**BP OIL**

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

April 23, 1990

Mr. Rafat Shahid
County of Alameda
Department of Environmental Health
470 27th St., Room 324
Oakland, CA 94612

RE: BP OIL FACILITY #11266
1541 PARK STREET
ALAMEDA, CA
(MOC #10-EYD)

Dear Mr. Shahid:

Please find enclosed results of BP Oil Company's Phase II site assessment completed in March of 1990 by EMCON Associates.

Results indicate localized area, roughly fourty (40) feet in diameter of high dissolved phase hydrocarbon contamination of groundwater. In addition, an as yet unidentified, non-fuel volitile organic compound was detected in one monitoring well. Our next round of quarterly sampling will include 8240 analysis of this groundwater to indentify the unknown compound. Results of this report are now being incorporated into a work plan for remedial actions at this facility.

After reviewing the enclosed, please contact me with any questions or recommendations you may have with regard to the next phase of this project.

Sincerely,

W.J. Hollis
Environmental Coordinator

WJH:dj

Enclosure

cc: Scott Hugenberger
Regional Water Quality Control Board
1111 Jackson St., Room 6000
Oakland, CA 94607

David Noe
Mobil Oil Corporation
3800 West Alameda Ave., #700
Burbank, CA 95105-4331

J.R. Rocco 19-5505-L
BP Oil Company
Cleveland, OH

EMCON
ASSOCIATES
Consultants in Wastes
Management and
Environmental Control

March 15, 1990
Project C90-04.06

Mr. W.J. Hollis
B.P. Oil Company
2868 Prospect Drive, Suite 360
Rancho Cordova, California 95670-6020

Re: Phase II Site Assessment
Report, Service
Station 11266, Alameda,
California
1541 PARK ST

Dear Mr. Hollis:

This letter report presents the results of a Phase II Site Assessment performed at B.P. Oil Company (BP) Service Station 11266, located at 1541 Park Street, Alameda, California (see Figure 1). The scope of work was outlined in the October 26, 1989 Workplan for Environmental Services submitted earlier to BP by EMCON Associates (EMCON).

Petroleum hydrocarbon-impacted soil and ground water were identified during removal of the fuel tanks in 1987. Following the tank removal, EMCON performed environmental services to characterize the lateral and vertical extent of impacted soil and ground water. Because this initial work was relatively successful in defining the plume dimensions, the scope of work was modified to confirm and expand on the data previously acquired.

This report includes site history, site hydrogeology, subsurface geology, and regional land and water use. To confirm the extent of impacted ground water and to collect aquifer data necessary for evaluation of remediation options, the following field tasks were undertaken. The results are summarized in this report.

- Ground-water samples were collected with a direct-push ground-water sampling probe and submitted for chemical analysis.
- Ground-water samples from existing wells were collected and analyzed.
- Pumping tests were performed.

## BACKGROUND

The tank removal and initial site assessment were conducted by Kaprealian Engineering Incorporated (KEI) in September 1987. KEI reported on the removal of three gasoline tanks (5,000-, 6,000-, and 8,000-gallon capacities) and one waste oil tank (250-gallon capacity). The excavations for the fuel tanks were approximately 12 feet deep. Soil and water from these excavations were analyzed for total petroleum hydrocarbons as gasoline (TPH gas), TPH as diesel, and benzene, toluene, xylenes, and ethylbenzene (BTXE). Soil from the waste oil tank excavation was analyzed for gravimetric waste oil as petroleum oil (GWO) and for TPH as diesel. Certified analytical results revealed that soil and ground water were impacted by TPH gas (3,200 parts per million [ppm] and 530 ppm, respectively). Soil from the waste oil tank excavation contained 150 ppm GWO and no detectable TPH as diesel (<10 ppm).

These analytical results prompted the installation of three on-site ground-water monitoring wells by KEI in March 1988 (see Figure 2). The 2-inch-diameter wells (MW-1, MW-2, and MW-3) were installed to a depth of 25 feet. Analysis of ground water from these wells indicated a limited lateral extent of impacted ground water. MW-1 contained 95 ppm TPH gas, but in MW-2 and MW-3 no petroleum hydrocarbons were detected. KEI implemented a quarterly ground-water monitoring program at the site. Levels of TPH gas and BTXE decreased over a 1-year period in MW-1, and no petroleum hydrocarbons were detected in the other two wells.

In March 1989, KEI was contracted to install three more monitoring wells (MW-4, MW-5, and MW-6) to define the limits of impacted ground water. These additional wells were constructed identically to the previous wells. Soil and ground-water samples from these locations did not contain detectable levels of petroleum hydrocarbons.

## FIELD ACTIVITIES

Since data from existing ground-water monitoring wells appeared to define adequately the extent of petroleum hydrocarbon-impacted ground water, field activities performed by EMCON were limited to

- collecting and analyzing ground-water samples from the six existing wells
- using a direct-push ground-water sampling method to confirm the lateral extent of the plume
- surveying the elevations of the monitoring wells to obtain accurate ground-water elevations for defining the water table
- performing pumping tests to determine aquifer characteristics for evaluating potential remediation options

Ground-water samples collected from the on-site wells and from on-site and off-site direct-push ground-water sample localities were analyzed for TPH and BTXE. The samples collected from the ground-water monitoring wells (MW-1 through MW-6) were submitted to a state-certified laboratory for chemical analysis. Ground-water sampling and analysis procedures for these samples are described in Attachment A, and the certified analytical results are included in Attachment B. Tracer Research Corporation (Tracer) was contracted to perform a ground-water screening survey. Three direct push ground-water samples (B-1, B-2, and B-3 in Figure 6) were collected with a soil-gas probe and were analyzed on site by means of a gas chromatograph. Ground-water samples were also collected from wells MW-2 and MW-6 (B-6 and B-4, respectively), analyzed in the field, and the analyses compared with the state-certified laboratory results. For details on the sampling and analysis procedures, see the Tracer report in Attachment C.

## FINDINGS

### Hydrogeologic Setting

Alameda lies on the east side of San Francisco Bay and is separated from Oakland by a tidal canal. The City of Alameda is underlain by Holocene sand, silt, and clay. Elevations in the site vicinity are less than 30 feet. The site elevation is

22 feet above mean sea level (MSL) and was surveyed with respect to a nearby United States Geologic Survey (USGS) benchmark.

Previous work by KEI indicates that the site is underlain entirely by poorly graded, fine- to medium-grained sand to a depth of at least 25 feet (see Figure 3). KEI sampled the soil only at depths of 5 and 10 feet in each of the six borings they drilled.

## Ground-Water Elevation, Gradient, and Flow Direction

EMCON measured water levels on November 28, 1989 before purging and sampling the six existing wells. These measurements and the pertinent data from the topographic survey are presented in Table 1. The well elevations were surveyed to establish reference points for constructing an accurate map of the ground-water elevation, hydraulic gradient, and flow direction (see Figure 4). Ground water flows east at a relatively low gradient (0.007) (toward the tidal canal). Previous reports by KEI (1988, 1989) have indicated an east-northeast flow direction; however, it is uncertain what effects the tides may have on ground-water elevation and flow direction.

## Water Well Survey

Existing wells within a 2,000-foot radius of the site were surveyed for potential ground-water receptors. The data presented in Figure 5 and in Table 2 reveal the general distribution of water supply wells registered with the Alameda County Flood Control and Water Conservation District. There are 14 wells within the 2,000-foot radius: 10 irrigation wells, 2 industrial wells, 1 domestic well, and 1 abandoned well. Four of these are downgradient from the site.

## Plume Characterization

EMCON's interpretation of the extent of the petroleum hydrocarbon plume is based on the analyses of ground-water samples (see Table 1). The benzene concentrations are plotted on the general site plan in Figure 6 and are used to delineate the extent of the dissolved petroleum hydrocarbon plume. Benzene concentrations indicate that the plume is laterally limited to a diameter of approximately 80 feet. The plume is most concentrated near the source and diminishes to nondetectable levels within 40 feet from MW-1 in any direction. **Analytical results of sampling from wells MW-2 and MW-4 suggest that an unknown volatile compound(s) occurs in the ground water.**

## Hydraulic Testing

EMCON performed a series of hydraulic tests to characterize the hydraulic properties of the local aquifer. For the purpose of remediation, estimates of aquifer transmissivity and hydraulic conductivity were used to predict the zone of influence (capture) relative to an extraction well. The hydraulic tests included a step-drawdown test, a constant-discharge test, and recovery tests. Presented below is the methodology employed to conduct the various tests, followed by a discussion of the results.

A step-drawdown test and 24-hour constant-discharge test were conducted at well MW-5 to determine the zone of influence for long-term extraction and to obtain an average discharge rate for use in designing a site ground-water remediation system. The test consisted of five parts: (1) baseline water-level measurements, (2) step-drawdown pumping, (3) water-level recovery, (4) constant-discharge pumping, and (5) a final water-level recovery. Pumping well MW-5 and observation well MW-4, located within 40 feet of the pumping well, were monitored continuously with pressure transducers and a data logger. A 7,000-gallon discharge tank held the discharge water that was pumped from the well during the tests. All equipment was steam-cleaned before and after testing.

### Step-Drawdown Test

The step-drawdown test enables the well's efficiency and a sustainable pumping rate for the constant-discharge test to be determined. During the step-drawdown test, the pumping rate was increased at approximately 1/2-hour time intervals. Each step was performed until drawdown within the well stabilized. Three steps were performed: (1) at 0.9 gallon per minute (gpm) for 30 minutes, (2) at 1 gpm for 30 minutes, and (3) at 1.4 gpm for 2.5 minutes. The water level in the pumping well was monitored and recorded in the field with a pressure transducer/datalogger system and an electric water-level sounder. Depth-to-water data versus time were plotted in the field to determine the optimal pumping rate for the constant discharge pumping test. A flow rate of 0.9 gpm was determined to be optimal. Recovery was monitored until the aquifer had recovered to approximately 90 percent of its original level.

### Constant-Discharge Test

A 17-hour constant-discharge test was conducted following the step-drawdown test and water-level recovery. The pumping rate of 0.9 gpm was expected to stress the water-bearing zone without dewatering the well during testing. Although no drawdown occurred in the observation well during the test, the pumping well approached the point of dewatering and never stabilized. In fact, data indicate a potential hydrologic barrier. After pumping ceased, water-level recovery was monitored. The recovery test was monitored in the field with a pressure transducer and an electric well sounder.

Depth-to-water versus time data from each test were plotted for all wells monitored and are displayed in Figures 7 through 10. Drawdown and recovery data are included in the analysis. Standard methods of analysis could not be used to evaluate the drawdown data because the well was inefficient (high hydraulic head losses through the screen and sand pack). The transmissivity was estimated by using the specific capacity from the step-drawdown tests. Transmissivity values calculated from the step-drawdown test were approximately 240 gallons per day per foot (gpd/ft) with a hydraulic conductivity of $7.6 \times 10^{-4}$ centimeters per second (cm/sec). Applying the straight-line solution (Theis 1935) to the recovery data derived from the step-drawdown and constant-discharge tests yielded transmissivity values of 340 gpd/ft and 400 gpd/ft, respectively, and hydraulic conductivity values of $7.6 \times 10^{-4}$ and $1.3 \times 10^{-3}$ cm/sec, respectively. The results are presented in Table 3. Average values calculated for the transmissivity and hydraulic conductivity are 330 gpd/ft and $1.1 \times 10^{-3}$ cm/sec, respectively.

### Capture Zone Calculations

A capture zone calculated for that part of the aquifer underlying the BP site provided the zone for remediating the benzene plume centered near monitoring well MW-1. The capture zone of an extraction well is the region of the aquifer that produces inflow into the well. The capture zone boundary is defined by the ground-water streamlines dividing the region producing inflow from the region that does not produce inflow to the extraction well. The size of the capture zone can be expressed as the distance from the extraction well to the capture zone boundary, measured perpendicularly to the regional ground-water flow direction. The capture zone is therefore a function of the hydraulic gradient, ground-water flow direction, aquifer transmissivity, and the extraction well discharge rate. Using the hydraulic properties determined from the hydraulic testing and an extraction flow rate of 0.5 gpm, a capture zone of approximately 40 feet was calculated (see Figure 4).

