Applied GeoSystems 3315 Almaden Expressway, Suite 34, San Jose, CA 95118 (408) 264-7723

• FREMONT • IRVINE • HOUSTON • BOSTON • SACRAMENTO • CULVER CITY • SAN JOSE

June 27, 1991

WORK PLAN
for
SUBSURFACE INVESTIGATIONS AND REMEDIATION
at
ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

AGS 60026.03

Prepared for
ARCO Products Company
P.O. Box 5811
San Mateo, California 94402
by
RESNA/Applied GeoSystems

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STATE OF CALIFORNIA

June 27, 1991

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INTRODUCTION

This Work Plan summarizes work previously performed by RESNA/Applied GeoSystems (AGS) and others, and describes the project tasks proposed to evaluate and remediate the lateral and vertical extent of gasoline hydrocarbons in the soil and ground water at the site. ARCO Products Company (ARCO) requested that AGS prepare this work plan for submittal to the Regional Water Quality Control Board (RWQCB) and the Alameda County Health Care Services Agency (ACHCSA).

The proposed work includes the following tasks:

Task 1: drill and sample soil borings;

Task 2: drill step-out borings to further delineate the extent of gasoline hydrocarbons in soil (as necessary);

Task 3: prepare a soil remediation feasibility study and addendum to work plan (if necessary);

Task 4: design and construct soil remediation facilities (if necessary);

Task 5: install, develop, and sample ground-water monitoring wells, and laboratory analyze water samples from the wells and perform quarterly ground-water monitoring of wells;

Task 6: conduct hydrogeologic tests and research (as necessary);

Task 7: install, develop, and sample offsite wells (if necessary);

Task 8: prepare a ground-water remediation feasibility study and addendum to work plan (if necessary);

Task 9: design and construct ground-water remediation facilities (if necessary);

Task 10: prepare and implement site closure plan.

This Work Plan is intended to serve as a general technical guide to approach site remediation and closure. Specified work descriptions for each project phase, and any necessary modifications to these tasks, will be included in addenda to this Work Plan which will be submitted ARCO, RWQCB, and ACHCSA for their review and approval prior to performing each phase of site work. Field tasks described above will be performed in accordance with AGS Field Protocol in Appendix A and the Site Safety Plan. The work plan addenda, investigation report(s), remediation feasibility study(ies), and remediation plan(s) will be submitted as separate documents.

SITE DESCRIPTION AND BACKGROUND

General

ARCO Station 276 is located at the southeast corner of the intersection of MacArthur Boulevard and 106th Avenue in Oakland, California, as shown on Plate 1, Site Vicinity Map. Immediately adjacent to and southeast of the station property is the Foothill Square Shopping Center parking lot. Several commercial business are located in the Foothill

Square Shopping Center, including a grocery store, coin laundry, dry cleaners, drug store, offices, and another service station at Foothill Boulevard and 108th Avenue. Private residences are north and northeast of the service station. The schematic layout of the service station and the offsite area showing soil boring locations is presented on Plate 2, Generalized Site Plan.

Regional Geology and Hydrogeology

The site is located within the East Bay Plain which is situated in the San Francisco Bay depression that is in part an irregular downward with faulting principally along northwest trending faults (Alameda County Flood Control and Groundwater Conservation District, June 1988). The site is at an elevation of approximately 55 feet above mean sea level (msl) and approximately 1/2 mile west of the major fault in the area, the Hayward Fault Zone. The subsurface soils in the vicinity of the site consist of highly permeable Pleistocene alluvium composed of poorly consolidated to unconsolidated clay, silt, sand, and gravel. The alluvium was derived mainly from the Diablo Range and represents coalescing alluvial fans (Alameda County Flood Control and Groundwater Conservation District, June 1988). Ground-water flow direction in the area is generally inferred to be to the west towards San Francisco Bay, but may have components to the north and east due to recharge areas along the Hayward Fault.

PREVIOUS WORK

1988 Offsite Investigation

Kaldveer Associated (KA) conducted a preliminary site history survey at the Foothill Square Shopping Center property southeast and adjacent to the ARCO Station 276 (KA, October

October 3, 1988). The work focused on a survey of present and past site and near-vicinity conditions and concluded that there was potential for soil and ground-water contamination from past uses of the site, and that several facilities within a 1-1/2 mile radius of the site had a history of releases.

KA also conducted a subsurface environmental investigation. The work included drilling 15 soil borings on the shopping center site, collecting soil samples, collecting "grab" water samples from a seasonally saturated perched water bearing zone encountered in the borings, and analyzing soil and ground-water samples. Analyses of soil and ground-water samples indicated the presence of petroleum hydrocarbons, primarily in the northwest parking lot area of the shopping center, the area which is immediately adjacent to the ARCO Station 276. Free product was present in Boring EB-1, located about 90 feet east of the ARCO station building. Concentrations of total petroleum hydrocarbons as gasoline (TPHg) in the ground-water samples ranged from nondetectable (ND) to 8.36 parts per million (ppm). Concentrations of benzene, toluene, ethylbenzene, and total xylenes (BTEX) in ground water ranged from ND to 0.87 ppm. Pesticides, polychlorobiphenols (PCBs), and semi-volatile compounds were also detected in a water sample. TPHg concentrations were present in trace amounts in some of the soil samples taken and benzene was detected in one soil sample at 0.11 ppm (KA, October 7, 1988).

Western Geologic Resources, Inc., (WGR) conducted a subsurface environmental investigation at the Foothill Square Shopping Center, which included constructing five ground-water monitoring wells and analyzing nine soil and five ground-water samples for TPHg and BTEX. Concentrations of TPHg were not detected in any of the soil samples but benzene was present in one sample at 0.016 ppm. Concentrations of TPHg in ground-water samples ranged from ND to 0.3 ppm. Ground-water samples also contained near trace level concentrations of BTEX and semi-volatile compounds (WGR, January 17, 1989). The

ground-water flow direction was determined to be toward the south at a gradient of about 0.04 ft/ft.

1988 Onsite Investigation

Pacific Environmental Group, Inc. (PEG) removed an underground waste-oil storage tank and excavated soils from the tank pit, and collected soil samples for analyses from the ARCO station site between September 29 and December 6, 1988. Hydrocarbons in soil in the vicinity of the tank pit were delineated and the soil excavated for disposal (PEG, February 6, 1989).

March 1989 Onsite Investigation

AGS drilled five soil borings (B-1 through B-5) onsite, collected soil samples for description and laboratory analysis for TPHg and BTEX, installed five ground-water monitoring wells in the borings (MW-1 through MW-5, respectively), and collected and analyzed ground-water samples for TPHg and BTEX. Boring/monitoring well locations are shown on Plate 3, Soil Sample Location Map. Soils encountered during drilling were primarily sandy and silty clay underlain by silty sand with clay and gravel lenses. Detailed depictions of subsurface materials encountered are presented on Plates 4 through 6, Geologic Cross Sections. The depth to first-encountered ground water in the borings was approximately 35 feet with exception to boring B-2 in which ground water was encountered at 17 feet below ground surface in an apparent localized perched water-bearing zone.

Concentrations of TPHg were present in soil samples collected from borings B-2 (MW-2) and B-5 (MW-5), located on the southeast portion of the station site near the underground gasoline-storage tanks, at concentrations up to 690 ppm and were below laboratory detection

limits in borings B-3 and B-4, located behind the station building in the vicinity of the former waste-oil tank. Soil sample laboratory analytical results are shown on Table 1, Analytical Results of Soil Samples. Ground-water samples from four of the five wells contained TPHg concentrations which ranged from nondetectable in monitoring well MW-1 to 165 ppm in monitoring well MW-2 (the perched zone well). Concentrations of BTEX ranged from nondetectable to 21 ppm of toluene in monitoring well MW-2. Tetrachloroethene was detected in the ground-water sample collected from monitoring well MW-4 at 1.5 ppm (AGS, August 8, 1989). No laboratory evidence of hydrocarbon impacted ground water was detected in samples collected from monitoring well MW-1, located in the north corner of the site. Waste-oil hydrocarbons were not detected in samples collected from monitoring well MW-4 located near the former waste-oil tank. Analytical results for ground-water samples are shown on Table 2, Analytical Results of Ground-Water Samples.

A records check of local wells within a 1/2-mile radius of the area identified three domestic wells, two irrigation wells, and three wells used for cathodic protection (Alameda County Flood Control and Water Conservation District, 1989; AGS, August 8, 1989). The total well depths of the domestic wells ranged from 75 feet to 120 feet below ground surface. Well locations are shown on Plate 7, Well Location Map and well descriptions are shown on Table 3, Water Well Data.

Since first quarter of 1989, AGS has been conducting quarterly monitoring of the five onsite ground-water monitoring wells on ARCO property. The inferred direction of ground-water flow, disregarding MW-2 which appeared to be in a perched zone, was evaluated to be toward the north/northwest at a gradient of about 0.003 ft/ft. Ground-water gradient for October 30, 1990 and January 30, 1991 are shown on Plates 8 and 9, Ground-Water Gradient Maps.

