SUBSURFACE PETROLEUM
HYDROCARBON EVALUATION

BP SERVICE STATION No. 11255

19924 Pacific Highway South
King County, Washington

Prepared for

BP Oil Company

W-7475

March, 1992

RZA AGRA, Inc.
Engineering & Environmental Services

AGRA
Earth & Environmental Group

Subsurface Petroleum Hydrocarbon Evaluation

BP Service Station No 11255

19924 Pacific Highway South

Sea-Tac, Washington 98188

Prepared for

BP Oil Company

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W-7475

February 1992

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SUBSURFACE PETROLEUM HYDROCARBON EVALUATION **W-7475**

BP SERVICE STATION NO 11255

19924 PACIFIC HIGHWAY SOUTH

KING COUNTY, WASHINGTON 98188

1.0 EXECUTIVE SUMMARY

The following report presents the results of our Subsurface Petroleum Hydrocarbon Evaluation consisting of a subsurface exploration program and analytical laboratory testing of soil and groundwater samples recovered from the subject site The purpose of this investigation was to qualitatively and quantitatively characterize the site for the presence of potential petroleum hydrocarbon impacts to the subsurface soils and groundwater. The site assessment involved the advancement of five borings to depths of 331/2 to 40 feet, the installation of monitoring wells in four of the borings; differential leveling techniques to determine the hydrogeologic gradient; analytical laboratory testing of soil and groundwater samples; data interpretation and report preparation. The following summary presents the significant findings detailed in this report.

- A Sensitive Receptor Survey completed for the site indicated three potential sensitive receptors within 1000 feet of the project site and four potential offsite sources of contamination within 1000 feet of the site.

- Subsurface conditions encountered during our exploration program indicated the site was generally underlain at shallow depths by a dense, silty, fine to medium sand with some gravel and discontinuous sand, silt and gravel lenses to an approximate depth of 35 feet below site grade. A very dense, gravelly, fine to coarse sand was encountered in borings MW-1 and MW-2 at depths ranging from 35 feet to the maximum extent of each boring.

- At the time of our explorations, groundwater was encountered in all four wells at variable depths ranging from 17 to 28 feet below the site grade The highly variable range of groundwater elevations and gradients observed on-site suggest there may be perched groundwater conditions present in the subsurface environment If perched groundwater conditions are present the generalized groundwater elevation contour maps, Figures 3A and 3B, presented in this report may not adequately represent hydrologic conditions.

- Analytical laboratory test results obtained during this assessment indicate the soil samples selected for analysis did not contain detectable concentrations of total petroleum hydrocarbons (TPH) as determined by EPA Method 8015 modified The soil samples also underwent BTEX (benzene, toluene, ethylbenzene and xylenes) analysis by EPA Method 8020 and analysis for total lead by EPA Method 7421. The test results indicated BTEX concentrations ranging from non-detectable to 0 22 parts per million (boring B-4) and total lead concentrations ranging from non-detectable to 12.9 ppm.

- Analytical testing of the groundwater samples collected from the monitoring wells installed during our explorations did not indicate detectable TPH, BTEX, and lead concentrations, with the exception of the groundwater samples collected from monitoring well MW-4 The samples from MW-4 were reported to contain a total petroleum hydrocarbon (TPH) concentration of 32 parts per million (ppm), B T E X concentrations ranging from .062 ppm (ethylbenzene) to 10 7 ppm (toluene), and dissolved lead concentrations to 24 parts per billion (ppb). TPH, BTEX and lead concentrations reported in the sample from MW-4 exceed the MTCA Method A cleanup levels

- After approximately one month of monitoring, an apparent thickness of 0 1 foot of liquid phase product was observed in monitoring well MW-4

2.0 PROJECT DESCRIPTION

The subject site is an approximately 30,000 square foot parcel, currently occupied by an operating BP Service Station The service station is located at 19924 Pacific Highway South in Sea-Tac, Washington. The location of the project site is presented on the Vicinity Map, Figure 1. The purpose of this study was to perform an environmental site assessment involving the evaluation of the site soils and groundwater in the vicinity of the underground storage tanks (USTs) and the associated pump islands with respect to potential petroleum hydrocarbon impacts.

The scope of the project consisted of the following:

1 Advancement of five borings to a depth which intersected the groundwater table and installation of monitoring wells in four of the borings

2. Collection of soil and water samples from the borings and monitoring wells. Submitting one soil sample and one groundwater sample from each boring and monitoring well, respectively, for quantitative analysis.
3. Measuring the groundwater elevation at each well in reference to an assigned datum and developing a groundwater elevation contour map with a inferred hydrologic down gradient direction
4 Completing a brief review of the site history, a brief review of surface conditions and a sensitive receptor survey within a 1 mile radius of the site
5 Preparation of a Subsurface Petroleum Hydrocarbon Evaluation report including our conclusions concerning the site conditions.

This report has been prepared for the exclusive use of BP Oil Company, Inc , and their agents for specific application to this project site, in accordance with generally accepted environmental assessment practices and the constraints of our approved scope of work No warranty is expressed or implied In the event other information regarding site conditions becomes known, or if there are any changes to the conditions on the existing site or nearby properties, the conclusions of this report should be reviewed and if necessary, revised by our office to reflect updated site information

3.0 SITE CONDITIONS

The subject property, which is currently occupied by an operating BP Service Station, is located on the northwest corner of the intersection of South 200th street and Pacific Highway South. Topographically, the site is situated near the top of a northeast-facing slope on a north-south trending ridge immediately east of Puget Sound.

The subject property is situated in a residential/retail neighborhood, approximately one mile south of the Sea-Tac International Airport, and roughly one quarter mile southwest of Angle Lake Surrounding properties include residential houses to the east and west of the Pacific Highway South business corridor Along the Pacific Highway business corridor to the North is a car rental agency, an apartment complex, storage facilities, an auto parts store and several automobile dealers. Along the Pacific Highway South Corridor to the south are commercial and retail properties such as a restaurant, a dry-cleaners, motel and several automobile dealers. There is a Chevron Service Station situated across Pacific Highway South to the west of the BP site and a fire station located across South 200th Street to the south

The BP Service Station is currently asphalt and concrete paved with numerous perimeter landscape planters There are three pump islands located along the western side of the property, and two storm drains situated along the southern edge of the property There are currently three underground storage tanks on the site Each of the tanks are approximately eight years old, range between 5,000-20,000 gallon capacity, and contain leaded and unleaded gasoline.

