SECOR
International Incorporated

November 11, 1999
Project 077.41738.002

Mr. Clint Adler
Alaska Department of Environmental Conservation
610 University Avenue
Fairbanks, Alaska 99709

Re: **Dual Completion SVE/AS Well Installation, Slug Test Results, and Fate and Transport Analysis**
Chevron Service Station 9-4115
11460 Old Seward Highway
Anchorage, Alaska
State Facility ID Number #1784

Dear Mr. Adler:

SECOR International Incorporated (SECOR) has prepared this letter on behalf of Chevron Product Company (Chevron) to document: 1) the installation of four dual completion soil vapor extraction and air sparging wells; 2) the completion of a slug test; and 3) the performance of a fate and transport analysis at the site referenced above (Figures 1 and 2). The purpose of the dual completion wells is to assist in the cleanup of petroleum hydrocarbons that are present in soil and groundwater beneath the site. The purpose of the slug test and the fate and transport analysis was to provide estimated fate and transport properties of the petroleum hydrocarbon impacted groundwater at the site. This work was performed as described in the *Work Plan for Remedial System Installation and Start-up, and Slug Test*, dated April 21, 1999. This work plan was approved by Alaska Department of Environmental Conservation (ADEC), as stated in their letter dated June 7, 1999 (Attachment A).

SITE BACKGROUND

The site is an active service station located on Old Seward Highway in Anchorage, Alaska. Currently, thirteen monitoring wells (MW-1 through MW-13) are present onsite, and two monitoring wells (MW-14 and MW-15) are present offsite. A site plan showing the well locations is included as Figure 1.

Subsurface materials encountered in soil borings previously drilled at the site consisted of silty sand with gravel to depths of 5 to 10 feet below ground surface (bgs). A sand with varying amounts of silt and gravel was encountered from approximately 5 to 10 feet bgs to the total depth explored (55 feet bgs). Depth-to-water in onsite monitoring wells has ranged historically from 41 to 43 feet bgs. Groundwater below the site

unconfined. Generally, the groundwater gradient at the site is approximately 0.014 feet/foot to the north-northwest.

Dissolved BTEX and gasoline range organics (GRO) have historically been detected at the highest concentrations in wells MW-1 and MW-11, located downgradient of the dispenser islands and underground storage tank (UST) complex. Separate phase hydrocarbons (SPH) have been periodically detected in well MW-1.

Previously, SECOR submitted remedial system design plans to ADEC on September 2, 1998. The system design plans illustrate the SVE/AS piping layout and remedial compound design. The remedial piping and remedial compound were installed by Pinnacle Construction between September 1998 and March 1999. In March 1999, SECOR initiated operation of the SVE system. Currently, the SVE system consists of a 5-hp vacuum blower, associated piping, and wells MW-1 and MW-11.

ASSESSMENT ACTIVITIES AND FINDINGS

On June 16, 1999, a slug test was conducted in three of the onsite wells. The purpose of the testing was to estimate hydraulic conductivity of the saturated zone in the area of each of the wells tested. These results will be utilized to estimate flow velocity and travel time to downgradient and crossgradient water supply wells.

On June 29 and June 30, 1999, four SVE/AS wells (SVE/AS 1 through SVE/AS 4) were installed at the site by Discovery Drilling of Anchorage, Alaska. Wells SVE/AS 1 and SVE/AS 2 were drilled to a total depth of 55 feet bgs with the AS well being screened from 53 feet to 55 feet bgs and the SVE well being screened from 20 feet to 45 feet bgs. Wells SVE/AS 3 and SVE/AS 4 were drilled to a total depth of 55 feet bgs with the AS well being screened from 53 feet to 55 feet bgs and the SVE well being screened from 10 feet to 45 feet bgs. Boring Logs showing well completion details are included as Attachment B.

The findings of this assessment are discussed below:

- **Slug Test.** On June 16, 1999 SECOR conducted falling- and rising-head slug tests in three groundwater monitoring wells (MW-7, MW-9 and MW-11) at the site. The testing was performed to establish hydraulic conductivity values for the shallowest portion of the water-bearing zone.

