.31	NA
RS-07	03-Mar-93	ppm	1500	NA	NA	< 0.25	1.4	9.6	69	NA
RS-08	03-Mar-93	ppm	3400	NA	NA	< 0.25	1.2	21	71	NA
RS-09	03-Mar-93	ppm	24	NA	NA	< 0.05	< 0.05	0.066	0.15	NA
RS-10	03-Mar-93	ppm	140	NA	NA	2.3	0.32	1.1	2.49	71
RS-11	03-Mar-93	ppm	60	NA	NA	0.15	0.088	0.18	0.5	NA
RS-12	03-Mar-93	ppm	3800	NA	NA	2.5	1.4	14	20.8	NA
RS-13	03-Mar-93	ppm	3100	NA	NA	4.1	1.4	27	26	NA
RS-14	03-Mar-93	ppm	1100	NA	NA	0.69	2.2	7.3	33	NA
RS-15	03-Mar-93	ppm	1900	NA	NA	5.1	1.7	28	79	480
RS-16	03-Mar-93	ppm	15000	NA	NA	100	260	170	460	80
RS-21	05-Mar-93	ppm	3700	NA	NA	3	79	45	226	NA
RS-22	05-Mar-93	ppm	6900	NA	NA	< 0.25	1.1	16	73	NA
RS-26	08-Mar-93	ppm	3700	NA	NA	6.3	76	50	216	NA
RS-27	08-Mar-93	ppm	15	NA	NA	< 0.05	0.33	0.19	0.95	NA
RS-28	08-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA	NA
RS-29	08-Mar-93	ppm	2000	NA	NA	0.86	24	33	168	NA

NOTES:

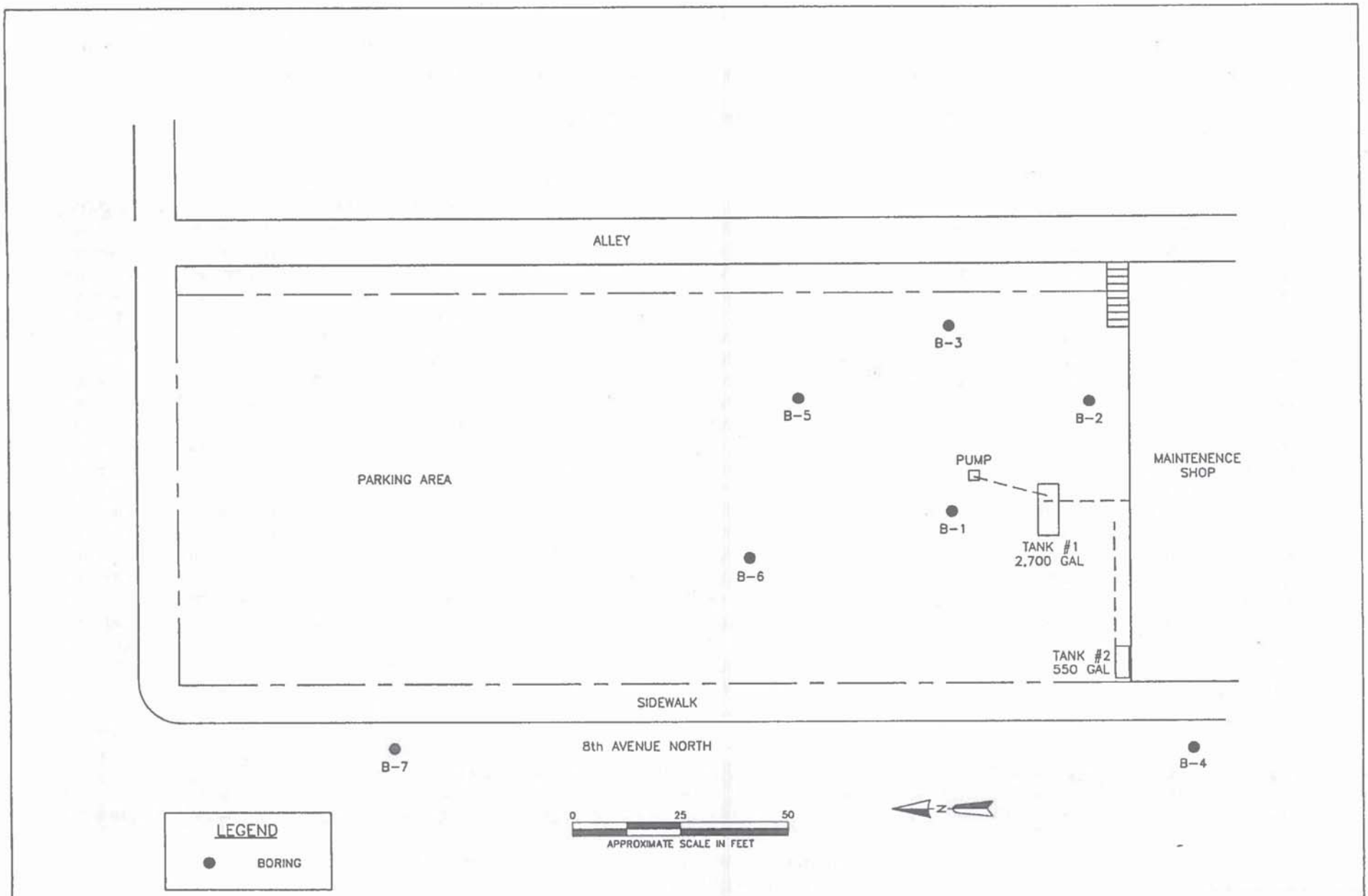
** - Sample not submitted

- Sample Exceeds MTCA Method A Criteria

NA - Not Analyzed

Samples RS-21 and RS-22 were analyzed for Halogenated Volatile Organics by EPA Method 8010 and no compounds were detected

Sample RS-01 was analyzed for PCBs by EPA Method 3330 and no compounds were detected



REF DWG	DESC.							
0								
0	I.T.	1/6/94	INITIAL ISSUE	D.H.				
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE	

ROY STREET PROJECT

3-1274-160

SCALE 1" = 25'