3.1 Site History

In an effort to determine the possibility of petroleum hydrocarbon-impacted subsurface materials occurring on the subject site from past on-site or off-site activities, the history of the site was reviewed utilizing records on file at the Seattle Public Library and the King County branch of the Washington State Archives Based on our review of several editions of the "Polks Guide", from various years, it appears that prior to occupation of the site by the current BP Station, the site was utilized as a Mobil Service Station beginning in 1974[4]. Records on file at the Washington State Archives indicate that a service station was built in 1953 under ownership of Fletcher Oil[5] At that time there were three (two 10,000 gallon and one 6,000 gallon) underground storage tanks with six fuel pumps in operation on-site[6] The station was apparently still in service in 1973[6] (refer to Appendix E for reference notes)

3.2 Sensitive Receptors and Potential Off-Site Sources of Contamination

The sensitive receptor survey performed by our office indicated there are no public or private water supply wells present within 2,500 feet and 1000 feet of the project site, respectively[6] However, there are several other sensitive receptors within 1,000 feet of the project site The nearest potential receptor is Angle Lake, located 900 feet to the northeast of the project site The second nearest sensitive receptor is Seattle Christian High School located 1,000 feet to the north. A third sensitive receptor is the presence of five residential building basements located within 1,000 feet of the project site to the north, east and west In addition, the survey indicated there maybe potential off-site sources of contamination within 1,000 feet of the project site. The potential off-site sources of contamination include underground storage tanks (UST) at the Chevron Station[7], possible UST's at the fire station and possible UST's at a car rental agency Other potential off-site sources of contamination include dry cleaning chemicals from a dry cleaning establishment located approximately 500 feet southwest of the subject site However, there were no reports of UST releases recorded on the Washington Department of Ecology Leaking Underground Storage Tank List for these facilities A completed sensitive receptor checklist is attached as Appendix A

4 0 SUBSURFACE EXPLORATION

The subsurface exploration program consisted of observing the advancement of five subsurface borings (B-1, B-2, B-3, B-4 and B-5) to depths of approximately 35 to 40 feet Groundwater monitoring wells (MW-1, MW-3, MW-4, MW-5) were installed in four of the five borings at the approximate locations shown on the Site and Exploration Plan, Figure 2. The boring locations were obtained by measuring from existing site features. The borings were drilled during the week of 8 April 1991 by a Seattle based exploration drilling company under subcontract to our firm Each boring consisted of advancing a 6-inch inside diameter (ID) hollow-stem auger with a truck-mounted B-61 drill rig. The borings were continuously observed and logged by an experienced geologist from our firm Prior to drilling each boring, the drilling equipment and sampling tools were decontaminated by steam cleaning. During the advancement of each boring, subsurface soil samples were obtained at depth intervals of approximately 5 feet to a maximum depth of approximately 33 1/2 to 40 feet below the existing site grade Each soil sample was screened in the field for the presence of volatile organic compounds, to facilitate selecting an appropriate soil sample for chemical analysis Four-inch diameter PVC monitoring wells were installed in all borings at the time of drilling The monitoring well as-built diagrams are shown on the attached boring logs in Appendix B.

Groundwater samples were obtained following measurement of the depth to groundwater in each well, the purging of a minimum of three casing volumes of groundwater from each well and allowing the well to recover to within 10 percent of the previously measured depth to groundwater The water samples were retrieved with a decontaminated disposable bailer and transferred immediately to laboratory-prepared glass containers Water samples which were to be analyzed for volatile compounds were placed in containers having a Teflon-septum seal so that inclusions of free gas in the containers were not trapped inside RZA's strict chain-of-custody procedures were used to maintain sample integrity

4.1 Subsurface Soil Conditions

A review of geologic maps and literature indicates the shallow site soils to be glacially derived materials characteristic of the Puget Sound region. The glacially derived materials found in this region generally consist of glacial till, glacial recessional outwash materials and glacial advance outwash materials[1]. A review of the local geologic maps and literature indicate the near surface geology of the subject parcel consists primarily of glacial till materials identified as the Vashon Glacial Till deposited during the Vashon Stade of the Fraser Glaciation occurring 11,000 to 19,000 years ago[1] The composition of the materials is described as a compact mixture gravel in a gray silty sand matrix with lenses of sand

and gravel[1] The formation is reported to be up to 50 feet thick and overlies another glacial till formation named the Salmon Springs Drift Formation[1]. The Salmon Springs Drift Formation is primarily oxidized sand and gravel and is reported to be generally 50 feet thick[1]

The results of the geologic literature review are supported by our observations of the soil samples collected during drilling procedures. Our observations indicate the near surface soils consist of a dense to very dense, damp to moist, silty, fine to medium sand with some gravel and apparently discontinuous sand, silt, and gravel lenses to an approximate depth of ten feet below the site grade. Beyond a depth of ten feet, the soil increases in moisture content with depth until saturated at the groundwater table. The formation observed in our explorations appears to be similar to the Vashon Glacial Till Formation described in the geologic literature review.

Based on our observations of the site subsurface conditions and the geologic history of the site, it appears the geologic structure of the subsurface environment, developed during the glaciation process and the associated recessional sedimentation may consist of multiple non-cohesive sediment zones, (sand or gravel lenses) bounded by semi-permeable confining layers. These zones may act as temporary groundwater storage areas creating perched groundwater conditions in the subsurface environment

4.2 Groundwater Conditions

Shallow groundwater conditions were evaluated on 16 April 1991, utilizing data from the monitoring wells installed in the soil borings during our environmental site assessment Groundwater was encountered in all four wells at a depth of 17 to 27 feet below site grade The depth to groundwater data was instrumental in establishing the groundwater elevation measurements and in developing the Groundwater Elevation Contour Maps, Figures 3A and 3B.

Measurements of the groundwater elevations were obtained during our differential leveling program. The differential leveling program involved establishing an arbitrary 100 00 foot elevation datum or control point at the northeast corner of the retail building The differences in elevation were then measured from the top of each monitoring well PVC casing relative to the arbitrary datum.

The information obtained from the groundwater elevation data indicated a hydrologic gradient ranging from 0 022 to 0.073 vertical feet per linear foot and an approximate direction of groundwater migration varying from the southeast to southwest. The range of hydrogeologic information obtained

for this study is due to the discrepancy in water elevations observed in the monitoring wells Generally ground water level elevations ranged from 71 21 feet to 72 91 feet for monitoring wells MW-1, MW-3 and MW-4 However, monitoring well MW-5 indicated a groundwater elevation of approximately 80 32 feet or 7 feet higher than the other monitoring wells on-site The approximately 7 foot discrepancy between the monitoring wells suggests that monitoring well MW-5 may reflect conditions in a separate discontinuous perched groundwater zone not connected to the groundwater conditions observed in the other wells As noted in the section on local geology it appears there are discontinuous sand and gravel lenses in the subsurface environment that would make such conditions possible. The Groundwater Elevation Contour Maps, Figures 3A and 3B, indicate the inferred contours of the groundwater surface Figure 3A is a groundwater elevation contour map inclusive of all four monitoring wells and indicates a hydrologic down gradient direction to the southwest. Figure 3B is a groundwater elevation contour map of three of the four wells (excluding monitoring well MW-5) and may indicate a more moderate hydrologic gradient and a migration direction to the southeast

5 0 QUANTITATIVE ANALYSES

5.1 Analytical Results: Soils

Soil samples collected from the subsurface borings near the gasoline tanks and pump islands were submitted to an analytical laboratory for analysis of Total Petroleum Hydrocarbons (TPH) by EPA Method 8015 modified, selected volatile aromatic hydrocarbons (BTEX) by EPA Method 8020; and for analysis of total lead by EPA Method 7421

The analytical laboratory test results from the soil samples did not indicate detectable total petroleum hydrocarbon or BTEX concentrations The soil samples analyzed for lead indicated total lead concentrations ranging from non-detectable to 12 9 ppm Table 1 summarizes these results.