  During the testing, a clean 4-foot-long by 3-1/2-inch-diameter weighted and capped PVC pipe (slug) was used. The slug was inserted into each well casing and lowered beneath the groundwater level to rapidly raise the water level in the well. Changes in hydrostatic pressure as the water level returned to the static level (falling-head test) were recorded with a pressure transducer and data logger. When the water level had stabilized, the slug was removed from the well to rapidly lower the water level in the well. The water level was then recorded over time as it rose to static (rising-head test).

The physical parameters at the time of testing for each well are presented on Table 1. Unconfined flow conditions were determined to exist based on the boring logs. The test data were analyzed by the method of Bouwer and Rice (1976) typically used for unconfined conditions. *Aqtesolv version 2.12* was used to analyze the slug test data. Guidelines for application of the method discussed by Bouwer (1989 and 1996) were used. References are included as Attachment C.

Estimated hydraulic conductivity values ranged from 3.0×10^{-3} to 6.7×10^{-3} centimeters per second. These values are typical for silty to clean sand (Freeze and Cherry, 1979) and are consistent with information presented on the boring logs. The slug testing results are presented in Table 2 and the data are shown graphically in Appendix D.

Values obtained from slug tests provide estimates of hydraulic conductivity in the immediate vicinity of the well. While the values obtained from the six tests are quite similar, it should be noted that the rising-head test results are considered to be the most reliable. The decreased reliability for the falling-head tests results from the fact that the static water level was located in the screened interval, and raising the water level in the well likely induced flow into the unsaturated zone. This condition may result in over-estimation of the hydraulic conductivity from the falling-head test data.

- **Fate and Transport Analysis.** The *Bioscreen modeling package* (U.S. EPA, 1996; Newell et al., 1997) was used to assess potential migration of groundwater constituents from the site. Benzene was used as an indicator for the purposes of the analysis.

  The results of the analysis indicate that benzene concentrations will drop off sharply with distance from the source area. Concentrations are predicted to decrease to 1 ug/l within 600 feet downgradient from the source. Lateral spreading is estimated to be minimal with a decrease to 1 ug/l within approximately 75 feet from the source. The estimated amount of vertical spreading is approximately one-tenth of the lateral spreading as a smaller dispersivity was estimated for the vertical dimension. Based upon the results of this model, benzene concentrations at the nearest water supply well intake should be significantly less than 1 ug/l. (The Alaska State groundwater cleanup level for benzene is 5 ug/l.) Nondetect analytical results collected from the nearby water supply wells (as close as 130 feet downgradient and 60 feet crossgradient of well MW-11) support this conclusion.

  Available site information was used for many of the parameter values within the model. The hydraulic conductivity and gradient were based on slug testing and water level measurement at the site. A first-order decay coefficient was estimated by plotting a line of best fit through the groundwater concentration history data for well MW-11. The source location was taken as the downgradient-most point of groundwater impact (the former drywell). The source strength and decay rate were based on the MW-11 groundwater concentration data as the monitoring well is located close to the former drywell. Other parameter values (porosity, dispersivity

[longitudinal, transverse and vertical], and retardation factor) were based on literature values and selected to provide predictions that were conservatively protective of human health and the environment. The model input parameter values used are indicated in Appendix E.

- **Subsurface Conditions encountered during Well Installation.** Soil encountered in each of the four borings consisted of grayish brown sand that was fine to coarse grained. Some gravelly sand was encountered beneath the site. Groundwater was encountered at approximately 43 bgs.

- **Soil Sampling and Analysis.** Soil samples were collected at 5-foot intervals for logging. Soil samples from 20', 30', and 40-41-1/2' bgs (capillary fringe) were submitted for chemical analysis. Samples were analyzed for gasoline range organics (GRO) by Alaska Method 101, benzene, toluene, ethylbenzene, xylenes (BTEX), and MtBE by EPA Method 8020, volatile organic compounds (HVOCs) by EPA Method 8260B, and polyaromatic hydrocarbons (PAHs) by EPA 8270C. Soil samples collected at 1', 3', 5', 10', 15', 20', 25, 30', and 35'bgs from well SVE/AS 3 were analyzed for geotechnical properties (total organic carbon, dry bulk density, porosity: air filled and water filled, and average soil moisture).