**From the calculated capture zone, it is indicated that the majority of the benzene plume will be captured by one extraction well located at or near MW-1. The entire plume could be captured if an extraction well were installed approximately 10 feet east of well MW-1.**

## CONCLUSIONS

Previous environmental assessments at this site revealed that the soil and ground water were impacted by a release from the fuel tanks, which have since been replaced. No free petroleum product was observed, and the impacted ground water was shallow, occurring near the base of the tank excavation at a depth of 10 to 12 feet.

Based on the results of this Phase II Site Assessment and review of previous work, the following is concluded:

- **The lateral extent of impacted ground water is limited to the area near well MW-1, as delineated by the absence of petroleum hydrocarbons in wells MW-2 through MW-6.**
- Since ground water is shallow, occurring near the base of the tank excavation, vadose soil contamination is not an issue.
- The closest potential receptors of the impacted ground water (water supply wells and the Airport Channel tidal canal located downgradient of the site) are presently beyond the delineated extent of the petroleum hydrocarbon plume.

- **Results of hydraulic testing of the aquifer revealed that a ground-water extraction well located near well MW-1 would provide an area of influence (capture zone) sufficient to capture the entire petroleum hydrocarbon plume when pumping at an optimal extraction flow rate of 0.5 gpm.**

If you have questions, please call.

Very truly yours,

EMCON Associates

Justin Bradley

Justin D. Bradley
Project Geologist

RSCramer

Richard S. Cramer
Project Manager
R.G. 4337

TL/RSC:djv

Attachments: Table 1 - Summary of Ground-Water Elevation and Chemistry Data
Table 2 - Water Producing Wells Within 2,000 Feet of Site
Table 3 - Summary of Hydraulic Testing Data
Figure 1 - Site Location
Figure 2 - Site Plan
Figure 3 - Cross Section A-A'
Figure 4 - Ground-Water Contours
Figure 5 - Well Survey
Figure 6 - Dissolved Benzene Concentration Contours and Capture Zone
Figure 7 - Step-Discharge Test Data
Figure 8 - Step-Test Recovery Data
Figure 9 - MW-5 Constant-Discharge Test
Figure 10- Constant-Discharge Pumping Recovery Data
Attachment A - Ground-Water Sampling and Analysis
Attachment B - Certified Analytical Reports
Attachment C - Ground-Water Screening Survey Report

## Table 1

## SUMMARY OF GROUND-WATER ELEVATION AND CHEMISTRY DATA (µg/l, ppb)

| Well | Sample Date | Depth to Ground Water (ft) | Top-of-Casing Elevation (ft-msl) | Ground-Water Elevation (ft-msl) | TPH Gas | Benzene | Toluene | Xylenes | Ethylbenzene |
|---|---|---|---|---|---|---|---|---|---|
| MW-1 | 11/28/89 | 9.77 | 22.63 | 12.86 | 15,000 | 280 | 880 | 1,200 | 340 |
| MW-2 | 11/28/89 | 10.25 | 22.75 | 12.50 | 170 [1] | <5.7 [2] | <1 | <3 | <1 |
| MW-3 | 11/28/89 | 10.72 | 23.45 | 12.73 | <50 | <0.5 | <1 | <3 | <1 |
| MW-4 | 11/28/89 | 10.41 | 23.63 | 13.22 | <50 [1] | <0.5 | <1 | <3 | <1 |
| MW-5 | 11/28/89 | 9.83 | 22.87 | 13.04 | <50 | <0.5 | <1 | <3 | <1 |
| MW-6 | 11/28/89 | 10.30 | 22.85 | 12.55 | <50 | <0.5 | <1 | <3 | <1 |
| B-1* | 11/15/89 | NM | -- | -- | 3 | <0.6 | 2 | <0.8 | 0.6 |
| B-2* | 11/15/89 | NM | -- | -- | 3 | <0.6 | 2 | <0.8 | 1 |
| B-3* | 11/15/89 | NM | -- | -- | 14 | <0.6 | 1 | <0.8 | 13 |
| B-4 | 11/15/89 | NM | -- | -- | 12 | <0.6 | 5 | <0.8 | <0.6 |
| B-5 | 11/15/89 | NM | -- | -- | 4 | <0.6 | 2 | <0.8 | <0.6 |

---

1. An unknown, discrete, volatile, non-fuel hydrocarbon was observed.

2. Raised detection limit due to unknown volatile component.

* Direct push ground-water samples

NM = Not measured

## Table 2

## WATER PRODUCING WELLS WITHIN 2,000 FEET OF SITE

| County Well Number | Date Drilled | Well Depth (feet) | Casing Diameter (inches) | Usage |
|---|---|---|---|---|
| T2S/R3W-7L-1 | NA | 90 | NA | Abandoned |
| T2S/R3W-7L-2 | NA | NA | 4 | Irrigation |
| T2S/R3W-7M-1 | 04/77 | 72 | 6 | Industrial |
| T2S/R3W-7M-2 | 04/77 | 82 | 6 | Industrial |
| T2S/R3W-7N-1 | NA | 206 | NA | Irrigation |
| T2S/R3W-7Q-1 | 09/77 | 28 | 5 | Irrigation |
| T2S/R3W-7Q-8 | 07/88 | 60 | 10 | Irrigation |
| T2S/R3W-18D-1 | 05/77 | 20 | 6 | Irrigation |
| T2S/R4W-12J-1 | 08/77 | 29 | 6 | Irrigation |
| T2S/R4W-12R-1 | NA | 325 | 10 | Domestic |
| T2S/R4W-12R-2 | 02/77 | 19 | 4 | Irrigation |
| T2S/R4W-12R-3 | 02/77 | 19 | 4 | Irrigation |
| T2S/R4W-12R-4 | 05/77 | 30 | 6 | Irrigation |
| T2S/R4W-13A-1 | 02/77 | 20 | 4 | Irrigation |

NA = Information not available

Table 3

## SUMMARY OF HYDRAULIC TESTING DATA

| Test Well | Test | Method | Transmissivity (gpd/ft) | Aquifer Thickness (feet) | Hydraulic Conductivity (cm/sec) |
|---|---|---|---|---|---|
| MW-5 | Step-Drawdown | Specific Capacity | 240[1] | 15 | $7.6 \times 10^{-4}$ |
| | Step-Drawdown Recovery | Theis | 340 | 15 | $1.3 \times 10^{-3}$ |
| | Constant Discharge | Jacob and Cooper | 80 | 15 | $2.5 \times 10^{-4}$ |
| | Recovery | Theis | 400 | 15 | $1.1 \times 10^{-3}$ |
| | Average[2] | | 330 | 15 | $1.1 \times 10^{-3}$ |

---

1. Average value calculated from step 1 and step 2.

2. Did not use constant-discharge value due to pumping well inefficiencies.

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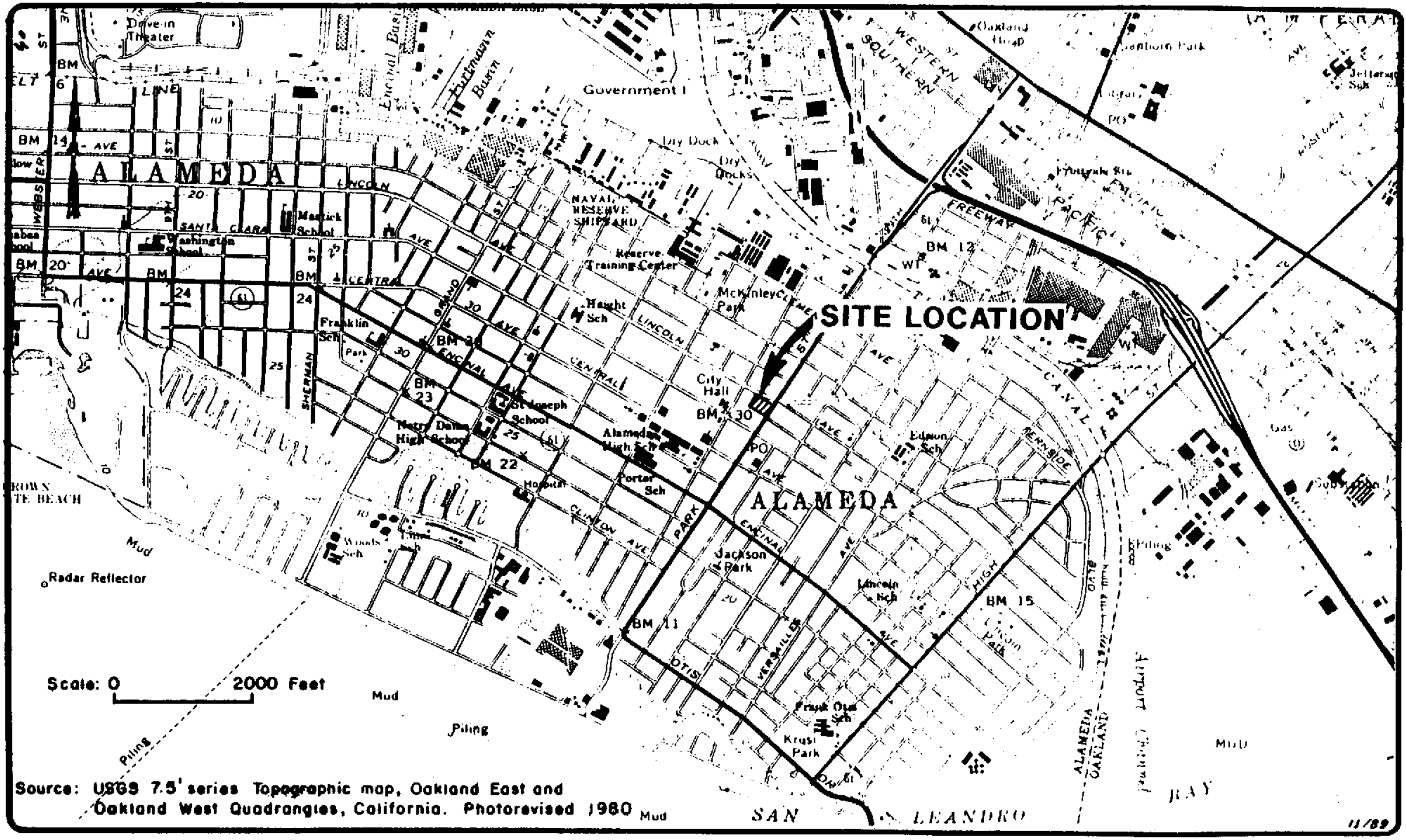

Source: USGS 7.5' series Topographic map, Oakland East and Oakland West Quadrangles, California. Photorevised 1980