5 2 Analytical Results Groundwater

Water samples collected from each monitoring well were submitted for TPH analysis by EPA Method 8015 modified; BTEX analysis by EPA Method 8020, and total lead analysis by EPA Method 7421. The analytical test results did not indicate detectable TPH or BTEX concentrations, with the exception of the water sample collected from monitoring well MW-4 The test results from MW-4 indicate a total petroleum hydrocarbon (as gasoline) concentration of 32,000 ppb, 7,890 ppb benzene, 10,700 ppb

toluene, 62 ppb ethylbenzene, and 5,370 ppb xylenes. Water samples collected from MW-1, MW-3 and MW-5 indicated detectable concentrations of dissolved lead. 24 ppb dissolved lead was detected in a water sample collected from MW-4. A summary of the analytical results is presented in Table 3.

6 0 ON-SITE CONTAINMENT OF DRILL CUTTINGS AND PURGE WATER

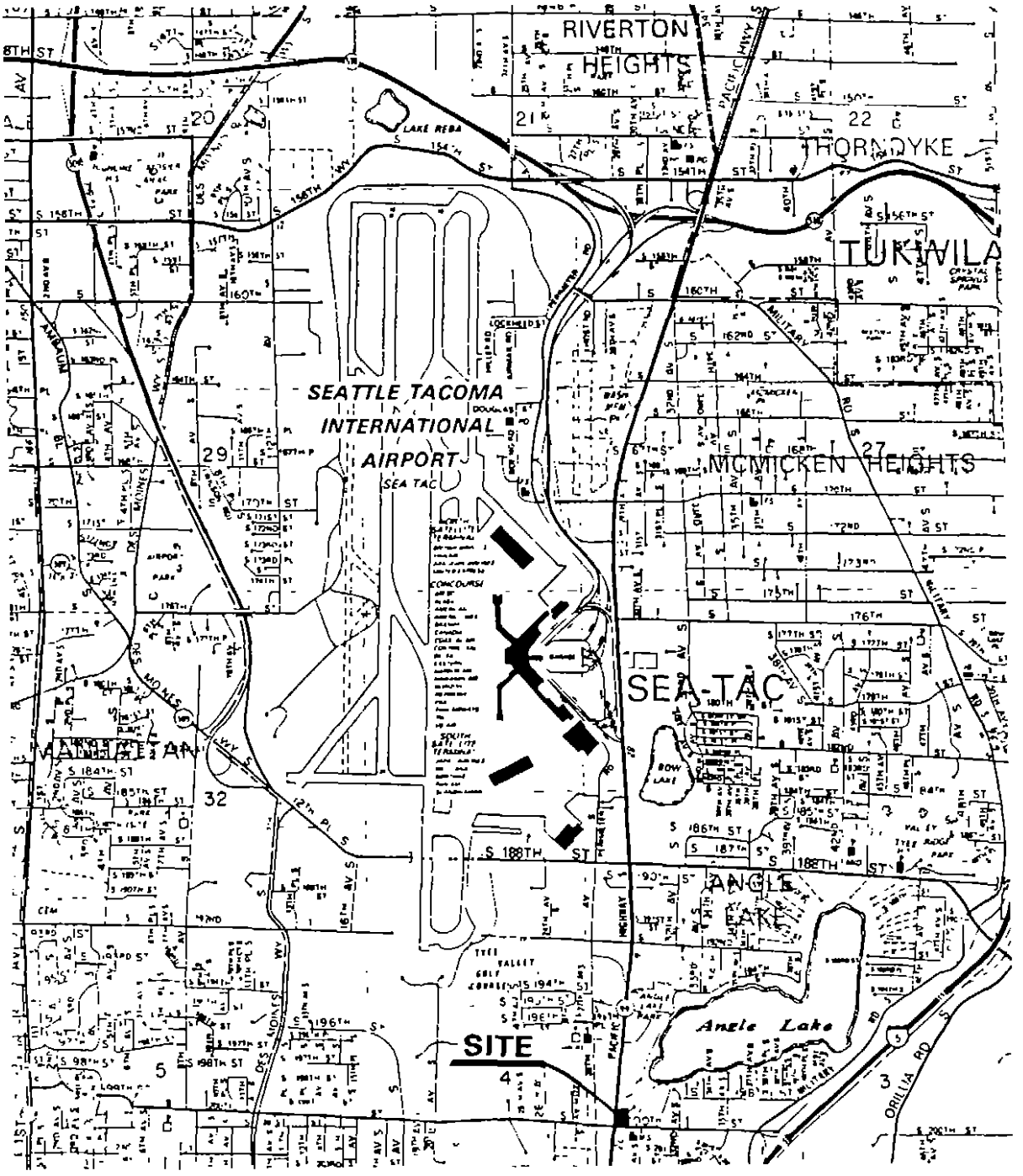
Soil cuttings, groundwater monitoring well development water and purge water generated from the subsurface exploration and sampling program were placed in 55 gallon Department of Transportation (DOT) approved steel containers with bolt down lids for storage on-site The containers were labeled identifying the contents of the 55 gallon barrel, the origin of the contents, and the date generated. The barrels will remain on-site until a characterization of the contents is completed Following characterization of the barrel contents, the barrels were removed from the site and disposed of at a suitable facility

7.0 CONCLUSIONS

Based on the soil sampling data obtained during our single sampling event, the on-site soils did not appear to be impacted by petroleum hydrocarbons in concentrations above the Model Toxics Control Act, (MTCA) Method A cleanup criteria. However, organic vapor background levels, obtained with an OVM from boring MW-4, exhibited a volatile organic compound concentration of 220 ppm during drilling. This was the only indication of petroleum hydrocarbon impact to the site soils during drilling or sampling. The analytical test results from the soil samples obtained from boring MW-4 do not indicate any subsurface soil contamination, suggesting the sample was not taken from the contaminated zone, or that the laboratory analyses should be questioned.

Water samples collected from the monitoring wells generally indicated non-detectable concentrations of total petroleum hydrocarbons with the exception of monitoring well MW-4 The water sample collected from monitoring well MW-4, apparently hydrologically down-gradient of the pump island, indicated TPH and BTEX concentrations above the MTCA Method A numerical cleanup criteria.