June 1989 Onsite and Offsite Soil Vapor Survey

PEG conducted a soil-vapor survey at the ARCO Station and the adjacent Foothill Square Shopping Center parking lot. Results of the survey are shown on Table 4, Analytical Results of Soil Vapor Survey Soil-Gas Samples. The highest total hydrocarbon gas concentrations (40,000 ppm) were found within approximately 125 feet south of the station building at depths of 21 - 24 feet below ground surface (PEG, July 17, 1989).

August 1989 Offsite Investigation

Based on the PEG soil vapor survey, ARCO requested additional offsite soil borings and AGS drilled nine borings (B-1 through B-9) at the Foothill Shopping Center parking lot to assess the extent of hydrocarbons in the subsurface soil. These boring locations are shown on Plate 2. The field and analytical data suggested a zone of hydrocarbon contamination located 20 feet below ground surface and centralized around 2 borings, 50 - 65 feet south/southeast of the ARCO station building, where the maximum TPHg concentrations were up to 1,400 ppm and total petroleum hydrocarbons as diesel (diesel) concentrations up to 320 ppm (AGS, January 17, 1991). The soil samples from other borings were found to contain hydrocarbon levels near or below the detection limits. Laboratory analytical results for soil samples analyzed during this phase of the work are presented in Table 5, Analytical Results of Soil Samples and Table 6, Compounds Detected in Soil Samples for VOC Analysis.

Two water bearing zones were confirmed to be present at the ARCO station site and adjacent property: a shallow perched zone which occasionally goes dry and has a relatively steep gradient (0.04 ft/ft) toward south/southeast and a deeper water bearing zone which has a flatter gradient of about 0.002 ft/ft with a northerly flow direction.

January - February 1990 Onsite Investigation

AGS personnel supervised the drilling of three soil borings (TPB-1 through TPB-3) to depths of approximately 20 feet below ground surface in the proposed new gasoline underground storage tank (UST) pit area, shown on Plate 3. Soil samples collected contained concentrations of TPHg and BTEX up to 290 ppm and 6.6 ppm respectively. Laboratory analytical results for soil samples collected from these borings are shown on Table 7, Analytical Results of Soil Samples From Borings TPB-1 Through TPB-3 in New Tank Pit. The groundwater table was encountered at about 18.5 feet below the ground surface in the borings (AGS, February 1991).

On February 8, 1990 four underground storage tanks (T-1 through T-4) were removed from the site under supervision of an AGS geologist. The tanks consisted of a 6,000 gallon supreme unleaded (T-1), a 6,000 gallon regular unleaded (T-2), a 4,000 gallon regular unleaded (T-3), and a 10,000 gallon (T-4) tank. Visible inspection of the removed tanks revealed the tanks appeared to be in good condition with no visible signs of leaks, puncture or corrosion. Locations of the former tanks are shown on Plate 3. Nine soil samples were obtained from the walls and the base of former tank pit excavation (13 feet below ground surface) and submitted for analyses. The samples contained concentrations of TPHg and BTEX up to 360 ppm and 43 ppm, respectively. Results of soil sample analyses are shown on Table 8, Analytical Results of Soil Samples from Former Tank Pits T1, T2, T3, and T4. Five composite samples from stockpiled soil from former tank pits were analyzed for aeration and disposal characterization. Soils were then aerated and removed from the site and properly disposed.

April 1990 Onsite Investigation

The excavation for the installation for four USTs was performed April 26, 1990. The excavated soil was visually inspected for any indication of petroleum hydrocarbons and monitored with an organic vapor monitor (OVM). OVM indicated concentrations of hydrocarbons greater than 500 ppm in saturated gravel lenses at the depth between 11 and 15 feet below ground surface. Soil samples collected from the bottom corners of the new tank pit (19 feet below ground surface) showed no detectable concentrations of TPHg and low levels of BTEX (maximum 0.035 ppm). These soil sample locations are shown on Plate 3 and laboratory analytical results for the samples are shown on Table 9, Analytical Results of Soil Samples from the New Tank Pit Excavation. Excavated soil containing hydrocarbon concentrations greater than 100 ppm was aerated and then removed from the site and properly disposed. Analytical results for these stockpiles soils are presented in Tables 10 and 11, Analytical Results of Soil Samples from New Tank Pit Excavation Stockpiled Soils and Analytical Results of Organic Lead in Soil Samples from New Tank Pit Excavation Stockpiled Soils, respectively (AGS, February 1991).

See previous page

May 1990 Onsite Investigation

The product supply pipelines associated with the USTs, and surrounding fill material were removed on May 29 and May 30, 1990 under AGS supervision. Eight soil samples were collected for analyses along the trench at 20 foot lateral intervals. The maximum TPHg concentration detected in product line trench soil samples was 14 ppm. Sample locations are shown on Plate 3 and laboratory analytical results are shown on Table 12, Analytical Results of Soil Samples from Stockpiled Soil Product-Line Trenches from Former Tank Pits T1, T2, T3, and T4 (additional aerated stockpiled soil analysis results) (February 11, 1991).

Quarterly water-level measurements and sampling for analyses and reporting by AGS are continuing at the site. Ground-water monitoring data is presented on Table 13, Cumulative Ground-Water Monitoring Data. Ground-water laboratory analytical data is presented on Table 14, Cumulative Results of Laboratory Analysis of Water Samples.

PROJECT TASKS

AGS proposes the following project Tasks 1 through 10 listed below as a method of approach to work to delineate the vertical and horizontal extent of gasoline hydrocarbons and to remediate gasoline hydrocarbons in soil and ground water at the site. Field work involved with the following project tasks will be performed in accordance with the attached AGS Field Protocol in Appendix A. Plate 10, Project Tasks Decision Tree for Tasks 1 through 10, graphically presents AGS investigative site approach. The tasks shown in Plate 4 are discussed in detail below. A Remediation Options Decision Tree (Plate 11) is also attached and depicts potential remediation alternatives for soil and ground water at this site.

TASK 1

Additional soil borings will be drilled and sampled as necessary to evaluate the lateral and vertical extent of gasoline hydrocarbons at the site. Specific locations of these soil borings will be selected and presented as needed for regulatory review. Soil samples will be submitted for laboratory analyses for BTEX and TPHg using modified Environmental Protection Agency (EPA) methods 8020 and 5030/8015. These laboratory analyses will be performed at a State-certified laboratory.

TASK 2

Additional step-out borings will be drilled and soil samples tested as necessary to further delineate the extent of gasoline hydrocarbons in the soil at the site (and offsite, if necessary).

TASK 3

If it is found that remediation of the soil is necessary at the site, a Feasibility Study and addendum to Work Plan will be prepared to evaluate clean-up levels and corrective actions for gasoline hydrocarbons in soil. This study will include remediation options and recommendations for the apparent best remediation alternative to be implemented. Plate 11 lists some of the typical soil remediation options which might be applicable to this site. Two or three disposal or treatment and disposal alternatives would be selected for an analysis.

TASK 4

After regulatory approval of the recommended remediation alternative and addendum to Work Plan for the site, construction Plans and Specifications will be prepared as needed. In some instances, simple excavation and disposal of contaminated soil to an appropriate landfill may be adequate, with clean backfill used to replace the excavated soil. If construction of treatment facilities is necessary, construction permits and operating permits will be obtained and Plan and Specification approval will be secured from the local Public Works Department, as necessary. A soil remediation system will then be installed and soil remediation will be performed.

TASK 5

On-site ground-water monitoring wells will be installed, developed, and sampled to delineate the lateral and vertical extent of gasoline hydrocarbons in ground water onsite. Ground-water samples will be submitted for laboratory analysis for BTEX and TPHg using the EPA methods discussed in Task 1 above at a State-certified laboratory.

TASK 6

Hydrogeologic tests and research will be performed as necessary to evaluate the potential migration of gasoline hydrocarbons, potential beneficial use of ground water, and general hydrogeologic characteristics as they pertain to possible ground-water remediation.

TASK 7

After regulatory approval of an offsite ground-water investigation plan (addendum to Work Plan), offsite wells will be installed, developed, and sampled as described in Task 5 above.

TASK 8

As necessary, a ground-water remediation Feasibility Study and addendum to Work Plan will be prepared to evaluate corrective actions for gasoline hydrocarbons in ground water. Task 8 can be conducted in conjunction with Task 3, the soil remediation Feasibility Study and Work Plan. Clean-up levels and corrective action of gasoline hydrocarbons in ground-water, including two to three alternatives for treatment and two to three alternatives for treated ground-water disposal, would be analyzed for technical and cost-effectiveness feasibility.

Plate 11 lists some typical ground-water remediation alternatives which may be applicable to this site.

TASK 9

After regulatory approval of the remediation Feasibility Study and addendum to Work Plan, a ground-water remediation system will be designed and installed; the necessary permits will be obtained; and ground-water remediation will be performed and monitored.

TASK 10

After soil and ground-water remediation has been performed to clean-up levels, a site closure plan will be prepared for regulatory review and approval.