**EMCON Associates**

BP OIL CORPORATION
SERVICE STATION No. 11266
SITE ASSESSMENT
ALAMEDA, CALIFORNIA

SITE LOCATION

FIGURE
1
PROJECT NO
C90-04 06

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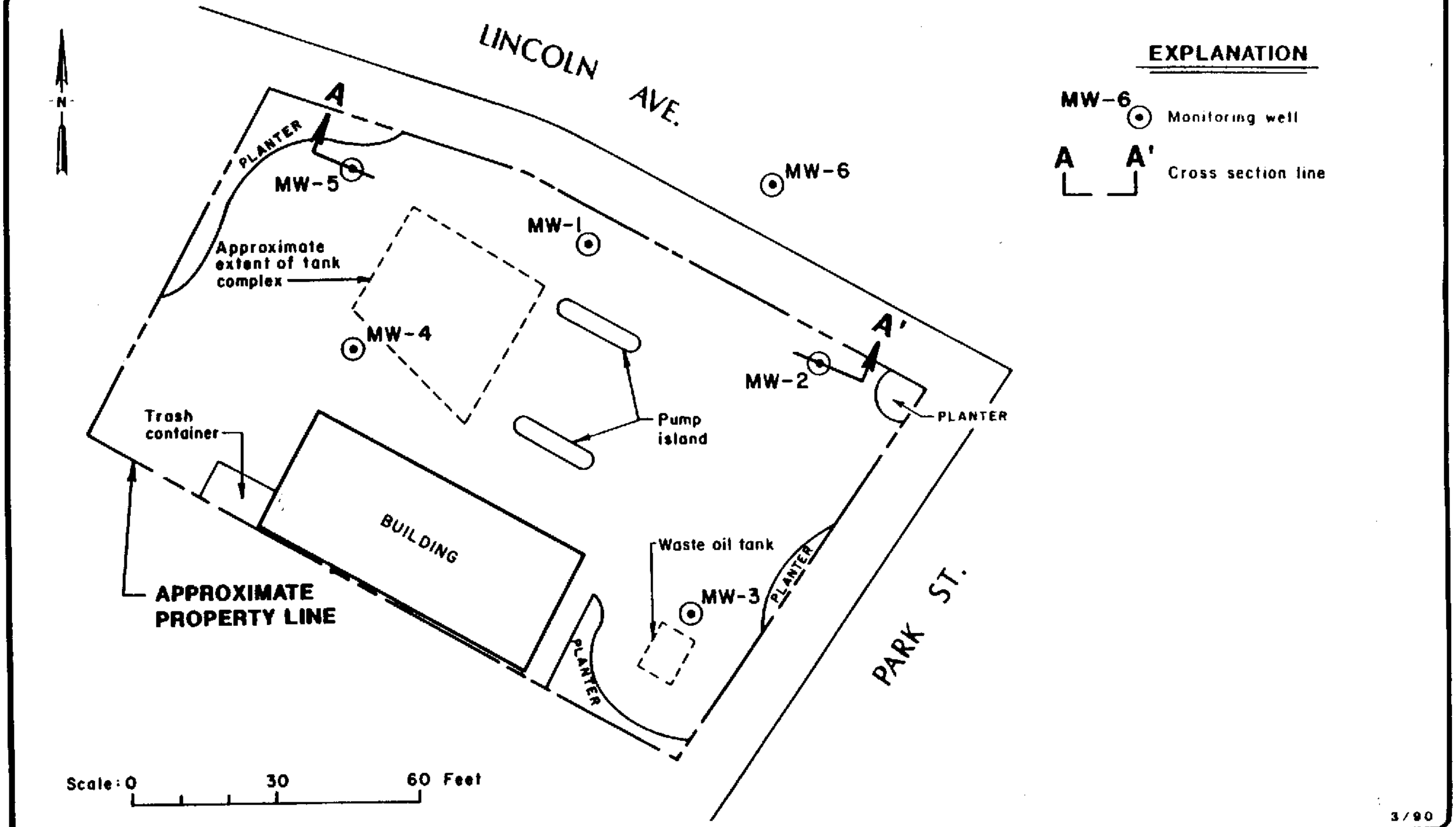

3/90

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SERVICE STATION No. 11266
SITE ASSESSMENT
ALAMEDA, CALIFORNIA

SITE PLAN

FIGURE 2

PROJECT NO
C90-04.06

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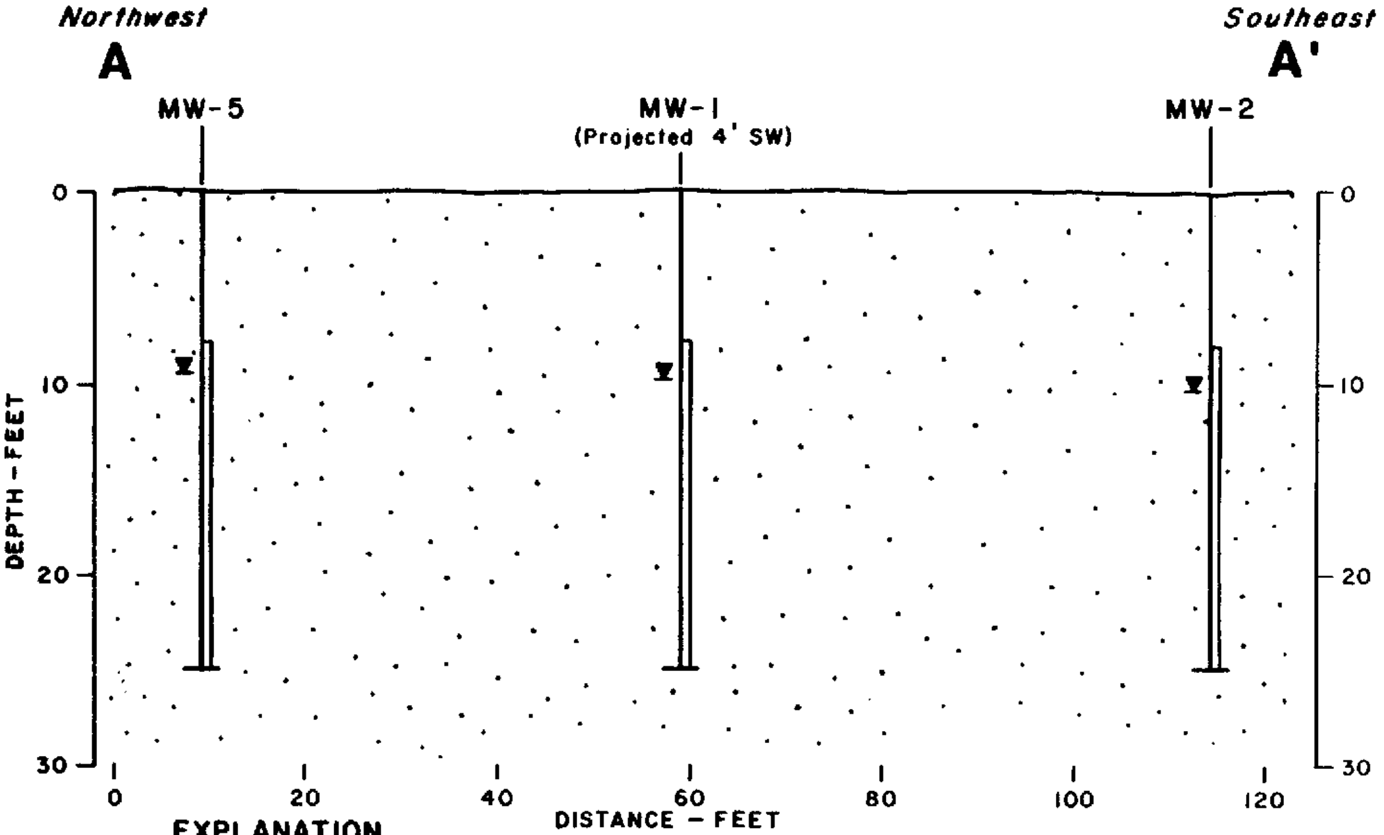

## EXPLANATION

⁚ Poorly graded sand (SP) (based on logs by KEI)

MW-1 — Well designation

(Projected 4' SW) — Projected distance and direction from well to cross section line

Cased borehole

Depth to ground water measured Nov. 1989

Perforated interval

Bottom of well

***NOTE:***
*See Figure 2 for section location.*

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SERVICE STATION No. 11266
SITE ASSESSMENT
ALAMEDA, CALIFORNIA

CROSS SECTION A-A'

FIGURE
3
PROJECT NO
C90-04.06

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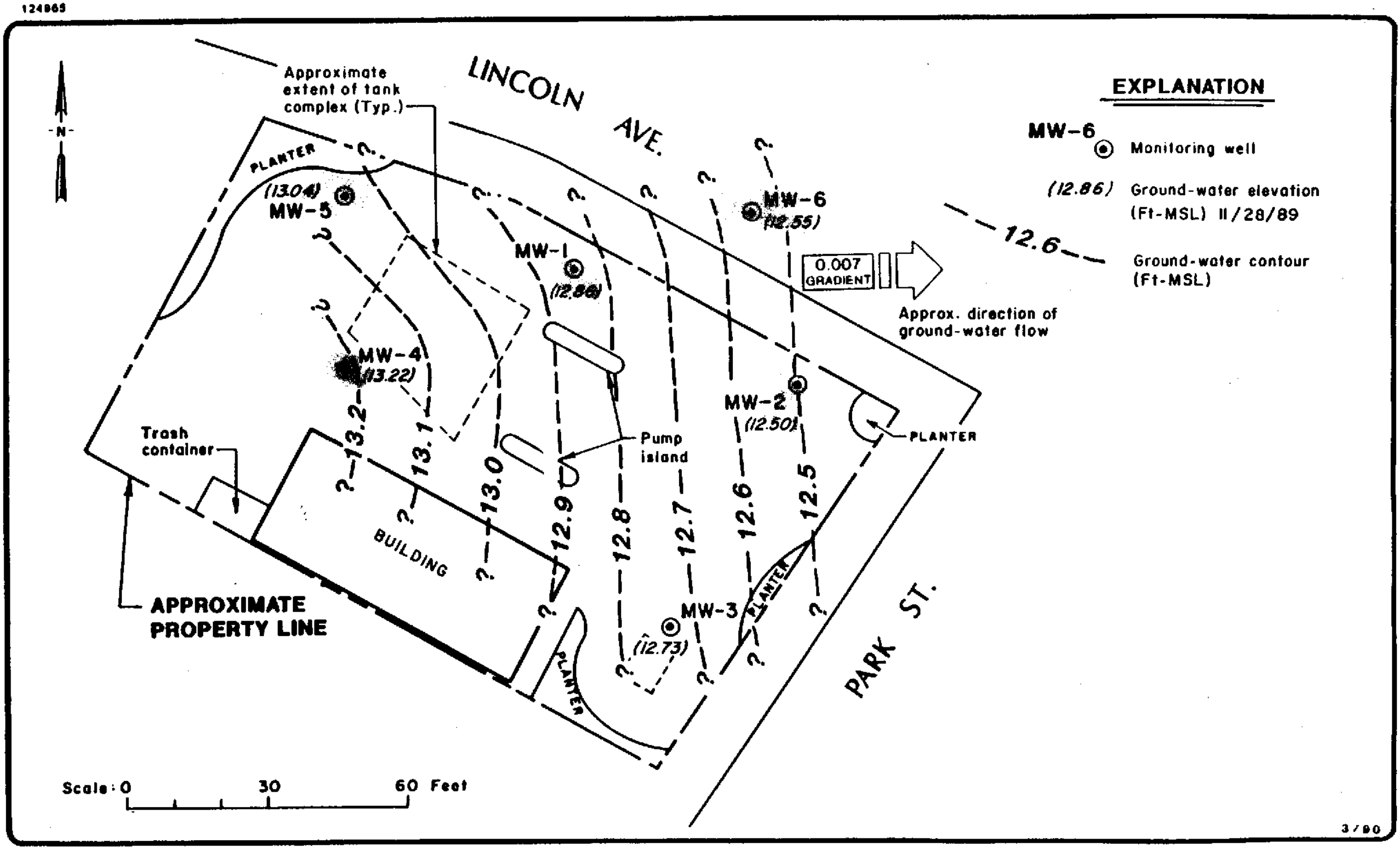