CAD FILE 12745285

PRELIMINARY SITE ASSESSMENT
SOIL BORING LOCATION MAP
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 5-2 REV. 0

PLTS_028065

REIEC

TABLE 5–2
PRELIMINARY SITE ASSESSMENT
SOIL ANALYTICAL DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

BORING LOCATION	SAMPLE ID –DEPTH	SAMPLE DATE	UNITS	WTPH–G GAS Method 8015M	WTPH–D DIESEL Method 8015M	WTPH–OILS OILS Method 418.1	BTEX – Method 8020			
							BENZENE	TOLUENE	ETHYL–BENZENE	TOTAL XYLENES
	MTCA Method A		ppm	100	200		0.5	40	20	20
B–1	RS1–2.5	12–Mar–93	ppm	< 20	290	> 100	NA	NA	NA	NA
	RS1–7.5	12–Mar–93	ppm	< 20	290	> 100	NA	NA	NA	NA
	RS1–12.5	12–Mar–93	ppm	310	NA	NA	2	0.66	5	25.2
	RS1–17.5	12–Mar–93	ppm	310	< 25	NA	2	0.66	5	25.2
	RS1–22.5	12–Mar–93	ppm	30	NA	NA	0.089	0.14	0.31	1.53
	RS1–27.5	12–Mar–93	ppm	30	NA	NA	0.089	0.14	0.31	1.53
	RS1–32.5	12–Mar–93	ppm	77	NA	NA	0.18	0.35	0.96	4.8
	RS1–37.5	12–Mar–93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	< 0.05
B–2	RS2–2.5	12–Mar–93	ppm	110	610	> 100	NA	NA	NA	NA
	RS2–7.5	12–Mar–93	ppm	110	610	> 100	NA	NA	NA	NA
	RS2–12.5	12–Mar–93	ppm	1800	NA	NA	4	24	23	115
	RS2–17.5	12–Mar–93	ppm	1800	240	NA	4	24	23	115
	RS2–22.5	12–Mar–93	ppm	59	NA	NA	0.8	1.1	0.85	3.9
	RS2–27.5	12–Mar–93	ppm	59	NA	NA	0.8	1.1	0.85	3.9
	RS2–32.5	12–Mar–93	ppm	94	< 25	NA	1.5	2.7	1.4	6.8
	RS2–37.5	12–Mar–93	ppm	9.8	NA	NA	0.74	< 0.05	0.11	1.34
B–3	RS3–2.5	15–Mar–93	ppm	< 20	< 50	< 100	NA	NA	NA	NA
	RS3–7.5	15–Mar–93	ppm	< 20	< 50	< 100	NA	NA	NA	NA
	RS3–17.5	15–Mar–93	ppm	210	NA	NA	10	7.3	3.7	15.8
	RS3–22.5	15–Mar–93	ppm	42	NA	NA	3.9	0.8	0.76	2.49
	RS3–27.5	15–Mar–93	ppm	42	NA	NA	3.9	0.8	0.76	2.49
	RS3–32.5	15–Mar–93	ppm	< 5	NA	NA	0.15	< 0.05	< 0.05	< 0.05
	RS3–37.5	15–Mar–93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	< 0.05

NOTES: – Sample Exceeds MTCA Method A Criteria

NA – Not Analyzed

PLTS_028066

REIEC

TABLE 5-2 (Continued)
PRELIMINARY SITE ASSESMENT
SOIL ANALYTICAL DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

BORING LOCATION	SAMPLE ID -DEPTH	SAMPLE DATE	UNITS	WTPH-G GAS Method 8015M	WTPH-D DIESEL Method 8015M	WTPH-OILS OILS Method 418.1	BTEX - Method 8020			
							BENZENE	TOLUENE	ETHYL-BENZENE	TOTAL XYLENES
B-4	RS4-2.5	15-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA
	RS4-7.5	15-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA
	RS4-12.5	15-Mar-93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	< 0.05
	RS4-17.5	15-Mar-93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	< 0.05
	RS4-22.5	15-Mar-93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	0.096
	RS4-27.5	15-Mar-93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	0.096
	RS4-37.5	15-Mar-93	ppm	6.6	NA	NA	< 0.05	< 0.05	< 0.05	< 0.05
B-5	RS5-2.5	16-Mar-93	ppm	< 20	< 50	400	NA	NA	NA	NA
	RS5-7.5	16-Mar-93	ppm	< 20	< 50	400	NA	NA	NA	NA
	RS5-12.5	16-Mar-93	ppm	46	NA	NA	0.88	0.28	0.97	1.37
	RS5-17.5	16-Mar-93	ppm	46	NA	430	0.88	0.28	0.97	1.37
	RS5-22.5	16-Mar-93	ppm	17	NA	NA	0.2	0.099	0.33	0.446
	RS5-32.5	16-Mar-93	ppm	7.2	NA	< 25	0.056	< 0.05	0.061	0.15
	RS5-37.5	16-Mar-93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	< 0.05
B-6	RS6-2.5	17-Mar-93	ppm	< 20	< 50	770	NA	NA	NA	NA
	RS6-7.5	17-Mar-93	ppm	< 20	< 50	770	NA	NA	NA	NA
	RS6-12.5	17-Mar-93	ppm	< 20	< 50	190	NA	NA	NA	NA
	RS6-17.5	17-Mar-93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	0.092
	RS6-22.5	17-Mar-93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	0.092
	RS6-27.5	17-Mar-93	ppm	< 5	NA	NA	< 0.05	< 0.05	< 0.05	< 0.05
B-7	RS7-2.5	17-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA
	RS7-7.5	17-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA
	RS7-12.5	17-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA
	RS7-17.5	17-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA
	RS7-22.5	17-Mar-93	ppm	< 20	< 50	< 100	NA	NA	NA	NA

NOTES: [shaded] – Sample Exceeds MTCA Method A Criteria
NA – Not Analyzed

PLTS_028067

Hydrocarbon contamination was greatest near the locations of the former tanks (i.e., B-1, B-2 and B-3). Soil from all other borings had very low levels of contamination. Elevated levels of TPH as diesel were detected in near-surface soil (2.5 and 7.5 feet bgs) in B-1 and B-2. This contamination may have resulted from spills at the maintenance shop. Gasoline contamination was largely confined to much lower depths based on results from B-1, B-2, and B-3.