SCHEDULE OF OPERATIONS

Preliminary time schedules to perform additional phases of work will be included with the addenda to work plans presented for regulatory review. AGS can initiate work at the site within one week after receiving authorization to proceed. A preliminary estimate to perform the tasks described in this Work Plan, including remediation (Task 1 through Task 10), is approximately two to five years and depicted in Plate 12, Preliminary Time Schedule.

PROJECT STAFF

Ms. Diane Barclay, a Certified Engineering Geologist (C.E.G. 1366) in the State of California, will be in overall charge of hydrogeologic facets, and Ms. Joan E. Tiernan, Ph.D., a Registered Civil Engineer (C.E. 044600) will be in overall charge of engineering facets of this project. Mr. Greg Barclay, General Manager, will provide supervision of field and office operations of the project. Mr. Joel Coffman, Assistant Project Geologist, will be responsible for the day-to-day field and office operations of the project. AGS employs a staff of geologists and technicians who will help complete the project.

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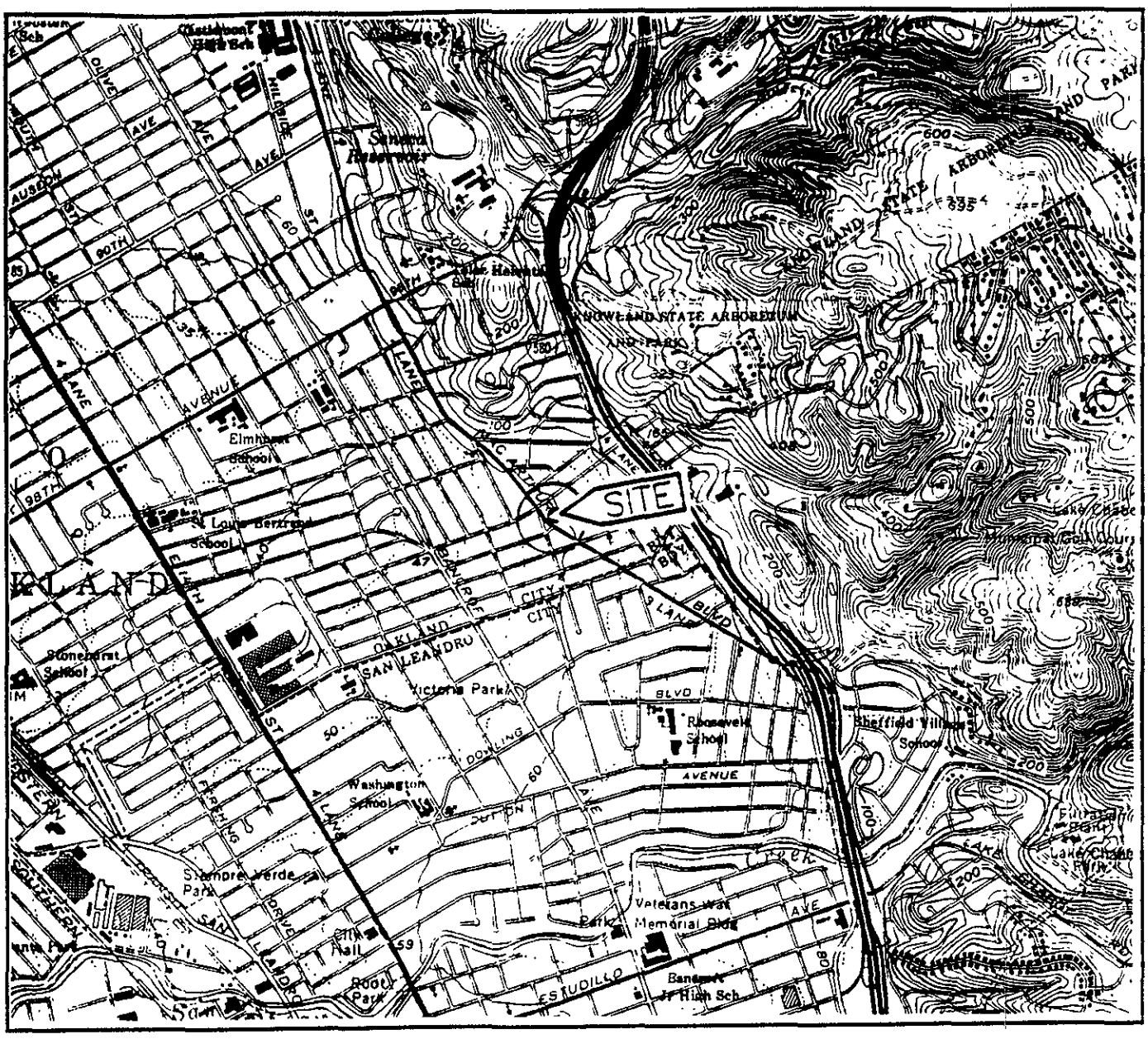


Source: U.S. Geological Survey
7.5-Minute Quadrangles
Oakland East/San Leandro
California.
Photorevised 1980

Approximate Scale

2000 1000 0 2000 4000

feet

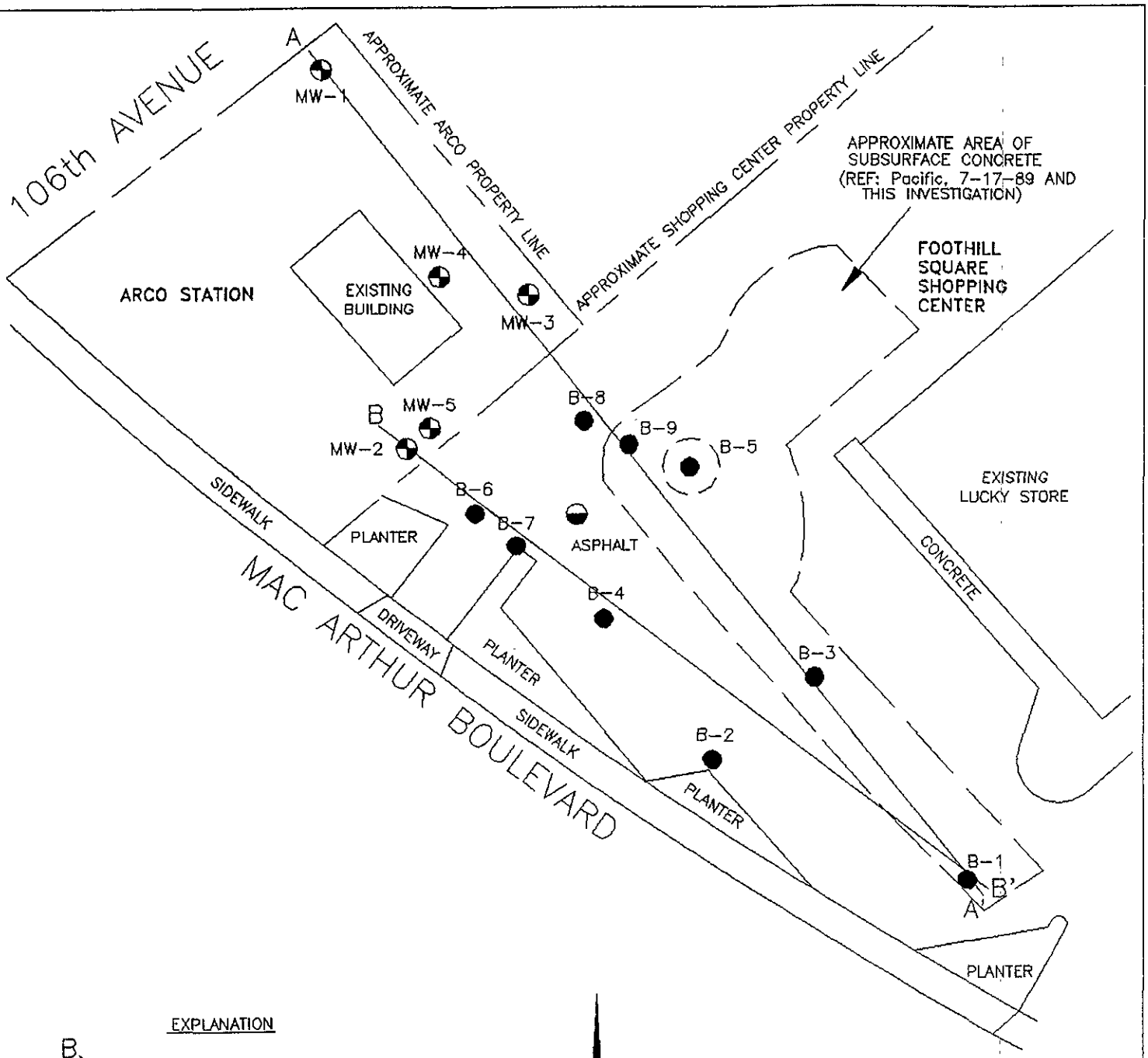
Applied GeoSystems

PROJECT 60026-4

SITE VICINITY MAP
ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

PLATE

1



EXPLANATION

B — B' = Geologic cross section line

MW-5 = Ground-water monitoring well (Applied GeoSystems, March 1989)

B-9 = Soil boring

= Ground-water monitoring well (WGR, Jan & Feb. 1990)

N

Approximate Scale

50 25 0 50 100

feet

Source: Surveyed by Ron Archer Civil Engineer, Inc.