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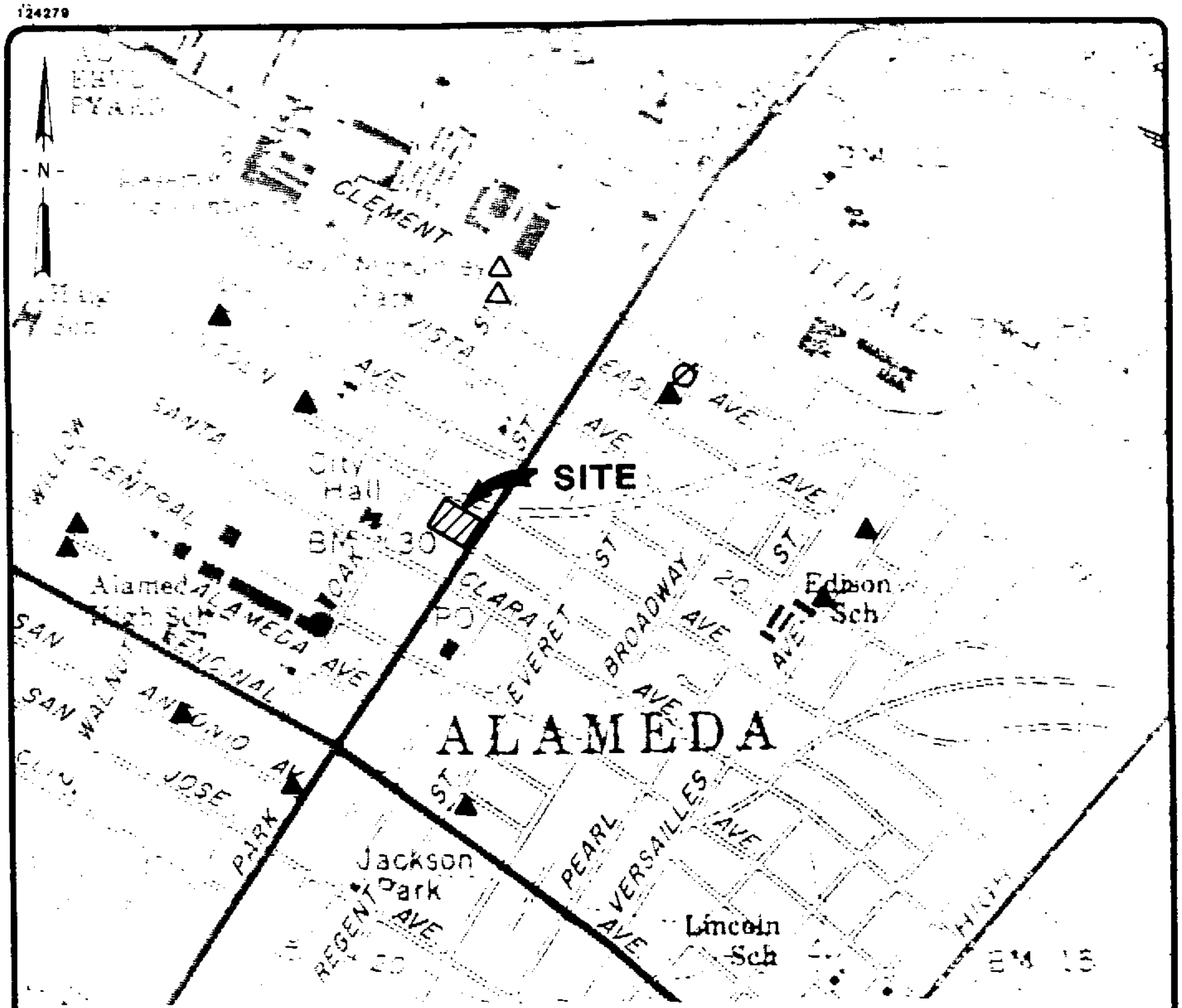
SERVICE STATION No. 11266
SITE ASSESSMENT
ALAMEDA, CALIFORNIA

GROUND - WATER CONTOURS
NOVEMBER 1989

FIGURE
4
PROJECT NO
C90 - 04.06



Base map enlarged from U.S.G.S. 7.5 minute Topographic Series, Oakland East Quadrangle, 1959, photorevised 1980; Scale 1:24000.

## EXPLANATION

● Domestic well

▲ Irrigation well

△ Industrial/municipal well

Ø Abandoned well

Scale: 0 1,000 2,000 Feet

1/90

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SERVICE STATION No. 11266
SITE ASSESSMENT
ALAMEDA, CALIFORNIA

WELL SURVEY

FIGURE
5
PROJECT NO.
C90-04.06

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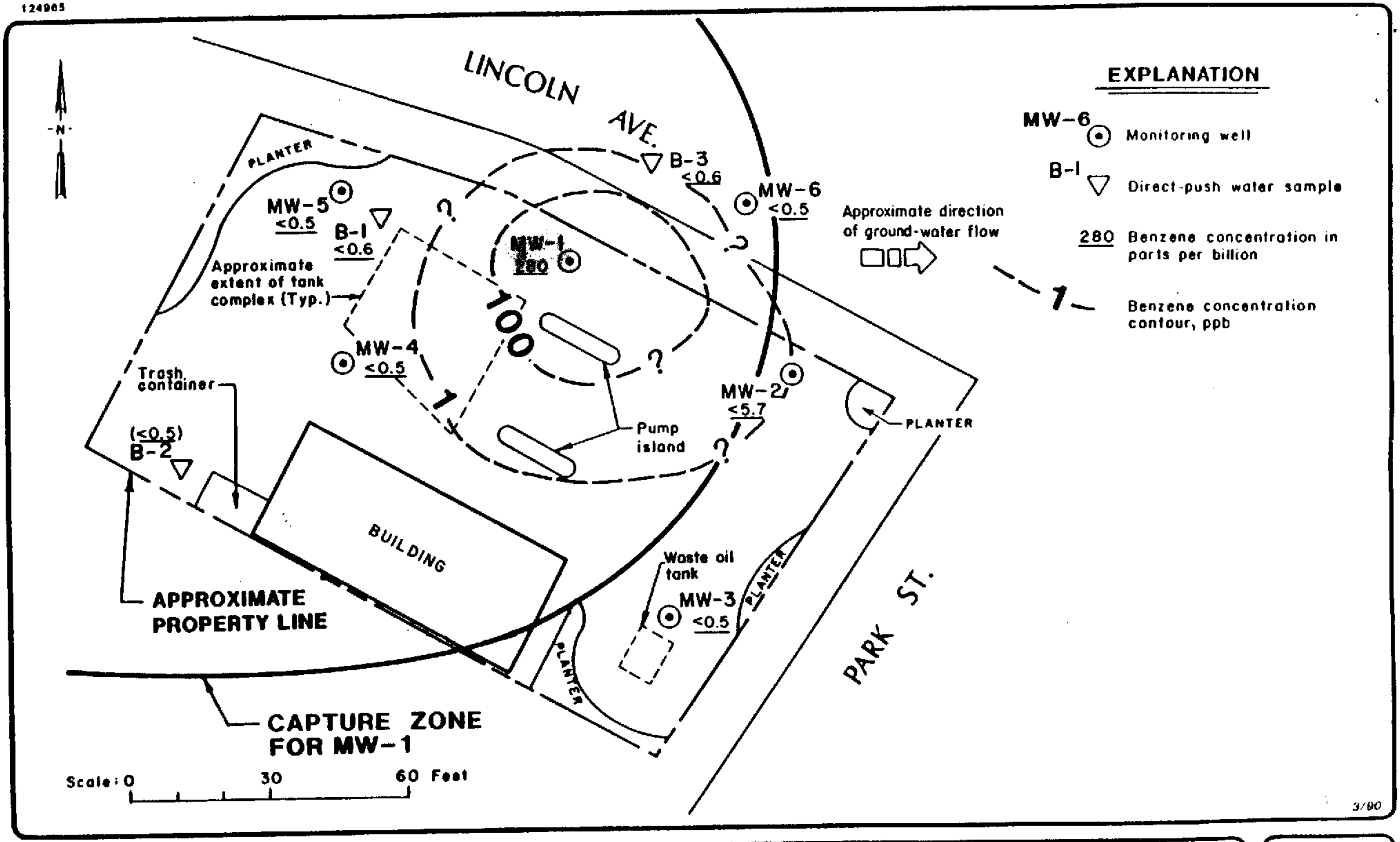

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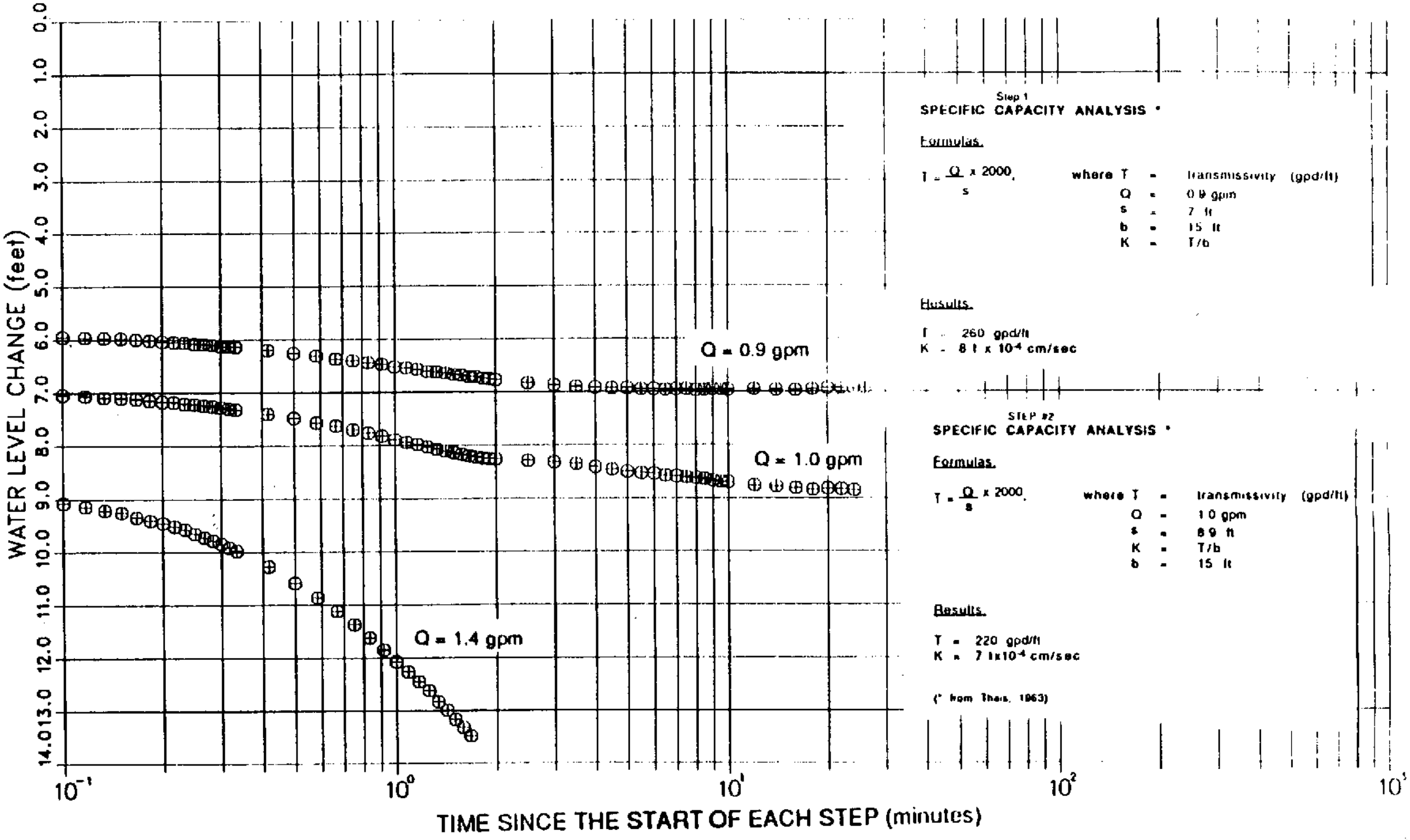
SITE ASSESSMENT
ALAMEDA, CALIFORNIA

DISSOLVED BENZENE CONCENTRATION CONTOURS
AND CAPTURE ZONE

FIGURE
6
PROJECT NO.
C90-04.06



Step 1
**SPECIFIC CAPACITY ANALYSIS ***

Formulas.