5.1.3 Initial Site Investigation

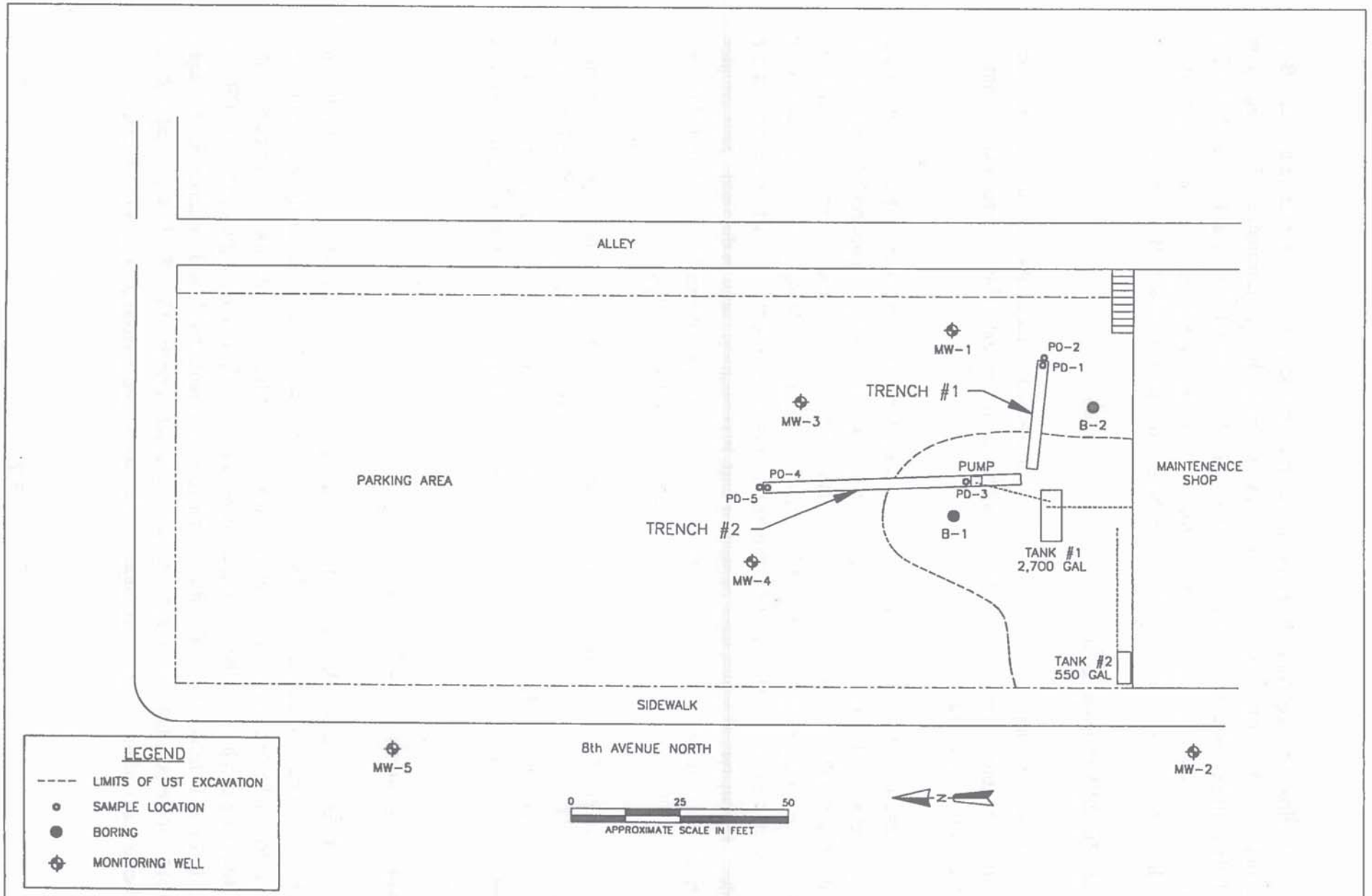
Five soil samples were analyzed for hydrocarbon contamination during the trenching program. Figure 5-3 identifies the locations of the samples and Table 5-3 presents a summary of the analytical results.

Samples PD-1 and PD-2 were collected east of the UST excavation at depths of 19 and 10 feet, respectively. PD-1 was collected near the water table and contained high levels of TPH-g and BTEX. PD-2 contained very low levels of hydrocarbons. The disparity in contaminant levels between these two samples indicated that hydrocarbon contamination was at depth near the end of the trench. This can be attributed to spreading once the product reached the water table. The analytical results were consistent with PID readings taken in the field. Soil samples from the depth interval of 16 to 20 feet bgs were collected approximately every 5 feet along the trench and PID readings of the soil-gas were uniformly above 400 ppm.

Sample PD-3 was collected in the source area at a depth of 17 feet bgs. This sample exceeded Method A criteria for TPH-g, benzene, and xylenes. Samples PD-4 and PD-5 were collected north of the UST excavation at depths of 17 and 10 feet bgs, respectively. Both samples contained very low levels of hydrocarbons indicating that this portion of the Site was clean.

5.1.4 Contaminated Soil Excavation

Thirteen soil samples were collected during the excavation and analyzed for TPH-g and BTEX. Figure 5-4 indicates the locations of these samples and the analytical results are presented in Table 5-4. (NOTE: The last two digits in the sample numbers correspond to the approximate depth at which the samples were obtained.) Data for samples TS15-15, TS6-19, and TS13-18 indicate that hydrocarbon contamination extends north of the excavation at a depth roughly corresponding to the water table. Data for samples TS4-25, TS8-25, and TS9-25 indicate that contaminated soil extended to the base of the excavation and was not entirely



REF DWG	DESC.							
0								
0	LT.	1/7/94	INITIAL ISSUE	G.H.	1/7/94			
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE	

ROY STREET PROJECT

3-1274-160

SCALE 1" = 25'

