REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT
CIRCLE K STATION #1461
SEATTLE, WASHINGTON

Prepared by

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DRAFT

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
DRO	Diesel Range Organics
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
FS	Feasibility Study
ft	Feet
GRO	Gasoline Range Organics
mg/kg	Milligram per Kilogram
MTCA	Model Toxics Control Act
MW	Monitoring Well
RCW	Revised Code of Washington
RI	Remedial Investigation
SVE	Soil Vapor Extraction
TPH	Total Petroleum Hydrocarbons
µg/L	Microgram per Liter
UST	Underground Storage Tank
WAC	Washington Administrative Code

EXECUTIVE SUMMARY

The Site had been operated as a retail gasoline station from 1968 to 1990, and then has been operated as a retail dry-cleaning store. Petroleum contamination was discovered in both soil and groundwater after a release in 1989 at the Site. Results from the most recent groundwater monitoring events conducted in November 2006 still showed presence of free products in two wells located within the property and two wells located on East McGraw Street (EA 2006).

The Feasibility Study evaluated remedial alternatives. The preferred remedial alternative includes applications of Surfactant-Enhanced Fluid Recovery (EFR), followed by in-situ chemical injection and groundwater monitoring.

1.0 INTRODUCTION

1.1 GENERAL FACILITY INFORMATION

Site Name: Circle K Station #1461
Property Address: 2350 24th Avenue East, Seattle, Washington

Facility Site Identification Number: 2322
Order Number for Consent Decree: 92-2-08095-8
Effective Date of Decree: April 8, 1992

Project Coordinator: Jing Liu, Ecology NWRO
Project Coordinator Address: 3190 160th Ave SE, Bellevue, Washington 98008
Project Coordinator Phone Number: (425) 649-4310

Current Owner: Mr. Kuk Jin Choung
Legal Description of the Facility: PIKES 2ND ADD TO UNION CITY 1&2 LESS E 6 FT

1.2 PURPOSE OF THIS REPORT

The purpose of this report is to satisfy the requirements of Chapter 173-340 Washington Administrative Code (WAC) and Consent Decree No. 92-2-08095-8 regarding a Remedial Investigation and Feasibility Study (RI/FS) for the Circle K Station #1461 in Seattle, Washington.

According to WAC 173-340-350(1), the purpose of an RI/FS is to collect, develop, and evaluate sufficient information regarding a site to select a cleanup action under WAC 173-340-360 through 173-340-390.

2.0 REMEDIAL INVESTIGATION

2.1 SITE DEFINITION AND SETTING

The Site is associated with a former gasoline service station property (the Property) at 2350 24th Avenue East in Seattle, Washington. The Site location relative to surrounding physical features is shown in Figure 1. Petroleum and associated products were released to soil and groundwater at the Property and comprise the Site. The plume has extended off-property beneath adjacent streets and residential property.

The Property is approximately 0.26 acres, located southeast of the intersection between 24 Ave East and East McGraw Street, approximately 1800 feet south of Lake Washington. It is in the Montlake neighborhood. The area surrounding this Site consists mainly of residential houses and buildings, with some small commercial business located west of the Site along the 24th Ave East. The Property consists of a one-story building and a newer addition to it, which are presently being utilized as a retail dry-cleaning store and a convenience store, known as Jay's Cleaners and Mont Market.

2.2 PROPERTY DEVELOPMENT AND HISTORY

The Property was operated as a gasoline and convenience store from 1968 to 1981, owned by Mr. George Renale. Prior to 1968, it is believed the Property was residential.

From 1981 to July 1990, the Property was leased by Mr. Renale to Circle K Corporation, who also operated the facility as a gasoline and convenience store. In November 1990, Mr. Kuk Jin Choung, the current owner, purchased the Property from Mr. Renale and has operated it as a retail dry-cleaning retail store since then.

In February 1992, Mr. Choung entered a Consent Decree with Ecology to begin investigation and remediation of contamination at the Site. Ecology's lien on the Property for the sum of $50,000 was released in January 2008 after Ecology received the full payment.

2.3 GEOLOGIC AND HYDROGEOLOGIC SETTING

2.3.1 TOPOGRAPHY

The regional topography in the vicinity of the Site slopes downward the north and northeast. The ground surface elevation at the Site is approximately 70 feet above mean sea level.

2.3.2 GEOLOGY

According to GeoEngineers, layers of sandy silt and silty fine sand were encountered beneath surface layers of asphalt, concrete, and fill material. Individual layers of sandy silt and silty sand vary in thickness over short distances and are often laterally discontinuous (GeoEngineers 1990a). Occasional gravel and cobbles were encountered. A very dense to hard layer consisting

of fine-grained glacial sediment was encountered at depths greater than approximately 14 feet in most of the borings.

2.3.3 HYDROGEOLOGY

Depth to groundwater at the Site ranges from approximately 9 to 12 feet bgs based on available data. The groundwater flow direction in the vicinity of the Site determined by using the data obtained in 1989 was to the northeast at a gradient of approximately 0.024 ft/ft (GeoEngineers 1990a). During operation of the product recovery system, there was a stable cone of depression encompassing the estimated lateral extent of the free product plume. However, groundwater level data obtained after the system was shut down did not suggest a strong groundwater gradient. It is assumed that groundwater levels in the wells have not only been affected by seasonal precipitation, but also by the utility corridors in the area. Groundwater elevation data are available for 2005 and 2006 in Table 3. Figure 5 shows groundwater elevations and contour lines using data collected from August 2006.

2. 4 SITE DISCOVERY

The former gasoline service station used to include a store building, a fuel pump island, two 4,000-gallon gasoline USTs, two 6,000-gallon gasoline USTs, one 500-gallon waste oil UST, and one 500-gallon heating oil tank. A generalized site plan of the former gasoline service station is presented in Figure 2.

As shown in Figure 2, several underground sewer lines are located beneath the north part of the Property. All of these lines drain north toward the main sanitary sewer line located beneath the center of East McGraw Street. The sanitary sewer line on East McGraw Street is located at a depth of approximately 12 feet below the surface of the street. The upgradient terminus of this sewer line is located immediately west of the manhole in front of the store. The sewer line slopes downward toward the east. The two catch basins located on the Property drain surface water runoff into the sanitary sewer system.

In August 1989, a leak was discovered in one of the gasoline USTs. Approximately 4,000 to 6,000-gallons of gasoline were released between 22 June 1989 and 7 August 1989 (GeoEngineers 1990a). Fuel odors were observed at Seattle Museum of History and Industry, approximately 2000 feet north of the Property subsequent to the discovery of the leak. Vapors were also observed at several other locations in the sanitary sewer line downgradient of this Property. It was believed that petroleum plume originated from the Property has migrated through the sanitary sewer system and resulted in the presence of vapor at these downgradient locations.

2. 5 ENVIRONMENTAL INVESTIGATION AND REMEDIAL ACTIVITIES

A subsurface contamination investigation was conducted by GeoEngineers from September to December 1989 by drilling sixteen borings to depth ranging from 19.0 to 31.0 feet bgs and installation of sixteen groundwater monitoring wells. Most of the wells were screened from 5 to 20 feet bgs, several wells were screened from about 4 to 19 feet bgs. Copies of the well logs are

included in Appendix A of GeoEngineers 1990a report. During monitoring wells installation, petroleum contaminated soil was observed at depth ranging from 8 to approximately 20 feet bgs. Monitoring well construction and field measurement data is in Table 1. Table 2 lists the soil analytical sample data collected during well installation. Free product was also observed during the investigation. Maximum product thickness was measured at 9.5 feet in MW-8 in December 1989. It appeared that free product initially flowed in a direction transverse to the direction of shallow groundwater flow in the vicinity of the Site. The lateral extent of the free product plume was defined and appeared to be confined to the area in the vicinity of the gasoline UST area and north of the leaky UST beneath the East McGraw Street (MW-2, MW-3, MW-4, MW-8 and MW-9). Petroleum contaminated groundwater was encountered in wells located immediately outside of the edge of the free product plume (MW-6, MW-13 and MW-15).

High concentrations of hydrocarbon vapors were detected in wells located in the vicinity of the free product plume. The low concentrations of hydrocarbon vapors measured in outlying wells indicated that subsurface hydrocarbon vapors in the soil probably have not migrated a significant distance laterally from the edge of the free product plume. Although fuel odors were detected in the sanitary sewer lines downgradient form the leaky tank, no evidence was observed that free product of fuel vapors flowed directly into the sanitary sewer system (GeoEngineers 1990a).

Remaining product in the tank reportedly was removed, and all six onsite USTs were excavated in October 1989, along with approximately 900 cubic yards of contaminated soil. Approximately 80 to 100 gallons of free product were recovered from the open excavation. Analytical results from soil confirmation samples collected at the waste oil and heating oil tank excavation areas showed compliance with cleanup levels. Contaminated soil in the gasoline UST area was removed to a depth of approximately 14 to 16 feet bgs. However, analytical results from samples collected from the north, south, and west walls of the gasoline tank excavation contained high concentrations of gasoline and/or BTEX far above the MTCA soil cleanup levels (GeoEngineers 1990a). The most extensive soil contamination appears to be located north and west of the gasoline UST area. The extent o the remaining soil contamination was not determined at that time. Soil and tank excavations are shown in Figure 3.

The pump island was demolished in March 1990, no information is available on confirmation sampling.

In December 1989, installation of a product recovery and groundwater treatment system was completed. The system was operated by Circle K briefly after it was installed till September 1990, and then Glacier was contracted by Ecology to operate and maintain the system from April 1992 to May 2000. Ecology then decided to shut down the system due to a low recovery rate, and evaluated some other treatment alternatives.

An SVE system was also installed in the tank excavation area. The period of operation of the SVE system is not known; however, it apparently was shut down in 1997 after readings indicated insignificant concentrations of hydrocarbons were being removed. The treatment system is now defunct.

In June 2005, a pilot test of EFR technology was conducted at the Site in an effort to remove free product, impacted groundwater, and petroleum vapors from targeted monitoring well locations.

EcoVac Services, Inc. was contracted to perform the test on four monitoring wells MW-4, MW-8, MW-9, and MW-13. During the 8-hr test, approximately 112 pounds of petroleum hydrocarbons (approximately 18 equivalent gallons of gasoline) were extracted. Free product levels were highest in MW-4, and measurable in wells MW-8, MW-9 and MW-13 prior to conducting the test. Follow-up monitoring sampling conducted two weeks after the EFR test showed that free product was not present in measurable quantities in any well, though trace quantities were found in MW-4, MW-8 and MW-9.

Three quarterly sampling events were conducted since the EFR pilot test, free product levels in the monitoring wells are rebounding slowly, though they have not returned to pre-test levels in MW-4. Table 4 summarizes free product levels before and after testing. Field observations conducted in February 2008 still indicated trace amount of free products in two wells located within the property (MW-4 and MW-13), and sheens and petroleum odors were observed in three wells located off-property to the north (MW-8, MW-9 and MW-15). However, data collected so far indicates that the extent of the contamination including free product remains relatively stable in the past twenty years, still being limited to the area north and west of the former excavation area (Figure 4). Groundwater Monitoring Results are summarized in Table 5.

2. 6 DATA GAPS

The extent of the petroleum plume has not been fully defined. It is possible that petroleum contaminated groundwater could extend beneath the nearest residence to the north. Also, the plume is undefined to the west and could possibly extend beneath 24th Avenue East. Additional investigations may be necessary to determine the full extent of residual soil contamination at the Site.

It is not clear whether the former tank excavation area has been re-contaminated. An addition to the former gasoline service station building has been constructed right above the former tank excavation area. No information is available whether contamination was encountered during construction. In addition, no information is available associated with the removal of the former pump island.

Soil vapor data should be collected to determine whether soil to vapor pathway is a potential concern at the Site.

2. 7 CONCEPTUAL MODEL

Gasoline was released to soil at this Site due to a leak from a UST as discovered in August 1989. The contamination reached the water table at about 8 feet below land surface and spread laterally to the north and west.

It appears that petroleum hydrocarbons in soil are located in a "smear zone," a zone created by fluctuations in the water table elevation, likely are a source of groundwater contamination. Contamination also exists in unsaturated soil (soil above the water table) and saturated soil (soil below the water table). It is estimated that contaminated soil exists at this Site from approximately 8 to 20 feet bgs in the areas north and west of the former UST excavation area,

and may also exists in the excavation backfill. The lateral extent of soil contamination has not been fully determined. Free product has been consistently observed in MW-4, MW-8, MW-9 and MW-13 since 2003. Groundwater plume appears larger than the extent of free product and has migrated beneath the East Mcgraw Street to the north, and possibly to the west beyond MW-13.

The following potential exposure/risk pathways may exist at this Site and has been evaluated as below.

- Direct Soil Contact Pathway: the majority of the Site is covered by buildings or asphalt pavement that prevents direct contact. However, direct contact exposure may occur if future site redevelopment or construction activities require excavation into contaminated subsurface soil. Potential receptors in this scenario would be workers involved in the excavation, and exposure duration would be limited.

- Groundwater Pathway: groundwater contamination detected at the Site mirrors the nature and extent of contaminants detected in soil. Until petroleum trapped in soil in the smear zone is addressed, it will continue to act as a source of groundwater contamination. However, SPU's water system provides all the drinking water supplies for this Property and the surrounding area. Ingestion of contaminants in groundwater is not likely a viable human exposure pathway. Table 5 includes a copy of ground water analytical data generated during previous studies.

- Vapor Pathway: an addition to the former gasoline service station structure was build right above the former gasoline UST area. It appears that petroleum contaminated soil still remains after tank removal on the bottom of the excavation. There is a potential for vapor intrusion in the store building. No data has been collected to determine if there is a potential for vapor intrusion in the adjacent residential houses.

- Surface Water: no surface water data are available. From the data collected so far, it is unlikely that contaminants form this Site has reached any surface waterbody.

The Site is qualified for an exemption of Terrestrial Ecological Evaluation in accordance with WAC 173-340-7491(1) because there is less than 1.5 acres of contiguous undeveloped land within 500 feet of any area of the Site.

2.8 SUMMARY OF FINDINGS

Gasoline petroleum contamination in soil and groundwater exists at the Property and has migrated off- property to the north and west. Migration of contaminants is very slow at this Site probably due to the low soil permeability; also it might be related with the previous operation of the product recovery and groundwater treatment system.

3.0 FEASIBILITY STUDY

3.1 CLEANUP OBJECTIVES

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable laws
- Provide for compliance monitoring
- Provide a reasonable restoration time-frame
- Use permanent solutions to the maximum extent practicable
- Consider public concerns
- Achieve source control

3.2 DEVELOPMENT OF CLEANUP STANDARDS

Under MTCA, cleanup standards are to be established on a site by site basis, and consist of the following:

- Cleanup levels for hazardous substances present at the site;
- Points of compliance, the location where these cleanup levels must be met;
- Other applicable regulatory requirements that apply to the site ("applicable state and federal laws").

3.2.1 CLEANUP LEVELS

Based on the findings of the previous investigations, the primary contaminants of concerns for the Site are TPH-G, benzene, toluene, ethylbenzene and total xylenes. Cleanup levels are established for the above identified contaminants as described below.

3.2.1.1 SOIL CLEANUP LEVELS

MTCA Method A cleanup levels are designed for relatively simple sites with few hazardous substances, and as such should be applicable to this Site. Method A soil cleanup levels are the appropriate choice for this Site.

3.2.1.2 GROUNDWATER CLEANUP LEVELS

As stated in Section 3.2.1.1, Method A cleanup levels are appropriate for this Site. The Method A groundwater cleanup levels will be applied to all the identified contaminants.

3.2.1.3 AIR CLEANUP LEVELS

Air cleanup levels are needed for this Site because of the potential for vapor intrusion into the store building and residential houses downgradient of the Site. Since Method A cleanup levels are not available for the contaminants as identified for this Site, Method B cleanup levels for indoor and outdoor air will be applied. Method B cleanup levels are established using applicable state and federal laws and the risk assessment equations and other requirements specified for each medium. Method B may be used at any site and is the most common method for setting up cleanup levels when sites are contaminated with substances not listed under Method A.

Any cleanup of soil or ground water would need to result in air concentrations less than the cleanup levels.

3.2.2 POINTS OF COMPLIANCE

Based on the investigations completed thus far, the following standard points of compliance are appropriate for this Site:

Soil: Soil at the Site needs to be protective of contact, vapor inhalation, and leaching. The point of compliance is therefore throughout the Site.

Groundwater: The point of compliance for groundwater is throughout the site.

Air: The point of compliance for air is ambient air throughout the site.

3.2.3 SUMMARY OF CLEANUP STANDARDS

Contaminated Media	TPH-G	Benzene	Toluene	Ethyl-benzene	Xylenes
Soil mg/Kg	30	.03	7	6	9
Air ug/m^3	none	.32	2,200	460	46
Ground Water ug/L	800	5	1,000	700	1,000
Point of Compliance	Soil	Throughout the Site			
	Air	Ambient air throughout the Site			
	Ground Water	Throughout the Site			

3.2.4 RELEVANT AND APPROPRIATE REQUIREMENTS

MTCA requires that cleanup actions comply with applicable state and federal laws [WAC 173-340-360(2)]. MTCA defines applicable state and federal laws to include "legally applicable

requirements" and "relevant and appropriate requirements" (ARARS). ARARS for the implementation of the cleanup action at this Site follow.

Federal Requirements

- Clean Water Act
- Clean Air Act
- Resource Conservation and Recovery Act (RCRA)
- Occupational Safety and Health Act (29 CFR 1910)
- Safe Drinking Water Act
- Rules for Transport of Hazardous Waste (49 CFR 107, 49 CFR 171)

State Requirements

- Model Toxics Control Act Regulations (WAC 173-340)
- Dangerous Waste Regulations (WAC 173-303)
- Minimum Standards for Construction and Maintenance of Wells (WAC 173-160) Regulation and Licensing of Well Contractors and Operators (WAC 173-162)
- State Clean Air Act, Chapter 70.94 RCW
- Washington Industrial Safety and Health Act Regulations (WAC 296-62)
- Water Pollution Control Act, Chapter 90.48 RCW
- Water Quality Standards for Surface Waters of the State of Washington (WAC173-201A)
- Water Quality Standards for Groundwater of the State of Washington (WAC 173-200)
- Underground Injection Control (WAC 173-218)
- Maximum Environmental Noise Levels (WAC 173-60)

Local Requirements

- City of Seattle Grading Permit
- Puget Sound Clean Air Agency Regulations

All actions carried out by Ecology or Ecology's contractor under the Consent Decree will be done in accordance with all applicable federal, state, and local requirements, including requirements to obtain necessary permits, except as provided in RCW 70.105D.090. The permits or other federal, state or local requirements that the agency has determined are applicable and that are known at this time are listed above. Under RCW 70.105D.090(1), Ecology and its consultants are exempt from the procedural requirements of Chapters 70.94, 70.95, 70.105, 77.55, 90.48, and 90.58 RCW and of any laws requiring or authorizing local government permits or approvals. However, Ecology and its consultants shall comply with the substantive requirements of such permits or approvals. During remedial action, Ecology and its consultants will continue to determine whether additional permits or approvals addressed in RCW 70.105D.090 (1) would otherwise be required for the remedial action under the Consent Decree. Ecology will be responsible for contacting the appropriate state and/or local agencies and working with those agencies to determine the substantive requirements those agencies believe are applicable to the remedial action. Pursuant to RCW 70.105D.090(2), in the event Ecology

determines that the exemption from complying with procedural requirements of the laws referenced in RCW 70.105D.090(1) would result in the loss of approval from a federal agency that is necessary for the State to administer any federal law, the exemption will not apply and Ecology and its consultants will comply with both the procedural and substantive requirements of the laws referenced in RCW 70.105D.090(1) including any requirements to obtain permits.

3.3 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

This section identifies and screens remedial technologies that are potentially applicable to this Site. The technologies passing through this screening process will be used to develop remedial alternatives and are further evaluated in the next section.

3.3.1 CONTAINMENT

Containment means a container, vessel, barrier, or structure, whether natural or constructed, that confines a hazardous substance within a defined boundary and prevents or minimizes its release into the environment (WAC 173-340-200). Slurry or sheet pile walls and surface capping are commonly used techniques to encapsulate contamination. Unless it is combined with another treatment technology it does nothing to destroy or eliminate the source of soil or groundwater contamination.

Since this technology does not destroy the contaminants of concern, it will not be retained for further evaluation.

3.3.2 EXCAVATION AND OFF-SITE DISPOSAL

Excavation is used to remove contaminated soil from a source area. This approach can be effective and relatively inexpensive if the contaminants are located at a shallow depth, above the water table, and there are no major obstructions on the Site. Although excavation is possible below the water table, it can be substantially more expensive because it is necessary to either dewater the Site (if possible) or to provide water management for the saturated soils. The excavation depth is typically limited by available equipment. Standard backhoes can reach an average depth of 15 feet bgs; deeper excavations require either larger, more expensive equipment or creating benches below the ground surface, to increase the reach of the equipment.

Roads, utilities, structures, and other obstructions at the Site can limit the location and depth of excavations, particularly in unstable soils. Shoring, protecting, or relocating the obstruction may be necessary. Excavation around obstructions is possible but may result in a substantial amount of contaminants remaining on the Site.

Excavated soil can either be transported off-site for treatment or disposal, or treated on site. Off site treatment and/or disposal can be expensive depending on the location of the Site relative to treatment or disposal facilities, the volume of soil involved, and the availability of different treatment or disposal options in the area. In addition, generally the same volume of soil hauled off site for disposal or treatment must be hauled back to the Site as backfill for the excavation.

Excavation of contaminated soil at this Site has been conducted in the past. This remedial alternative is primarily limited by location of the road and convenience store on each side of the treatment area and the depth of the water table. Therefore excavation alone may not address all areas of contamination leaving some portions of the Site untreated, yielding the similar results as previous attempts at this remedial alternative.

It is not practicable to excavate the remaining known contaminated area at this time. The Site is located in the intersection between 24 Ave East and East McGraw Street in Seattle. 24th Avenue is an arterial street in the MontLake area, the traffic is very busy. Excavation will cause traffic shut down or re-route and will affect the business in the vicinity of the Site. Also due to the presence of utility lines beneath the street, it is not possible to dig without damage/replace the utility lines. Therefore, excavation will not be retained for further evaluation at this time. However, it could be applied if future investigation identifies any contaminated soil which is accessible for excavation.

3.3.3 AIR SPARGING AND SOIL VAPOR EXTRACTION

Air Sparging (also known as "in-situ air stripping" and "in-situ volatilization") is a remedial technology that reduces concentrations of volatile constituents in petroleum products that are adsorbed to soils and dissolved in groundwater by the injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved state to a vapor phase. The air is then vented through the unsaturated zone.

Air Sparging is often used together with Soil Vapor Extraction (SVE). The SVE system creates a negative pressure in the unsaturated zone through a series of extraction wells to control the vapor plume migration (EPA 2004).

Air Sparging/SVE only treats unsaturated-zone soils; other methods may also be needed to treat saturated-zone soils and groundwater. SVE system was previously tried at this Site, but not successful. The presence of free product might have negatively impacted the treatment effectiveness. Also, considering the low permeability of subsurface soil at this Site and high cost associated with system setup and long-term operation and maintenance, it appears this technology is not appropriate for this Site at this time, and it will not be retained for further evaluation.

3.3.4 DUAL/MULTI-PHASE EXTRACTION

Dual-phase extraction (DPE), also known as multi-phase extraction, vacuum-enhanced extraction, or sometimes bioslurping, is an *in-situ* technology that uses pumps to remove various combinations of contaminated groundwater, separate-phase petroleum product, and hydrocarbon vapor from the subsurface. Extracted liquids and vapor are treated and collected for disposal, or re-injected to the subsurface (EPA 2004).

EFR is one form of a multi-phased extraction system which can simultaneously removes vapors, free product, and groundwater from the subsurface. It volatilizes adsorbed and free phase VOCs through a process similar to vapor extraction, but with a much higher vacuum and radius of

influence. EFR is also very unique in that it can treat adsorbed phase VOCs existing within the "smear zone" (i.e. the zone of seasonal or climatic groundwater fluctuation) that act as a continuing source for dissolved phase VOCs. EFR dewaters and exposes the smear zone to the effects of "high rate" soil vapor extraction. EFR has also been well documented to be effective in the reduction in dissolved phase concentrations. Importantly, EFR also introduces oxygen to the vadose and saturated zones, thereby enhancing aerobic biodegradation. However, multiple spaced EFR may be needed to allow for natural vertical flushing by water table rebound and seasonal water table fluctuation.

EFR can be a relatively inexpensive treatment method. The process is extremely mobile, and does not need long-term operation and maintenance. A typical EFR event lasts for one day and as many as eight monitoring/recovery wells can be treated at one time. The effectiveness of EFR at sites with small quantities of free product and/or very high hydrocarbon concentrations, such as this Site, can be improved by the use of a surfactant to increase mobility of the free product and hydrocarbons adsorbed to the soil. Surfactants facilitate contaminant removal primarily by means of enhancing mobility of the contaminant through the subsurface by reducing interfacial tension. Contaminant solubility may also increase by the formation of micro-emulsions, which are subsequently "captured" (generally within 16 to 48 hours) by the EFR capture process. Aerobic biodegradation is enhanced during this process, as the surfactants are considered a co-metabolite to aerobic hydrocarbon digesting microbes.

In June 2005 an EFR pilot test was conducted on four monitoring wells at this Site. Approximately 112 pounds of hydrocarbons was removed during the 8-hour EFR test period. It is likely that repeated applications of EFR could help remove free product and dissolved hydrocarbons and vapors from the subsurface, and the efficiency may be improved by adding surfactant to the treatment. However, it may not be possible to achieve cleanup standards in a reasonable timeframe just by applying EFR. For this reason, EFR will be carried forward for further consideration in conjunction with other remedial technologies.

3.3.5 IN-SITU CHEMICAL OXIDATION

In-situ chemical oxidation technologies can be used for in-situ destruction of petroleum contaminants. A variety of chemical oxidants and application techniques are commercially available that can be used at sites contaminated with petroleum compounds. With sufficient contact time, chemical oxidants are capable of converting the petroleum hydrocarbon mass to carbon dioxide and water and ultimately irreversibly reduce the concentration of petroleum hydrocarbons in soil and groundwater. In contrast to other remedial technologies, contaminant reduction can be achieved relatively quickly (e.g., weeks or months) (EPA 2004).

While many of the chemical oxidants have been used in wastewater treatment for decades, only recently have they been used to treat hydrocarbon contaminated groundwater and soil in-situ. Chemical oxidation technologies are predominantly used to address contaminants in the source area saturated zone and capillary fringe, however recent developments in soil mixing technology in combination with fast reaction time of chemical oxidants are allowing for treatment of the unsaturated and smear zone because the soil can be mixed thoroughly maximizing contact of contaminated soil and chemical oxidant.

At petroleum contaminated UST sites, the most commonly used chemical oxidants are hydrogen peroxide/Fenton's reagent and ozone. Sodium or Potassium Permanganate has been used, but experiences with these compounds are more limited.

One limitation of this technology is the depth below the surface that can be treated with soil mixing. In addition, clays and silts may not be as easy to mix thoroughly as these soils are more cohesive than sands and gravels. Consequently, the product may not contact all areas of contamination leaving areas untreated. The performance of chemical oxidation systems are negatively impacted by the presence of free product. While the chemical reaction is capable of treating the contaminants, the concentration of contaminants will overwhelm the treatment capacity. Due to the presence of free product at this Site, other remedial technologies (e.g., free product recovery) may need to precede chemical oxidation for the remediation to be safe and cost effective. For this reason chemical oxidation will be carried forward for further consideration in conjunction with other remedial technologies.

3.3.6 IN-SITU BIOREMEDIATION

In-situ bioremediation is a treatment process that uses naturally occurring microorganisms to break down petroleum hydrocarbons into less toxic or nontoxic substances (EPA 1996).

Numerous bioremediation technologies are commercially available to enhance microbial growth and population size by creating optimal environmental conditions. In-situ bioremediation systems treat the contaminated soil or groundwater in the location in which it was found. Generally, treatment involves injecting or mixing (through wells, excavation, or direct push technologies) solutions containing oxygen, nutrients and/or microbes into the saturated soil that will enhance and accelerate the natural bioremediation process.

In-situ bioremediation is an effective and inexpensive approach to remediate low levels of petroleum contamination. However, it may be difficult to inject product into low permeable soils. Consequently, the product may not contact all areas of contamination leaving some areas untreated. For this Site, due to the presence of free product, other remedial technologies (e.g., free product recovery) may need to precede in-situ bioremediation for the remediation to be effective. This technology will be carried forward for further consideration in conjunction with other remedial technologies.

3.3.7 NATURAL ATTENUATION

Natural Attenuation refers to physical, chemical or biological processes that act without human intervention to clean up hazardous substances in the environment. These processes include adsorption on soil particles, biodegradation, dilution and dispersion in groundwater.

Natural Attenuation will not provide for a reasonable restoration time frame at this Site itself. Contamination was discovered more than 20 years ago and free product was still present during the most recent field activities conducted in 2008. The extent of the contamination including free product appears to be stabilizing and not retreating. This indicates that natural attenuation alone is unable to achieve cleanup goals within a reasonable timeframe at this Site, and more active remedial measures will be required.

3.4 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Based on the evaluation of the Site and the available cleanup technologies, the following three alternatives have been developed by combining technologies considered above. Please note the remedial alternatives described below only address the contamination as currently known. If future investigation identifies new contamination, the remedial alternatives need to be re-evaluated and may need to be revised.

3.4.1 ALTERNATIVE NO. 1: EFR WITH NATURAL ATTENUATION

Alternative No. 1 would include applications of EFR, followed by natural attentuation, plus long-term groundwater monitoring. The EFR pilot test conducted in 2005 has demonstrated that application of this technique is likely to help remove free product and dissolved hydrocarbons and vapors from the subsurface. Results from other similar sites have shown that the effectiveness of EFR can be improved by the use of a surfactant to increase the mobility of the free product and hydrocarbons adsorbed to the soil.

EFR will be conducted in 4 phases, as described below.

Phase 1: EFR Event The first phase of EFR includes 8-hr extraction from four monitoring wells, MW-4, MW-8, MW-9 and MW-13. The existing product recovery well may also be pumped to remove any free product that has accumulated since the system was shut off.

Phase 2: Surfactant Injection: one 8-hr EFR/surfactant injection events will be conducted, consisting of approximately 4 to 6 hours of extraction followed by 2 to 4 hours of surfactant injection.

Phase 3: Surfacant "Capture": Two 8-hr EFR/surfactant capture events will take place on consecutive days, commencing approximately 16 to 48 hours following the completion of the EFR/surfactant injection events. The goal of the EFR/surfactant capture event is to recover approximately 100 or more times the volume of the undiluted surfactant.

Phase 4: "Polishing" EFR Event: an 8-hr "polishing" event will take place approximately four weeks following the completion of the EFR/surfactant capture events to remove any remnants of free product, surfactant, and/or microemulsions that may exist.

Effectiveness of EFR treatment will be evaluated. Multiple EFR treatments may be needed. If confirmation sampling shows that residual contamination still remains on the Site following EFR applications, then monitored natural attenuation will start. However, if cleanup standards can not be achieved within a reasonable timeframe, then more aggressive remedial techniques should be considered.

3.4.2 ALTERNATIVE NO. 2: EFR WITH IN-SITU CHEMICAL OXIDATION

Alternative No. 2 would include applications of EFR as described in Section 3.4.1, followed by in-situ chemical oxidation, plus confirmation groundwater monitoring.

3.4.3 ALTERNATIVE NO. 3: EFR WITH IN-SITU BIOREMEDIATION

Alternative No. 2 would include applications of EFR, followed by in-situ bioremediation, plus confirmation groundwater monitoring.

3.5 EVALUATION OF ALTERNATIVES

This section provides comparative evaluation of the remedial alternatives in accordance with WAC 173-340-350, "Remedial Investigation and Feasibility Study". The alternatives are evaluated against criteria stated in WAC-173-340-360, "Selection of Cleanup Actions". The following table contains a detailed evaluation of alternatives and their applied technologies.

Detailed Evaluation of Alternatives and Applied Technologies			
Alternative Number	**Alternative 1**	**Alternative 2**	**Alternative 3**
Description, and Ranking	EFR and natural attenuation	EFR and in-situ chemical oxidation	EFR and in-situ bioremediation
Compliance with MTCA Threshold Criteria			
Protection of Human Health and the Environment	Yes – Alternative will protect human health and the environment.	Yes – Alternative will protect human health and the environment.	Yes – Alternative will protect human health and the environment.
Compliance with Cleanup Standards	Yes –Active remedial measure of EFR and monitored natural attentuation are used for soils and groundwater not complying with cleanup standards.	Yes –Active remedial measures (EFR and in-situ chemical oxidation) are used for soils and groundwater not complying with cleanup standards.	Yes –Active remedial measures (EFR and in-situ bioremediation) are used for soils and groundwater not complying with cleanup standards.
Compliance with Applicable State and Federal Laws	Yes – Alternative complies with applicable laws.	Yes – Alternative complies with applicable laws.	Yes – Alternative complies with applicable laws.
Provision for Compliance Monitoring	Yes – Alternative includes provisions for compliance monitoring (i.e., long-term groundwater monitoring).	Yes – Alternative includes provisions for compliance monitoring.	Yes – Alternative includes provisions for compliance monitoring.
Restoration Time Frame	Restoration time frame is 8 to 10 years or even longer.	Restoration time frame is 5-6 years	Restoration time frame is 5-6 years
Evaluation Criteria			
Protectiveness (30% Weighted Factor):	This alternative will achieve overall protection (6).	This alternative will be most protective for the Site (9).	This alternative will achieve overall protection (8).
Permanence (20% Weighted Factor):	Applications of EFR will help remove contaminants. However residual contamination may remain on the Site. Natural attentuation may not be able to address the residual contamintion as expected. This alternative is not as permanent as Alternatives 2 or 3 (5).	Alternative reduces the volume of impacted material by removal of contaminants through applications of EFR and destruction of contaminants through in-situ chemical oxidation (9).	Alternative reduces the volume of impacted material by removal of contaminants through applications of EFR and destruction of contaminants through in-situ bioremediation (9).
Long-Term Effectiveness (20% Weighted Factor):	Residual contamination may remain on the Site after EFR applications. This will be addressed through natural attentuation. However, the effectiveness of natural attentuation is not known at this time (5).	Alternative destroys the contaminants, its long effectiveness is high. However, it is likely that additional applications of chemical injection will be needed to achieve the cleanup standards (7).	Alternative destroys the contaminant. However, it's very challenging to make conditions favorable for microbe growth (7).
Short-Term Risk Management (10% Weighted Factor):	Short-term risks include exposure to chemicals used in EFR , exposure to noise etc. This alternative has the lowest short-term risks (8).	Short-term risks include exposure to chemicals used in EFR and in-situ chemical oxidation, exposure to noise etc. There may be repeated applications of both EFR and in-situ chemical oxidation. Short-term risks are higher than Alternative 1 (7).	Short-term risks include exposure to chemicals used in EFR and in-situ bioremediation, exposure to noise etc. There may be repeated applications of both EFR and in-situ chemical oxidation. Short-term risks are higher than Alternative 1 (7).
Implementability (10% Weighted Factor):	Most Implementable; it may require shut down of East McGraw street for EFR applications.	Implementable; it may require shut down of East McGraw street during EFR applications and in-situ chemical oxidation (6).	Implementable; it may require shut down of East McGraw street during EFR applications and in-situ bioremediation (6).
Public Concerns (10% Weighted Factor):	Temporary access restrictions to East McGraw Street during EFR applications (7).	Temporary access restrictions to East McGraw Street during EFR applications and in-situ chemical oxidation (6).	Temporary access restrictions to East McGraw Street during EFR applications and in-situ bioremediation (6).
Overall Alternative Ranking	6.0	8.0	7.6

3.6 PREFERRED ALTERNATIVE

The preferred alternative for this Site is Alternative 2, which consists of EFR and in-site chemical oxidation and confirmation groundwater monitoring. Selection of this alternative over Alternative 1 and 3 as the preferred alternative is primarily based on its relatively high certainty to achieve cleanup objectives within a reasonable timeframe.

4.0 REFERENCES

EA November 2006, *Circle K Station #1461, Groundwater Monitoring Data Summary, Work Order #17079, Contract Number: 30700*

EA August 2006, *Circle K Station #1461, Groundwater Monitoring Data Summary, Work Order #17079, Contract Number: 30700*

EA May 2006, *Circle K Station #1461, Groundwater Monitoring Data Summary, Work Order #17079, Contract Number: 30700*

EA February 2006, *Circle K Station #1461, Groundwater Monitoring Data Summary, Work Order #17079, Contract Number: 30700*

EA June 2005, *Investigation Report for Washington State Department of Ecology, Mixed Funding LUST Sites, Circle K Station #1461.*

EPA 2004. *How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers.*

(EPA 510-B-94-003; EPA 510-B-95-007; and EPA 510-R-04-002).

Ecology November 2003, *Circle K Station #1461, 2350 24th Avenue East, Seattle, WA, Field Investigations, 2003.*

Glacier Environmental Services 2000, *Interim Report, Groundwater Treatment System, Jay's Cleaners, 2350 24th Ave East, Seattle, WA.*

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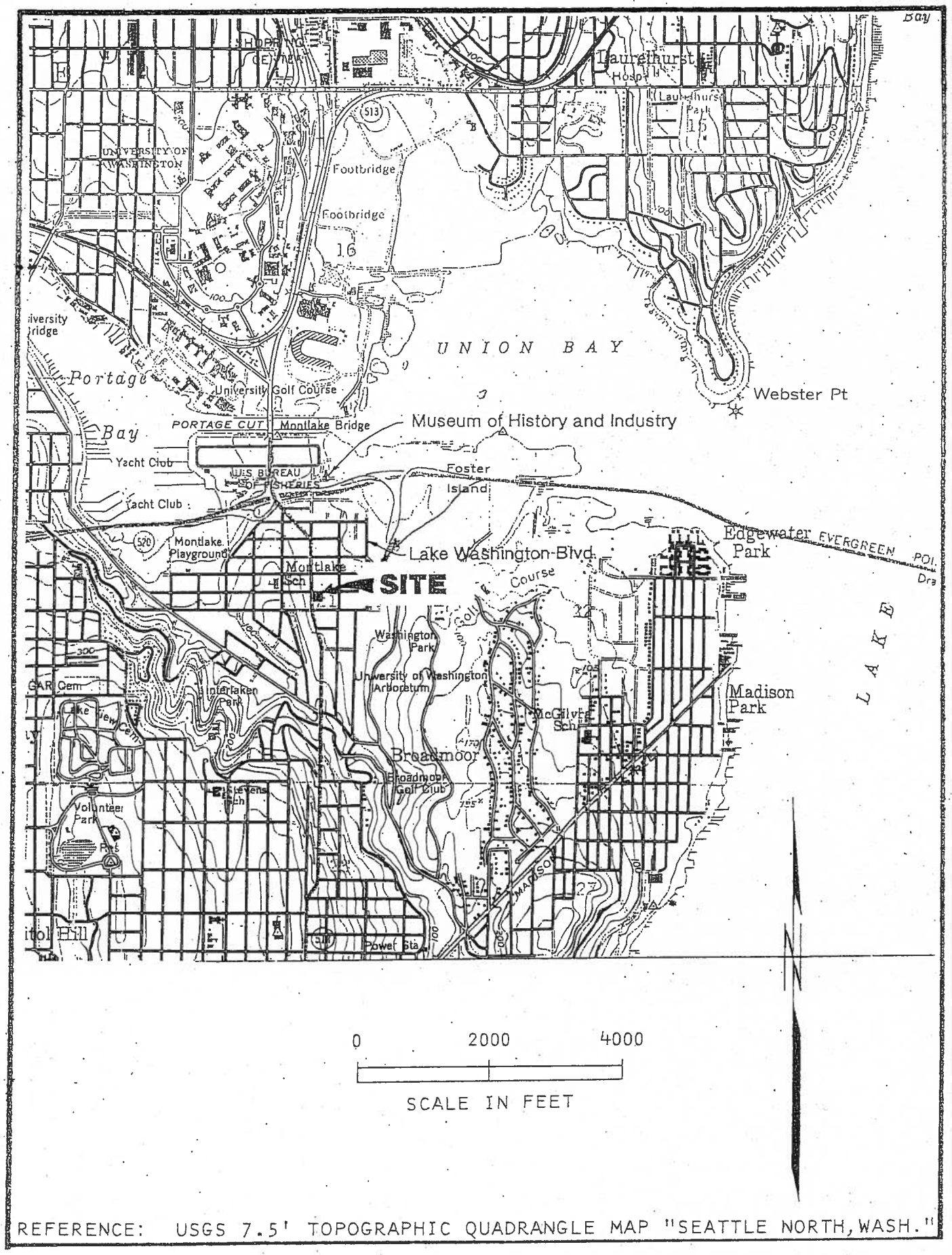
Glacier Environmental Services 1992, *Report of First Phase Activity, Former Circle K #146, Seattle, Washington.*

GeoEngineers 1990c, *Progress Report No. 2, Remedial Monitoring Program, Circle K Facility 1461, Seattle, Washington for Circle K Corporation,* November 1990.

GeoEngineers 1990b, *Progress Report No. 1, Remedial Monitoring Program, Circle K Facility 1461, Seattle, Washington for Circle K Corporation,* August 1990.

GeoEngineers 1990a, *Report of Geotechnical Services, Subsurface Contamination Study and Remedial Action Monitoring, Circle K Facility 1461, Seattle, Washington,* March 1990.

Figures



REFERENCE: USGS 7.5' TOPOGRAPHIC QUADRANGLE MAP "SEATTLE NORTH, WASH."

1780·001·804 TEP:KKT 9·19·

Figure 1 Site Location

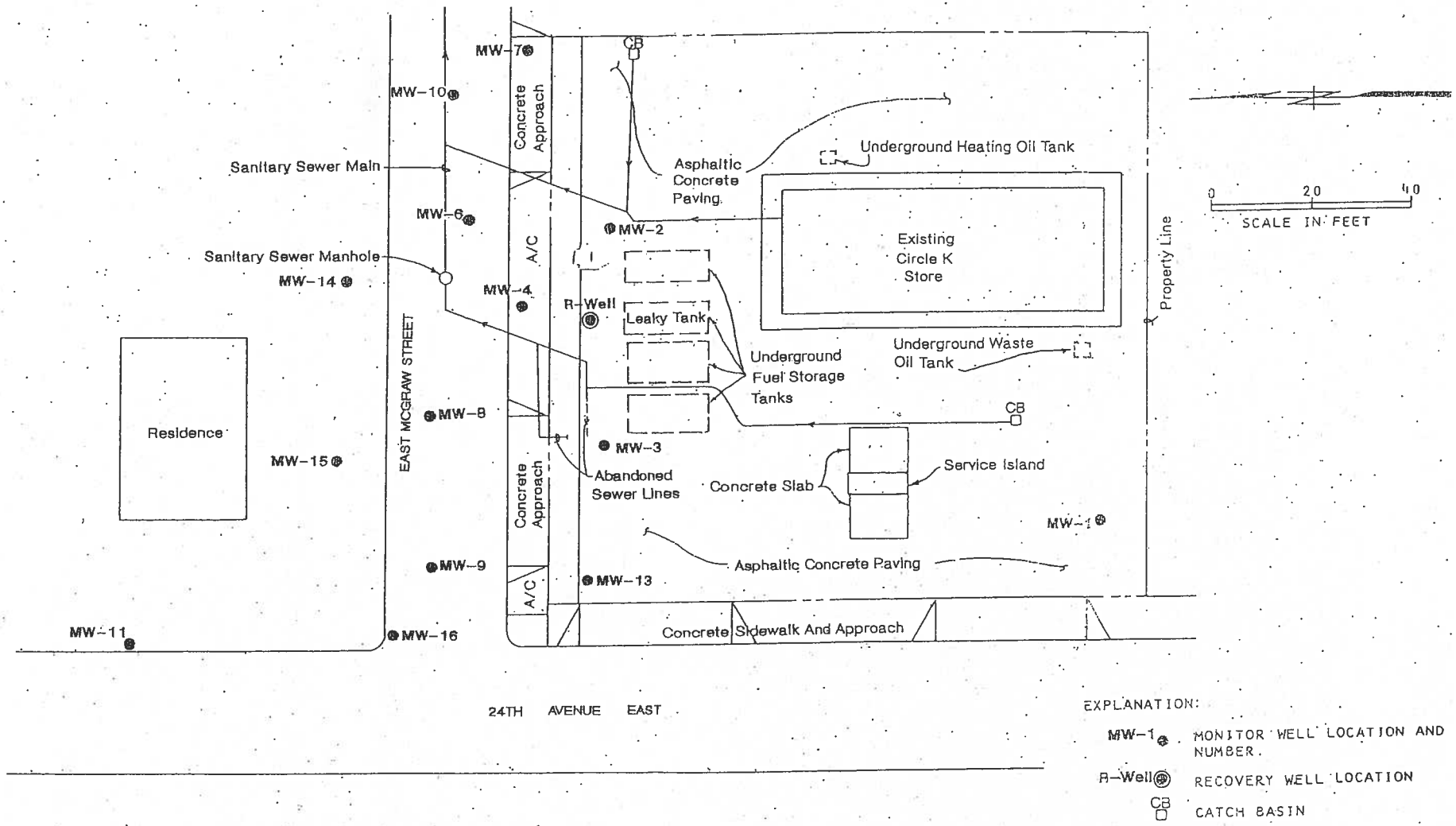
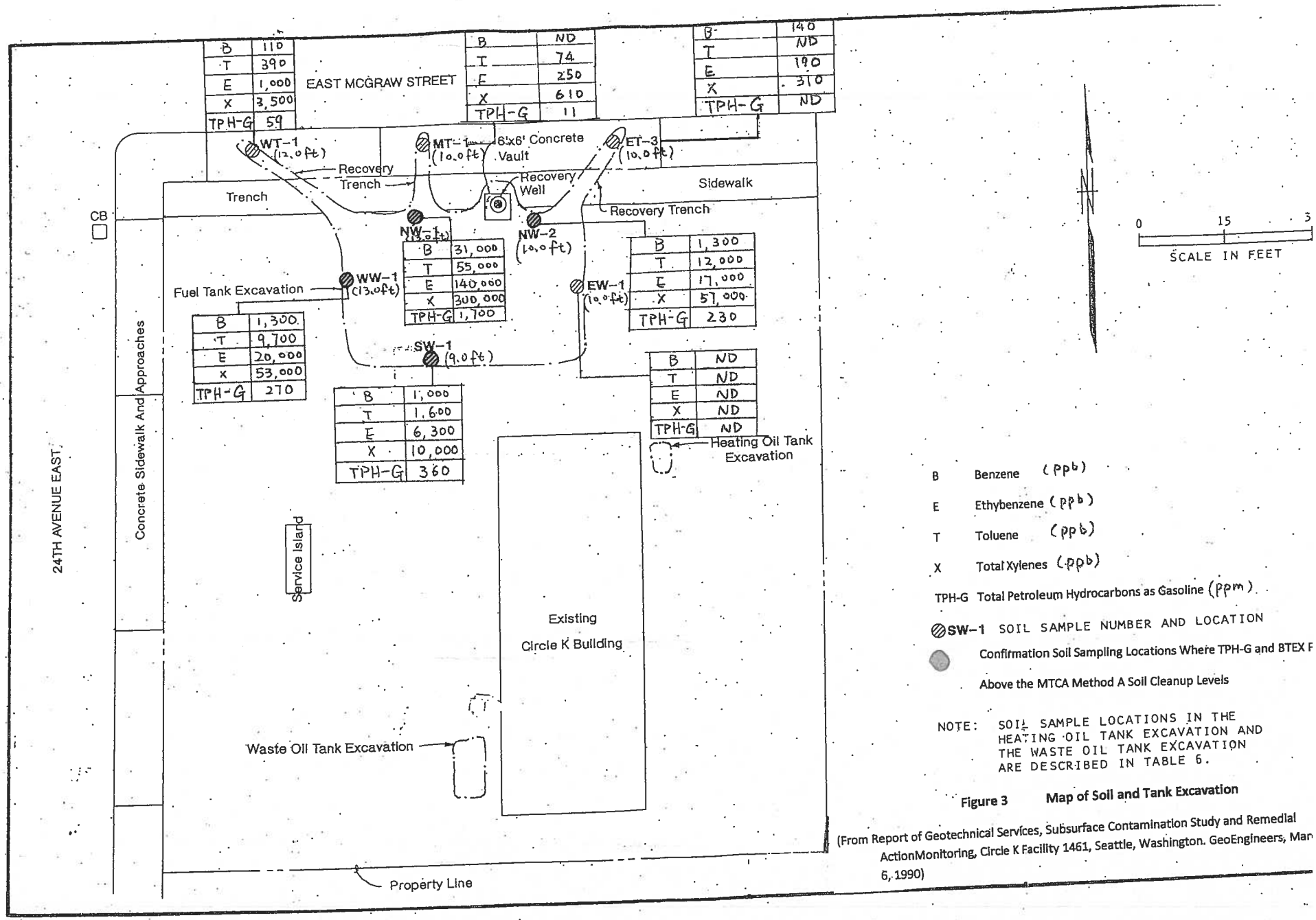


Figure 2 **Former Circle K Station #1461 Site Layout**

(From Report of Geotechnical Services, Subsurface Contamination Study and Remedial Action Monitoring, Circle K Facility 1461, Seattle, Washington. GeoEngineers, March 6, 1990)



B Benzene (ppb)

E Ethybenzene (ppb)

T Toluene (ppb)

X Total Xylenes (ppb)

TPH-G Total Petroleum Hydrocarbons as Gasoline (ppm)

SW-1 SOIL SAMPLE NUMBER AND LOCATION

Confirmation Soil Sampling Locations Where TPH-G and BTEX F

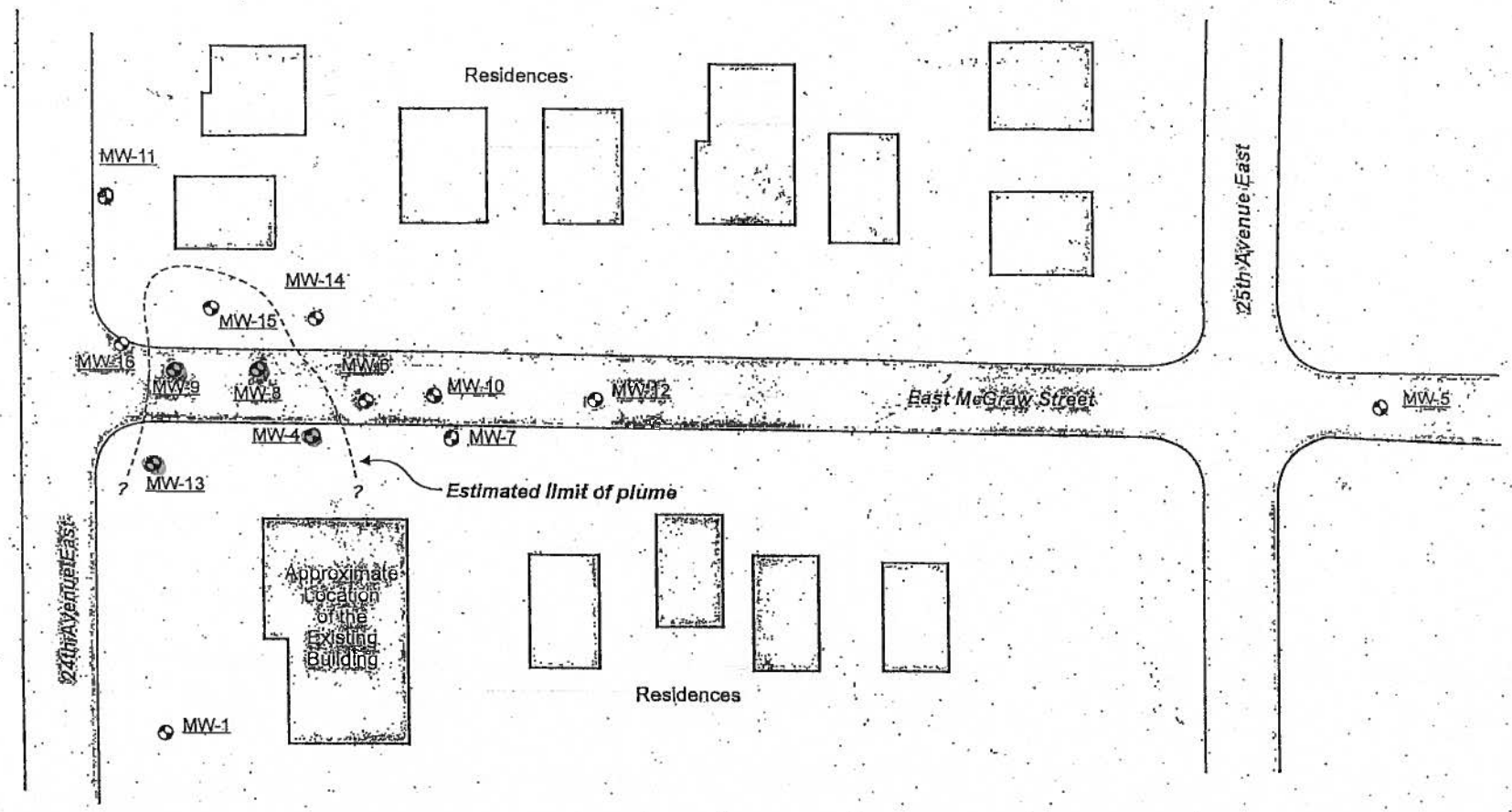
Above the MTCA Method A Soil Cleanup Levels

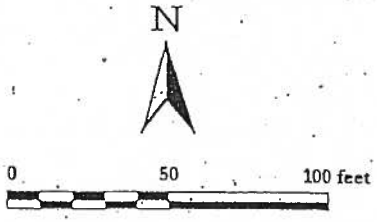
NOTE: SOIL SAMPLE LOCATIONS IN THE HEATING OIL TANK EXCAVATION AND THE WASTE OIL TANK EXCAVATION ARE DESCRIBED IN TABLE 6.