$T = \frac{Q}{s} \times 2000$, where T = transmissivity (gpd/ft)
Q = 0.9 gpm
s = 7 ft
b = 15 ft
K = T/b

Results.

T = 260 gpd/ft
K = 8.1 x $10^{-4}$ cm/sec

STEP #2
**SPECIFIC CAPACITY ANALYSIS ***

Formulas.

$T = \frac{Q}{s} \times 2000$, where T = transmissivity (gpd/ft)
Q = 1.0 gpm
s = 8.9 ft
K = T/b
b = 15 ft

Results.

T = 220 gpd/ft
K = 7.1x$10^{-4}$ cm/sec

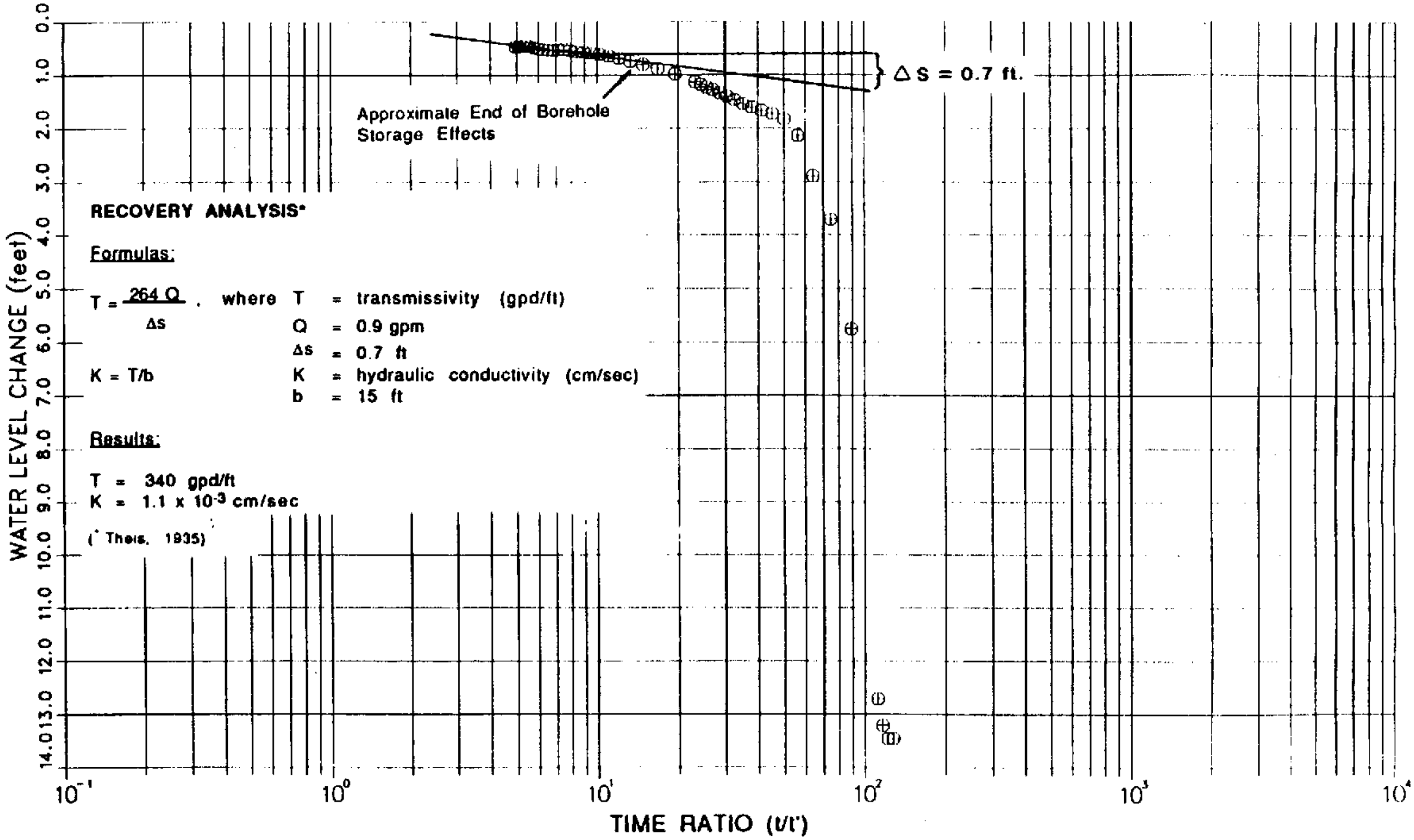
(* from Theis, 1963)

**EMCON Associates**

BP OIL COMPANY
Service Station No. 11266
ALAMEDA, CA.

STEP -DISCHARGE TEST DATA - WELL MW-5

Figure
**7**
PROJECT NO
690-04.04



**RECOVERY ANALYSIS***

**Formulas:**

$T = \frac{264\,Q}{\Delta s}$, where T = transmissivity (gpd/ft)
Q = 0.9 gpm
$\Delta s$ = 0.7 ft
K = T/b K = hydraulic conductivity (cm/sec)
b = 15 ft

**Results:**

T = 340 gpd/ft
K = $1.1 \times 10^{-3}$ cm/sec

(* Theis, 1935)

**EMCON Associates**

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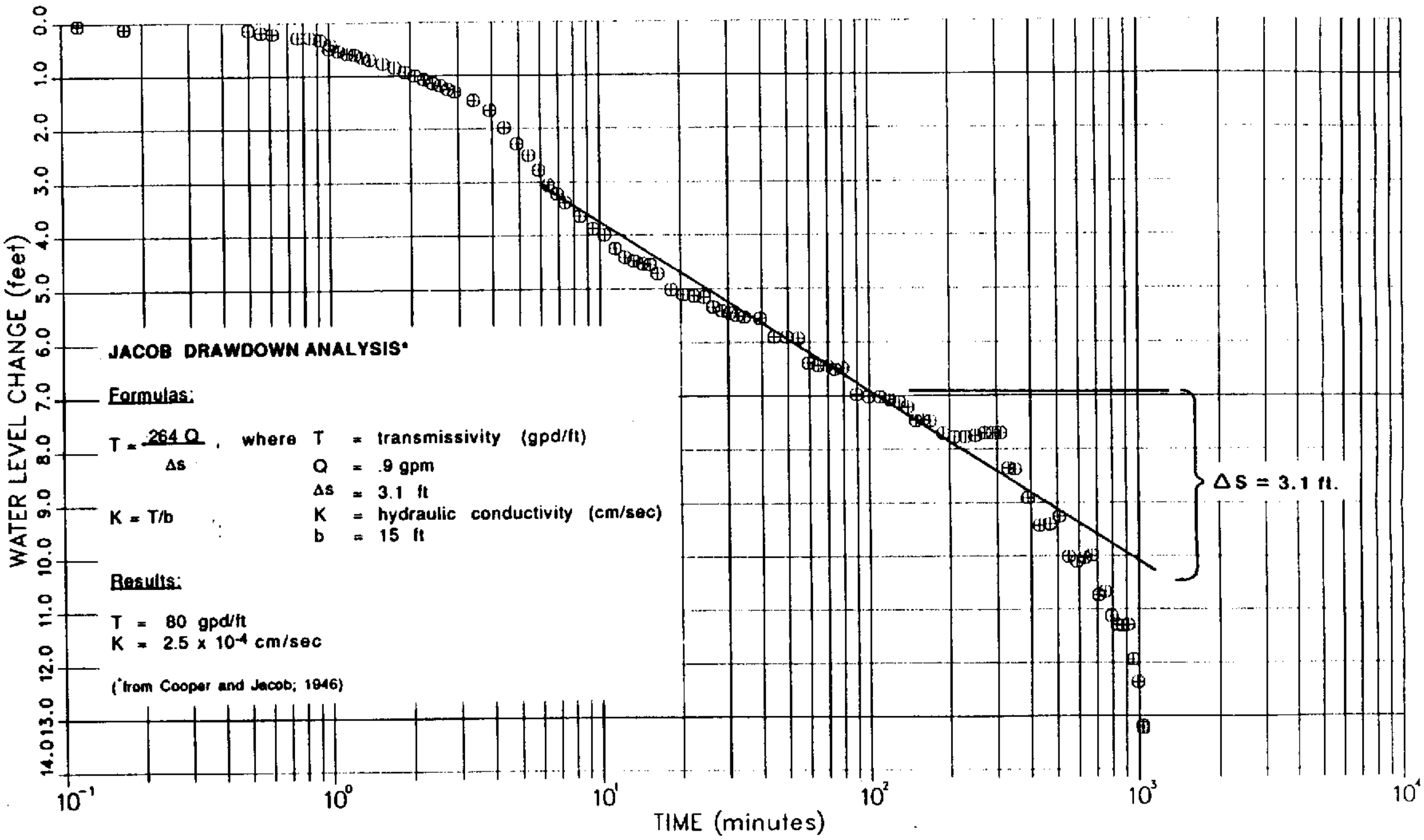
Service Station No. 11266
ALAMEDA, CA.

STEP-TEST RECOVERY DATA - MW-5

Figure
**8**

PROJECT NO.
[illegible]



**JACOB DRAWDOWN ANALYSIS***

**Formulas:**

$T = \frac{264\,Q}{\Delta s}$, where T = transmissivity (gpd/ft)
Q = .9 gpm
Δs = 3.1 ft
K = T/b
K = hydraulic conductivity (cm/sec)
b = 15 ft

**Results:**

T = 80 gpd/ft
K = $2.5 \times 10^{-4}$ cm/sec

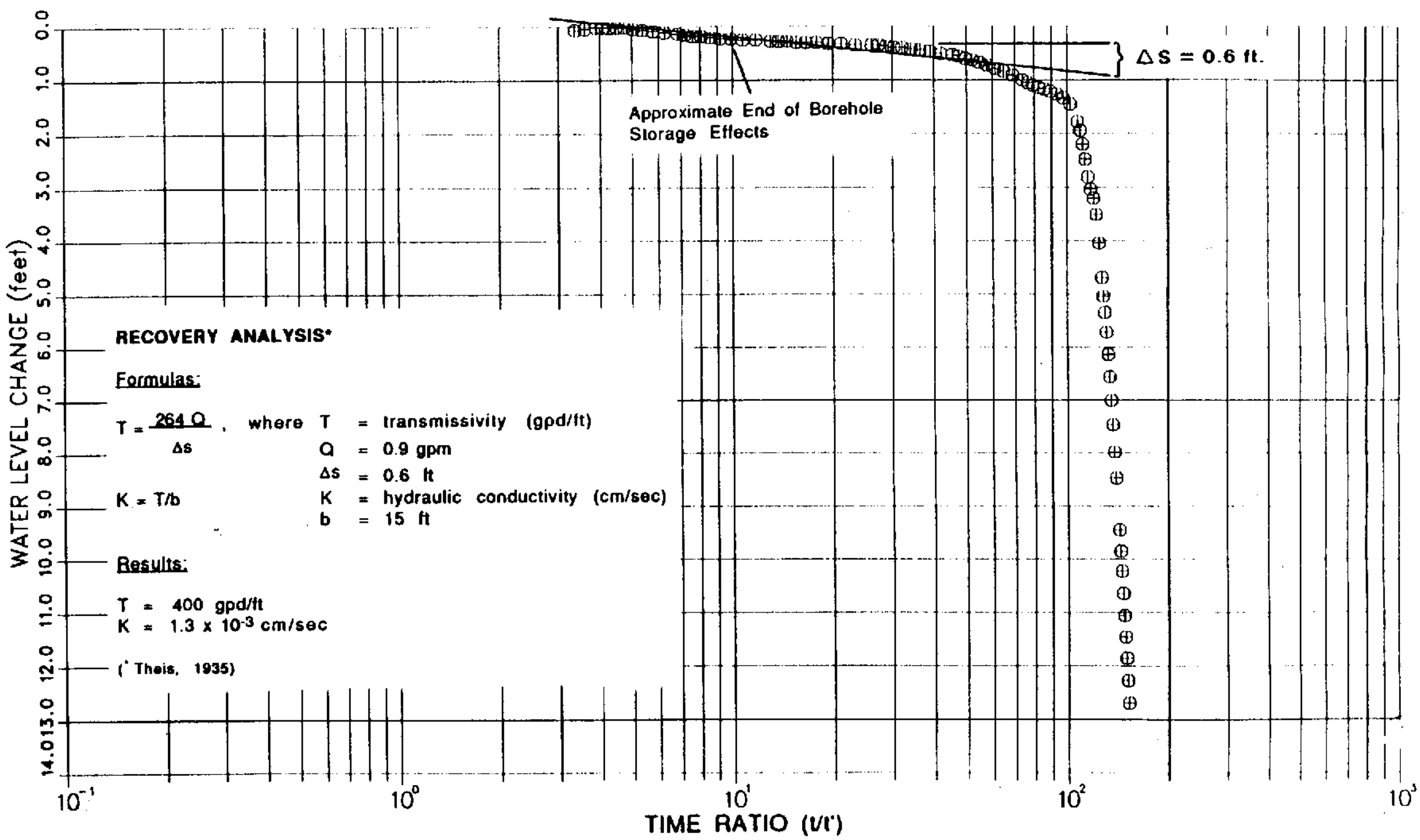
(*from Cooper and Jacob; 1946)