CAD FILE 1274S12S

INITIAL SITE INVESTIGATION
TRENCH AND SAMPLE LOCATIONS
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

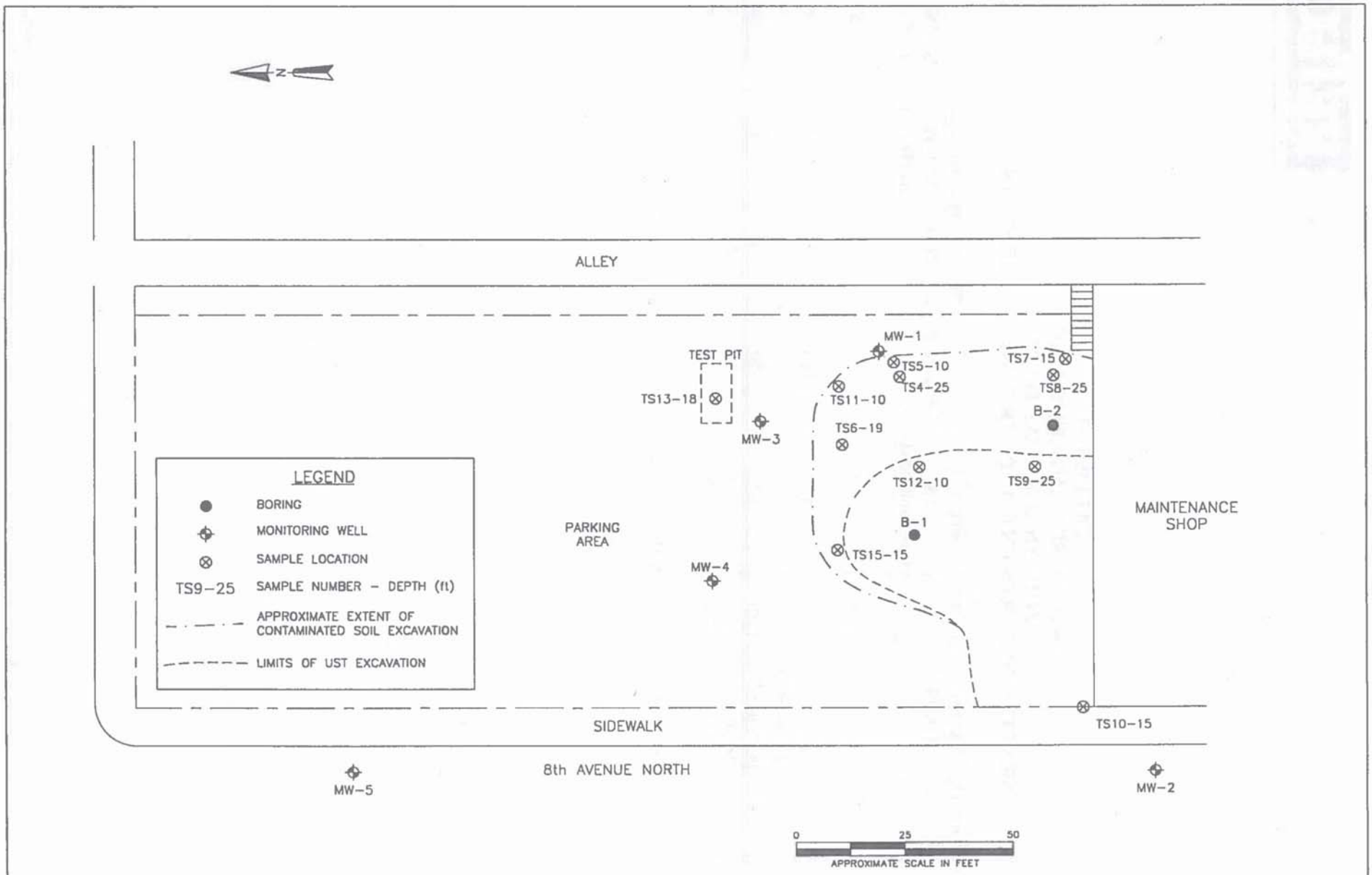
DRAWING NO. FIGURE 5-3 REV. 0

PLTS_028069

TABLE 5–3
INITIAL SITE INVESTIGATION
SOIL ANALYTICAL DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

SAMPLE ID	DEPTH	SAMPLE DATE	UNITS	WTPH–G GAS Method 8015M	BTEX – Method 8020			
					BENZENE	TOLUENE	ETHYL–BENZENE	TOTAL XYLENES
MTCA Method A			ppm	100	0.50	40	20	20
PD–1	19	28–Jun–93	ppm	3,300	17.00	45	39	220
PD–2	10	28–Jun–93	ppm	< 19	< 0.25	< 20	< 10	< 5
PD–3	17	28–Jun–93	ppm	1,700	7.50	< 20	12	60
PD–4	17	28–Jun–93	ppm	< 19	< 0.25	< 20	< 10	< 5
PD–5	10	28–Jun–93	ppm	< 19	< 0.25	< 20	< 10	< 5

NOTE: – Sample Exceeds MTCA Method A Criteria



REF DWG	DESC.						
0	LT.	10/12/93	LOCATION OF ABANDONED WELLS & MONITORING WELLS DATA	G.H.			
0	LT.	5/20/94	INITIAL ISSUE	G.H.			
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE

ROY STREET PROJECT

3-1274-160

SCALE 1" = 25'

CAD FILE 1274S25S

CONTAMINATED SOIL EXCAVATION
SAMPLE LOCATIONS
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 5-4 REV. 0

PLTS_028071

REIEC

TABLE 5-4
CONTAMINATED SOIL EXCAVATION
SOIL ANALYTICAL DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

SAMPLE ID – DEPTH	SAMPLE DATE	UNITS	WTPH-G GAS Method 8015M	BTEX – Method 8020			
				BENZENE	TOLUENE	ETHYL-BENZENE	TOTAL XYLENES
MTCA Method A		ppm	100	0.5	40	20	20
TS1-17	27-Sep-93	ppm	110	0.29	1.8	2.1	11
TS2-15	27-Sep-93	ppm	41	0.14	< 0.064	0.46	0.67
TS4-25	04-Oct-93	ppm	1400	8.2	51	22	120
TS5-10	04-Oct-93	ppm	1200	< 0.58	9.3	10	68
TS6-19	04-Oct-93	ppm	1300	7.7	43	22	120
TS7-15	04-Oct-93	ppm	< 5	< 0.056	< 0.056	< 0.056	< 0.11
TS8-25	04-Oct-93	ppm	560	3.5	20	9.1	50
TS9-25	04-Oct-93	ppm	1600	2.9	7.6	24	110
TS10-15	06-Oct-93	ppm	37	0.1	0.8	0.82	4.3
TS11-10	06-Oct-93	ppm	< 5	< 0.056	< 0.056	< 0.056	< 0.113
TS12-10	06-Oct-93	ppm	< 5	< 0.056	< 0.056	< 0.056	< 0.113
TS13-18	06-Oct-93	ppm	360	4.8	19	4.6	27
TS15-15	14-Oct-93	ppm	1500	3.8	28	23	130