  GRO was reported in one sample (SVE/AS 4 @41.5') at a concentration of 9.69 mg/kg. Benzene was reported in one sample (SVE/AS 2 @41.5') at a concentration of 0.03 mg/kg. Relatively low concentrations of toluene, ethylbenzene, and xylene were reported in each well at the capillary fringe sample. MtBE was reported as nondetect in all samples. Soil analytical results are presented in Table 3. Soil geotechnical data is presented in Table 4. Field and laboratory procedures are presented as Attachment F. Certified analytical reports and chain-of-custody documentation are presented as Attachment G.

- **Stockpiled Soil.** Approximately 8 cubic yards of soil generated during the installation of the wells was stockpiled onsite. Two samples were collected from the stockpiled soil and analyzed for GRO, BTEX, and total lead. Soil was disposed of at Alaska Soil Recycling in Anchorage, Alaska. Stockpiled soil analytical data is presented in Table 5.

SUMMARY OF FINDINGS

- GRO was reported in one sample (SVE/AS 4 @41.5') at a concentration of 9.69 mg/kg. Benzene was reported in one sample (SVE/AS 2 @41.5') at a concentration of 0.03 mg/kg. Toluene, ethylbenzene, and xylene were reported at relatively low

concentrations in each soil sample collected from the capillary fringe zone.

- Slug test results indicate that estimated hydraulic conductivity values for the site range from 3.0×10^{-3} to 6.7×10^{-3} centimeters per second. These values are typical for silty to clean sand and are consistent with the soil types reported in the borings at the site.
- The fate and transport analysis indicates that benzene concentrations will drop off sharply with distance from the source area. Concentrations are predicted to decrease to 1 ug/l within 600 feet downgradient from the source. Lateral spreading is estimated to be minimal with a decrease to 1 ug/l within approximately 75 feet from the source. The estimated amount of vertical spreading is approximately one-tenth of the lateral spreading as a smaller dispersivity was estimated for the vertical dimension. Based upon the results of this model, benzene concentrations at the nearest water supply well intake should be significantly less than 1 ug/l. (The Alaska State groundwater cleanup level for benzene is 5 ug/l.) Nondetect analytical results collected from the nearby water supply wells (as close as 130 feet downgradient and 60 feet crossgradient of well MW-11) support this conclusion.
- Approximately 8 cubic yards of soil generated during the installation of the wells was disposed of at Alaska Soil Recycling in Anchorage, Alaska.

The newly installed SVE wells were connected to the SVE system in August 1999. Gauging and sampling of the onsite groundwater monitoring wells and sampling of the nearby offsite water supply wells is ongoing.

If you have any questions or comments regarding this report, please call us at (916) 364-1880.

Sincerely,
SECOR International Incorporated

Roger Hoffmore
Project Geologist

Greg Barclay
Principal Geologist

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Table 2 - Slug Test Results

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Table 3 - Soil Analytical Data – SVE/AS Wells
Table 4 - Geotechnical Soil Analysis
Table 5 - Soil Analytical Data - Stockpiled Soil
Figure 1 - Site Map
Attachment A - ADEC Letters Dated June 7, 1999
Attachment B - Boring Logs
Attachment C - References
Attachment D - Graphical Representations of the Slug Test Results
Attachment E - Fate and Transport Model Data
Attachment F - Field and Laboratory Procedures
Attachment G - Certified Analytical Reports and Chain-of-Custody Documentation

cc: Mr. Bob Cochran, Chevron Products Company

Table 1
Slug Test Parameters

Chevron Service Station 9-4115
11460 Old Seward Highway
Anchorage, Alaska

Well	Casing Radius (in)	Boring Radius (in)	Screened Interval (ft)	Depth to Water (ft btoc)	Total Well Depth (ft btoc)	Water Producing Thickness (ft)	Aquifer Type
MW-7	2.0	6.0	32 to 52	44.2	49.9	5.6	unconfined
MW-9	2.0	5.0	33 to 52	43.0	51.3	8.2	unconfined
MW-11	2.0	5.0	33 to 52	42.6	51.2	8.5	unconfined

Notes:
1) Abbreviations: in - inches, ft - feet, ft btoc - feet below top-of-casing.
2) Depth To Water and Total Well Depth measured on 6/16/99.
3) Water Producing Thickness taken as diference between Total Well Depth and Depth To Water and used for all depth parameters in the well test analysis.