Figure 3 Map of Soil and Tank Excavation

(From Report of Geotechnical Services, Subsurface Contamination Study and Remedial ActionMonitoring, Circle K Facility 1461, Seattle, Washington. GeoEngineers, Mar 6, 1990)

1760-001-804 JGR:BDH 1-16-90





Locations of All Features Shown Are Approximate

Figure 4 **Current Site Layout and Approximate Extent of Gasoline Plume**

● Wells with Free Product (2/15/2008)

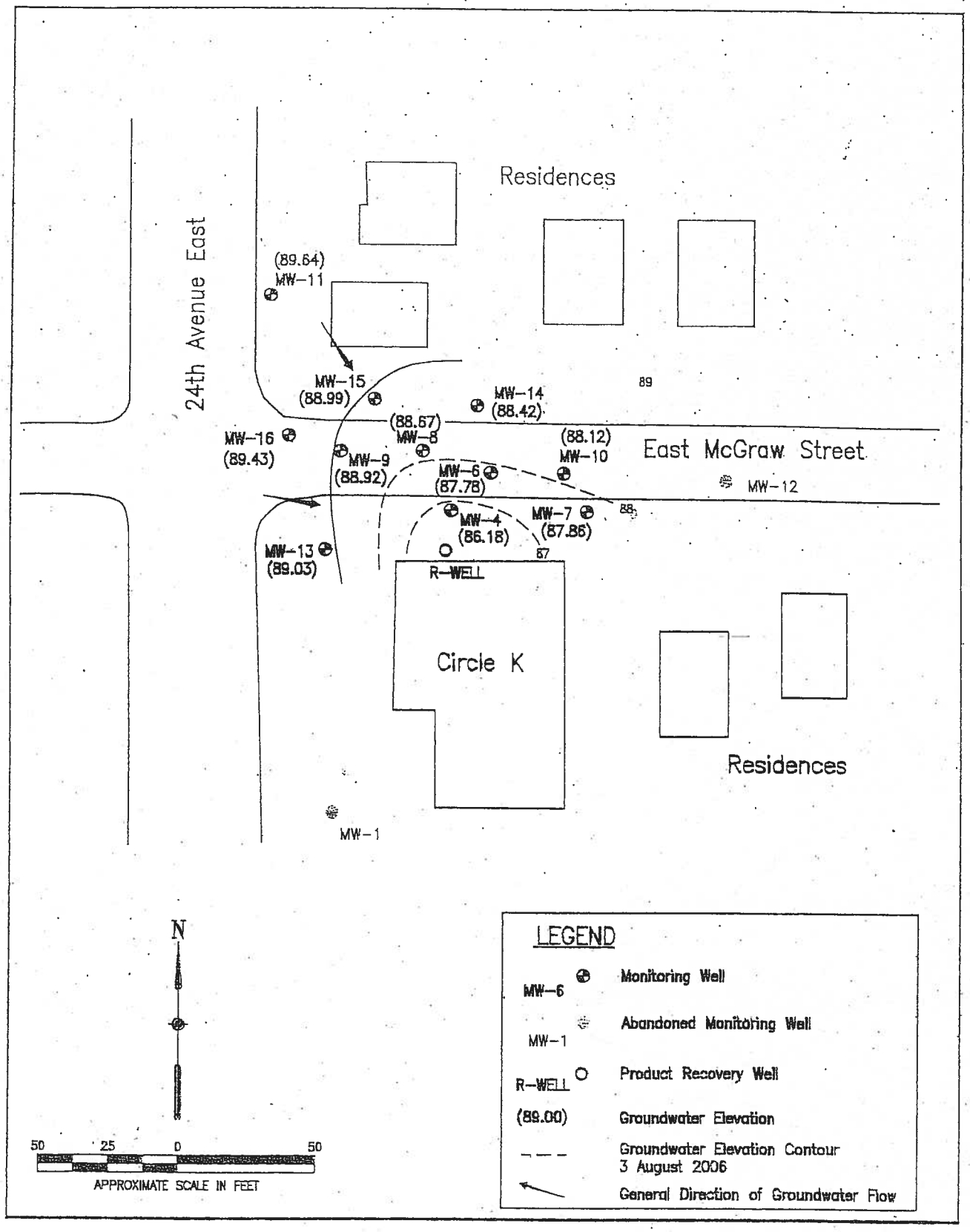


Figure 5 Groundwater Elevations and Contour Lines, 3 August 2006

From Report *Circle K Station #1461, Groundwater Monitoring Data Summary, Work Order #17079, Contract Number: 30700,* EA November 7, 2006

TABLES

TABLE 1. MONITORING WELL CONSTRUCTION AND FIELD MEASUREMENT DATA - CIRCLE K STATION #1461

Well ID	Date Installed	Well Diameter (inches)	Reported Screen Depth (ft bgs)	Total Depth (ft btoc)	Top of Casing Elevation (ft)	Depth to Water 3-Aug-06 (ft btoc)	Depth to Product 3-Aug-06 (ft btoc)	Free Product Thickness 3-Aug-06 (ft)	Groundwater Elevation 3-Aug-06 (ft)
MW-4	9/12/1989	2	4 - 18.5	17.90	100.73	14.67	14.55	0.12	86.18
MW-6	10/2/1989	2	5 - 20	20.43	100.24	12.46	NA	NA	87.78
MW-7	10/2/1989	2	5 - 20	20.49	99.75	11.89	NA	NA	87.86
MW-8	10/3/1989	2	5 - 20	19.45	100.70	12.04	12.03	0.01	88.67
MW-9	10/3/1989	2	5 - 21	20.35	101.41	12.50	12.49	0.01	88.92
MW-10	10/3/1989	2	5 - 20	20.47	99.96	11.84	NA	NA	88.12
MW-11	10/4/1989	2	5 - 20	20.31	100.89	11.25	NA	NA	89.64
MW-12	10/4/1989	2	5 - 20	abandoned	abandoned	NA	NA	NA	NA
MW-13	12/20/1989	2	4 - 19	18.81	102.19	13.19	13.16	0.03	89.03
MW-14	12/20/1989	2	4 - 19	18.87	100.40	11.98	NA	NA	88.42
MW-15	12/21/1989	2	4 - 18.5	16.81	101.29	12.3	NA	NA	88.99
MW-16	12/21/1989	2	4 - 19	18.94	101.15	11.72	NA	NA	89.43

Well ID	Date Measured	Water Quality Parameters					
		pH	Conductivity (mS/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
MW-6	8/3/2006	7.06	1.67	1.5	0.71	17.6	-42
MW-15	8/3/2006	5.62	2.233	1.3	0.78	15.8	42.4

NOTES:

°C = degrees Celsius.
ft bgs = feet below ground surface.
ft btoc = feet below top of casing.
NA = Not applicable.
NTUs = Nephelometric turbidity units.
mS/cm = milliSiemans per centimeter.
mg/L = milligrams per liter.
mV = milliVolts

Table 2 Summary of Soil Sample Analytical Data, Monitor Well Borings

From *Report of Geotechnical Services, Subsurface Contamination Study and Remedial Action Monitoring, Circle K Facility 1461, Seattle, Washington,* GeoEngineers March 6, 1990

			EPA Method 8020				Modified EPA Method 8015	
Sample Number	Depth (feet)	Sample Date	Benzene (ppb)	Ethyl-Benzene (ppb)	Toluene (ppb)	Total Xylenes (ppb)	Gasoline (ppm)	Diesel (ppm)
MW-1	8.5	09/11/89	ND	ND	ND	ND	ND	ND
MW-2	8.5	09/11/89	ND	ND	ND	ND	ND	ND
MW-3	8.5	09/12/89	ND	57	72	310	9	ND
MW-4	8.5	09/12/89	ND	27,000	27,000	159,000	1,200	ND
MW-5	8.5	09/12/89	ND	ND	ND	ND	ND	ND
MW-6	8.0	10/02/89	ND	ND	ND	ND	ND	ND
MW-6	10.0	10/02/89	ND	ND	ND	ND	ND	ND
MW-7	10.0	10/02/89	ND	29	100	175	ND	ND
MW-8	10.0	10/03/89	ND	ND	ND	ND	ND	ND
MW-9	10.0	10/03/89	ND	ND	ND	ND	ND	ND
MW-10	10.0	10/03/89	ND	ND	ND	ND	ND	ND
MW-11	11.0	10/04/89	ND	ND	ND	ND	ND	ND
MW-12	10.0	10/04/89	ND	ND	ND	ND	ND	ND
MW-13	8.0	12/20/89	460	220	1100	1200	ND	ND
MW-14	13.0	12/20/89	ND	ND	ND	ND	ND	ND
MW-15	8.0	12/21/89	ND	ND	ND	ND	ND	ND
MW-15	13.0	12/21/89	510	90	840	510	ND	ND
MW-16	8.0	12/21/89	ND	ND	63	ND	ND	ND

Notes:
"ppb" = parts per billion
"ppm" = parts per million
"ND" = "not detected"; see lab data sheets in Appendix B for analyte detection limits

TABLE 3. GROUNDWATER ELEVATION SUMMARY - CIRCLE K STATION #1461

Well ID	Top of Casing Elevation (ft)	Groundwater Elevation 31 May 2005 (ft)	Groundwater Elevation 14 Feb 2006 (ft)	Groundwater Elevation 18 May 2006 (ft)	Groundwater Elevation 3 August 2006 (ft)	Annual Water Level Fluctuation (ft)
MW-4	100.73	91.02	92.10	90.75	86.18	5.92
MW-6	100.24	88.69	88.72	88.70	87.78	0.94
MW-7	99.75	90.63	94.12	90.15	87.86	6.26
MW-8	100.70	90.69	91.72	90.50	88.67	3.05
MW-9	101.41	91.34	92.71	90.99	88.92	3.79
MW-10	99.96	90.13	91.29	89.96	88.12	3.17
MW-11	100.89	92.23	98.52	91.29	89.64	8.88
MW-13	102.19	91.29	92.64	91.14	89.03	3.61
MW-14	100.40	91.62	93.36	91.15	88.42	4.94
MW-15	101.29	91.86	93.76	91.25	88.99	4.77
MW-16	101.15	91.64	93.15	90.55	89.43	3.72
					Average =	4.46

NOTES:

ft bgs = feet below ground surface.

ft btoc = feet below top of casing.

TOC elevations are per INCA 22 March 2006 survey.

Table 4 Thickness of Free Product in Groundwater Monitoring Wells (feet)

Monitoring Wells	6/16/2003	5/31/2005 Before EFR Test	6/23/2005 2 Weeks after EFR Test	2/14/2006	5/18/2006	8/3/2006	2/15/2008
MW-4	0.09	0.3	Trace	0.02	0.14	0.12	Trace<0.01
MW-6	--	--	--	Not observed	Not observed	--	Not observed
MW-7	--	--	--	Trace	Not observed	--	--
MW-8	0.9	Trace	Trace	Trace	0.05	0.01	Sheen and hydrocarbon observed
MW-9	0.02	0.02	Trace	0.02	Trace	0.01	No product measured, sheen observed
MW-10	--	--	--	Trace	Not observed	--	--
MW-11	--	--	--	Not observed	Not observed	--	--
MW-12	--	--	--	--	Not observed	--	Abandoned
MW-13		0.01	Not Measured	Trace	Trace	0.03	0.01
MW-14	--	--	--	Trace	Not observed	--	--
MW-15	Not observed	--	--	Not observed	Not observed	--	No product measured, sheen and ordor observed
MW-16	--	--	--	Trace	Not observed	--	Not observed

--: Not measured

Table 5 Summary of Groundwater Analytical Data

Well ID	Sampling Date	TPH-G (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)
MW-1	9/13/1989	--	1.5	ND	1.9	1.6
	3/9/1990	--	ND	ND	ND	ND
	4/9/1992	<100	51	14	14	9
	6/4/1999	ND	ND	3.59	3.87	0.83
	4/11/2001	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	6/16/2003	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
MW-4	4/9/1992	Not sampled - Free product observed in well				
	6/4/1999	30,800	3,580	3,490	3,920	788
	4/11/2001	117,000	7,370	28,000	2,680	17,100
	6/16/2003	Not sampled - Free product observed in well				
	5/31/2005	Not sampled - Free product observed in well				
	6/23/2005	65,600	240	3,750	1,640	10,700
	2/14/2006	Not sampled - Free product observed in well				
	5/18/2006	Not sampled - Free product observed in well				
	8/3/2006	Not sampled - Free product observed in well				
MW-5	4/9/1992	<100	<1	1	<1	3
	4/11/2001	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	6/16/2003	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
MW-6	10/9/1989	--	250	ND	3.2	110
	3/8/1990	--	14	0.5	2.8	1.8
	6/11/1990	--	18	1.7	6.2	7.9
	4/9/1992	<100	4	1	<1	3
	6/4/1999	ND	ND	2.88	ND	ND
	4/11/2001	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	6/16/2003	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	2/14/2006	67.5	0.982	0.500 U	3.84	7.13
	5/18/2006	50.0 U	0.514	0.500 U	1.48	1.00 U
	5/18/2006	50.0 U	0.500 U	0.500 U	1.28	1.00 U
	8/3/2006	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
MW-7	10/9/1989	--	3	ND	1	ND
	3/8/1990	--	1	ND	ND	ND
	4/9/1992	<100	4	<1	5	9
	6/4/1999	ND	ND	3.38	2.29	ND
	4/11/2001	0.05 U	0.500 U	0.500 U	0.500 U	1.00 U
	6/16/2003	0.05 U	0.500 U	0.500 U	0.500 U	1.00 U
MW-8	6/4/1999	43700	570	6,130	17,000	1,220
	4/11/2001	464,000	802	9,770	1,520	7,030
	6/16/2003	Not sampled - Free product observed in well				
	5/31/2005	Not sampled - Free product observed in well				
	6/23/2005	Not sampled - Free product observed in well				
	2/14/2006	102,000	342	143,000	2,670	14,800
	2/14/2006*	89,000	452	14,000	2,770	14,900
	5/18/2006	Not sampled - Free product observed in well				
	8/3/2006	Not sampled - Free product observed in well				
MW-9	6/4/1999	54,400	610	4,990	6,760	1,230
	4/11/2001	35,400	420	2,310	1,500	7,350
	6/16/2003	Not sampled - Free product observed in well				
	5/31/2005	Not sampled - Free product observed in well				
	6/23/2005	71,300	1,820	6,140	1,820	9,350
	2/14/2006	Not sampled - Free product observed in well				

Table 5 Summary of Groundwater Analytical Data

Well ID	Sampling Date	TPH-G (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)
	5/18/2006	52,200	535	2,300	1,730	8,390
	8/3/2006	Not sampled - Free product observed in well				
MW-10	10/9/1989	--	1.2	ND	ND	ND
	3/8/1990	--	ND	ND	ND	ND
	6/11/1990	--	ND	ND	ND	ND
	6/4/1999	ND	ND	ND	3.03	ND
	5/18/2006	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
MW-11	10/9/1989	--	3	ND	ND	3
	3/9/1990	--	0.9	ND	0.9	ND
	6/11/1990	--	ND	ND	ND	ND
	4/9/1992	<100	1	<1	<1	<1
	6/4/1999	ND	ND	35.8	ND	ND
	4/11/2001	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	6/16/2003	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	2/14/2006	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
MW-12	4/9/1992	<100	4	<1	<1	3
	6/4/1999	ND	ND	2.99	1.14	ND
MW-13	12/21/1989	--	13,000	1,700	20,000	8,800
	3/9/1990	--	54,000	3,500	50,000	18,000
	6/11/1990	--	31,000	1,800	24,000	12,000
	4/9/1992	56,000	5,900	5,700	1,200	6,400
	7/13/2003	Not sampled - Free product observed in well				
	5/13/2005	Not sampled - Free product observed in well				
	6/23/2005	115,000	8,560	16,800	1,920	12,900
	6/23/2005*	121,000	8,560	16,900	1,880	12,700
	2/14/2006	74,700	2,270	6,660	1,530	14,100
	5/18/2006	109,000	7,260	14,700	1,810	15,500
	8/3/2006	Not sampled - Free product observed in well				
MW-14	12/21/1989	--	1.1	1.9	5.7	13.0
	3/8/1990	--	4.7	0.7	6.3	4.5
	6/11/1990	--	ND	ND	49	ND
	4/9/1992	<100	4	2	5	8
	4/11/2001	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	6/16/2003	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	5/31/2005	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
MW-15	12/21/1989	--	7,300	1,000	9,000	5,800
	3/8/1990	--	28,000	1,400	22,000	6,500
	6/11/1990	--	20,000	1,800	28,000	10,000
	6/4/1999	24,700	37.9	367	3,100	547
	4/11/2001	23,800	58.4	310	526	2,920
	6/16/2003	3,150	6.22	83.3	12.6	199
	5/31/2005	878	1	0.500 U	2.60 I	3.39 I
	6/23/2005	950	2.01	3.18	2.48	6.34
	2/14/2006	137	0.5U	0.5U	0.5U	1.0 U
	5/18/2006	381	0.791	1.69	0.816	5.82
	8/3/2006	1,350	2.92	6.86	6.03	42
	8/3/2006*	1,580	3.29	6.60	6.78	45.1
MW-16	12/21/1989	--	4.30	7.10	20.00	36.0
	3/8/1990	--	ND	ND	ND	ND
	6/11/1990	--	ND	ND	ND	0.8

Table 5 Summary of Groundwater Analytical Data

Well ID	Sampling Date	TPH-G (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)
MW-16	4/9/1992	<100	5	2	5	9
	6/4/1999	182	ND	3.39	8.93	1.93
	4/11/2001	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	6/16/2003	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
	2/14/2006	50.0 U	0.500 U	0.500 U	0.500 U	1.00 U
Note:						
* Duplicate						
--: Not measured						
U: not detected at or above the specified reporting limit						
I: The analyte concentration may be artificially elevated due to coeluting compounds or components.						

EA 2006

Release ID#: 1548
Seattle

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7 November 2006
61994.01 LN0034

Mr. Roger Nye
Washington Department of Ecology
Toxics Cleanup Program
3190 – 160th Avenue Southeast
Bellevue, Washington 98008-5452

RE: Circle K Station #1461
Groundwater Monitoring Data Summary for August 2006
Recommendations for Additional Cleanup Action Tests
Work Order #17079, Contract Number: 30700

Dear Mr. Nye:

This letter provides a summary of the results from the groundwater sampling event conducted on 3 August 2006 at Circle K Station #1461, in the Montlake area of Seattle.

1.0 FIELD ACTIVITIES

On 3 August 2006, EA Engineering, Science, and Technology, Inc. (EA) personnel gauged all monitoring wells at the site for the presence of free product. Free product was measured in four wells at the following thicknesses; 0.12 ft in MW-4, 0.03 ft in MW-13, 0.01 ft in MW-8, and 0.01 ft in MW-9. Free product was not observed in wells MW-6, MW-7, MW-10, MW-11, MW-14, MW-15 or MW-16.

EA collected groundwater samples from MW-6 and MW-15 in accordance with the Sampling and Analysis Plan (SAP)[1], using a peristaltic pump and low-flow sampling procedures. Wells with measurable free product (MW-4, MW-8, MW-9, and MW-13) were not sampled. (The remaining wells are not included in quarterly sampling, per the SAP.)

In the monitoring wells sampled, the tubing intake was placed three to five feet from the bottom of the wells during sampling. Groundwater was purged at a rate of 300-350 milliliters per minute. Groundwater quality parameters were measured every three minutes during purging until parameters stabilized. Groundwater samples were then collected. A duplicate sample was collected from MW-15 (CK-MW15D). Table 1 summarizes monitoring well construction information, water level measurements, and field parameter measurements obtained after the readings stabilized. A site map showing monitoring well locations is attached as Figure 1.

In accordance with the SAP, groundwater samples were submitted for laboratory analysis of gasoline range organics (GRO); benzene, toluene, ethylbenzene, and xylenes (BTEX); diesel range organics (DRO); and lube oil range organics (LRO). Samples were not analyzed for lead due to historical non-detect or near non-detect concentrations. Groundwater purged during

[1] EA Engineering, Science, and Technology, Inc. 2006. Sampling and Analysis Plan for Amendment No. 2, Revision 1, Work Order #17079, Contract Number: 30700. March 8.

monitoring well sampling was contained in a 55-gallon drum within the fenced enclosure at the rear of the Jays Cleaners/Mont's Market building.

2.0 GROUNDWATER MONITORING RESULTS

Laboratory reports for groundwater samples are attached. Analytical results and are summarized in Table 2, along with prior sampling results. GRO, DRO, and benzene concentrations for the August 2006 sampling event are also shown on Figure 1. Analytical results for the August 2006 sampling event are generally consistent with previous results. Following is a discussion of the findings.

- Results for the sample collected from MW-6 were below the laboratory reporting limits for all analytes.

- In the sample from MW-15, GRO was detected at a concentration of 1,350 micrograms per liter (µg/L), exceeding the MTCA Method A cleanup criteria of 800 µg/L. DRO was reported at a concentration of 520 µg/L, slightly exceeding the MTCA Method A cleanup criteria of 500 µg/L. However, the laboratory noted that the sample chromatographic pattern for the DRO analysis did not resemble the fuel standard used for quantitation. (During previous sampling rounds, the laboratory has noted that DRO detections were primarily due to overlap from a gasoline-range product.) All four BTEX constituents were detected in this sample at concentrations below the MTCA criteria.

Quality control (QC) samples were collected and analyzed according to the approved SAP. Results for the field QC samples (field duplicate and trip blank samples) were within acceptance limits. The results of laboratory QC samples (*i.e.,* matrix spikes, blanks, blank spikes, and duplicates) were within the laboratory's acceptance limits. The laboratory noted that the sample temperature upon receipt was 11° C; this exceeds the standard sampling protocol range of 2° to 6°C. This occurred because the samples were delivered to the laboratory immediately after collection and did not have time to cool completely.

3.0 GROUNDWATER ELEVATION DATA

Groundwater elevations measured in the site wells on 3 August 2006 had decreased from measurements from May 2006, as expected due to seasonal decreases in rainfall. Groundwater contours for August 2006 are provided on Figure 2. Groundwater flow was generally to the southeast (with some more southerly and easterly components) at a gradient of approximately 0.035 ft/ft.

During previous groundwater sampling events by EA in May 2005, February 2006, and May 2006, no dominant direction of groundwater flow was apparent across the site. Estimated groundwater contours for the February and May 2006 sampling events are shown on Figures 3 and 4. Of the four sampling events performed by EA, the highest groundwater elevations were observed in February 2006 and the lowest elevations were observed in August 2006. This is as expected based on seasonal rainfall variations. (Note that we have not yet completed one full year of quarterly sampling; the final quarterly sampling event for 2006 is scheduled for November.)

Although the seasonal high and low water levels occurred when expected, a review of 2006 water elevation data indicates that the degree of water level fluctuation in the site monitoring wells is not consistent between wells. The maximum water level fluctuation during 2006 was calculated for each site well ("annual water level fluctuation" in Table 3). The average annual water level fluctuation for all monitoring wells during 2006 was 4.46 ft. However, several wells exhibited significantly different annual water level fluctuations, as follows:

- MW-6 had a much smaller fluctuation of only 0.94 ft
- MW-8 also had a significantly smaller fluctuation of 3.05 ft
- MW-11 had a much larger fluctuation of 8.88 ft
- MW-4 also had a significantly larger fluctuation of 5.92 ft.

This difference in water level fluctuations between wells impacts the groundwater flow direction at the site. Wells MW-6 and MW-8, located near the center of the study area, fluctuate little, while wells MW-4 and MW-11, located near the south and north edges of the study area, fluctuate significantly. This causes a shift in groundwater flow direction at the site, with groundwater appearing to flow radially toward MW-6 at times during the year (see Figures 3 and 4) and more southeasterly at other times (see Figure 2).

The reason for the variation in annual water level fluctuations at the site is not known. A review of well logs and site lithology did not reveal any apparent causes. The reported lithology does not differ significantly for those wells with significant variations in fluctuations.

Several corrections and updates can be made to the site information presented in EA's 2005 summary report, based on the 2006 sampling data. The depth to groundwater at the site ranges from at least 2.4 ft bgs (MW-11 in February) to 14.5 ft bgs (MW-4 in August). This is a considerably wider range than that identified previously (9 to 12 ft bgs), based only on information presented in the 1990 GeoEngineers report[2]. Additionally, the groundwater flow directions observed differs from that presented in the GeoEngineers report (identified by them as generally to the northeast).

4.0 DISCUSSION AND CONCLUSIONS

The primary concern at this site remains the presence of free product. Until the free product is removed, it will continue to act as an ongoing source for groundwater contamination.

On 9 June 2005, a test was conducted at the former Circle K facility to determine the effectiveness of enhanced fluid recovery (EFR®). During the 8-hr test, approximately 18 gallons of hydrocarbons were extracted from the subsurface in the vapor and liquid phases. Prior to testing, free product levels were highest in MW-4, and measurable in wells MW-8, MW-9 and MW-13. On 23 June 2006, free product was not present in measurable quantities in any well, though trace quantities were found in MW-4, MW-8 and MW-9. Since the test, free product levels were measured during three quarterly sampling events. Levels of free product have rebounded, though they have not returned to pre-test levels in MW-4. The following table

[2] GeoEngineers. 1990. Report of Geotechnical Services, Subsurface Contamination Study and Remedial Action Monitoring, Circle K Facility 1461, Seattle, Washington. Report prepared for The Circle K Corporation. March 6.

summarizes free product levels before testing and at current levels. Additional measurements are presented in Table 2.

Monitoring Well	Product Thickness 31 May 2005 (Before EFR Test)	Product Thickness 23 June 2006 (2 weeks after EFR Test)	Product Thickness 3 August 2006
MW-4	0.3	Trace	0.12
MW-8	Trace	Trace	0.01
MW-9	0.02	Trace	0.01
MW-13	0.01	None measured	0.03

During the EFR® test conducted last year, a significant quantity of free product was removed, however over the past year, free product levels in the monitoring wells are rebounding. Because of this, gasoline and BTEX constituent concentrations are not decreasing in groundwater. Typically, EFR® is used numerous times at a site before free product removal is complete. The addition of a non-toxic, biodegradable, surfactant has been shown to improve free product removal during EFR® events. Adding the surfactant alters the properties of organic-water interface. The surfactant mobilizes the free product, allowing easier extraction using EFR®. To test if the addition of surfactants will remove free product more rapidly than the traditional EFR®, another test is recommended, though this time with the addition of a surfactant. The test will be conducted in 4 phases, as described below.

Phase 1: EFR® Test Event

The first phase of the test requires an 8-hour EFR® test event. This test will remove contaminants by the multi-phase/dual-phase extraction process, reduce the aerial and vertical extent of the plumes, determine if additional EFR® events are necessary prior to surfactant injection, determine the surfactant injection volumes/locations/sequence, and determine the duration of the next phase of the test.

Also during Phase 1, the existing product recovery well will be pumped to remove any free product that has accumulated since the system was turned off.

Phase 2: Surfactant Injection

During Phase 2, an EFR®/surfactant injection event will be conducted. This event will consist of approximately 4 to 6 hours of extraction followed by 2 to 4 hours of surfactant injection.

Phase 3: Surfactant "Capture"

Two 8-hour EFR®/surfactant capture events will take place on consecutive days as Phase 3, commencing 16 to 48 hours following the completion of Phase 2. The goal of this phase event is to recover approximately at 100 times the volume of the undiluted surfactant injected into the groundwater.

Phase 4: "Polishing" EFR® Event

During Phase 4 an 8-hour "polishing" event will take place approximately four weeks following the completion of Phase 3 to remove any remnants of free product or surfactant that may exist remain.

Suggest conducting the test when water levels are high. Based on historical information, this would suggest the best time to conduct the test would be during the winter months, sometime between December and March.

After the test, we recommend conducting an additional quarterly groundwater sampling event including product measurement in all site wells following the EFR event.

Please feel free to contact me at (425) 451-7400 if you have any questions about the enclosed.

Sincerely,
EA ENGINEERING, SCIENCE,
AND TECHNOLOGY, INC.

Jil Frain, P.E.
Project Manager
jfrain@eaest.com

Attachments:

Figure 1 – Site Map with Groundwater Monitoring Results – Circle K Station #1461
Figure 2 – Groundwater Elevations and Contour Lines, 3 August 2006 – Circle K Station #1461
Figure 3 – Groundwater Elevations and Contour Lines, 18 May 2006 – Circle K Station #1461
Figure 4 – Groundwater Elevations and Contour Lines, 14 February 2006 – Circle K Station #1461
Table 1 – Monitoring Well Construction and Field Measurement Data – Circle K Station #1461
Table 2 – Summary of Groundwater Analytical Data – Circle K Station #1461
Table 3 – Groundwater Elevation Summary – Circle K Station #1461
Appendix A – Purge and Sampling Forms
Appendix B – Laboratory Reports

Figures

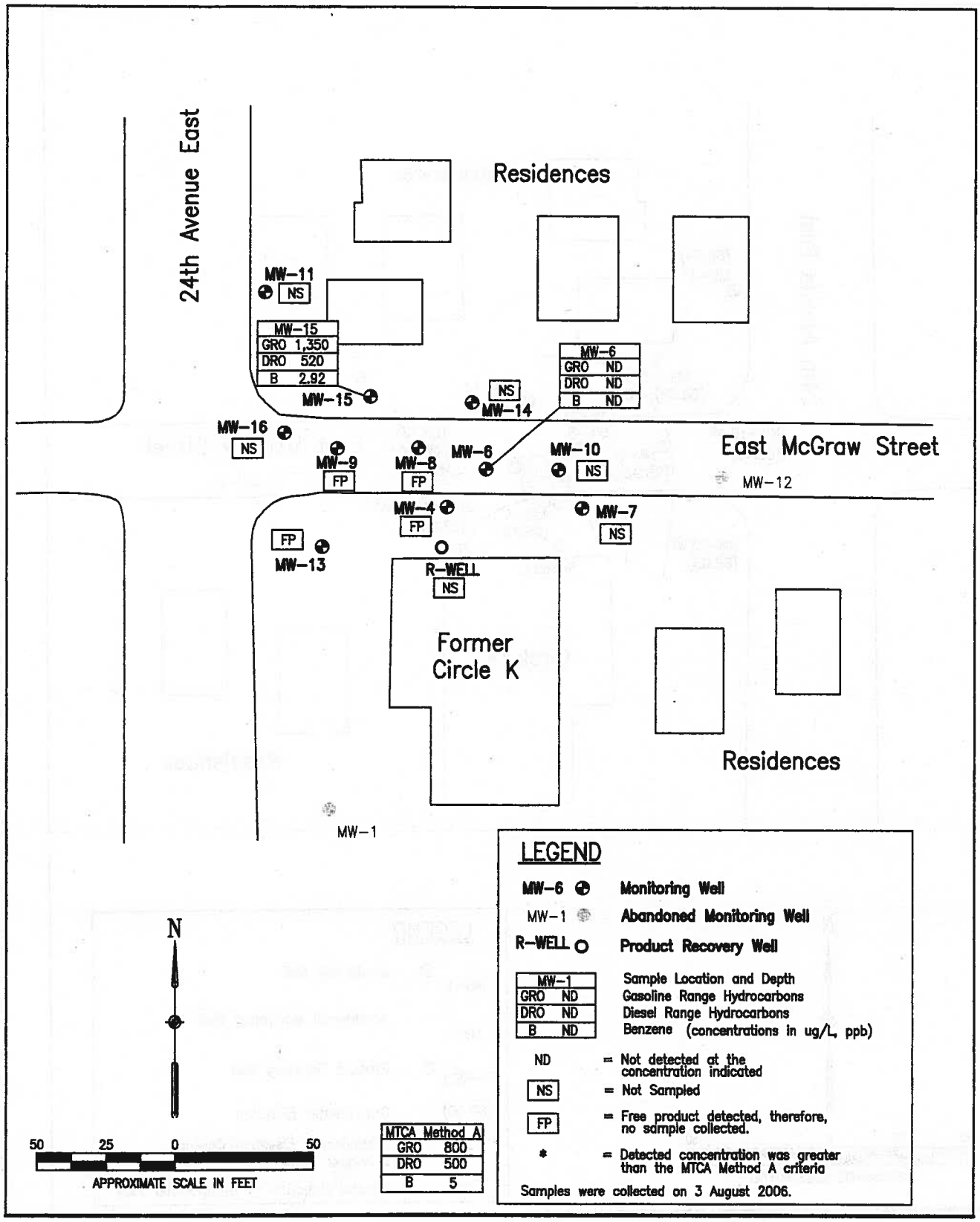

Figure 1. Site Map with Groundwater Monitoring Results – Circle K Station #1461

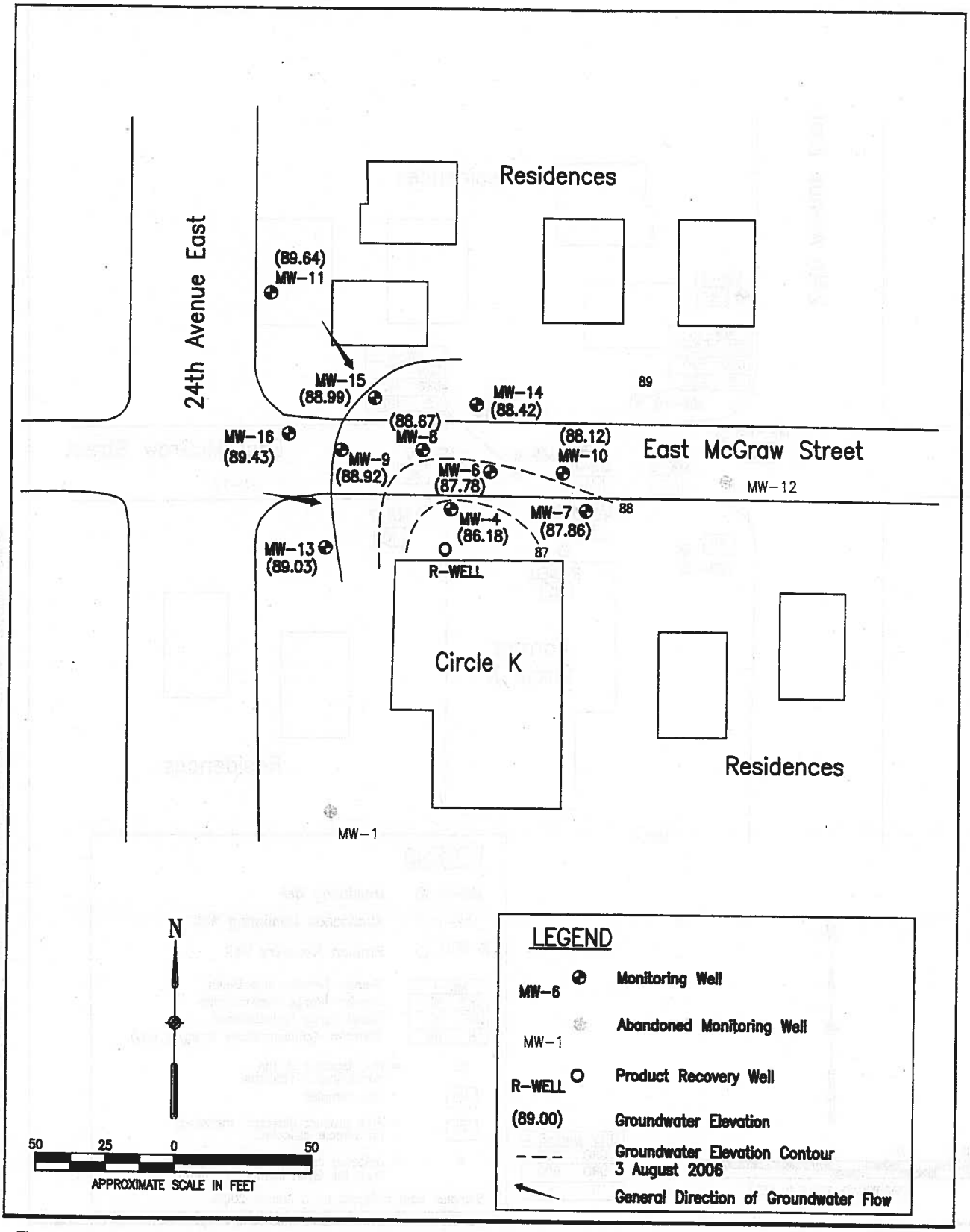

Figure 2. Groundwater Elevations and Contour Lines, 3 August 2006 – Circle K Station #1461

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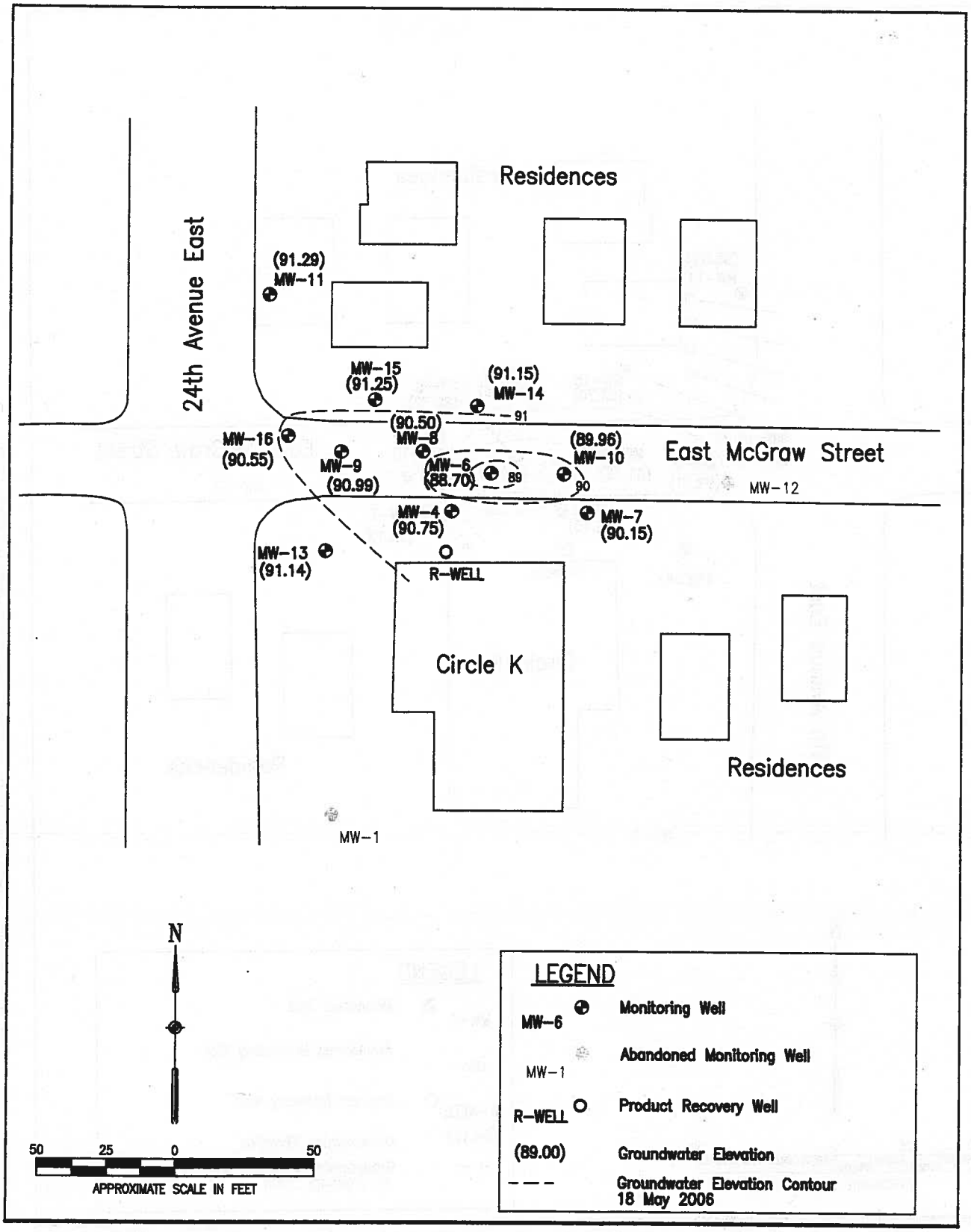

Figure 3. Groundwater Elevations and Contour Lines, 18 May 2006 – Circle K Station #1461

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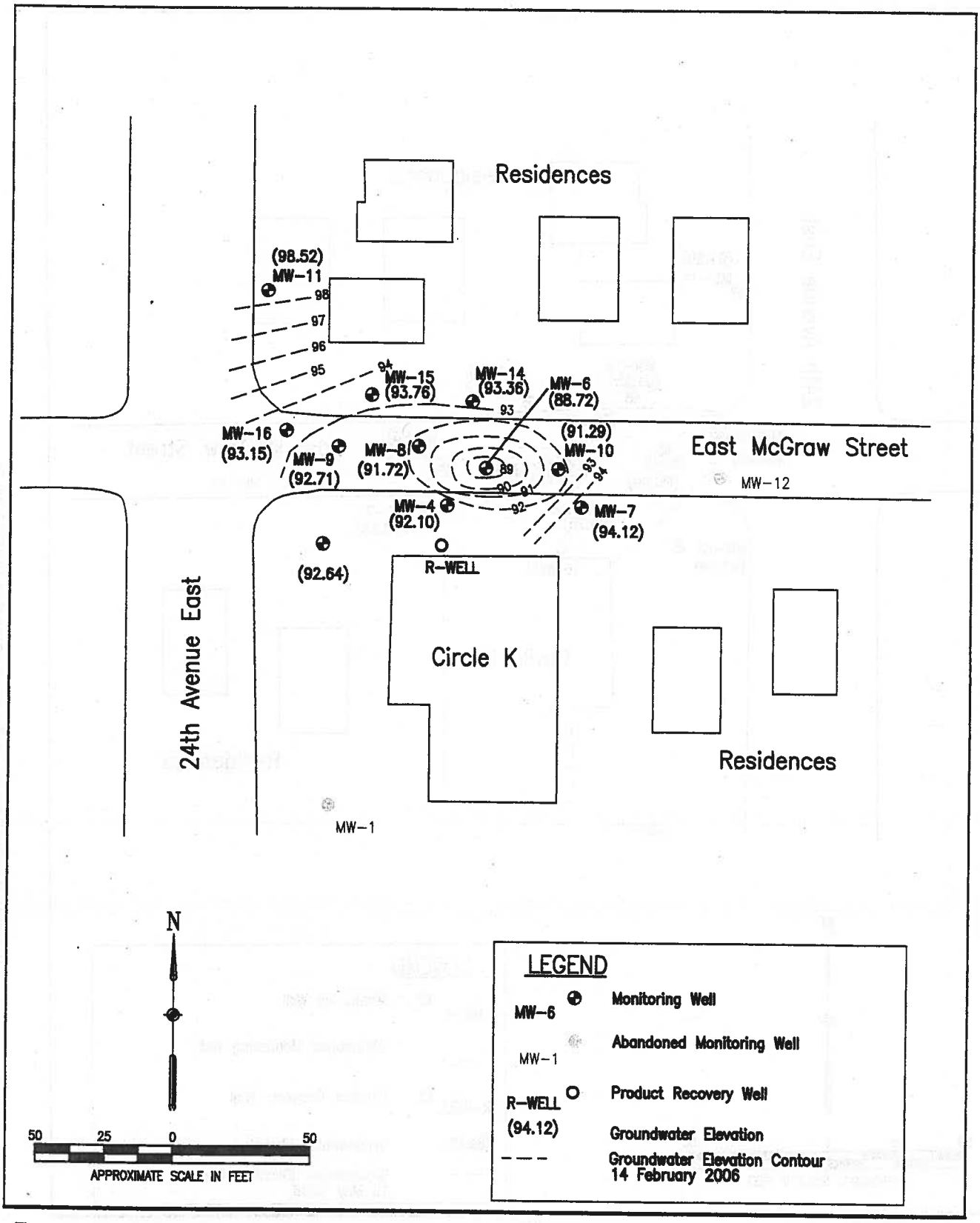

Figure 4. Groundwater Elevations and Contour Lines, 14 February 2006 – Montlake Circle K

Tables

TABLE 1. MONITORING WELL CONSTRUCTION AND FIELD MEASUREMENT DATA - CIRCLE K STATION #1461

Well ID	Date Installed	Well Diameter (inches)	Reported Screen Depth (ft bgs)	Total Depth (ft btoc)	Top of Casing Elevation (ft)	Depth to Water 3-Aug-06 (ft btoc)	Depth to Product 3-Aug-06 (ft btoc)	Free Product Thickness 3-Aug-06 (ft)	Groundwater Elevation 3-Aug-06 (ft)
MW-4	9/12/1989	2	4 - 18.5	17.90	100.73	14.67	14.55	0.12	86.18
MW-6	10/2/1989	2	5 - 20	20.43	100.24	12.46	NA	NA	87.78
MW-7	10/2/1989	2	5 - 20	20.49	99.75	11.89	NA	NA	87.86
MW-8	10/3/1989	2	5 - 20	19.45	100.70	12.04	12.03	0.01	88.67
MW-9	10/3/1989	2	5 - 21	20.35	101.41	12.50	12.49	0.01	88.92
MW-10	10/3/1989	2	5 - 20	20.47	99.96	11.84	NA	NA	88.12
MW-11	10/4/1989	2	5 - 20	20.31	100.89	11.25	NA	NA	89.64
MW-12	10/4/1989	2	5 - 20	abandoned	abandoned	NA	NA	NA	NA
MW-13	12/20/1989	2	4 - 19	18.81	102.19	13.19	13.16	0.03	89.03
MW-14	12/20/1989	2	4 - 19	18.87	100.40	11.98	NA	NA	88.42
MW-15	12/21/1989	2	4 - 18.5	16.81	101.29	12.3	NA	NA	88.99
MW-16	12/21/1989	2	4 - 19	18.94	101.15	11.72	NA	NA	89.43

		Water Quality Parameters					
Well ID	Date Measured	pH	Conductivity (mS/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
MW-6	8/3/2006	7.06	1.67	1.5	0.71	17.6	-42
MW-15	8/3/2006	5.62	2.233	1.3	0.78	15.8	42.4

NOTES:

°C = degrees Celsius.
ft bgs = feet below ground surface.
ft btoc = feet below top of casing.
NA = Not applicable.
NTUs = Nephelometric turbidity units.
mS/cm = milliSiemans per centimeter.
mg/L = milligrams per liter.
mV = milliVolts

TABLE 2. SUMMARY OF GROUNDWATER ANALYTICAL DATA
CIRCLE K STATION #1461

Well ID	Date Sampled	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (total) (ug/L)	GRO (ug/L)	DRO (ug/L)	LRO (ug/L)	Product Thickness
CK-MW4	4/11/2001	7,370	28,000	2,680	17,100	117,000	NA	NA	0.03
	6/16/2003	No sample collected							0.09
	5/31/2005	No sample collected							0.3
	6/23/2005	240	3,750	1,640	10,700	65,600	1,870 D-08	500 U	?
	2/14/2006	Not Sampled - Free product measured in well							0.02
	5/18/2006	Not Sampled - Free product measured in well							0.14
	8/3/2006	Not Sampled - Free product measured in well							0.12
CK-MW6	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	ND
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	1.0 U	NA	NA	ND
	2/14/2006	0.982	0.500 U	3.84	7.13	67.5	243 U	485 U	ND
	5/18/2006	0.514	0.500 U	1.48	1.00 U	50.0 U	243 U	485 U	ND
	5/18/2006*	0.500 U	0.500 U	1.28	1.00 U	50.0 U	240 U	481 U	ND
	8/3/2006	0.500 U	0.500 U	0.500 U	1.00 U	50.0 U	238 U	476 U	ND
CK-MW8	4/11/2001	802	9770	1520	7030	46,400	NA	NA	0.01
	6/16/2003	No sample collected							0.01
	5/31/2005	No sample collected							?
	6/23/2005	No sample collected							?
	2/14/2006	342	143,000	2,670	14,800	102,000	2,390 D-08	472 U	?
	2/14/2006*	452	14,000	2,770	14,900	89,000	2,230 D-08	472 U	?
	5/18/2006	Not Sampled - Free product measured in well							0.05
	8/3/2006	Not Sampled - Free product measured in well							0.01
CK-MW9	4/11/2001	420	2,310	1,500	7,350	35,400	NA	NA	0.01
	6/16/2003	No sample collected							0.02
	5/31/2005	No sample collected							0.02
	6/23/2005	1,820	6,140	1,820	9,350	71,300	1,810 D-08	500 U	?
	2/14/2006	Not Sampled - Free product measured in well							0.02
	5/18/2006	535	2,300	1,730	8,390	52,200	2,530 D-08	485 U	?
	8/3/2006	Not Sampled - Free product measured in well							0.01
CK-MW10	5/18/2006	0.5 U	0.5 U	0.5 U	1.0 U	50.0 U	236 U	472 U	ND
CK-MW11	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	ND
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	ND
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	240 U	481 U	ND
CK-MW13	7/11/2003	No sample collected							0.02
	5/13/2005	No sample collected							0.01
	6/23/2005	8,560	16,800	1,920	12,900	115,000	3,720 D-08	500 U	ND
	6/23/2005*	8,560	16,900	1,880	12,700	121,000	3,010 D-08	500 U	ND
	2/14/2006	2,270	6,660	1,530	14,100	74,700	3,010 D-08	472 U	?
	5/18/2006	7,260	14,700	1,810	15,500	109,000	4,650 D-08	481 U	?
	8/3/2006	Not Sampled - Free product measured in well							0.03
CK-MW14	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	ND
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	1.0 U	NA	NA	ND
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	243 U	485 U	?
CK-MW15	4/11/2001	58.4	310.0	526.0	2,920.0	23,800	NA	NA	ND
	6/16/2003	6.2	83.3	12.6	199.0	3,150	NA	NA	ND
	5/31/2005	1.26	0.500 U	2.60 I-06	3.39 I-06	1878	NA	NA	ND
	6/23/2005	2.01	3.18	2.48	6.34	950	749 D-08	500 U	ND
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	137	552	472 U	ND
	5/18/2006	0.791	1.69	0.816	5.82	381	236 U	472 U	ND
	8/3/2006	2.92	6.86	6.03	41.9	1350	520 D-06	481 U	ND
	8/3/2006*	3.29	6.60	6.78	45.1	1,580	392 D-06	476 U	ND
CK-MW16	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	ND
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	ND
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	50.00 U	236 U	472 U	?
MTCA Method A		5	1,000	700	1,000	800/1,000	500	500	

NOTES:

Sample results from 2001 and 2003 were provided by the Washington Department of Ecology.

Shaded cells indicate the results exceed the cleanup criteria.

* Duplicate sample.

MTCA Method A cleanup level for gasoline is 800 ug/L instead of 1,000 ug/L when benzene is present.

U = Not detected at or above the specified reporting limit.

D-08 = Results in the diesel organics range are primarily due to overlap from a gasoline range product.

D-06 = The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

I-06 = The analyte concentration may be artificially elevated due to coeluting compounds or components.

DRO = Diesel range organics.

GRO = Gasoline range organics.

LRO = Lube-oil range organics.

ug/L = micrograms per liter.

mg/L - milligrams per liter

NA = not analyzed

? = "trace" product ~<0.01 ft free product in well

ND = no free product detected in this well

TABLE 3. GROUNDWATER ELEVATION SUMMARY - CIRCLE K STATION #1461

Well ID	Top of Casing Elevation (ft)	Groundwater Elevation 31 May 2005 (ft)	Groundwater Elevation 14 Feb 2006 (ft)	Groundwater Elevation 18 May 2006 (ft)	Groundwater Elevation 3 August 2006 (ft)	Annual Water Level Fluctuation (ft)
MW-4	100.73	91.02	92.10	90.75	86.18	5.92
MW-6	100.24	88.69	88.72	88.70	87.78	0.94
MW-7	99.75	90.63	94.12	90.15	87.86	6.26
MW-8	100.70	90.69	91.72	90.50	88.67	3.05
MW-9	101.41	91.34	92.71	90.99	88.92	3.79
MW-10	99.96	90.13	91.29	89.96	88.12	3.17
MW-11	100.89	92.23	98.52	91.29	89.64	8.88
MW-13	102.19	91.29	92.64	91.14	89.03	3.61
MW-14	100.40	91.62	93.36	91.15	88.42	4.94
MW-15	101.29	91.86	93.76	91.25	88.99	4.77
MW-16	101.15	91.64	93.15	90.55	89.43	3.72
					Average =	4.46

NOTES:

ft bgs = feet below ground surface.

ft btoc = feet below top of casing.

TOC elevations are per INCA 22 March 2006 survey.

Release ID #: 1548
Seattle

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14 August 2006
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Mr. Roger Nye
Washington Department of Ecology
Toxics Cleanup Program
3190 – 160th Avenue Southeast
Bellevue, Washington 98008-5452

RE: Circle K Station #1461 Groundwater Monitoring Data Summary for May 2006
Work Order #17079, Contract Number: 30700

Dear Mr. Nye:

This letter provides a short summary of the results from the groundwater sampling event conducted on 18 May 2006 at Circle K Station #1461, in the Montlake area of Seattle.

1.0 FIELD ACTIVITIES

On 18 May 2006, EA Engineering, Science and Technology, Inc. (EA) personnel gauged all monitoring wells at the site for the presence of free product. Free product was measured in well MW-4 at a thickness of 0.14 ft and in MW-8 at a thickness of 0.05 ft. Less than 0.01 ft of product (trace) was measured in wells MW-9 and MW-13. "Trace" product measurements are not reliable, and may or may not be an indicator of free product in wells. Free product was not observed in MW-6, MW-7, MW-10, MW-11, MW-12, MW-14, MW-15 or MW-16.

EA collected groundwater samples from MW-6, MW-9, MW-10, MW-13, and MW-15 in accordance with the Sampling and Analysis Plan (SAP)[1], using a peristaltic pump and low-flow sampling procedures. Wells with 0.02 ft or more of free product were not sampled. The tubing intake was placed approximately five feet off the bottom of the well during sampling.

Groundwater was purged at a rate of 300-500 milliliters per minute. Groundwater quality parameters were measured every three minutes during purging until parameters stabilized. Groundwater samples were then collected. A duplicate sample was collected from MW-6 (CK-MW6D). Table 1 summarizes monitoring well construction information, water level measurements, and field parameter measurements obtained after the readings stabilized. A site map with monitoring well locations is attached as Figure 1.

In accordance with the SAP, groundwater samples were submitted for laboratory analysis of diesel range organics (DRO); lube oil range organics (LRO); gasoline range organics (GRO); benzene, toluene, ethylbenzene, and xylenes (BTEX); and lead. Groundwater purged during monitoring well sampling was contained in a 55-gallon drum within the fenced enclosure at the rear of the Jays Cleaners/Mont's Market building.

[1] EA Engineering, Science, and Technology, Inc. 2006. Sampling and Analysis Plan for Amendment No. 2, Revision 1, Work Order #17079, Contract Number: 30700. March.

INTERIM
RW - 3/20/09

2.0 GROUNDWATER MONITORING RESULTS

Laboratory results for monitoring well groundwater samples are attached and are summarized in Table 2, along with prior sampling results. GRO, DRO, LRO and benzene concentrations for the May 2006 sampling event are also listed on Figure 1. Following is a general discussion of the findings.

- Results for the sample and duplicate sample collected from MW-6 were below the laboratory reporting limits for all analytes except benzene at 0.514 micrograms per liter (µg/L) and ethylbenzene at 1.48 µg/L.

- Analytical results for the groundwater sample collected from MW-9 were above the laboratory reporting limits for GRO, DRO and BTEX. Constituents detected at concentrations above the MTCA Method A criteria were: benzene (535 µg/L), toluene (2,300 µg/L), ethylbenzene (1,730 µg/L), xylenes (8,390 µg/L), GRO (52,200 µg/L), and DRO (2,530 µg/L).

- Analytical results for the groundwater samples from MW-10 were below the laboratory reporting limits for all analytes.

- Analytical results for the groundwater sample collected from MW-13 were above the laboratory reporting limits for GRO, DRO and BTEX. Constituents detected at concentrations above the MTCA Method A criteria were: benzene (7,260 µg/L), toluene (14,700 µg/L), ethylbenzene (1,810 µg/L), xylenes (15,500 µg/L), GRO (109,000 µg/L), and DRO (4,650 µg/L).

- Results for MW-15 were below MTCA Method A cleanup criteria for all constituents analyzed. DRO and LRO were not detected above laboratory reporting limits. Constituents detected in the sample from MW-15 were: benzene (0.791 µg/L), toluene (1.69 µg/L), ethylbenzene (0.816 µg/L), xylenes (5.82 µg/L), and GRO (381 µg/L).

3.0 DISCUSSION AND CONCLUSIONS

Results of the May 2006 sampling event are generally consistent with previous results.

During the May sampling event, analytical results for samples collected from MW-6 and MW-10 were below MTCA cleanup levels, defining the contaminant plume on the east. DRO and GRO contamination exceeding the MTCA Method A cleanup limits was found in wells MW-9 and MW-13. Additionally, free product was detected in MW-4 and MW-8. It should be noted that all DRO detections were described by the laboratory as primarily due to overlap from a gasoline-range product. The benzene and toluene concentrations in MW-13, observed to decline slightly during the February 2006 sampling event, have rebounded to levels observed in June 2005.

A groundwater contour map for May 2006 is provided on Figure 1. No dominant groundwater flow direction is apparent at the site.

Please feel free to contact me at (425) 451-7400 if you have any questions about the enclosed.

Sincerely,
EA ENGINEERING, SCIENCE,
AND TECHNOLOGY, INC.