Approximately 1 month following initial sampling, water levels were measured again. The results indicated the presence of 0 1 foot of liquid phase petroleum hydrocarbons in monitoring well MW-4 Based on the presence of liquid phase petroleum hydrocarbons, an emergency response groundwater and liquid phase petroleum hydrocarbon system was installed in monitoring well MW-4



BP SEATAC
SEATTLE, WASHINGTON

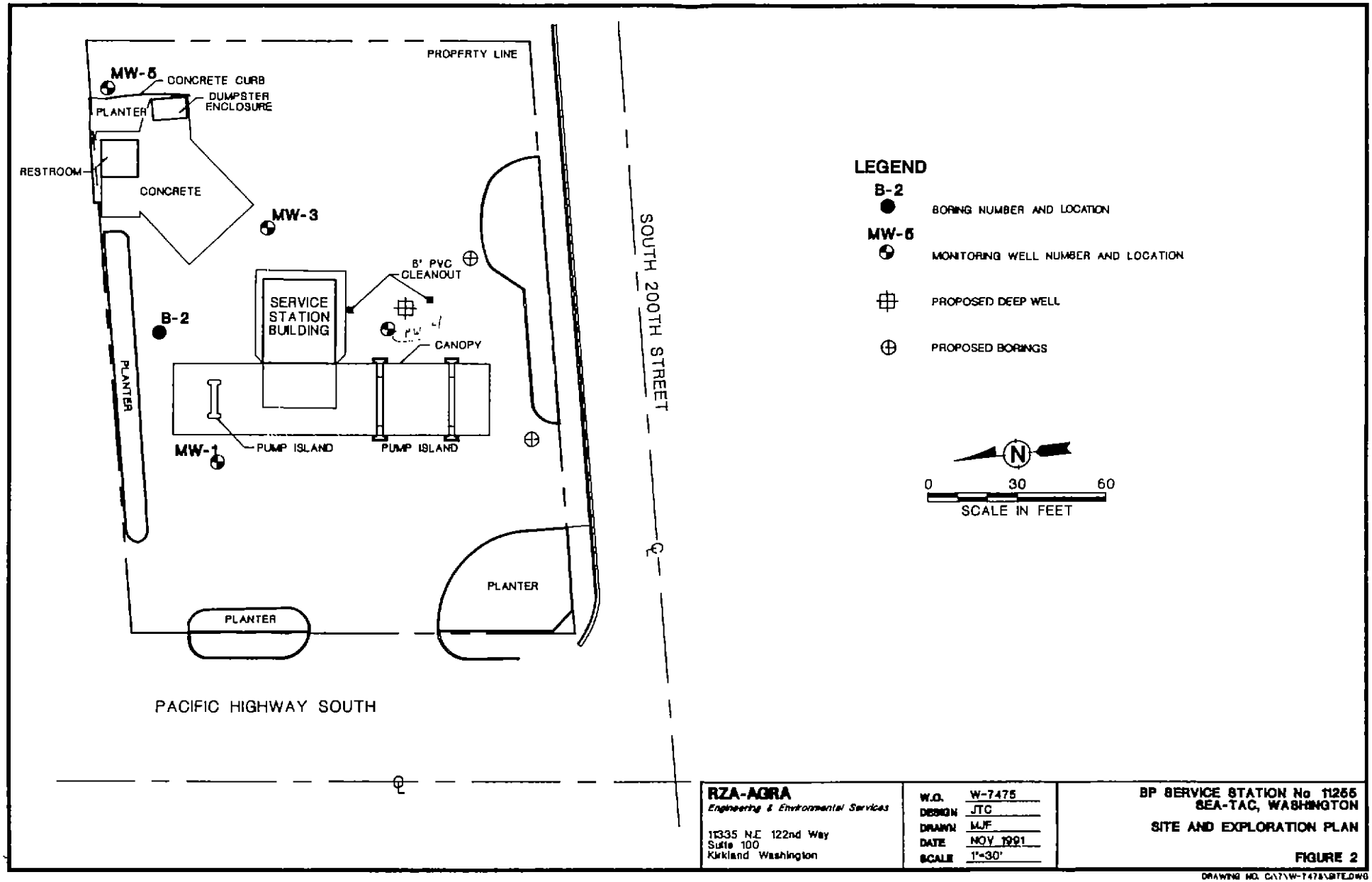
VICINITY MAP

FIGURE 1

WO	W-7475
BY	JTC
DATE	MAY 1991
SCALE	NTS

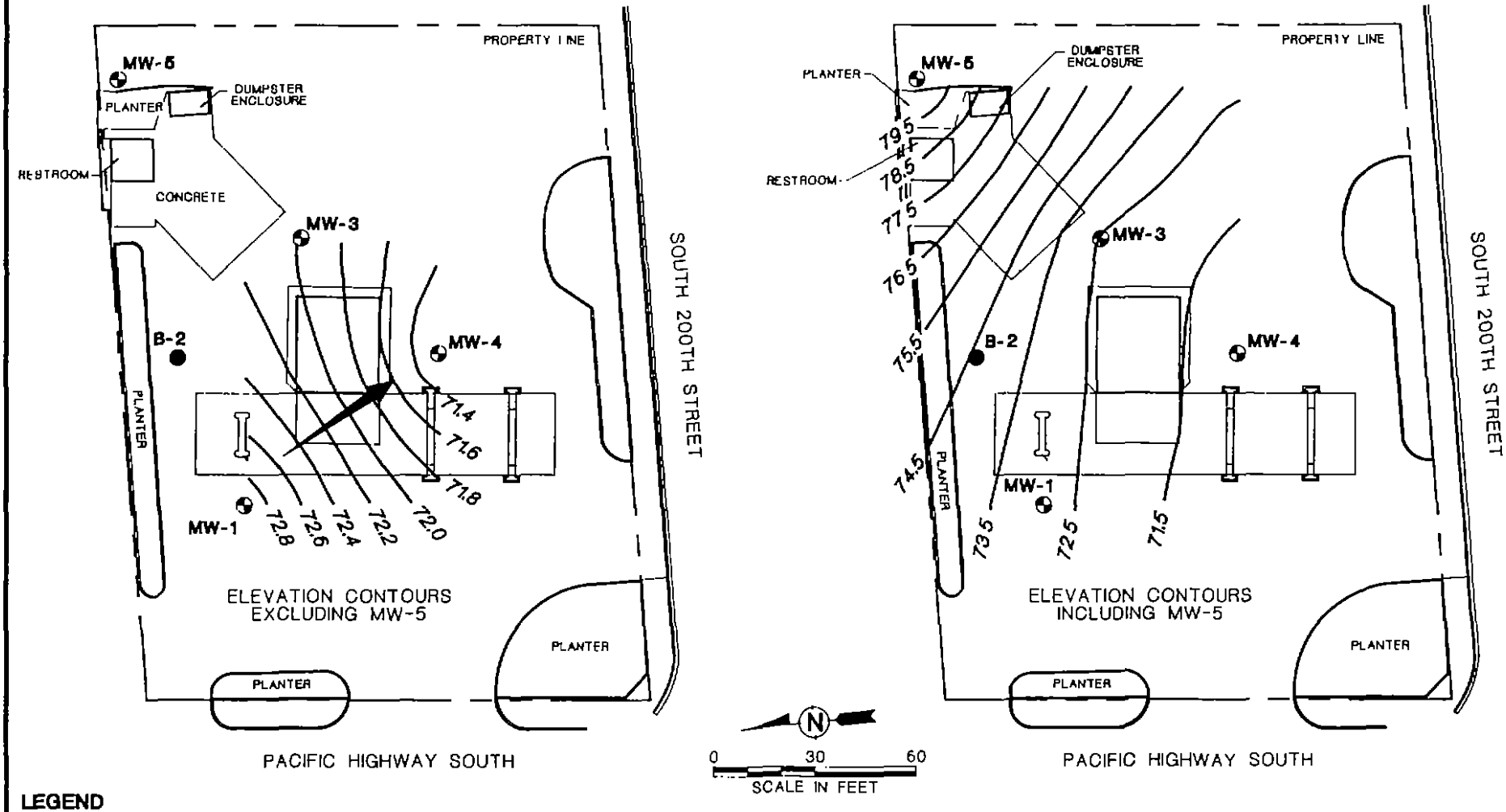
RITTENHOUSE-ZEMAN & ASSOCIATES, INC
Geotechnical & Environmental Consultants
1400 140th Avenue N E
Bellevue, WA 98005

