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

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.

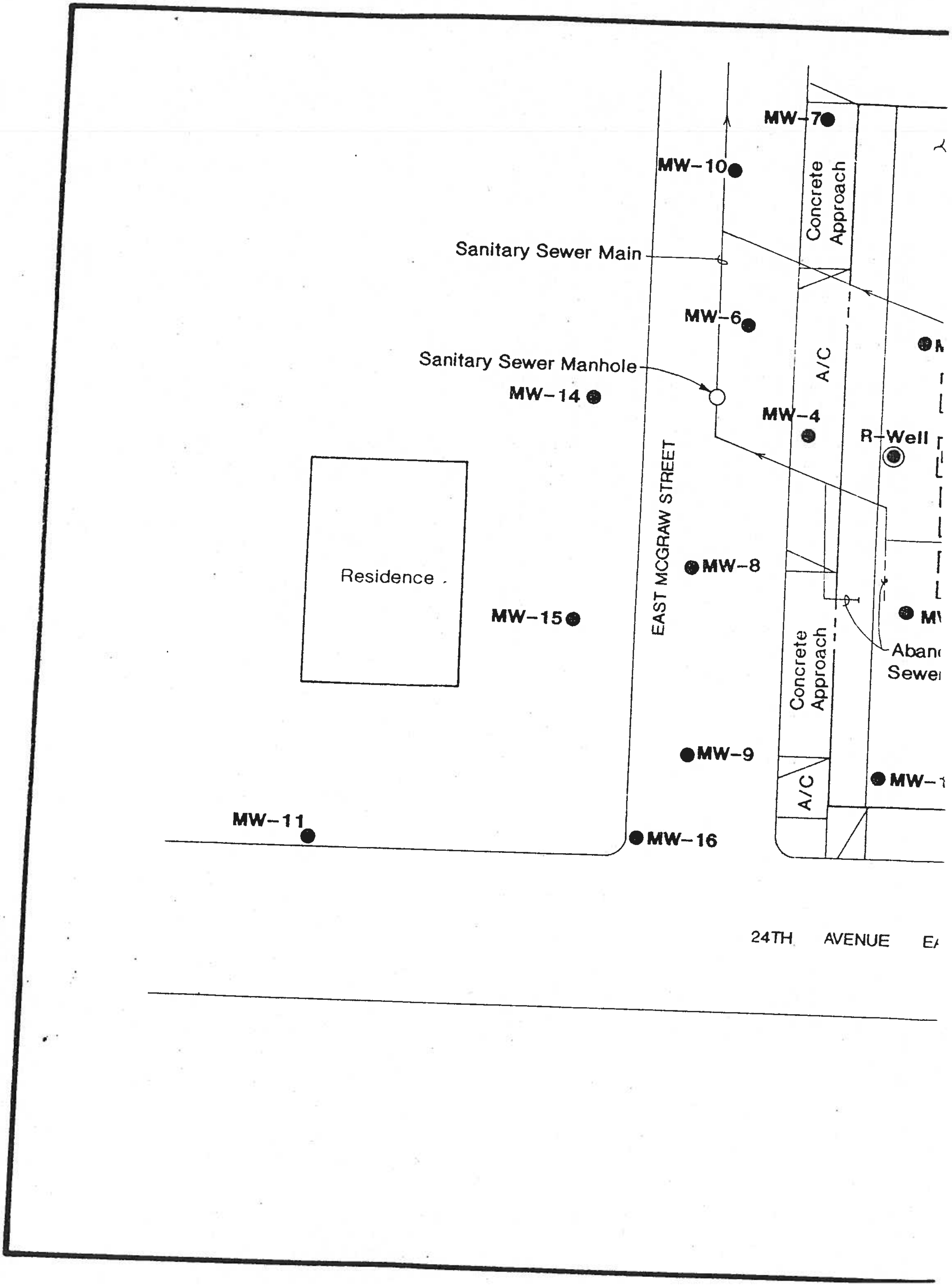
A free product recovery and ground water treatment system was installed and operated during this phase of site remediation. Our initial monitoring of the remediation systems indicate effective recovery of free product and contaminated ground water. Approximately 280 gallons of free product were recovered 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.