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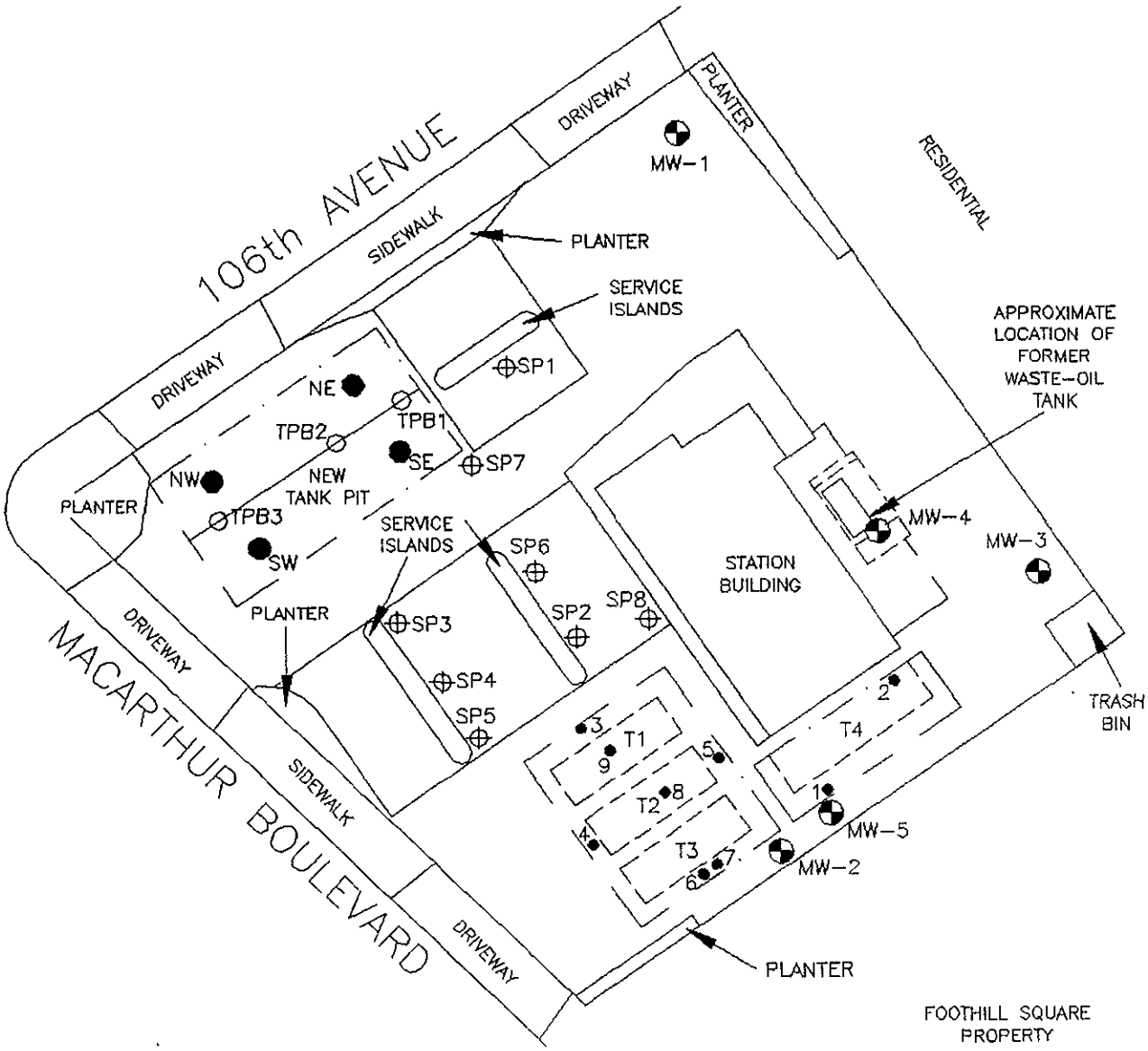
PROJECT 60026-4

GENERALIZED SITE PLAN
ARCO Station 276
10600 Mac Arthur Boulevard
Oakland, California

PLATE 2



EXPLANATION

T4 = Former tank pits

TPB3 ○ = Boring in proposed tank pit

MW-5 ⊕ = Monitoring well (Applied GeoSystems, 1989)

NW ● = New tank pit excavation bottom sample location

9 ● = Former tank pit sample location (S7-TP1SW-1 through S-13-TP2BN-9)

SP8 ⊕ = Product line trench sample location (S-0529-SP1 through S-0613-SP8)

Approximate Scale

30 15 0 30 60

feet

Source: Modified from plan supplied by ARCO and surveyed by *Ron Archer* Civil Engineer, Inc.

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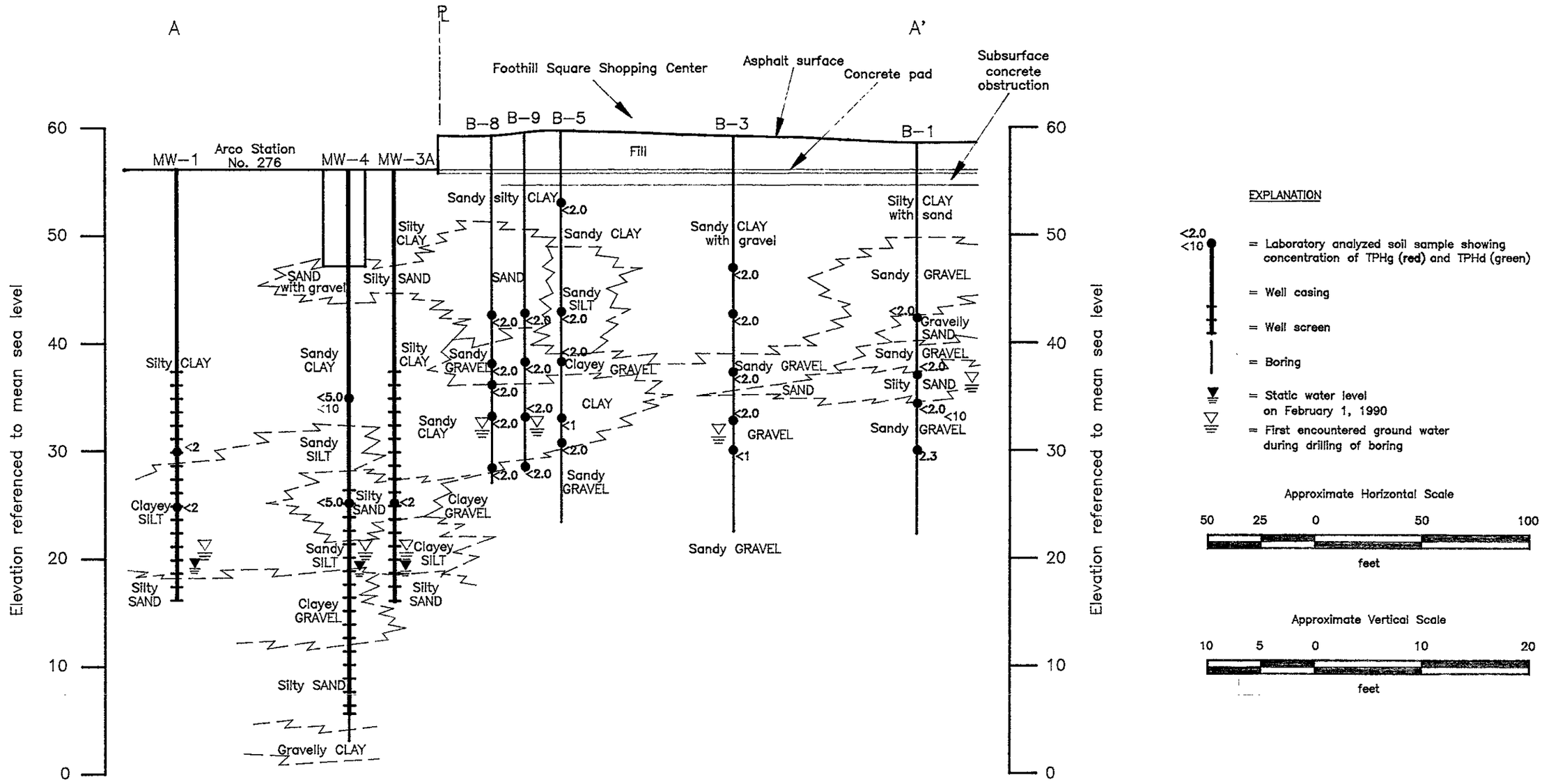
PROJECT 60026-4