RZA



RZA-AGRA *Engineering & Environmental Services* 11335 N.E. 122nd Way Suite 100 Kirkland Washington	W.O. W-7475 DESIGN JTC DRAWN MJF DATE NOV 1991 SCALE 1"=30'	BP SERVICE STATION No. 11255 SEA-TAC, WASHINGTON SITE AND EXPLORATION PLAN FIGURE 2	

DRAWING NO. C:\7\W-7475\SITE.DWG



LEGEND

- **B-2** ● — BORING NUMBER AND LOCATION
- **MW-5** ⊕ — MONITORING WELL NUMBER AND LOCATION
- —79.5— INFERRED GROUNDWATER SURFACE ELEVATION CONTOUR IN FEET
- ← INFERRED DIRECTION OF GROUNDWATER MIGRATION

RZA-AGRA
Engineering & Environmental Services
11335 N.E. 122nd Way
Suite 100
Kirkland Washington

W.O	W-7475
DESIGN	JTC
DRAWN	MJF
DATE	NOV 1991
SCALE	1"=30'

BP SERVICE STATION No. 11265
SEA-TAC, WASHINGTON

GROUNDWATER SURFACE ELEVATION CONTOUR MAP FOR 16 APRIL 1991

FIGURE 3

DRAWING NO. C:\7\W-7475\DW-4-91.DWG

SENSITIVE RECEPTORS SURVEY

Store No BP Oil Service Station #11255
Location 19924 Pacific Highway South
City/State Seattle, Washington 98188

I WATER SUPPLY

A. Is there a public water supply well within 2,500 feet? Y (N)
If yes, distance_____

B Is there a private water supply well within 1,000 feet? Y (N)
If yes, distance_____

C Describe type of local water supply Include supplier's name, source, and distance to site
Highline Water District #75 supplies water to the project vicinity The water is obtained from the Cedar & Tolt River Watersheds

D. Is the site within an aquifer protection district? If yes, describe
No

E. Comments

II SENSITIVE RECEPTORS

A. Are there any sensitive receptors, i.e bodies of water; schools and day care facilities, hospitals, convalescent centers, and retirement facilities, basements and subways, and/or others within 1,000 feet of the subject site?

(Y) N

Type of Receptor	Location	Position Relative to Site	Other
The Seattle Christian High School	near S 196th St. & 28th Avenue S	approx 1000 ft. to the north-n.e of the site	
Angle Lake	East of Pacific Hwy S	approx. 900 feet northeast of the site	
residential basements	a few to north, east, and west		

B Comments
There are approximately 5 basements associated with residential dwellings within 1000 ft. of the site located to the north, east, and west.

III POTENTIAL OFF-SITE SOURCES

A. Are there any potential off-site sources of contamination within 2500 feet of the site?

(Y) N

(i.e. underground storage tanks, leaking underground storage tanks, others)

Underground Storage Tanks
Possibly Dry Cleaning Chemicals

B Comments

There is a Chevron gasoline station across Pacific Hwy S to the west of the BP site There are 5 USTs containing leaded, unleaded,& diesel fuel Also, there is a fire station across S 200th St. to the south, which may have USTs There are several auto rental facilities within 1000 ft to the north and south which may have USTs There is a dry cleaner approx. 500 ft. to the southwest of the site Dry cleaning chemicals, such as perchlorethylene, may be used on site

IV OBSERVATION WELLS

A. Describe observation wells, if any Include number of wells, presence and amount of liquid petroleum hydrocarbons

None recorded

V SIGNATURE OF PREPARER Jennifer Wolfe

DATE May 21, 1991

This Sensitive Receptors Survey is only a limited, non-conclusive document to be used as a general indication of key sensitive receptors in the immediate vicinity of the site No warranty, express or implied, is made

APPENDIX B
SUBSURFACE EXPLORATION PROCEDURES
W-7475

Subsurface Exploration

The borings were drilled by an exploration drilling company under contract to RZA. The borings consisted of advancing 6-inch I D hollow-stem augers utilizing a truck-mounted drill rig Each of the explorations was advanced to a depth of approximately 20 feet below ground surface During the drilling process, samples were generally obtained at 5-foot depth intervals beginning at 2 1/2 feet below ground surface The explorations were logged under the full-time supervision of an environmental geologist. The geologist classified the subsurface materials, kept a detailed log and maintained custody of the recovered samples

Characterization of Soils

Disturbed representative samples were obtained using the Standard Penetration Test procedure as described in ASTM D-1586 The test sampling method consists of driving a standard 2-inch outside diameter split barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches The number of blows for each 6-inch interval is recorded. The number of blows required to drive a sampler the final 12 inches is considered the standard penetration resistance ("N") or blow count. If a total of 50 blows is recorded within one 6-inch interval, the blow count is recorded as 50 blows for the actual number of inches of penetration The blow count, or "N" value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils

Soil Sampling Procedure

The soil samples were recovered at each interval using procedures designed to minimize the risk of cross-contamination Prior to each boring, the drilling equipment and sampling tools were cleaned Prior to each sampling attempt, the sampling tools were scrubbed with a stiff brush and a detergent solution consisting of Liquinox and warm water, and then rinsed with potable water and liberal quantities of distilled water The samples were classified in the field, immediately transferred to laboratory-treated glass jars, and tightly sealed with a Teflon-lined threaded cap Samples were stored and transported in a chilled ice chest throughout the field program

The boring logs presented in this appendix are based on the drilling action, visual inspection of the samples secured, laboratory results, and field logs The various types of soils are indicated, as well as the depths where the soils or characteristics of the soils changed It should be noted that these changes may have been gradual, and if the changes occurred between sample intervals, they were interpreted Subsurface water conditions were evaluated by observing the moisture condition of the samples, the free water on the sampling rods, and installation of monitoring wells in the borings