**EMCON Associates**

BP OIL COMPANY
Service Station No. 11266
ALAMEDA, CA.

MW-5 CONSTANT DISCHARGE TEST

Figure
9
PROJECT NO.
[illegible]



**RECOVERY ANALYSIS***

Formulas:

$T = \frac{264\,Q}{\Delta s}$ , where T = transmissivity (gpd/ft)

Q = 0.9 gpm

$\Delta s$ = 0.6 ft

K = T/b

K = hydraulic conductivity (cm/sec)

b = 15 ft

Results:

T = 400 gpd/ft

K = $1.3 \times 10^{-3}$ cm/sec

(* Theis, 1935)

**EMCON Associates**

BP OIL COMPANY
Service Station No. 11266
ALAMEDA, CA.

CONSTANT–DISCHARGE PUMPING RECOVERY DATA – WELL MW–5

Figure
**10**
PROJECT NO.
0907-04.04

## Attachment A:

# GROUND-WATER
# SAMPLING AND ANALYSIS

# SAMPLING AND ANALYSIS PROCEDURES

## INTRODUCTION

The sampling and analysis procedures for water-quality monitoring programs are contained in this appendix. The procedures will ensure that consistent and reproducible sampling methods are used; proper analytical methods are applied; analytical results are accurate, precise, and complete; and the overall objectives of the monitoring program are achieved.

The following documents have been used as guidelines for the development of these procedures:

- *Procedures Manual for Ground-Water Monitoring at Solid Waste Disposal Facilities* (EPA-530/SW-611, August 1977)
- *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document* (OSWER 9950.1, September 1986)
- *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA SW-846, 3rd edition, November 1986)
- *Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater* (EPA-600/4-82-057, July 1982)
- *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020, revised March 1983)

## SAMPLE COLLECTION

Sample collection procedures include equipment cleaning, water level and well total depth measurements, and well purging and sampling.

### Equipment Cleaning

Sample bottles, caps, and septa used in sampling for volatile and semivolatile organics will be triple rinsed with high-purity deionized water. After rinsing, sample bottles will be dried overnight at a temperature of 200°C. Sample caps and septa will be drilled overnight at a temperature of 60°C. Sample bottles, caps, and septa will be protected from all forms of solvent contact between drying and actual use at the sampling site. All sampling containers will be used only once and discarded after analysis is complete.

Plastic bottles and caps used in sampling for metals will be soaked overnight in a 1-percent nitric acid solution. Next, the bottles and caps will be triple rinsed with deionized water. Finally, the bottles and caps will be air dried before being used at the site. All plastic bottles and caps will be constructed of linear polyethylene or polypropylene. All sampling containers will be used only once and discarded after analysis is complete.

Before starting the sampling event, all equipment that will be placed in the well or come in contact with ground water will be disassembled and cleaned thoroughly with detergent water, and then steam-cleaned with deionized water. Any parts that may absorb contaminants, such as plastic pump valves, bladders, etc., will be cleaned as described above or replaced. The inside surfaces of the positive displacement (bladder) pump tubing will be cleaned by healing the tubing overnight at 120°C with a low-flow, inert air source.

Once the bladder pump is cleaned and reassembled, a pump blank will be obtained by pumping organic-free water through the bladder pump assembly. The pump effluent will be sampled and analyzed by EPA Method 601 or EPA Method 602. The pump effluent analysis results must be below the method reporting limit for each parameter before the pump is taken to the site for use.

During field sampling, all equipment surfaces that are placed in the well or contact ground water will be steam-cleaned with deionized water before purging or sampling the next well.

Water Level, Floating Hydrocarbon, and Well Total Depth Measurements

Before purging and sampling, the depth to water, floating hydrocarbon thickness, and the well total depth will be measured using an electric sounder and a bottom-filling, clear Teflon® bailer. Alternately, an oil-water interface measuring system may be used to record floating hydrocarbon thickness and depth to water. The electric sounder is a transistorized instrument that uses a reel-mounted, two conductor, coaxial cable that connects the control panel to the sensor. Cable markings are stamped at 1-foot intervals. The water level will be measured by lowering the sensor into the monitoring well. A low current circuit is completed when the sensor contacts the water, which serves as an electrolyte. The current is amplified and fed into an indicator light and audible buzzer, signaling when water has been contacted. A sensitivity control compensates for very saline or conductive water. The electric sounder will be decontaminated by rinsing with deionized water after each use. The bailer will be lowered to a point just below the liquid level, retrieved, and inspected for floating hydrocarbon.

The oil-water interface measuring system consists of a sonic probe that emits a continuous audible tone when immersed in a nonconductive fluid, such as oil or gasoline, and an intermittent tone when immersed in a conductive fluid, such as water. The floating hydrocarbon thickness and water level will be measured by lowering the sonic probe into the well. Liquid levels will be recorded relative to the tone emitted at the ground surface. The sonic probe will be decontaminated by rinsing with deionized water after each use.

All liquid measurements will be recorded to the nearest 0.01 foot in the field logbook. The ground-water elevation at each monitoring well will be calculated by subtracting the measured depth to water from the surveyed elevation of the top of the well casing. (Every attempt will be made to measure depth to water for all wells on the same day.) Well total depth is then measured by lowering the sensor to the bottom of the well. Well total depth, used to calculate purge volumes and to determine whether the well screen is partially obstructed by silt, will be recorded to the nearest 0.5 foot in the field logbook.

## Well Purging

Before sampling, standing water in the casing and gravel pack will be purged from the monitoring well using a bladder pump, pneumatic displacement pump, or Teflon® bailer. Monitoring wells will be purged according to the protocol presented in Figure A-1. In most monitoring wells, the amount of water purged before sampling will be greater than or equal to four casing volumes. Some monitoring wells are expected to be evacuated to dryness after the removal of less than four casing volumes. The low-yield monitoring wells will be allowed to recharge for up to 24 hours. Samples will be taken as soon as the monitoring wells have recharged to a level sufficient for sample collection. If insufficient water has recharged after 24 hours, the monitoring well will be recorded as dry for the sampling event.

All field measurements will be recorded in a waterproof field logbook. Figure A-2 shows an example of the Water Sample Field Data Sheet on which field data are recorded. Field data sheets will be reviewed by the sampling coordinator after the sampling event is completed.

The pH, specific conductance, and temperature meter will be calibrated each day before beginning field activities. The calibration will be checked once each day to verify meter performance. All field meter calibrations will be recorded on a Field Meter Log Form (see Figure A-3).

## Well Sampling

A Teflon® bailer or bladder pump will be the only equipment acceptable for well sampling. When collecting samples for volatile organic analysis with a bladder pump, the pump flow will be regulated to approximately 100 milliliters per minute to minimize pump effluent turbulence and aeration. Glass bottles of at least 40 milliliters volume and fitted with Teflon®-lined septa will be used in sampling for volatile organics. These bottles will be filled completely to prevent air from remaining in the bottle. A positive meniscus forms when the bottle is completely full. A convex Teflon® septum is placed over the positive meniscus to eliminate air. After capping, the bottle is inverted and tapped to verify that it contains no air bubbles. The sampling containers for other parameters will be filled, filtered as required, and capped.

When required, dissolved concentrations of metals will be determined using appropriate field filtration techniques. When a Teflon® bailer is used, the sample will be filtered by emptying the contents of the bailer into a pressure transfer vessel. A disposable 0.45-micro acrylic copolymer filter will be threaded onto the transfer vessel at the discharge point and the vessel will be sealed. Pressure will be applied to the vessel with a hand pump and the filtrate will be directed into the appropriate containers. Each filter will be used once and discarded.

When a bladder pump is used to collect samples for dissolved constituents, filtering will be performed by attaching a disposable 0.45-micron acrylic copolymer filter directly to the pump effluent line with a pressure fitting. As the pump cycles, the effluent will be pressured through the filter and directed into the appropriate containers. Each filter will be used once and discarded.

## SAMPLE PRESERVATION AND HANDLING

The following section specified sampling containers, preservation methods, and sampling handling procedures.

### Sample Containers and Preservation

Sample containers vary with each type of analytical parameter. Container types and materials will be selected to be nonreactive with the particular analytical parameter tested.

### Sampling Handling

All sample containers will be labeled immediately following collection. Samples will be kept cool with cold packs until received by the laboratory. Cold packs will be replaced each day to maintain refrigeration. At the time of sampling, each sample will be logged on a Chain-of-Custody Record which will accompany the sample to the laboratory.

Samples are transferred from the site to EMCON's laboratory by the sampling team. Upon receipt of the samples by EMCON laboratory personnel, a unique sample identification number will be assigned to each sample container. This number will be recorded on the Chain-of-Custody Record and will be used to identify the sample in all subsequent internal chain-of-custody and analytical records. Sample shipment from EMCON to laboratories performing the selected analyses routinely occurs within 24 hours of sample receipt. EMCON's laboratory manager will ensure that the holding times for requested analyses are not exceeded.

## SAMPLE DOCUMENTATION

The following procedures will be used during sampling and analysis to provide chain-of-custody control during sample handling from collection through storage. Sample documentation will include the use of the following:

- Field logbooks to document sampling activities in the field
- Labels to identify individual samples
- Chain-of-custody record sheets for documenting possession and transfer of samples
- Laboratory analysis request sheets for documenting analyses to be performed

## Field Logbook

In the field, the sampler will record the following information on the Water Sample Field Data Sheet (see Figure A-2) for each sample collected:

- Project number
- Client name
- Location
- Name of sampler
- Date and time
- Well accessibility and integrity
- Pertinent well data (e.g., casing diameter, depth to water, well depth)
- Calculated and actual purge volumes
- Purging equipment used
- Sampling equipment used
- Appearance of each sample (e.g., color, turbidity, sediment)
- Results of field analyses (temperature, pH, specific conductance)
- General comments

The field logbooks will be signed by the sampler.