Table 2
Slug Test Results

Chevron Service Station 9-4115
11460 Old Seward Highway
Anchorage, Alaska

Well	Test Type	Analytical Method	Hydraulic Conductivity (cm/s)
MW-7	Falling Head	Bouwer and Rice	6.7E-03
MW-7	Rising Head	Bouwer and Rice	6.3E-03
MW-9	Falling Head	Bouwer and Rice	3.2E-03
MW-9	Rising Head	Bouwer and Rice	3.7E-03
MW-11	Falling Head	Bouwer and Rice	3.2E-03
MW-11	Rising Head	Bouwer and Rice	3.0E-03

Note: cm/s - centimeters per second.

Table 3
Soil Analytical Data
SVE/AS Well Installation

Chevron Service Station 9-4115
11460 Old Seward Highway
Anchorage, Alaska

Sample Name	Sample Depth (feet bgs)	Date Sampled	GRO (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethly-benzene (mg/kg)	Xylenes (mg/kg)	MTBE (mg/kg)
SVE/AS 1@20'	20	6/29/99	<1.92	<0.02	**0.08**	**0.03**	**0.09**	<0.19
SVE/AS 1@30'	30	6/29/99	<1.53	<0.02	<0.02	<0.02	<0.02	<0.15
SVE/AS 1@40'	40	6/29/99	<2.02	<0.02	**0.09**	**0.04**	**0.17**	<0.20
SVE/AS 2@20'	20	6/29/99	<1.94	<0.02	**0.10**	**0.03**	**0.07**	<0.19
SVE/AS 2@30'	30	6/29/99	<1.71	<0.02	<0.02	<0.02	<0.02	<0.17
SVE/AS 2@41.5'	41.5	6/29/99	<1.69	**0.03**	**0.11**	**0.11**	**0.16**	<0.17
SVE/AS 3@20'	20	6/29/99	<1.27	<0.01	**0.02**	<0.01	<0.01	<0.13
SVE/AS 3@30'	30	6/29/99	<1.54	<0.02	<0.02	<0.02	<0.02	<0.15
SVE/AS 3@41.5'	41.5	6/29/99	<1.98	<0.02	**0.04**	**0.04**	**0.09**	<0.20
SVE/AS 4@20'	20	6/29/99	<1.01	<0.01	<0.01	<0.01	<0.01	<0.10
SVE/AS 4@30'	30	6/29/99	<1.95	<0.02	0.04	<0.02	**0.03**	<0.19
SVE/AS 4@41.5'	41.5	6/29/99	**9.69**	<0.03	**0.19**	**0.06**	**4.51**	<0.25

GRO = Gasoline Range Organics by Alaska Method 101
All samples were analyzed for HVOCs by EPA 8260 and PAHs by EPA 8270.
All analytes were reported as nondetect.
mg/kg = milligrams per kilogram

Table 4
Geotechnical Analysis Results

Chevron Service Station 9-4115
11460 Old Seward Highway
Anchorage, Alaska

Sample Name	Sample Depth	Date Sampled	Soil Moisture Content %	Total Porosity Air-Filled %	Total Porosity Water-Filled %	Dry Bulk Density g/cc	Organic Carbon mg/kg
SVE/AS-3@1'	1	6/29/99	5	14.5	7.1	2.17	18,500
SVE/AS-3@3'	3	6/29/99	4	7.6	15.8	2.09	7,120
SVE/AS-3@5'	5	6/29/99	10	0.02	26.38	1.98	11,300
SVE/AS-3@10'	10	6/29/99	6	33.5	6.7	1.62	1,300
SVE/AS-3@15'	15	6/29/99	5	14.5	10.9	2.05	617
SVE/AS-3@20'	20	6/29/99	3	33.2	8.4	1.59	749
SVE/AS-3@25'	25	6/29/99	1	25.7	3.9	1.93	679
SVE/AS-3@30'	30	6/29/99	3	23.8	9.4	1.82	1,780
SVE/AS-3@35'	35	6/29/99	3	34.1	6.6	1.62	1,240

mg/kg = milligrams per kilogram
g/cc = grams per cubic centimeters
* = Semivolatile Organics by EPA 8270C (all other semivolatile organics were reported as non-detect)
Soil Moisture Content by SM 2540B
Total Porosity, fluid saturation and sample densities by API RP-40
Organic Carbon by SM 5310 B
-- = Sample not tested