SOIL SAMPLE LOCATION MAP
ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

PLATE 3



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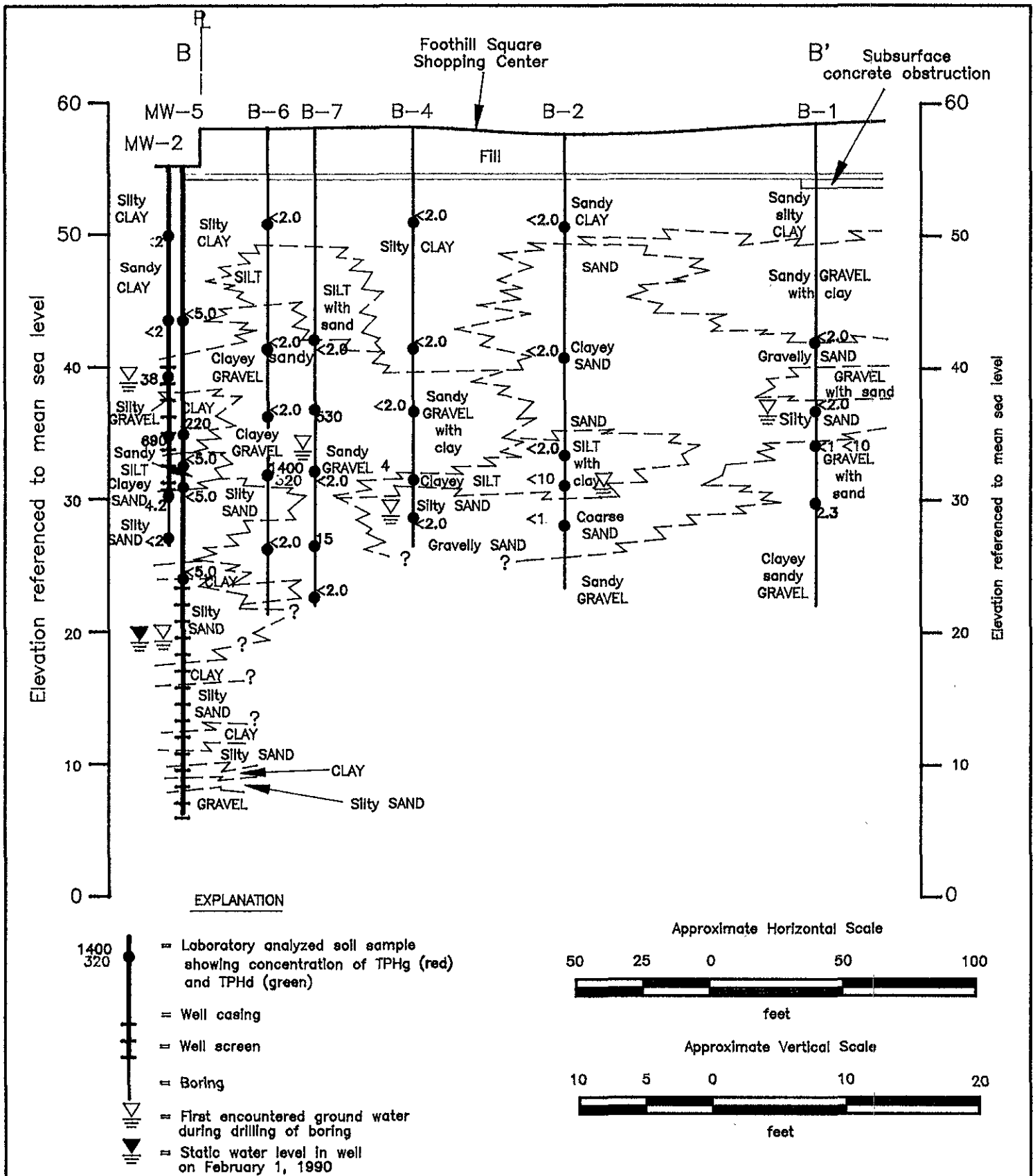
PROJECT 60026-4

GEOLOGIC CROSS SECTION A - A'
ARCO Station 276
10600 Mac Arthur Boulevard
Oakland, California

PLATE
4



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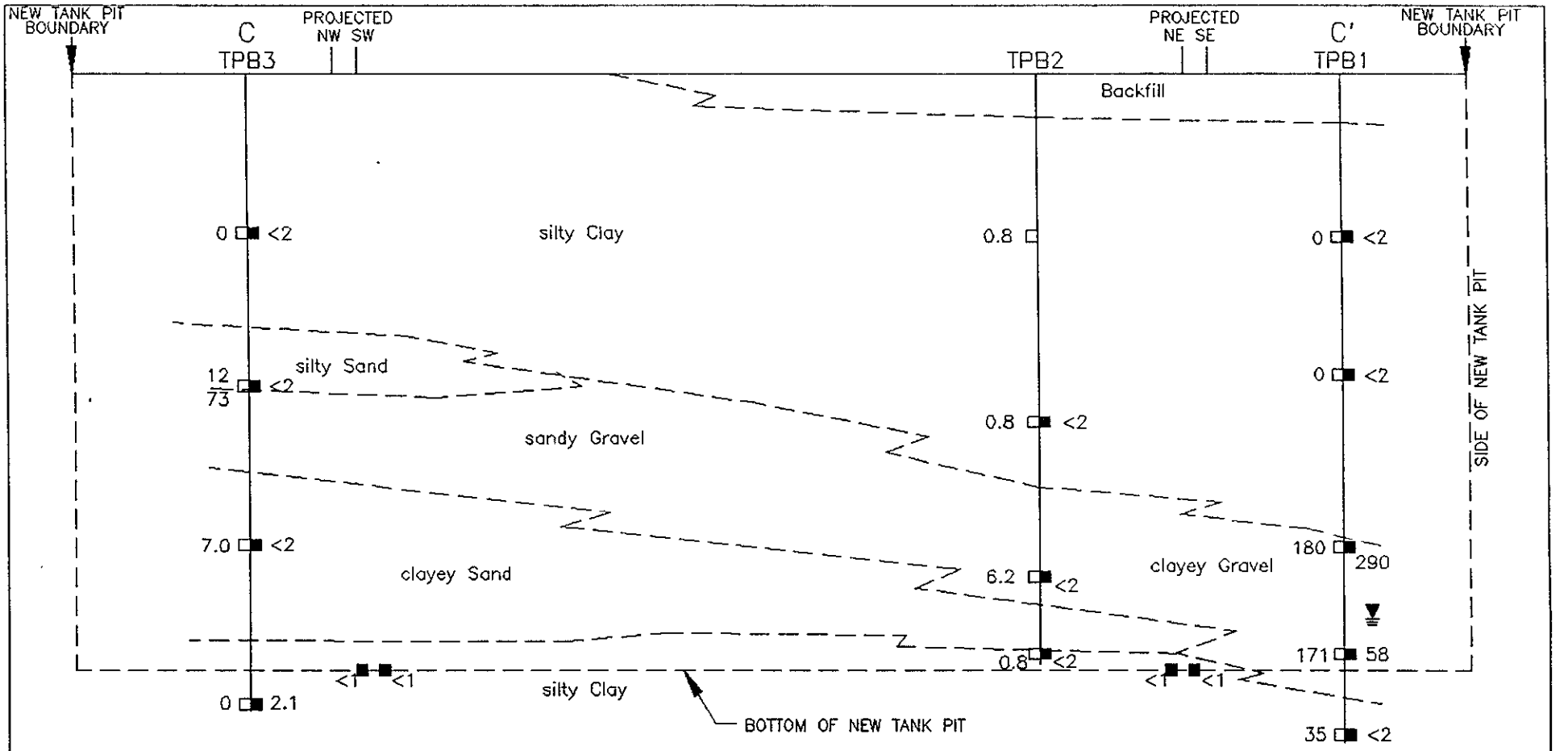
PROJECT 60026-4

GEOLOGIC CROSS SECTION B - B'
ARCO Station 276
10600 Mac Arthur Boulevard
Oakland, California

PLATE 5



EXPLANATION

180 = Organic vapor meter reading field (ppm)

290 = Analytical result of (TPH) as gasoline (ppm)

= Boring

<2 = Less than detection limit

= Static water level

Approximate Horizontal Scale

5 0 5 10

feet

Approximate Vertical Scale

5 0 5 10

feet

PLATE 6

GEOLOGIC CROSS SECTION C-C'
ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