Field Screening

Each soil sample was screened in the field for the presence of volatile organic compounds, to facilitate selecting an appropriate soil sample for chemical analysis The screening involved placing approximately 4 ounces of sampled soil directly into a plastic bag The sample was then shaken vigorously for about 15 seconds and a head space reading was taken after plunging the probe of an organic vapor meter through the sealed plastic bag Prior to sample collection, background measurements of the air space in the plastic bags indicated non-detectable concentrations of organic vapors. Field head space analysis was performed on each sample utilizing an organic vapor meter (OVM) The highest value displayed by the instrument was recorded for each sample The volatile organic compound values displayed by the OVM during the drilling program ranged from non-detectable headspace values to levels as high as 220 ppm (during the advancement of boring MW-4) However, the OVM is not capable of identifying specific compounds of their actual concentrations in the soil samples Therefore, this method is considered only a screening tool that aids in detecting the presence of volatile organic compounds with an ionization potential less than 10 0 eV, which include many petroleum hydrocarbons

Monitoring Well Construction

The monitoring wells were constructed of a section of 4-inch I D Schedule 40 polyvinyl chloride (PVC) casing five feet long threaded flush to a 15 foot length of schedule 40,0 01-inch slotted PVC well screen Washed 10/12 graded sand was then allowed to surround the screened portion of the well during withdrawal of the augers Above the screened portion of the wells, the annulus of each boring was backfilled with approximately 2 feet of granular bentonite. At the surface, an approximately 2-foot thick cap of concrete was placed Each of the wells was completed with a locking, weatherproof monument mounted flush to surface grade The as-built drawings for each of the four monitoring wells are presented in this appendix.

Well Development Procedures

Prior to groundwater sampling, the monitoring wells were developed by hand bailing methods. Water was removed from each well, allowed to recharge and the process continued until water entering the well was visibly clear of silt and sand The well development process ensures proper seating of the annular sandpack around the well screen and removal of fines

Groundwater Sampling Procedures

The groundwater sampling procedure for these wells consisted of evacuating 3-5 well casing volumes of water from a well using a PVC bailer cleaned prior to each well purge. Once each well was purged, a new laboratory certified disposable Teflon bailer was lowered slowly through the air/water interface, and a sample from near water surface was retrieved from the monitoring well The water was carefully decanted into three different types of sampling containers The first sampling consisted of filling two 40 milliter (ml) laboratory-cleaned and dried glass vials The vials were sealed with a Teflon-lined threaded cap, such that no air bubbles were trapped inside These samples were analyzed for dissolved BTEX by EPA method 602 The next sampling involved filling a one liter, laboratory-cleaned and dried amber glass bottle and capping with a Teflon-lined threaded cap These samples were analyzed for TPH by modified EPA method 8015 The final sampling performed consisted of filling a 500 ml plastic bottle. Once the 500 ml of water was collected in the bottle, approximately 2 ml of concentrated nitric acid (HNO_3) was placed in the sample to bring the pH of the water down to less than 2 and preserve the sample prior to laboratory analyses These samples were analyzed for total lead by EPA method 7421.

PROJECT *BP Seatac* W O *W-7475* WELL NO *MW-1*

Elevation reference *Not available*
Ground surface elevation Casing elevation

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER
0	*Very dense, wet to saturated, gravelly SAND with some silt*		S-1	58/6"	1	
35						
40	*Boring terminated at 40 feet*					
45						
50						
55						
60		B				

AS-BUILT DESIGN

Select sand filter pack

Screen (4-inch I D PVC with 0 020-inch slots)

Threaded end cap

TESTING

LEGEND

I 2-inch O D split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue Washington 98005

Drilling started *8 April 1991* Drilling completed *8 April 1991* Logged by *JTC*

PROJECT *BP Seatac* W.O. *W-7475* WELL NO *MW-1*

Elevation reference *Not available*
Ground surface elevation Casing elevation

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER
0	*3" Asphalt*					
	Dense, moist, light brown, silty, fine to medium SAND with some gravel		S-1	50/4"	1	
5						
	Grading to very dense		S-2	50/5"	1	
10						
	Very dense, damp, gray, fine to medium SAND with some gravel		S-3	50/3"	3	
15						
			S-4	50/5"	4	
20						
	Very dense damp tan fine to medium SAND with some gravel		S-5	50/5"	1	
25						ATD
	becoming saturated		S-6	50/3"	2	
30						

AS-BUILT DESIGN

Flush-mounted steel monument
Ground surface
Top of casing
Concrete
Bentonite seal
Casing (Schedule-40 4-inch ID PVC)
Select sand filter pack
Screen (4-inch ID PVC with 0.020-inch slots)

TESTING

LEGEND

2-inch O.D. split-spoon sample

ATD Observed groundwater level (ATD = at time of drilling)

RZA
RITTENHOUSE-ZEMAN & ASSOCIATES INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue, Washington 98005

Drilling started *8 April 1991* Drilling completed *8 April 1991* Logged by *TDW*

PROJECT *BP Seatac* W.O. *W-7475* WELL NO. *B-2*

Elevation reference
Ground surface elevation Casing elevation

AS-BUILT DESIGN

No Well Installed

TESTING

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER
30	*Stiff, moist, yellowish tan SILT*					
	Very dense, saturated, gray gravel		S-14	50/3"	0	
35	*Boring terminated at 35 feet*					
40						
45						
50						
55						
60						

LEGEND

I 2-inch O D split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES, INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue Washington 98005

Drilling started *9 April 1991* Drilling completed *9 April 1991* Logged by *JTC*

PROJECT *BP Seatac* W O. *W-7475* WELL NO. *B-2*

Elevation reference
Ground surface elevation Casing elevation

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER
0	*3" Asphalt*					
	Crushed rock and pea gravel					
	Medium dense, moist, brown SAND with some gravel					
5			S-8	13	1	
			S-9	10	2	
10	*Pea Gravel*		S-10	50/3"	1	
	Very dense, moist to wet, gray, silty, fine to medium SAND with some gravel		S-11	50/2"	2	
20			S-12	50/3"	2	
	Very dense, damp tan, silty fine to medium SAND with some gravel					
25			S-13	50/5"	1	ATD
	becoming saturated					
30						

AS-BUILT DESIGN

No Well Installed

TESTING

LEGEND

I 2-inch O D split-spoon sample

ATD Observed groundwater level (ATD = at time of drilling)

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue Washington 98005

Drilling started *9 April 1991* Drilling completed *9 April 1991* Logged by *JTC*

PROJECT *BP Seatac* W O. *W-7475* WELL NO *MW-3*

Elevation reference
Ground surface elevation Casing elevation

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER	AS-BUILT DESIGN	TESTING
30	*Very dense, wet to saturated, light brown to gray, fine to medium SAND with some gravel*		S-7	50/6"	1		*Select sand filter pack*; *Screen (4-inch ID PVC with 0.020-inch slots)*; *Threaded end cap*	
35	*Boring terminated at 34 feet*							
40								
45								
50								
55								
60								

LEGEND

I 2-inch O D split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

RZA
RITTENHOUSE-ZEMAN & ASSOCIATES INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue Washington 98005