Table 5
Soil Analytical Data
Stockpiled Soil

Chevron Service Station 9-4115
11460 Old Seward Highway
Anchorage, Alaska

Sample Name	Date Sampled	GRO (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	Total Lead (mg/kg)
S-1	6/30/99	<1.64	<0.02	0.04	0.03	0.06	5.92
S-2	6/30/99	25	0.1	0.45	0.44	1.82	4.92

GRO = Gasoline Range Organics
mg/kg = milligrams per kilograms

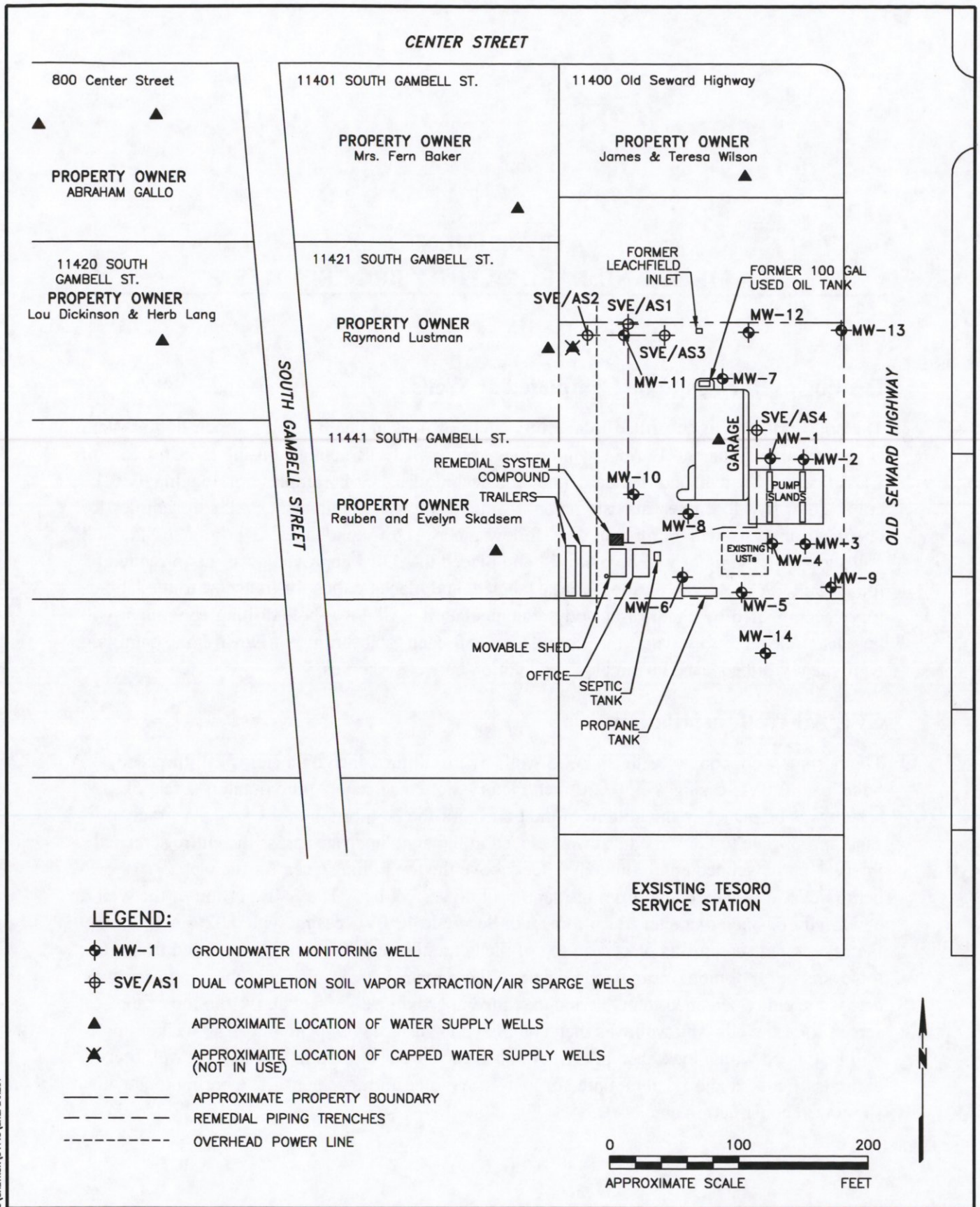

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FIGURE 1

CHEVRON SERVICE STATION #9-4115
11460 OLD SEWARD HIGHWAY AT KLATT ROAD
ANCHORAGE, ALASKA

SITE MAP

ATTACHMENT F
FIELD AND LABORATORY PROCEDURES

Drilling of Borings to be Completed as Wells

The soil borings will be drilled to approximately 55 feet in depth using 10-inch hollow-stem auger drilling equipment. Borings will be logged by a SECOR geologist using the Unified Soil Classification System and standard geologic techniques. Soil samples for logging will be collected at five-foot intervals using a split-spoon sampler or equivalent. All soil samples for chemical analysis will be prepared as follows, per ADEC guidelines: a portion of the soil collected in the sampler will be removed and placed in ADEC approved glass jars provided by the laboratory, preserved as appropriate, labeled, and placed on ice for transport to the laboratory accompanied by chain-of-custody documentation. All down-hole drilling equipment will be steam-cleaned following the completion of each soil boring. Down-hole sampling equipment will be washed in an alconox solution between samples.

SVE/AS Well Installation

The borings were converted to SVE/AS wells by installing 1-inch diameter, flush-threaded, Schedule 40 PVC casing with 0.020-inch factory-slotted screen. Approximately 2 feet of screen was be placed in the bottom of the boring for the AS portion of the well. A grade of sand appropriate to the screen size was placed in the annular space across the entire screened interval, and extended approximately 2 feet above the top of the screen for the well. A bentonite seal was extended from the sand pack to 45 feet bgs. The SVE portion of the well consisted of 2-inch diameter, flush-threaded; Schedule 40 PVC casing with 0.020-inch factory-slotted screen was placed on top of the bentonite seal. The screen extended from 10 to 45 