NOTE: – Sample Exceeds MTCA Method A Criteria

removed by the excavation. Data for sample TS5-10 indicates that some contamination may extend to the east of the excavation area.

5.1.5 Supplementary Site Investigation

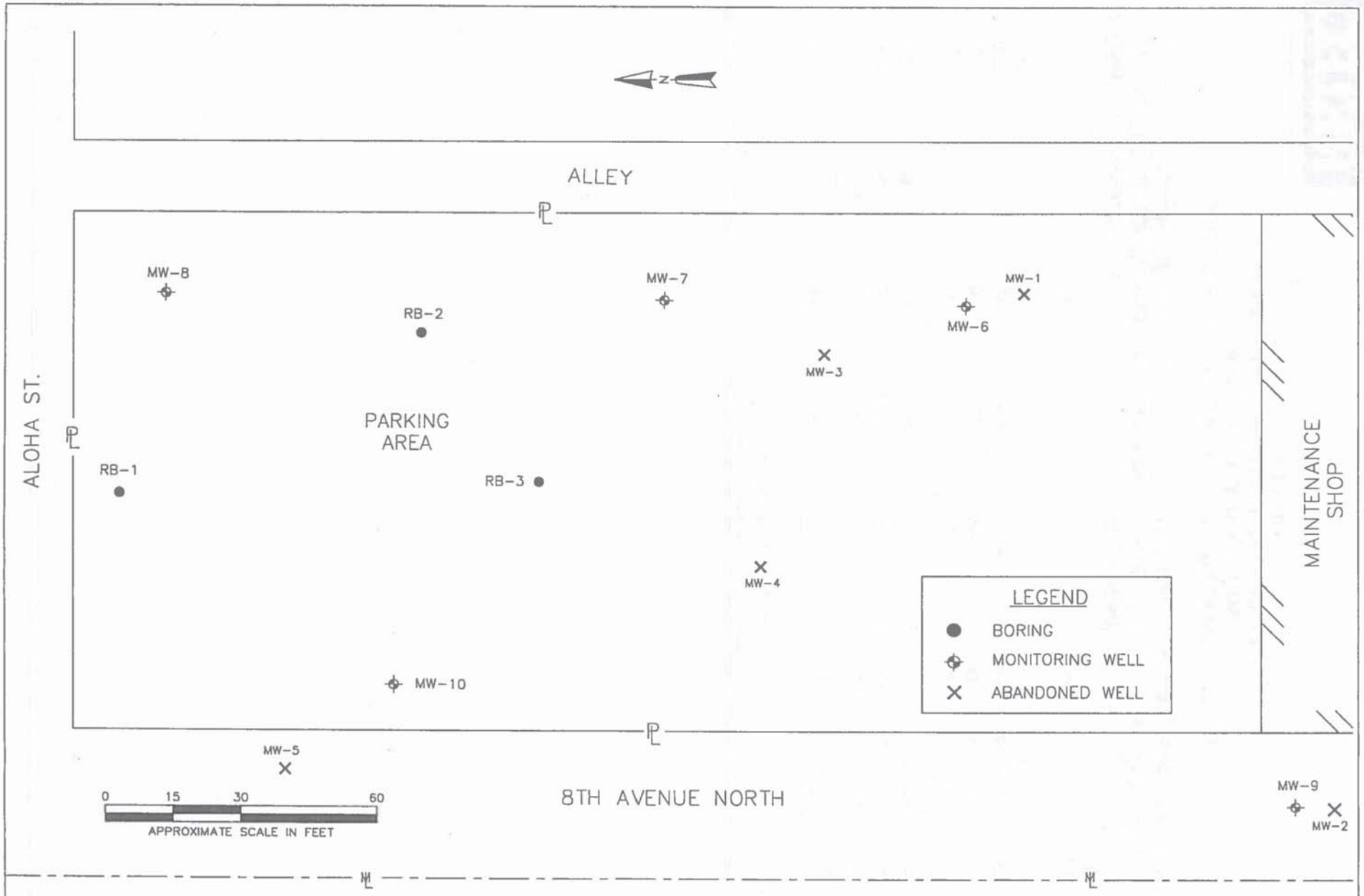
Seven borings were installed during the supplementary site investigation. These borings were utilized to replace existing wells and to investigate soil and groundwater contamination farther downgradient than had been previously investigated. Figure 5-5 indicates the locations of these borings and Table 5-5 summarizes the analytical results of soil sampling. Analytical results indicate that contaminated soil near the water table was only present immediately downgradient of the former USTs in MW-6 and MW-7.

5.1.6 Summary of Soil Results

Based upon all the soil analytical data collected to date, it is clear that contaminated soil exceeding MTCA clean-up levels remains at the Site to the north and east of the limits of excavation. In addition, data obtained during the excavation (Table 5-5) indicates that some contamination exceeding clean-up levels exists at the base of the excavation. The extent of contamination under the shop building is unknown. To the north, contamination appears to extend beyond the location of well MW-7. Approximate bounds for the majority of the remaining soil contamination is shown in Figure 5-6. The basis for this approximation is primarily data from test-pit samples TS13-18 TS4-25, TS9-25, and TS8-25 (Table 5-4) and samples MW7-16.5 and MW7-18.5 that were collected from the boring for monitoring well MW-7.