Jil Frain, P.E.
Project Manager
jfrain@eaest.com

Attachments:

Figure 1 – Site Map with Groundwater Elevations and Contour Lines – Circle K Station #1461
Figure 2 – Site Map with Groundwater Monitoring Results – Circle K Station #1461
Table 1 – Monitoring Well Construction and Field Measurement Data – Circle K Station #1461
Table 2 – Summary of Groundwater Analytical Data – Circle K Station #1461
Appendix A – Purge and Sampling Forms
Appendix B – Laboratory Reports

Figures

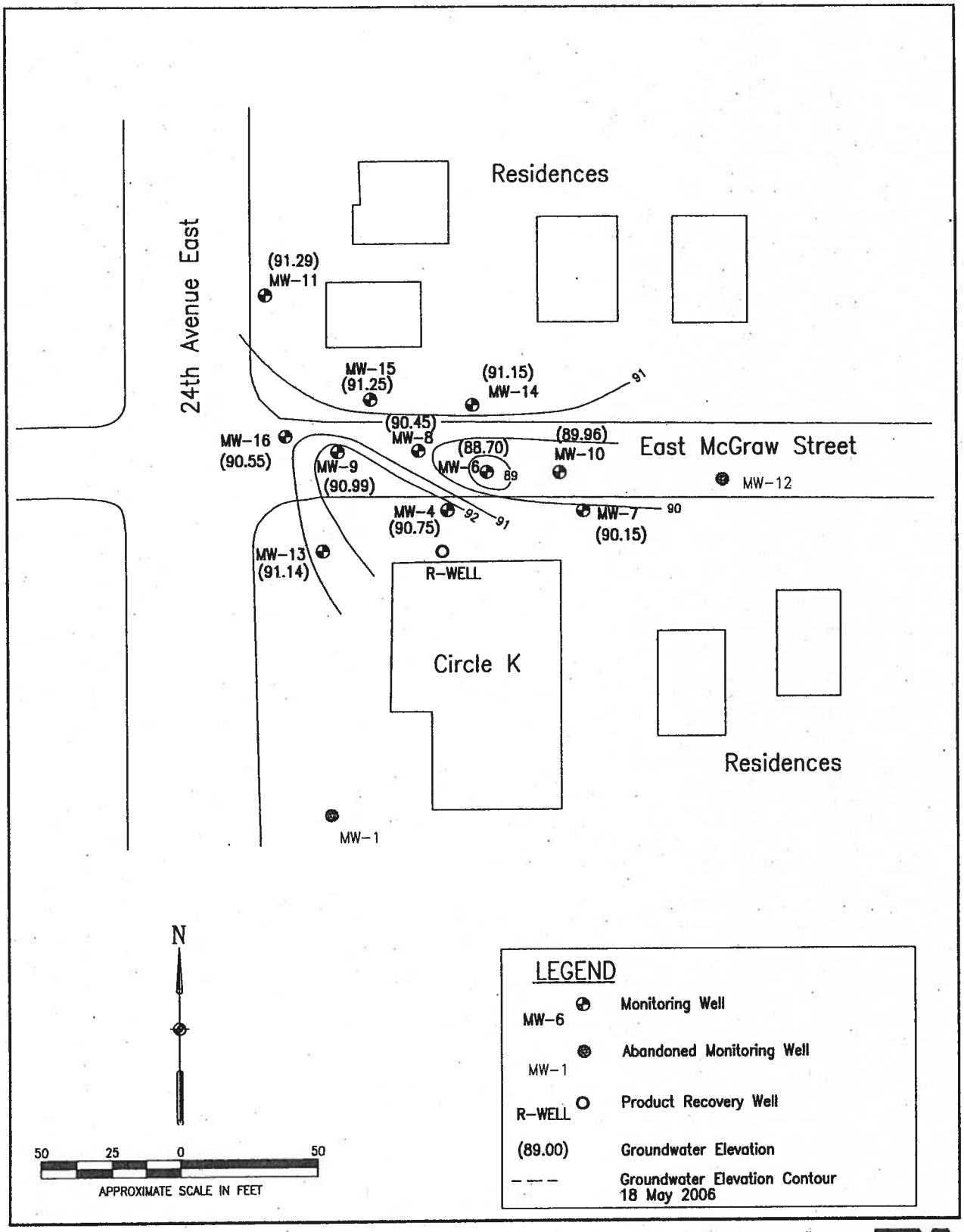

Figure 1. Site Map with Groundwater Elevations and Contour Lines – Circle K Station #1461

G:\Projects\61994.01 2006_2007 Ecology LUST Sites\Circle K\May 2006 GW Report\Fig1 May06 GW Elevations.dwg, Model, 8/14/2006 10:30:59 AM

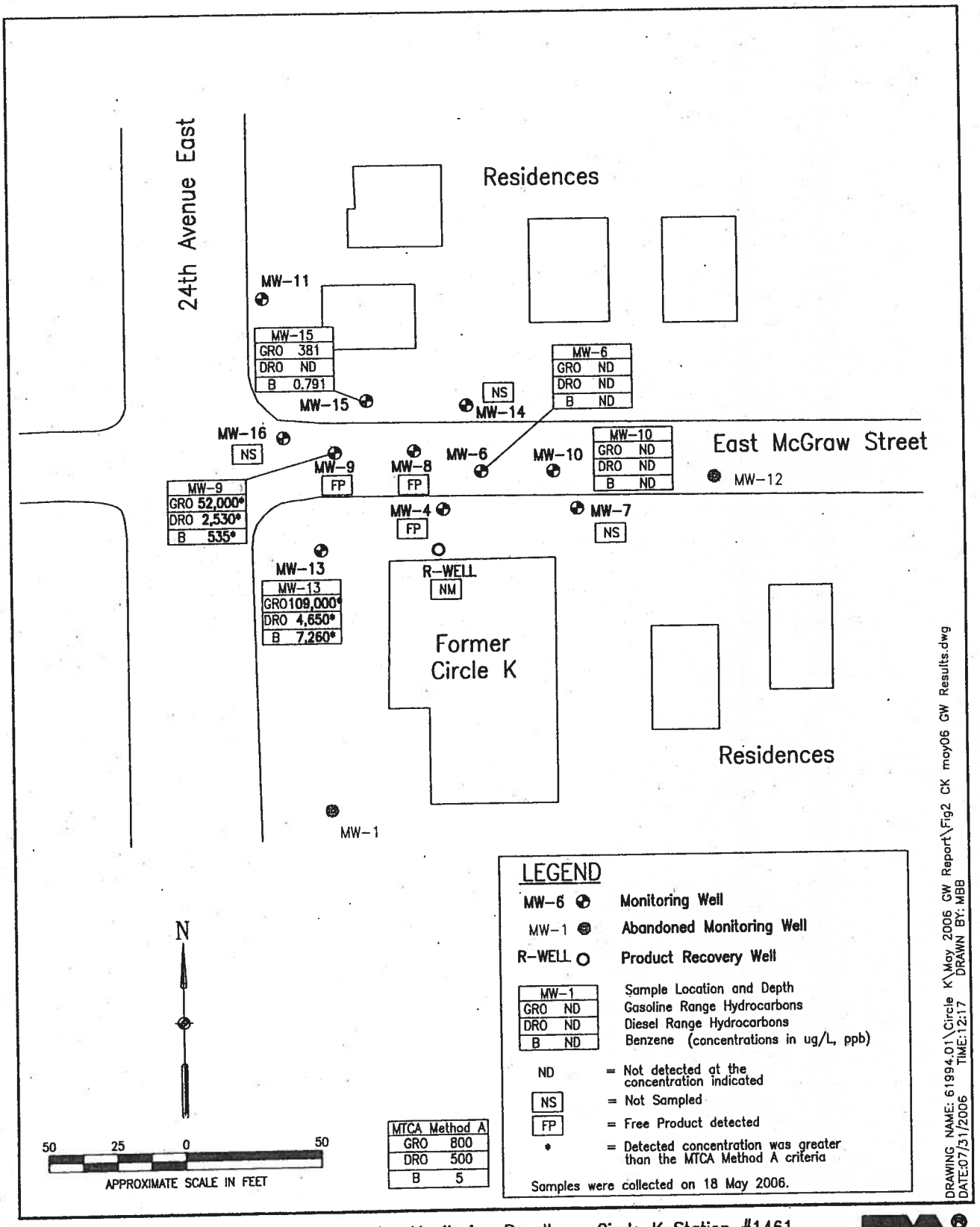

Figure 2. Site Map with Groundwater Monitoring Results – Circle K Station #1461

Tables

TABLE 1. MONITORING WELL CONSTRUCTION AND FIELD MEASUREMENT DATA
CIRCLE K STATION #1461

Well ID	Date Installed	Well Diameter (inches)	Reported Screen Depth (ft bgs)	Total Depth (ft btoc)	Top of Casing Elevation (ft)	Depth to Water 18-May-06 (ft btoc)	Depth to Product 18-May-06 (ft btoc)	Groundwater Elevation 18-May-06 (ft)
MW-4	9/12/1989	2	4 - 18.5	17.90	100.73	10.12	9.98	90.75
MW-6	10/2/1989	2	5 - 20	20.43	100.24	11.54	NA	88.70
MW-7	10/2/1989	2	5 - 20	20.49	99.75	9.6	NA	90.15
MW-8	10/3/1989	2	5 - 20	19.45	100.70	10.25	10.20	90.45
MW-9	10/3/1989	2	5 - 21	20.35	101.41	10.42	trace	90.99
MW-10	10/3/1989	2	5 - 20	20.47	99.96	10.00	NA	89.96
MW-11	10/4/1989	2	5 - 20	20.31	100.89	9.6	NA	91.29
MW-12	10/4/1989	2	5 - 20	abandoned	abandoned	NA	NA	NA
MW-13	12/20/1989	2	4 - 19	18.81	102.19	11.05	trace	91.14
MW-14	12/20/1989	2	4 - 19	18.87	100.40	9.25	NA	91.15
MW-15	12/21/1989	2	4 - 18.5	16.81	101.29	10.04	NA	91.25
MW-16	12/21/1989	2	4 - 19	18.94	101.15	10.60	NA	90.55

Well ID	Date Measured	Water Quality Parameters					
		pH	Conductivity (mS/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
MW-6	5/18/2006	7.13	58.9	15.7	0.50	14.9	-112
MW-9	5/18/2006	6.58	61.8	75.6	0.20	16.0	-132
MW-10	5/18/2006	6.95	51.0	13.8	0.40	16.2	30
MW-13	5/18/2006	6.57	57.2	4.0	0.30	15.7	-125
MW-15	5/18/2006	5.62	18.4	2.5	0.20	15.3	-110

NOTES:

°C = degrees Celsius.
ft bgs = feet below ground surface.
ft btoc = feet below top of casing.
Top-of-casing elevation data are from INCA Engineers (22 March 2006).

NA = Not applicable.
NTUs = Nephelometric turbidity units.
mS/cm = milliSiemans per centimeter.

mg/L = milligrams per liter.
mV = milliVolts

TABLE 2. SUMMARY OF GROUNDWATER ANALYTICAL DATA
CIRCLE K STATION #1461

Well ID	Date Sampled	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (total) (ug/L)	GRO (ug/L)	DRO (ug/L)	LRO (ug/L)	MTBE (ug/L)	Lead (mg/L)	Free Product
CK-MW4	4/11/2001	7,370	28,000	2,680	17,100	117,000	NA	NA	NA	NA	Yes
	6/23/2005	240	3,750	1,640	10,700	65,600	1,870 D-08	500 U	50.0 U	NA	?
	2/14/2006	Not Sampled - Free product measured in well									Yes
	5/18/2006	Not Sampled - Free product measured in well									Yes
CK-MW6	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	1.0 U	NA	No
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	1.0 U	NA	NA	NA	NA	No
	2/14/2006	0.982	0.5 U	3.84	7.13	67.5	243 U	485 U	NA	0.001 U	No
	5/18/2006	0.514	0.5 U	1.48	1.00 U	50.0 U	243 U	485 U	NA	NA	No
	5/18/2006*	0.500 U	0.5 U	1.28	1.00 U	50.0 U	240 U	481 U	NA	NA	No
CK-MW8	4/11/2001	802	9770	1520	7030	46,400	NA	NA	NA	NA	Yes
	2/14/2006	342	143,000	2,670	14,800	102,000	2,390 D-08	472 U	NA	NA	Yes
	2/14/2006*	452	14,000	2,770	14,900	89,000	2,230 D-08	472 U	NA	NA	
	5/18/2006	Not Sampled - Free product measured in well									Yes
CK-MW9	4/11/2001	420	2,310	1,500	7,350	35,400	NA	NA	NA	NA	Yes
	6/23/2005	1,820	6,140	1,820	9,360	71,300	1,810 D-08	500 U	200 U	NA	?
	2/14/2006	Not Sampled - Free product measured in well									Yes
	5/18/2006	535	2,300	1,730	8,390	52,200	2,530 D-08	485 U	NA	NA	?
CK-MW10	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	NA	NA	No
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	1.0 U	NA	No
	5/18/2006	0.5 U	0.5 U	0.5 U	1.0 U	50.0 U	236 U	472 U	NA	NA	No
CK-MW11	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	1.0 U	NA	No
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	NA	NA	No
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	240 U	481 U	NA	0.01580	No
CK-MW13	4/11/2001	Not Sanpled									NA
	6/16/2003	Not Sampled - Free product measured in well									Yes
	6/23/2005	8,560	16,800	1,920	12,900	115,000	3,720 D-08	500 U	50.0 U	NA	No
	6/23/2005*	8,560	16,900	1,880	12,700	121,000	3,010 D-08	500 U	50.0 U	NA	No
	2/14/2006	2,270	6,660	1,530	14,100	74,700	3,010 D-08	472 U	NA	NA	?
	5/18/2006	7,260	14,700	1,810	15,500	109,000	4,650 D-08	481 U	NA	NA	?
CK-MW14	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	1.0 U	NA	No
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	1.0 U	NA	NA	NA	NA	No
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	243 U	485 U	NA	0.001 U	?
CK-MW15	4/11/2001	58.4	310.0	526.0	2,920.0	23,800	NA	NA	NA	NA	No
	6/16/2003	6.2	83.3	12.6	199.0	3,150	NA	NA	15.5	NA	No
	5/31/2005	1.26	0.500 U	2.60 I-06	3.39 I-06	878	NA	NA	1.00 U	0.001 U	No
	6/23/2005	2.01	3.18	2.48	6.34	950	749 D-08	500 U	1.00 U	NA	No
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	137	552	472 U	NA	0.001 U	No
	5/18/2006	0.791	1.69	0.816	5.82	381	236 U	472 U	NA	NA	No
CK-MW16	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	NA	NA	No
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	1.0 U	NA	No
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	50.00 U	236 U	472 U	NA	0.001 U	?
MTCA Method A		5	1,000	700	1,000	800/1,000	500	500	20	0.015	

NOTES:

Sample results from 2001 and 2003 provided by Washington Department of Ecology

Shaded cells indicate the results exceed the cleanup criteria.

* Duplicate sample.

MTCA Method A cleanup level for gasoline is 800 ug/L instead of 1,000 ug/L when benzene is present.

U = Not detected at or above the specified reporting limit.

D-08 = Results in the diesel organics range are primarily due to overlap from a gasoline range product.

I-06 = The analyte concentration may be artificially elevated due to coeluting compounds or components.

DRO = Diesel range organics.

GRO = Gasoline range organics.

LRO = Lube-oil range organics.

ug/L = micrograms per liter.

mg/L - milligrams per liter

NA = not analyzed

? = "trace" product -<0.01 ft free product in well

Release ID#: 1548
Seattle

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11 May 2006
61994.01 LN0014

Mr. Roger Nye
Washington Department of Ecology
Toxics Cleanup Program
3190 – 160th Avenue Southeast
Bellevue, Washington 98008-5452

RE: Circle K Station #1461 Groundwater Monitoring Data Summary
Work Order #17079, Contract Number: 30700

Dear Mr. Nye:

This letter provides a short summary of the results from the groundwater sampling event conducted on 14 February 2006 at Circle K Station #1461, in the Montlake area of Seattle.

1.0 FIELD ACTIVITIES

On 14 February 2006, EA Engineering, Science and Technology, Inc. (EA) personnel gauged all monitoring wells at the site for the presence of free product. Free product was measured in well MW-4 and MW-9 at a thickness of 0.02 ft. Less than 0.01 ft of product (trace) was measured in MW-7, MW-8, MW-10, MW -13, MW-14 and MW-16. "Trace" product measurements are not reliable, and may or may not be an indicator of free product in wells. Free product was not observed in MW-6, MW-11 or MW-15.

EA collected groundwater samples from MW-6, MW-8, MW-11, MW-13, MW-14, MW-15, and MW-16, as required in the Sampling and Analysis Plan (SAP) using a peristaltic pump and low-flow sampling procedures. Wells with 0.02 ft or more of free product were not sampled. The tubing intake was generally placed mid-screen or approximately four feet off the bottom of the well.

A peristaltic pump was used to purge groundwater at a rate of 300-500 milliliters per minute. Groundwater quality parameters were measured every three minutes during purging until parameters stabilized. Groundwater samples were then collected. A duplicate sample was collected from MW-8 (CK-MW8D). Table 1 summarizes monitoring well construction information, water level measurements, and field parameter measurements obtained after the readings stabilized. A site map with monitoring well locations is attached as Figure 1.

In accordance with the SAP, groundwater samples were collected for laboratory analysis. The analyses conducted were diesel range organics (DRO); lube oil range organics (LRO); gasoline range organics (GRO); benzene, toluene, ethylbenzene, and xylenes (BTEX); and lead. Groundwater purged during monitoring well sampling was contained in a 50-gallon drum onsite within the fenced enclosure at the rear of the Jays Cleaners/Mont's Market building.

On 22 March 2006, elevations of site monitoring wells were surveyed by INCA Engineers. Additional site features were also surveyed to aid in the preparation of a site map. Minor corrections were made to

6 of the 11 monitoring well elevations listed on Table 1. The largest change of 0.02 feet was recorded for wells MW-11 and MW-15.

2.0 GROUNDWATER MONITORING RESULTS

Analytical results for the groundwater samples from MW-14 and MW-16 were below the laboratory detection limits for all analytes. The lead results for the sample from MW-11 of 0.0158 mg/L slightly exceeded the Method A cleanup criteria of 0.015 mg/L. Other analytes were not detected in the sample. Contaminant concentrations detected in groundwater samples collected from MW8 and MW-13 exceeded Method A cleanup criteria for DRO, GRO, and BTEX constituents. Detected concentrations of GRO and some BTEX constituents in groundwater samples from MW-6 and MW-15 did not exceed Method A cleanup criteria.

Analytical results for groundwater samples are attached and are summarized in Table 2. Following is a general discussion of the findings.

3.0 DISCUSSION AND CONCLUSIONS

Using the revised elevations of the on site wells, the groundwater surface was contoured. The results do not suggest a strong groundwater gradient, in fact, it appears that groundwater flows into the area around MW-6. Removing MW-6 from the contour map does not change this general result. We have attached an approximated, freehand sketch of the suspected groundwater gradient (Figure 1).

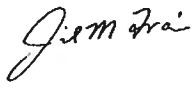
During the February sampling event, DRO and GRO contamination exceeding the MTCA Method A cleanup limits was found in wells MW-8, MW-13 and MW-15. Due to the presence of free product in MW-4 and MW-9, it can be presumed that groundwater concentrations in these wells also exceed the cleanup limits. In general, it appears that the contamination at the Montlake Circle K Site remains within the same wells, at approximately the same concentrations as in prior sampling events. The only exception was a decline (by approximately 60%) of benzene and toluene concentrations in MW-13.

Based on these results, and the fact that the groundwater appears not to be migrating, we recommend discontinuing sampling at MW-11, MW-16 and MW-14. Petroleum contamination has not been detected in any of these wells during sampling by EA, or by other contractors during prior sampling events. We do recommend sampling MW-10 during the next quarterly sampling round as a means to bound contamination on the east.

Please feel free to contact me at (425) 451-7400 if you have any questions about the enclosed.

Sincerely,

EA ENGINEERING, SCIENCE,
AND TECHNOLOGY, INC.



Jil Frain, P.E.
Project Manager
jfrain@eaest.com

Attachments:

Figure 1 – Site Map with Groundwater Elevations and Flow Direction – Montlake Circle K
Table 1 – Monitoring Well Construction and Field Measurement Data
Table 2 – Summary of Groundwater Analytical Data
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Attachment B – Laboratory Reports

Figures

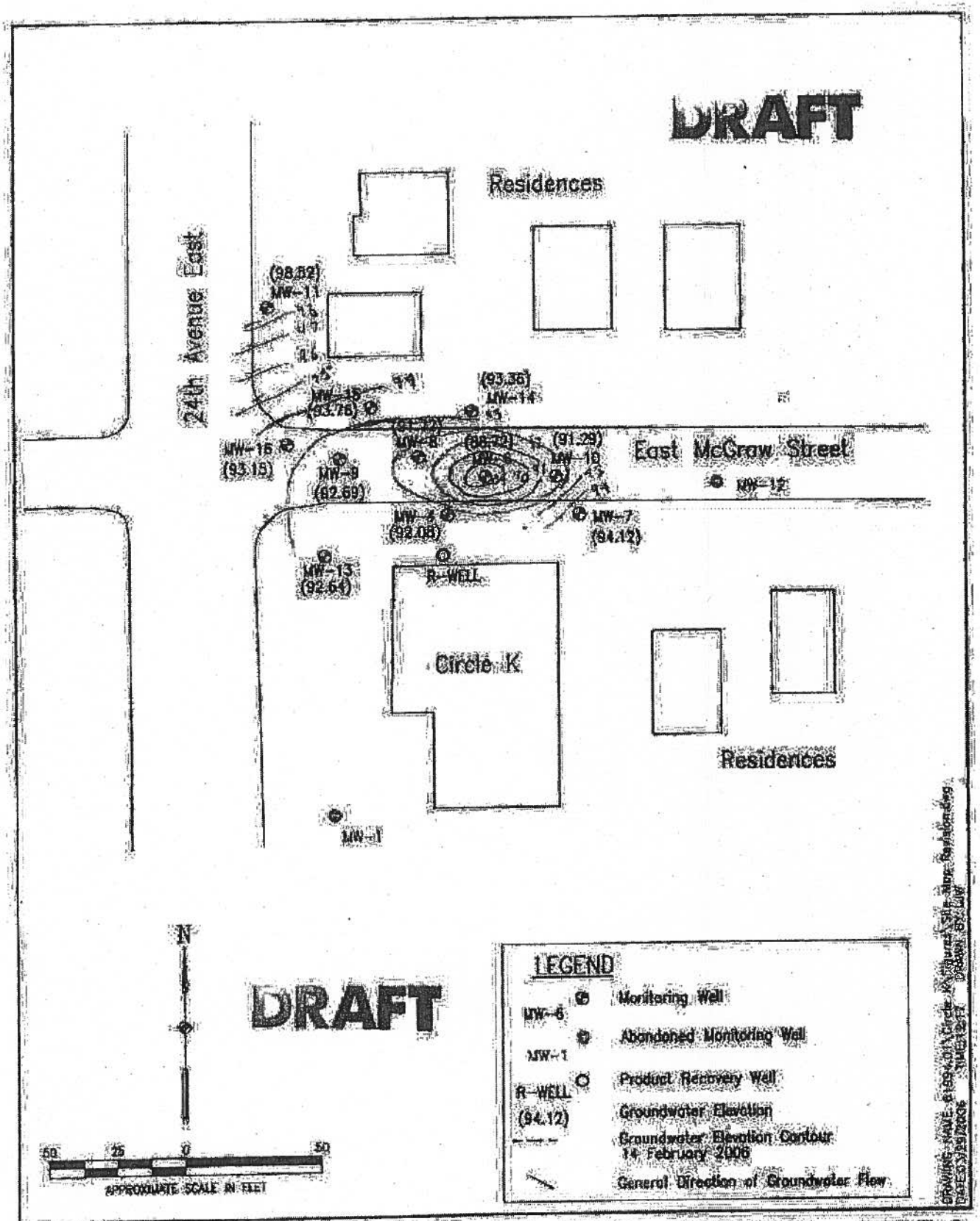

Figure 1: Site Map with Groundwater Elevations and Flow Direction – Montlake Circle K

Tables

TABLE 1. CIRCLE K STATION #1461

Well ID	Date Installed	Well Diameter (inches)	Reported Screen Depth (ft bgs)	Measured Total Depth 14-Feb-06 (ft btoc)	Top of Casing Elevation (ft)	Depth to Water 14-Feb-06 (ft btoc)	Depth to Product 14-Feb-06 (ft btoc)	Groundwater Elevation 14-Feb-06 (ft)
MW-4	9/12/1989	2	4 - 18.5	17.90	100.73	8.65	8.63	92.1*
MW-6	10/2/1989	2	5 - 20	20.44	100.24	11.52	NA	88.72
MW-7	10/2/1989	2	5 - 20	20.49	99.75	5.63	trace	94.12
MW-8	10/3/1989	2	5 - 20	19.45	100.70	8.98	trace	91.72
MW-9	10/3/1989	2	5 - 21	20.35	101.41	8.72	8.70	92.71*
MW-10	10/3/1989	2	5 - 20	20.47	99.96	8.67	trace	91.29
MW-11	10/4/1989	2	5 - 20	20.31	100.89	2.37	NA	98.52
MW-12	10/4/1989	2	5 - 20	abandoned	abandoned	NA	NA	NA
MW-13	12/20/1989	2	4 - 19	18.81	102.19	9.55	trace	92.64
MW-14	12/20/1989	2	4 - 19	18.87	100.40	7.04	7.04	93.36
MW-15	12/21/1989	2	4 - 18.5	16.81	101.29	7.53	NA	93.76
MW-16	12/21/1989	2	4 - 19	18.94	101.15	8.00	trace?	93.15

Well ID	Date Measured	Water Quality Parameters					
		pH	Conductivity (mS/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
MW-6	2/14/2006	6.75	0.438	45	0.94	12.0	-77
MW-8	2/14/2006	6.11	0.388	8	0.29	12.8	-55
MW-11	2/14/2006	5.31	0.093	13	0.27	11.4	6
MW-13	2/14/2006	6.16	0.406	1	0.38	12.9	-84
MW-14	2/14/2006	6.18	0.292	18	0.42	11.9	111
MW-15	2/14/2006	4.92	0.110	9	1.07	11.3	233
MW-16	2/14/2006	6.09	0.329	19	1.45	12.7	95

NOTES:

°C = degrees Celsius.
ft bgs = feet below ground surface.
ft btoc = feet below top of casing.
NA = Not applicable.
NTUs = Nephelometric turbidity units.
mS/cm = milliSiemans per centimeter.
mg/L = milligrams per liter.
mV = milliVolts

TABLE 2. SUMMARY OF GROUNDWATER ANALYTICAL DATA, CIRCLE K STATION

Well ID	Date Sampled	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (total) (ug/L)	GRO (ug/L)	DRO (ug/L)	LRO (ug/L)	MTBE (ug/L)	Lead (mg/L)	Free Product
CK-MW-4	4/11/2001	7,370	28,000	2,680	17,100	117,000	NA	NA	NA	NA	Yes
	6/23/2005	240	3,750	1,640	10,700	65,600	1,870 D-08	500 U	50.0 U	NA	?
	2/14/2006	Not Sampled - Free product measured in well									Yes
CK-MW-6	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	1.0 U	NA	No
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	1.0 U	NA	NA	NA	NA	No
	2/14/2006	0.982	0.5 U	3.84	7.13	67.5	243 U	485 U	NA	0.001 U	No
CK-MW-8	4/11/2001	802	9770	1520	7030	46,400	NA	NA	NA	NA	Yes
	2/14/2006	342	143,000	2,670	14,800	102,000	2,390 D-08	472 U	NA	NA	Yes
	2/14/2006 Dup	452	14,000	2,770	14,900	89,000	2,230 D-08	472 U	NA	NA	?
CK-MW-9	4/11/2001	420	2,310	1,500	7,350	35,400	NA	NA	NA	NA	Yes
	6/23/2005	1,820	6,140	1,820	9,350	71,300	1,810 D-08	500 U	200 U	NA	?
	2/14/2006	Not Sampled - Free product measured in well									Yes
CK-MW-11	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	1.0 U	NA	No
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	NA	NA	No
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	240 U	481 U	NA	0.01580	No
CK-MW-13*	6/23/2005	8,560	16,800	1,920	12,900	115,000	3,720 D-08	500 U	50.0 U	NA	No
	6/23/2005 Dup	8,560	16,900	1,880	12,700	121,000	3,010 D-08	500 U	50.0 U	NA	No
	2/14/2006	2,270	6,660	1,530	14,100	74,700	3,010 D-08	472 U	NA	NA	?
CK-MW-14	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	1.0 U	NA	No
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	1.0 U	NA	NA	NA	NA	No
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	243 U	485 U	NA	0.001 U	?
CK-MW-15	4/11/2001	58.4	310.0	526.0	2,920.0	23,800	NA	NA	NA	NA	No
	6/16/2003	6.2	83.3	12.6	199.0	3,150	NA	NA	15.5	NA	No
	5/31/2005	1.26	0.500 U	2.60 I-06	3.39 I-06	878	NA	NA	1.00 U	0.001 U	No
	6/23/2005	2.01	3.18	2.48	6.34	950	749 D-08	500 U	1.00 U	NA	No
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	137.00	236 U	472 U	NA	0.001 U	No
CK-MW-16	4/11/2001	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	NA	NA	No
	6/16/2003	0.5 U	0.5 U	0.5 U	1.0 U	0.05 U	NA	NA	1.0 U	NA	No
	2/14/2006	0.5 U	0.5 U	0.5 U	1.0 U	50.00 U	236 U	472 U	NA	0.001 U	?
MTCA Method A		5	1,000	700	1,000	800/1,000	500	500	20	0.015	

NOTES:

Sample results from 2001 and 2003 provided by Washington Department of Ecology

Shaded cells indicate the results exceed the cleanup criteria.

* Sample CK-MW-13D is a duplicate of CK-MW-13.

MTCA Method A cleanup level for gasoline is 800 ug/L instead of 1,000 ug/L when benzene is present.

U = Not detected at or above the specified reporting limit.

D-08 = Results in the diesel organics range are primarily due to overlap from a gasoline range product.

I-06 = The analyte concentration may be artificially elevated due to coeluting compounds or components.

DRO = Diesel range organics.

GRO = Gasoline range organics.

LRO = Lube-oil range organics.

ug/L = micrograms per liter.

mg/L - milligrams per liter

NA = not analyzed

? = "trace" product ~<0.01 ft free product in well

Release ID #: 1548
Seattle

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16 February 2006
61994.01 LN0006

Mr. Roger Nye
Washington Department of Ecology
Toxics Cleanup Program
3190 – 160th Avenue Southeast
Bellevue, Washington 98008-5452

RE: Circle K Station #1461 Groundwater Data Summary
Work Order #17079, Contract Number: 30700

Dear Mr. Nye:

Enclosed is a summary of the analytical results from groundwater samples collected during May and June 2005 at Circle K Station #1461, in the Montlake area of Seattle (Table A). Results for the one sample collected in May (from well MW-15) were available and were presented in the Investigation Report submitted in June 2005, however results for the samples collected in June (from wells MW-4, MW-9, MW-13, and MW-15) were received after the due date for that report. A copy of a site figure is attached to show well locations.

As described in the Investigation Report, on 23 June 2005, two weeks after performance of an Enhanced Fluid Recovery (EFR) test at the site, the five monitoring wells within the plume boundaries (MW-4, MW-8, MW-9, MW-13, and MW-15) were gauged for the presence of free product. Free product was measured in well MW-8 at a thickness of 0.01 ft. Less than 0.01 ft of product (trace) was measured in MW-4 and MW-9. Free product was not observed in MW-13 or MW-15. Monitoring wells with less than 0.01 ft of free product were sampled.

Gasoline-range organics (GRO) concentrations in all four wells sampled exceeded the Model Toxics Control Act (MTCA) cleanup criterion of 800 micrograms per liter (µg/L). Diesel-range organics (DRO) concentrations in all four wells also exceeded the MTCA cleanup criterion of 500 µg/L. However, the laboratory noted that "results in the diesel organics range are primarily due to overlap from a gasoline range product." Benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations exceeded the MTCA cleanup criteria in the samples from wells MW-4, MW-9, and MW-13. No lube-oil range organics (LRO) or methyl tertiary-butyl ether (MTBE) was detected in any of the samples. Detection limits for LRO and MTBE were generally elevated due to the high concentrations of other petroleum constituents in the samples. The detection limit for MTBE exceeded the MTCA cleanup criterion for all samples except that from well MW-15. Although MTBE was detected in the sample from MW-15 using EPA Method 8021B, it was not confirmed when the sample was run by EPA Method 8260B.

A comparison to historical data provided in the Department of Ecology's 2003 summary table (Attached, labeled Table 1), as well as field measurement data collected by EA Engineering in May 2005, indicates the following:

2/21/06

- MW-4 – In 2001 and 2003 this well contained less than 0.1 ft of free product. In May 2005, before the EFR test, the measured free product thickness was 0.3 ft. Following the EFR test, only a trace of free product was detected. The well was sampled in April 2001; concentrations of GRO and BTEX have decreased since that time.

- MW-8 – In 2001 and 2003 this well contained 0.1 ft of free product. In May 2005, before the EFR test, only a trace of free product was detected in the well. Following the EFR test, 0.01 ft of free product was detected.

- MW-9 – In 2001 and 2003 this well contained 0.01 to 0.02 ft of free product. In May 2005, before the EFR test, 0.02 ft of free product was detected in the well. Following the EFR test, a trace of free product was detected. The well was previously sampled in April 2001; concentrations of GRO and BTEX have increased since that time.

- MW-13 – In 2003, this well contained 0.02 ft of free product. In May 2005, 0.01 ft of free product was detected. Following the EFR test, no free product was detected. No water quality data were provided for 2001 or 2003; therefore, no comparison can be done.

- MW-15 – In 2001, 0.01 ft of free product was present. No free product was detected in 2003. No free product was detected in May or June 2005. The well was previously sampled in 2001 and 2003; concentrations of GRO and BTEX have decreased from each sampling event to the next.

Wells MW-6, MW-8, MW-11, MW-13, MW-14, MW-15, and MW-16 were sampled on 14 February 2006. Wells MW-4 and MW-9 had 0.02 ft of free product, and were therefore not sampled. Results of that sampling will be provided to you in March.

Please feel free to contact me at (425) 451-7400 if you have any questions about the enclosed.

Sincerely,

EA ENGINEERING, SCIENCE,
AND TECHNOLOGY, INC.

Jil Frain

Jil Frain, P.E.
Project Manager
jfrain@eaest.com

TABLE A. SUMMARY OF GROUNDWATER ANALYTICAL DATA, CIRCLE K STATION

Well ID	Date Sampled	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (total) (ug/L)	GRO (ug/L)	DRO (ug/L)	LRO (ug/L)	MTBE (ug/L)	Lead (mg/L)
CK-MW-4	6/23/2005	**240**	**3,750**	**1,640**	**10,700**	**65,600**	**1,870 D-08**	500 U	50.0 U	NA
CK-MW-9	6/23/2005	**1,820**	**6,140**	**1,820**	**9,350**	**71,300**	**1,810 D-08**	500 U	200 U	NA
CK-MW-13*	6/23/2005	**8,560**	**16,800**	**1,920**	**12,900**	**115,000**	**3,720 D-08**	500 U	50.0 U	NA
CK-MW-13D*	6/23/2005	**8,560**	**16,900**	**1,880**	**12,700**	**121,000**	**3,010 D-08**	500 U	50.0 U	NA
CK-MW-15	5/31/2005	1.26	0.500 U	2.60 I-06	3.39 I-06	**878**	NA	NA	1.00 U	0.00100 U
CK-MW-15	6/23/2005	2.01	3.18	2.48	6.34	**950**	**749 D-08**	500 U	1.00 U	NA
MTCA Method A Cleanup Criteria		5	1,000	700	1,000	800/1,000	500	500	20	0.015

NOTES:

Shaded cells indicate the results exceed the cleanup criteria.

* Sample CK-MW-13D is a duplicate of CK-MW-13.

DRO = Diesel range organics.

GRO = Gasoline range organics.

LRO = Lube-oil range organics.

ug/L = micrograms per liter.

mg/L - milligrams per liter

MTCA Method A cleanup level for gasoline is 800 ug/L instead of 1,000 ug/L when benzene is present.

NA = not analyzed

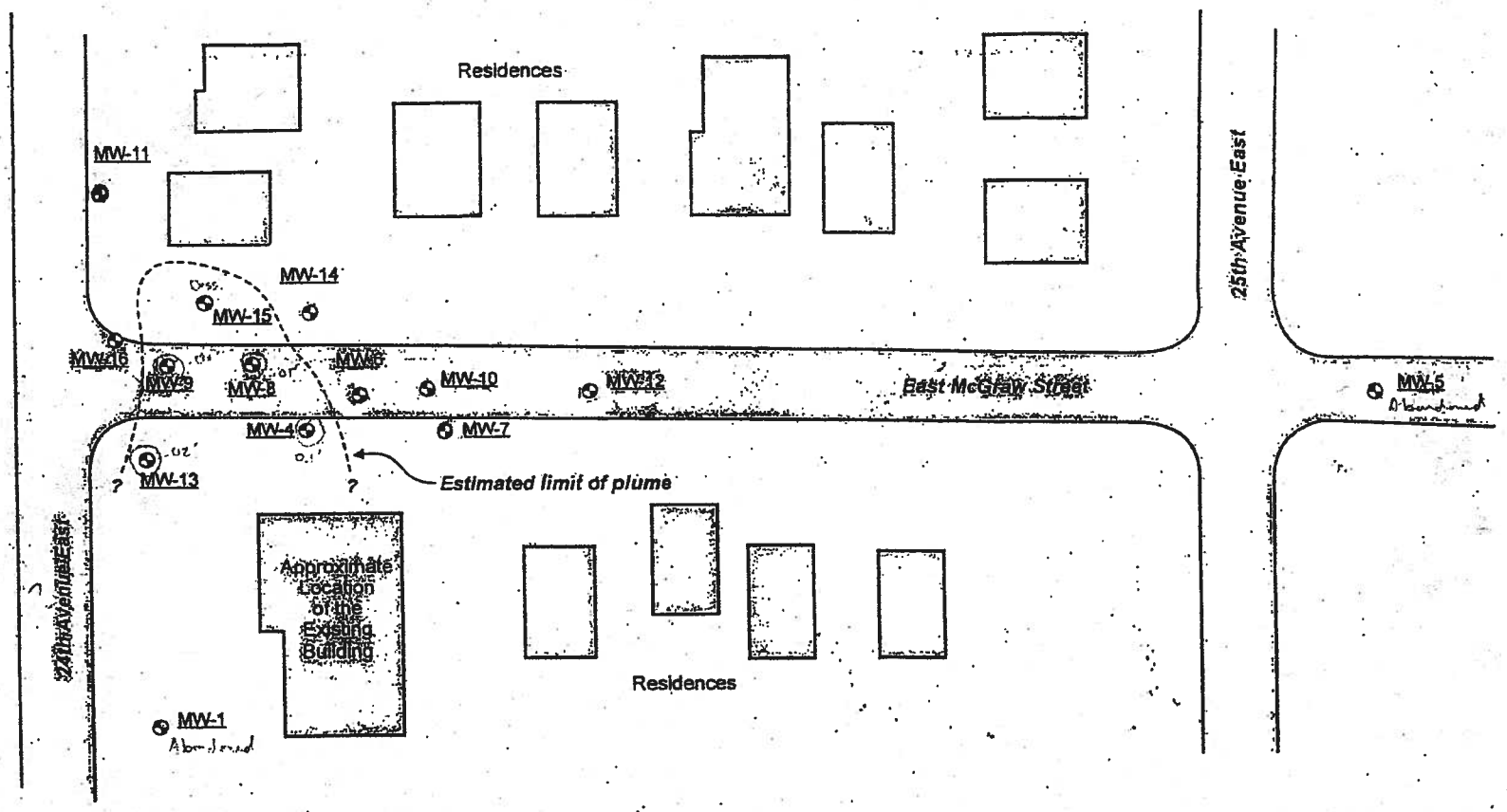
U = Not detected at or above the specified reporting limit.

D-08 = Results in the diesel organics range are primarily due to overlap from a gasoline range product.

I-06 = The analyte concentration may be artificially elevated due to coeluting compounds or components.

At the time of sampling, MW-4 and MW-9 contained a trace (<0.01 inch) of free product. MW-13 and MW-15 had no observed free product.

61994.01-6000-B



O = free product

N

0 50 100 feet

Locations of All Features Shown Are Approximate

Former Circle K
Montlake Area
Seattle, Washington

Pinnacle GeoSciences

TABLE 1 (page 1 of 2)
SUMMARY OF GROUND WATER FIELD DATA
MONTLAKE CIRCLE K
SEATTLE, WASHINGTON

Monitoring Well Number	Date Measured	Casing Rim Elevation [1] (feet)	Depth to Water [2] (feet)	Depth to Product [2] (feet)	Ground Water Elevation [1] (feet)	Corrected Elevation [3] (feet)	Change in Elevation [4] (feet)
MW-1	11-Apr-01	100.94	12.62	--	88.32		--
	16-Jun-03	103.25	12.13	--	91.12		
	11-Jul-03	103.25	12.34	--	90.91		
MW-4	11-Apr-01	98.38	10.23	10.20	88.15	88.18	--
	16-Jun-03	100.73	10.56	10.47	90.17	90.25	
	11-Jul-03	100.73	10.72	10.62	90.01	90.10	
MW-5	11-Apr-01	90.94	9.97	--	80.97		--
	16-Jun-03	93.34	10.95	--	82.39		
	11-Jul-03	93.34	11.31	--	82.03		
MW-6	11-Apr-01	97.92	11.57	--	86.35		--
	16-Jun-03	100.25	11.63	--	88.62		
	11-Jul-03	100.25	11.63	--	88.62		
MW-7	11-Apr-01	97.43	8.15	--	89.28		--
	16-Jun-03	99.75	10.38	--	89.37		
	11-Jul-03	99.75		--	99.75		
MW-8	11-Apr-01	98.36	10.18	10.17	88.18	88.19	--
	16-Jun-03	100.70	10.68	10.67	90.02	90.03	
	11-Jul-03	100.70	10.87	10.86	89.83	89.84	

TABLE 1 (page 2 of 2)
SUMMARY OF GROUND WATER FIELD DATA
MONTLAKE CIRCLE K
SEATTLE, WASHINGTON

Monitoring Well Number	Date Measured	Casing Rim Elevation [1] (feet)	Depth to Water [2] (feet)	Depth to Product [2] (feet)	Ground Water Elevation [1] (feet)	Corrected Elevation [3] (feet)	Change in Elevation [4] (feet)
MW-9	11-Apr-01	99.03	10.34	10.33	88.69	88.70	--
	16-Jun-03	101.42	10.97	10.95	90.45	90.47	
	11-Jul-03	101.42	11.22	11.21	90.20	90.21	
MW-10	11-Apr-01	97.55	9.66	--	87.89		--
	16-Jun-03	99.96	10.53	--	89.43		
	11-Jul-03	99.96	10.86	--	89.10		
MW-11	11-Apr-01	98.62	2.89	--	95.73		--
	16-Jun-03	100.91	10.07	--	90.84		
	11-Jul-03	100.91	10.80	--	90.11		
MW-12	11-Apr-01	96.56	11.18	--	85.38		--
	16-Jun-03	98.97	11.27	--	87.70		
	11-Jul-03	98.97	11.23	--	87.74		
MW-13	11-Apr-01	99.95	NM	NM	--		--
	11-Jul-03	102.19	11.86	11.84	90.33	90.35	
MW-14	11-Apr-01	98.07	8.46	--	89.61		--
	16-Jun-03	100.45	9.87	--	90.58		
	11-Jul-03	100.41	Dry	--	--		

TABLE 1 (page 3 of 3)
SUMMARY OF GROUND WATER FIELD DATA [1]
MONTLAKE CIRCLE K
SEATTLE, WASHINGTON

Monitoring Well Number	Date Measured	Casing Rim Elevation [1] (feet)	Depth to Water [2] (feet)	Depth to Product [2] (feet)	Ground Water Elevation [1] (feet)	Corrected Elevation [3] (feet)	Change in Elevation [4] (feet)
MW-15	11-Apr-01	99.04	9.11	9.10	89.93	89.94	--
	16-Jun-03	101.34	10.69	--	90.65		
	11-Jul-03	101.31	11.11	--	90.20		
MW-16	11-Apr-01	99.04	9.43	--	89.61		--
	16-Jun-03	101.25	10.60	--	90.65		
	11-Jul-03	101.16	10.98	--	90.18		

[1] April 2001 elevations are based on GeoEngineers, Inc. *Progress Report No. 1; Remedial Monitoring Program; Circle K Facility 1461; August 23, 1990.* The June and July 2003 elevations are based on a new survey performed on July 1, 2003 and are relative to a temporary benchmark with an assumed elevation of 100.00 feet, shown in Figure 1.

[2] Depth to water and product below a fixed spot on the well casing rim.

[3] Ground water elevation corrected for the presence of free product, assuming a specific gravity of 0.85 for the product.

[4] Change in ground water elevation since preceeding monitoring event. Positive number indicates rising water level, negative indicates falling water level.

TABLE 2 (page 1 of 3)
SUMMARY OF GROUND WATER SAMPLE ANALYTICAL DATA [1]
MONTLAKE CIRCLE K #1461
SEATTLE, WASHINGTON

Monitoring Well Number [2]	Date	Benzene [3] (µg/L)	DQ	Toluene [3] (µg/L)	DQ	Ethyl-benzene [3] (µg/L)	DQ	Xylenes [3] (µg/L)	DQ	MTBE [3] (µg/L)	DQ	GRO [4] (mg/L)	DQ	Free Product Present?
MW-1	11-Apr-01	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
	16-Jun-03	0.500	U	0.500	U	0.500	U	1.00	U	1.00	U	0.0500	U	No
MW-4	11-Apr-01	7,370		28,000		2,680		17,100		--		117		Yes
	16-Jun-03	--		--		--		--		--		--		Yes
MW-5	11-Apr-01	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
	16-Jun-03	0.500	U	0.500	U	0.500	U	1.00	U	1.00	U	0.0500	U	No
MW-6	11-Apr-01	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
	16-Jun-03	0.500	U	0.500	U	0.500	U	1.00	U	1.00	U	0.0500	U	No
MW-7	11-Apr-01	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
	16-Jun-03	0.500	U	0.500	U	0.500	U	1.00	U	1.00	U	0.0500	U	No
MW-8	11-Apr-01	802		9,770		1,520		7,030		--		46.4		Yes
	16-Jun-03	--		--		--		--		--		--		Yes
MW-9	11-Apr-01	420		2,310		1,500		7,350		--		35.4		Yes
	16-Jun-03	--		--		--		--		--		--		Yes
Cleanup Level [5]		5		1,000		700		1,000		20		0.8/1.0 [6]		

TABLE 2 (page 2 of 3)
SUMMARY OF GROUND WATER SAMPLE ANALYTICAL DATA [1]
MONTLAKE CIRCLE K #1461
SEATTLE, WASHINGTON

Monitoring Well Number [2]	Date	Benzene [3] (µg/L) DQ	Toluene [3] (µg/L) DQ	Ethyl-benzene [3] (µg/L) DQ	Xylenes [3] (µg/L) DQ	MTBE [3] (µg/L) DQ	GRO [4] (mg/L) DQ	Free Product Present?
MW-10	11-Apr-01	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
	16-Jun-03	0.500 U	0.500 U	0.500 U	1.00 U	1.00 U	0.0500 U	No
MW-11	11-Apr-01	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
	16-Jun-03	0.500 U	0.500 U	0.500 U	1.00 U	1.00 U	0.0500 U	No
MW-12	11-Apr-01	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
	16-Jun-03	0.500 U	0.500 U	0.500 U	1.00 U	1.00 U	0.0500 U	No
MW-13	11-Apr-01	--	--	--	--	--	--	
	16-Jun-03	--	--	--	--	--	--	
MW-14	11-Apr-01	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
	16-Jun-03	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
MW-15	11-Apr-01	56.4	310	526	2,920	--	23.8	No
	16-Jun-03	6.22	83.3	12.6	199	15.5	3.15	No
MW-16	11-Apr-01	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
	16-Jun-03	0.500 U	0.500 U	0.500 U	1.00 U	1.00 U	0.0500 U	No
Cleanup Level [5]		5	1,000	700	1,000	20	0.8/1.0 [6]	

TABLE 2 (page 3 of 3)
SUMMARY OF GROUND WATER SAMPLE ANALYTICAL DATA [1]
MONTLAKE CIRCLE K #1461
SEATTLE, WASHINGTON

Notes:

[1] Samples analyzed by North Creek Analytical, Inc. of Bothell, Washington.

[2] Well locations are shown on Figure 2.

[3] By EPA Method 8021B.

[4] Gasoline-range organics by Ecology Method NWTPH-G.

[5] MTCA Method A Ground Water Cleanup Level.

[6] The cleanup level for gasolinerange organics is 0.8 mg/L when benzene is present, and 1.0 mg/L when benzene is not present.

µg/L = micrograms per liter

mg/L = milligrams per liter

"--" = not tested

DQ = data qualifier

U = not detected at or above the specified concentration

J = estimated concentration outside instrument calibration range

Bolded concentrations exceed the MTCA Method A ground water cleanup levels

EA 2005

Investigation Report
For
Washington State Department of Ecology
Mixed Funding LUST Sites

Volume 1

BP Oil Station #11352
Country Junction Store
Hansville General Store
Cornet Bay Marina
Circle K Station #1461
Tiki Car Wash

Prepared for

Washington State Department of Ecology
Toxics Cleanup Program
Northwest Regional Office

Prepared by

EA Engineering, Science, and Technology, Inc.
12011 Bellevue-Redmond Road, Suite 200
Bellevue, Washington 98005

June 2005
Revision: 1
EA Project No. 61994.01

CONTENTS

6. CIRCLE K STATION #1461

6.1 SITE DESCRIPTION AND HISTORY

The former Circle K site (now known as Jay's Cleaners) is located at 2350 24th Avenue East, in the Montlake area of Seattle, King County, Washington (Figure 6.1). The facility was operated as a convenience store and gasoline station from 1968 to 1981. The owner leased the site to the now bankrupt Circle K Corporation from 1981 to July 1990. The facility continued to operate as a convenience store with gasoline (leaded and unleaded) sales during that time. Prior to 1968, the site was likely residential.

In August 1989, a leak was discovered in one of the gasoline USTs. Reportedly, a review of the inventory records for the 4,000-gallon tank indicated that approximately 4,000 to 6,000-gallons of gasoline were released between 22 June 1989 and 7 August 1989 (GeoEngineers 1990). Remaining product in the tank reportedly was removed on 7 August 1989. All six onsite USTs were excavated in October 1989, along with approximately 900 cyd of contaminated soil. The removed USTs included two 4,000-gallon gasoline tanks, two 6,000-gallon gasoline tanks, one 500-gallon waste oil tank, and one 500-gallon heating oil tank. The former tank locations are indicated in a figure included in Appendix E. Contaminated soil in the gasoline UST area was removed to a depth of approximately 14 to 16 ft bgs. Contaminated soil remained at the limits of the excavation (GeoEngineers 1990).

In December 1989, installation of a product recovery and treatment system was completed. The groundwater treatment system consisted of (1) a recovery well and a series of recovery trenches (excavated toward the free product plume and backfilled with pea gravel), (2) a dual pumping system for recovering free product and contaminated groundwater, and (3) an aboveground groundwater treatment system using a series of activated carbon filters. Figures showing the system configuration are included in Appendix E. The system was operated briefly after it was installed, and again from 1992 through 1996, at which time it was shut down due to a low recovery rate.

An SVE system was also installed in the tank excavation area. Slotted PVC pipe was installed horizontally at depths of 4 to 5 ft bgs. The vapor recovery pipes were connected to a blower and the extracted vapors ran through a condensate trap and a series of two activated carbon filters. The period of operation of the SVE system is not known; however, it apparently was shut down in 1997 after readings indicated insignificant concentrations of hydrocarbons were being removed.

Sixteen monitoring wells were installed during 3 phases of a site assessment performed by GeoEngineers in September, October, and December 1989 (GeoEngineers 1990). Five of the wells have since been abandoned, leaving 11 wells currently available to monitor the plume. Three of these wells are on the Circle K property (MW-4, MW-7, and MW-13); five of the wells are in East McGraw Street (MW-6, MW-8, MW-9, MW-10, and MW-16); and three of the wells are north of McGraw Street in the road right-of-way (MW-11, MW-14, and MW-15). Most of

the wells reportedly were screened from 5 to 20 ft bgs. Several wells were screened from about 4 to 19 ft bgs. Available well construction details for the remaining wells are provided in Table 6.1. Copies of the well logs are included in Appendix E.

Prior to this investigation, the wells were last sampled in June 2003. Free product was observed in four of the wells (MW-4, MW-8, MW-9, and MW-13) at that time. Benzene and GRO were detected at concentrations above the MTCA Method A cleanup criteria in groundwater from well MW-15. MTBE was reported at a concentration below the cleanup criteria in MW-15 (by EPA Method 8021B, which is prone to false positives). Petroleum constituents were not detected the six other monitoring wells. A summary of the June 2003 date is provided in Appendix E.

6.2 GEOLOGY AND HYDROGEOLOGY

According to GeoEngineers, layers of sandy silt and silty fine sand were encountered beneath surface layers of asphalt, concrete, and fill material. Individual layers of sandy silt and silty sand vary in thickness over short distances and are often laterally discontinuous (GeoEngineers 1990). Occasional gravel and cobbles were encountered. A very dense to hard layer consisting of fine-grained glacial sediment was encountered at depths greater than approximately 14 ft in most of the borings.

Groundwater at the site occurs approximately 9 to 12 ft bgs, based on available data. Water level data obtained in 1989 was used to evaluate groundwater flow. The groundwater flow direction at that time was determined to be to the northeast at a gradient of approximately 0.024 ft/ft in 1989 (GeoEngineers 1990). Early product thickness measurements in site monitoring wells ranged up to 9.5 ft (in well MW-8; see table in Appendix E). GeoEngineers noted that free product appeared to have flowed in a northwest direction (different from the apparent groundwater flow direction) away from the leaky UST, based on their free product measurements obtained in 1989. Water level data obtained in June 2003 and in May 2005 did not clearly establish the groundwater flow direction.

6.3 FIELD ACTIVITIES

6.3.1 Initial Monitoring Well Sampling

On 31 May 2005, EA performed the gauging of groundwater and free product levels in the 11 monitoring wells at the former Circle K site. Free product was observed in monitoring wells: MW-4 (0.3 ft), MW-8 (trace), MW-9 (0.02 ft), and MW-13 (0.01 ft). See Table 6.1 for monitoring well gauging and construction information. Groundwater samples were not collected from monitoring wells that contained free product.

A groundwater sample was collected from MW-15 using a peristaltic pump and low-flow sampling procedures. Monitoring well MW-15 was first opened and water level, product level, and total depth measurements obtained and recorded before installing ¼-inch diameter tubing in the well. The tubing intake was placed approximately 2 ft below the water surface. A peristaltic pump was used to purge groundwater at a rate of 300-500 ml/min. Groundwater quality

parameters were measured every 3 minutes during purging until parameters stabilized. A groundwater sample was then collected. Groundwater quality parameters stabilized at the following readings: pH (5.08), specific conductivity (0.157 mS/cm), turbidity (0 NTUs), DO (0.00 mg/L), temperature (13.9 Celsius), and ORP (211 millivolts). The groundwater sample (from MW-15) was analyzed for GRO, BTEX, MTBE, and total lead.

6.3.2 Enhanced Fluid Recovery Pilot Test

On 9 June 2005, an EFR pilot test was performed at the site in an effort to remove free product, impacted groundwater, and petroleum vapors from targeted monitoring well locations. EcoVac Services, Inc., was contracted to perform the test on four monitoring wells at the former Circle K site (MW-4, MW-8, MW-9, and MW-13). Free product measurements were made in the wells prior to conducting the test. Free product thickness measurements at that time were as follows: 0.42 ft in MW-4, a sheen in MW-8, 0.01 ft in MW-9, and 0.01 ft in MW-13.

A vacuum truck from Emerald Services, Inc., was used to provide the vacuum for the test and also the storage, transportation and disposal of the wastewater generated during the test. The EFR test was performed over an 8-hour period and included multiple well extraction tests as well as individual well tests.

Drop tube assemblies were placed in each of the four wells to be used during the test. Vacuum hose ran from each well to a manifold, then to the vacuum truck. The hose ran under a driving ramp placed across the southern lane of East McGraw Street, to allow traffic to pass by during the test. A traffic plan was prepared by Traffic Control Services and submitted to the City of Seattle prior to the test. Traffic flaggers and signs were used to divert traffic around the closed northern lane of East McGraw Street.

Water levels were measured in surrounding wells while the test was being performed to assess drawdown effects of the test. Vacuum readings were later recorded from surrounding wells to assess the radius of influence the EFR test was having at the site.

At the completion of the EFR test, a drop tube assembly was lowered into MW-14 to remove accumulated sediments from the well. Prior to this, the measured total depth of MW-14 was 10.5 ft btoc. After removal of sediment and water from well the total depth of the well was measured to be 18.87 ft btoc. This well may have damage to the PVC screen or casing joints, based on the amount of sediment that was observed in the well.

6.3.3 Follow-up Monitoring Well Sampling

On 23 June 2005, two weeks after the EFR test, the five monitoring wells within the plume boundaries (MW-4, MW-8, MW-9, MW-13, and MW-15) were gauged for the presence of free product. Free product was measured in well MW-8 at a thickness of 0.01 ft. Less than 0.01 feet of product (trace) was measured in MW-9 and MW-4. Free product was not observed in MW-15 or MW-13.

Monitoring wells with less than 0.01 feet of free product were sampled. Sampling procedures were the same as during the first sampling round. Groundwater samples were analyzed for GRO, BTEX, MTBE, and DRO. Hydrocarbon odors were noted emanating from the purged groundwater from the four wells sampled.

6.4 RESULTS

Field parameter measurements for both rounds of sampling are provided in Table 6.1. Analytical results for the first round of groundwater sampling (one sample) are discussed below. Results for the second round of groundwater samples were not available in time to be included in this report.

6.4.1 Initial Monitoring Well Sampling

GRO was detected in the groundwater sample from MW-15 at a concentration of 878 µg/L, which is just above the MTCA Method A cleanup criteria of 800 µg/L (for samples also containing benzene). Benzene (1.26 µg/L), ethylbenzene (2.60 µg/L), and xylenes (3.39 µg/L) were detected at concentrations below the cleanup criteria. Toluene and MTBE results were below the laboratory detection limits.

6.4.2 Enhanced Fluid Recovery Pilot Test

Approximately 1,600 gallons of contaminated groundwater/liquid phase product was removed from the site during the 8-hour EFR test period. The total amount of hydrocarbons removed during the EFR test was estimated to be 112 pounds, as measured in the vapor phase. This mass of hydrocarbons is equivalent to approximately 18 gallons of gasoline. The highest extraction rate observed during the test was 5.7 pounds per hour from MW-9. Extraction rates calculated for the remaining tested wells were: 5.0 pounds per hour from MW-4, 4.5 pounds per hour from MW-8, and 1.9 pounds per hour from MW-13.