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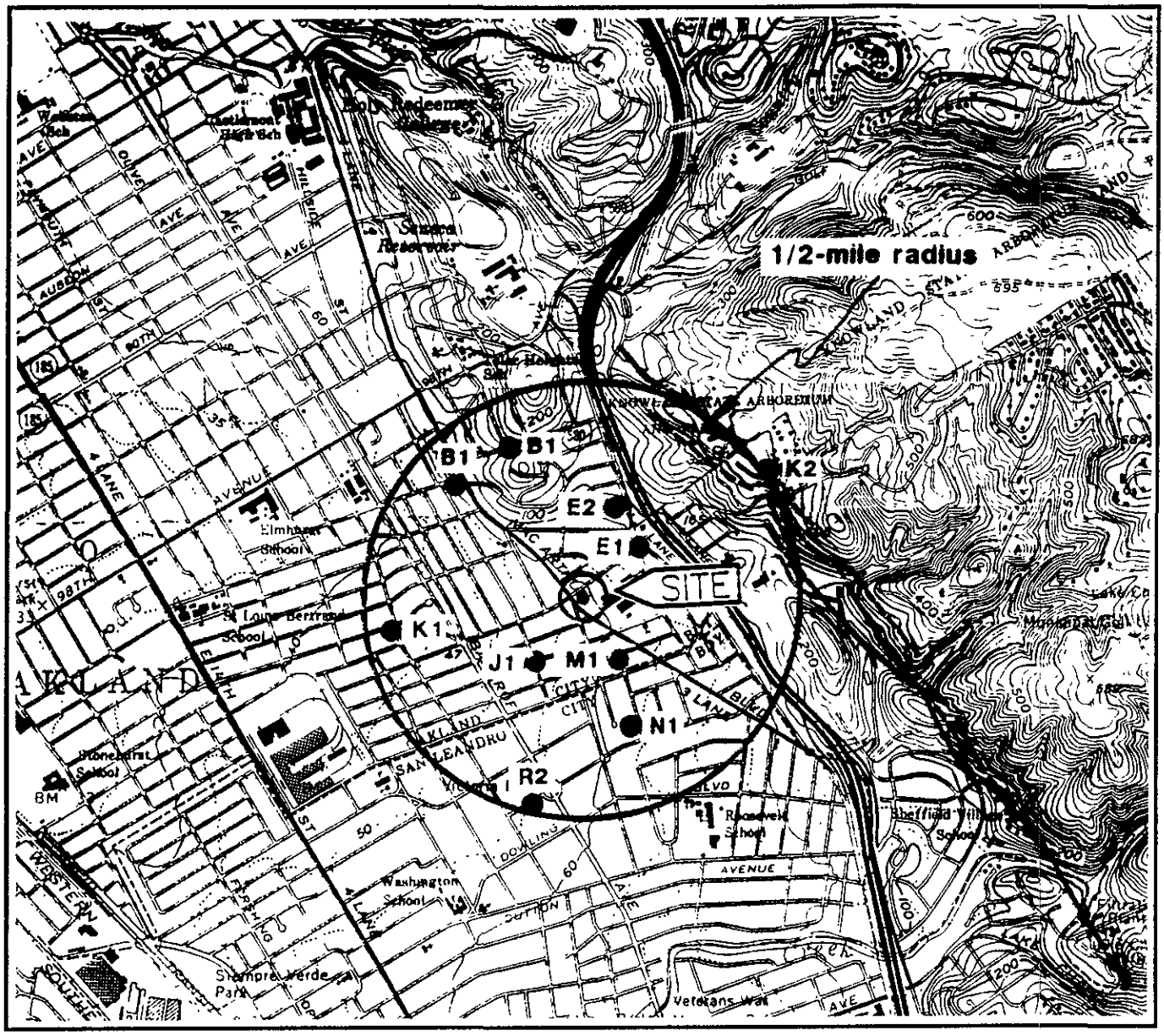
PROJECT 60026-4



Source: U.S. Geological Survey
7.5-Minute Quadrangles
Oakland East/San Leandro,
California.
Photorevised 1980

N

R2 ● = Ground-water well

Approximate Scale

2000 1000 0 2000 4000

feet

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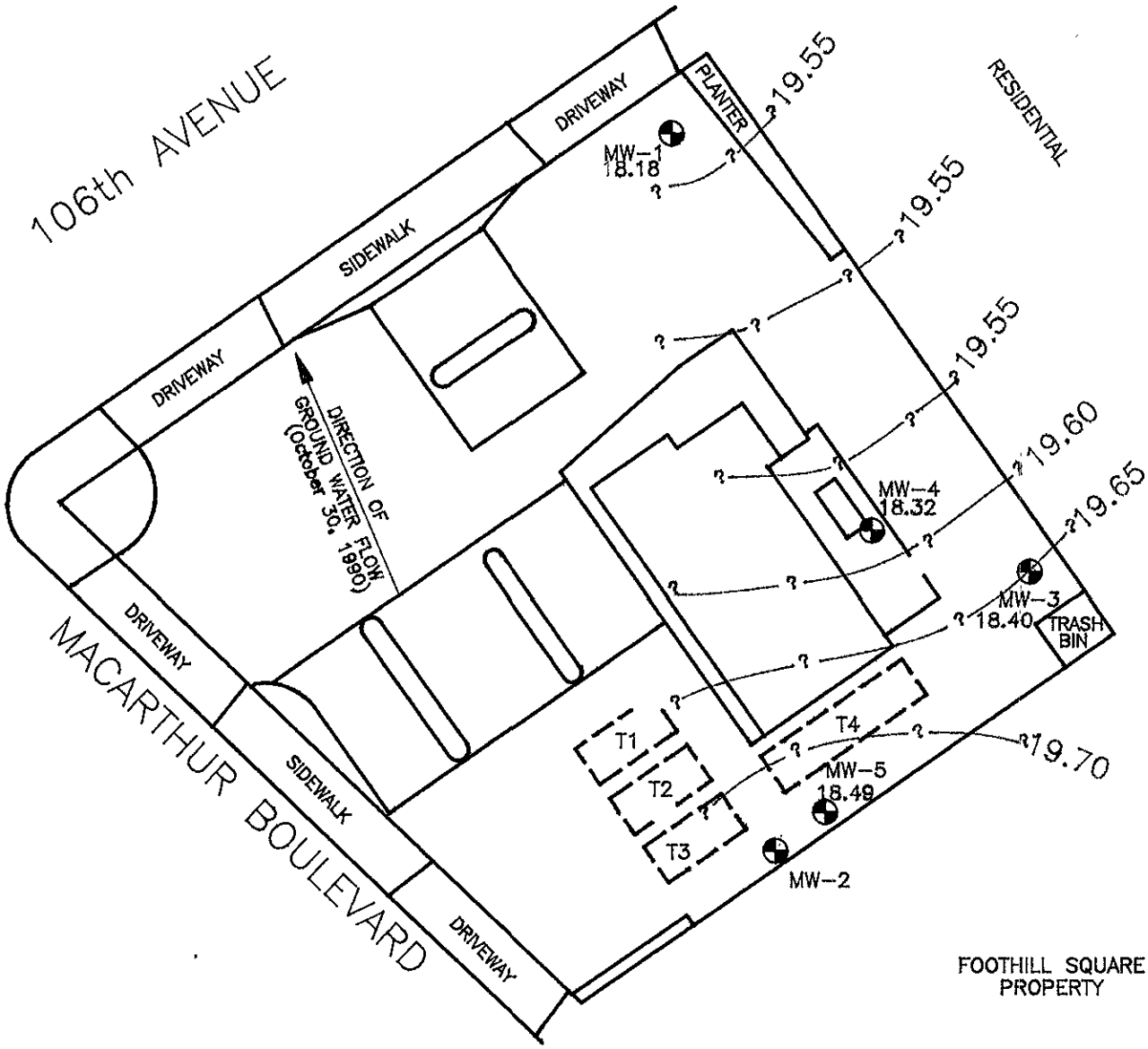
PROJECT 60026-4