Remaining hydrocarbon contamination at the Site is confined primarily to depths corresponding to the capillary fringe of the water table. The evidence suggests that hydrocarbons have spread in conjunction with the flow of groundwater. Localized deposits of coarse-grained material were observed near the water table that extended in a northerly direction. This and similar deposits would be expected to exacerbate the spreading of contamination because of the locally enhanced conductivity. Further, the first set of monitoring wells (especially MW-1, MW-2, and MW-3) may have contributed to the spreading of contamination by acting as localized points of recharge to the water table aquifer.

In spite of the remaining contamination at depth, the majority of hydrocarbon contamination in the source area was removed during the tank removal and subsequent



REF DWG	DESC.						
0	LT.	11/19/93	REVISED WELL & BORING LOCATIONS	G.H.			
0	LT.	1/7/94	INITIAL ISSUE	G.H.			
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE

ROY STREET PROJECT

3-1274-160

SCALE 1" = 30'

CAD FILE 12745235

SUPPLEMENTARY SITE INVESTIGATION
BORING AND MONITORING WELL LOCATIONS
SEATTLE DEPARTMENT OF
PARKS AND RECREATION

RETEC
REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 5-5 REV. 0

PLTS_028074

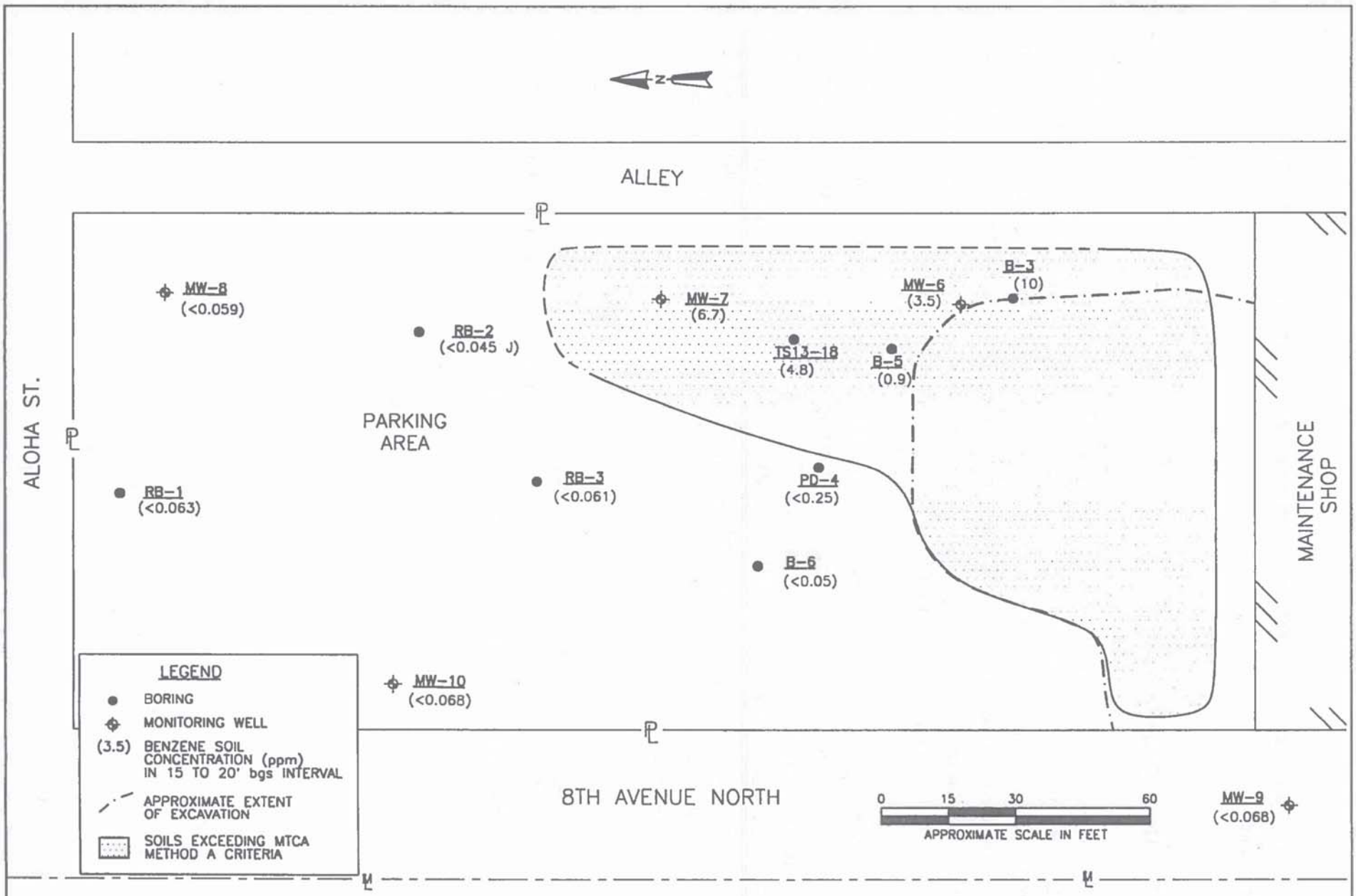
RETEC

TABLE 5-5
SUPPLEMENTARY SITE INVESTIGATION
SOIL ANALYTICAL DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

SAMPLE ID – DEPTH	SAMPLE DATE	UNITS	WTPH-G GAS Method 8015M	BTEX – Method 8020			
				BENZENE	TOLUENE	ETHYL-BENZENE	TOTAL XYLENES
MTCA Method A		ppm	100	0.5	40	20	20
MW6-25	11-Oct-93	ppm	19	3.5	0.23	0.44	0.93
MW7-16.5	11-Oct-93	ppm	4100	6.7	160	55	300
MW7-18.5	11-Oct-93	ppm	840	2.2	30	12	62
MW8-20	18-Oct-93	ppm	< 5	< 0.059	< 0.059	< 0.059	< 0.12
RB1-17.5	18-Oct-93	ppm	< 5	< 0.063	< 0.063	< 0.063	< 0.13
RB2-12.5	18-Oct-93	ppm	< 5	< 0.062	< 0.062	< 0.062	< 0.12
RB2-17.5	18-Oct-93	ppm	< 5	0.045 J	< 0.062	0.058 J	0.18
MW9-17.5	18-Oct-93	ppm	< 5	< 0.068	< 0.068	< 0.068	< 0.14
RB3-17.5	18-Oct-93	ppm	< 5	< 0.061	< 0.061	< 0.061	< 0.12
MW10-17.5	19-Oct-93	ppm	< 5	< 0.068	< 0.068	< 0.068	< 0.14