Vacuum was observed in the following surrounding wells; MW-6, MW-7, and MW-16. Water levels measured during the test period indicate the greatest drawdown occurred in MW-16. EcoVac's report on the EFR results is included in Appendix E.

6.4.3 Follow-up Monitoring Well Sampling Results

Follow-up groundwater sampling was performed on 23 June. Results of analytical testing of these groundwater samples have not yet been received. They will be forwarded to Ecology when they become available.

6.5 CONCLUSIONS AND RECOMMENDATIONS

The EFR test was performed as a product and mass removal action pilot test. It was not meant to provide final site remediation and cleanup. EFR helped remediate the site by removing free

phase hydrocarbons, dissolved phase hydrocarbons and vapors from the subsurface. A total of approximately 112 pounds of hydrocarbons were removed from site by the EFR test.

The limited vacuum and drawdown observed in surrounding monitoring wells is evidence of very tight soil conditions at the site. These conditions have limited the migration of contaminants, but also limit the effectiveness of remedial/recovery equipment in removing hydrocarbons.

The five monitoring wells in the contaminant plume area were gauged two weeks following the EFR test. Free product, ranging from a trace to 0.01 ft, was detected in three of the wells at that time. Additional monitoring of site wells is recommended on at least a quarterly basis to evaluate the impact of the EFR test and to determine if additional EFR remediation (or another type of remediation) appears warranted. At a minimum, wells MW-4, MW-8, MW-9, MW-13, and MW-15 should be monitored. Occasional sampling of the remaining monitoring wells is also recommended to confirm that the plume is not migrating. Resurveying of the site monitoring wells is also recommended due to the irregular water level measurements obtained.

FIGURES

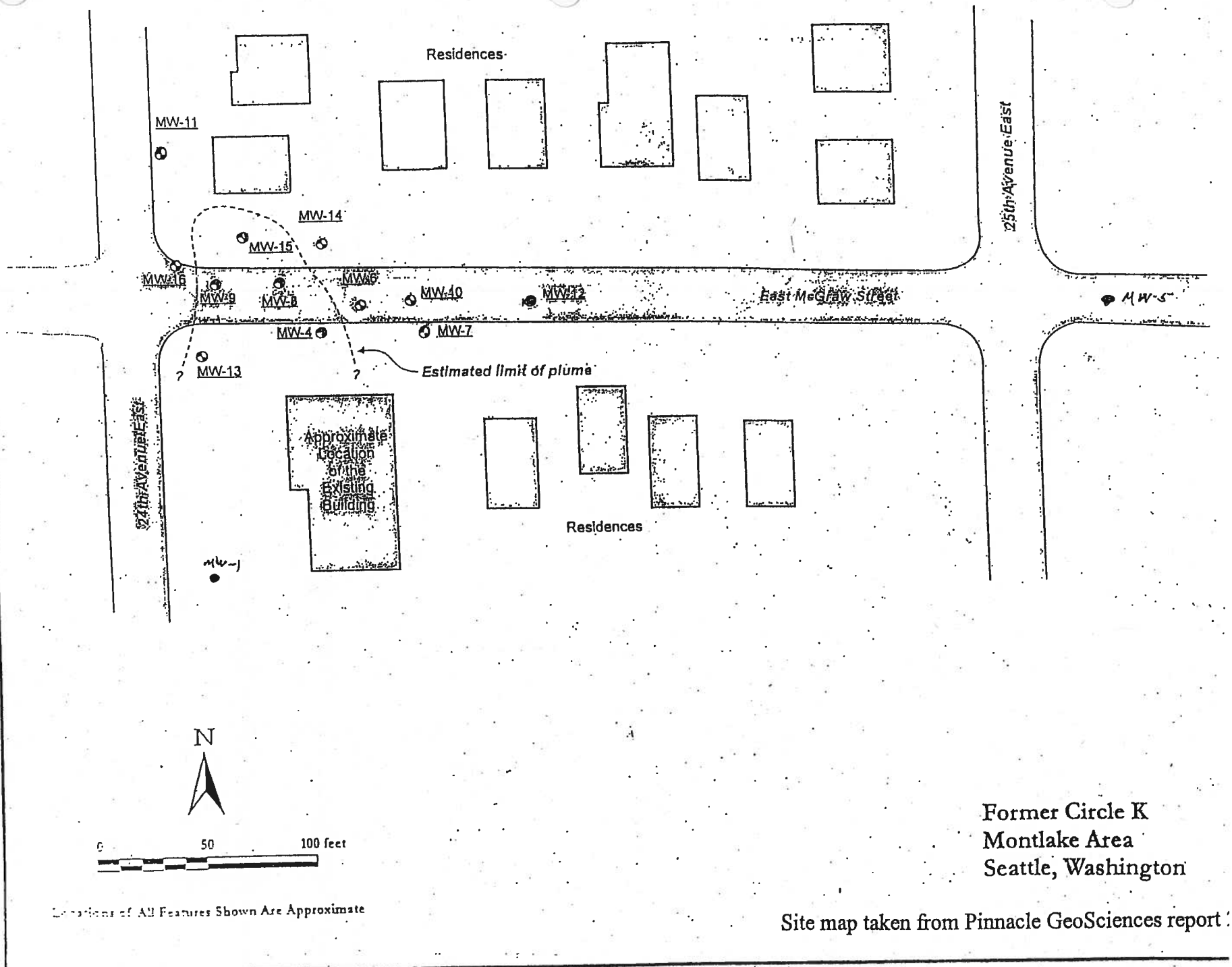


Figure 6.1 Site Map, Circle K Station #1461

TABLES

TABLE 6.1. MONITORING WELL CONSTRUCTION AND FIELD MEASUREMENT DATA
CIRCLE K STATION #1461

Well ID	Date Installed	Well Diameter (inches)	Reported Screen Depth (ft bgs)	Measured Total Depth 31 May 2005 (ft btoc)	Top of Casing Elevation (ft)	Depth to Water 31 May 2005 (ft btoc)	Depth to Product 31 May 2005 (ft btoc)	Groundwater Elevation 31 May 2005 (ft)	Corrected Elevation* 31 May 2005 (ft)
MW-4	9/12/1989	2	4 - 18.5	17.90	100.73	10.01	9.71	90.72	90.98
MW-6	10/2/1989	2	5 - 20	20.53	100.25	11.55	NA	88.70	NA
MW-7	10/2/1989	2	5 - 20	20.49	99.75	9.12	trace	90.63	NA
MW-8	10/3/1989	2	5 - 20	19.60	100.70	10.01	trace	90.69	NA
MW-9	10/3/1989	2	5 - 21	20.35	101.42	10.09	10.07	91.33	91.35
MW-10	10/3/1989	2	5 - 20	20.47	99.96	9.83	trace	90.13	NA
MW-11	10/4/1989	2	5 - 20	20.29	100.91	8.66	NA	92.25	NA
MW-12	10/4/1989	2	5 - 20	abandoned	98.97	NA	NA	NA	NA
MW-13	12/20/1989	2	4 - 19	18.89	102.19	10.91	10.90	91.28	91.29
MW-14	12/20/1989	2	4 - 19	18.87	100.41	8.79	8.78	91.62	91.63
MW-15	12/21/1989	2	4 - 18.5	16.96	101.31	9.43	NA	91.88	NA
MW-16	12/21/1989	2	4 - 19	18.94	101.16	9.51	trace?	91.65	NA

Well	Date Measured	Water Quality Parameters					
		pH	Conductivity (mS/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
MW-15	5/31/2005	5.08	0.157	0	0.00	13.9	211
MW-4	6/23/2005	5.57	0.15	0	0.00	15.7	-81
MW-9	6/23/2005	5.55	0.42	0	0.00	15.6	7
MW-13	6/23/2005	5.52	0.345	1	0.00	16.1	-95
MW-15	6/23/2005	4.87	0.15	0	0.21	14.6	209

NOTES:
°C = degrees Celsius.
ft bgs = feet below ground surface.
ft btoc = feet below top of casing.
mg/L = milligrams per liter
mS/cm = milliSiemans per centimeter.
mV = milliVolts
NA = Not applicable.
NTUs = Nephelometric turbidity units.

Ecology 2003

Release ID: ~~5~~ 1548
Seattle

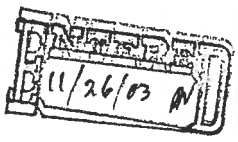
Circle K Station #1461

2350 24th Avenue East, Seattle, WA

Field Investigations, 2003

Report prepared by
Roger Nye, Current Project Manager

11/26/03



Introduction:

The work on the site was funded through an Ecology PPR request. (AFRS Project # 8729). The work was contracted out to Glacier Environmental Services, Inc. Glacier subcontracted the sampling work out to Pinnacle GeoSciences.

Work Performed:

Fourteen monitoring wells were measured or sampled on 6/16/03. (MW1, MWs 4-16). (See attached site map.) Depth to groundwater was 10 – 12 ft. throughout the site. MW2 and MW3 could not be found and are probably beneath a newer addition to the building on site. MW13 was paved over with asphalt but was dug out. MW14 did not have sufficient water to purge and is a grab sample. Purge water from MW15 had a petroleum odor.

Samples were delivered for analyses directly to North Creek Analytical, Inc. in Bothell. Appropriate sample acquisition, handling, storage, and preservation protocols were followed. ~~Soil and~~ groundwater sample acquisition equipment was decontaminated using standard procedures. (See attached field notes). Purge water from the wells was disposed of in a permitted groundwater treatment system operated by Glacier Environmental.

Samples were analyzed for TPHG (gasoline), BTEX (benzene, toluene, ethylbenzene, and xylenes), and MTBE. Analytical methods included NWTPH-G, EPA 8021B (BTEX and MTBE), and EPA 8260B (confirmation of MTBE). Wells with significant free product were not sampled.

Measurable free product was observed in MW4, MW8, MW9, and MW13. MW15 had dissolved-phase contaminant levels for benzene and TPHG slightly in excess of Method A standards. All the other wells were below standards. (See attached tabulated results). Chromatogram analyses were not done on these samples because the site hasn't been an operating fuel facility for many years.

A current groundwater flow direction was not available for this site and well locations and elevations were surveyed. A consistent groundwater flow direction was still not apparent however, possibly because the many utility corridors in the area are affecting groundwater levels in the wells.

MW1 and MW5 were considered redundant given historical and recent data, and were closed by filling with bentonite and capping with concrete.

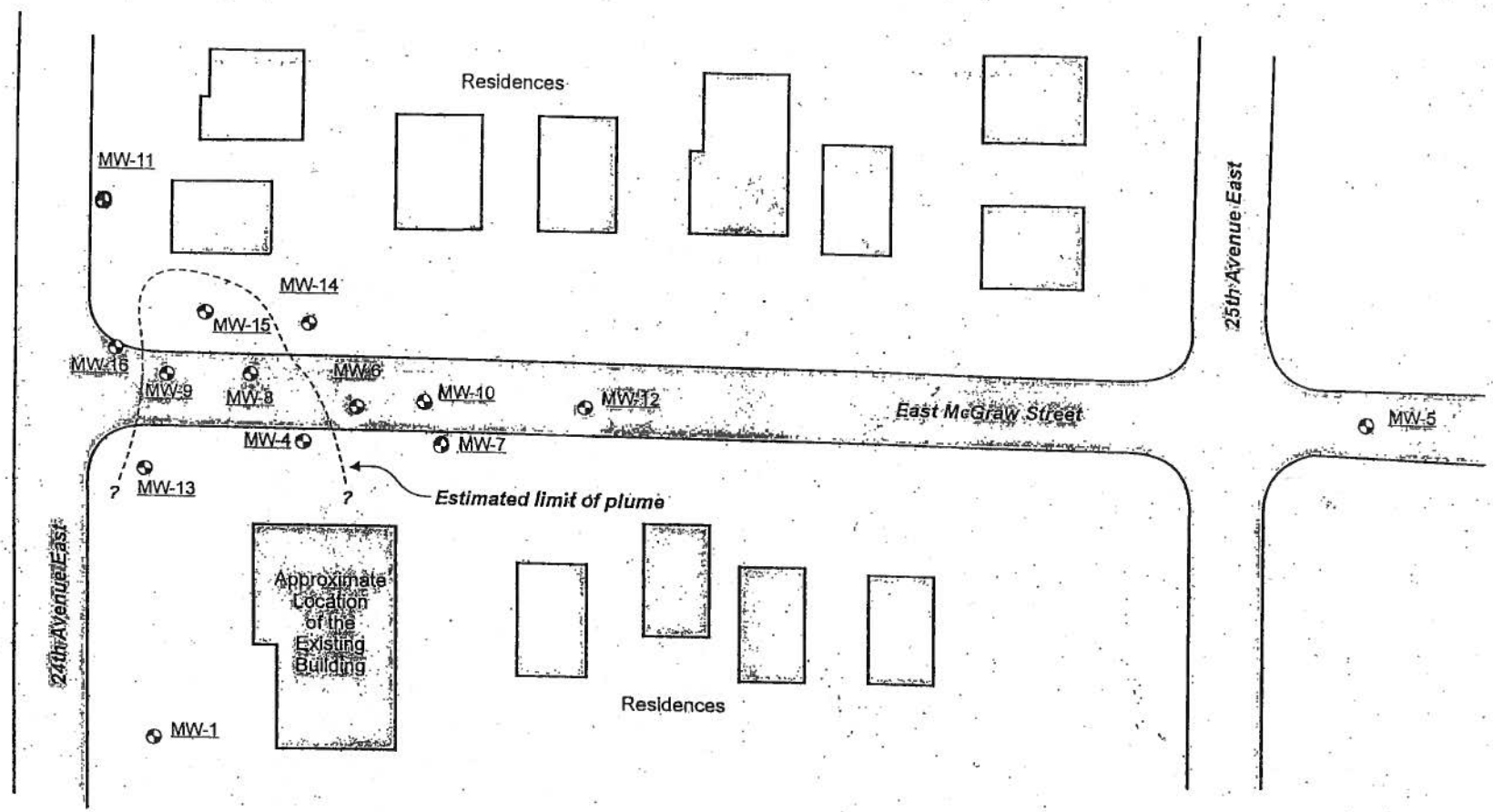
Ten wells (MWs 6-10, MWs 12-16) required repair of the wellheads. Threads were re-tapped, oversize bolts were installed, and gaskets were cleaned and replaced.

Measurements, field notes, laboratory documentation, and well-closure notification are attached.

Conclusions:

The data indicate a small, well-defined gasoline plume in groundwater extending northwards beneath East McGraw street about 100ft. from the former location of USTs on the property. (See attached site map). Contaminant levels in the plume are very high. Data fourteen years old indicates groundwater flow is towards the north with a shallow gradient. It is possible that groundwater with high dissolved phase could extend beneath the nearest residence to the north. The plume is undefined to the west and could possibly extend that direction an unknown distance beneath 24th Avenue East.

The non-operational soil/groundwater treatment system in place at the site should be evaluated and restarted to determine if appreciable amounts of contamination could still be recovered after its hiatus in operation. If not, the existing remedial system should be modified or replaced to draw contamination back towards the source and recover it. Ultimately, some investigation by geoprobe borings may be required to determine if contaminated soil remains at the site and to define groundwater contamination to the west.



N

0 50 100 feet

Locations of All Features Shown Are Approximate

Former Circle K
Montlake Area
Seattle, Washington

TABLE 1 (page 1 of 2)
SUMMARY OF GROUND WATER FIELD DATA
MONTLAKE CIRCLE K
SEATTLE, WASHINGTON

Monitoring Well Number	Date Measured	Casing Rim Elevation [1] (feet)	Depth to Water [2] (feet)	Depth to Product [2] (feet)	Ground Water Elevation [1] (feet)	Corrected Elevation [3] (feet)	Change in Elevation [4] (feet)
MW-1	11-Apr-01	100.94	12.62	--	88.32		--
	16-Jun-03	103.25	12.13	--	91.12		
	11-Jul-03	103.25	12.34	--	90.91		
MW-4	11-Apr-01	98.38	10.23	10.20	88.15	88.18	--
	16-Jun-03	100.73	10.56	10.47	90.17	90.25	
	11-Jul-03	100.73	10.72	10.62	90.01	90.10	
MW-5	11-Apr-01	90.94	9.97	--	80.97		--
	16-Jun-03	93.34	10.95	--	82.39		
	11-Jul-03	93.34	11.31	--	82.03		
MW-6	11-Apr-01	97.92	11.57	--	86.35		--
	16-Jun-03	100.25	11.63	--	88.62		
	11-Jul-03	100.25	11.63	--	88.62		
MW-7	11-Apr-01	97.43	8.15	--	89.28		--
	16-Jun-03	99.75	10.38	--	89.37		
	11-Jul-03	99.75		--	99.75		
MW-8	11-Apr-01	98.36	10.18	10.17	88.18	88.19	--
	16-Jun-03	100.70	10.68	10.67	90.02	90.03	
	11-Jul-03	100.70	10.87	10.86	89.83	89.84	

TABLE 1 (page 2 of 2)
SUMMARY OF GROUND WATER FIELD DATA
MONTLAKE CIRCLE K
SEATTLE, WASHINGTON

Monitoring Well Number	Date Measured	Casing Rim Elevation [1] (feet)	Depth to Water [2] (feet)	Depth to Product [2] (feet)	Ground Water Elevation [1] (feet)	Corrected Elevation [3] (feet)	Change in Elevation [4] (feet)
MW-9	11-Apr-01	99.03	10.34	10.33	88.69	88.70	--
	16-Jun-03	101.42	10.97	10.95	90.45	90.47	
	11-Jul-03	101.42	11.22	11.21	90.20	90.21	
MW-10	11-Apr-01	97.55	9.66	--	87.89		--
	16-Jun-03	99.96	10.53	--	89.43		
	11-Jul-03	99.96	10.86	--	89.10		
MW-11	11-Apr-01	98.62	2.89	--	95.73		--
	16-Jun-03	100.91	10.07	--	90.84		
	11-Jul-03	100.91	10.80	--	90.11		
MW-12	11-Apr-01	96.56	11.18	--	85.38		--
	16-Jun-03	98.97	11.27	--	87.70		
	11-Jul-03	98.97	11.23	--	87.74		
MW-13	11-Apr-01	99.95	NM	NM	--		--
	11-Jul-03	102.19	11.86	11.84	90.33	90.35	
MW-14	11-Apr-01	98.07	8.46	--	89.61		--
	16-Jun-03	100.45	9.87	--	90.58		
	11-Jul-03	100.41	Dry	--	--		

TABLE 1 (page 3 of 3)
SUMMARY OF GROUND WATER FIELD DATA [1]
MONTLAKE CIRCLE K
SEATTLE, WASHINGTON

Monitoring Well Number	Date Measured	Casing Rim Elevation [1] (feet)	Depth to Water [2] (feet)	Depth to Product [2] (feet)	Ground Water Elevation [1] (feet)	Corrected Elevation [3] (feet)	Change in Elevation [4] (feet)
MW-15	11-Apr-01	99.04	9.11	9.10	89.93	89.94	--
	16-Jun-03	101.34	10.69	--	90.65		
	11-Jul-03	101.31	11.11	--	90.20		
MW-16	11-Apr-01	99.04	9.43	--	89.61		--
	16-Jun-03	101.25	10.60	--	90.65		
	11-Jul-03	101.16	10.98	--	90.18		

[1] April 2001 elevations are based on GeoEngineers, Inc. *Progress Report No. 1; Remedial Monitoring Program; Circle K Facility 1461; August 23, 1990*. The June and July 2003 elevations are based on a new survey performed on July 1, 2003 and are relative to a temporary benchmark with an assumed elevation of 100.00 feet, shown in Figure 1.

[2] Depth to water and product below a fixed spot on the well casing rim.

[3] Ground water elevation corrected for the presence of free product, assuming a specific gravity of 0.85 for the product.

[4] Change in ground water elevation since preceeding monitoring event. Positive number indicates rising water level, negative indicates falling water level.

TABLE 2 (page 1 of 3)
SUMMARY OF GROUND WATER SAMPLE ANALYTICAL DATA [1]
MONTLAKE CIRCLE K #1461
SEATTLE, WASHINGTON

Monitoring Well Number [2]	Date	Benzene [3] (µg/L) DQ	Toluene [3] (µg/L) DQ	Ethyl-benzene [3] (µg/L) DQ	Xylenes [3] (µg/L) DQ	MTBE [3] (µg/L) DQ	GRO [4] (mg/L) DQ	Free Product Present?
MW-1	11-Apr-01	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
	16-Jun-03	0.500 U	0.500 U	0.500 U	1.00 U	1.00 U	0.0500 U	No
MW-4	11-Apr-01	7,370	28,000	2,680	17,100	--	117	Yes
	16-Jun-03	--	--	--	--	--	--	Yes
MW-5	11-Apr-01	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
	16-Jun-03	0.500 U	0.500 U	0.500 U	1.00 U	1.00 U	0.0500 U	No
MW-6	11-Apr-01	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
	16-Jun-03	0.500 U	0.500 U	0.500 U	1.00 U	1.00 U	0.0500 U	No
MW-7	11-Apr-01	0.500 U	0.500 U	0.500 U	1.00 U	--	0.0500 U	No
	16-Jun-03	0.500 U	0.500 U	0.500 U	1.00 U	1.00 U	0.0500 U	No
MW-8	11-Apr-01	802	9,770	1,520	7,030	--	46.4	Yes
	16-Jun-03	--	--	--	--	--	--	Yes
MW-9	11-Apr-01	420	2,310	1,500	7,350	--	35.4	Yes
	16-Jun-03	--	--	--	--	--	--	Yes
Cleanup Level [5]		5	1,000	700	1,000	20	0.8/1.0 [6]	

TABLE 2 (page 2 of 3)
SUMMARY OF GROUND WATER SAMPLE ANALYTICAL DATA [1]
MONTLAKE CIRCLE K #1461
SEATTLE, WASHINGTON

Monitoring Well Number [2]	Date	Benzene [3] (µg/L)	DQ	Toluene [3] (µg/L)	DQ	Ethyl-benzene [3] (µg/L)	DQ	Xylenes [3] (µg/L)	DQ	MTBE [3] (µg/L)	DQ	GRO [4] (mg/L)	DQ	Free Product Present?
MW-10	11-Apr-01	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
	16-Jun-03	0.500	U	0.500	U	0.500	U	1.00	U	1.00	U	0.0500	U	No
MW-11	11-Apr-01	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
	16-Jun-03	0.500	U	0.500	U	0.500	U	1.00	U	1.00	U	0.0500	U	No
MW-12	11-Apr-01	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
	16-Jun-03	0.500	U	0.500	U	0.500	U	1.00	U	1.00	U	0.0500	U	No
MW-13	11-Apr-01	--		--		--		--		--		--		
	16-Jun-03	--		--		--		--		--		--		
MW-14	11-Apr-01	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
	16-Jun-03	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
MW-15	11-Apr-01	58.4		310		526		2,920		--		23.8		No
	16-Jun-03	6.22		83.3		12.6		199		15.5		3.15		No
MW-16	11-Apr-01	0.500	U	0.500	U	0.500	U	1.00	U	--		0.0500	U	No
	16-Jun-03	0.500	U	0.500	U	0.500	U	1.00	U	1.00	U	0.0500	U	No
Cleanup Level [5]		5		1,000		700		1,000		20		0.8/1.0 [6]		

TABLE 2 (page 3 of 3)
SUMMARY OF GROUND WATER SAMPLE ANALYTICAL DATA [1]
MONTLAKE CIRCLE K #1461
SEATTLE, WASHINGTON

Notes:

[1] Samples analyzed by North Creek Analytical, Inc. of Bothell, Washington.

[2] Well locations are shown on Figure 2.

[3] By EPA Method 8021B.

[4] Gasoline-range organics by Ecology Method NWTPH-G.

[5] MTCA Method A Ground Water Cleanup Level.

[6] The cleanup level for gasolinerange organics is 0.8 mg/L when benzene is present, and 1.0 mg/L when benzene is not present.

µg/L = micrograms per liter

mg/L = milligrams per liter

"--" = not tested

DQ = data qualifier

U = not detected at or above the specified concentration

J = estimated concentration outside instrument calibration range

Supplied concentrations exceed the MTCA Method A ground water cleanup levels.

Glacier 2000

Interim Report

Groundwater Treatment System
Jay's Cleaners
2350 24th Avenue East
Seattle, WA

January 11, 2000
Project 98015

Prepared for:
Washington State Department of Ecology
3190 160th Avenue SE
Bellevue, WA

Prepared by:
Glacier Environmental Services
12521 Evergreen Drive
Mukilteo, WA

TABLE OF CONTENTS

Jay's Cleaners
Groundwater Treatment System
2350 24th Avenue East
Seattle, WA

1.0 Summary

This letter report presents the findings of the June 1999 field sampling event conducted at the above referenced site. Enclosed please find the original field notes and laboratory results for groundwater monitoring and sampling for the above referenced site. As indicated on the data sheets, monitoring wells MW-1, MW-4, MW-8, MW-9, MW-11, MW-15 and MW-16 had a noticeable sheen and hydrocarbon odor. Monitoring wells MW-13 was cemented over and MW-14 was dry at a depth of 10.0 feet below grade.

In years past, the wells contained product thickness layers ranging up to several feet. However, since the winter quarter of 1997 we have not observed any free product on the top of the water column greater than an 1/8th of an inch. Also, as the annual influent sample results have shown a steady decline (please see Interim Report dated June 28, 1998) it was determined that a sampling event of all the monitoring wells was appropriate. Laboratory results from the sampling events are presented in Table 1.

2.0 Sample Results

As indicated in the Table 1, four of the monitoring wells have elevated levels of Gasoline Range Hydrocarbons and BTEX components. These four wells (see Figures 1 and 2) are all within 75' of the recovery well which is located down gradient from where the original release occurred. Other wells located immediately adjacent (ranging from 10-100' away) were confirmed by the laboratory to contain chemical contamination lower than the MTCA Level A cleanup levels.

Table 1 – Monitoring Well Sample Results

Sample ID	Date	Benzene (ug/L)	Tolulene[1] (ug/L)	Xylene (ug/L)	Ethyl-Benzene	GRH (mg/l)
MW-8	6/4/99	570	6130	17000	1220	43700
MW-15	6/4/99	37.9	367	3100	547	24700
MW-16	6/4/99	ND	3.39	8.93	1.93	182

MW-11	6/4/99	ND	35.8	ND	ND	ND
MW-9	6/4/99	610	4990	6760	1230	54400
MW-1	6/4/99	ND	3.59	3.87	.830	ND
MW-4	6/4/99	3580	3490	3920	788	30800
MW-7	6/4/99	ND	3.38	2.29	ND	ND
MW-12	6/4/99	ND	2.99	1.14	ND	ND
MW-10	6/4/99	ND	ND	3.03	ND	ND
MW-6	6/4/99	ND	2.88	ND	ND	ND
MTCA Level A Action Levels		1 ug/l	40 ug/l	30 ug/l	20 ug/l	1,000 mg/l

1. Lab reported 3-4 ppb laboratory cross contamination problem with Tolulene.

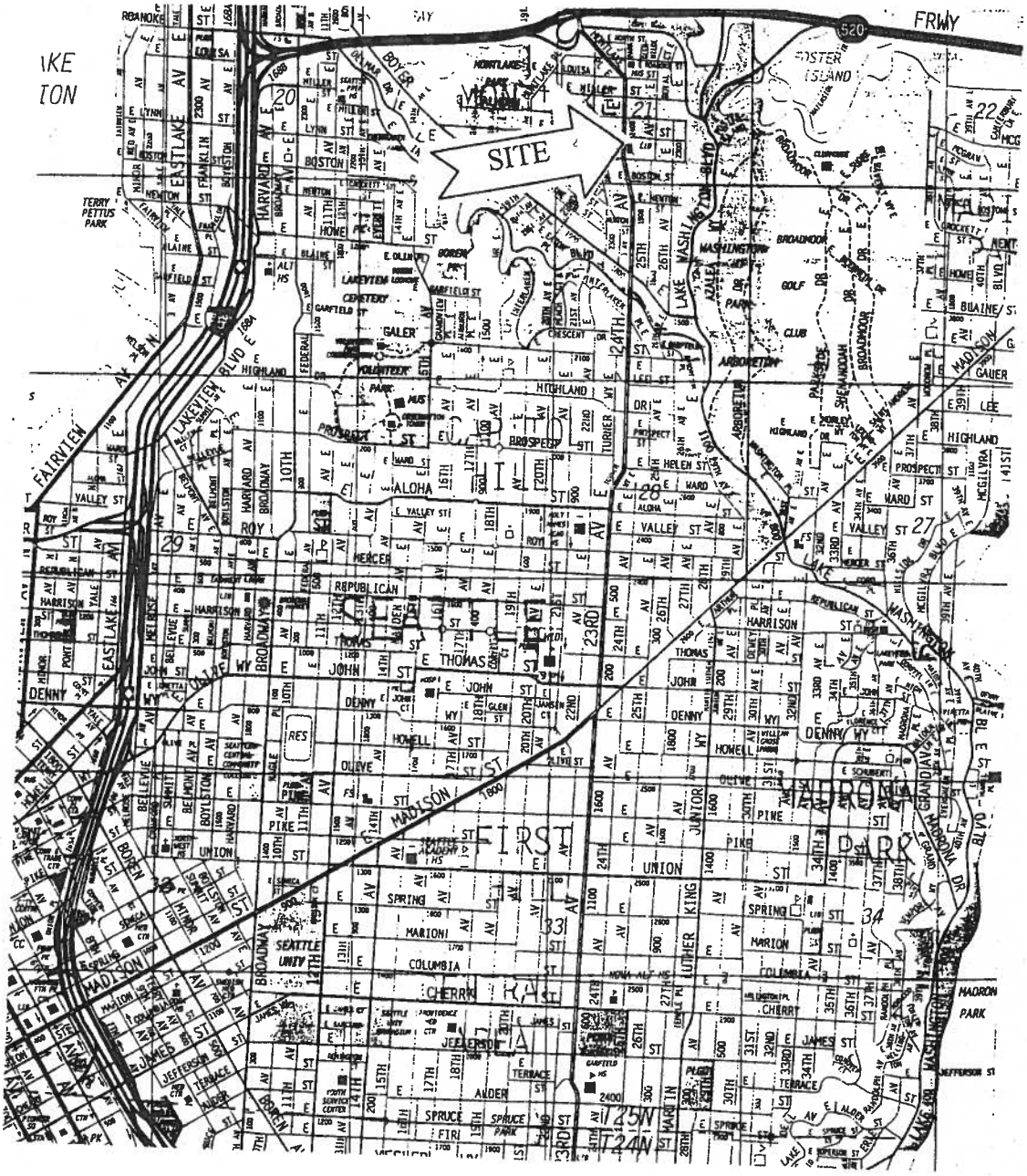
3.0 Conclusion

Based on this data, it seems possible that the impact to the groundwater is confined to the area immediately surrounding the impacted wells, and is possibly a result of contaminated soil which remains in place around these wells. Therefore, if we can devise a method to remediate the PCS surrounding these wells, we might be able to speed the cleanup process up significantly. One possible method of achieving this goal is to install a limited air sparging system. At this time we our recommending that consideration be given to developing a method to implement such a system. If you would like to discuss some ideas we have to launch a pilot project to test the effectiveness of such a system, please contact me at 425-355-2826. Otherwise we will continue to maintain and monitor the current systems already in place.

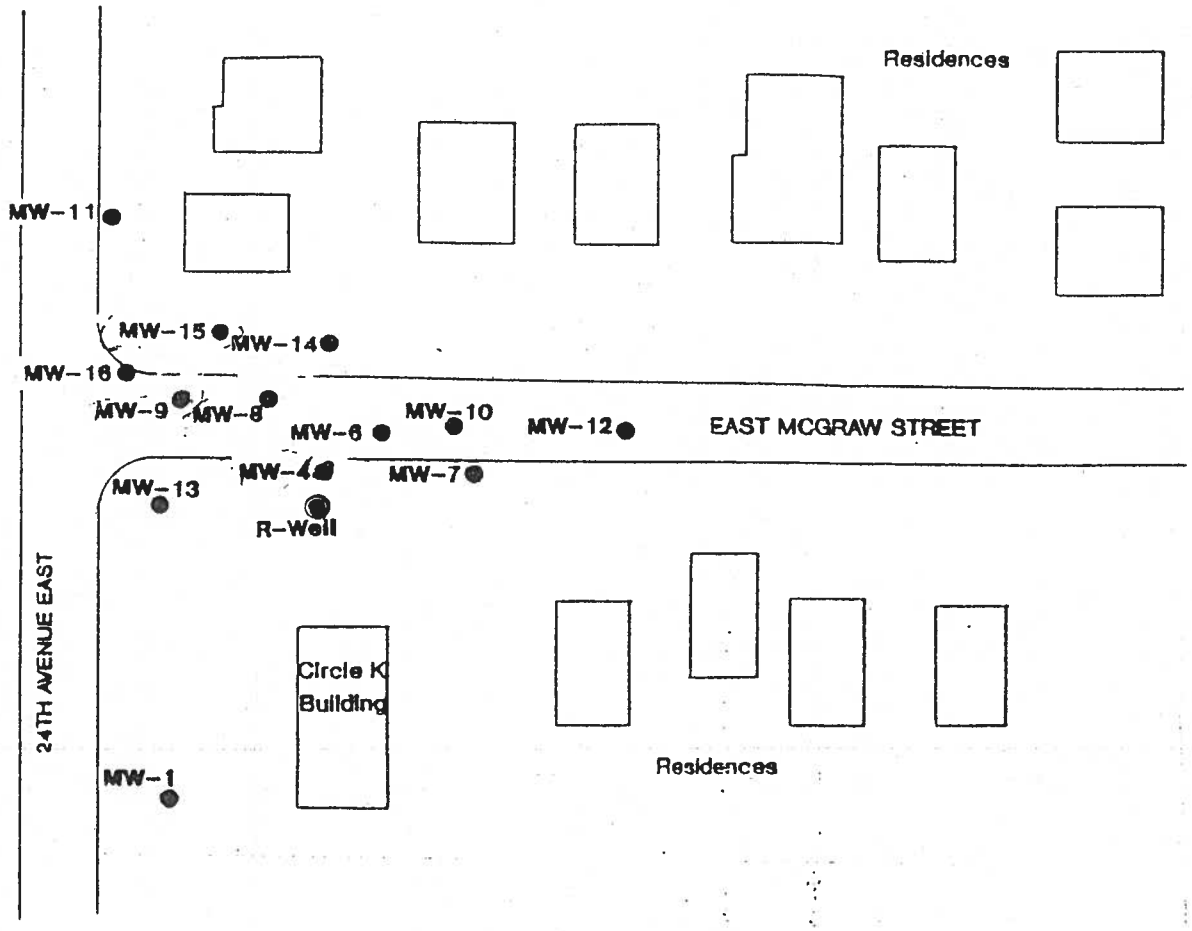
Best Regards,
Glacier Environmental Services, Inc.,

Curt Lightle
Project Supervisor

Figures



GLACIER ENVIRONMENTAL SERVICES, INC. 12521 Evergreen Drive, Suite A Mukilteo, WA 98275	DATE: 10/31/99 JOB #: 98- 015	Figure -1 Site Vicinity Map Jay's Cleaners 2350 24th NE Seattle, WA



GLACIER ENVIRONMENTAL SERVICES, INC. 12521 Evergreen Drive, Suite A Mukilteo, WA 98275	DATE: 10/31/99 JOB #: 98015	Figure –2 Sample Location Map Jay's Cleaners 2350 24th Avenue East Seattle, WA

Consent Decree 1992

SUPERIOR COURT OF THE STATE OF WASHINGTON
FOR KING COUNTY

STATE OF WASHINGTON,
DEPARTMENT OF ECOLOGY,

Plaintiff,

v.

KUK JIN CHOUNG,

Defendant.

92-2-08025 8

No.

ORDER ENTERING
CONSENT DECREE

ORIGINAL

Having reviewed the Consent Decree signed by the parties to this matter, the Joint Motion for Entry of the Consent Decree, the Affidavit of E. Christina Beusch, and the file herein, it is hereby

ORDERED AND ADJUDGED that the Consent Decree in this matter is Entered and that the Court shall retain jurisdiction over the Consent Decree to enforce its terms.

Signed this _____ day of April, 1992.

JACK A. RICHEY
COURT COMMISSIONER

APR 8 - 1992

Superior Court Judge

Presented by:

E. Christina Beusch
E. Christina Beusch
Assistant Attorney General

EXP01

OFFICE OF THE ATTORNEY GENERAL
Ecology Division
4407 Woodview Drive S.E.

I. INTRODUCTION

A. In entering into this Consent Decree (Decree), the mutual objective of the Washington State Department of Ecology (Ecology) and Mr. Kuk Jin Choung (Defendant), is to provide for reimbursement for costs incurred by Ecology in remediating a release or threatened release of hazardous substances at the Circle K Station #1461 site.

B. The complaint in this action is being filed simultaneously with this Decree. An answer has not been filed, and there has not been a trial on any issue of fact or law in this case. The parties wish to resolve the issues raised by Ecology's complaint and agree that settlement of these matters without litigation is reasonable and in the public interest and that entry of this Decree is the most appropriate means of resolving these matters.

C. In signing this Decree, the Defendant agrees to its entry and agree to be bound by its terms.

D. The court is fully advised of the reasons for entry of this Decree, and good cause having been shown: IT IS HEREBY ORDERED, ADJUDGED, AND DECREED AS FOLLOWS:

II. JURISDICTION

A. This court has jurisdiction over the subject matter and personal jurisdiction over the parties pursuant to the Model Toxics Control Act (ch. 70.105D RCW).

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B. Ecology has authority pursuant to RCW 70.105D.040(4) to file this Consent Decree with the appropriate superior court after appropriate public notice and comment.

C. On the basis of the testing and analysis described in the Statement of Facts, Section V, and Ecology files and records, Ecology has determined that a release of hazardous substances has occurred at the site.

D. Ecology has determined that the Defendant is a potentially liable person for the site pursuant to RCW 70.105D.040. The Defendant has been given notice of Ecology's determination, and has had opportunity to comment thereon.

E. The Defendant has applied to Ecology for financial assistance under WAC 173-340-560. Based on the Defendant's application, Ecology has determined the Defendant is eligible for mixed funding. Ecology has also determined that making available mixed funding under the circumstances described in Section V of this Decree will achieve a more expeditious or enhanced cleanup than would otherwise occur and will prevent or mitigate unfair economic hardship.

F. Entering this Decree will result in a more expeditious cleanup of the site and is appropriate given the use of mixed funding at the site.

G. The actions to be taken pursuant to this Decree are necessary to protect the public health, welfare and the environment.

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III. PARTIES BOUND

This Decree shall apply to and be binding upon Mr. Kuk Jin Choung and his marital community and Ecology and their successors and assigns. The undersigned representative of each party hereby certifies that he/she is fully authorized to enter into this Decree and to execute and legally bind such party to comply with the Decree. The parties agree to undertake all actions required by the terms and conditions of this Decree and the Defendant agrees not to contest state jurisdiction regarding this Decree. No change in ownership or corporate status shall alter the responsibility of the Defendant under this Decree.

IV. DEFINITIONS

A. "Site" refers to the property and business located at 2350 24th Ave. East, Seattle, Washington.

B. "Remedial action" refers to the work performed by Ecology to clean up the site.

C. "Remedial action costs" refer to those direct and indirect costs incurred by Ecology under this Consent Decree. Such costs include work performed by Ecology or its contractors for investigations, remedial actions, and order preparation, negotiations, oversight, and administration. Ecology costs shall also include costs of direct activities; e.g., employee salary, laboratory costs, travel costs,

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contractor fees, and employee benefit packages; and agency indirect costs of direct activities.

D. "Days" refers to calendar days unless specified otherwise.

E. "Parties" refers to the Department of Ecology and Mr. Kuk Jin Choung and his marital community.

F. The definitions set forth in ch. 70.105D RCW and ch. 173-340 WAC shall control the meanings of the terms used in this Decree.

V. STATEMENT OF FACTS

Ecology makes the following findings of fact:

A. Site Location and Status

The Circle K Station #1461 site is located at 2350 24th Ave. East, Seattle, Washington. The site is currently being operated as a dry cleaning business.

B. Facility History and Operations

The Circle K Station #1461 site was purchased by George Renale of San Francisco, California in 1968. The site was operated as a Stop-N-Go gasoline and convenience store until 1981. From 1981 until July of 1990 Mr. Renale leased the site to the now bankrupt Circle K Corporation who operated the site as a convenience store and gasoline station. The underground storage tanks used to store gasoline were removed by the Circle K Corporation on or around July 1990. The present

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owner, Kuk Jin Choung, purchased the site from George Renale in November of 1990.

C. Previous Site Investigations

Geo Engineers and Glacier Environmental conducted tank removal and partial site remediation at the direction of Circle K Corporation. Tank removal was completed but site remediation was not due to a filing of bankruptcy by the Circle K Corporation. Two Geo Engineers' reports (#1780-001-B04 and #1780-002-B04) document the previous work. These reports indicate petroleum releases at the site.

VI. WORK TO BE PERFORMED

A. Scope of Work

Ecology shall direct the remedial action at the site according to the following scope of work:

1. Assess the extent and degree of contamination. This includes evaluating existing information, and gathering additional information if necessary.

2. Develop and recommend method(s) for additional cleanup of soil and groundwater contamination if necessary. Cleanup may involve excavation of contaminated soils or an alternative treatment technology such as a vapor extraction system, or a combination thereof. The extent of excavation shall be the limits of contamination, or such other limits as determined by Ecology in accordance with WAC 173-340. Ecology shall coordinate treatment of the excavated soils. On-site o

off-site treatment of the soils may prove impracticable, and Ecology shall then coordinate proper disposal of the soil. Alternative treatment technology may be employed if that technology is determined to be the most suitable for the situation, in the professional judgment of the designated project coordinator (see Part VII of this document). Cleanup shall continue until cleanup standards in accordance with WAC 173-340 Part VII are achieved. Ecology may determine that cleanup requires groundwater treatment.

3. Conduct a remedial investigation to assess the potential for on-site and off-site environmental and human health impacts of identified contamination. If groundwater contamination is found, a more extensive remedial investigation, including a groundwater study, and also a feasibility study may be required to assess the extent of contamination and propose methods of remediation.

4. Develop a Cleanup Action Plan as soon as possible after the remedial investigation and, if necessary, the feasibility study have been completed. Ensure the Cleanup Action Plan is or has been properly implemented.

5. Document all observations, conditions, and results in a final report with at least four copies, one for the property owner and three for the Ecology site inspector.

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VII. DESIGNATED PROJECT COORDINATOR

The project coordinator for Ecology is:

Joe Hickey (206) 649-7202
Department of Ecology
Northwest Regional Office
3190 - 160th Avenue S.E.
Bellevue, WA 98008-5452

The project coordinator shall be responsible for overseeing the implementation of this Decree. To the maximum extent possible, communications between Ecology and the Defendant, and all documents, including reports, approvals, and other correspondence concerning the activities performed pursuant to the terms and conditions of this Decree, shall be directed through the project coordinator. Should Ecology change project coordinator, written notification shall be provided by Ecology at least ten (10) calendar days prior to the change.

VIII. REIMBURSEMENT OF ECOLOGY'S COSTS

1. Ecology has determined that the Defendant is eligible for mixed funding. The Defendant agrees to reimburse Ecology for the costs Ecology incurs in remediating the release and/or threatened release of hazardous substances at the site, including future monitoring (if any), up to a maximum dollar amount of fifty thousand dollars ($50,000) including interest if applicable. In the event Ecology incurs remedial action costs exceeding $50,000, payment of such costs shall be satisfied by use of funds from the Toxics Control Account.

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2. Payment of Ecology's remedial action costs shall be due on the first (1st) of each calendar month commencing upon receipt of billing from Ecology. Ecology shall provide the Defendant itemized quarterly statements describing the remedial action costs incurred at the site.

3. During the reimbursement period, the Defendant agrees to make monthly payments of not less than three hundred ($300) dollars. The Defendant shall be notified in writing when its obligation to reimburse Ecology under this Decree has been satisfied.

4. Monthly payments not received by Ecology within thirty (30) days of the date due shall be considered late payments and bear interest at a rate of one percent (1%) per month, or fraction thereof.

5. Ecology's determination regarding mixed funding applies only to the Defendant and is not transferable. In the event the Defendant sells, assigns, or otherwise transfers any or all interest in the site while this Decree is in effect, the new owner may be liable for remedial action costs incurred by Ecology at the site. If the Defendant sells, assigns, or otherwise transfers its interest in the site while this Decree is in effect, the remedial action costs incurred by Ecology up to the date of such sale, assignment, or transfer shall, subject to paragraph 1 above, become immediately due and payable regardless of whether the payment period described in

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paragraph 3 above has commenced. Unless the immediate payment required under this paragraph fully satisfies the Defendant's obligation under Section VIII, paragraph 1 of this Decree, the Defendant shall remain liable for payment of Ecology's future remedial action costs at the site according to the terms of this agreement.

6. The Defendant consents to the immediate filing of a special lien in the amount of fifty thousand dollars ($50,000) on the property located at 2350 - 24th Avenue East, Seattle, Washington to secure the Defendant's performance under this Decree. Once the Defendant's obligation to reimburse Ecology under this Decree has been satisfied, the Defendant may request in writing that Ecology file a lien termination statement with the court.

7. The Defendant agrees that if it fails to fully reimburse Ecology for its share of remedial action costs or refuses to make the monthly payments required under this Decree after receiving thirty (30) days written demand, Ecology may pursue any means authorized by law including but not limited to foreclosure of its lien to satisfy the Defendant's obligation under this Decree. If foreclosure of the lien occurs but fails to satisfy the Defendant's obligation under this Decree, the Defendant shall remain liable to reimburse Ecology for any outstanding balance owing.

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Foreclosure proceedings will be in accordance with all applicable Washington State laws and regulations.

IX. ACCESS

Ecology or any Ecology authorized representative or contractor hired by Ecology, shall have the authority to enter and freely move about the site at all reasonable times for the purposes of performing remedial action at the site.

X. TRANSFERENCE OF PROPERTY

A. No voluntary conveyance or relinquishment of Defendant's title, easement, leasehold, or other interest in any portion of the site shall be consummated without provision for continued performance of all of Defendant's obligations under this Decree. If an involuntary conveyance or relinquishment of such interest occurs, the Defendant shall, if possible, give prior written notice of this Decree to the transferee.

B. Within 90 days of entry of this Decree, the Defendant shall record a notice in the title records to that portion of the property underlying the site over which Defendant holds fee title. The notice shall state that a Consent Decree entered in the above-captioned proceeding imposes certain restrictions on the use and improvement of the site, and that said restrictions run with the land. Within 30 days of filing the notice with the King County Auditor, the Defendant shall forward a copy of the notice to Ecology.

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XI. DISPUTE RESOLUTION

The Defendant may request Ecology to resolve disputes which may arise during the implementation of this Consent Decree. Such request shall be in writing and directed to the signatory of this Consent Decree. Ecology resolution of the dispute shall be binding and final. The Defendant is not relieved of any requirement of this Consent Decree during the pendency of the dispute and remains responsible for timely compliance with the terms of the Consent Decree unless otherwise provided by Ecology in writing.

XII. AMENDMENT OF CONSENT DECREE

Any Amendment to this Decree must be in writing and signed by the parties. Such amendment shall become effective when entered by the court.

XIII. INDEMNIFICATION

The Defendant agrees to indemnify and save and hold the State of Washington, its employees, and agents harmless from any and all claims or causes of action for death or injuries to persons or for loss or damage to property arising from or on account of acts or omissions of the Defendant, its officers, employees, agents, or contractors in entering into and implementing this Decree; provided, however, that the Defendant shall not indemnify the State of Washington nor save nor hold its employees and agents harmless from any claims or causes of action brought by third parties arising out of the

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negligent acts or omissions of the State of Washington, or the employees or agents of the state, in implementing the activities pursuant to this Decree.

XIV. PUBLIC NOTICE AND PARTICIPATION

Ecology shall be the lead for public notice and participation at the site. If requested, Ecology shall allow the Defendant to review fact sheets, press releases, and public notices prior to issuance.

XV. SATISFACTION OF THIS DECREE

The provisions of this Decree shall be deemed satisfied upon the Defendant's reimbursement to Ecology of all reasonable costs incurred by Ecology in performing remedial action at the site.

XVI. EFFECTIVE DATE

This Decree is effective upon the date it is entered by the court.

XVII. PUBLIC NOTICE AND WITHDRAWAL OF CONSENT

This Decree will be subject to public notice and comment under RCW 70.105D.040(4)(a). Ecology reserves the right to withdraw or withhold its consent to the proposed final Decree as the comments received by Ecology disclose facts or considerations which indicate that the proposed Decree is inappropriate, improper, or inadequate.

If the court withholds or withdraws its consent, this Decree shall be null and void at the option of any party and

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the accompanying complaint shall be dismissed without cause and without prejudice. In such an event, no party shall be bound by the requirements of this Decree.

Carol L. Fleskes — 2/19/92

CAROL FLESKES, Program Manager
Hazardous Waste Cleanup
Washington State
Department of Ecology

Date

Choung Kuk Jin — 2-18-92

KUK JIN CHOUNG
Owner and Operator
Circle K Station #1461

Date

E. Christina Beusch — April 1, 1992

E. CHRISTINA BEUSCH, WSBA #18226
Assistant Attorney General
Ecology Division
Washington State
Office of Attorney General

Date

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GeoEngineers 1990

REPORT OF GEOTECHNICAL SERVICES
SUBSURFACE CONTAMINATION STUDY
AND REMEDIAL ACTION MONITORING
CIRCLE K FACILITY 1461
SEATTLE, WASHINGTON

3/6/90

GeoEngineers

March 6, 1990

Consulting Geotechnical Engineers and Geologists

The Circle K Corporation
P.O. Box 52084
Phoenix, Arizona 85072

Attention: Mr. Robert F. Staab

We are submitting two copies of our geotechnical report regarding subsurface contamination and remedial action monitoring at the site of Circle K Facility No. 1461 in Seattle, Washington. The Circle K Corporation requested that GeoEngineers provide geotechnical consulting services in response to a gasoline leak from an underground storage tank at the subject site. The general scope of our services is described in our confirming agreement dated September 1, 1989. Our services were authorized by Mr. Robert F. Staab of the Circle K Corporation on September 5, 1989.

We appreciate the opportunity to be of service to the Circle K Corporation. Please call if you have any questions regarding this report.

Yours very truly,

GeoEngineers, Inc.

James A. Miller
Principal

OKP:JAM:cs

cc: ✓ Mr. Joseph Hickey
Washington Dept. of Ecology
Northwest Regional Office
4350 - 150th Ave. NE
Redmond, WA 98052-5301

File No. 1780-001-B04

GeoEngineers, Inc.
2405 140th Ave. NE, Suite 105
Bellevue, WA 98005
Telephone (206) 746-5200
Fax. (206) 746-5068

Geo Engineers

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GeoEngineers

REPORT OF GEOTECHNICAL SERVICES
SUBSURFACE CONTAMINATION STUDY
AND REMEDIAL ACTION MONITORING
CIRCLE K FACILITY 1461
SEATTLE, WASHINGTON

INTRODUCTION

The results of our subsurface contamination study and remediation activities at Circle K Facility No. 1461 are presented in this report. Facility No. 1461 consists of a convenience store which also markets leaded and unleaded gasoline. The store is located at 2350 - 24th Avenue East in Seattle, Washington. The site location relative to surrounding physical features is shown in Figure 1. A generalized site plan of the facility is presented as Figure 2.

On August 7, 1989, a leak was discovered in one of the site's underground gasoline storage tanks (Figure 2). A review of the inventory records for this 4,000-gallon tank indicated that approximately 4,000 to 6,000 gallons of gasoline were released between June 22, 1989 and August 7, 1989. The product remaining in the leaking tank was removed and the Washington State Department of Ecology (Ecology) was notified of the release on August 7, 1989.

Fuel vapors were observed in a restroom located in the basement of the Museum of History and Industry subsequent to the discovery of the leak in the underground fuel tank. The Museum is located approximately 2000 feet north of the Circle K site as shown in Figure 1. Seattle Engineering Department personnel responsible for wastewater discharge performed a qualitative investigation of potential sources for the fuel vapors. According to the Seattle Engineering Department, the vapors appeared to originate from the sanitary sewer system.

Fuel odors were observed at several locations in the sanitary sewer lines upgradient of the Museum of History and Industry. The vapors appeared to be concentrated in areas of the sewer lines associated with construction activities along Lake Washington Boulevard (Figure 1). Because the area upgradient of the Museum is almost exclusively residential, the nearest potential source of the fuel vapors observed in the sanitary sewer system was believed to be the Circle K facility. As shown in Figure 2, the leaky

underground fuel tank at the Circle K facility was located within 40 feet of the main sanitary sewer line beneath East McGraw Street. Several reports of fuel odors in the general vicinity of the Circle K site suggested that the underground storage tank leak had potentially affected off-site locations.

This report presents results from the assessment of subsurface contamination at the site and the initial phase of soil and ground water remediation.

PURPOSE AND SCOPE

The purposes of our geotechnical services were to (1) explore and evaluate subsurface conditions, (2) develop recommendations for remedial actions, (3) coordinate and observe remedial construction activities, and (4) monitor the effectiveness of the initial remedial measures at the site. The general scope of services provided by GeoEngineers during this investigation is listed below.

1. Research potential pathways for the migration of fuel and/or gasoline vapors from the site to the sanitary sewer system.
2. Explore and evaluate subsurface contamination at the site through several phases of exploratory drilling and monitor well installations.
3. Monitor the excavation and removal of six underground storage tanks (USTs).
4. Design and monitor the installation of a free (floating) product recovery and ground water treatment system.
5. Design and monitor the installation of a soil vapor extraction system (VES).
6. Interface with regulatory agencies, contractors, and neighboring residents during all phases of this investigation.
7. Evaluate the field and laboratory data with regard to existing regulatory concerns.

A description of the specific scope of services completed during each phase of this investigation is included in subsequent sections of the report.

SITE CONDITIONS

GENERAL

Circle K Facility No. 1461 is located southeast of the intersection between 24th Avenue East and East McGraw Street, approximately 1800 feet south of Lake Washington. The area surrounding the site consists mainly of residential houses and buildings, with some small commercial businesses located west of the site along 24th Avenue East. The regional topography in the vicinity of the site slopes downward toward the north and northeast. The ground surface elevation at the site is approximately 70 feet above mean sea level.

The general layout of Circle K Facility No. 1461 is shown in Figure 2. At the start of our site assessment activities, facilities on the property included the store building, a fuel pump service island, four underground fuel storage tanks, one underground waste oil tank, and one underground heating oil tank. The four underground fuel tanks were used for the storage of regular and unleaded gasoline. The underground waste oil and heating oil tanks were not being used at the time of our site assessment.

As shown in Figure 2, several underground sewer lines are located beneath the north part of the site. All of these lines drain north toward the main sanitary sewer line located beneath the center of East McGraw Street. The sanitary sewer line on East McGraw Street is located at a depth of approximately 12 feet below the surface of the street. The upgradient terminus of this sewer line is located immediately west of the manhole in front of the store. The sewer line slopes downward toward the east. The two catch basins located on the Circle K property drain surface water runoff into the sanitary sewer system.

The specific scope of services completed for the subsurface contamination assessment of the site is listed below.

1. Drill sixteen exploration borings located both on-site and off-site using hollow-stem auger equipment.
2. Obtain soil samples at five-foot intervals in each boring, and field screen each sample for evidence of fuel hydrocarbon contamination using visual, headspace vapor, and water sheen techniques.

3. Analyze selected soil samples from each boring for benzene, ethylbenzene, toluene, and xylenes (BETX) using EPA Method 8020, and for fuel hydrocarbons using modified EPA Method 8015.
4. Install ground water monitor wells in the exploration borings.
5. Determine the monitor well casing elevations to an accuracy of 0.01 feet using an assumed site datum.
6. Measure the ground water table elevations in the monitor wells and sample each well for the presence of free (floating) fuel hydrocarbons.
7. Measure the air space in each well casing for combustible hydrocarbon vapors using a Bacharach TLV Sniffer.
8. Obtain ground water samples from the monitor wells for laboratory analysis of BETX compounds using EPA Method 602, and total petroleum hydrocarbons (TPH) using EPA Method 418.1.
9. Measure the free (floating) product recovery rates in three of the monitor wells following bailer drawdown tests.
10. Evaluate the field and laboratory data with regard to existing regulatory concerns and the feasibility of various soil and ground water remediation options.

SUBSURFACE SOIL CONDITIONS

Subsurface soil conditions beneath and adjacent to the Circle K site were explored by drilling sixteen hollow-stem auger borings at the locations indicated in Figure 3. The borings were drilled and sampled to depths ranging from 19.0 to 31.0 feet below ground surface. Details of the field exploration program and boring logs are presented in Appendix A. The exploration borings were drilled in September, October, and December 1989 during three separate phases of the site assessment.