Drilling started *10 April 1991* Drilling completed *10 April 1991* Logged by *JTC*

PROJECT *BP Seatac* W.O. *W-7475* WELL NO. *MW-3*

Elevation reference *Not available*
Ground surface elevation Casing elevation

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER
0	3" Asphalt					
	Very dense, moist, light brown, silty, fine to medium SAND with some gravel					
			S-1	50/3"	1	
5						
			S-2	50/6"	1	
10						
			S-3	50/5"	4	
15						
			S-4	50/3"	0	
20						
	Very dense, moist to wet, light brown to gray, silty, fine to medium SAND with a trace of gravel					
			S-5	50/3"	4	
25						ATD
			S-6	50/4"	1	
30						

AS-BUILT DESIGN

Flush-mounted steel monument
Ground surface
Top of casing
Concrete
Bentonite seal
Casing (Schedule-40 4-inch ID PVC)
Select sand filter pack
Screen (4-inch ID PVC with 0.020-inch slots)

TESTING

LEGEND

2-inch O.D. split-spoon sample

ATD Observed groundwater level (ATD = at time of drilling)

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue Washington 98005

Drilling started *10 April 1991* Drilling completed *10 April 1991* Logged by *JTC*

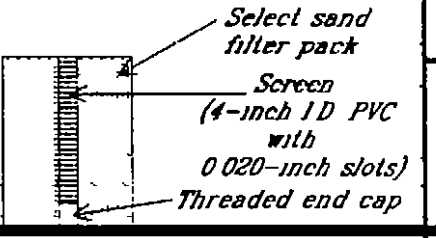
PROJECT *BP Seatac* W O *W-7475* WELL NO *MW-4*

Elevation reference
Ground surface elevation Casing elevation

AS-BUILT DESIGN

TESTING

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER
30			S-7	50/6"	0	
	Boring terminated at 33 5 feet					
35						
40						
45						
50						
55						
60						



LEGEND

2-inch O D split-spoon sample

Observed groundwater level (ATD = at time of drilling)

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue Washington 98005

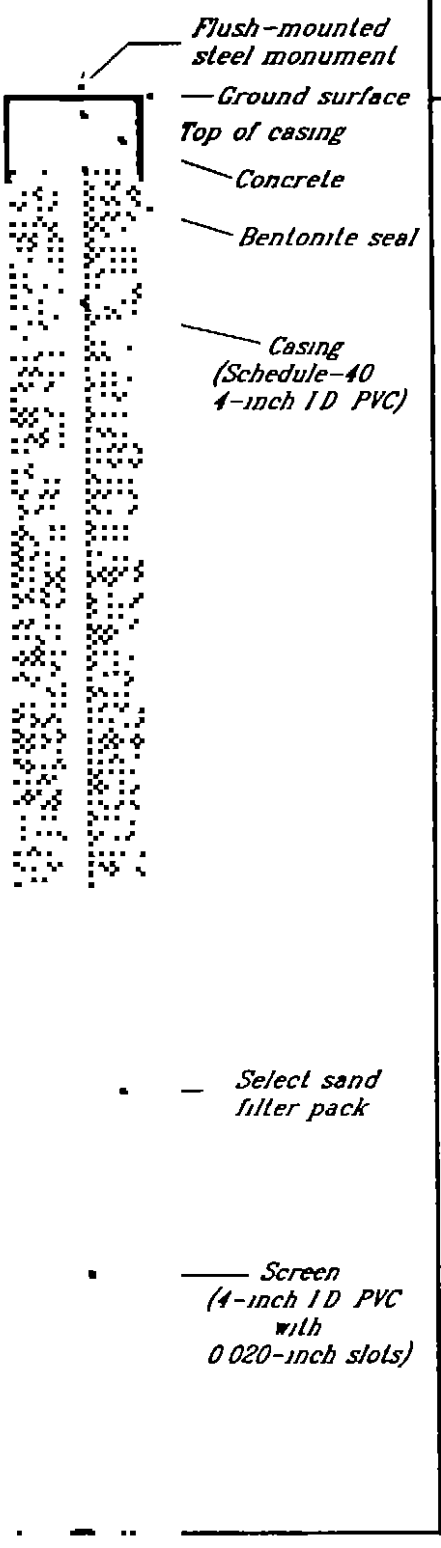
Drilling started *10 April 1991* Drilling completed *10 April 1991* Logged by *JTC*

PROJECT *BP Seatac* W.O. *W-7475* WELL NO *MW-4*

Elevation reference
Ground surface elevation Casing elevation

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER
0	3" Asphalt					
	Dense, moist, light brown, silty, fine to medium SAND with some gravel		S-1	33	4	
5						
	Very dense, moist, light brown to dark brown, silty, fine to medium SAND with some gravel and organics		S-2	50/5"	13	
10						
	Very dense, moist, light brown to gray, silty, fine to medium SAND with some gravel		S-3	50/6"	0	
15						
			S-4	50/5"	0	
20						
	Very dense, wet to saturated, light brown to gray, silty, fine to medium SAND with some gravel		S-5	50/5"	4	ATD
25						
			S-6	50/4"	76	
30						

AS-BUILT DESIGN



TESTING

LEGEND

2-inch O.D. split-spoon sample

ATD Observed groundwater level (ATD = at time of drilling)

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue, Washington 98005

Drilling started *10 April 1991* Drilling completed *10 April 1991* Logged by *JTC*

PROJECT *BP Seatac* W O. *W-7475* WELL NO. *MW-5*

Elevation reference
Ground surface elevation Casing elevation

AS-BUILT DESIGN

TESTING

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER
30	*Grading to saturated*					
			S-7	50/11"	1	
	Boring terminated at 33 feet					
35						
40						
45						
50						
55						
60						

LEGEND

2-inch O D split-spoon sample

Observed groundwater level (ATD = at time of drilling)

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue, Washington 98005

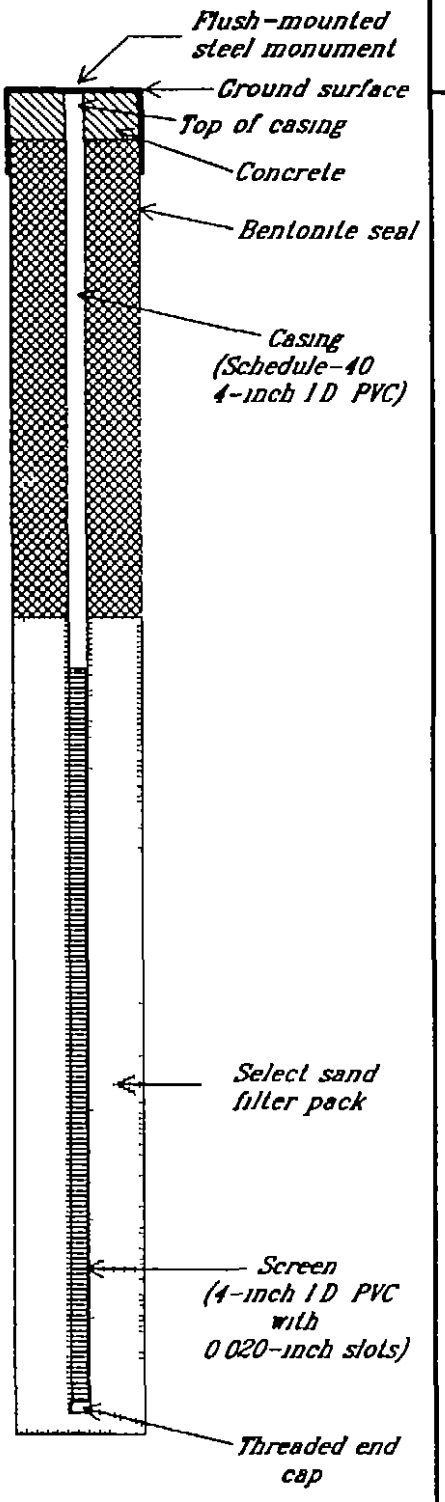
Drilling started *11 April 1991* Drilling completed *11 April 1991* Logged by *JTC*