NOTES: – Sample Exceeds MTCA Method A Criteria

J – Estimated value below detection limit



REF DWG	DESC.						
2	D.M.	1/18/95	REVISED WELL & BORING LOCATIONS				
0	L.T.	5/20/94	INITIAL ISSUE	G.H.			
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE

ROY STREET PROJECT

3-1274-160

SCALE 1" = 30'

CAD FILE 12745285

APPROXIMATE EXTENT OF SOILS EXCEEDING MTCA METHOD A CRITERIA SEATTLE DEPARTMENT OF PARKS AND RECREATION

REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 5-6 REV. 0

PLTS_028076

excavation projects. Over 3,000 tons of soil were excavated from the source area during these operations.

5.2 Groundwater Results

Groundwater from wells MW-1 through MW-5 was sampled by E.P. Johnson on March 22, 1993. A second round of sampling from these wells was performed by RETEC on June 17, 1993 (Tables 5-6 and 5-7). These results are considered misleading since the wells were screened through the medium dense silty sand into the confined aquifer. The wells were abandoned during the supplementary site investigation and an additional five wells (MW-6 through MW-10) were installed by RETEC and Geoboring.

Wells MW-6 and MW-7 were sampled on October 12, 1993, prior to development, in order to get some preliminary information. Complete sampling rounds were performed in October 1993, January 1994, April 1994, and September 1994 by RETEC (Table 5-8). TPH and BTEX concentrations in wells MW-6 and MW-7 consistently exceed MTCA clean-up levels by several orders of magnitude. Groundwater quality in the vicinity of wells MW-8, MW-9, and MW-10 is comparatively good. Clean-up levels were slightly exceeded in samples from wells MW-8 and MW-9.

The body of groundwater data, which describe conditions over a 1-year period, indicate that the plume of dissolved hydrocarbons has neither worsened nor improved to any discernable extent at the Site. In addition, the area of impacted groundwater is consistent with the assumed zone of remaining soil contamination depicted in Figure 5-6.

TABLE 5–6
PRELIMINARY SITE ASSESSMENT
GROUNDWATER ANALYTICAL DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

SAMPLE ID	DATE	UNITS	WTPH–G GAS Method 8015M	WTPH–D DIESEL Method 8015M	WTPH–OILS OILS Method 418.1	BTEX – Method 8020			
						BENZENE	TOLUENE	ETHYL–BENZENE	TOTAL XYLENES
MTCA Method A		ppm	1	1		0.005	0.04	0.03	0.02
MW–1	22–Mar–93	ppm	5.1	< 0.5	< 1	10	0.27	0.48	0.427
MW–2	22–Mar–93	ppm	0.65	< 0.5	< 1	0.1	0.042	0.024	0.067
MW–3	22–Mar–93	ppm	27	< 0.5	< 1	1.5	3.3	0.59	3.5
MW–4	22–Mar–93	ppm	0.94	< 0.5	< 1	0.39	0.082	0.039	0.108
MW–5	22–Mar–93	ppm	0.67	< 0.5	< 1	0.14	0.049	0.0093	0.078

NOTE: – Sample Exceeds MTCA Method A Criteria

REIEC

TABLE 5-7
INITIAL SITE INVESTIGATION
GROUNDWATER ANALYTICAL DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

SAMPLE ID	DATE	UNITS	BTEX – Method 8240			
			BENZENE	TOLUENE	ETHYL-BENZENE	TOTAL XYLENES
MTCA Method A		ppm	0.005	0.04	0.03	0.02
MW-1	17-Jun-93	ppm	20	14	0.84	6.7
MW-2	17-Jun-93	ppm	0.028	0.0072	< 0.001	< 0.002
MW-3	17-Jun-93	ppm	4.8	21	1.9	12.3
MW-4	17-Jun-93	ppm	< 0.001	< 0.001	< 0.001	< 0.002
MW-5	17-Jun-93	ppm	< 0.001	< 0.001	< 0.001	< 0.002

SAMPLE ID	VOLATILE ORGANIC COMPOUNDS(1) – Method 8240					
	Vinyl Chloride	1,1-Dichloroethene	t-1,2-Dichloroethene	c-1,2-Dichloroethene	Trichloroethane	Tetrachloroethene
MTCA Method A	0.0002				0.2	0.005
MW-2	1.1	0.025	0.025	9.3	1.4	0.17