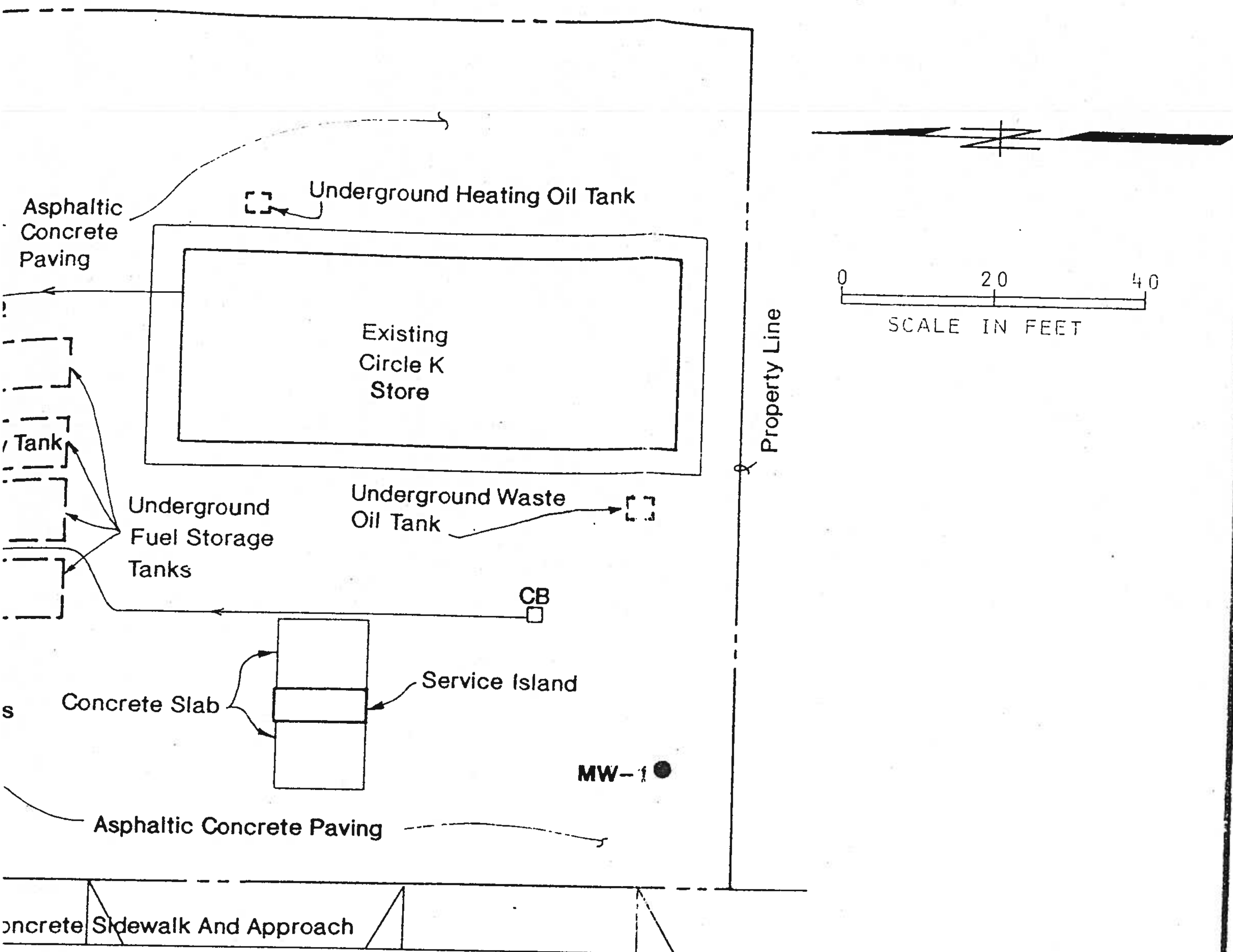
RECOMMENDATIONS

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



MW-7
MW-10
Concrete Approach
Sanitary Sewer Main
MW-6
Sanitary Sewer Manhole
MW-14
A/C
MW-4
R-Well
EAST MCGRAW STREET
Residence
MW-8
MW-15
Concrete Approach
MW-9
A/C
MW-11
MW-16
24TH AVENUE



EXPLANATION:

MW-1 ●	MONITOR WELL LOCATION AND NUMBER.
R-Well ◉	RECOVERY WELL LOCATION
CB □	CATCH BASIN

GeoEngineers

SITE PLAN

FIGURE 2