Layers of sandy silt and silty fine sand were encountered beneath the surface layers of asphaltic concrete, concrete, and fill material. The individual layers of sandy silt and silty sand vary in thickness over short distances, and are often laterally discontinuous. Occasional gravel and cobbles were encountered in some of the silt and sand layers. A very dense to hard layer consisting of fine-grained glacial sediments was encountered at depths greater than approximately 14 feet in most of the borings.

GROUND WATER CONDITIONS

Ground water conditions in the vicinity of the site were explored by installing monitor wells in the sixteen borings. Construction details for the monitor wells are included with the boring logs in Appendix A. The depth to ground water in each well was measured periodically throughout the duration of this study. A summary of ground water elevations measured in the monitor wells between September 1989 and late December 1989 is presented in Table 1.

The ground water table in the site vicinity ranges from approximately 10 to 12 feet below the ground surface. Ground water elevations measured on October 9 and December 28, 1989 were used to construct the ground water contour maps presented as Figures 4 and 5, respectively. The ground water elevations measured in MW-5 and MW-12 (not shown in Figures 4 or 5) are consistent with the ground water contours shown in Figures 4 and 5. Based on our ground water monitoring data, shallow ground water in the vicinity of the site flows toward the northeast at a gradient of approximately 125 feet/mile (.024 ft/ft). Ground water elevations in individual wells fluctuated during this study in response to (1) seasonal precipitation, (2) nearby open excavations affecting local recharge or discharge of ground water, (3) the thickness of free product on the water table, and (4) operation of the fuel recovery system.

SUBSURFACE CONTAMINATION

Potential subsurface contamination at the site was evaluated by field observations, collecting and analyzing soil and ground water samples, measuring the concentration of hydrocarbon vapors in the monitor wells, and measuring the thickness of free product in the monitor wells. The subsurface contamination data resulting from our investigation of site conditions are summarized in Tables 2, 3, 4 and 5. Laboratory data sheets and chain-of-custody records for the soil samples collected from the borings are included in Appendix B. Appendix C contains laboratory data sheets and chain-of-custody records for the ground water samples collected from the monitor wells.

The field screening methods used to detect the potential presence of petroleum hydrocarbons in soil samples collected from the borings included

visual examination, headspace vapor measurements, and sheen testing. A description of the field screening techniques used during this investigation are included in Appendix A. Field screening results for soil samples collected from the monitor well borings are noted in the boring logs (Appendix A).

Fuel hydrocarbon odors were detected during the drilling of MW-2, MW-3, MW-4, MW-6, MW-8, MW-9, MW-10, MW-13, and MW-15. Headspace vapor measurements were made in the field on soil samples using a Bacharach TLV Sniffer. The highest headspace vapor concentrations were detected in samples collected from MW-2, MW-3, MW-4, MW-6, MW-8, MW-9, MW-13 and MW-15. Headspace vapor concentrations ranged up to greater than 10,000 ppm (91 percent LEL) in the soil samples collected from these eight monitor wells.

Based on field screening results, selected soil samples were analyzed for the presence of BETX and fuel hydrocarbons. As shown in Table 2, BETX and fuel hydrocarbons were not detected in most of the soil samples. Relatively low concentrations of BETX were detected in the soil samples obtained from MW-3, MW-7, MW-13, MW-15 and MW-16. The highest concentration of fuel hydrocarbons was 1200 ppm, detected in the soil sample collected from MW-4 at a depth of 8.5 feet. This sample also contained the highest concentrations of ethylbenzene (27,000 ppb), toluene (27,000 ppb) and xylenes (159,000 ppb). Well MW-4 is located immediately downgradient from the leaky underground fuel tank, and the depth of this soil sample corresponds laterally to the approximate depth of the tank bottom.

The concentrations of combustible hydrocarbon vapors in the well casings were measured with a Bacharach TLV Sniffer on December 28, 1989. Table 3 presents the results of the vapor measurements. Hydrocarbon vapors were detected at concentrations greater than 10,000 ppm (91 percent LEL) in MW-2, MW-3, MW-4, MW-6, MW-8, MW-9, MW-13 and MW-15. Hydrocarbon vapor concentrations of 480 and 1600 ppm were detected in MW-7 and MW-16, respectively. The concentrations of hydrocarbons vapors in the remaining wells were less than 400 ppm, which is typical of "background" conditions for measurements in monitor well casings with a Bacharach TLV Sniffer.

Free (floating) product was detected in MW-2, MW-3, MW-4, MW-8 and MW-9. Table 4 presents free product thickness data collected from

September 1989 through December 1989. Contour maps of the apparent thickness of free product as measured in the wells casings on October 9 and December 28, 1989 are presented as Figures 6 and 7. Based on our measurements, free product appears to have flowed in a northwest direction away from the leaky underground tank. As shown in Table 4, Wells MW-8 and MW-9, located northwest of the leaky underground tank, contained a significant thickness of free product. Between October 9 and December 8, 1989 the thickness of free product in Well MW-8 increased from 0.11 feet to 9.50 feet, while the thickness of free product in Well MW-9 decreased from 4.63 feet to 0.50 feet. On December 28, 1989 the thickness of free product in MW-8 was 0.37 feet and in MW-9 was 0.27 feet. Maximum product thickness measured on October 9, 1989 was 5.90 feet in Well MW-4. Maximum product thickness measured on December 28, 1989 was 0.55 feet in MW-4.

Water/product bail-down tests were performed on Wells MW-2, MW-3 and MW-4 in September 1989. The ground water depth and free product thickness were measured in each well over a period of six days after removing all of the free product present in the well. Results from this test indicated relatively low product thickness recovery rates (0.14-0.65 feet/day).

Ground water samples collected from the monitor wells were analyzed for the presence of BETX by EPA Method 602. Ground water samples collected from MW-1 and MW-5 were also analyzed for the presence of TPH by EPA Method 418.1. A summary of the water quality results is presented in Table 5.

Water samples collected from wells which contained free product were not analyzed because of potential mixing of free product with the water. However, very high concentrations of BETX can be assumed for shallow ground water in the vicinity of wells containing free product.

The water samples collected from MW-6, MW-13, and MW-15 contained the highest concentrations of BETX. These three wells are located near the edge of the free product plume. Samples collected from the other monitor wells contained relatively low or undetected concentrations of BETX. Total petroleum hydrocarbons (TPH) were not detected in the ground water samples obtained from MW-1 and MW-5.

TANK REMOVAL AND EXCAVATION OF CONTAMINATED SOIL

Installation of an effective subsurface remediation system required the removal of the four underground fuel storage tanks. During our site assessment fieldwork, a waste oil tank and heating oil tank were discovered at the site (Figure 2). These two tanks were not being used as part of facility operations, and were likely installed and maintained by the service station which formerly occupied the site.

The limits of the excavations for removal of underground tanks at the Circle K site are shown in Figure 8. Tables 6 and 7 summarize the chemical data resulting from the laboratory analyses of soil samples collected from the excavations. A summary of the analytical data for samples collected from the soil stockpiles is presented in Table 8. Laboratory data sheets and chain-of-custody records for the soil samples collected from the excavations and stockpiles are included in Appendix D.

The waste oil and heating oil tanks contained significant quantities of residual product prior to removal. ChemPro removed the residual products from the USTs. All of the USTs were excavated, removed and transported off-site by ChemPro.

Approximately 900 cubic yards of contaminated soil were removed from the excavations and placed in covered stockpiles for temporary storage at the Circle K site. The stockpiles were segregated according to the type and relative concentrations of contaminants observed during the excavation of the soil. All of the contaminated soil was transported off-site for disposal at the Olympic View Sanitary Landfill, located in Kitsap County, Washington.

One of the objectives of the remedial activities was to excavate and expose the lateral sanitary and stormwater sewer lines located beneath the north part of the property. These sewer lines drain into the main sanitary sewer line beneath East McGraw Street. Because fuel vapors previously had been detected in the sanitary sewer lines in the vicinity of the site, we examined the lateral sewer lines located in the area of the free product plume for evidence of leakage of free product into the sewer system.

During the excavation of the underground fuel tanks and the recovery trenches, several abandoned sewer and drain lines were encountered which were previously not known to exist. These abandoned lines were encountered

at depths ranging from 3 to 6 feet below existing grade along the northern property line, which is shallower than the bottom of the leaky tank. The locations of sewer and catch basin drain lines known to exist beneath the site are shown in Figure 2. All of the sewer lines which were not being used to drain existing structures or catch basins were completely removed or abandoned in place by grouting the ends of the pipes.

Waste Oil and Heating Oil Tanks: The underground waste oil and heating oil tanks were excavated and removed on October 11, 1989. Table 6 presents a summary of the laboratory data resulting from the chemical analyses of soil samples collected from the limits of the tank excavations.

Visual examination of the waste oil and heating oil tanks after excavation and removal revealed some surface pitting of the exterior tank walls, but no perforations. Field screening of soil samples indicated the presence of petroleum-related contaminants in the soil surrounding each of the tanks. Soil which appeared to be contaminated with petroleum hydrocarbons was removed from each of the tank excavations prior to collecting soil samples for laboratory analysis.

Less than 10 cubic yards of contaminated soil were removed from the heating oil tank excavation after removing the tank. Petroleum-related contamination appeared to be confined to the soil immediately surrounding this UST.

Approximately 80 cubic yards of contaminated soil were removed from the waste oil tank excavation. Most of the soil contamination was encountered below the base of the waste oil tank and along the east wall of the tank excavation. Excavation of contaminated soil extended to a maximum depth of approximately 11 feet below ground surface.

As shown in Table 6, all of the soil samples collected from the limits of the waste oil and heating oil tank excavations contained TPH concentrations of less than 200 parts per million (ppm), which is currently used by Ecology as a soil cleanup guideline for evaluating contamination at underground tank sites.

Gasoline Storage Tanks: The four underground gasoline storage tanks were excavated and removed on October 16, 1989. Free product was visible at the bottom of the excavation after removing each of the tanks. Except

for the leaky tank, perforations, pitting and excessive corrosion were not observed on any of the gasoline tanks after they were removed from the excavation.

An area of apparent minor corrosion was observed at the base of the leaky tank immediately after removal of the tank from the excavation. Approximately one-half hour after the leaky tank was excavated and removed, a one-inch diameter perforation was visible in the corroded area on the tank bottom, and some residual product was observed leaking from this perforation.

Additional Soil Excavation near Former Gasoline Tanks: Additional areas of contaminated and uncontaminated soil were excavated within and adjacent to the gasoline tank excavation to assist with the remediation of contaminated soil and ground water. These soil excavations were designed to assist with the recovery of (1) free product on the water table, (2) contaminated ground water, and (3) fuel-related soil vapors. The locations and approximate limits of the soil excavations are shown in Figure 8.

After removing the four underground gasoline tanks from the site, contaminated soil was excavated from the tank excavation to a depth of approximately 14 to 16 feet below existing grade. The recovery well excavation, located along the north wall of the tank excavation, extended to a depth of about 21.5 feet below existing grade. Three ground water/free product recovery trenches were excavated to depths ranging from 12 to 14 feet below existing grade along the north wall of the tank excavation (Figure 8). Approximately 80 to 100 gallons of free product were recovered from the open excavations. The recovered free product was transported off-site by ChemPro.

Eight soil samples were collected from the walls of the gasoline tank and recovery trench excavations at the locations indicated in Figure 8. These samples were collected and analyzed to determine the concentrations of fuel-related contaminants present at the limits of excavation. A summary of the analytical results for these samples is presented in Table 7. Each soil sample was analyzed for fuel hydrocarbons by modified EPA Method 8015, and for BETX by EPA Method 8020.

All of the samples collected from the walls of the tank excavation, except for EW-1, contained high concentrations of BETX and fuel

hydrocarbons. The three samples collected near the distal ends of the recovery trenches (Sample Nos. WT-1, MT-1 and ET-3) contained relatively low concentrations of BETX and fuel hydrocarbons. However, field screening of soil samples collected during excavation of the west and middle recovery trenches indicated extensive fuel-related contamination. The soil encountered during the excavation of the east recovery trench did not appear to contain high concentrations of fuel hydrocarbons based on field screening techniques.

Sampling and Disposal of the Soil Stockpiles: All of the soil removed from the various excavations was stored temporarily in covered stockpiles at the site. Several composite soil samples were collected from the stockpiles for laboratory analysis to characterize the soil for landfill disposal. A summary of the laboratory results for these composite samples is presented in Table 8.

Sample No. WO-11 was collected from a stockpile of soil removed from the waste oil tank excavation and which appeared to be slightly contaminated by petroleum hydrocarbons. This soil required excavation and removal to provide access to soil containing higher concentrations of petroleum contaminants. As shown in Table 8, Sample No. WO-11 contained a TPH concentration of 108 ppm, which is less than the Ecology guideline of 200 ppm (TPH) for soil requiring remediation at underground tank sites. This soil stockpile was used to backfill part of the waste oil tank excavation.

Sample No. C-1 was collected from the stockpile composed of gasoline-contaminated soil removed from the gasoline tank and recovery trench excavations. This soil contained high concentrations of BETX, TPH and gasoline (Table 8). Sample No. C-2, collected from the stockpile composed of contaminated soil excavated from the heating oil and waste oil tank excavations, contained a high TPH concentration (488 ppm). Both of these stockpiles were removed from the site and transported to the Olympic View Sanitary Landfill between October 21 and November 8, 1989.

INSTALLATION OF GROUND WATER AND SOIL REMEDIATION SYSTEMS

Free Product Recovery and Ground Water Treatment System: The ground water and free product remediation system is designed to recover subsurface

water as it flows through the two carbon filters. Elevated concentrations of benzene (16,000 to 36,000 ppb) were detected in the samples collected from the water flowing from the first carbon filter into the second carbon filter (Sampling Port No. 2). The results from these two rounds of sampling indicated that the first carbon filter was saturated with benzene. This spent carbon filter was replaced on January 5, 1990.

The discharge from the water treatment system was monitored and sampled in accordance with the requirements outlined in the Metro Authorization for Discharge. A sample of the treated discharge water was collected from Sampling Port No. 3 on December 18, 1989. Results from the chemical analysis of this sample are summarized in Table 10. The analytical results indicate undetected or trace concentrations of the compounds which were tested. The pH of the discharge water is typical of clean ground water, and combustible vapors were not detected at the point of discharge to the lateral sewer pipe. The results of our first episode of monthly sampling and monitoring of the ground water treatment system were submitted to Metro on January 16, 1990.

The VES was tested after completing installation of the remediation equipment. The exhaust blower fan was operated for approximately 30 minutes on December 6, 1989. The average vacuum pressure in the VES was approximately 15 inches of water, which corresponds to an average flow rate of approximately 80 cubic feet per minute (cfm) for the blower fan. A Bacharach TLV Sniffer was used to measure the hydrocarbon vapor concentrations in the VES. Measurements at Sampling Port No. 1, located upstream of the carbon filters, indicated a hydrocarbon vapor concentration of 8,500 ppm. The concentrations of hydrocarbon vapors in Sampling Port Nos. 2 and 3 were 160 ppm and 140 ppm, respectively.

DISCUSSION OF RESULTS

ASSESSMENT OF SUBSURFACE CONTAMINATION

Free product was detected on the ground water table in five of the monitor wells installed during our subsurface contamination study. Ground water is located at a depth of approximately 10 to 12 feet beneath the site, and the direction of ground water flow is toward the northeast. Free product thickness measurements suggest that the free product appears to have

flowed initially in a direction transverse to the direction of shallow ground water flow in the vicinity of the site. The location of the free product plume northwest of the leaky tank is probably related to discontinuous layers of permeable sediments within the ground water table zone, which provided a preferential pathway for the migration of free product. The variations in the free product thicknesses measured in MW-8 and MW-9 during our site assessment activities may indicate a gradual shift in the flow of the free product plume from a northwest direction to a northeast direction, coincident with the direction of ground water flow. The lateral extent of the free product plume was defined based on free product thickness measurements, and appears to be confined to a relatively small area north of the leaky underground fuel tank.

Fuel-contaminated ground water was encountered in the monitor wells located immediately outside of the edge of the free product plume. Data resulting from the chemical analyses of water quality samples collected from MW-6, MW-13, and MW-15 indicate benzene concentrations ranging from 250 to 13,000 ppb. These concentrations exceed Ecology's current ground water cleanup guideline of 66 ppb benzene at underground storage tank sites. The current drinking water quality standard for benzene is 5 ppb.

Measurements of hydrocarbon vapors in the monitor well casings indicate high concentrations of vapors in the wells located in the vicinity of the free product plume. However, based on vapor measurements in the remaining wells, the subsurface hydrocarbon vapors in the soil have not migrated far from the free product plume. Subsurface hydrocarbon vapors are not regulated by a cleanup standard.

Subsurface gasoline-related soil contamination appears to limited to the vicinity of the former underground gasoline storage tanks. Samples collected from the north, south, and west walls of the gasoline tank excavation contained concentrations of fuel hydrocarbons and/or BETX which exceed current Ecology cleanup guidelines for soil contamination at underground storage tank sites. The current Ecology cleanup guidelines are 200 ppm for TPH or fuel hydrocarbons, and 660 ppb for benzene.

High concentrations of fuel hydrocarbons and BETX were detected in the soil sample collected at a depth of 8.5 feet in MW-4, located north of the

leaky UST. This sample exceeded the Ecology cleanup guideline of 200 ppm TPH. Soil samples collected for chemical analyses from the other monitor well borings did not contain fuel-related contaminants in concentrations exceeding Ecology's guidelines. However, soil with high concentrations of gasoline and benzene can be expected in the water table zone throughout the limits of the free product (Figure 7).

Laboratory analysis of fuel hydrocarbons (modified EPA Method 8015) indicate the presence of elevated concentrations of diesel fuel in several of the soil samples collected from the limits of the gasoline tank and recovery trench excavations (Table 7). The presence of diesel fuel contamination is not consistent with the gasoline leak that is considered the principal source of subsurface contamination at the site. The compound identified as diesel fuel may be a degradation product from the free gasoline product dissolving the tar coating observed around some of the underground fuel tanks. The presence of diesel fuel in these soil samples could also be the result of leakage from one or more of the site's former USTs, which may have stored diesel fuel.

Soil samples obtained from the limits of the heating oil and waste oil tank excavations indicate that soil remaining in these areas does not contain TPH concentrations greater than the Ecology cleanup guideline of 200 ppm.

A few sections of the lateral and main sanitary sewer lines are located at a depth corresponding to the limits and depth of the free product plume, and free product may have directly entered the sewer system prior to site remediation activities. Although fuel vapors were detected by the Seattle Engineering Department in the sanitary sewer system downstream of the site in August 1989, no evidence of the direct transport of free product from the site into the sanitary sewer system was observed during our subsurface studies. However, fuel vapors originating from the site also could be migrating from the soil into the sewer system through damaged sections of the sewer lines.

Repairs were made on some of the lateral sewer and drain lines located in the vicinity of the gasoline tank excavation to eliminate potential pathways for future migration of free product and vapor into the sanitary

backfill of the gasoline tank and recovery trench excavations. Continued operation of the VES at similar untreated hydrocarbon vapor concentrations will result in very short operating lives for the carbon filters. Hydrocarbon vapor concentrations removed by the VES are likely to be less when the average rate of free product recovery decreases to less than 1 gpd.

The installation of a separate set of vapor recovery lines connected to the sewer lines will allow direct remediation of fuel vapors present in the sewer system if high fuel vapor concentrations are detected in the sanitary sewer lines at a later date. If necessary, a separate aboveground VES will be installed to remove and treat fuel vapors which may be present in the sewer system. However, the recovery of sewer vapors is not anticipated because the combination of the existing soil VES and free product recovery system is expected to prevent the entry of significant concentrations of subsurface fuel vapors into the sanitary sewer system.

CONCLUSIONS

Based on the results of our subsurface contamination study at Circle K Facility No. 1463, on-site and off-site ground water and soil contamination have resulted from a leak in one of the site's underground fuel storage tanks. Although fuel odors were detected in the sanitary sewer lines downgradient from the leaky tank, we observed no evidence of free product or fuel vapors flowing directly into the sanitary sewer system during site assessment and remediation activities.

The lateral extent of the free product plume was defined and appears to be confined to a relatively small area north of the leaky underground fuel tank. Fuel-contaminated ground water and high concentrations of hydrocarbon vapors were encountered in the monitor wells located immediately outside of the edge of the free product plume.

All of the existing underground storage tanks were excavated and removed from the site. Contaminated soil removed from the tank excavations and the recovery trenches was transported off-site for landfill disposal. Soil samples collected during remediation activities indicate high concentrations of BETX in the soil surrounding the former underground

gasoline tanks, and in the soil in the vicinity of the free product plume. The most extensive soil contamination appears to be located north and west of the gasoline tank excavation.

A free product recovery and ground water treatment system was installed and operated during this phase of site remediation. Our initial monitoring of the remediation systems indicate effective recovery of free product and contaminated ground water. Approximately 280 gallons of free product were recovered from the ground water table during this phase of site remediation. Laboratory data indicate effective treatment of approximately 46,500 gallons of contaminated ground water. A soil vapor extraction system was installed, successfully tested, and is ready for continuous operation after the rate of free product recovery decreases.

The remedial action plan implemented to recover free product and treat contaminated soil and ground water is progressing successfully. Results from our initial monitoring of the site remediation systems indicate a positive effect on containing and reducing subsurface contamination in the area. We anticipate that the combined operation of the free product recovery system and the soil VES will minimize the potential for the discharge of subsurface fuel vapors into the sewer system.

RECOMMENDATIONS

Continued operation and monitoring of the free product recovery and ground water treatment system is recommended. The ground water elevation, free product thickness, and concentration of hydrocarbon vapors should be measured monthly in each of the fourteen existing monitor wells. Water quality samples should be collected from the wells located near the edge of the free product plume, and the samples should be analyzed for the presence of BETX. The monitor wells should be sampled semi-annually in March and September, corresponding to the maximum and minimum seasonal water levels in the wells.

Monthly sampling and monitoring of the treated water discharged into the sanitary sewer system is required by the Metro Authorization for Discharge. Monthly reports containing results from the sampling and analyses outlined in the Authorization for Discharge are required by Metro. Additional samples should be collected from the three water sampling ports

on a routine basis and analyzed for BETX to verify the effectiveness of the treatment system and to evaluate whether the filters need replacement.

We anticipate longer time intervals between carbon filter replacements due to the decrease in the pumping rate of contaminated ground water flowing through the treatment system. Alternative ground water treatments systems will be evaluated if the carbon filtration system consumes excessive quantities of activated carbon.

We recommend that the VES not be operated until the average rate of free product recovery decreases to less than 1 gpd. After the VES begins continuous operation, we recommend monitoring the vapor concentrations using the installed sampling ports and a Bacharach TLV Sniffer. Monitoring of the treated and untreated soil vapors is required for compliance with the PSAPCA Permit, and for verification of effective trapping of vapors in each of the carbon filters. Periodic collection of air samples from the sampling ports for BETX analysis (EPA Method 8020) is also recommended. Vacuum pressure and hydrocarbon vapor concentration should be measured monthly in selected monitor wells once the VES is operating.

Relatively high rates of carbon consumption may occur during operation of the VES. Optional methods for treatment of the recovered vapors should be evaluated if carbon replacement costs become excessive.

LIMITATIONS

We have prepared this report for use by the Circle K Corporation. The report may be made available to regulatory agencies. This report is not intended for use by others, and the information contained herein may not be applicable to other sites.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time this report was prepared. No other conditions, expressed or implied, should be understood.

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GeoEngineers

Please call if your have questions regarding this report.

Respectfully submitted,

GeoEngineers, Inc.

Otto K. Paris
Project Geologist

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Principal

OKP:JAM:db

TABLE 1
GROUND WATER ELEVATIONS IN MONITOR WELLS, SEPTEMBER 1989 THROUGH DECEMBER 1989

Monitor Well Number	TOC Elevation (Feet)	GROUND WATER SURFACE ELEVATIONS (Feet)											
		09/13/89	09/19/89	09/22/89	10/05/89	10/09/89	11/06/89	12/06/89	12/08/89	12/11/89	12/13/89	12/18/89	12/28/89
MW-1	100.94	89.26	89.23	89.24	NM	89.06	89.29	90.48	90.37	NM	NM	NM	89.32
MW-2*	98.58	87.95	88.00	87.96	NM	87.77	---	---	---	---	---	---	---
MW-3*	99.63	88.57	88.66	88.60	NM	88.64	---	---	---	---	---	---	---
MW-4*	98.38	88.16	88.61	88.39	NM	89.43	88.45	90.56	87.85	85.67	85.68	85.46	84.70
MW-5	90.94	79.24	79.21	79.22	NM	79.01	79.45	NM	80.72	NM	NM	NM	80.47
MW-6	97.92	---	---	---	87.25	87.33	NM	NM	87.71	87.17	87.06	NM	86.52
MW-7	97.43	---	---	---	85.86	85.81	NM	NM	88.58	88.55	88.52	NM	87.98
MW-8*	98.36	---	---	---	87.85	87.81	NM	NM	89.58	88.24	88.14	87.34	86.31
MW-9*	99.03	---	---	---	88.32	88.14	88.60	NM	88.81	88.37	88.22	87.95	87.63
MW-10	97.55	---	---	---	86.50	86.56	87.15	NM	87.85	87.72	87.75	NM	87.37
MW-11	98.62	---	---	---	88.23	88.15	88.74	91.93	91.69	NM	90.84	NM	89.25
MW-12	96.56	---	---	---	83.71	84.76	85.31	86.27	86.40	NM	NM	NM	86.21
MW-13	99.95	---	---	---	---	---	---	---	---	---	---	---	87.54
MW-14	98.07	---	---	---	---	---	---	---	---	---	---	---	88.41
MW-15	99.04	---	---	---	---	---	---	---	---	---	---	---	88.22
MW-16	99.04	---	---	---	---	---	---	---	---	---	---	---	88.57
R-WELL*	95.29	---	---	---	---	---	88.44	92.07	87.35	84.36	84.47	NM	83.62

Notes:

"TOC" = Top of well casing; elevations based on assumed datum of 100.00 feet.

"NM" = Not measured.

"---" = Monitor well not yet constructed, or destroyed during remediation activities.

"*" = Free product present in well.

R-WELL = Ground water recovery well; depression pump was activated after measuring the water levels on 12/06/89.

Reported water surface elevations are corrected for the equivalent column height of water for wells containing free product.

TABLE 2
SUMMARY OF SOIL SAMPLE ANALYTICAL DATA, MONITOR WELL BORINGS

Sample Number	Depth (feet)	Sample Date	EPA Method 8020				Modified EPA Method 8015	
			Benzene (ppb)	Ethyl-Benzene (ppb)	Toluene (ppb)	Total Xylenes (ppb)	Gasoline (ppm)	Diesel (ppm)
MW-1	8.5	09/11/89	ND	ND	ND	ND	ND	ND
MW-2	8.5	09/11/89	ND	ND	ND	ND	ND	ND
MW-3	8.5	09/12/89	ND	57	72	310	9	ND
MW-4	8.5	09/12/89	ND	27,000	27,000	159,000	1,200	ND
MW-5	8.5	09/12/89	ND	ND	ND	ND	ND	ND
MW-6	8.0	10/02/89	ND	ND	ND	ND	ND	ND
MW-6	10.0	10/02/89	ND	ND	ND	ND	ND	ND
MW-7	10.0	10/02/89	ND	29	100	175	ND	ND
MW-8	10.0	10/03/89	ND	ND	ND	ND	ND	ND
MW-9	10.0	10/03/89	ND	ND	ND	ND	ND	ND
MW-10	10.0	10/03/89	ND	ND	ND	ND	ND	ND
MW-11	11.0	10/04/89	ND	ND	ND	ND	ND	ND
MW-12	10.0	10/04/89	ND	ND	ND	ND	ND	ND
MW-13	8.0	12/20/89	460	220	1100	1200	ND	ND
MW-14	13.0	12/20/89	ND	ND	ND	ND	ND	ND
MW-15	8.0	12/21/89	ND	ND	ND	ND	ND	ND
MW-15	13.0	12/21/89	510	90	840	510	ND	ND
MW-16	8.0	12/21/89	ND	ND	63	ND	ND	ND

Notes:
"ppb" = parts per billion
"ppm" = parts per million
"ND" = "not detected"; see lab data sheets in Appendix B for analyte detection limits

TABLE 3
HYDROCARBON VAPOR CONCENTRATIONS IN GROUND WATER MONITOR WELL CASINGS ON DECEMBER 28, 1989

Monitor Well Number	Hydrocarbon Vapor Concentrations (ppm)
MW-1	260
MW-2*	>10,000
MW-3*	>10,000
MW-4	>10,000
MW-5	<100
MW-6	>10,000
MW-7	480
MW-8	>10,000
MW-9	>10,000
MW-10	200
MW-11	230
MW-12	210
MW-13	>10,000
MW-14	380
MW-15	>10,000
MW-16	1,600

Notes:
"ppm" = "parts per million"
*Hydrocarbon vapor concentrations as measured on September 13, 1989. Wells MW-2 and MW-3 were destroyed during remediation activities in October 1989.
Hydrocarbon vapor concentrations were measured in the monitor well casings using a Bacharach TLV Sniffer calibrated to hexane (110 ppm = 1% LEL).

TABLE 4
THICKNESS OF FREE PRODUCT IN GROUND WATER MONITOR WELLS, SEPTEMBER 1989 THROUGH DECEMBER 1989

Monitor Well Number	THICKNESS OF FREE PRODUCT (Feet)											
	09/13/89	09/19/89	09/22/89	10/05/89	10/09/89	11/06/89	12/06/89	12/08/89	12/11/89	12/13/89	12/18/89	12/28/89
MW-2	0.10	1.15	1.60	NM	2.11	---	---	---	---	---	---	---
MW-3	0.32	2.08	2.81	NM	4.43	---	---	---	---	---	---	---
MW-4	0.80	5.34	6.28	NM	5.90	1.73	3.35	5.30	1.80	1.75	0.50	0.55
MW-8	---	---	---	0.19	0.11	NM	NM	9.50	9.20	6.10	2.33	0.37
MW-9	---	---	---	2.98	4.63	2.73	NM	0.50	0.61	0.65	0.30	0.27
R-WELL	---	---	---	---	---	0.10	0.02	0.08	0.15	0.10	NM	0.06

Notes:

"NM" = Not measured

"---" = Monitor well not yet constructed, or destroyed during remediation activities.

R-WELL = Ground water recovery well; depression pump was activated after measuring the thickness of free product on 12-06-89.

TABLE 5
SUMMARY OF GROUND WATER QUALITY DATA, MONITOR WELL SAMPLES

Monitor Well Number	Sample Date	EPA Method 602				EPA Method 418.1
		Benzene (ppb)	Ethyl-Benzene (ppb)	Toluene (ppb)	Total Xylenes (ppb)	TPH (ppm)
MW-1	09/13/89	1.5	ND	1.9	1.6	ND
MW-5	09/13/89	1.1	ND	2.5	2.6	ND
MW-6	10/09/89	250	ND	3.2	110	NA
MW-7	10/09/89	2.8	ND	1.4	ND	NA
MW-10	10/09/89	1.2	ND	ND	ND	NA
MW-11	10/09/89	2.6	ND	ND	3.0	NA
MW-12	10/09/89	ND	ND	ND	ND	NA
MW-13	12/21/89	13,000	1,700	20,000	8,800	NA
MW-14	12/21/89	1.1	1.9	5.7	13	NA
MW-15	12/21/89	7,300	1,000	9,000	5,800	NA
MW-16	12/21/89	4.3	7.1	20	36	NA

Notes:
"ppb" = parts per billion
"ppm" = parts per million
"ND" = "not detected"; see laboratory data sheets in Appendix C for analyte detection limits
"NA" = not analyzed

TABLE 6
SUMMARY OF SOIL SAMPLE ANALYTICAL DATA, WASTE OIL AND HEATING OIL TANK EXCAVATIONS

Tank Excavation	Sample Number	Sample Date	Location	Depth (feet)	TPH (ppm)
Waste Oil Tank	WO-2	10/11/89	Excavation floor	8.0	76
	WO-6	10/12/89	Excavation floor	11.0	2
	WO-7	10/12/89	North wall	10.0	<1
	WO-8	10/12/89	East wall	9.5	6
	WO-9	10/12/89	South wall	10.0	1
	WO-10	10/12/89	West wall	9.5	<1
Heating Oil Tank	HO-2	10/13/89	North wall	6.0	8
	HO-3	10/13/89	East wall	7.0	1
	HO-4	10/13/89	South wall	6.5	2
	HO-5	10/13/89	West wall	6.5	110
	HO-6	10/13/89	Excavation floor	8.5	14

Notes:
"TPH" = Total Petroleum Hydrocarbons by EPA Method 418.1
"ppm" = parts per million

TABLE 7
SUMMARY OF SOIL SAMPLE ANALYTICAL DATA, GASOLINE TANK AND RECOVERY TRENCH EXCAVATIONS

Sample Number	Sample Date	Depth (feet)	EPA Method 8020				Modified EPA Method 8015	
			Benzene (ppb)	Ethyl-Benzene (ppb)	Toluene (ppb)	Total Xylenes (ppb)	Gasoline (ppm)	Diesel (ppm)
EW-1	10/20/89	10.0	ND	ND	ND	ND	ND	ND
WW-1	10/20/89	13.0	1,300	9,700	20,000	53,000	270	600
NW-1	10/20/89	13.0	31,000	55,000	140,000	300,000	1,700	4,100
SW-1	10/20/89	9.0	1,000	1,600	6,300	10,000	360	ND
NW-2	10/23/89	10.0	1,300	12,000	17,000	57,000	230	400
WT-1	10/26/89	12.0	110	390	1,000	3,500	59	150
MT-1	10/26/89	10.0	ND	74	250	610	11	55
ET-3	10/27/89	10.0	140	ND	190	310	ND	7

Notes:
"ppb" = parts per billion
"ppm" = parts per million
"ND" = not detected; see laboratory data sheets in Appendix D for analyte detection limits
Sample locations shown in Figure 6

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TABLE 8
SUMMARY OF SOIL SAMPLE ANALYTICAL DATA, SOIL STOCKPILE COMPOSITE SAMPLES

Laboratory Analysis (EPA Method)	Units	Soil Excavation Stockpiles		
		Sample C-1 GasolineTank/ Recovery Trench	Sample C-2 Waste Oil/ Heating Oil Tanks	Sample WO-11 Waste Oil Tank
Benzene (8020)	(ppb)	6,500	1.8	NA
Ethylbenzene (8020)	(ppb)	9,500	120	NA
Toluene (8020)	(ppb)	10,500	12	NA
Total Xylenes (8020)	(ppb)	20,500	550	NA
TPH (418.1)	(ppm)	2,248	488	108
Gasoline (Mod. 8015)	(ppm)	4,400	NA	NA
Flash Point (1010)	--	<32 F	NA	NA
PCBs (8080)	(ppm)	NA	All <1.0	NA
VOCs (8010)	(ppb)	NA	All <1.0	NA
Arsenic (EP Tox/Metals)	(ppm)	NA	0.25	NA
Barium (EP Tox/Metals)	(ppm)	NA	1.07	NA
Cadmium (EP Tox/Metals)	(ppm)	NA	0.14	NA
Chromium (EP Tox/Metals)	(ppm)	NA	0.005	NA
Lead (EP Tox/Metals)	(ppm)	NA	1.32	NA
Mercury (EP Tox/Metals)	(ppm)	NA	0.0001	NA
Selenium (EP Tox/Metals)	(ppm)	NA	0.05	NA
Silver (EP Tox/Metals)	(ppm)	NA	0.003	NA

Notes:
"ppb" = parts per billion
"ppm" = parts per million
"TPH" = total petroleum hydrocarbons
"PCBs" = polychlorinated biphenyl compounds
"VOCs" = halogenated volatile organic compounds
"NA" = not analyzed
Composite Samples C-1 and C-2 were collected on October 18, 1989.
Composite Sample WO-11 was collected on October 12, 1989.

TABLE 9
SUMMARY OF BETX ANALYSIS, WATER TREATMENT SYSTEM SAMPLES

Sampling Port Number	Sample Date	EPA Method 602 (ppb)			
		Benzene	Ethylbenzene	Toluene	Total Xylenes
1	12/11/89	23,000	740	17,000	3,000
1	12/28/89	23,000	1,000	19,000	6,000
2	12/11/89	16,000	<500	800	<500
2	12/28/89	36,000	<500	6,000	<500
3	12/11/89	<0.5	<0.5	6.4	<0.5
3	12/28/89	14	<0.5	<0.5	<0.5

Notes:
"ppb" = parts per billion
Sampling port locations shown in Figure 9.

TABLE 10
SUMMARY OF WATER QUALITY DATA, DISCHARGE FROM WATER TREATMENT SYSTEM DECEMBER 18, 1989

Compound	EPA Method	Concentration (ppm)
Arsenic	7060	0.008
Cadmium	7131	<0.0003
Chromium	7190	<0.02
Copper	7210	<0.02
Lead	7421	<0.005
Mercury	7470	<0.0005
Nickel	7520	0.09
Silver	7760	<0.01
Zinc	7950	0.10
Cyanide	9012	<0.01
Oil and Grease	413.2	0.31
pH	150.1	6.8

Notes:
"ppm" = parts per million
Samples collected from Sampling Port No. 3 on December 18, 1989; these samples are representative of water discharged into the sanitary sewer system after undergoing treatment.

REFERENCE: USGS 7.5' TOPOGRAPHIC QUADRANGLE MAP "SEATTLE NORTH, WASH."

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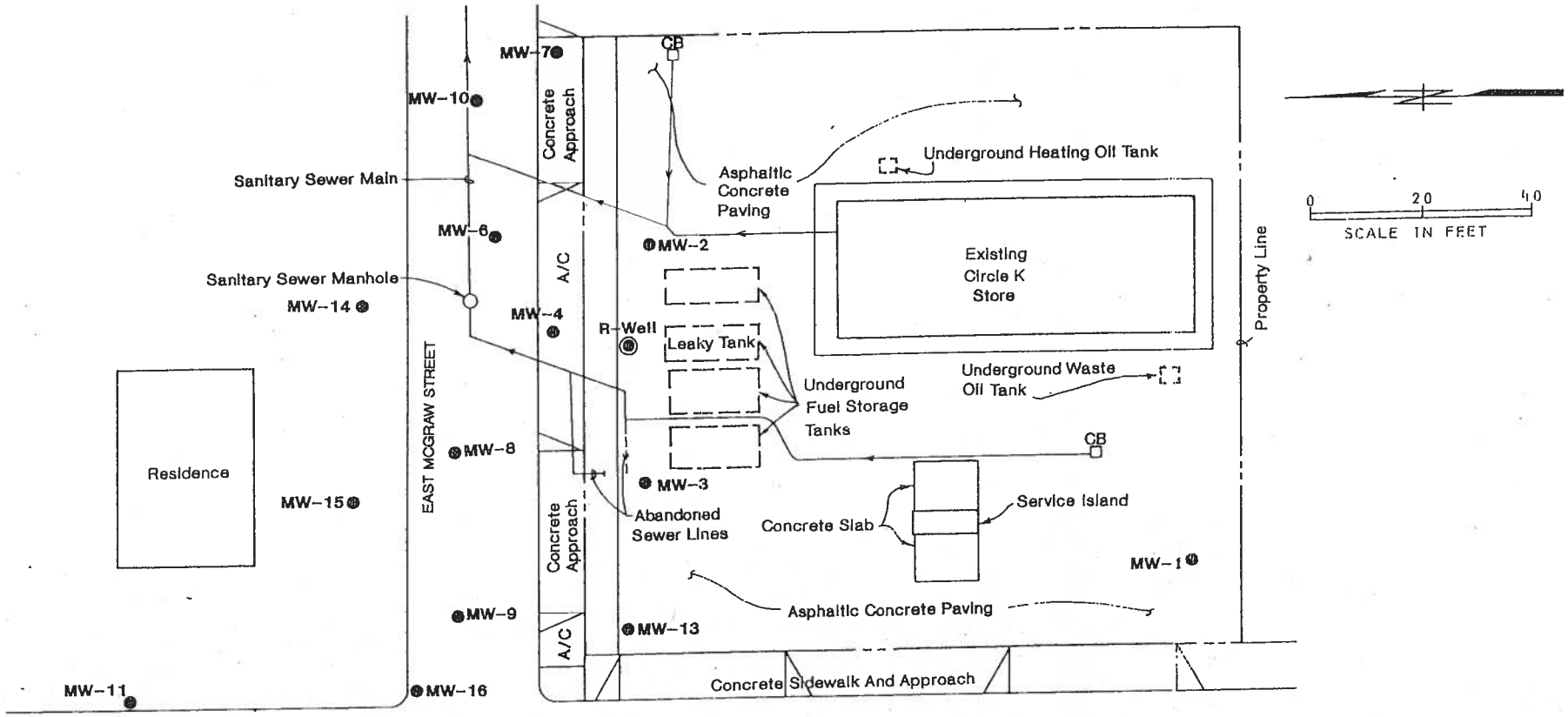
GeoEngineers	**VICINITY MAP**
	FIGURE 1



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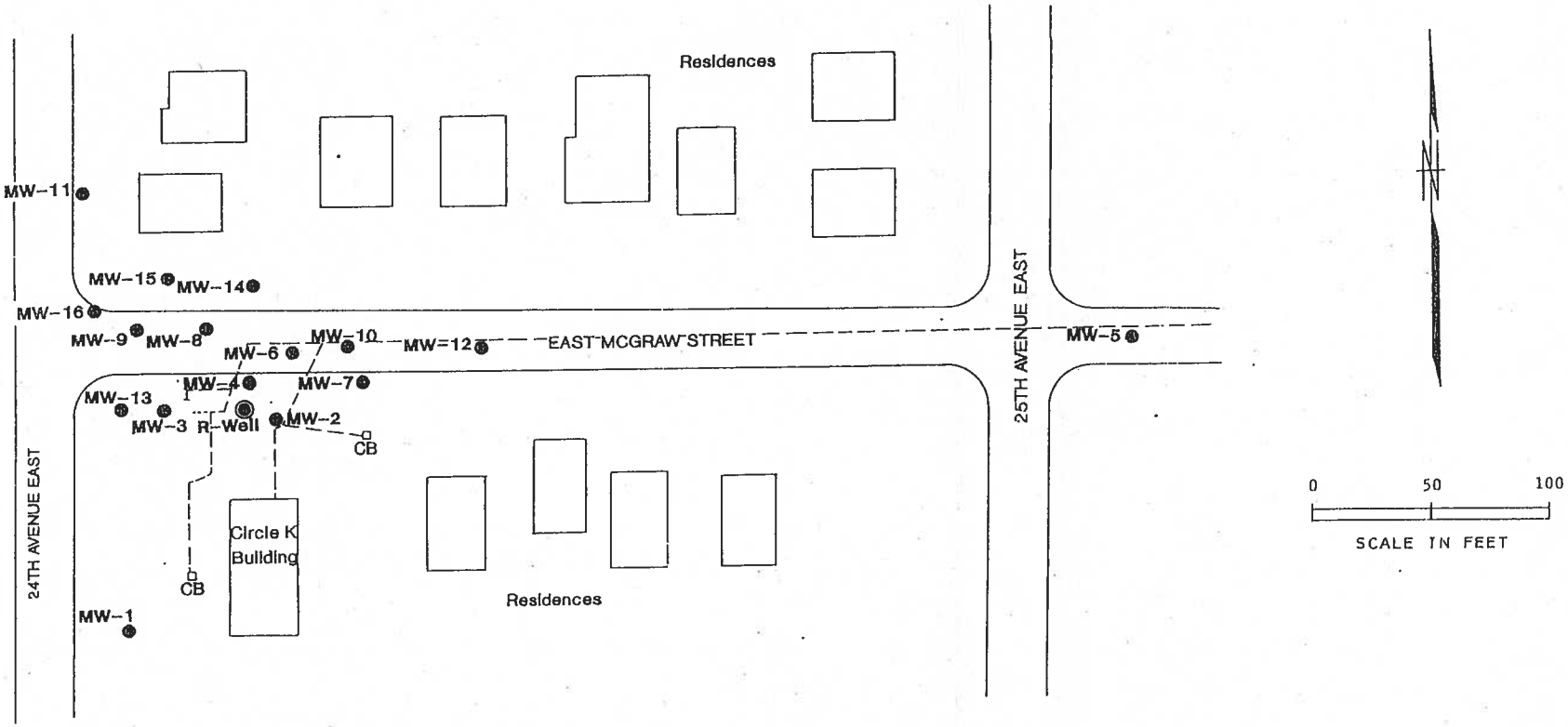
SITE PLAN

FIG 2



EXPLANATION:

- MW-1 ⊗ MONITOR WELL LOCATION AND NUMBER
- R-Well ◉ RECOVERY WELL LOCATION
- CB □ CATCH BASIN
- ––– UNDERGROUND SEWER AND DRAIN PIPES

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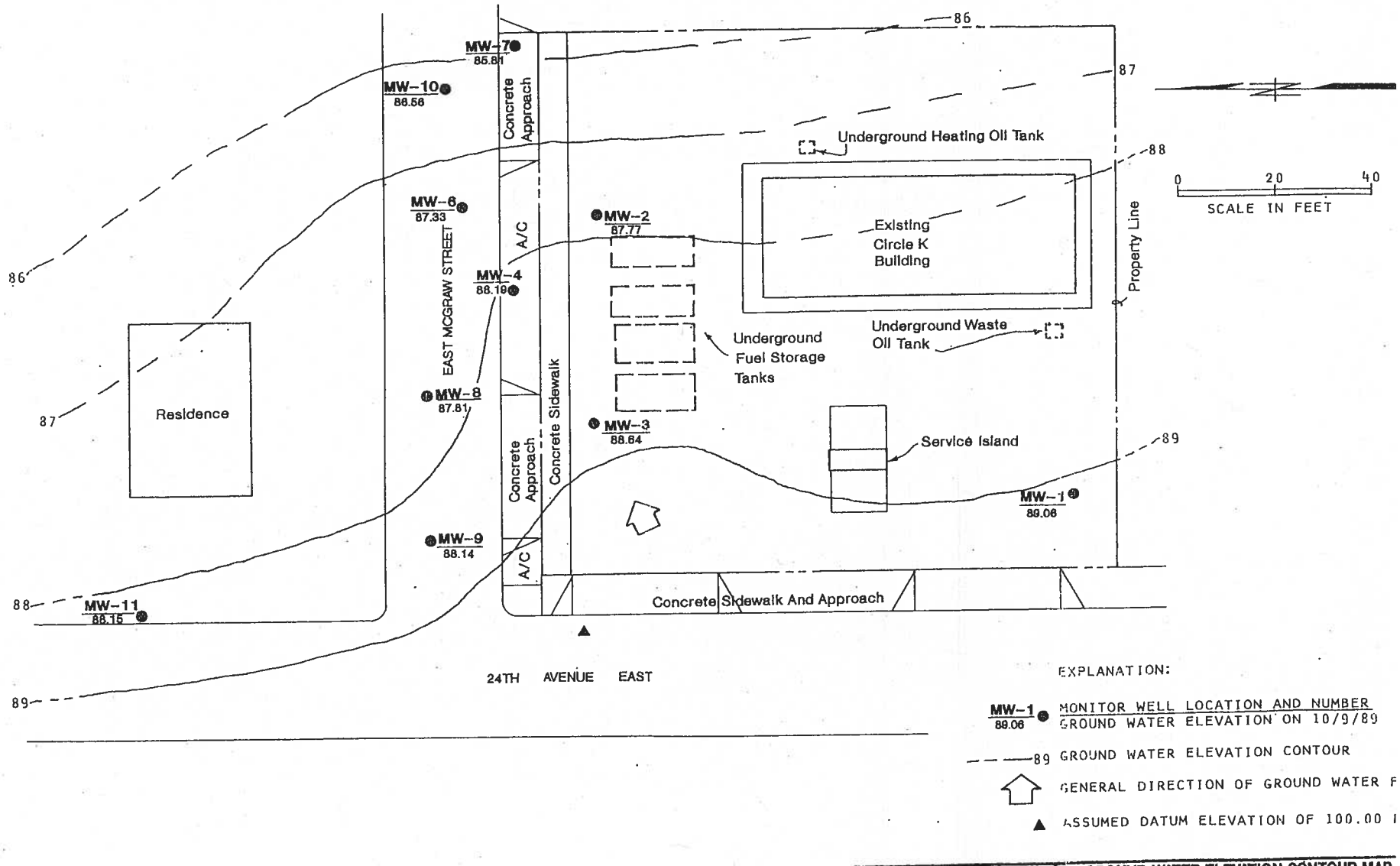
MONITOR WELL LOCATION MAP

FIG[illegible] 3



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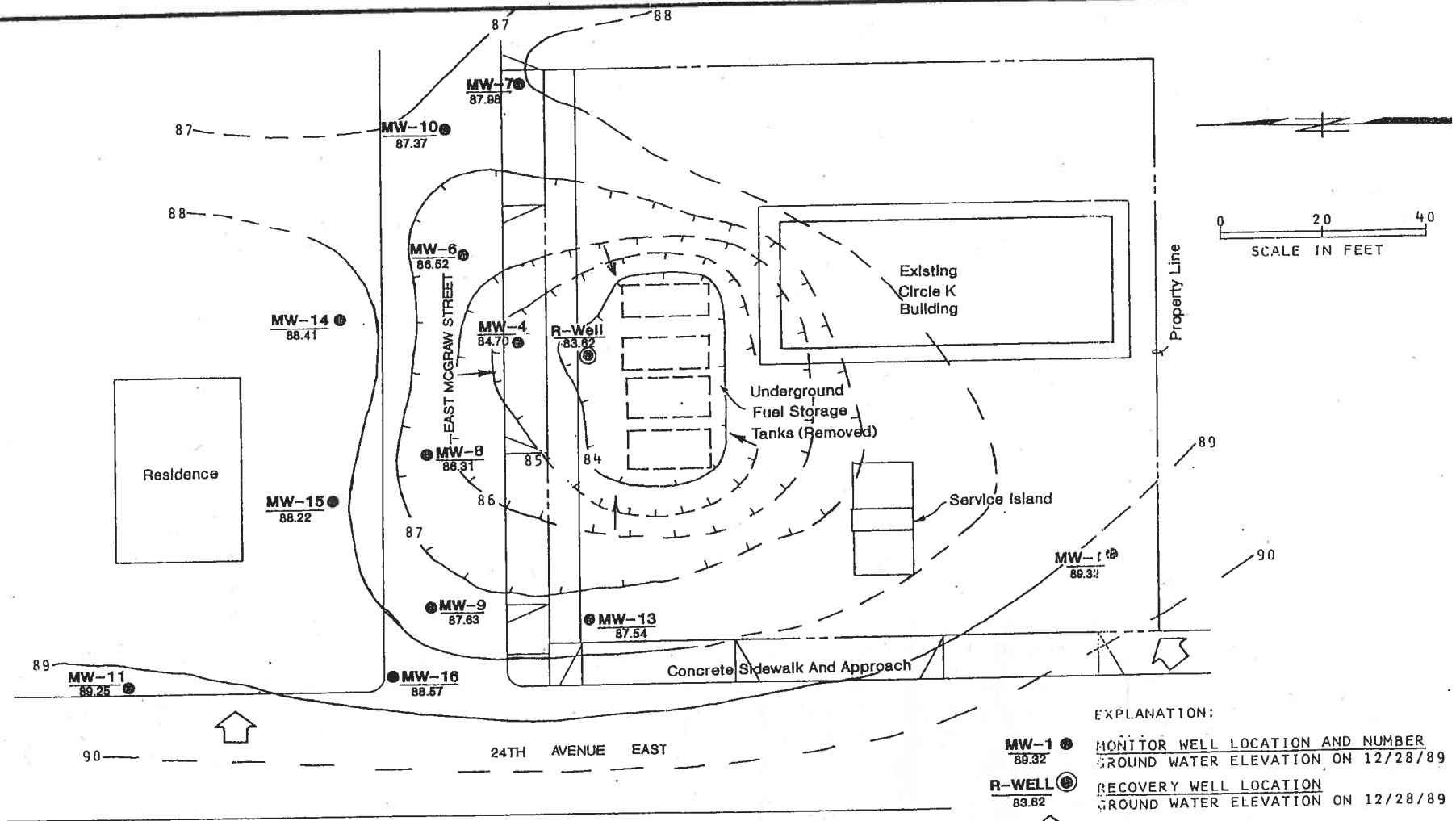
GROUND WATER ELEVATION CONTOUR MAP
OCTOBER 9, 1989

FIG 4



NOTE: GROUND WATER ELEVATION OBTAINED APPROXIMATELY THREE WEEKS AFTER START OF GROUND WATER PUMPING FROM THE RECOVERY WELL.

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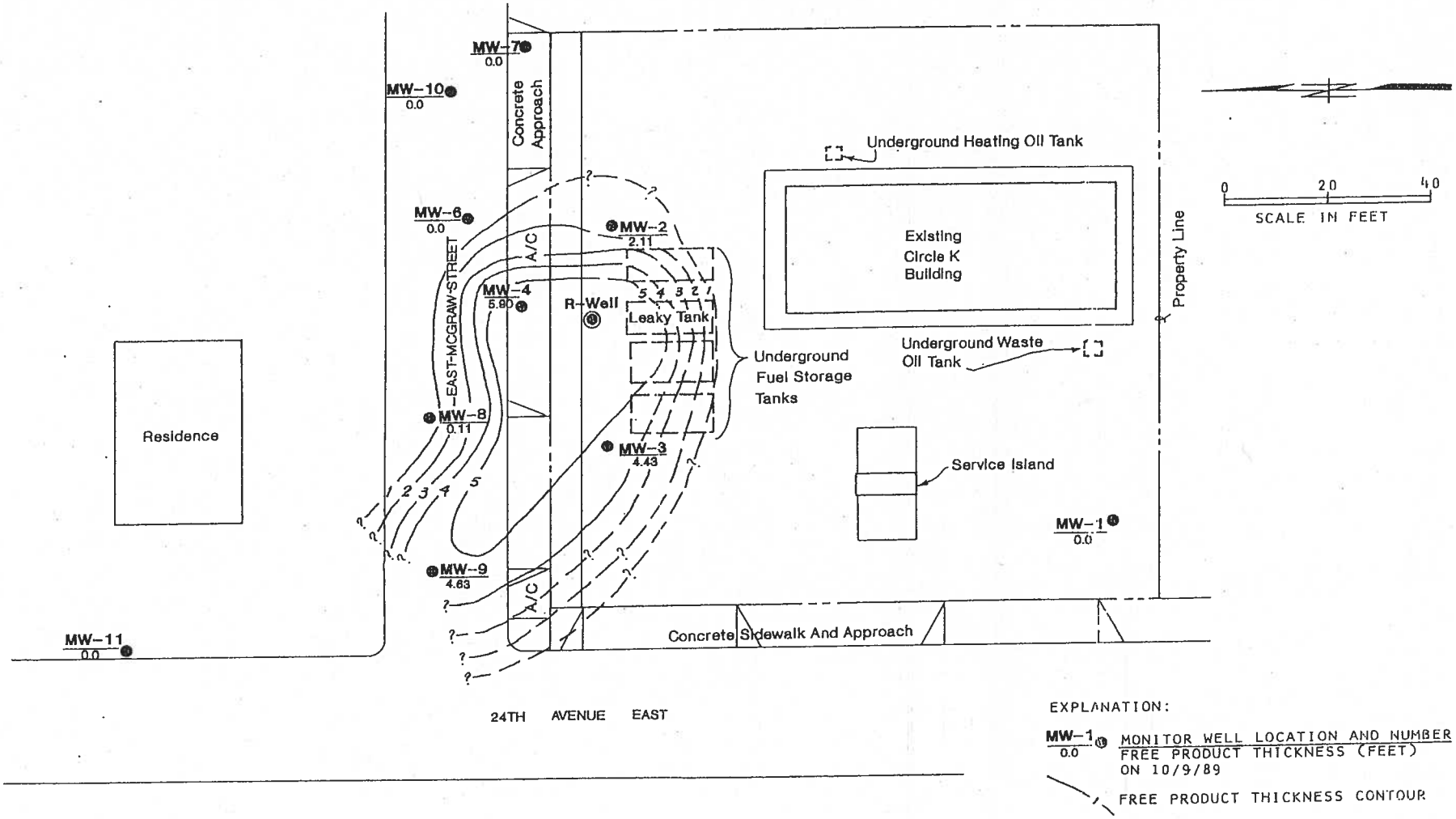
GROUND WATER ELEVATION CONTOUR MAP
DECEMBER 28, 1989

FIG 5



NOTE: WELL MW-8 CONTAINED SUBSTANTIAL THICKNESSES OF FREE PRODUCT ON LATER MEASUREMENT DATES.