## Labels

Sample labels will contain the following information:

- Project number
- Sample number (i.e., well designation)
- Sampler's initials
- Date and time of collection
- Type of preservative used (if any)

### Sampling and Analysis Chain-of-Custody Record

The Sampling and Analysis Chain-of-Custody Record (see Figure A-4), initiated at the time of sampling, contains, but is not limited to, the well number, sample type, analytical request, date of sampling, and the name of the sampler. The record sheet will be signed, times, and dated by the sampler when transferring the samples. Custody transfers will be recorded for each individual sample; for example, if samples are split and sent to more than one laboratory, a record sheet will accompany each sample. The number of custodians in the chain of possession will be kept to a minimum. A copy of the Sampling and Analysis Chain-of-Custody Record is returned to EMCON with the analytical results.

### Ground-Water Sampling and Analysis Request

A Ground-Water Sampling and Analysis Request (see Figure A-5) and/or purchase order will accompany the samples delivered to each laboratory. These requests serve as official communication to the laboratory of the particular analysis(es) required for each sample and provide evidence that the chain-of-custody is complete.

At minimum, the Ground-Water Sampling and Analysis Request includes the following information:

- Date submitted
- Submitted analytical parameters
- Well number
- Sample source

## ANALYTICAL METHODS

Samples collected as part of the proposed monitoring programs will be analyzed in accordance with accepted analytical procedures. The following publications are the primary references for analytical procedures:

- *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020, revised March 1983)
- *Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater* (EPA-600/4-82-057, July 1982)
- *Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods* (EPA SW-846, 3rd edition, November 1986)
- *Leaking Underground Fuel Tank (LUFT) Manual*, State Water Resources Control Board, State of California Leaking Underground Fuel Tank Task Force, May 1988

The laboratories selected to perform the analytical work will be certified by the Department of Health Services (DHS) for Hazardous Waste Testing.

## QUALITY CONTROL

Quality assurance measures will be taken to confirm the integrity of the field and laboratory data generated during the monitoring program. The procedures used to assess data quality are described in this section. An evaluation of the field and laboratory quality assurance data will be included in the technical reports.

### Field Quality Assurance Procedures

Field quality assurance procedures will be included in each monitoring event and includes the documentation of field instrument calibration and collecting and analyzing trip blanks, field blanks, and duplicate samples. Split samples may also be included in the monitoring program.

#### Trip and Field Blanks

Trip and field blanks will be used during the sampling events to detect contamination introduced through sampling procedures, external field conditions, sample transportation, container preparation, sample storage, and the analytical process.

Trip blanks will be prepared at the same time and location as the sample containers for a particular sampling event. Trip blanks will accompany these containers to and from that event, but will at no time be opened or exposed to the atmosphere. One trip blank for volatile organic parameters will typically be included per sampling event.

Field blanks will be prepared in the same manner as trip blanks but will be exposed to the ambient atmosphere at a specified monitoring point during sample collection to determine the influence of the external field conditions on sample integrity. One field blank for volatile organic parameters will typically be included per day of sampling.

#### Duplicate Samples

Duplicate samples will be collected to document field precision. For each sampling event, duplicate monitoring well samples will be collected at a specified frequency, typically 5 percent. Where possible, field duplicates will be taken at sampling points known or suspected to contain constituents of interest. Duplicates will be packed and shipped "blind" to the laboratory for analysis with the samples from that particular event (i.e., these samples will not exhibit any special markings indicating that they are quality control samples).

## Laboratory Quality Assurance Procedures

Laboratory quality assurance procedures will include those required under the DHS Hazardous Waste Testing Program. Specific laboratory quality assurance procedures are included in their laboratory QA manual, including reporting surrogate recoveries, matrix spike recoveries, and matrix spike duplicate (or duplicate) results.

Method blanks will be analyzed daily to assess the effect of the laboratory environment of the analytical results. Method blanks will be performed for each parameter analyzed.

Each sample to be analyzed for organic parameters will contain surrogate spike compounds. The surrogate recoveries will be used to determine if the analytical instruments are operating within limits. Surrogate recoveries will be compared to control limits established and updated by the laboratory based on its historical operation.

Matrix spikes will be analyzed at a frequency of approximately 10 percent. Matrix spike results will be evaluated to determine whether the sample matrix is interfering with the laboratory analysis and provide a measure of the accuracy of the analytical data. Matrix spike recoveries will be compared to control limits established and updated by the laboratory based on its historical operation.

Laboratory duplicates will be analyzed at a frequency of approximately 10 percent. Spike duplicate results will be evaluated to determine the reproducibility (precision) of the analytical method. Reproducibility values will be compared to control limits established and updated by the laboratory based on its historical operation.

Laboratory QA data will be included with the analytical results. This QC data will include method blanks, surrogate spike recoveries (for organic parameters only), matrix spike recoveries, and matrix spike duplicates.

Figure A-1

# MONITORING WELL PURGING PROTOCOL

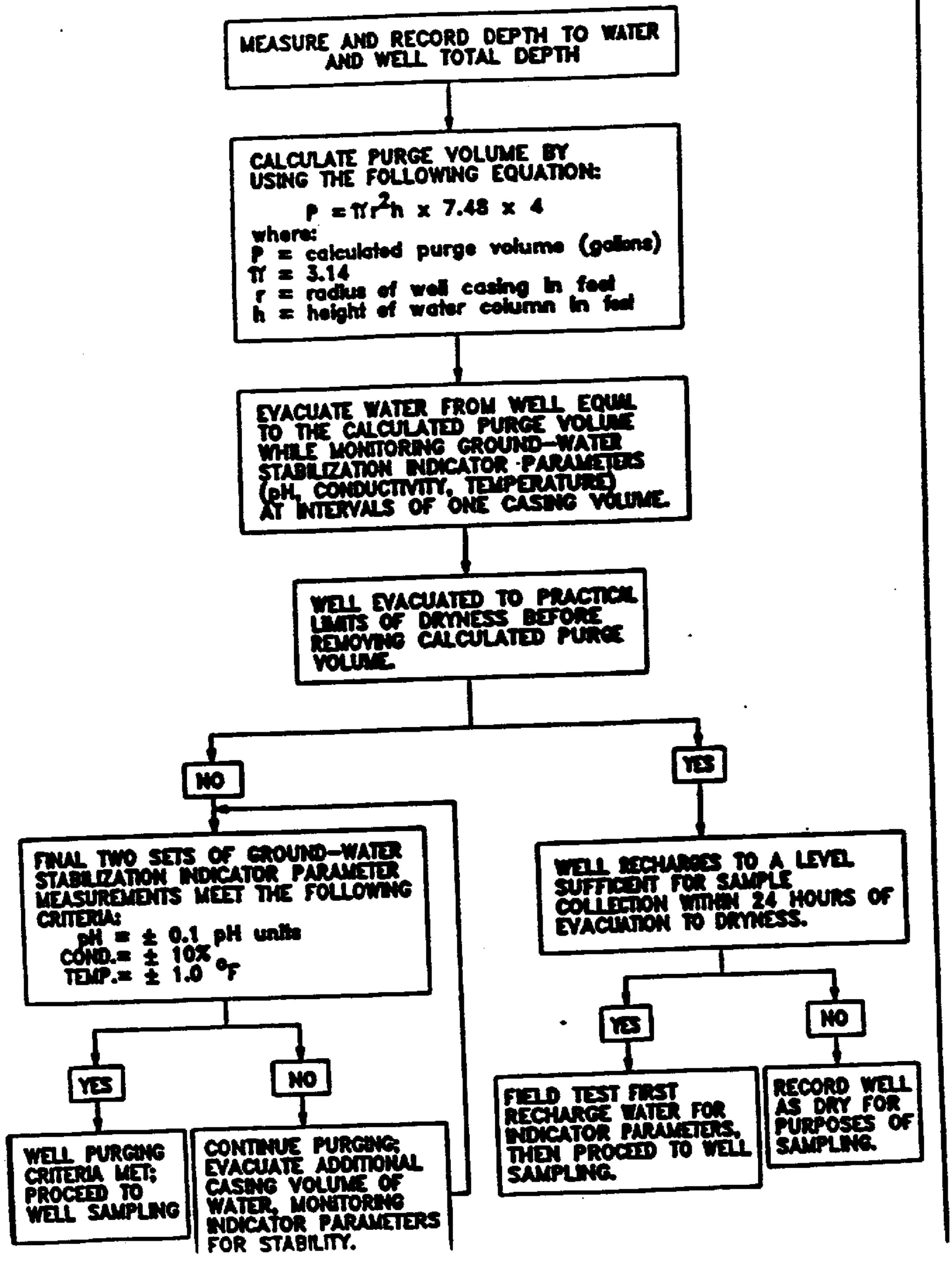


Figure A-2

# WATER SAMPLE FIELD DATA SHEET

EMCON ASSOCIATES

PROJECT NO.: ____________

SAMPLE ID.: ________ ________ ________

CLIENT: ____________

DATE: ____________

LOCATION: ____________

SAMPLE POINT DESIGNATION: ________

SAMPLER: ____________

GROUND-WATER ___

OTHER (NR) ____________________

CASING DIAMETER: 2 inch___ 3 inch___ 4 inch___ 6 inch___ OTHER________

CASING ELEVATION (feet/MSL): ________

CALCULATED PURGE VOL. (gal.): ________

DEPTH OF WELL (feet): ____________

ACTUAL PURGE VOL. (gal.): ________

DEPTH TO WATER (feet): ____________

## FIELD MEASUREMENTS

| TIME | VOLUME (gal.) | PH (units) | E.C. (umhos/cm @ 25°C) | TEMPERATURE (°F) | COLOR (visual) | OTHER |
|---|---|---|---|---|---|---|
| | | | | | | |
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ODOR: ____________

## PURGE METHOD

___2" BLADDER PUMP ___BAILER (Teflon) ___WELL WIZARD ___DEDICATED

___SUBMERSIBLE PUMP ___BAILER (PVC) ___CENTRIFUGAL PUMP ___OTHER________

___PERISTALTIC PUMP ___DIPPER ___PNEUMATIC DISPLACEMENT PUMP

## SAMPLE METHOD

___2" BLADDER PUMP ___BAILER (Teflon) ___WELL WIZARD ___DEDICATED

___SURFACE SAMPLER ___BAILER (PVC) ___DIPPER ___OTHER________

___PERISTALTIC PUMP ___SUBMERSIBLE PUMP

WELL INTEGRITY: ____________________

REMARKS: ____________________

Figure A-3

# FIELD METER LOG

| | | TEMPERATURE | | pH RESULTS | | | | | | SPECIFIC CONDUCTIVITY | | | D.I. WATER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ATE | METER # | THERMOMETER NBS | METER | READ 7 | CALIB. 7 | READ 10 | CALIB. 10 | READ 4 | CALIB. 4 | STD. | READ STD. | CALIB. STD. | SPEC. COND. |
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Figure A-4

**EMCON ASSOCIATES**
1921 Ringwood Avenue
San Jose, California 95131
(408) 453-7300

|  |  |
|---|---|
| **CONTENT :** | **SAMPLER :** |
| **SOURCE :** | **PROJECT NO :** |
| **SITE :** | **DATE :** |
| **CLIENT CONTACT :** | **QUANTITY :** |
| **EXPECTED REMOVAL DATE :** | **DRUM ID :**____________ |

Figure A-5

# SAMPLING AND ANALYSIS CHAIN OF CUSTODY RECORD

PROJECT NO ____________ SAMPLE TYPE ____________ EMCON LABORATORY NO ____________

| Sample Information | | | Bottle Information | | | | Lab Information | |
|---|---|---|---|---|---|---|---|---|
| Sample ID | Lab ID | Parameters | No. | Type | Pres. | Filt. | Lab | PO # |
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| Chain of Custody Documentation | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sampler | Date | Rec'd By | Date | Comments | Rec'd By | Date | Comments |
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Sampled By ____________

Laboratory Representative ____________

Relinquished By ____________

Received By ____________

Relinquished By ____________

Received By ____________

Relinquished By ____________

Received By ____________

Figure A-6

# EMCON ASSOCIATES
# GROUND WATER SAMPLING AND ANALYSIS REQUEST FORM

PROJECT NAME :

DATE SUBMITTED :

Project Mgr. Authorization: ____________

Project No. : ____________

Task Code: ____________

Send Results To: ____________

____________

____________

____________

SPECIAL INSTRUCTIONS / CONSIDERATIONS :

| Well Lock Number(s) |
|---|
| |
| |
| |
| |

☐ CHECK BOX TO AUTHORIZE DATA ENTRY

Site Contact: ____________
Name Phone #

| Well Number or Source | Casing Diameter (inches) | Casing Length (feet) | Depth to Water (feet) | ANALYSES REQUESTED |
|---|---|---|---|---|
| | | | | |

Laboratory and Lab QC Instructions :

NOTE : IT IS VERY IMPORTANT TO INCLUDE A COPY OF PROJECT PROPOSAL AND WELL LOCATION MAP OR SKETCH WITH THIS REQUEST.