WELL LOCATION MAP
ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

PLATE

7



EXPLANATION

18.49 = Elevation of ground water in feet, October 30, 1990

18.45 = Line of equal elevation of ground water above mean sea level

MW-5 = Approximate location of monitoring well

N

Approximate Scale

30 15 0 30 60

feet

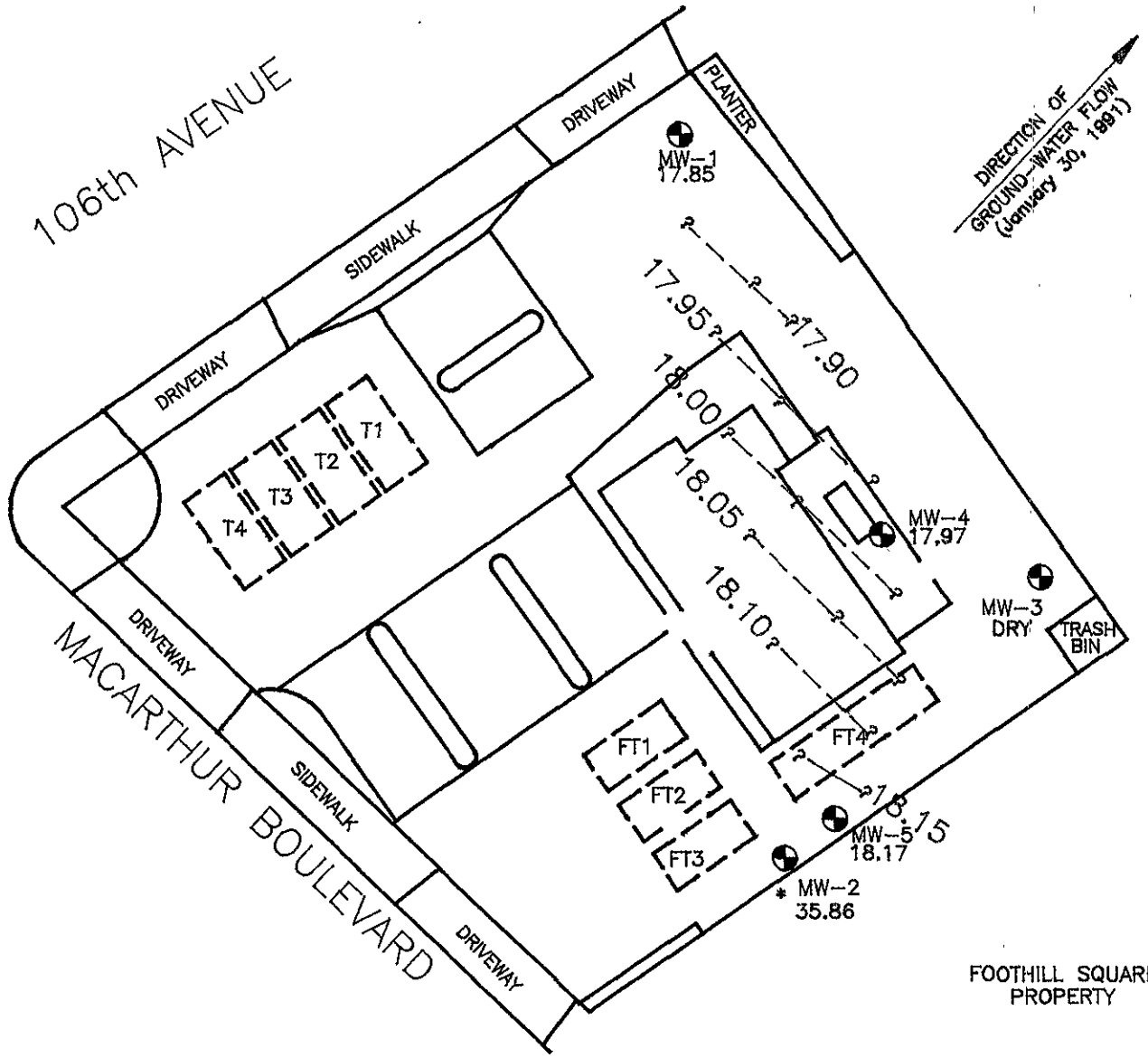
Source: Modified from plan supplied by ARCO and surveyed by Ron Archer, Civil Engineer, Inc.

Applied GeoSystems

PROJECT 60026-4

GROUND-WATER GRADIENT MAP
ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

PLATE 8



EXPLANATION

18.17 = Elevation of ground water in feet, January 30, 1991

18.15 — = Line of equal elevation of ground water above mean sea level

MW-5 ⊕ = Approximate location of monitoring well (Applied GeoSystems, 1989)

* MW-2 = Constructed in a shallow perched zone and not used for ground-water gradient interpretation

Approximate Scale

30 15 0 30 60

feet

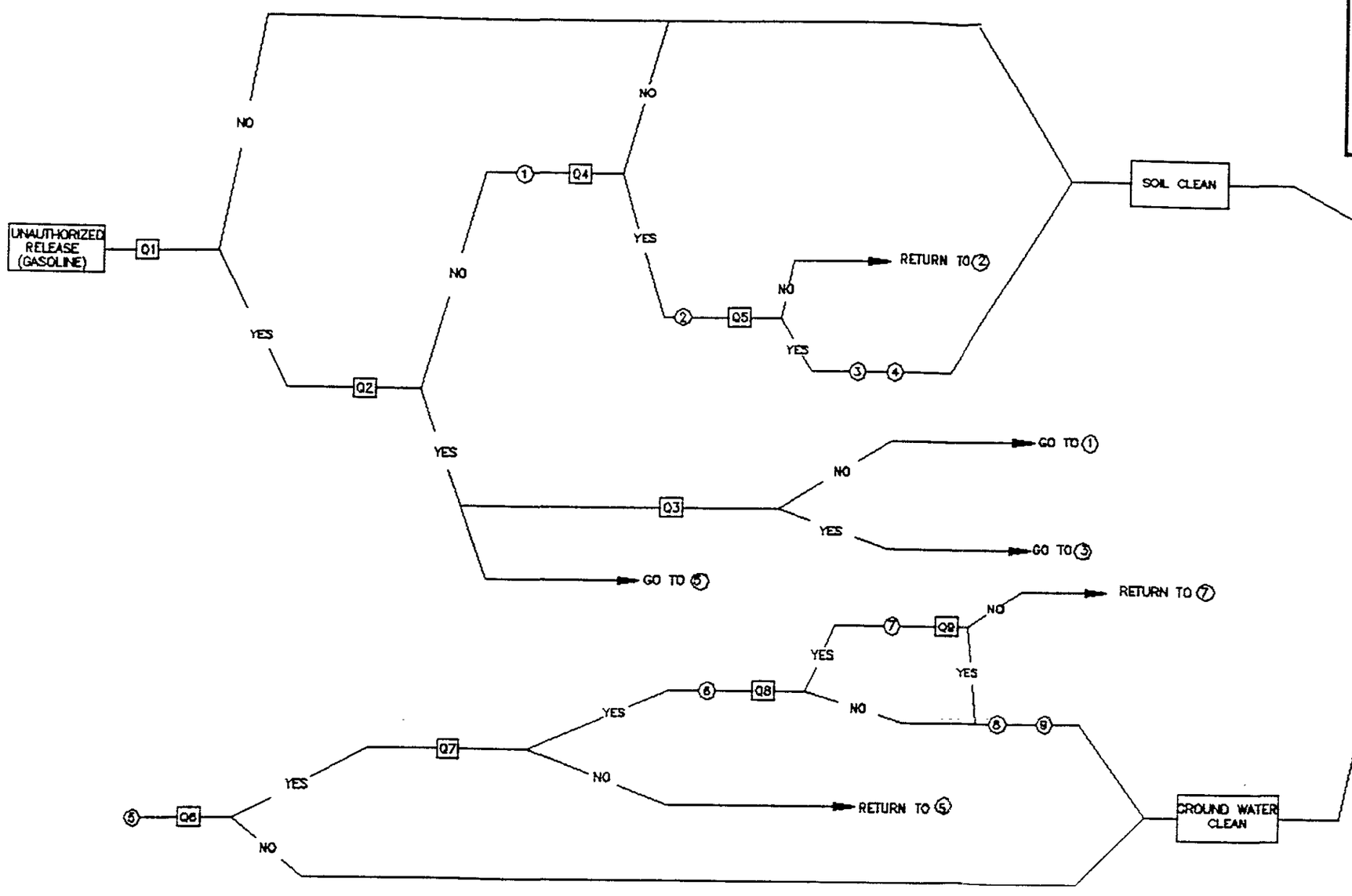
Source: Modified from plan supplied by ARCO and surveyed by Ron Archer, Civil Engineer, Inc.

Applied GeoSystems

PROJECT 60026-4

GROUND-WATER GRADIENT MAP
ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

PLATE 9



QUESTION

Q1: Is soil impacted by release?
Q2: Is ground-water impacted by release?
Q3: Is impacted soil defined?
Q4: Are there detectable concentrations of TPHg in the soil?
Q5: Is impacted soil defined?
Q6: Are there Gasoline Hydrocarbon at or above detectable concentrations in water samples?
Q7: Is extent of gasoline hydrocarbon in ground-water characterized onsite?
Q8: Gasoline hydrocarbons in ground-water extend offsite?
Q9: Is extent of gasoline hydrocarbons in ground-water characterized offsite?

PROJECT TASKS

SOIL INVESTIGATION

Task (1) Drill and sample Soil Borings
Task (2) Drill Step-Out Borings

SOIL REMEDIATION (if necessary)

Task (3) Prepare Soil Remediation Feasibility Study and Action Plan (if necessary)
Task (4) Remedial Soil (if necessary)

ONSITE GROUND-WATER INVESTIGATION

Task (5) Install/Develop Ground-water Monitoring wells and Sample/Analyze Ground-water
Task (6) Conduct Hydrology Tests and Research

OFFSITE GROUND-WATER INVESTIGATION (if necessary)

Task (7) Install Offsite Well(s), Sample/Analyze

GROUND-WATER REMEDIATION (if necessary)

Task (8) Prepare Ground-Water Remediation Feasibility Study and Action Plan
Task (9) Remediate Ground-Water