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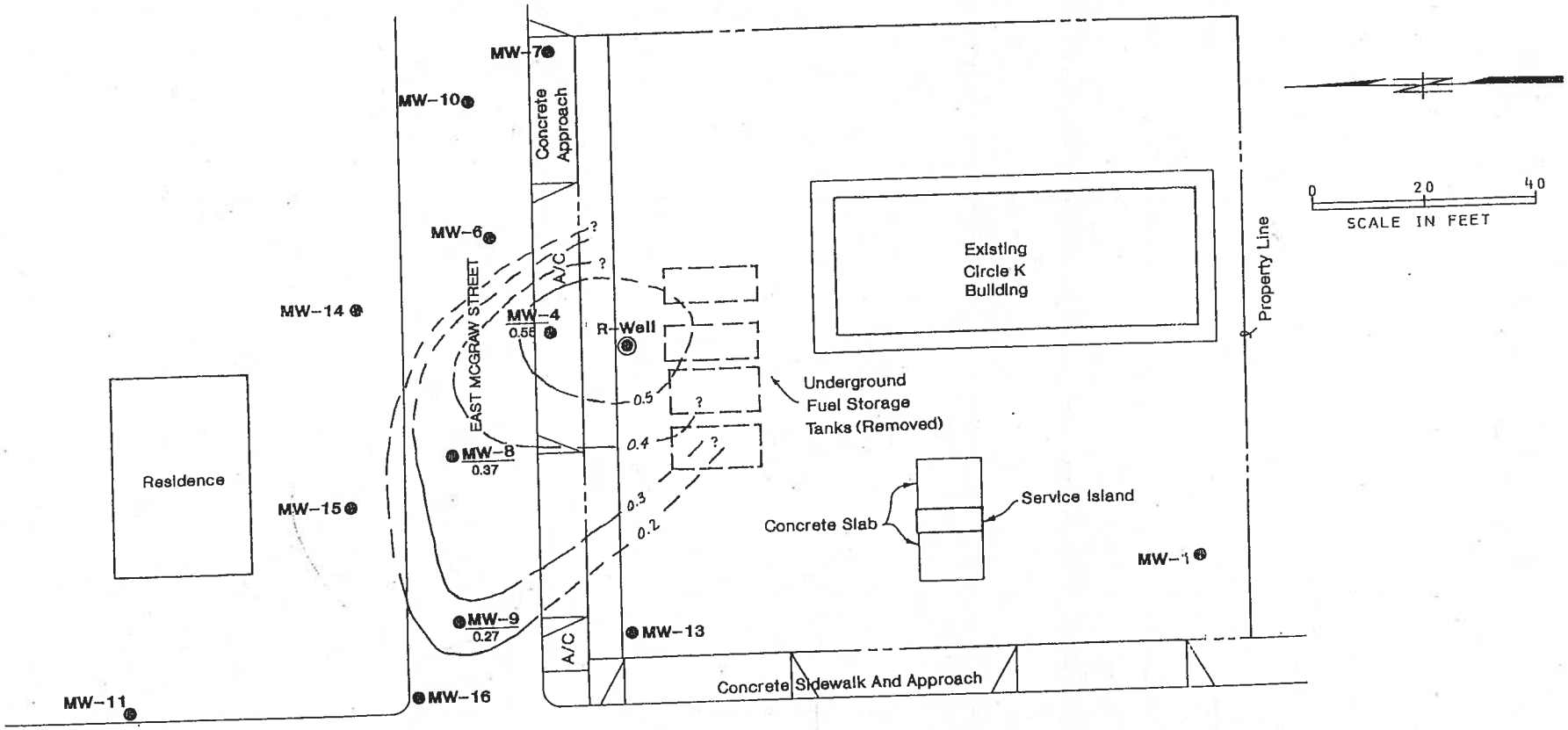
FREE PRODUCT THICKNESS CONTOUR MAP
OCTOBER 9, 1989

FIGURE 3



EXPLANATION:

MW-4 / 0.55 — MONITOR WELL LOCATION AND NUMBER / PRODUCT THICKNESS(FEET) ON 12/28/8

—0.4— PRODUCT THICKNESS CONTOUR

R-WELL — RECOVERY WELL LOCATION

NOTE: PRODUCT THICKNESS DATA OBTAINED APPROXIMATELY THREE WEEKS AFTER START OF GROUND WATER PUMPING FROM THE RECOVERY WELL.

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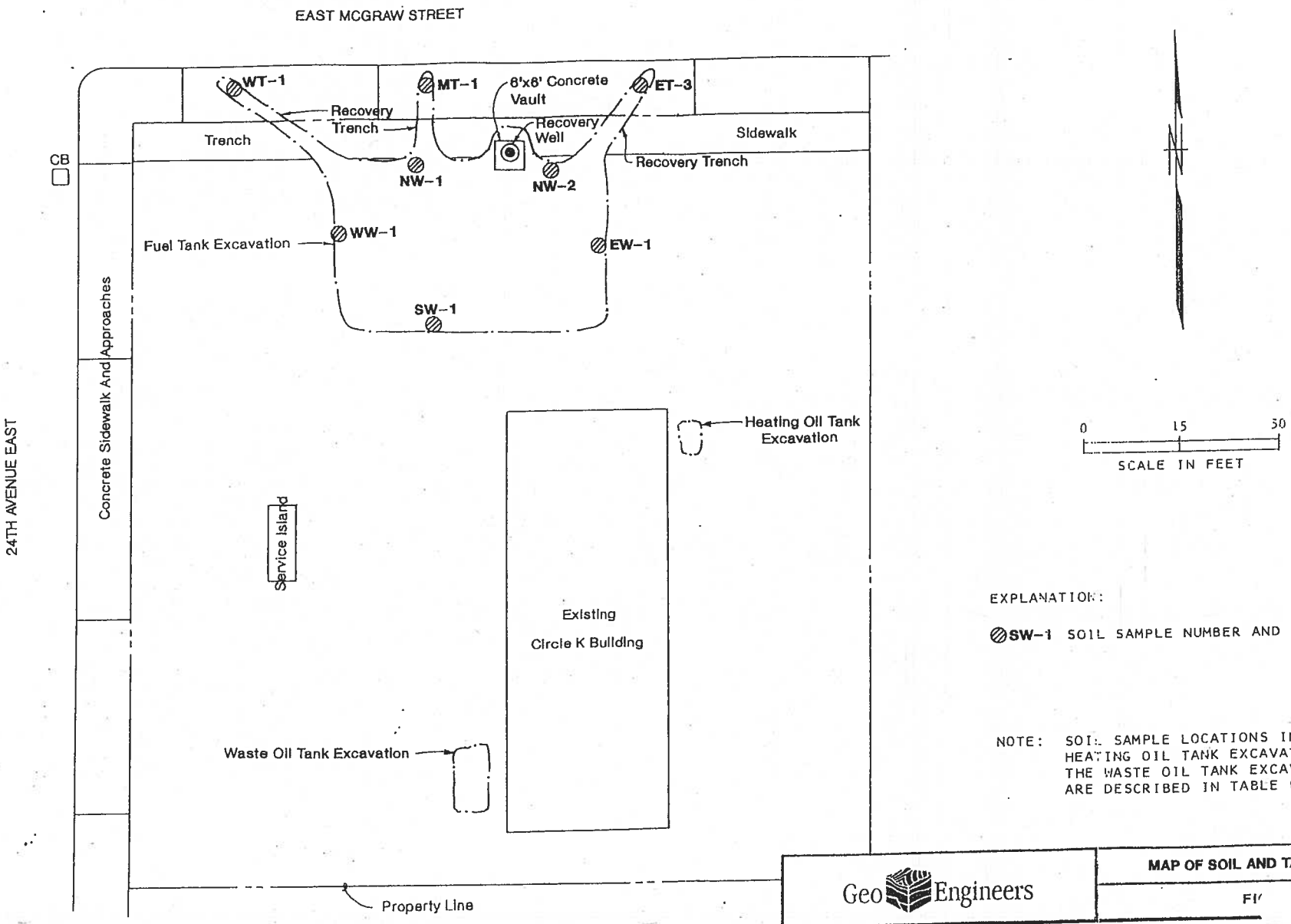
FREE PRODUCT THICKNESS CONTOUR MA
DECEMBER 28, 1989

FI E 7



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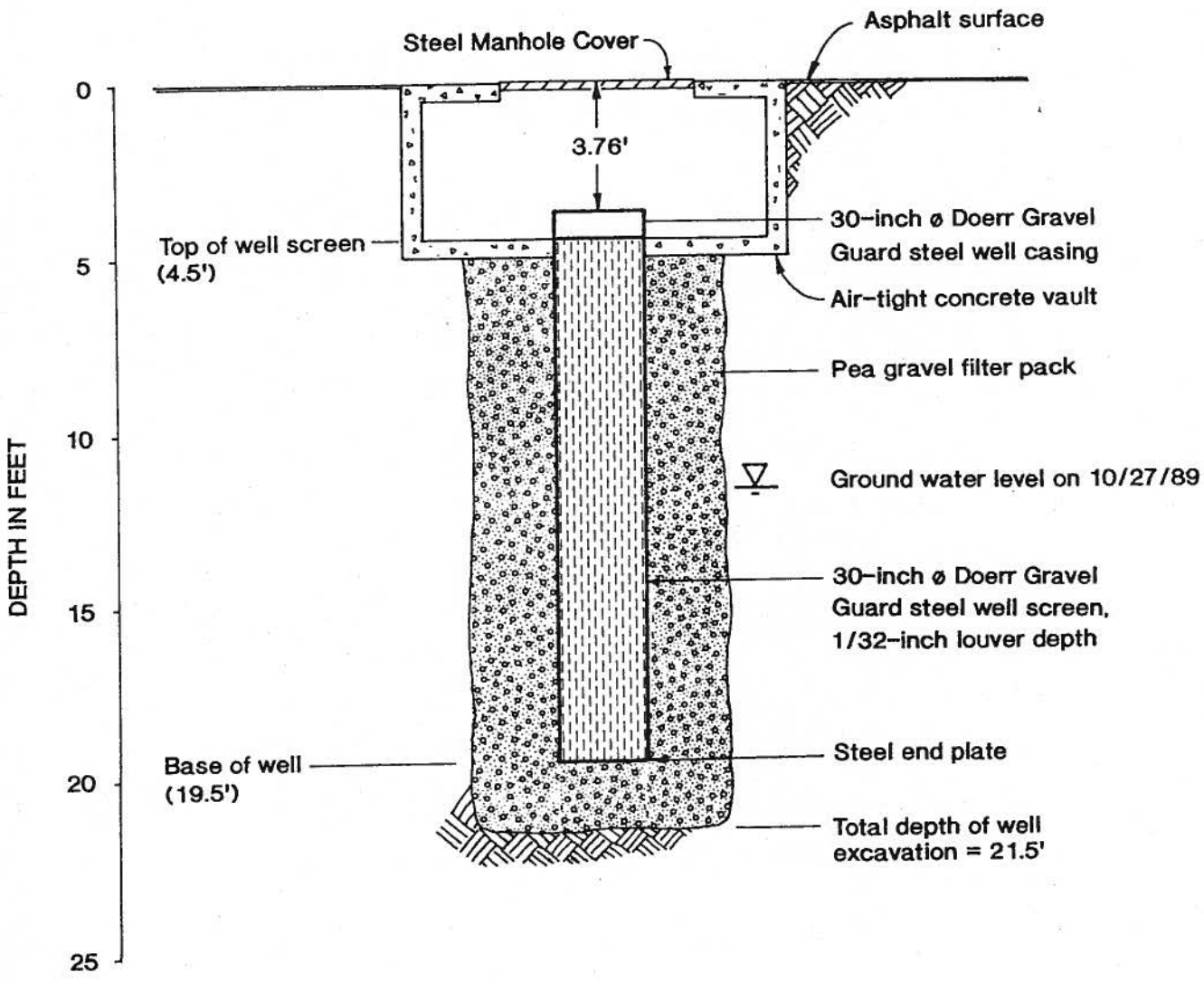
MAP OF SOIL AND TANK EXCAVATIONS

FIGURE 8



Note: Pea gravel filter pack extends beyond well screen a minimum of 3 feet.

GeoEngineers	RECOVERY WELL CONSTRUCTION DETAIL
	FIGURE 9

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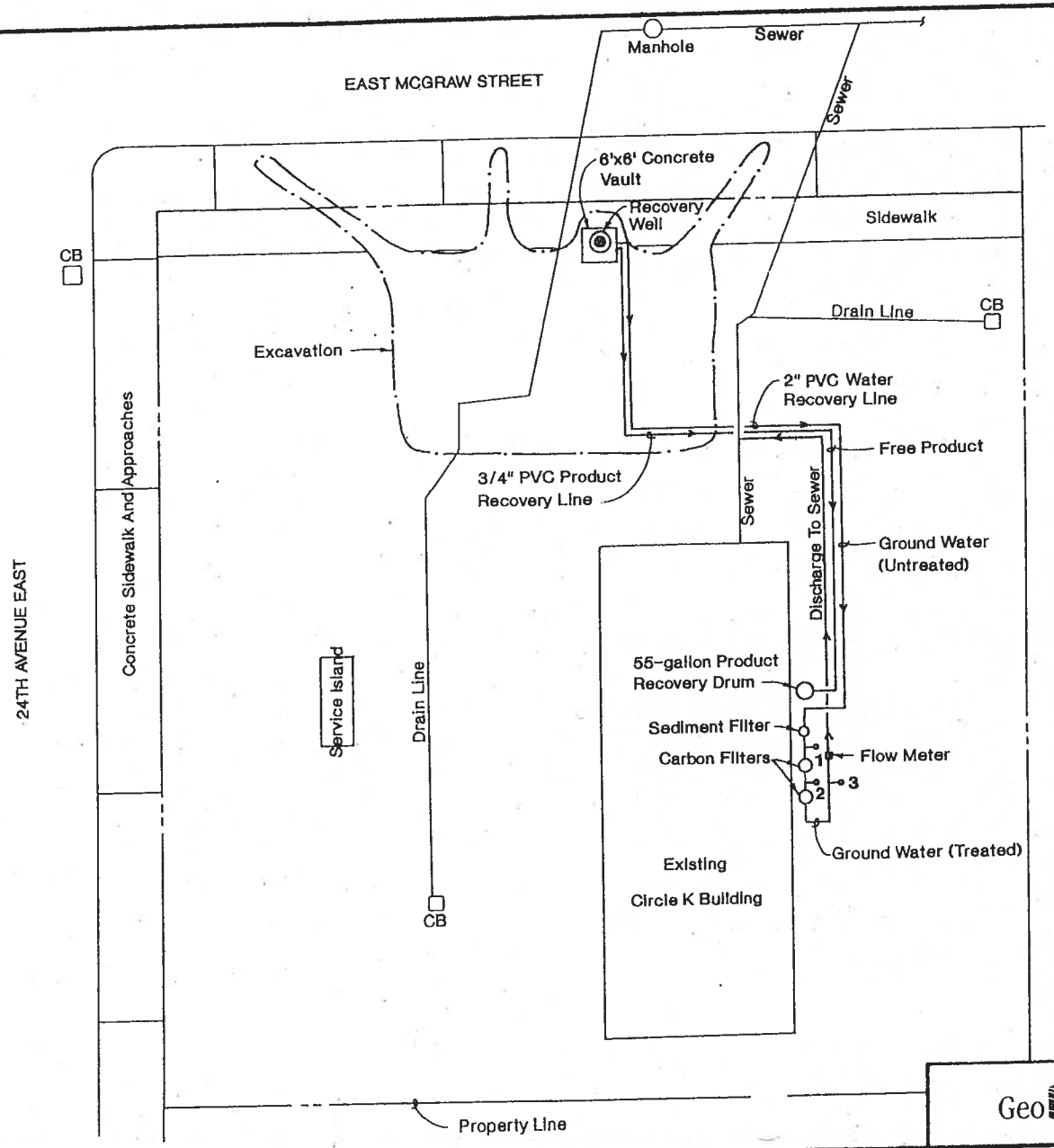

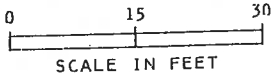

EXPLANATION:

1 SAMPLING PORT LOCATION AND NUMBER

CB CATCH BASIN

NOTE: ALL PVC PIPES IN WATER AND PRODUCT RECOVERY SYSTEM ARE BURIED 3-4 FEET BELOW EXISTING GRADE.

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GROUND WATER TREATMENT AND PRODUCT RECOVERY SYSTEM – PLAN VI

FI : 10

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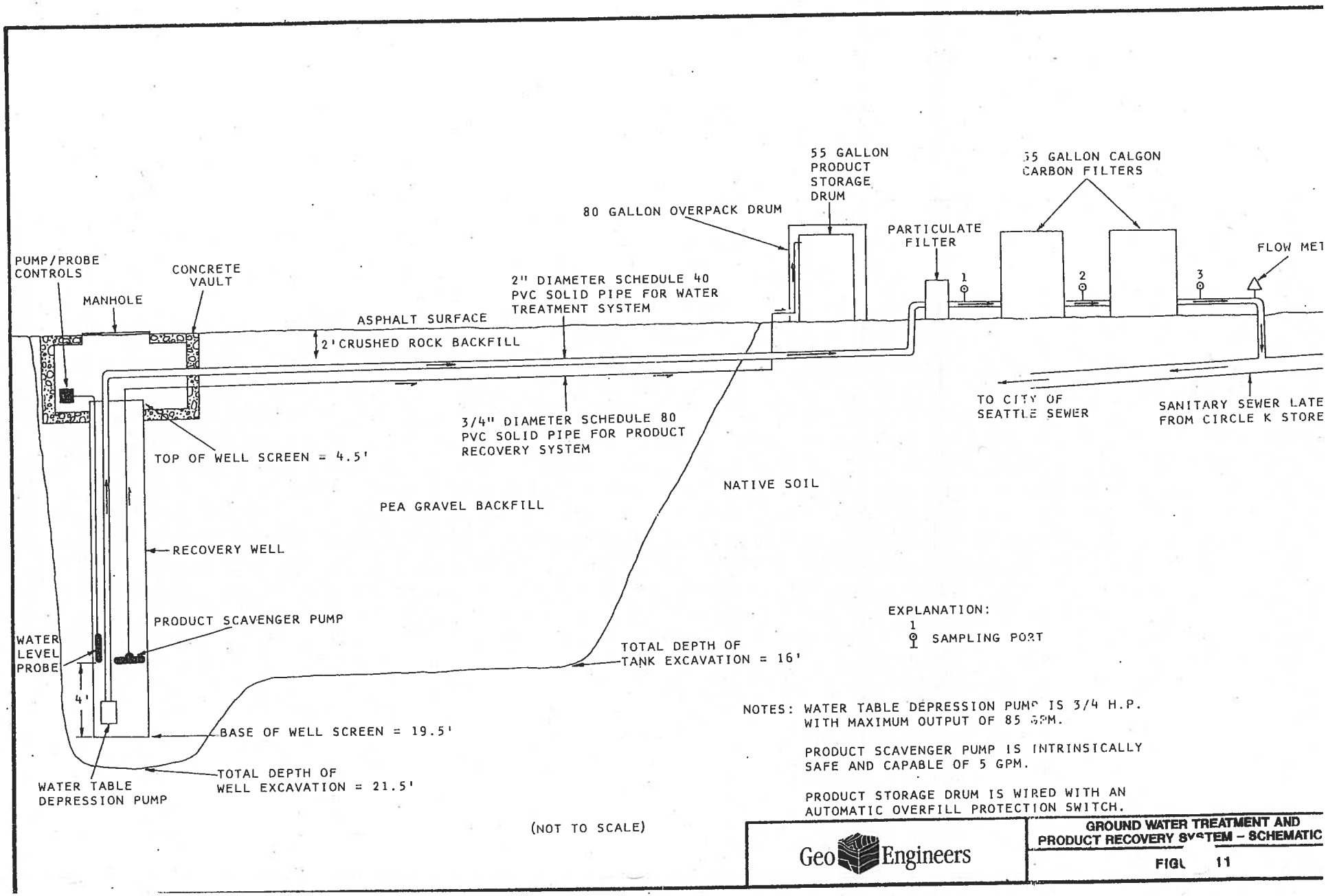

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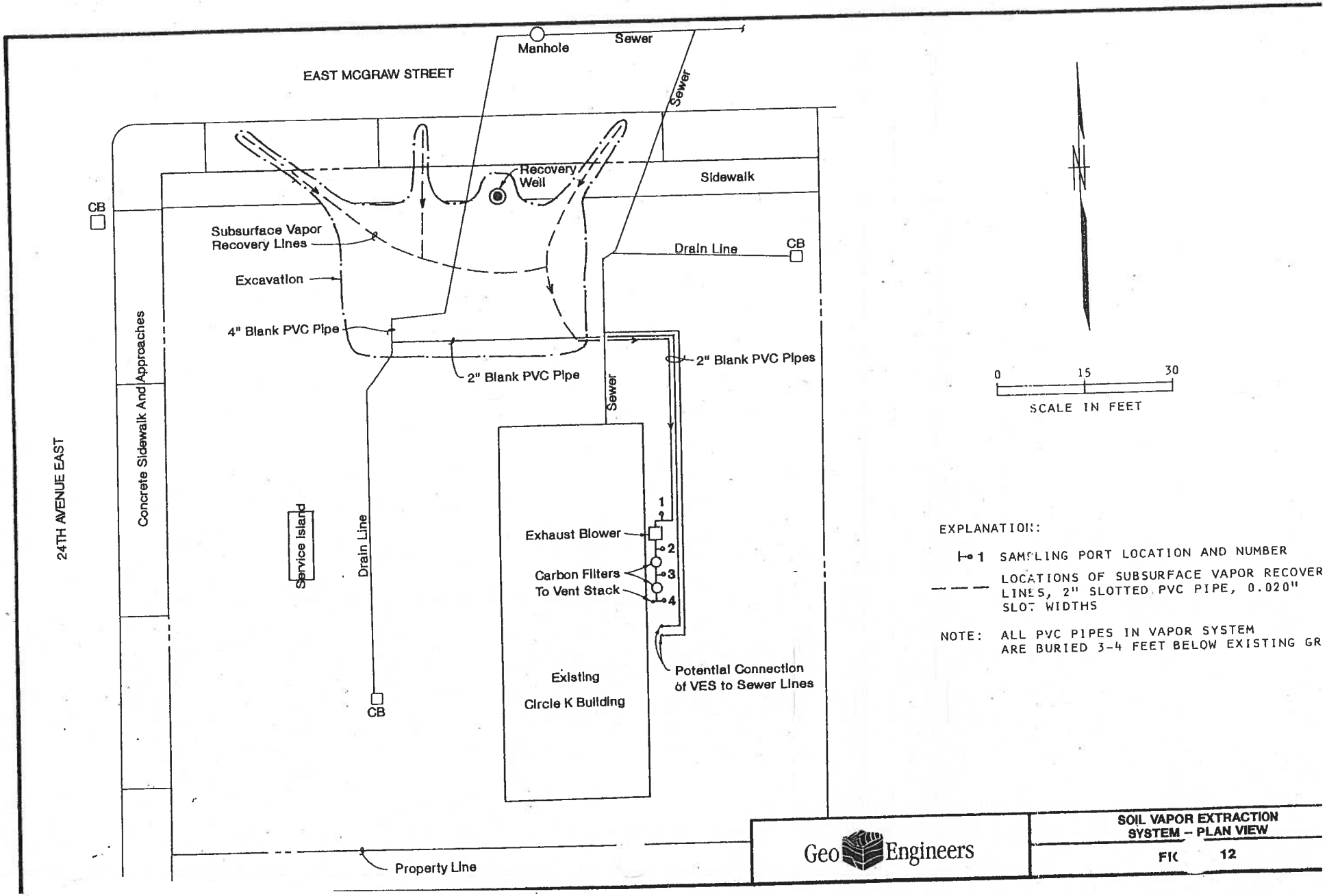
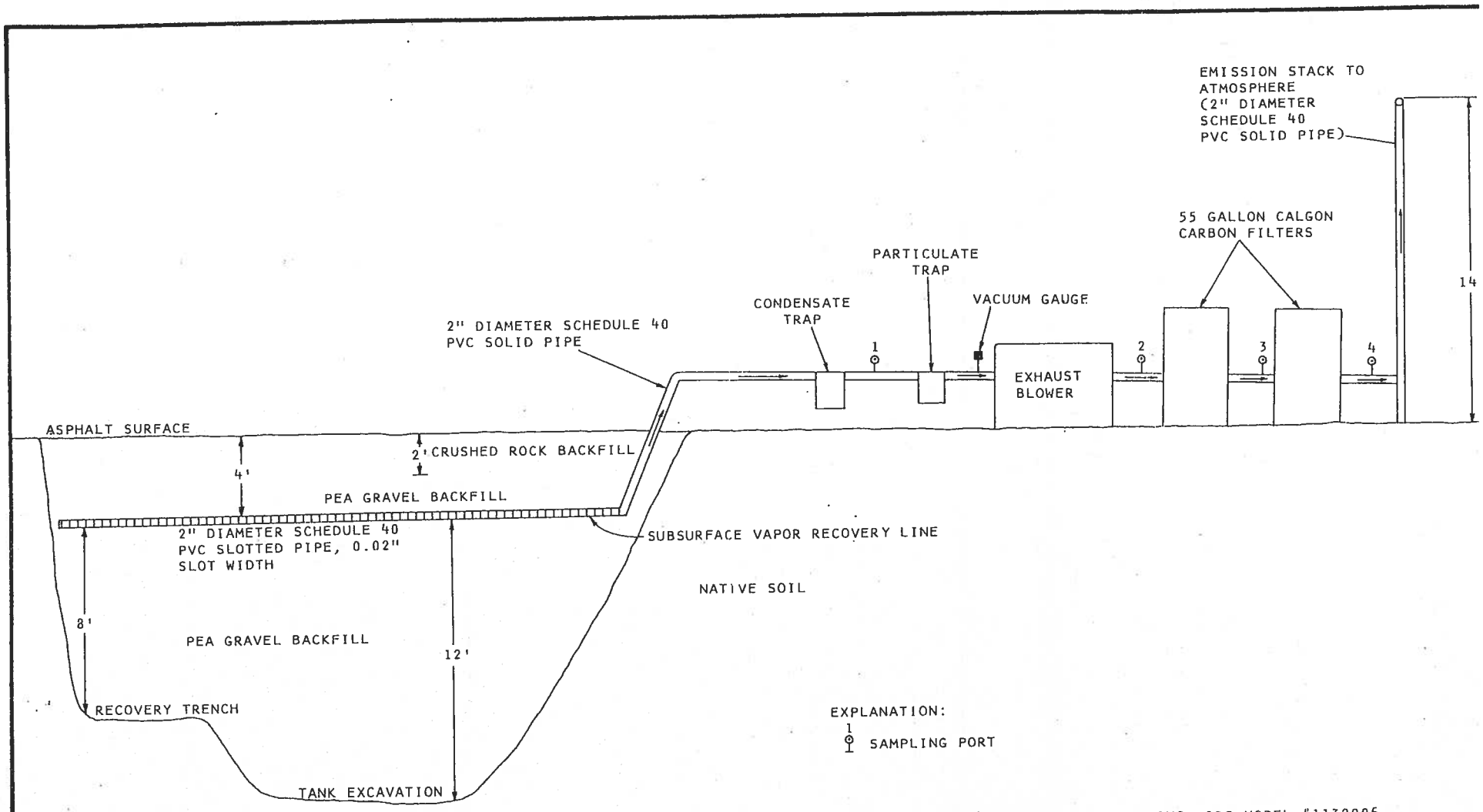
GROUND WATER TREATMENT AND PRODUCT RECOVERY SYSTEM – SCHEMATIC

FIGURE 11

1780-01-B04 JG R: BDH 1-18-90



1780-001-B04 JGR:KKT 1-12-90



1780-01-B04 JGR:BDH 1-18-90

APPENDIX A

Field Explorations

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APPENDIX A

FIELD EXPLORATIONS

DRILLING AND SOIL SAMPLING PROGRAM

Subsurface conditions at the Circle K site were explored by drilling sixteen borings using hollow-stem auger methods. Locations of the borings are indicated in Figure 3. The borings were drilled in three separate phases of our site assessment activities. Wells MW-1 through MW-5 were drilled with equipment owned and operated by Soil Sampling Service, Inc. from September 11, 1989 to September 12, 1989. GeoBoring and Development, Inc. drilled MW-6 through MW-12 from October 2, 1989 to October 4, 1989. Wells MW-13 through MW-16 were completed by GeoBoring and Development, Inc. from December 20, 1989 to December 21, 1989. Boring depths ranged from 19.0 feet to 31.0 feet. The drilling and soil sampling equipment was cleaned with a hot-water pressure washer between each boring.

A hydrogeologist from our staff determined the boring locations, examined and classified the soils encountered, and prepared a detailed log of each boring. Soils encountered were classified visually in general accordance with ASTM D-2488-83, which is described in Figure A-1. An explanation of the boring log symbols is presented in Figure A-2. The boring logs are given in Figures A-3 through A-18.

Soil samples were obtained from the borings using either a Dames & Moore split-barrel sampler (2.4-inch-ID), or a split-spoon sampler (2.5-inch-ID) with 6-inch brass tubes. For MW-1 through MW-13, the sampler was driven 18 inches by a 300-pound weight falling a vertical distance of approximately 30 inches. A 140-pound weight was used to drive the sampler in borings MW-14 through MW-16. The number of blows needed to advance the sampler the final 12 inches is indicated to the left of the corresponding sample notations on the boring logs.

FIELD SCREENING OF SOIL SAMPLES

A GeoEngineers representative conducted field screening on soil samples obtained from the exploratory borings. Field screening results are used as a general guideline to delineate areas of potential petroleum-related contamination in soils. In addition, screening results are often used as

a basis for selecting soil samples for chemical analysis. The field screening methods employed included: (1) visual examination, (2) sheen testing, and (3) headspace vapor testing using the Bacharach TLV Sniffer calibrated to hexane. The results of headspace and sheen screening are included on the boring logs.

Visual screening consists of inspecting the soil for the presence of stains indicative of residual fuel hydrocarbons. Visual screening is generally more effective in detecting the presence of heavier petroleum hydrocarbons such as motor oil, or when hydrocarbon concentrations are high. Sheen testing and measuring headspace vapors are more sensitive screening methods, and have been effective in detecting contamination at levels less than regulatory cleanup guidelines.

Sheen testing involves immersion of the soil sample in water and observing the water surface for signs of a sheen. Because of its sensitivity, the sheen method is first tested on soils obtained from a portion of the site believed to be clean and unaffected by residual fuel and petroleum hydrocarbons, thereby establishing a site-specific background level of sheen.

Sheens are classified as follows:

No Sheen (NS)	No visible sheen. Note: background samples at the site are classified as NS.
Slight Sheen (SS)	Light colorless sheen, spotty to globular; spread is irregular, not rapid; areas of no sheen remain; film dissipates rapidly.
Moderate Sheen (MS)	Light to heavy film, may have some color or iridescence, globular to stringy; spread is irregular to flowing.
Heavy Sheen (HS)	Heavy colorful film with iridescence; stringy, spread is rapid; sheen flows off the sample; most of water surface is covered with sheen.

Headspace vapor screening involves placing a soil sample in a plastic sample bag. The sample bag is sealed and shaken slightly to expose the soil to the air trapped in the bag. The probe of a Bacharach TLV Sniffer is inserted into the bag and the instrument measures the concentration of combustible vapors present within the sample bag headspace. The TLV Sniffer records concentrations in parts per million (ppm) and is calibrated to hexane. The TLV Sniffer is designed to measure combustible hydrocarbon vapors at concentrations between 100 and 10,000 ppm. Similar to sheen testing, background vapor levels were established using on-site soils which were not believed to be contaminated.

Field screening results are site specific. The results vary with soil type, soil moisture and organic content, temperature, and type of contaminant(s).

MONITOR WELL CONSTRUCTION

Two-inch-diameter, Schedule 40 polyvinylchloride (PVC) casing was installed in each of the hollow-stem auger borings at the completion of drilling. The lower portion of the PVC casing consists of machine slotted (0.020-inch slot width) well screen, allowing entry of water, free (floating) hydrocarbons, and hydrocarbon vapors into the well casing. Medium sand was placed in the borehole annulus surrounding the well screen. The well casings are protected within flush-grade surface monuments. Monitor well construction details are indicated in Figures A-3 through A-18.

The monitor wells were developed by removing water from the wells with a stainless steel bailer. The elevations of the well casings were measured to the nearest 0.01 foot with an engineers level. An elevation datum of 100 feet was assumed on the steel catch basin grate located at the southeast corner of the 24th Avenue East and East McGraw Street intersection (Figure 4). Elevations referenced to this datum are included on the monitor well logs.

GROUND WATER SAMPLING PROGRAM

Ground water samples were collected from the monitor wells by GeoEngineers within five days of well construction. Water quality samples were not collected from wells MW-2, MW-3, MW-4, MW-8 and MW-9, because the wells contained free product. The water samples were collected with a

teflon bailer after at least three well casing volumes of water were removed from each well. The water samples were transferred to septum vials in the field and kept cool during transport to the testing laboratory.

The bailer was cleaned prior to each sampling attempt with a fresh water rinse, a trisodium phosphate (TSP) wash, and a distilled water rinse.

GROUND WATER ELEVATIONS

The depth to the ground water table relative to the monitor well casing rims was measured from September 1989 through December 1989. The measurements were made using a weighted fiberglass tape and water-finding paste or an electric water level probe. The fiberglass tape and electric probe were cleaned with a TSP wash and a distilled water rinse prior to use in each well. Ground water elevations were calculated by subtracting the water table depth from the casing rim elevations. A correction factor has been applied to the ground water elevations in the wells containing free product. Ground water elevation data are summarized in Table 1.

Free product thicknesses were measured in MW-2 and MW-3 during September and October. Product thicknesses in MW-4, MW-8 and MW-9 were recorded from September through December. The measurements were made with a weighted fiberglass tape and product-finding paste. Product thickness data are presented in Table 4.

HYDROCARBON VAPOR CONCENTRATIONS

Hydrocarbon vapor concentrations were measured in the monitor wells in September 1989 and December 1989. Vapor concentrations were also measured in some of the lateral sewer lines exposed during site remediation activities. A Bacharach TLV Sniffer that is calibrated to hexane was used for the measurements. The lower threshold of significance for the TLV Sniffer in this application is 400 ppm, or 4 percent of the Lower Explosive Limit (LEL) of hexane. Hydrocarbon vapor concentrations measured in the well casings in December 1989 are presented in Table 3.

GROUND WATER AND VAPOR REMEDIATION SYSTEM SAMPLING

Water samples were collected on December 11, 1989 and December 28, 1989 from the three sampling ports on the water treatment system shown in Figure 9. Water samples were also collected from Sample Port No. 3 on December 18, 1989, as required by Metro to monitor the water quality of the discharge from the water treatment system.

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50% OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS MORE THAN 50% PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-83.
2. Soil classification using laboratory tests is based on ASTM D2487-83.
3. Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry – Absence of moisture, dusty, dry to the touch

Moist – Damp, but no visible water

Wet – Visible free water or saturated, usually soil is obtained from below water table

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SOIL CLASSIFICATION SYSTEM

FIGURE A-1

GEI 85-88

LABORATORY TESTS:

CA Chemical Analysis

VAPOR CONCENTRATION DATA:

Vapor concentration given in parts per million

SHEEN CLASSIFICATION SYSTEM:

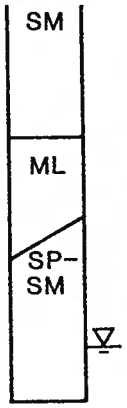
NS No visible sheen

SS Slight sheen

MS Moderate sheen

HS Heavy sheen

SOIL GRAPH:



Soil Group Symbol (See Note 2)

Distinct Contact Between Soil Strata

Gradual Change Between Soil Strata

Water Level

Bottom of Boring

BLOW-COUNT/SAMPLE DATA:

Blows required to drive a split-barrel sampler (2.4-inch I.D.) 12 inches or other indicated distances using 300 pound hammer falling 30 inches.

"P" indicates sampler pushed with weight of hammer or hydraulics of drill rig.

Blows required to drive a split-barrel sampler (1.5-inch I.D.) 12 inches or other indicated distances using 140 pound hammer falling 30 inches.

22 ■ Location of relatively undisturbed sample

12 ⊠ Location of disturbed sample

P □ Location of sampling attempt with no recovery

10 ◪ Location of sample attempt using Standard Penetration Test procedures

NOTES:

1. Information presented in the attached text and the Key To Boring Log Symbols is required to adequately explain the data on the boring logs.
2. Soil classification system is summarized in Figure A-1.
3. The reader must refer to the discussion in the report test as well as the exploration logs for a proper understanding of subsurface conditions.

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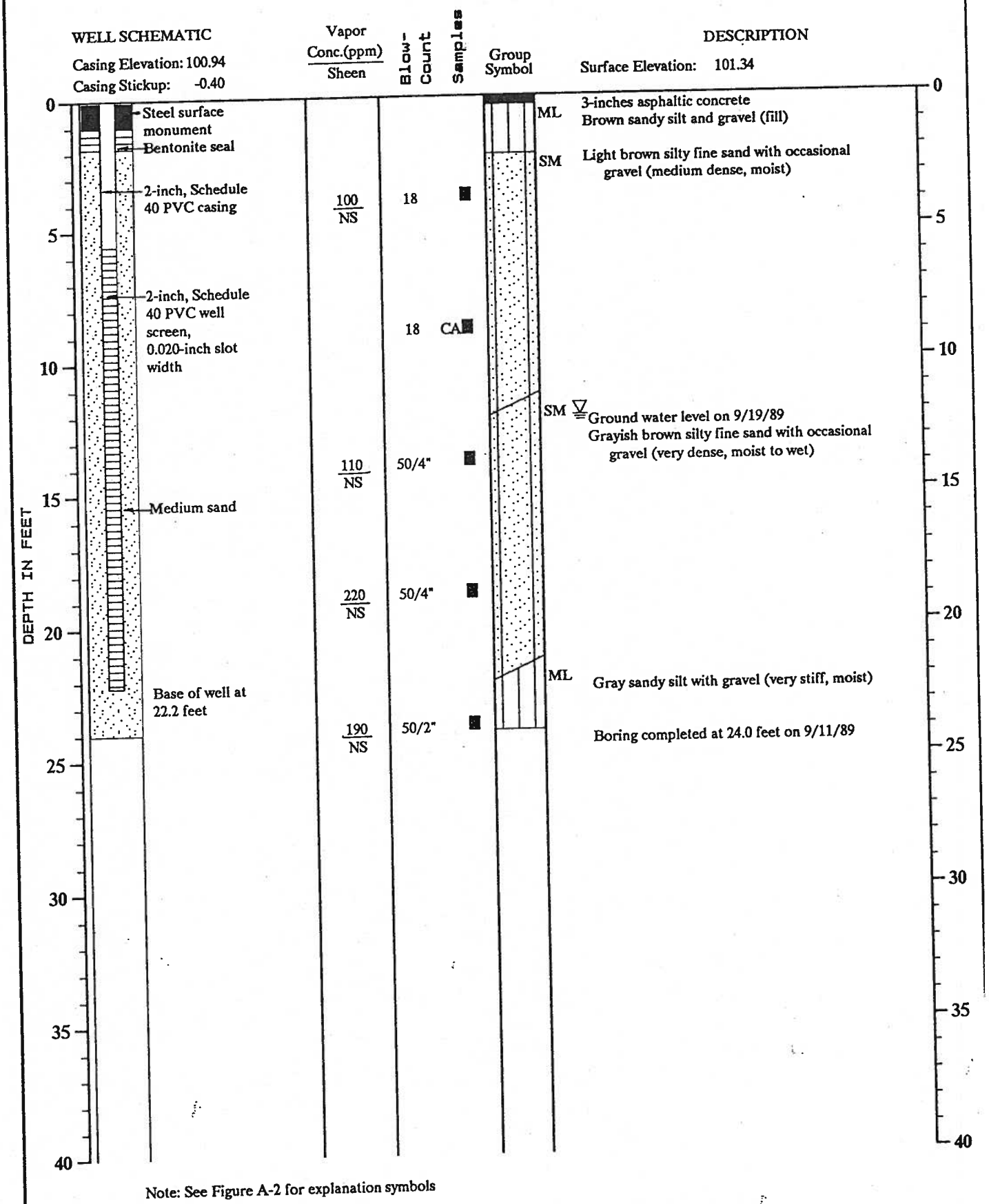
KEY TO BORING LOG SYMBOLS

FIGURE A-2

GEI 107-100 Rev. 1/90

MONITOR WELL NO. MW-1



Note: See Figure A-2 for explanation symbols

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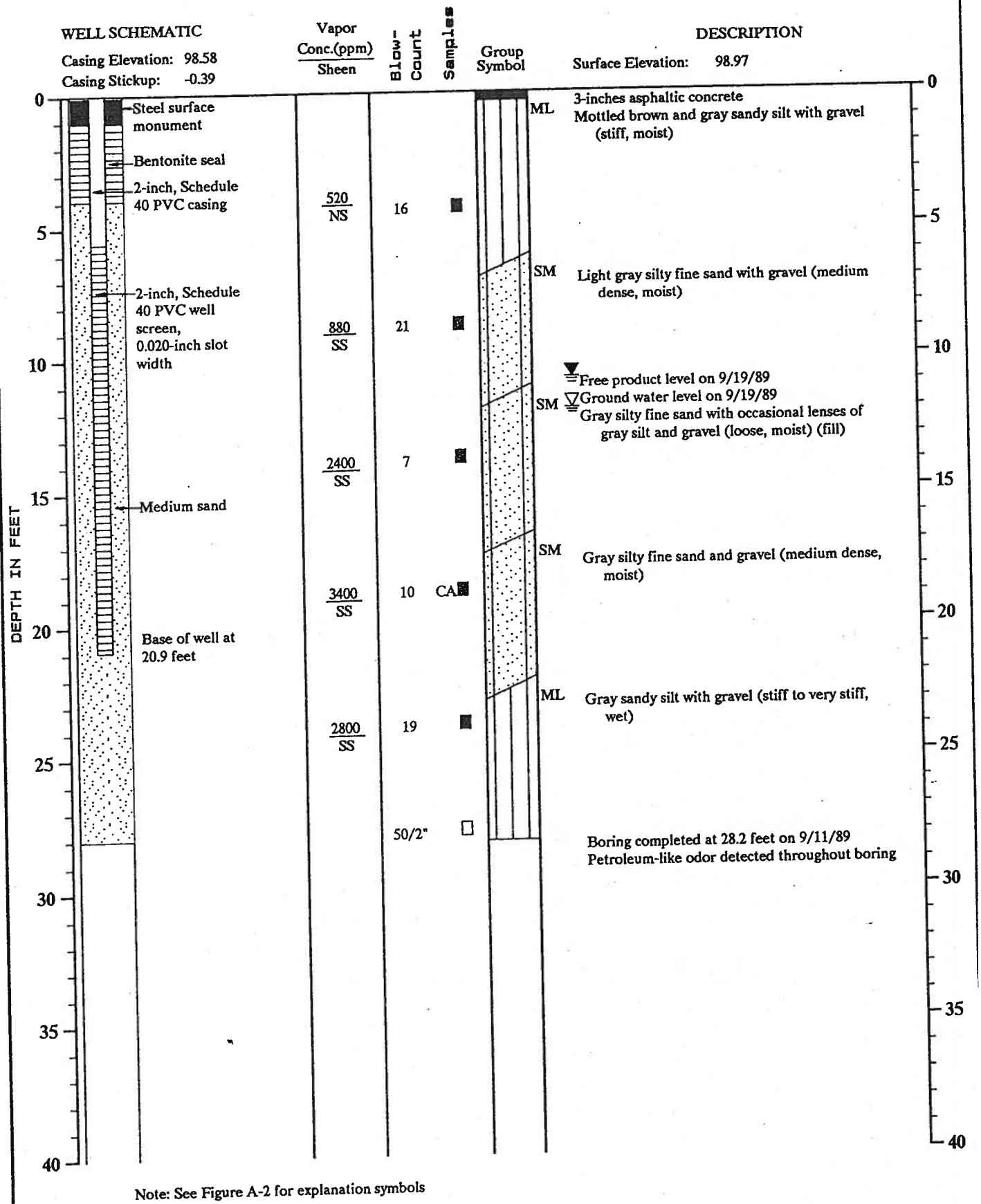
Log of Monitor Well

Figure A-3

MONITOR WELL NO. MW-2



Note: See Figure A-2 for explanation symbols

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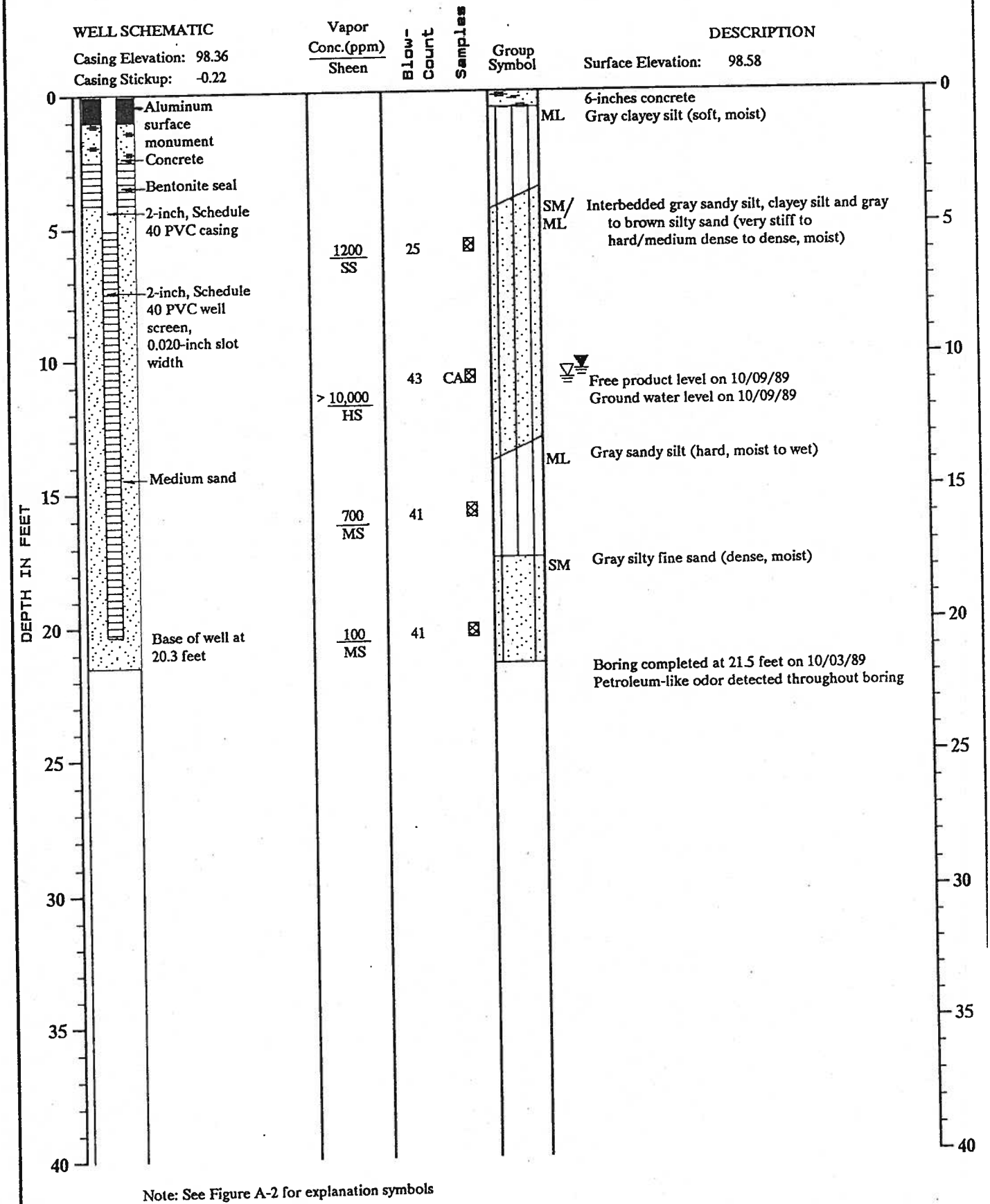
Log of Monitor Well

Figure A-4

MONITOR WELL NO. MW-8



Note: See Figure A-2 for explanation symbols

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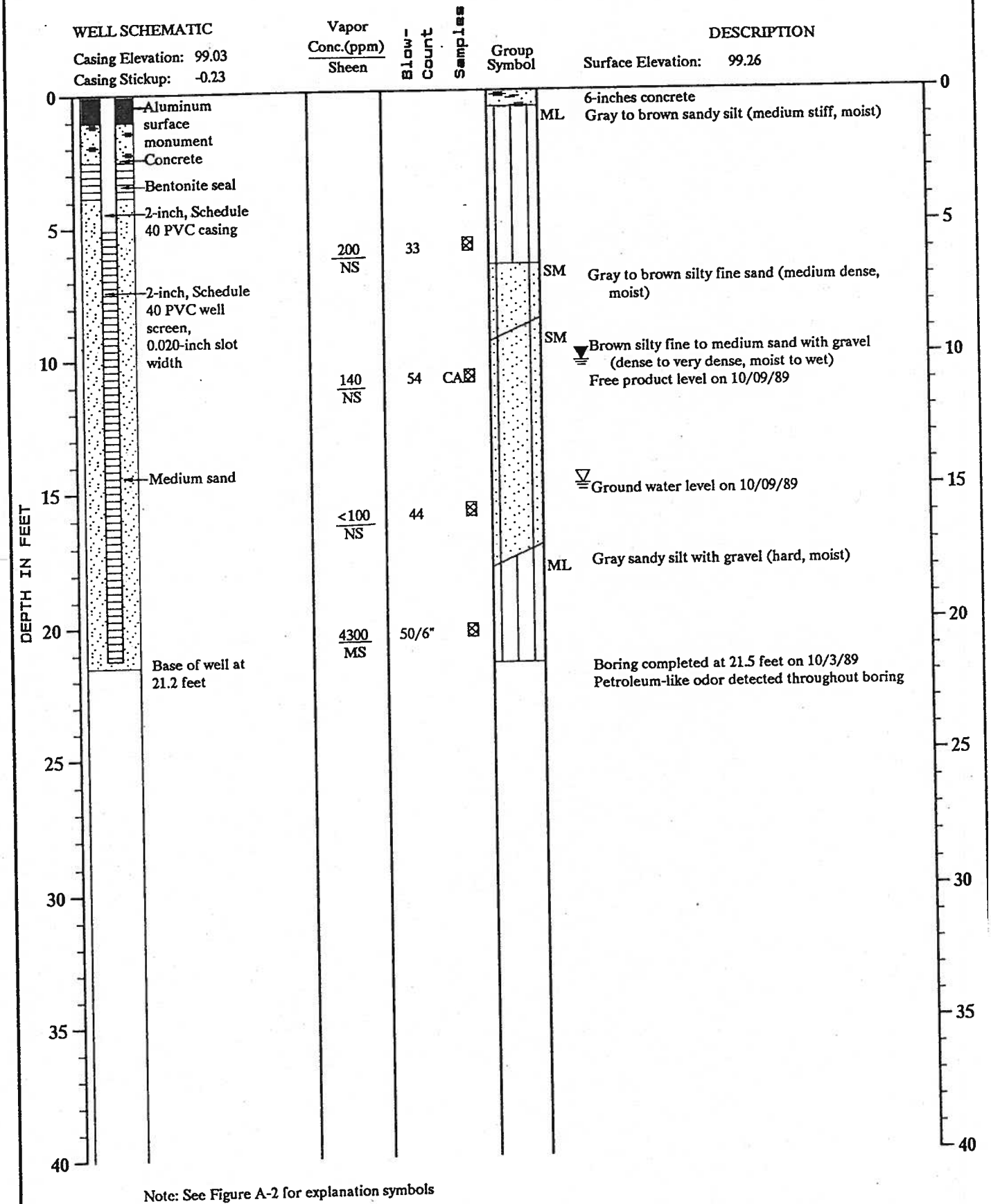
Log of Monitor Well

Figure A-10

MONITOR WELL NO. MW-9



Note: See Figure A-2 for explanation symbols

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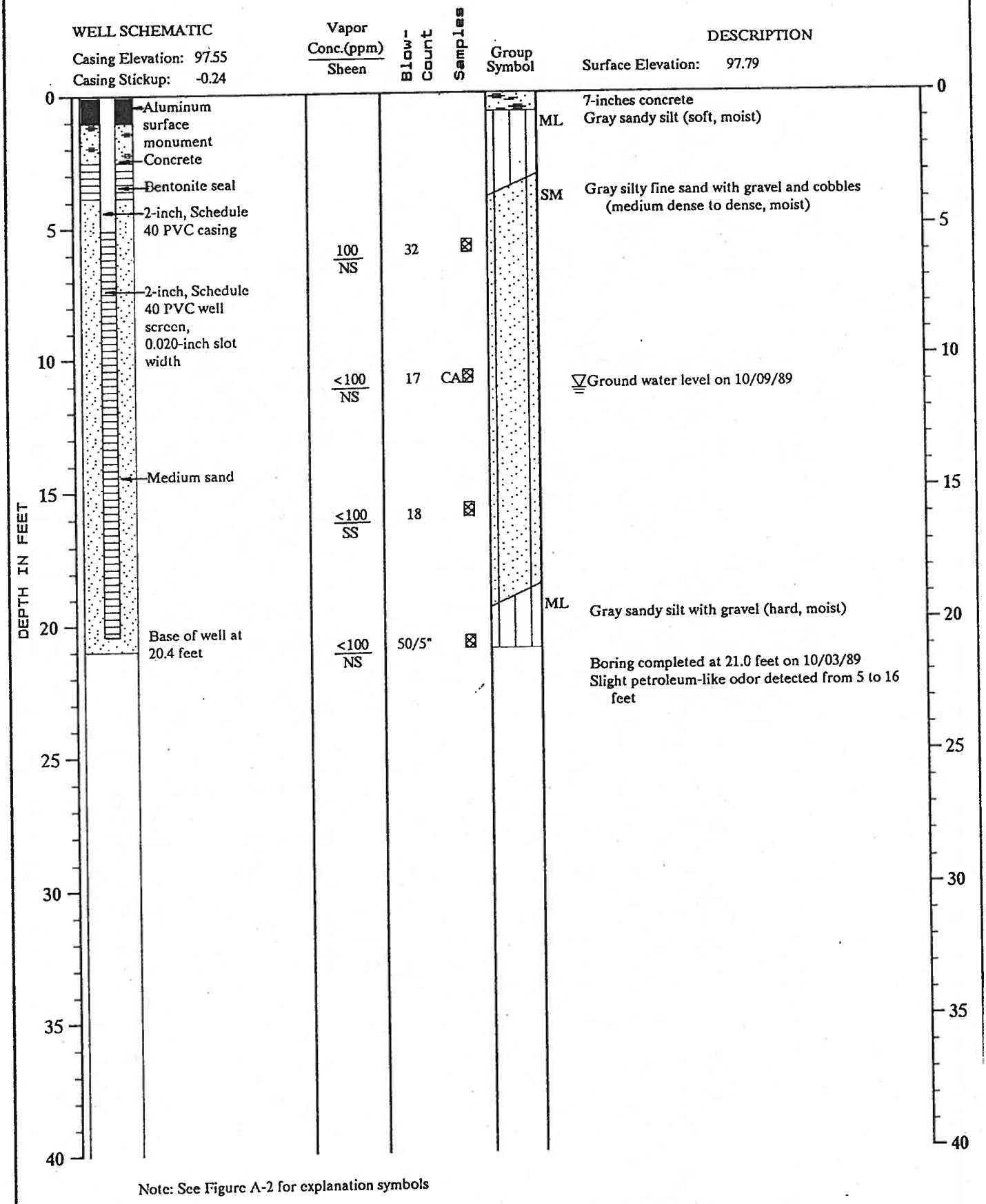
Log of Monitor Well