# Attachment B:

# CERTIFIED ANALYTICAL REPORTS

Columbia Analytical Services, Inc.
1921 Ringwood Avenue • San Jose, CA 95131 • (408) 437-2400
CAS

December 19, 1989

Bill Woods
EMCON Associates
1921 Ringwood Avenue
San Jose, CA 95131

RE: BP-Alameda/C90-04.03

Dear Mr. Woods:

Enclosed are the results of the water samples submitted to our lab on November 30, 1989. For your reference, our service request number for this work is E89-1667.

Please call if you have any questions.

Respectfully submitted:

Timothy P. Dean

Timothy P. Dean
COLUMBIA ANALYTICAL SERVICES, INC.

le/TPD

# COLUMBIA ANALYTICAL SERVICES, INC.

## Analytical Report

| | | | |
|---|---|---|---|
| CLIENT: | EMCON Associates | DATE RECEIVED: | 11/30/89 |
| SUBMITTED BY: | Client | DATE EXTRACTED: | N/A |
| PROJECT: | C90-04.03 | DATE ANALYZED: | 12/07/89 |
| SAMPLE DESCRIPTION: | Water | WORK ORDER #: | E89-1667 |

### BTEX Analyses
DHS LUFT Method
EPA Method 602/8020
ug/L(ppb)

| Sample Name: | MRL | MW-1 | MW-2 | MW-3 |
|---|---|---|---|---|
| Benzene | 0.5 | 280 | <5.7* | <0.5 |
| Toluene | 1 | 880 | <1 | <1 |
| Ethyl Benzene | 1 | 340 | <1 | <1 |
| Total Xylenes | 3 | 1200 | <3 | <3 |
| Gasoline | 50 | 15000 | 170** | <50 |

| Sample Name: | MW-4 | MW-5 | MW-6 |
|---|---|---|---|
| Benzene | <0.5 | <0.5 | <0.5 |
| Toluene | <1 | <1 | <1 |
| Ethyl Benzene | <1 | <1 | <1 |
| Total Xylenes | <3 | <3 | <3 |
| Gasoline | <50** | <50 | <50 |

MRL - Method Reporting Limit
* Raised reporting limit due to presence of unknown, volatile component.
**An unknown discrete, volatile, non-fuel hydrocarbon was observed in this sample.

Approved by Timothy P. Dean Date 12/19/89

EMCON ASSOCIATES

# SAMPLING AND ANALYSIS CHAIN OF CUSTODY RECORD

PROJECT NO C90-04.03 SAMPLE TYPE Water EMCON LABORATORY NO E89-1667

| Sample Information | | | Bottle Information | | | | Lab Information | |
|---|---|---|---|---|---|---|---|---|
| Sample ID | Lab ID | Parameters | No. | Type | Pres. | Filt. | Lab | PO # |
| MW-1 | 1-3 | gas, BTXE | 3 | 40ml VOA | HCl | No | CAS -SJ- | |
| MW-2 | 4-6 | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | |
| MW-3 | 7-9 | | | | | | | |
| MW-4 | 10-12 | | | | | | | |
| MW-5 | 13-15 | | | | | | | |
| MW-6 | 16-18 | | | | | | | |
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| Chain of Custody Documentation | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sampler | Date | Rec'd By | Date | Comments | Rec'd By | Date | Comments |
| Chaco | 11/28/89 | HF | 11-30-89 | | | | |
| ↓ | ↓ | ↓ | ↓ | | | | |
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Sampled By

atory Representative

Relinquished By

Received By

Relinquished By

Received By

Relinquished By

Received By

# Attachment C:

# GROUND-WATER SCREENING SURVEY

**Tracer Research Corporation**

**PREPARED FOR:**

Emcon Associates
1921 Ringwood Avenue
San Jose, California 995131
(408) 453-7300

# GROUNDWATER SCREENING SURVEY
# BP GAS
# ALAMEDA, CALIFORNIA

NOVEMBER 1989

**SUBMITTED BY:**

Tracer Research Corporation

K-258-89-SG
EMCONBPA.REP

## TABLE OF CONTENTS

APPENDIX A

## INTRODUCTION

A groundwater screening survey was performed by Tracer Research Corporation (TRC) at BP Gas in Alameda, California. The survey was conducted on November 15, 1989 under contract to Emcon Associates. The purpose of the field screening was to determine the distribution of volatile organic compounds (VOCs) in groundwater.

For this investigation, a total of five groundwater samples, including two well samples, were collected and analyzed in the field. Samples were analyzed for the following compounds:

benzene
toluene
ethylbenzene
xylenes
total gasoline hydrocarbons (TPH C1-C7)
total diesel hydrocarbons (TPH C8-C14)

Xylenes are reported as the total of the three xylene isomers and total hydrocarbons are approximately C1-C14 aliphatic, alicyclic and aromatic compounds.

The compounds in this suite were chosen because of their suspected presence in the groundwater. Groundwater samples were screened on the flame ionization detector.

## EQUIPMENT

Tracer Research Corporation utilized a one ton Ford analytical field van that was equipped with one gas chromatograph and two Spectra Physics SP4270 computing integrators. In addition, the van has two built-in gasoline powered generators that provide the electrical power (110 volts AC) to operate all of the gas chromatographic instruments and field equipment. A specialized hydraulic mechanism consisting of two cylinders and a set of jaws was used to drive and withdraw the sampling probes. A hydraulic hammer was used to assist in driving probes past cobbles and through unusually hard soil.

## GROUNDWATER SAMPLING PROCEDURES

Sampling probes consist of 7 to 14 foot lengths of 3/4 inch diameter hollow steel pipe. Groundwater samples were collected by driving the hollow probes with detachable drive points below the water table and then withdrawing the probes several inches to permit water inflow into the resulting hole. A Kango roto-hammer was used to drill holes through the asphalt layers so that sampling probes could be inserted into the ground. Once inserted into the ground, the above-ground end of the sampling probes were fitted with a vacuum adaptor (metal reducer) and a length of polyethylene tubing leading to a vacuum pump. A vacuum of up to 24 inches of mercury was applied to the interior of the probe and open hole for 15 to 20 minutes or until the water was drawn up the probe. The water thus accumulated was then removed by drawing a vacuum on a 1/4 inch polyethylene tube inserted down the probe to the bottom of the open hole. Loss of volatile compounds by evaporation is accordingly reduced when water is induced to flow into the very narrow hole, because it can be sampled with little exposure to air. The polyethylene tubing was only used once and then discarded to avoid any cross-contamination problems.

Two groundwater samples, B-4 and B-5, were collected from wells located on-site. All groundwater samples were collected in 40 mL VOC vials that are filled to exclude any air and then capped with Teflon-lined septa caps.

## ANALYTICAL PROCEDURES

A Varian 3300 gas chromatograph, equipped with a flame ionization detector (FID), was used for the water analyses. The FID was used for the analyses of benzene, toluene, ethylbenzene and total hydrocarbons. Compounds were separated on a 3' by 1/8" OD packed column with OV-101 as the stationary phase. Nitrogen was used as the carrier gas.

Hydrocarbon compounds detected in water samples were identified by chromatographic retention time. Quantification of compounds was achieved by comparison of the detector response of the sample with the response measured for calibration standards (external standardization). Instrument calibration checks were run periodically throughout the day as were system blanks to check for contamination in the sampling equipment.

Detection limits for the compounds of interest are a function of the injection volume as well as the detector sensitivity. Thus, the detection limit typically varies with the sample size. Generally, the larger the injection size the greater the sensitivity. However, peaks for compounds of interest must be kept within the linear range of the analytical equipment. If any compound has a high concentration, it is necessary to use small injections, and in some cases to dilute the sample to keep it within linear range. This may cause decreased detection limits for other compounds in the analyses.

The detection limits range down to 0.3 ug/L for those compounds screened on the FID depending on the conditions of the measurement, in particular, the sample size. If any component being analyzed is not detected, the detection limit for that compound in that analysis is given as a "less than" value (e.g. <0.3 ug/L). Detection limits obtained from GC analyses are calculated from the current response factor, the sample size, and the estimated minimum peak size (area) that would have been visible under the conditions of the measurement.

## QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Tracer Research Corporation's normal quality assurance procedures were followed in order to prevent any cross-contamination of groundwater samples.

- Steel probes are used only once during the day and then washed with high pressure soap and hot water spray or steam-cleaned to eliminate the possibility of cross-contamination. Enough probes are carried on each van to avoid the need to reuse any during the day. Probes are marked with a number that is recorded in the logbook.
- Probe adaptors (steel reducer and tubing) are used once during the course of the day and cleaned at the end of each working day by baking in the GC oven. The tubing is replaced periodically as needed during the job to insure cleanliness and good fit. Probe adaptor numbers are recorded in the logbook.
- Silicone tubing (connecting the adaptor to the vacuum pump) is replaced as needed to insure proper sealing around the syringe needle. This tubing does not directly contact groundwater samples.
- Glass syringes are used for only one sample per day and are washed and baked out at night.
- Septa through which samples are injected into the chromatograph are replaced on a daily basis to prevent possible gas leaks from the chromatographic column.
- Analytical instruments are calibrated each day by the use of chemical standards prepared in water by serial dilution from commercially available pure chemicals. Calibration checks were also run after approximately every five sampling locations. Standards were run at the beginning, in the middle, and at the end of each day.
- 2 cc subsampling syringes are checked for contamination prior to sampling each day by injecting nitrogen carrier gas into the gas chromatograph.
- Prior to sampling each day, system blanks are run to check the sampling apparatus (probe, adaptor, 10 cc syringe) for contamination by drawing

ambient air from above ground through the system and comparing the analysis to a concurrently sampled air analysis.

. All sampling and 2 cc subsampling syringes are decontaminated each day and no such equipment is reused before being decontaminated. Microliter size subsampling syringes are reused only after a nitrogen carrier gas blank is run to insure it is not contaminated by the previous sample.

# APPENDIX A: CONDENSED DATA

EMCON ASSOCIATES/BP GAS/ALAMEDA, CALIFORNIA JOB#K-257-89-SG
11/15/89
CONDENSED DATA

| SAMPLE | BENZENE ug/l | TOLUENE ug/l | ETHYL BENZENE ug/l | XYLENES ug/l | TPH C1-C7 ug/l | TPH C8-C14 ug/l |
|---|---|---|---|---|---|---|
| Air | 0.7 | 3 | <0.3 | <0.4 | 6 | <0.3 |
| B1-10.5' | <0.6 | 2 | 0.6 | <0.8 | 2 | <0.6 |
| B2-13' | <0.6 | 2 | 1 | <0.8 | 3 | 76 |
| B3-12' | <0.6 | 1 | 12 | <0.8 | 14 | <0.6 |
| B4-10' | <0.6 | 5 | <0.6 | <0.8 | 12 | <0.6 |
| B5-10' | <0.6 | 2 | <0.6 | <0.8 | 4 | <0.6 |

Analyzed by: S. Evans
Checked by: G. Santo
Proofed by: L. Laylander