feet bgs. A grade of sand appropriate to the screen size was placed in the annular space across the entire screened interval, and extended approximately 2 feet above the top of the screen for the well. The well was then completed to surface with bentonite. The well casing will be topped with a locking cap. The well head will be contained in a watertight well box, either traffic rated and flush mounted or in a "stove-pipe" arrangement. The boring logs will show well construction details

Soil Sampling

Soil samples were collected by advancing 2 1/2-inch-diameter split spoon into undisturbed soil, reached through the center of the auger. Soil samples for chemical analysis were retained in an ADEC approved glass jar, labeled, preserved if necessary and capped. The samples were then sealed in zip-lock bags, placed on ice, and transported to the laboratory accompanied by the appropriate chain-of-custody documentation.

Soil Sampling for Stockpiled Soil

Soil samples were collected by placing soil into an ADEC approved glass jar, labeled, preserved if necessary and capped, after removing approximately 6 inches to 1 foot of surface material in the sample location. Two samples were collected per approximately 50 cubic yards of soil. The samples were then sealed in zip-lock bags, placed on ice, and transported to the laboratory accompanied by the appropriate chain-of-custody documentation.

Laboratory Analysis for Soil Samples

Analysis of GRO was performed by Alaska Method 101. Benzene, toluene, ethylbenzene, xylenes (BTEX compounds), and MtBE were performed by EPA 8020. Volatile and Semivolatile Organics were performed by EPA 8270C and EPA 8260B, respectively. Analysis for lead was done using EPA method 6010A.

References:

Bouwer, H., and R.C. Rice. 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells. Water Resources Research, 12(3), 423-428.

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C.J. Newell, R.K. McLeod and J.R. Gonzales. Bioscreen Natural Attenuation Decision Support System, Version 1.4 Revisions. U.S. EPA Center for Subsurface Modeling Support web page (http://www.epa.gov/ada/bioscreen.html). July 1997.

Freeze, R.A. and J.A. Cherry. 1979. Groundwater. Prentice-Hall, Englewood Cliffs, NJ. 604 pp.

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