Figure A-11

MONITOR WELL NO. MW-10



Note: See Figure A-2 for explanation symbols

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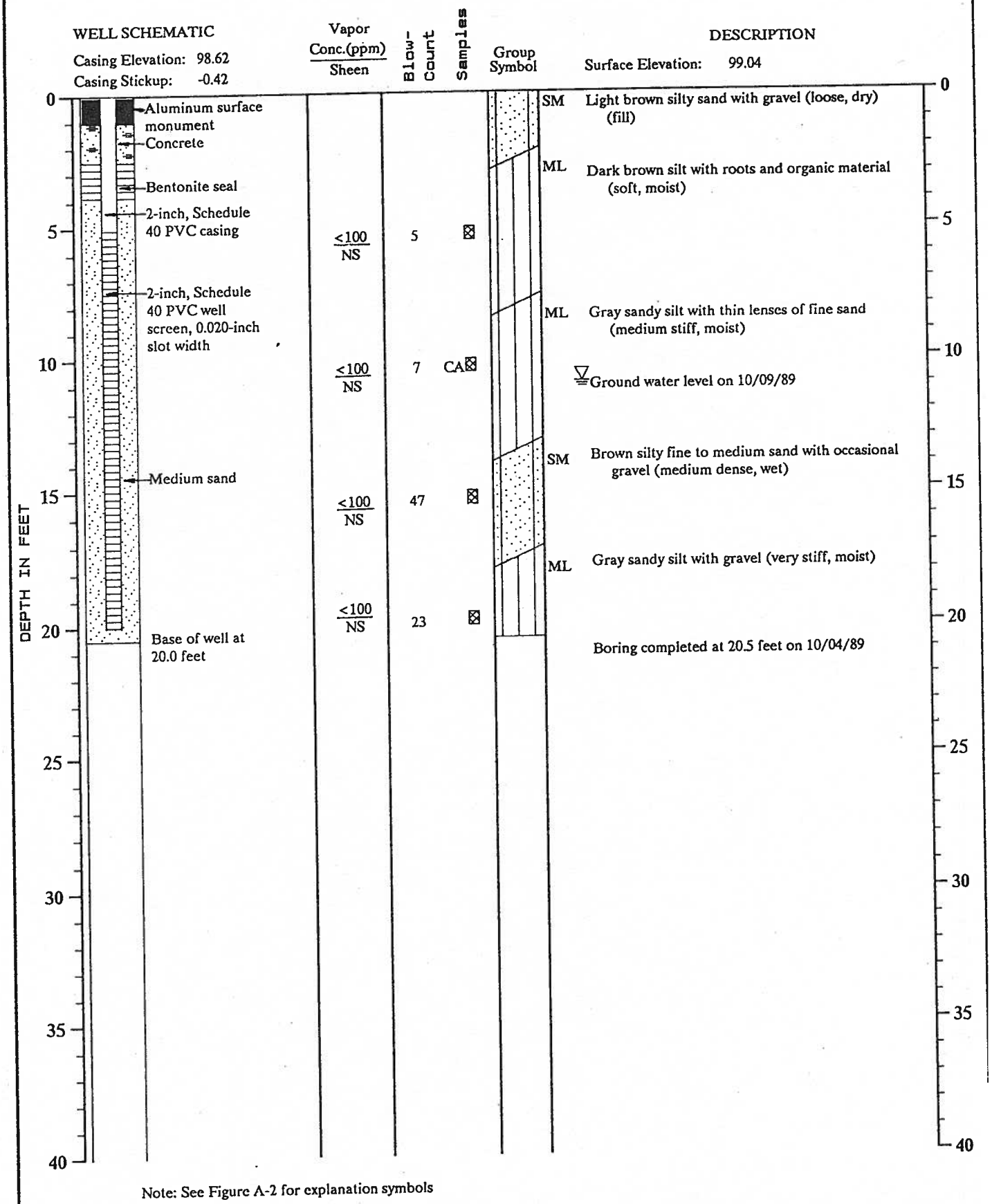
Log of Monitor Well

Figure A-12

TEP:OKP:CDO 2/8/90

-001-B04

MONITOR WELL NO. MW-11



Note: See Figure A-2 for explanation symbols

TEP:OKP:CDO 2/8/90

1-001-B04

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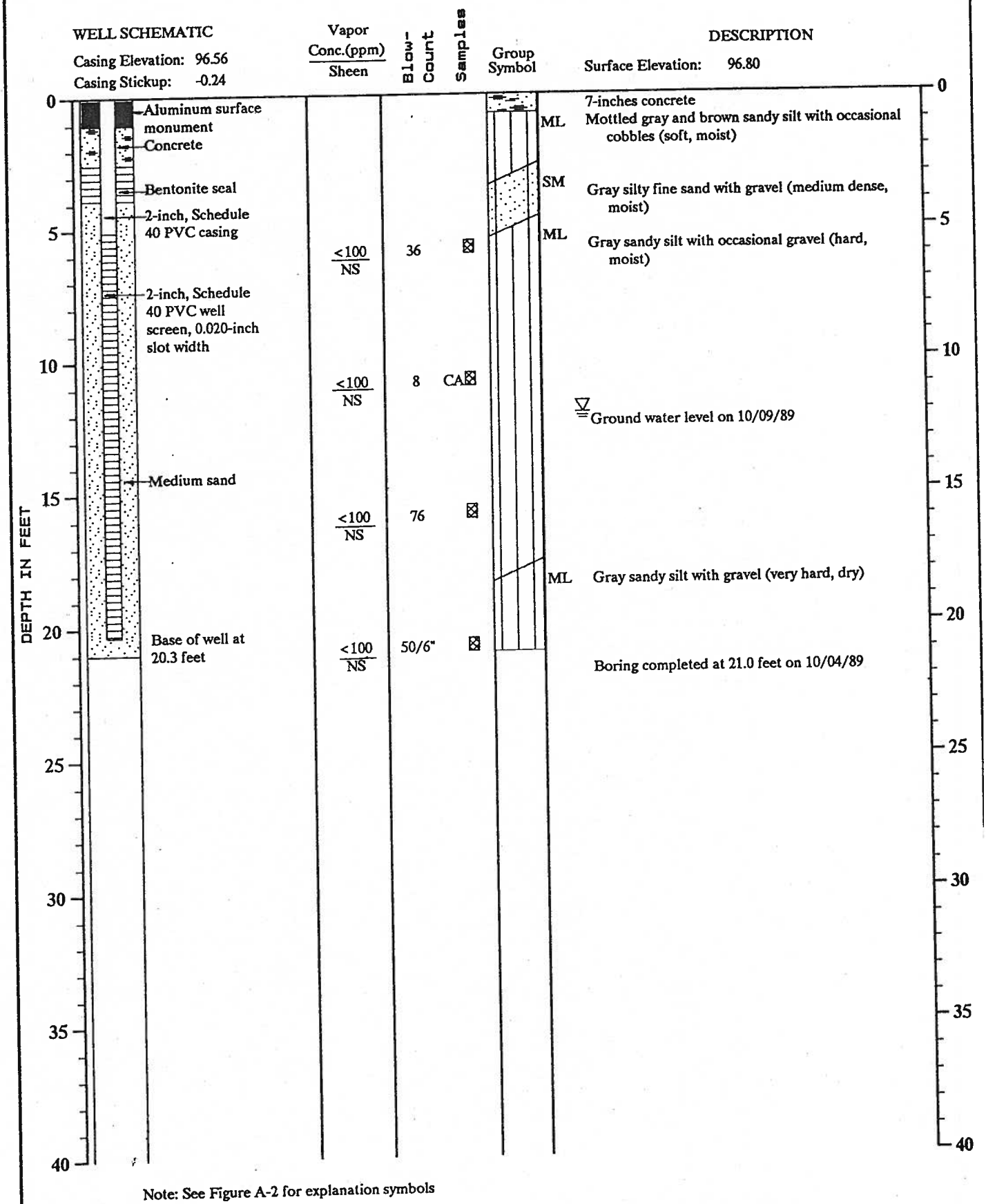
Log of Monitor Well

Figure A-13

MONITOR WELL NO. MW-12



Note: See Figure A-2 for explanation symbols

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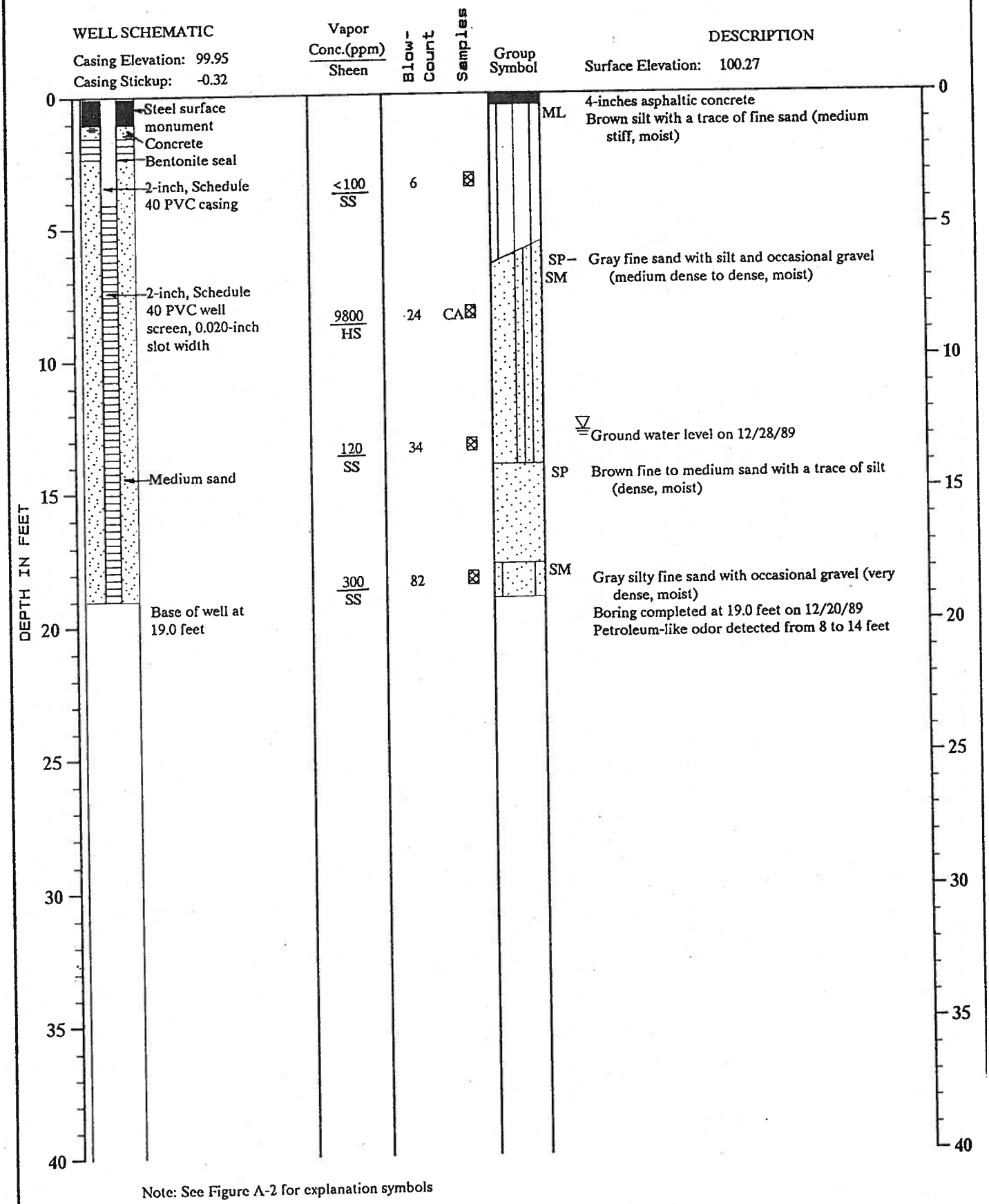
Log of Monitor Well

Figure A-14

MONITOR WELL NO. MW-13



Note: See Figure A-2 for explanation symbols

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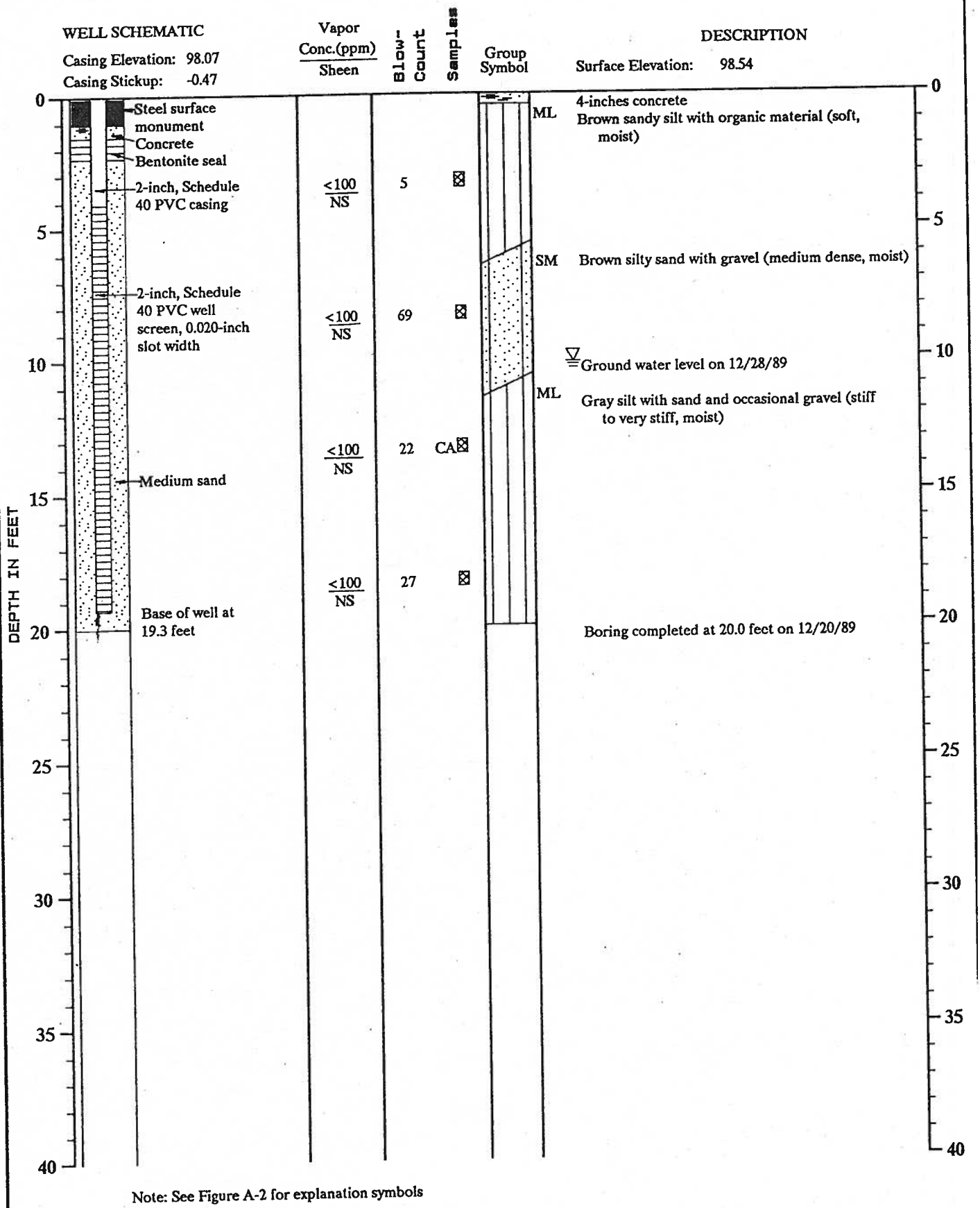
Log of Monitor Well

Figure A-15

TEP:OKP:CDO 2/8/90

-001-B04

MONITOR WELL NO. MW-14



Note: See Figure A-2 for explanation symbols

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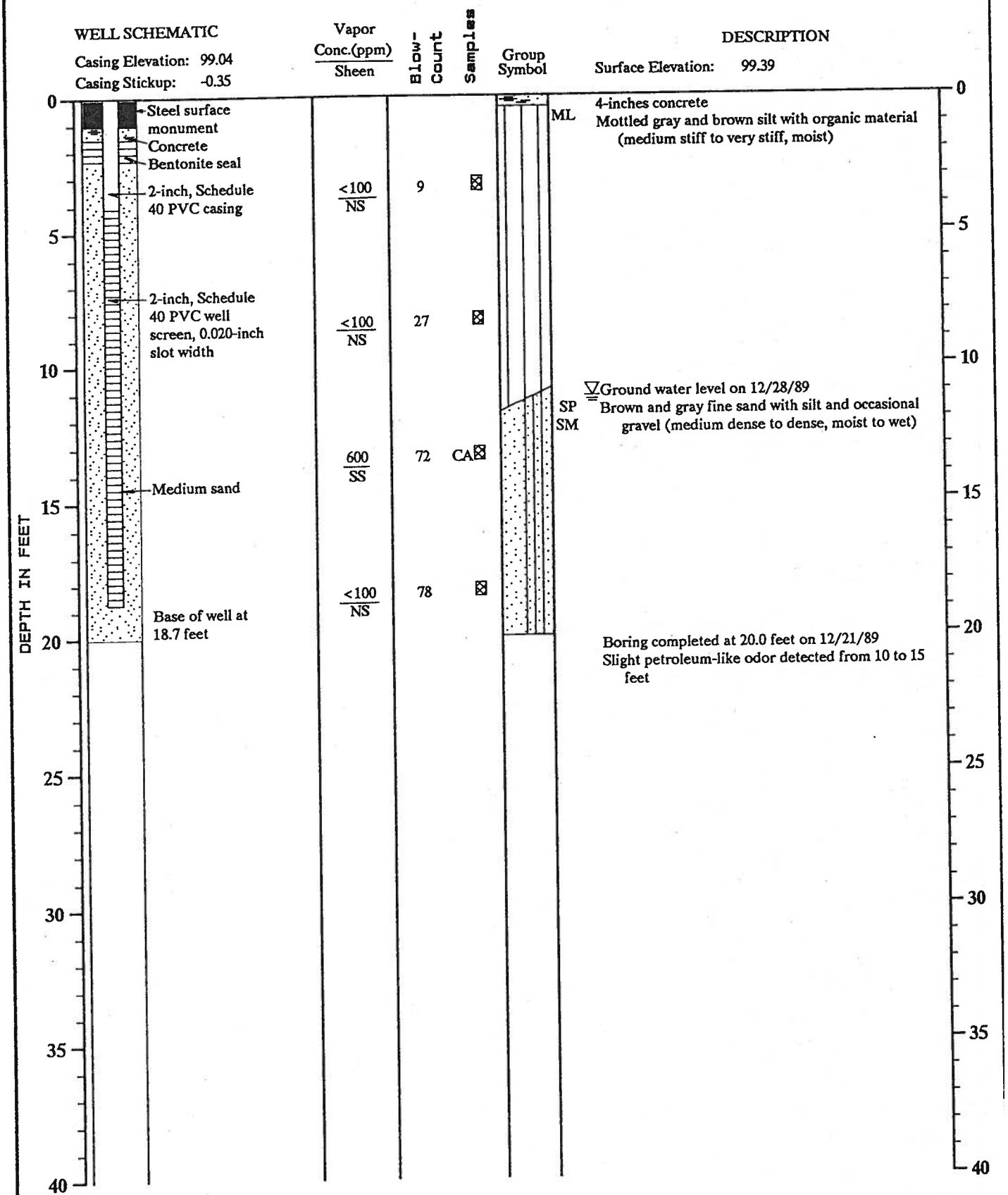
Log of Monitor Well

Figure A-16

MONITOR WELL NO. MW-15



Note: See Figure A-2 for explanation symbols

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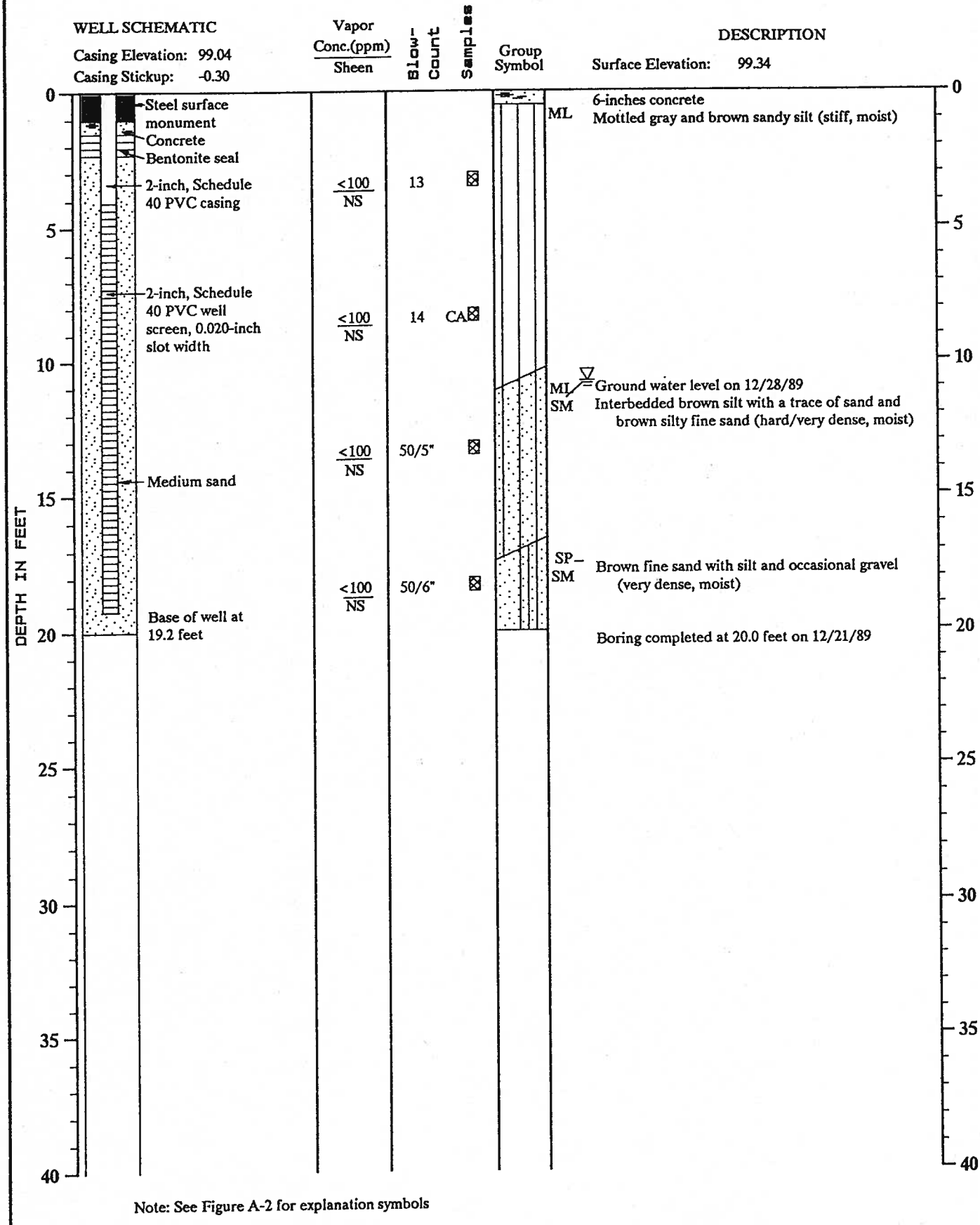
Log of Monitor Well

Figure A-17

TEP:OKP:CDO 1/10/90

-001-B04

MONITOR WELL NO. MW-16



Note: See Figure A-2 for explanation symbols

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Log of Monitor Well

Figure A-18

TEP:OKP:CDO 1/10/90

1-001-B04

PROGRESS REPORT NO. 1
REMEDIAL MONITORING PROGRAM
CIRCLE K FACILITY 1461
SEATTLE, WASHINGTON
FOR
CIRCLE K CORPORATION

9/23/90

2350 24th Ave E.
Seattle

GeoEngineers

August 23, 1990

Consulting Geotechnical
Engineers and Geologists

The Circle K Corporation
P.O. Box 52084
Phoenix, Arizona 85072

Attention: Mr. Robert F. Staab

We are submitting two copies of "Progress Report No. 1" regarding ongoing remedial actions at the site of Circle K Facility 1461 in Seattle, Washington. The general scope of our services is described in our proposal dated January 18, 1990. Our services were authorized by Mr. Robert F. Staab of the Circle K Corporation on January 24, 1990.

We appreciate the opportunity to be of service to the Circle K Corporation. Please call if you have any questions regarding this report.

Yours very truly,

GeoEngineers, Inc.

James A. Miller
Principal

OKP:JAM:cs

cc: Mr. Joseph Hickey
Washington Dept. of Ecology
Northwest Regional Office
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File No. 1780-002-B04

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PROGRESS REPORT NO. 1
REMEDIAL MONITORING PROGRAM
CIRCLE K FACILITY 1461
SEATTLE, WASHINGTON
FOR
CIRCLE K CORPORATION

INTRODUCTION

This progress report summarizes the results of the subsurface fuel recovery and ground water monitoring programs at the site of Circle K Facility 1461 between January 5 and June 28, 1990. Facility 1461 is located in Seattle, Washington and consists of a convenience store which formerly marketed leaded and unleaded gasoline. Initial results of our subsurface remedial monitoring are presented in our report dated March 6, 1990. The free product recovery and ground water treatment systems started operating on a full-time basis on December 6, 1989. This report presents data from the monitoring of remediation activities and site conditions and evaluates the effectiveness of the remedial plan.

Chemical Processors, Inc., Environmental Services Division (ChemPro) installed the free product recovery, ground water treatment, and vapor extraction system at the site. ChemPro was also responsible for maintenance of the equipment until March 1, 1990. After that time, Glacier Environmental Services, Inc. (Glacier) acquired the responsibilities associated with the operation and maintenance of the recovery and treatment systems.

MONITORING ACTIVITIES

MONITOR WELL MEASUREMENTS

The locations of all existing monitor wells at the site are shown in Figure 1. Free product thicknesses, ground water elevations and well casing hydrocarbon vapor concentrations were measured monthly in each well during this reporting period. Field procedures used to monitor and sample the wells are described in Appendix A.

Product Thickness: Free product was detected in Wells MW-4, MW-8 and MW-9. Product thicknesses in the three wells ranged from 0.14 feet to 1.19 feet between January and June 1990. Monthly free product thicknesses

measured in the monitor wells are listed in Table 1. The product thickness fluctuations in each well as based on our monthly measurements is shown in Figure 2.

Product thickness in MW-9, located approximately 60 feet from the recovery well, has decreased steadily since March 1990. The product thickness in MW-4 and MW-8 increased during the same time period. MW-4, located closest to the recovery well and backfilled tank excavation, generally contains the greatest amount of product.

Contour maps of the apparent thickness of free product as measured in the well casings on March 8 and June 8, 1990, are presented as Figures 3 and 4, respectively. The lateral extent of the product plume remained stable during this reporting period. Free product is bailed monthly from the monitor wells as part of our monitoring activities at the site.

Water Levels: Ground water elevations were measured monthly in each of the monitor wells. Ground water elevations measured between January and June, 1990 are presented in Table 2. A ground water contour map based on the March 8, 1990 data is presented as Figure 5. As discussed in our March 6, 1990 report, shallow ground water in the vicinity of the site flows towards the northeast, except where water levels are influenced by pumping in the recovery well.

Ground water elevations in individual wells fluctuated in response to pumping and seasonal precipitation. A graph of the ground water elevations measured in MW-4, MW-8 and MW-11 for the period of October 9, 1989 to June 8, 1990 is shown in Figure 6. Ground water levels were highest in mid-January and early February due to increased precipitation during this period. From October 1989 to February 1990, water levels in wells outside of the ground water cone of depression increased by as much as 4 feet. Ground water elevations measured at the site decreased by 0.31 feet to 2.96 feet during the period of January 11 to June 8, 1990. Ground water levels in monitoring wells located within the cone of depression fluctuated by less than 2 feet between January 11 and June 8, 1990.

Hydrocarbon Vapor Concentrations: Hydrocarbon vapor concentrations in the monitor well casings were measured monthly using a Bacharach TLV Sniffer calibrated to hexane. Table 3 lists the hydrocarbon vapor concentrations measured in the well casings during this reporting period.

Hydrocarbon vapor concentrations were detected consistently at concentrations greater than 10,000 parts per million (91% LEL) in MW-4, MW-8, MW-9 and MW-13 during this reporting period. Vapor concentrations in MW-6, MW-14 and MW-15 varied from less than 100 parts per million (ppm) to greater than 10,000 ppm. Hydrocarbon vapor concentrations did not exceed 400 ppm in the other monitor wells.

GROUND WATER QUALITY

Two rounds of water quality samples were obtained from monitor wells located near the edge of the free product plume on March 8-9 and June 11, 1990. Samples were not collected from wells that contained free product. The water samples were analyzed for benzene, ethylbenzene, toluene and xylenes (BETX) using EPA Method 8020. A summary of the analytical results is presented in Table 4. Laboratory data sheets and chain-of-custody records are included in Appendix B. The concentrations of benzene detected in ground water samples collected from the wells are indicated in Figure 4.

Water samples collected from MW-13 and MW-15 contained high concentrations of BETX compounds. The benzene concentrations in these two wells appears to have decreased slightly during the period between our March and June sampling episodes. Samples collected from the other monitor wells during this reporting period contained relatively low or non-detected concentrations of BETX. Based on the water quality data obtained from the monitor wells, the plume of BETX-contaminated ground water at the site has remained relatively stable from March to June, 1990.

FREE PRODUCT RECOVERY SYSTEM

The volume of free product recovered at the site using the Filter Scavenger pumping system has been measured by ChemPro or Glacier personnel as part of the routine maintenance of the recovery and treatment systems. Since March 1, 1990 the amount of free product recovered at the site has been reported by Glacier on a weekly basis. Product is pumped to an aboveground storage drum prior to removal from the site. The Filter

Scavenger recovery system has been operating continuously at the site since December 6, 1989, except for several pump maintenance and repair episodes totaling about 10 to 20 days.

Approximately 189 gallons of product were pumped from the recovery well between January 5 and June 25, 1990. A total of 502 gallons of product have been recovered at the site since pumping began on December 6, 1989. Product recovery data are summarized in Table 5.

A plot of the rate of free product recovery during the period from January 9 to June 25, 1990 is shown in Figure 7. The product recovery rate gradually decreased from 4.6 gallons per day (gpd) in mid-January to approximately 0.5 gpd during May and June 1990.

GROUND WATER TREATMENT SYSTEM

The ground water depression pump has been operating almost continuously since December 6, 1989. The pump was shut down during demolition of the service island between March 21 and March 23, 1990. The ground water treatment system was turned off from June 10 to June 12, 1990 for equipment maintenance.

Approximately 110,000 gallons of water were pumped, treated and discharged to the Metro sewer from January 11 to June 8, 1990. The average rate of ground water recovery during this period was 740 gallons per day. As shown in Figure 5, the recovery well appears to be drawing shallow ground water from the vicinity of all wells containing free product. The ground water cone of depression has remained relatively stable since the recovery system began continuous operation in December 1989. The depth to ground water in the recovery well is approximately 15.5 feet below ground surface.

Eight rounds of water samples were collected from the water treatment system sampling ports during this reporting period. The samples were analyzed for BETX (EPA Method 8020) to evaluate the effectiveness of the two carbon filters in removing fuel-related contaminants from the recovered ground water. The locations of the sampling ports and a description of the water treatment system is included in our March 6, 1990 report. Table 6 summarizes the chemical data obtained from BETX analysis of samples

collected from the water treatment system. Laboratory data sheets and chain-of-custody records for the samples collected from the water treatment system are included in Appendix C.

Benzene concentrations in untreated ground water samples collected from Sampling Port No. 1 ranged from 20,000 to 33,000 parts per billion (ppb). As shown in Table 6, the benzene concentrations detected in the samples collected from Sampling Port No. 2 fluctuated between 5.8 and 4,700 ppb during this reporting period. Based on the chemical data obtained from Sampling Port No. 2, the primary carbon filter was replaced with the secondary (polishing) carbon filter, and a new carbon filter was installed as the polishing filter. Spent carbon filters were replaced on February 1, March 13, May 5 and July 2, 1990. The primary carbon filters appear to have a life span of approximately six weeks before significant concentrations of BETX are discharged into the polishing filter. The polishing filter has been effective in removing any remaining BETX compounds from the treated water prior to discharge into the sanitary sewer line (Table 6).

One round of samples was obtained from the three sampling ports on January 11, 1990 and analyzed for total petroleum hydrocarbons (TPH) by EPA Method 418.1. These samples were collected and analyzed to determine if significant concentrations of petroleum hydrocarbons other than gasoline were present in the ground water passing through the treatment system. TPH concentrations of 13, 0.08 and 0.08 ppm were detected in the samples collected from Sampling Port Nos. 1, 2 and 3, respectively.

The discharge from the water treatment system to the Municipality of Metropolitan Seattle (Metro) sanitary sewer was monitored and sampled in accordance with the requirements outlined in the Metro Authorization for Discharge. Samples of the treated discharge water were collected monthly from Sampling Port No. 3. Samples were analyzed for nine metals (EPA Method 7000 series), cyanide (EPA Method 9010), fats/oil/grease (EPA Method 413.2) and pH (EPA Method 150.1). Analytical results for these samples are summarized in Table 7. The discharged water contained undetected or trace concentrations of the analyzed compounds. The pH of the discharge water is typical of clean ground water. Laboratory data sheets for these samples are included in Appendix C.

Hydrocarbon vapor concentrations were measured monthly at the point of discharge to the lateral sanitary sewer line using a Bacharach TLV Sniffer calibrated to hexane. Hydrocarbon vapor concentrations ranged from non-detected to 1,000 ppm (9% LEL) during this reporting period.

Results of our monthly sampling and monitoring of the discharge from the ground water treatment system were submitted to Metro on February 12, March 16, April 20, June 1 and June 26, 1990. Metro approved our request to discontinue monthly testing for metals and cyanide after the February 1990 sampling episode.

VAPOR EXTRACTION SYSTEM (VES)

Preliminary testing of the VES in December 1990 indicated the presence of high concentrations of combustible hydrocarbon vapors in the tank excavation backfill and the surrounding subsurface soils. Vapor measurements obtained from the sampling ports while testing the system on February 8, 1990 indicated that the primary and secondary carbon filters were saturated with fuel vapors after the VES had operated for less than eight hours. Details of the VES currently installed at the site are included in our March 6, 1990 report. The VES was not operated continuously during this reporting period.

Additional VES testing was performed on March 13, 1990. A portable internal combustion unit (ICU) was connected to the existing VES piping. The slotted PVC piping is buried in the pea gravel backfill of the former gasoline tank excavation. A vacuum blower fan was used to extract subsurface vapors through the ICU. A mixture of ambient air and soil vapor passed through the ICU at a flow rate of approximately 60 cubic feet per minute for about two hours. A concentration of 20,000 ppm (2% by volume) combustible hydrocarbon vapors was measured entering into the ICU throughout the duration of the test. This concentration represents a minimum vapor concentration, as greater concentrations of combustible hydrocarbon vapors would have exceeded the limits of the ICU operating temperature.

The VES testing confirmed our opinion that treatment of vapors using a carbon filtration system would not be cost-effective if free product is present in the excavation backfill. Therefore, the VES was not utilized for subsurface remediation during most of this reporting period.

DISCUSSION OF RESULTS

ASSESSMENT OF SUBSURFACE CONTAMINATION

Free product was observed floating on shallow ground water in three monitor wells from January to June 1990. Product thicknesses in the wells ranged from 0.14 to 1.19 feet during this period. Based on product thickness measurements, the lateral extent of the product plume appears to have remained stable since product recovery began in December 1989. Floating product appears to be confined to a relatively small area located north and northwest of the former leaky underground fuel tank (Figures 3 and 4).

Fuel-contaminated ground water is present in the monitor wells located immediately outside of the edge of the free product plume. Analytical data for MW-13 and MW-15 water quality samples indicate benzene concentrations ranging from 20,000 to 54,000 ppb in the vicinity of these two wells. Benzene concentrations in ground water from MW-6 ranged from 14 to 18 ppb. The current Washington State Department of Ecology cleanup guideline for benzene in ground water at underground storage tank sites is 66 ppb. The current drinking water quality standard for benzene is 5 ppb. The proposed compliance cleanup level for benzene in ground water as listed in the DRAFT Model Toxics Control Act Cleanup Regulation (June 21, 1990) is also 5 ppb.

High concentrations of hydrocarbon vapors were measured in the monitor well casings located adjacent to the free product plume. The low concentrations of hydrocarbon vapors measured in outlying wells indicate that the subsurface hydrocarbon vapors in the soil have not migrated a significant distance laterally from the edge of the free product plume.

REMEDIATION SYSTEM PERFORMANCE

The ground water remediation system has been operating almost continuously during this reporting period. Our remedial monitoring indicates the system is effective in recovering free product and contaminated ground water from the estimated limits of the free product plume. Ground water elevations measured in the monitor wells confirm the presence of a stable cone of depression encompassing the lateral extent of the free product plume.

The rate of free product recovery decreased from approximately 4.0 gpd in mid-January to 0.5 gpd in May and June 1990. Factors which likely control the product recovery rate at this site include (1) the decreasing volume of free product in the subsurface, (2) seasonal fluctuations in the ground water table elevation, and (3) the relative permeability of the subsurface soils. The relatively large volume of product recovered during the first month of pumping probably resulted from high flow rates within the tank excavation backfill material and the native soils located in the immediate vicinity of the recovery well.

Although product thicknesses in MW-4, MW-8 and MW-9 fluctuated throughout this reporting period, a significant amount of free product likely remains in the subsurface. We expect product recovery to continue at a rate of about 0.5 gpd for at least six more months.

The ground water remediation system effectively treated 110,000 gallons of fuel-contaminated ground water recovered at the site from January 11 to June 8, 1990. Water quality at the edge of the contaminated water plume has improved after six months of ground water pumping. Benzene concentrations in MW-11 and MW-16 decreased to below laboratory detection limits in June 1990. The concentrations of benzene detected in the water samples obtained from MW-6 decreased from 250 ppb in October 1989 to 18 ppb in June 1990. High benzene concentrations continued to be detected in the water samples collected from MW-13 and MW-15 during March and June 1990. The high BETX concentrations detected in these two wells indicate that subsurface free product may be present near both of these wells. The BETX concentrations detected in the ground water near MW-13 and MW-15 will likely decline as free product is removed from the ground water adjacent to the wells.

The VES currently installed at the site was not operated during most of this reporting period. Results from a preliminary test using a portable ICU indicate that high concentrations of hydrocarbon vapors are present in the pea gravel backfill of the former tank excavation and the surrounding subsurface soils.

RECOMMENDATIONS

Continued operation and monitoring of the free product recovery and ground water treatment system is recommended. The ground water elevation,

free product thickness and concentration of hydrocarbon vapors should be measured monthly in each of the fourteen existing monitor wells. Quarterly water quality samples should be collected from the wells located near the edge of the free product plume, and the samples should be analyzed for BETX.

Monthly sampling and monitoring of the treated water discharged into the sanitary sewer system is required by the Metro Authorization for Discharge. Monthly reports containing results from the sampling and analyses outlined in the Authorization for Discharge are required by Metro. Additional samples should be collected from the three water sampling ports on a routine basis and analyzed for BETX to evaluate the effectiveness of the treatment system and whether the carbon filters need replacement.

We recommend that the VES not be operated as presently installed. The VES is not cost-effective for treating the high concentrations of hydrocarbon vapors resulting from the presence of free product currently being recovered through the backfilled tank excavation. A thermal oxidation unit is currently being evaluated for the treatment of subsurface hydrocarbon vapors recovered at the site.

Additional progress reports summarizing the results of our ongoing remedial monitoring at this site will be submitted at approximate six-month intervals.

LIMITATIONS

We have prepared this report for use by the Circle K Corporation. The report may be made available to regulatory agencies. This report is not intended for use by others, and the information contained herein may not be applicable to other sites.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time this report was prepared. No other conditions, express or implied, should be understood.

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Please call if your have questions regarding this report.

Respectfully submitted,

GeoEngineers, Inc.

James G. Roth
Hydrogeologist

Otto K. Paris
Project Geologist

James A. Miller, P.E.
Principal

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TABLE 1
PRODUCT THICKNESS IN GROUND WATER MONITOR WELLS

Well Number	Measurement Date	Product Thickness (feet)
MW-04	01/11/90	0.95
	02/08/90	1.06
	03/08/90	0.88
	04/09/90	0.56
	05/09/90	1.19
	06/08/90	1.01
MW-08	01/11/90	0.98
	02/08/90	0.60
	03/08/90	0.43
	04/09/90	0.46
	05/09/90	0.48
	06/08/90	0.86
MW-09	01/11/90	0.15
	02/08/90	0.31
	03/08/90	0.66
	04/09/90	0.51
	05/09/90	0.31
	06/08/90	0.14

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TABLE 2
GROUND WATER ELEVATIONS IN MONITOR WELLS

Monitor Well No.	TOC Elevation (feet)	Ground Water Surface Elevations (feet)					
		01/11/90	02/08/90	03/08/90	04/09/90	05/09/90	06/08/90
MW-01	100.94	89.03	88.74	88.74	88.90	89.08	88.72
MW-04*	98.38	85.01	85.23	84.76	84.67	84.11	84.04
MW-05	90.94	81.35	81.75	81.28	80.85	80.85	80.78
MW-06	97.92	87.02	87.09	86.71	86.39	86.09	85.97
MW-07	97.43	89.22	90.17	89.10	88.18	87.92	87.48
MW-08*	98.36	87.63	87.82	86.90	86.45	86.01	85.99
MW-09*	99.03	88.16	88.56	87.82	87.43	87.32	87.33
MW-10	97.55	87.88	88.12	87.84	87.43	87.21	87.04
MW-11	98.62	91.72	91.14	90.14	88.99	88.89	89.17
MW-12	96.56	86.68	86.90	86.64	86.22	86.34	86.28
MW-13	99.95	87.58	87.59	87.43	87.27	87.27	87.25
MW-14	98.07	90.37	90.37	89.07	88.19	87.76	87.41
MW-15	99.04	90.98	90.94	89.52	88.56	88.29	88.29
MW-16	99.04	89.81	89.64	89.11	88.33	88.22	88.39

Notes:
"TOC" = top of well casing; elevations based on assumed datum of 100.00 feet.
* = free product present in well; reported water surface elevations are corrected for the equivalent column height of water.

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TABLE 3
HYDROCARBON VAPOR CONCENTRATIONS IN GROUND WATER MONITOR WELL CASINGS

Monitor Well No.	Hydrocarbon Vapor Concentrations (ppm)					
	01/11/90	02/08/90	03/08/90	04/09/90	05/09/90	06/08/90
MW-01	210	120	130	<100	100	150
MW-04	>10,000	>10,000	>10,000	>10,000	>10,000	>10,000
MW-05	<100	<100	<100	<100	<100	<100
MW-06	>10,000	6,200	10,000	2,400	120	2,200
MW-07	300	180	110	<100	<100	190
MW-08	>10,000	>10,000	>10,000	>10,000	>10,000	>10,000
MW-09	>10,000	>10,000	>10,000	>10,000	>10,000	>10,000
MW-10	210	<100	<100	<100	<100	100
MW-11	180	<100	105	<100	400	<100
MW-12	200	<100	<100	<100	<100	110
MW-13	>10,000	>10,000	>10,000	>10,000	>10,000	>10,000
MW-14	1,400	<100	<100	1,000	2,000	<100
MW-15	960	2,900	5,000	560	2,800	>10,000
MW-16	<100	<100	<100	<100	<100	<100

Notes:
"ppm" = parts per million
Hydrocarbon vapor concentrations were measured in the monitor well casings using a Bacharach TLV Sniffer calibrated to hexane (110 ppm = 1% LEL)

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TABLE 4
SUMMARY OF GROUND WATER QUALITY DATA, MONITOR WELL SAMPLES

Monitor Well	Date	Benzene (ppb)	Ethlybenzene (ppb)	Toluene (ppb)	Xylenes (ppb)
MW-01	09/13/89	1.5	ND	1.9	1.6
	03/09/90	ND	ND	ND	ND
	06/11/90	NA	NA	NA	NA
MW-06	10/09/89	250	ND	3.2	110
	03/08/90	14	0.5	2.8	1.8
	06/11/90	18	1.7	6.2	7.9
MW-07	10/09/89	2.8	ND	1.4	ND
	03/08/90	0.5	ND	ND	ND
	06/11/90	NA	NA	NA	NA
MW-10	10/09/89	1.2	ND	ND	ND
	03/08/90	ND	ND	ND	ND
	06/11/90	ND	ND	ND	ND
MW-11	10/09/89	.2.6	ND	ND	3
	03/09/90	0.9	ND	0.9	ND
	06/11/90	ND	ND	ND	ND
MW-13	12/21/89	13,000	1,700	20,000	8,800
	03/09/90	54,000	3,500	50,000	18,000
	06/11/90	31,000	1,800	24,000	12,000
MW-14	12/21/89	1.1	1.9	5.7	13
	03/08/90	4.7	0.7	6.3	4.5
	06/11/90	ND	ND	49	ND
MW-15	12/21/89	7,300	1,000	9,000	5,800
	03/09/90	28,000	1,400	22,000	6,500
	06/11/90	20,000	1,800	28,000	10,000
MW-16	12/21/89	4.3	7.1	20	36
	03/09/90	ND	ND	ND	ND
	06/11/90	ND	ND	ND	0.8

Notes:
BETX by EPA Method 8020
"ppb" = parts per billion
"ND" = not detected; see laboratory data sheets in Appendix B for analyte detection limits.
"NA" = not analyzed

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TABLE 5 (Page 1 of 2)
SUMMARY OF FREE PRODUCT RECOVERY DATA

Date	Free Product Recovered (gallons)	Cumulative Free Product Recovered (gallons)	Free Product Recovery Rate (gpd)
12/07/89	40	40.0	40
12/11/89	150	190.0	37.5
12/13/89	60	250.0	30
12/14/89	20	270.0	20
12/19/89	38	308.0	7.6
12/20/89	1.0	309.0	1.0
12/22/89	2.0	311.0	1.0
12/27/89	2.0	313.0	0.4
01/02/90	0.0	313.0	0.0
01/03/90	0.0	313.0	0.0
01/09/90	13.5	326.5	2.3
01/11/90	2.4	328.9	1.2
01/16/90	22.8	351.7	4.6
01/19/90	6.4	358.1	2.1
01/23/90	14.4	372.5	3.6
01/26/90	8.8	381.3	2.9
01/30/90	5.6	386.9	1.4
02/02/90	5.6	392.5	1.9
02/06/90	6.0	398.5	1.5
02/10/90	11.2	409.7	2.8
02/13/90	7.2	416.9	2.4
02/16/90	3.2	420.1	1.1
02/20/90	7.6	427.7	1.9
02/24/90	2.8	430.5	0.7
03/02/90	4.8	435.3	0.8
03/09/90	7.2	442.5	1.0
03/13/90	4.0	446.5	1.0
03/16/90	2.8	449.3	0.9
03/23/90*	2.7	452.0	0.4
03/31/90	5.2	457.2	0.7

Notes:
"gpd" = gallons per day
*Product pump was inoperative for part of this period

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TABLE 5 (Page 2 of 2)

Date	Free Product Recovered (gallons)	Cumulative Free Product Recovered (gallons)	Free Product Recovery Rate (gpd)
04/06/90*	0.2	457.4	0.0
04/13/90	8.2	465.6	1.2
04/21/90	5.8	471.4	0.7
04/27/90	5.6	477.0	0.9
05/04/90	3.2	480.2	0.5
05/11/90	3.6	483.8	0.5
05/18/90	4.0	487.8	0.6
05/25/90	3.6	491.4	0.5
06/04/90	2.5	493.9	0.2
06/11/90	3.3	497.2	0.5
06/17/90*	3.6	500.8	0.6
06/25/90*	1.2	502.0	0.2

Notes:
"gpd" = gallons per day
*Product pump was inoperative for part of this period.

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TABLE 6
SUMMARY OF BETX ANALYSIS, WATER TREATMENT SYSTEM SAMPLES

Sampling Port Number	Sample Date	EPA Method 8020 (ppb)			
		Benzene	Ethlybenzene	Toluene	Total Xylenes
1	01/11/90	31,000	<2,500	32,000	10,000
	02/08/90	29,000	1,900	30,000	7,000
	02/27/90	33,000	1,800	34,000	13,000
	03/15/90	25,000	1,600	26,000	9,900
	04/09/90	29,000	2,300	35,000	14,000
	04/27/90	NA	NA	NA	NA
	05/10/90	20,000	1,500	23,000	11,000
	06/11/90	20,000	1,400	26,000	12,000
2	01/11/90	1,500	ND	16	2.2
	02/08/90	19	ND	2.9	2.6
	02/27/90	4,700	3.6	420	16
	03/15/90	6.2	0.9	8	4.5
	04/09/90	150	0.5	18	2.9
	04/27/90	4,200	25	190	<25
	05/10/90	5.8	ND	5.5	5.4
	06/11/90	3,800	5.0	94	8.4
3	01/11/90	ND	ND	ND	ND
	02/08/90	ND	ND	ND	ND
	02/27/90	0.6	ND	ND	ND
	03/15/90	ND	ND	ND	ND
	04/09/90	ND	ND	ND	ND
	04/27/90	ND	ND	ND	ND
	05/10/90	ND	ND	ND	ND
	06/11/90	ND	ND	ND	1.4

Notes:
"ppb" = parts per billion
"NA" = not analyzed
"ND" = not detected; see laboratory data sheets in Appendix C for analyte detection limits.

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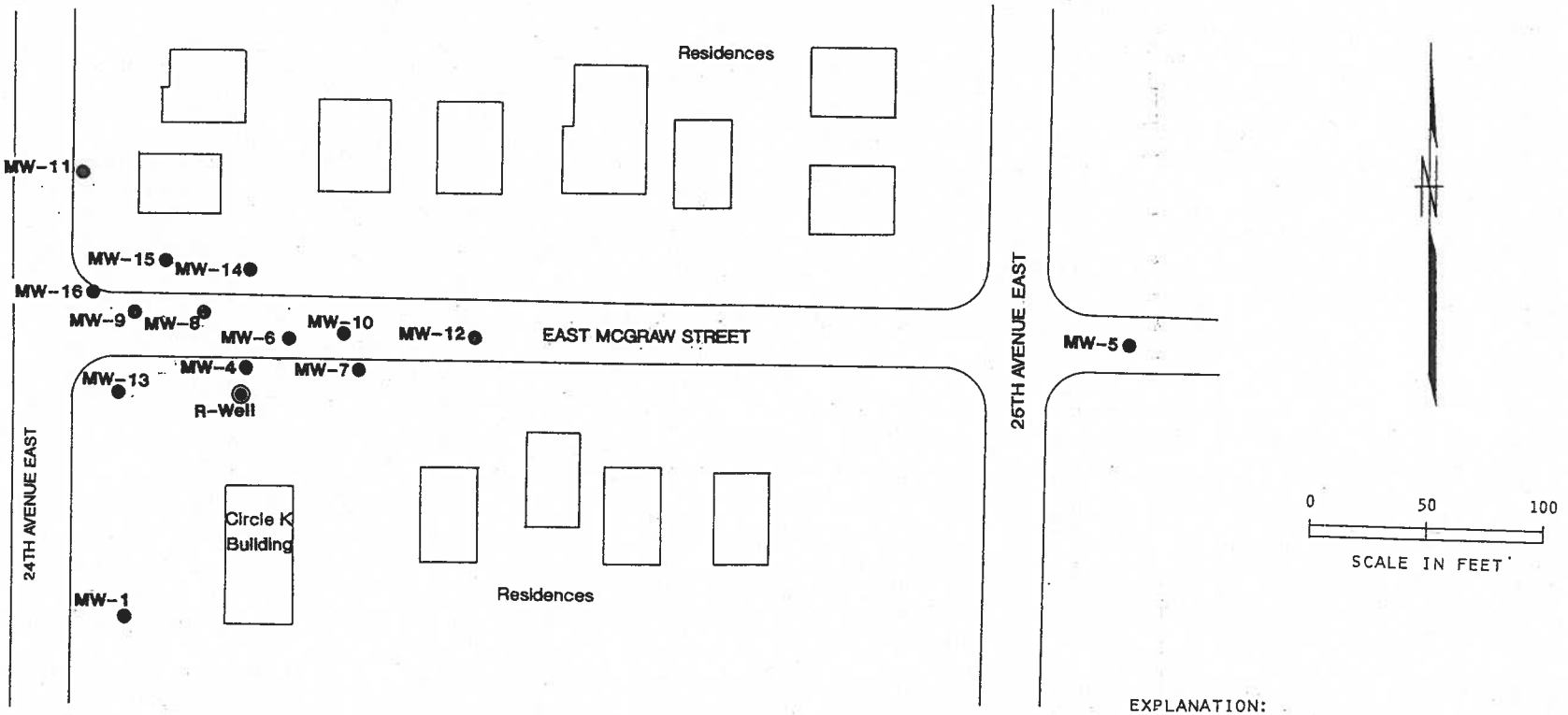
TABLE 7
SUMMARY OF WATER QUALITY DATA, DISCHARGE FROM WATER TREATMENT SYSTEM

Compound	EPA Method	Concentration (ppm)					
		01/11/90	02/08/90	03/09/90	04/09/90	05/09/90	06/11/90
Arsenic	7060	<0.0005	<0.005	NA	NA	NA	NA
Cadmium	7131	<0.0003	<0.0003	NA	NA	NA	NA
Chromium	7190	<0.02	<0.02	NA	NA	NA	NA
Copper	7210	<0.02	<0.02	NA	NA	NA	NA
Lead	7421	<0.005	<0.005	NA	NA	NA	NA
Mercury	7470	<0.0005	<0.0005	NA	NA	NA	NA
Nickel	7520	<0.03	0.05	NA	NA	NA	NA
Silver	7760	<0.02	<0.02	NA	NA	NA	NA
Zinc	7950	0.07	0.05	NA	NA	NA	NA
Cyanide	9012	<0.01	<0.02	NA	NA	NA	NA
Oil & Grease	413.2	0.09	<1.0	<1.0	<1.0	<1.0	<1.0
pH	150.1	6.7	6.6	6.6	6.7	6.6	6.6

Notes:
"NA" = not analyzed
Samples collected from Sampling Port No. 3; these samples are representative of water discharged from the water treatment system into the sanitary sewer line.