PROJECT *BP Seatac* W.O *W-7475* WELL NO. *MW-5*

Elevation reference
Ground surface elevation Casing elevation

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	HEAD SPACE	GROUND WATER
0	3" Asphalt					
	Dense, moist, light brown, silty, fine to medium SAND with some gravel		S-1	44	1	
5						
	Very dense, moist, light brown to gray, silty, fine to medium SAND with some gravel		S-2	50/5"	1	
10						
			S-3	50/5"	0	
15	Increasing gravel content					ATD
			S-4	50/1"	0	
20						
	Very dense wet to saturated, light brown to gray, silty, fine to medium SAND with some gravel		S-5	50/6"	4	
25						
			S-6	50/5"	76	
30						

AS-BUILT DESIGN



TESTING

LEGEND

2-inch O.D. split-spoon sample

ATD Observed groundwater level (ATD = at time of drilling)

RZA
RITTENHOUSE-ZEMAN & ASSOCIATES, INC
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue Washington 98005

Drilling started *11 April 1991* Drilling completed *11 April 1991* Logged by *JTC*

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 17021 (1)
Date: April 18, 1991
Client: Rittenhouse-Zeman

Client ID: S-5
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD*
Benzene	< 0.05	< 0.05	---
Toluene	< 0.05	< 0.05	---
Ethyl Benzene	< 0.05	< 0.05	---
Xylenes	< 0.05	< 0.05	---
Total Petroleum Hydrocarbons	< 10	< 10	---
Total Lead	6.0	6.9	14.0

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922 5047

Report To: Rittenhouse-Zeman Date: April 18, 1991

Report On: Analysis of Soil Lab No.: 17021

IDENTIFICATION:
Samples Received on 04-12-91
Project: W-7475 BP SeaTac

ANALYSIS:

Lab Sample No.	1	2	3	4	5
Client ID	S-5	S-11	B-3 S-4	B-4 S-5	B-5 S-5
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
*Benzene	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
*Toluene	< 0.05	< 0.05	< 0.05	0.06	< 0.05
*Ethyl Benzene	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
*Xylenes	< 0.05	< 0.05	< 0.05	0.22	< 0.05
*Total Petroleum Fuel Hydro-carbons	< 10	< 10	< 10	< 10	< 10
Total Lead	6.0	< 1.7	< 1.7	12.9	6.7

* Samples were analyzed using purge and trap techniques which can only detect gasoline. (Method 5030)

SOUND ANALYTICAL SERVICES

C. LARRY ZURAW

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922 2310 - FAX (206)922 5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 17197 (4) Client ID: B-5
Date: April 29, 1991 Matrix: Water
Client: Rittenhouse-Zeman Units: ppm

Compound	Sample(S)	Duplicate(D)	RPD*
Benzene	< 0.001	< 0.001	---
Toluene	< 0.001	< 0.001	---
Ethyl Benzene	< 0.001	< 0.001	---
Xylenes	< 0.001	< 0.001	---
Total Petroleum Fuel Hydrocarbons	< 0.1	< 0.1	---

Lab No: 17197 (1) Client ID: B-1
Date: April 29, 1991 Matrix: Water
Client: Rittenhouse-Zeman Units: ppm

Compound	Sample(S)	Duplicate(D)	RPD*
Total Lead	< 0.005	< 0.005	---

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 FAX (206)922-5047

Report To: Rittenhouse-Zeman Date: April 29, 1991

Report On: Analysis of Water Lab No.: 17197

IDENTIFICATION:
Samples Received on 04-23-91
Project: W-7475 BP Seattle

ANALYSIS:

Lab Sample No.	1	2	3	4
Client Identification	B-1	B-3	B-4	B-5
Units	ppm	ppm	ppm	ppm
*Benzene	< 0.001	< 0.001	7.89	< 0.001
*Toluene	< 0.001	< 0.001	10.7	< 0.001
*Ethyl Benzene	< 0.001	< 0.001	0.062	< 0.001
*Xylenes	< 0.001	< 0.001	5.37	< 0.001
*Total Petroleum Fuel Hydrocarbons TPH as	< 0.1	< 0.1	32 Gasoline	< 0.1
**Total Lead	< 0.005	< 0.005	0.024	< 0.005

*Samples were analyzed using purge and trap techniques which can only detect gasoline. (Method 5030)

**by Graphite Furnace

Note - Results reported on an as received basis.

SOUND ANALYTICAL SERVICES

C. LARRY ZURAW

APPENDIX E

DOCUMENTS REVIEWED

W-7375

1.) Waldron, Howard 1962 - *Geology of the Des Moines Quadrangle*, Washington United States Geological Survey, Department of the Interior Map CQ 159

2) Polk's Guide, King County Directory, 1929 to 1990,

3) U.S Environmental Protection Agency (EPA), Region 10 Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) list, hazardous waste sites, King County, 11 March 1991,

4.) Washington State Department of Ecology (WDOE) Leaking Underground Storage Tanks List. February 1991;

5) Washington State Archives, King County Branch.

6) Washington Department of Ecology, Water Well Records

7) Washington Department of Ecology, Registered Underground Storage Tank List.

BP OIL

BP Oil Company
Aetna Bldg Suite 360
2868 Prospect Park Drive
Rancho Cordova California 95670-6020
(916) 631-0733

March 23, 1992

Mr. Joe Hickey
Washington Department of Ecology
Northwest Regional Office
3190 160th Avenue S.E.

RE: BP FACILITY #11255
19924 PACIFIC HIGHWAY SOUTH
SEA-TAC, WASHINGTON 98188

Dear Mr. Hickey,

Attached please find the results of the Subsurface Petroleum Hydrocarbon Evaluation at the above referenced facility.

Please call me at 916/631-6919 with any questions regarding this submission.

Respectfully,

Peter J. DeSantis

Peter J. DeSantis sml
Environmental Resources Management

PJD:sml

Attachment

cc: John Cooper-RZA AGRA, Kirkland, WA
David Baker-Mobil Oil
Site file