NOTES: (1) Only those compounds which were detected are listed

– Sample Exceeds MTCA Method A Criteria

TABLE 5–8
SUPPLEMENTARY SITE INVESTIGATION
GROUNDWATER ANALYTICAL DATA
SEATTLE DEPARTMENT OF PARKS AND RECREATION

SAMPLE ID	DATE	UNITS	Gasoline–range TPH	Volatile Organic Compounds			
				Benzene	Toluene	Ethyl–benzene	Total Xylenes
MTCA Method A		ppm	1	0.005	0.04	0.03	0.02
MW–6	12–Oct–93	ppm	150	9.1	6.8	2.6	7.3
MW–6	26–Oct–93	ppm	100	17	14	1.4	11
MW–6	25–Jan–94	ppm	66	8.8	4.6	1.5	8.1
MW–6	25–Apr–94	ppm	120	15	7.2	2.6	13.3
MW–6 (Dup)	25–Apr–94	ppm	150	17	10	2.3	16.6
MW–6	15–Sep–94	ppm	56	15	2	1.5	7.1
MW–7	12–Oct–93	ppm	75	20	22	3	15
MW–7	26–Oct–93	ppm	74	8.3	7.4	1.1	8.3
MW–7	25–Jan–94	ppm	53	1.6	2.7	1.4	5.1
MW–7	25–Apr–94	ppm	140	3.9	7.4	3.1	14.1
MW–7	15–Sep–94	ppm	66	3.4	2.7	1.9	7.7
MW–7 (Dup)	15–Sep–94	ppm	77	3.6	3	2.1	8.7
MW–8	26–Oct–93	ppm	0.28	0.019	0.001	< 0.001	0.048
MW–8	25–Jan–94	ppm	0.23 J	0.013	0.0007 J	< 0.001	0.0045
MW–8 (Dup)	25–Jan–94	ppm	0.21 J	0.012	0.0006 J	< 0.001	0.0037
MW–8	25–Apr–94	ppm	< 0.25	0.0022	< 0.001	< 0.001	0.0017
MW–8	15–Sep–94	ppm	0.21 J	< 0.001	0.0005 J	< 0.001	0.0016 J
MW–8 (Dup)	15–Sep–94	ppm	< 0.25	< 0.001	0.0005 J	< 0.001	0.0017 J
MW–9	26–Oct–93	ppm	0.21 J	0.0095	0.0013	< 0.001	< 0.002
MW–9	25–Jan–94	ppm	< 0.25	0.0057	0.0011	< 0.001	< 0.002
MW–9	25–Apr–94	ppm	< 0.25	< 0.001	< 0.001	< 0.001	< 0.002
MW–9	15–Sep–94	ppm	< 0.25	0.0035	0.0006 J	< 0.001	< 0.002
MW–10	26–Oct–93	ppm	< 0.25	< 0.001	0.0013	< 0.001	< 0.002
MW–10	25–Jan–94	ppm	0.19 J	< 0.001	0.0032	< 0.001	< 0.002
MW–10	25–Apr–94	ppm	< 0.25	< 0.001	0.0025	< 0.001	< 0.002
MW–10	15–Sep–94	ppm	< 0.25	< 0.001	0.0009 J	< 0.001	< 0.002

NOTES:
Volatile Organic Compounds analyzed by EPA Method 8020.
Gasoline–range TPH were analyzed using WDOE WTPH–G (Washington Total Petroleum Hydrocarbons – Gasoline) specified methods.
J – Estimated value below detection limit; ppm = parts per million.
Shading represents concentrations exceeding MTCA Method A cleanup levels for groundwater.

6.0 CONCLUSIONS

Removal of USTs and substantial volumes of hydrocarbon contaminated soil at the Seattle Parks facility on Roy Street has eliminated the primary source of contamination to groundwater. Nevertheless, contaminated soil remains at the Site. The contamination is in soil located at the base of the excavations (20 to 25 feet bgs) and to the east and north of the area of excavation. Contaminant migration to the north appears to have been exacerbated by localized seams of coarse-grained material observed during the excavation of contaminated soil, and by water recharged to the affected area by the first set of wells which penetrated the aquitard. This soil contamination may be localized near the water table at depths ranging from 12 to 18 feet bgs. Remaining soil contamination exceeds MTCA clean-up levels for TPH and BTEX constituents and serves as a continuing, albeit reduced, source of contamination to groundwater. The volume of soil exceeding clean-up levels is difficult to predict based on existing data.

Significant groundwater contamination remains at the site. Concentrations of TPH and BTEX are significantly above clean-up levels and are not being attenuated appreciably with time. The source of groundwater contamination at the site originated from fuel handling practices and the storage of fuels in leaky USTs. Contaminated soil not removed during the previous excavations serves as a continuing source of contamination to groundwater. Groundwater flowing into the site is not currently a source of contamination as demonstrated by data from MW-9 (Table 5-8). In addition, no free hydrocarbon product has been observed in monitoring wells at the Site.

Near-surface geology and hydrogeology beneath the Site are not completely understood. The primary geologic issue of concern is lithology near the silty sand layer presumed to be acting as an aquitard at depths of approximately 20 to 25 feet bgs. This layer could be significant from the standpoint of designing remedial systems for remaining soil and groundwater contamination. Penetration of the aquitard with air sparging wells or groundwater pumping wells, for example, could impair the performance of these systems. Further, the water table ranges from 5 to 8 feet above the aquitard and varies seasonally (See Figures 4-1 and 4-2). This thin layer of groundwater may also pose a significant design challenge. For example, in situ technologies such as air sparging are best implemented under circumstances where air can be injected to the aquifer well below (e.g., 10 feet) the zone of contamination.

The primary risk to human health and the environment at the Site is contaminated groundwater. The Roy Street Facility is located in a commercial/industrial area and there is

currently no groundwater being extracted nearby for use as drinking water. The flow of groundwater at the site is towards Lake Union which lies less than 1,000 feet from the Site. Lake Union is therefore the most significant potential receptor to contaminated groundwater originating from the Site. As a result, ambient water quality criteria may be the most suitable criteria for establishing groundwater clean-up levels.

7.0 REFERENCES

Bouwer, H. and R. C. Rice, 1976. A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. Water Resources Research. 12(3):423-428.

Dalton, Olmsted & Fuglevand, Inc., 1992. *Summary Report Environmental Testing Seattle Facility*. Maryatt Industries, Inc. December.

Earth Consultants, Inc., 1992. *Preliminary Phase I Environmental Site Assessment and Subsurface Investigation.* Westlake Terminals, Inc. September.

Enviros, Inc., 1992. *Final Report: Level 1 Environmental Assessment of Lake Union Air Property, Seattle, Washington.* Seattle Commons. December.

Enviros, Inc., 1993. *Final Report: Limited Groundwater Investigation of Lake Union Air Property, Seattle, Washington.* Seattle Commons. March.

E.P. Johnson Construction, Inc. and Environmental, 1993. *Draft Site Characterization Report.* Seattle Department of Parks and Recreation. March.

Geotech Consultants, Inc., 1992. *Underground Storage Tank Removal and Supplemental Environmental Studies.* Bayside Volvo. September.

Hart Crowser, 1989. *Site Characterization, Seattle School District Building, Seattle, Washington.* Seattle Public Schools. July.

Remediation Technologies, Inc., 1993. *Site Characterization Report, Roy Street Facility, Seattle Department of Parks and Recreation, Seattle, Washington.* Seattle Department of Parks and Recreation. August.

SCS Engineers, 1992. *City of Seattle, Site Investigation to Assess Soil Contamination and Locate Underground Storage Tanks.* Seattle Department of Parks and Recreation. May.