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MONITOR WELL LOCATION MAP

FIGURE 1

1780-002-B04 OKP:BDH 7.23.90

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PRODUCT THICKNESS IN MONITOR WELLS

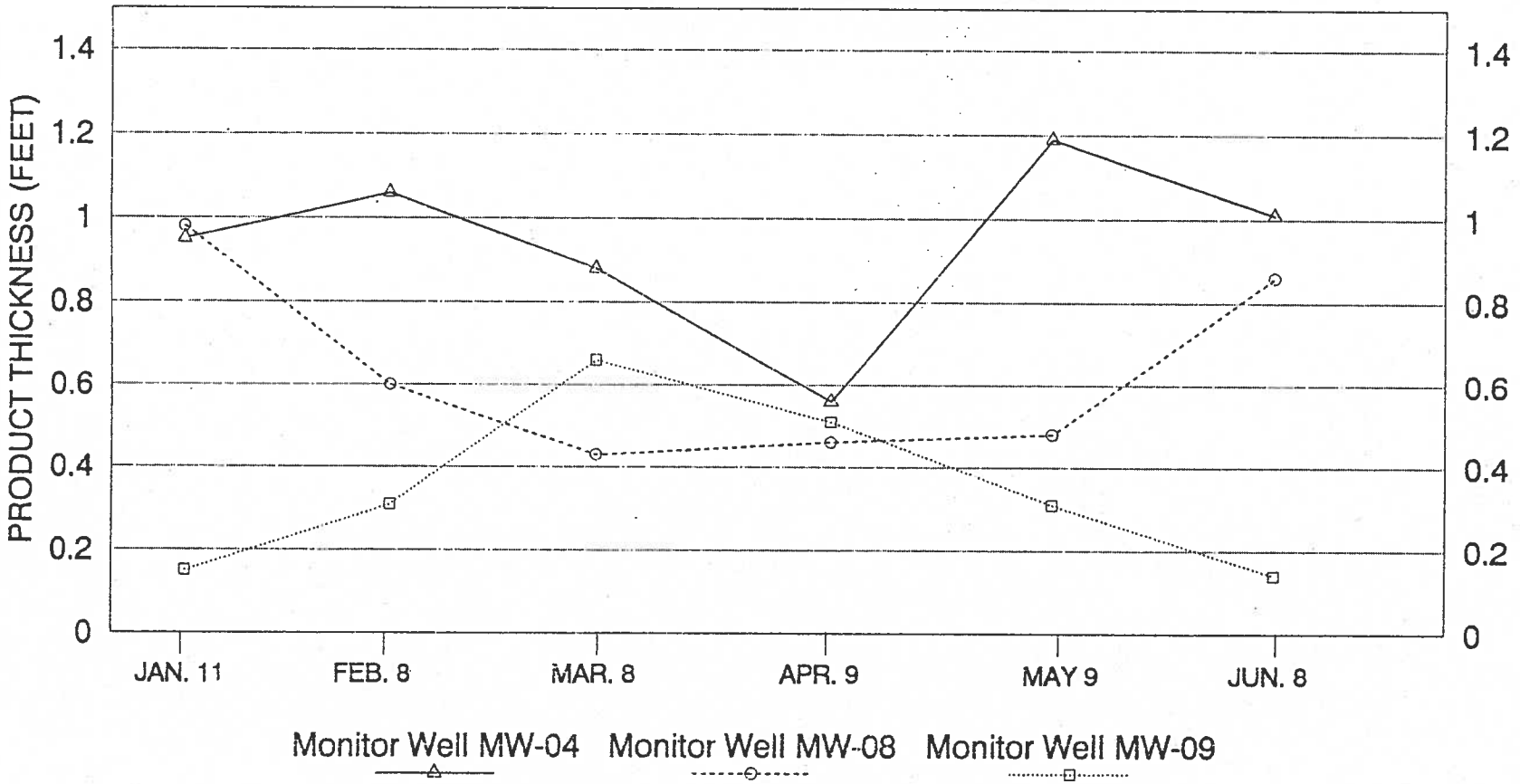
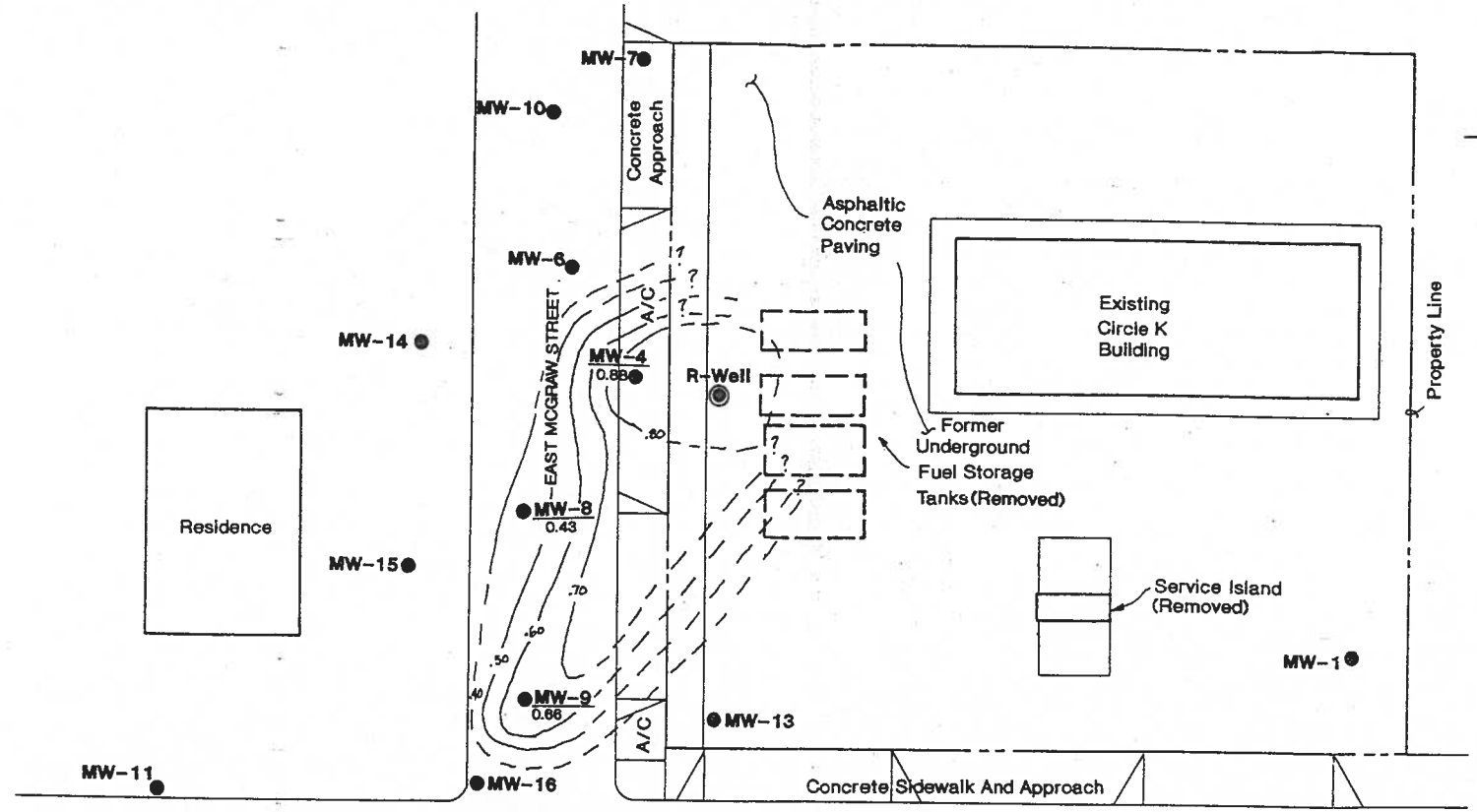


FIGURE 2

PRODUCT THICKNESS WELLS MW-04, MW-08 AND MW-09



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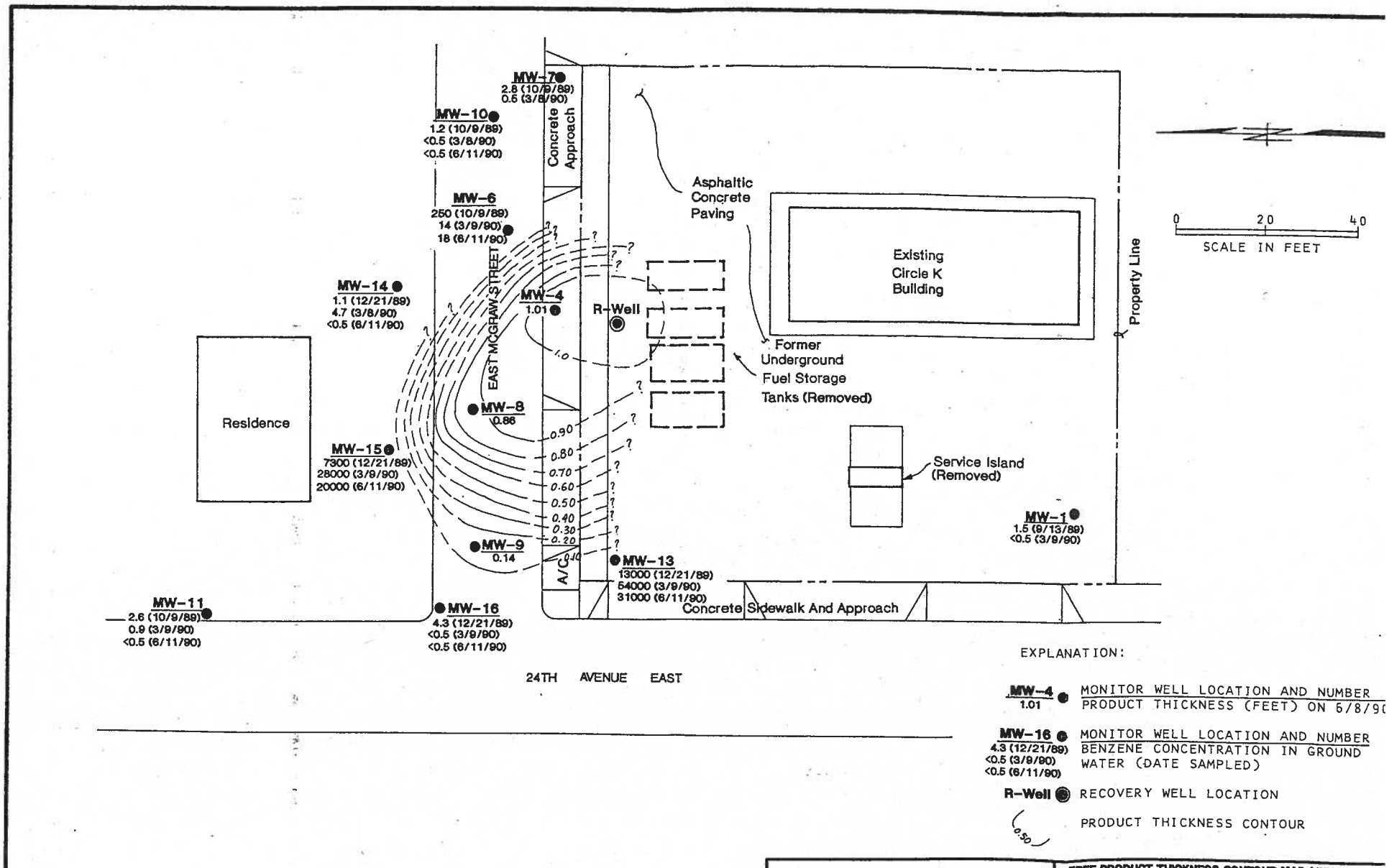
FREE PRODUCT THICKNESS CONTOUR MAP
MARCH 8, 1990

FIGURE 3



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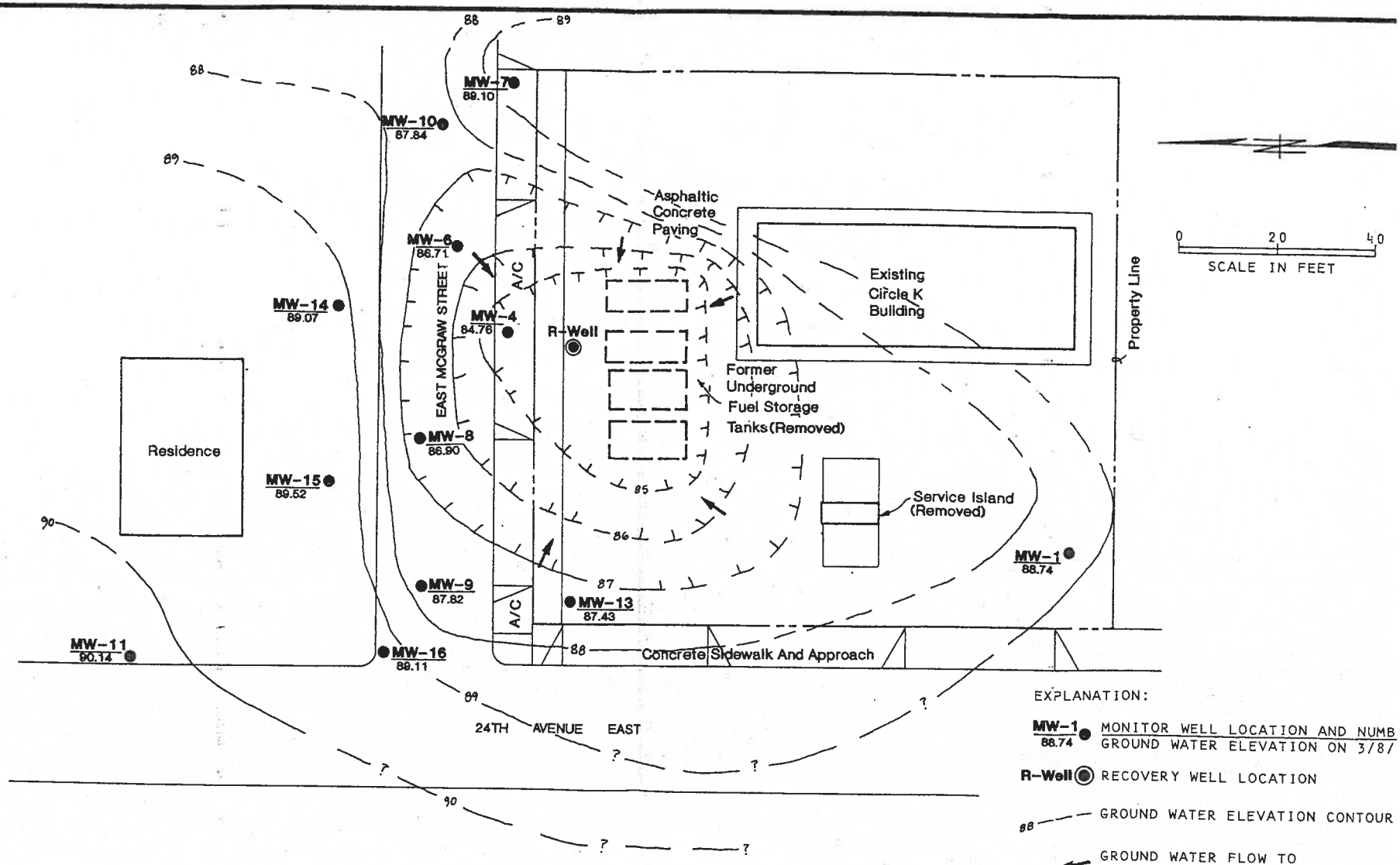
FREE PRODUCT THICKNESS CONTOUR MAP (JUNE 8, 199(
AND BENZENE CONCENTRATIONS IN MONITOR WELLS

FIGURE 4



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GROUND WATER ELEVATION CONTOUR MAP MARCH 8, 1990

FIGURE 5

1780-002-B04 OKP:BDH 7.23.90

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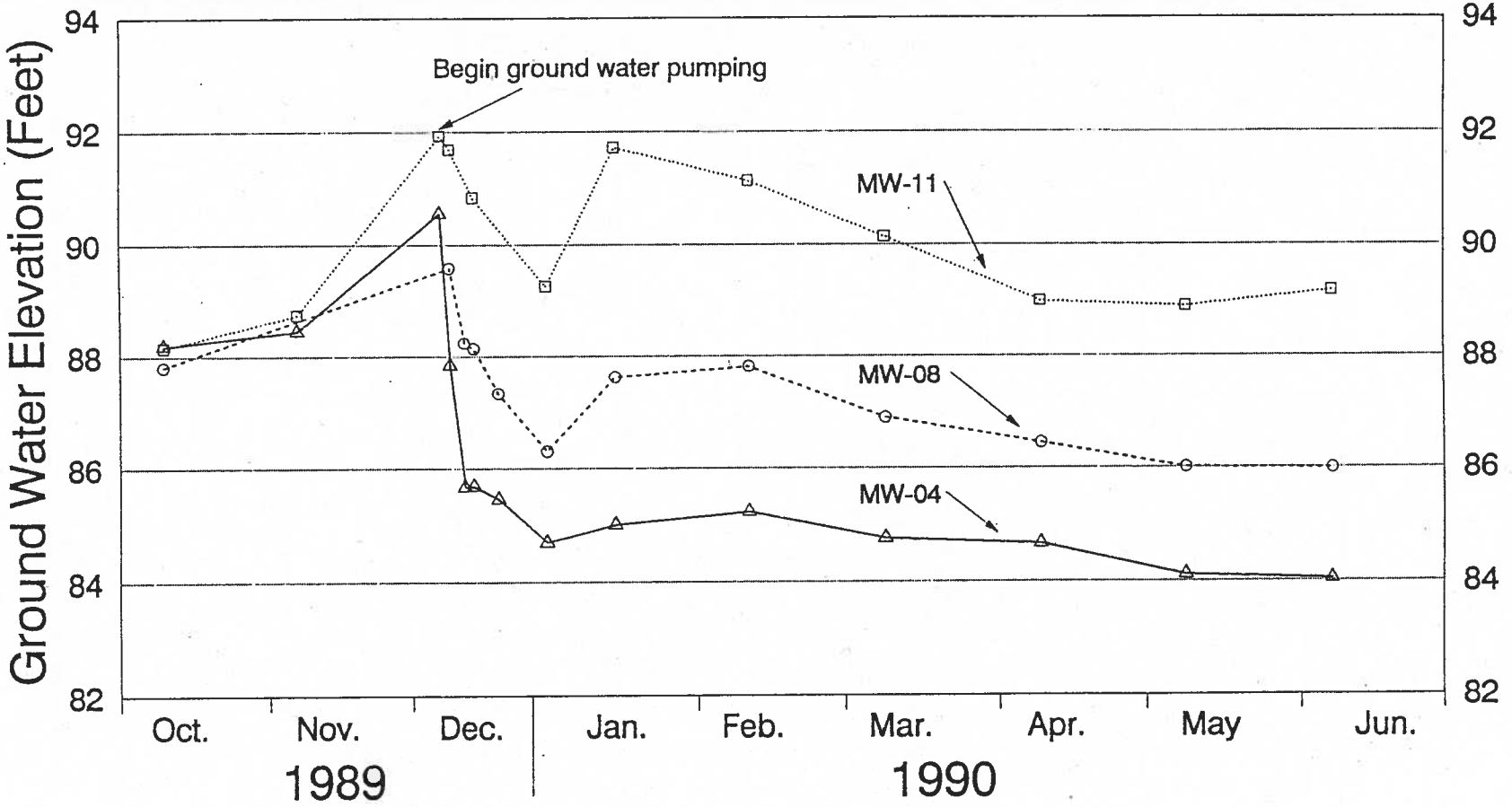
GROUND WATER ELEVATION FROM 10/09/89 TO 06/08/90 FOR MONITOR WELLS MW-04, MW-08 AND MW-11



Note: Ground water elevations based on assumed datum of 100.00 feet.
Ground water elevations in MW-04 and MW-08 are adjusted for free product thickness.
Ground water depression pump began continuous operation on 12/06/90.

FIGURE 6

WATER LEVEL HYDROGRAPH
WELLS MW-04, MW-08 AND MW-11

1780-002-B04 OKP:BDH 7-20-90

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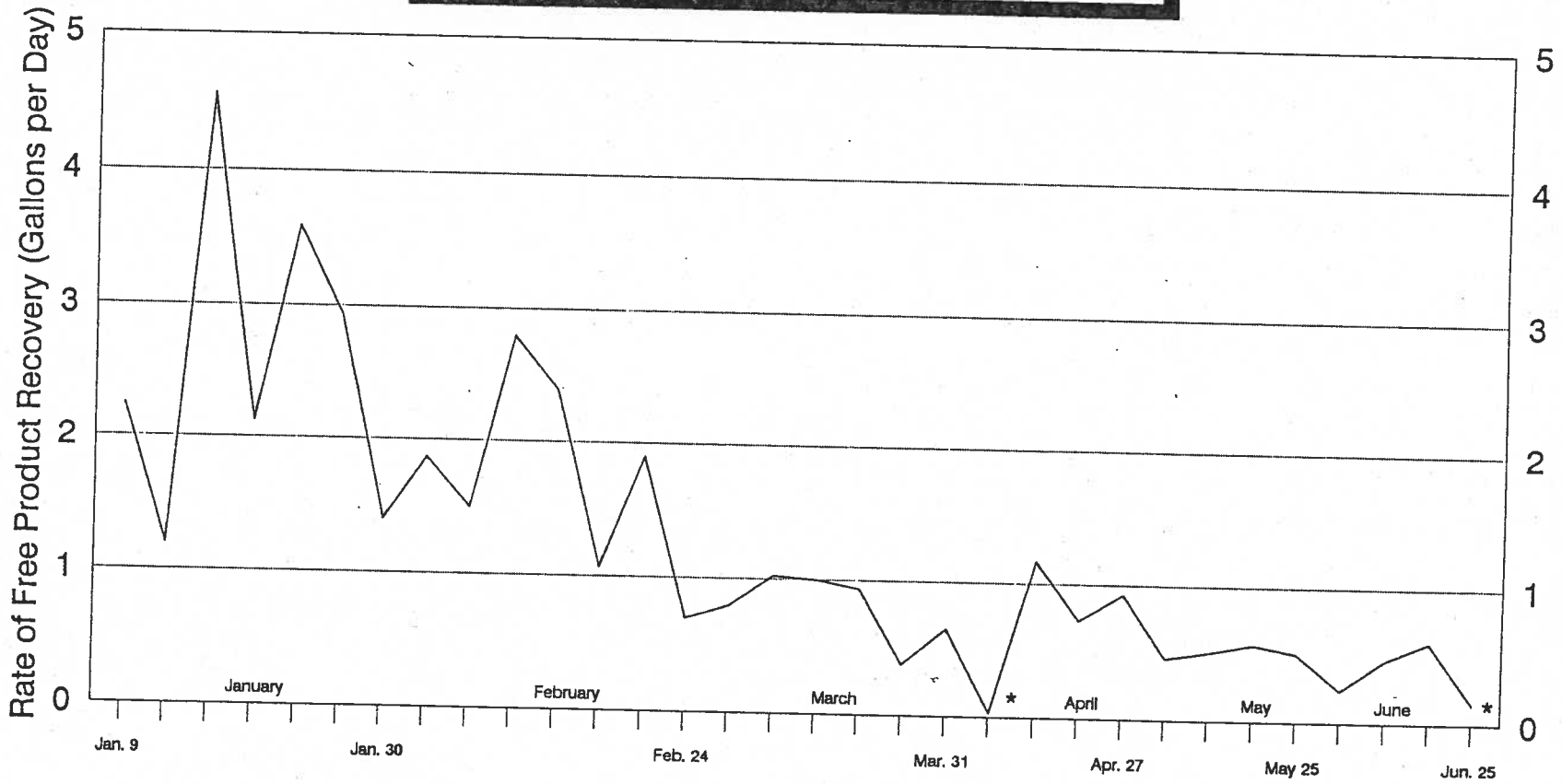
FREE PRODUCT RECOVERY
JANUARY 9 TO JUNE 25, 1990



* Low product recovery due to temporary malfunction of product recovery pump.

FIGURE 7

AVERAGE DAILY RATE OF PRODUCT RECOVERY

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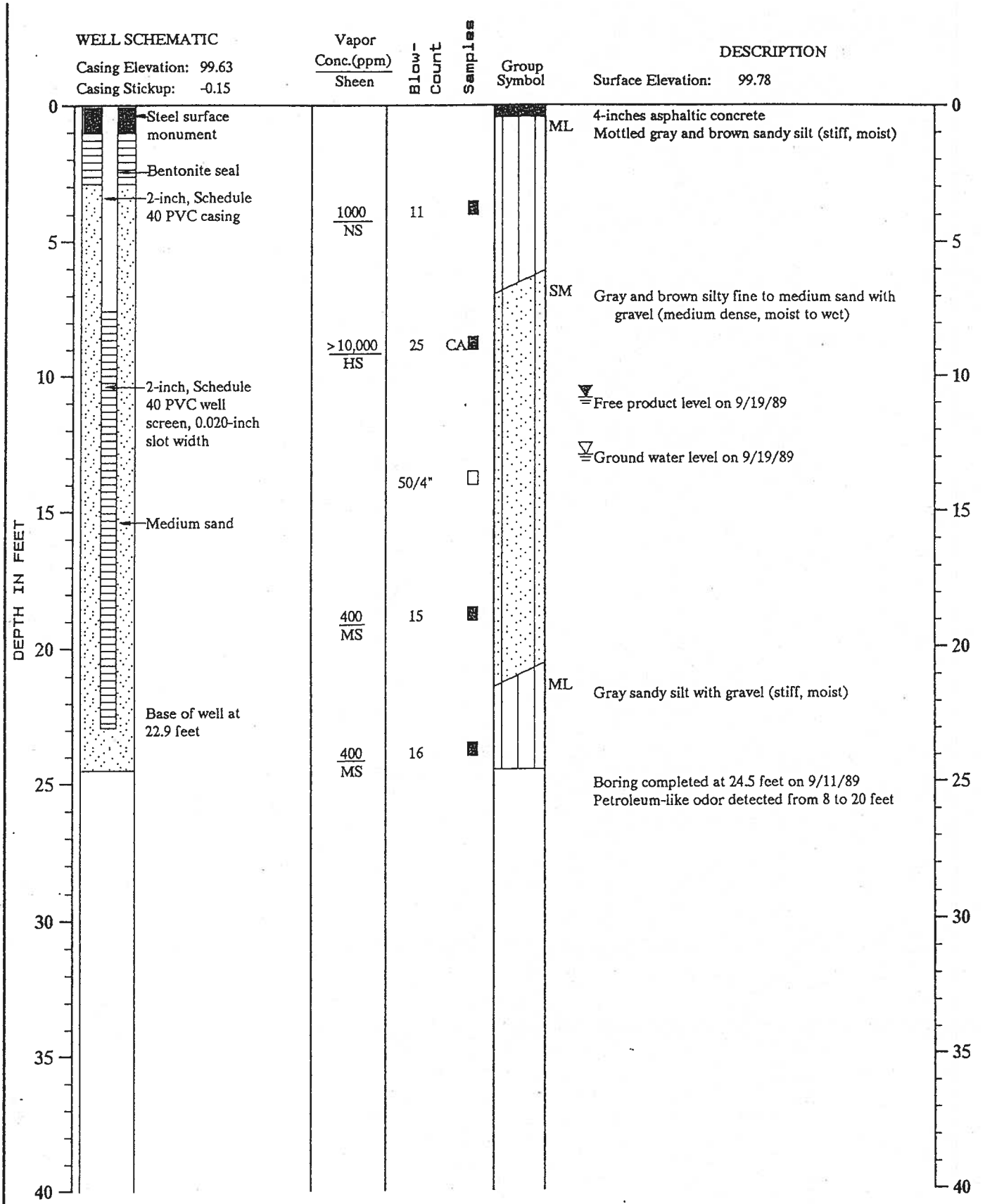
CIRCLE K FACILITY 1461
SEATTLE, WASHINGTON
FOR
CIRCLE K CORPORATION

11/9/90



Note: See Figure A-2 for explanation symbols

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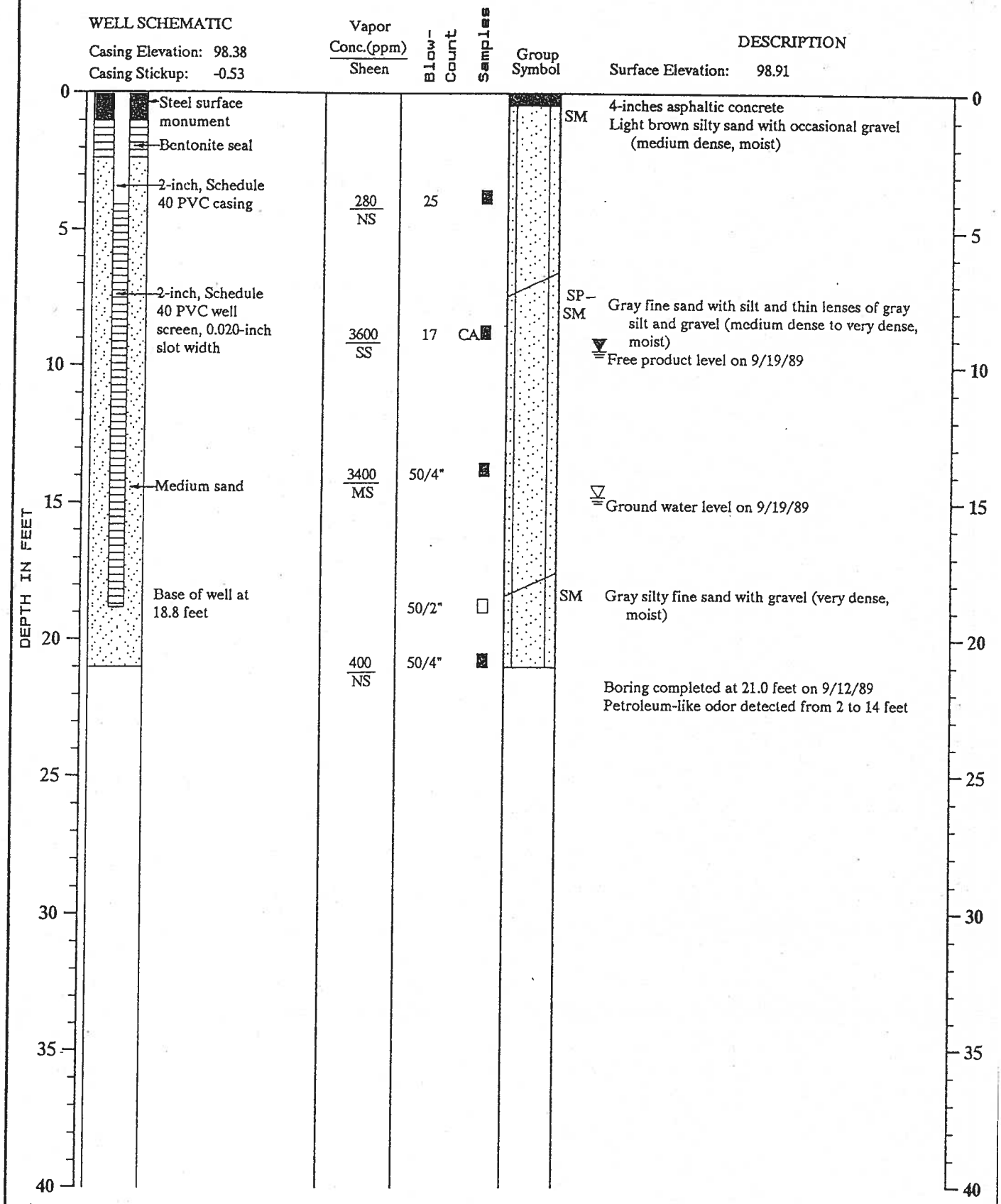
Log of Monitor Well

Figure A-5



Note: See Figure A-2 for explanation symbols

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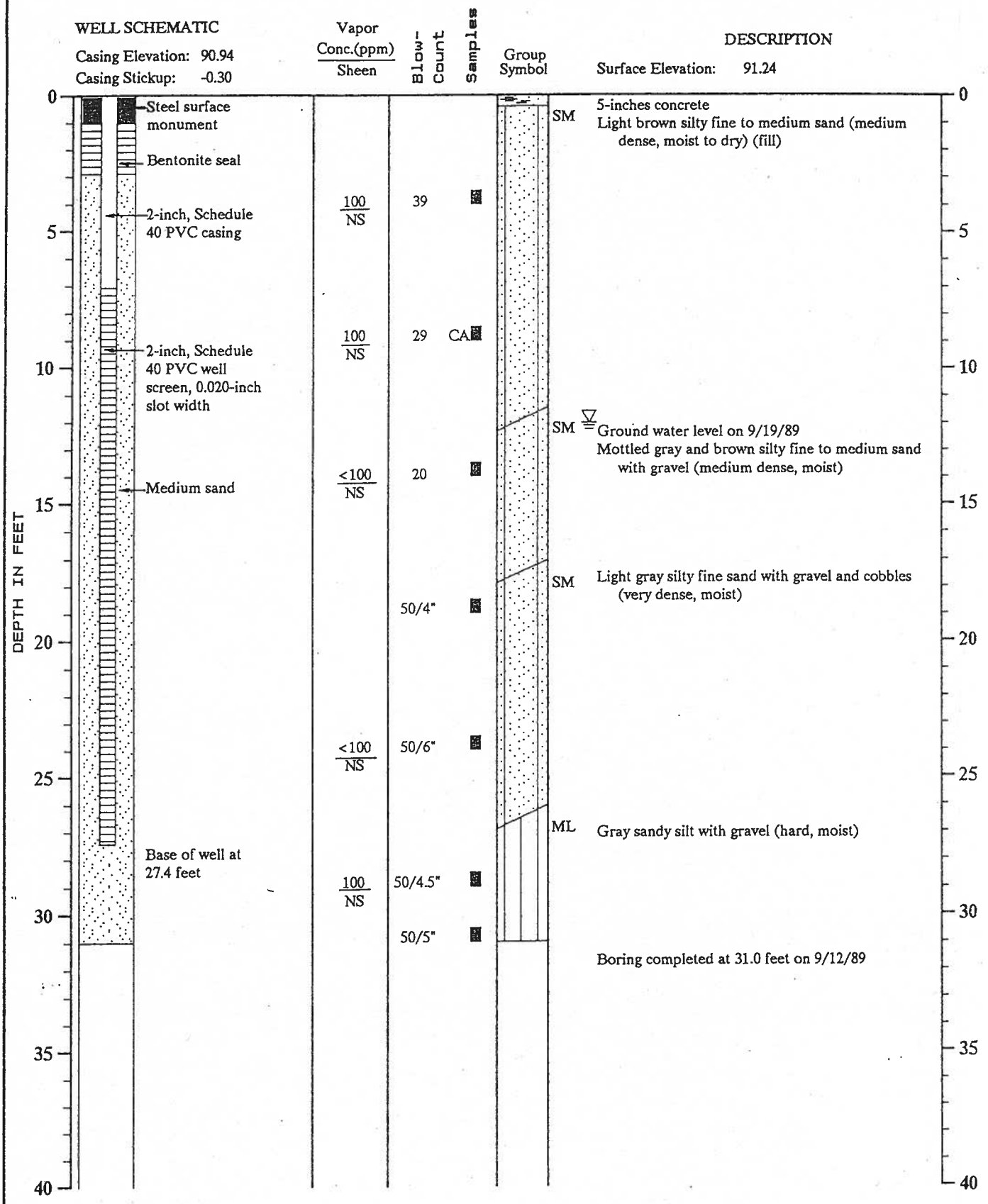
Log of Monitor Well

Figure A-6

TEP:OKP:CDO 1/9/90

1780-001-B04



Note: See Figure A-2 for explanation symbols

TEP:OKP:CDO 1/9/90

1780-001-B04

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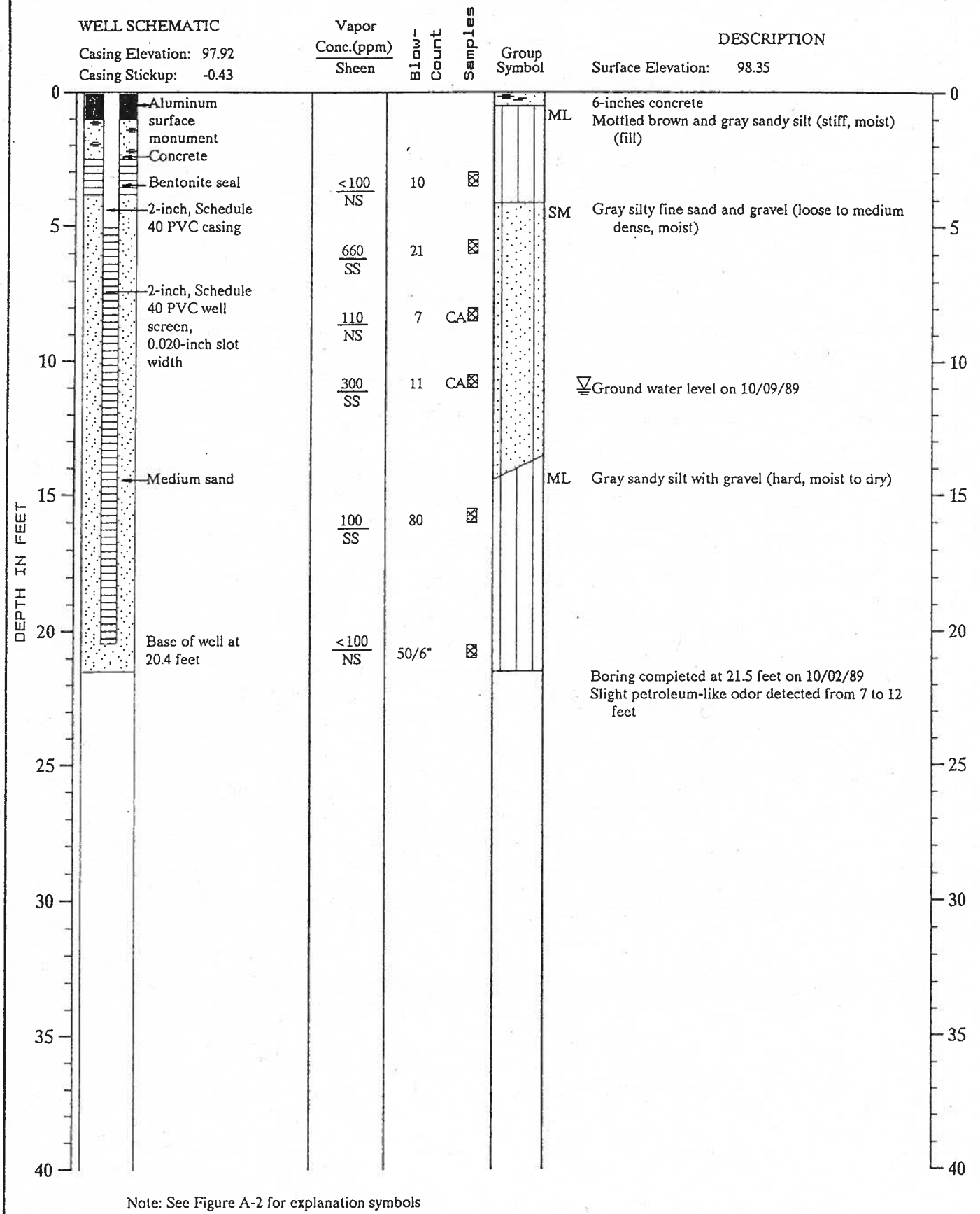
Log of Monitor Well

Figure A-7

MONITOR WELL NO. MW-6



Note: See Figure A-2 for explanation symbols

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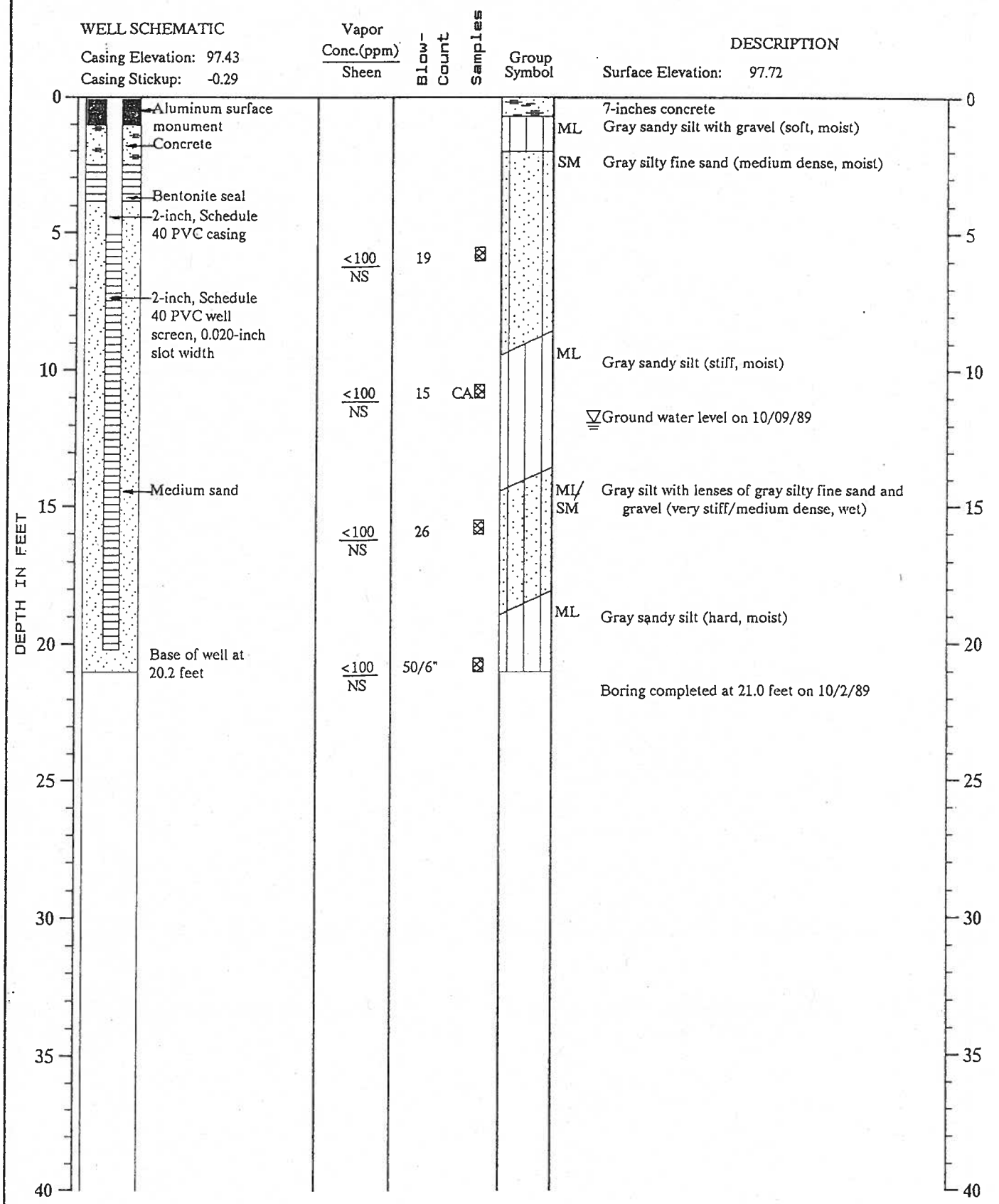
Log of Monitor Well

Figure A-8

TEP:OKP:CDO 2/8/90

1780-001-B04



Note: See Figure A-2 for explanation symbols

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Log of Monitor Well

Figure A-9

Geo Engineers

November 9, 1990

Consulting Geotechnical
Engineers and Geologists

The Circle K Corporation
P.O. Box 52084
Phoenix, Arizona 85072

Attention: Mr. Robert F. Staab

We are submitting three copies of "Progress Report No. 2" regarding remedial actions at the site of Circle K Facility 1461 in Seattle, Washington. The general scope of our services is described in our proposal dated January 18, 1990. Our services were authorized by Mr. Robert F. Staab of the Circle K Corporation on January 24, 1990.

We appreciate the opportunity to be of service to the Circle K Corporation. Please call if you have any questions regarding this report.

Yours very truly,

GeoEngineers, Inc.

James A. Miller
Principal

OKP:JAM:cs

File No. 1780-002-B04

GeoEngineers, Inc.
2405 140th Ave. NE, Suite 105
Bellevue, WA 98005
Telephone (206) 746-5200
Fax. (206) 746-5068

Geo Engineers

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GeoEngineers

PROGRESS REPORT NO. 2
REMEDIAL MONITORING PROGRAM
CIRCLE K FACILITY 1461
SEATTLE, WASHINGTON
FOR
CIRCLE K CORPORATION

INTRODUCTION

This report summarizes the results of the subsurface fuel recovery and ground water monitoring programs at the site of former Circle K Facility 1461 between June 28 and October 5, 1990. Facility 1461 was located in Seattle, Washington and consisted of a convenience store which marketed leaded and unleaded gasoline. The Circle K Corporation filed for bankruptcy (Chapter 11, Title 11, United States Code) on May 15, 1990 and closed Facility 1461 on July 31, 1990. We received a letter from the Circle K Corporation on September 26, 1990 stating that Circle K had rejected the lease of Facility 1461 and would discontinue their remediation program at the site effective October 5, 1990. On October 9, 1990 we received a follow-up letter requesting immediate termination of our services at the site.

This report presents data from the monitoring of remediation activities and site conditions and evaluates the effectiveness of the remedial plan. The results of our subsurface remedial monitoring prior to June 28, 1990 are presented in our reports dated March 6 and August 23, 1990.

The free product recovery and ground water treatment systems started operating on a full-time basis on December 6, 1989. Glacier Environmental (Glacier Environmental Services, Inc.) has been responsible for the operation and maintenance of the recovery and treatment systems. Glacier Environmental has not monitored or serviced the recovery and treatment systems since September 25, 1990. It is our understanding that the property owner of the site has continued to operate the recovery and treatment systems since Circle K discontinued their remedial activities on October 5, 1990.

MONITORING ACTIVITIES

MONITOR WELL MEASUREMENTS

The locations of all existing monitor wells at the site are shown in Figure 1. Free product thicknesses, ground water elevations and well casing hydrocarbon vapor concentrations were measured monthly in each well during this reporting period.

Product Thickness: Free product was detected in wells MW-4, MW-8, MW-9 and MW-15. Product thicknesses in wells MW-4, MW-8 and MW-9 ranged from 0.22 feet to 1.00 feet between July 8 and September 10, 1990. Product thicknesses in well MW-15 ranged from 0.01 feet to 3.22 feet during the same period. The greatest thickness of free product in each of the four wells measured during this reporting period was detected during our September monitoring episode. Free product thicknesses measured in the monitor wells are listed in Table 1. Free product was bailed monthly from the monitor wells as part of our monitoring activities at the site.

Water Levels: Ground water elevations were measured monthly in each of the monitor wells. Ground water elevations measured during the period covered by this report are presented in Table 2. As discussed in our previous reports, shallow ground water in the vicinity of the site flows toward the northeast, except where water levels are influenced by pumping in the recovery well.

Ground water elevations in all wells except MW-16 decreased during this reporting period. From July 8 to September 10, 1990, ground water elevations in individual wells decreased by approximately 0.1 to 1.7 feet. The ground water elevation in MW-16 increased by 0.34 feet from July to September 1990.

Hydrocarbon Vapor Concentrations: Hydrocarbon vapor concentrations in the monitor well casings were measured monthly using a Bacharach TLV Sniffer calibrated to hexane. Table 3 lists the hydrocarbon vapor concentrations measured in the well casings during this reporting period.

Hydrocarbon vapors were detected at concentrations greater than 10,000 parts per million (91% LEL) in MW-4, MW-8, MW-9, MW-13 and MW-15. Hydrocarbon vapor concentrations were generally less than 400 ppm (parts per million) in the other monitor wells.

FREE PRODUCT RECOVERY SYSTEM

The volume of free product recovered at the site using the Filter Scavenger pumping system was measured weekly by Glacier Environmental personnel as part of the routine monitoring of the recovery and treatment systems. Product was pumped to an aboveground storage drum prior to removal from the site. The Filter Scavenger recovery system has been operating continuously at the site since December 6, 1989, except for several pump maintenance and repair episodes totaling about 10 to 20 days.

Approximately 36 gallons of product were pumped from the recovery well between June 25 and September 25, 1990. A total of 538 gallons of product has been recovered at the site since pumping began on December 6, 1989. The product recovery rate averaged 0.4 gallons per day during this report period. Product recovery data are summarized in Table 4.

GROUND WATER TREATMENT SYSTEM

The ground water depression pump has operated almost continuously since December 6, 1989. The pump was shut down during demolition of the service island between March 21 and March 23, 1990. The ground water treatment system was turned off from June 10 to June 12, 1990 for equipment maintenance.

Approximately 42,000 gallons of water were pumped, treated and discharged to the Metro sewer from June 8 to September 12, 1990. Ground water was recovered at an average rate of about 450 gallons per day during this period. The recovery well appears to be drawing shallow ground water from the vicinity of all wells containing free product. The ground water cone of depression has remained relatively stable since the recovery system began continuous operation in December 1989. The depth to ground water in the recovery well is approximately 15.5 feet below ground surface.

Three rounds of water samples were collected from the water treatment system sampling ports during this reporting period. The samples were analyzed for BETX (benzene, ethylbenzene, toluene and xylenes) by EPA Method 8020 to evaluate the effectiveness of the two carbon filters in removing fuel-related contaminants from the recovered ground water. The locations of the sampling ports and a description of the water treatment system are included in our March 6, 1990 report. Table 5 summarizes the chemical data obtained from analyses of samples collected from the water

treatment system. Laboratory data sheets and chain-of-custody records for the samples collected from the water treatment system are included in Appendix A.

Benzene concentrations in untreated ground water samples collected from Sampling Port No. 1 ranged from 16,000 to 35,000 µg/l (micrograms per liter). As shown in Table 5, the benzene concentrations detected in the samples collected from Sampling Port No. 2 fluctuated between 57 and 640 µg/l during this reporting period. Based on the chemical data obtained from Sampling Port No. 2, the primary carbon filter was replaced on August 20, 1990 with the secondary (polishing) carbon filter, and a new carbon filter was installed as the polishing filter. The primary carbon filters appear to have a life span of approximately six weeks before significant concentrations of BETX are discharged into the polishing filter. The polishing filter was effective in removing any remaining BETX compounds from the treated water prior to discharge into the sanitary sewer line (Table 5).

The discharge from the water treatment system to the Metro (Municipality of Metropolitan Seattle) sanitary sewer was monitored and sampled in accordance with the requirements outlined in the Metro Authorization for Discharge. Samples of the treated discharge water were collected monthly from Sampling Port No. 3. BETX and oil and grease were not detected in the discharge water. The pH of the discharge water is typical of clean ground water. Laboratory data obtained from the sampling of the treated discharge water are included in Table 5. Laboratory data sheets for these samples are included in Appendix A.

Hydrocarbon vapor concentrations were measured monthly at the point of discharge to the lateral sanitary sewer line using a Bacharach TLV Sniffer calibrated to hexane. Hydrocarbon vapor concentrations ranged from 800 ppm to 1,000 ppm (7% to 9% LEL) during this reporting period.

Results of our monthly sampling and monitoring of the discharge from the ground water treatment system were submitted to Metro on July 31 and September 7, 1990.

DISCUSSION OF RESULTS

ASSESSMENT OF SUBSURFACE CONTAMINATION

Free product was observed floating on shallow ground water in four monitor wells between July and September 1990. Product thicknesses in wells MW-4, MW-8 and MW-9 ranged from 0.22 to 1.00 feet during this period. Product thicknesses in these three wells did not change significantly from the thicknesses measured prior to July 1990.

Product was first detected in MW-15 on July 8, 1990. As stated in our September 17, 1990 letter to Circle K, product thickness in MW-15 increased from trace amounts in mid-July to 3.22 feet on September 10, 1990. No monitor wells exist downgradient of MW-15.

Ground water quality samples were not collected from the monitor wells during this reporting period. Chemical data resulting from our most recent round of monitor well sampling on June 11, 1990 showed that fuel-contaminated ground water was present in the monitor wells located immediately outside of the edge of the free product plume. Several of the monitor wells contained BETX concentrations which exceeded draft MTCA (Model Toxics Control Act) Compliance Cleanup Levels (July 18, 1990). The lateral extent of ground water contamination north of MW-15 and west of MW-13 is not known because no downgradient monitor wells exist in these areas.

High concentrations of hydrocarbon vapors were measured in the monitor well casings located in and adjacent to the free product plume. The low concentrations of hydrocarbon vapors measured in outlying wells indicate that subsurface hydrocarbon vapors in the soil probably have not migrated a significant distance laterally from the edge of the free product plume. Residents in the vicinity of the site have not reported any problems with hydrocarbon vapors during this reporting period.

REMEDIATION SYSTEM PERFORMANCE

The ground water remediation system has been operating almost continuously during this reporting period. Our remedial monitoring indicates that the system is effective in recovering free product and contaminated ground water. Ground water elevations measured in the monitor wells confirm the presence of a stable cone of depression around the recovery well.

The rate of free product recovery decreased from approximately 0.8 gpd (gallons per day) in July to 0.3 gpd in August and September 1990. Factors which likely control the product recovery rate at this site include: (1) the decreasing volume of free product in the subsurface, (2) seasonal fluctuations in the ground water table elevation, and (3) the relative permeability of the subsurface soils. Based on our monitor well measurements, a significant volume of free product likely remains in the subsurface.

The ground water remediation system effectively treated 42,000 gallons of fuel-contaminated ground water recovered at the site between June 8 and September 12, 1990. Because water samples were not collected from the monitor wells during this reporting period, it is not possible to fully evaluate the effectiveness of the ground water remediation system.

RECOMMENDATIONS

The presence of free product in MW-15 warrants additional studies to evaluate the downgradient extent of free product and ground water contamination in the vicinity of MW-15. The following regulations require a complete assessment of the occurrence of free product in the ground water and immediate containment and recovery of the product:

- The U.S. Environmental Protection Agency's underground storage tank regulations (40 CFR Parts 280.64 and 280.65).
- State of Washington, Water Pollution Control Law (Sections RCW 90.48.320 and RCW 90.48.325).
- State of Washington, Model Toxics Control Act Cleanup Regulation (Section 173-340-450, July 18, 1990 DRAFT).

Explorations may be necessary to determine if the plume of free product extends beneath the private residences in the vicinity of MW-15. A risk to human health may exist if the plume of free product has migrated to the locations of the private residences. We recommend that the presence of free product in MW-15 be addressed by (1) installing additional downgradient monitor wells and (2) developing a remedial action plan to begin recovery of the free product and contaminated ground water in the vicinity of this well.

Continued operation and monitoring of the existing free product recovery and ground water treatment system is recommended. The ground water elevation, free product thickness and concentration of hydrocarbon vapors should be measured monthly in each of the fourteen existing monitor wells. Quarterly water quality samples should be collected from the wells located near the edge of the free product plume, and the samples should be analyzed for BETX.

The Metro Discharge Authorization was revised by Metro on September 11, 1990. The revised authorization requires sampling of the treated water for BETX and oil and grease twice yearly. Monthly reports containing results from any sampling and analyses outlined in the Authorization continue to be required by Metro. Additional samples should be collected from the three water sampling ports on a routine basis and analyzed for BETX to evaluate the effectiveness of the treatment system and whether the carbon filters need replacement.

The existing remedial installation was designed to accommodate a VES (vapor extraction system) to treat gasoline contamination in the vadose (unsaturated) zone. We recommend installation and operation of the VES as soon as possible. VES design and installation details are presented in our March 6, 1990 report.

LIMITATIONS

We have prepared this report for use by the Circle K Corporation. The report may be made available to regulatory agencies and other parties interested in this site. This report is not intended for use by others, and the information contained herein may not be applicable to other sites.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time this report was prepared. No other conditions, express or implied, should be understood.

- o O o -

GeoEngineers

Please call if your have questions regarding this report.

Respectfully submitted,

GeoEngineers, Inc.

James G. Roth
Hydrogeologist

Otto K. Paris
Project Geologist

James A. Miller, P.E.
Principal

JGR:OKP:JAM:cs

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TABLE 1
PRODUCT THICKNESS IN GROUND WATER MONITOR WELLS

Well Number	Measurement Date	Product Thickness (feet)
MW-04	07/08/90	0.68
	08/07/90	0.71
	08/13/90	0.22
	09/10/90	1.00
MW-08	07/08/90	0.34
	08/07/90	0.42
	08/13/90	0.24
	09/10/90	0.76
MW-09	07/08/90	0.42
	08/07/90	0.41
	08/13/90	0.25
	09/10/90	0.46
MW-15	07/08/90	0.08
	07/12/90	0.01
	07/18/90	0.03
	07/24/90	0.30
	08/07/90	0.94
	08/13/90	1.00
	09/10/90	3.22 *

Note: Product thickness equals the elevation of the product/air interface minus the elevation of the product/water interface.

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TABLE 2
GROUND WATER ELEVATIONS IN MONITOR WELLS

Monitor Well No.	TOC Elevation (feet)	Ground Water Surface Elevations (feet)		
		07/08/90	08/07/90	09/10/90
MW-01	100.94	88.38	88.10	87.78
MW-04*	98.38	84.32	84.34	84.23
MW-05	90.94	80.39	79.99	79.48
MW-06	97.92	85.96	85.69	85.35
MW-07	97.43	87.23	86.33	85.63
MW-08*	98.36	85.92	85.70	85.47
MW-09*	99.03	87.13	86.93	86.73
MW-10	97.55	86.79	86.29	85.86
MW-11	98.62	88.58	88.22	86.92
MW-12	96.56	86.09	85.63	85.12
MW-13	99.95	87.04	86.86	86.67
MW-14	98.07	87.34	86.73	86.34
MW-15*	99.04	87.83	87.35	87.05
MW-16	99.04	87.97	87.61	88.31

Notes:
"TOC" = top of well casing; elevations based on assumed datum of 100.00 feet.
* = free product present in well; reported water surface elevations are corrected for the equivalent column height of water.

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TABLE 3
HYDROCARBON VAPOR CONCENTRATIONS IN GROUND WATER MONITOR WELL CASINGS

Monitor Well No.	Hydrocarbon Vapor Concentrations (ppm)		
	07/08/90	08/07/90	09/10/90
MW-01	160	120	100
MW-04	>10,000	500	>10,000
MW-05	<100	160	<100
MW-06	1,000	180	<100
MW-07	180	120	<100
MW-08	>10,000	>10,000	>10,000
MW-09	>10,000	>10,000	>10,000
MW-10	110	320	<100
MW-11	290	200	<100
MW-12	160	240	<100
MW-13	>10,000	2,100	1,000
MW-14	800	120	200
MW-15	>10,000	>10,000	5,000
MW-16	100	100	100

Notes:
"ppm" = parts per million
Hydrocarbon vapor concentrations were measured in the monitor well casings using a Bacharach TLV Sniffer calibrated to hexane (110 ppm = 1% LEL)

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TABLE 4
SUMMARY OF FREE PRODUCT RECOVERY DATA

Date	Free Product Recovered (gallons)	Free Product Recovery Rate (gpd)	Cumulative Free Product Recovered (gallons)
*07/02/90	0.0	0.0	501.9
07/09/90	5.3	0.8	507.2
07/16/90	8.8	0.5	516.0
07/23/90	3.2	0.5	519.2
07/30/90	4.0	0.6	523.2
08/08/90	2.9	0.3	526.1
08/13/90	1.6	0.3	527.7
08/20/90	3.0	0.4	530.7
08/27/90	2.2	0.3	532.9
09/11/90	2.1	0.1	535.0
09/18/90	0.4	0.1	535.4
09/25/90	2.6	0.4	538.0

Notes:
"gpd" = gallons per day
* = Product pump was inoperative for part of this period

TABLE 5
SUMMARY OF WATER QUALITY DATA, WATER TREATMENT SYSTEM SAMPLES

Sampling Port Number	Sample Date	EPA Method 8020 (ug/l)				EPA Method 150.1	EPA Method 413.2
		Benzene	Ethylbenzene	Toluene	Total Xylenes	pH	Oil and Grease (mg/l)
1	07/09/90	33,000	2,500	41,000	21,000	NA	NA
	08/13/90	16,000	ND	18,000	9,600	NA	NA
	09/12/90	35,000	1,700	41,000	12,000	NA	NA
2	07/09/90	57	0.5	6.0	4.6	NA	NA
	08/13/90	640	ND	27	ND	NA	NA
	09/12/90	120	ND	15	ND	NA	NA
3	07/09/90	0.5	ND	1.3	1.0	6.8	<1
	08/13/90	ND	ND	ND	ND	6.7	<1
	09/12/90	ND	ND	ND	ND	NA	NA

Notes:
"mg/l" = milligrams per liter
"ug/l" = micrograms per liter
"NA" = not analyzed
"ND" = not detected; see laboratory data sheets in Appendix A for analyte detection limits.