SITE CLOSURE

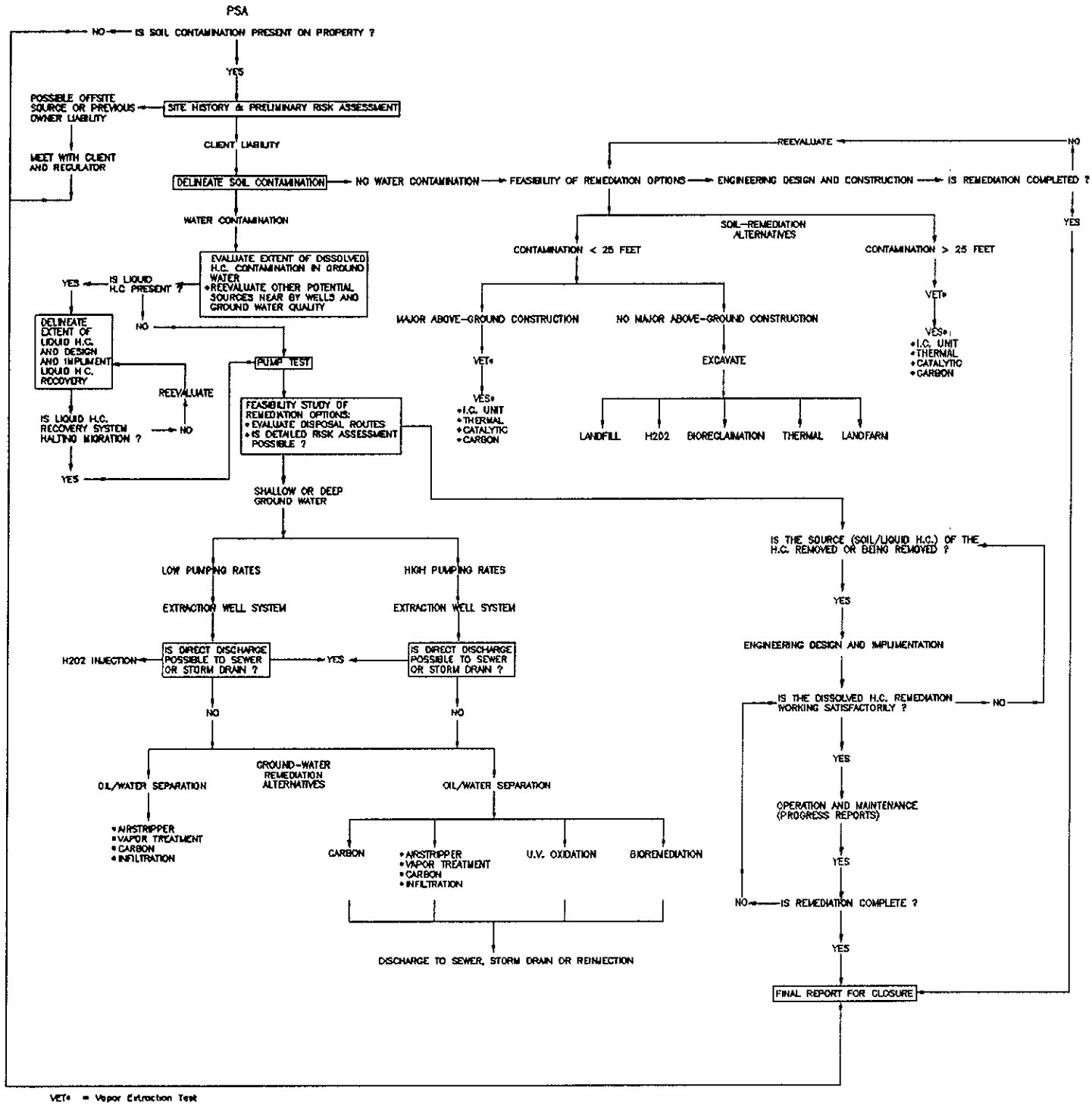
Task (10) Prepare site closure plan

Applied GeoSystems

PROJECT 60026-4

PROJECT TASK DECISION TREE
ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

PLATE 10



VET• = Vapor Extraction Test

VES• = Vapor Extraction System

Applied GeoSystems

PROJECT 60026-4

REMEDIATION OPTIONS DECISION TREE

ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

PLATE 11

TASK 1:
Drill and Sample soil borings

TASK 2:
Drill Step-Out borings

TASK 3:
Prepare Soil Remediation Feasibility Study and Action Plan (if necessary)

TASK 4:
Remedial Soil (if necessary)

TASK 5:
Install/Develop Ground-Water Monitoring Wells and Sample/Analyze Ground-Water

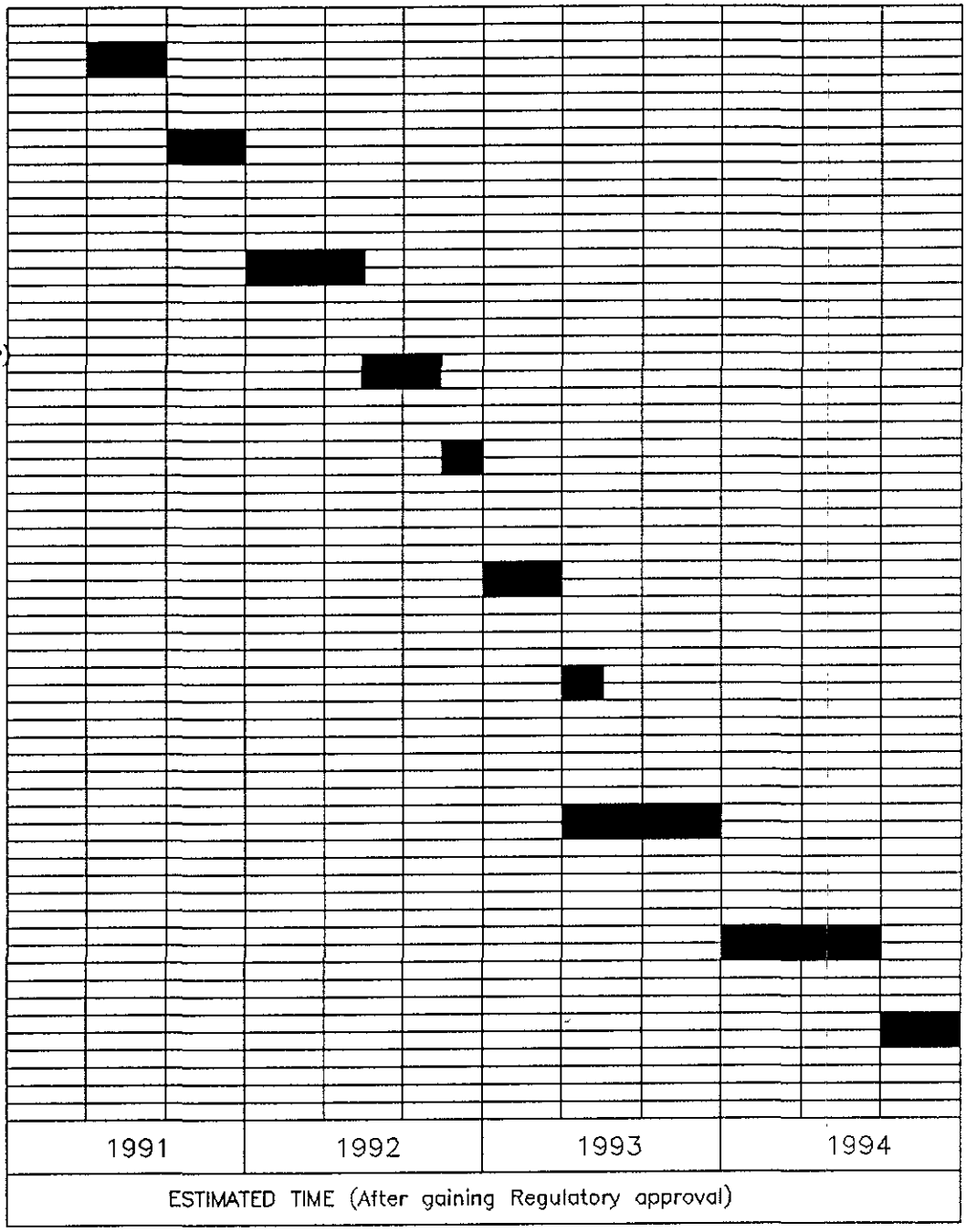
TASK 6:
Conduct Hydrology Tests and Research

TASK 7:
Install Offsite Well(s), Sample/Analyze

TASK 8:
Prepare Ground-Water Remediation Feasibility Study and Action Plan

TASK 9:
Remediate Ground-Water

TASK 10:
Prepare Site Closure Plan



Applied GeoSystems

PROJECT **60026-4**

PRELIMINARY TIME SCHEDULE
ARCO Station 276
10600 MacArthur Boulevard
Oakland, California

PLATE
12

TABLE 1
ANALYTICAL RESULTS OF SOIL SAMPLES
ARCO 276
Oakland, California
(March 1989)

Sample	TPHg	Benzene	Toluene	Ethyl-benzene	Xylenes
S-26-B1	<2	<0.005	<0.005	<0.05	<0.005
S-31-B1	<2	<0.005	<0.005	<0.05	0.078
S-5.56-B2	<2	<0.005	<0.005	<0.05	<0.005
S-11-B1	<2	<0.005	0.066	<0.05	0.079
S-16-B2	38	0.30	0.91	0.38	2.4
S-20-B2	690	7.4	36	10	62
S-28-B2	<2	<0.05	<0.05	<0.05	<0.05
S-30.5-B3	<2	<0.005	<0.005	<0.05	<0.005
S-21-B4*	<5.0	<0.05	<0.05	<0.05	<0.05
S-31-B4	<5.0	<0.05	<0.05	<0.05	<0.05
S-11-B5	<5.0	0.13	<0.05	<0.05	<0.05
S-16-B5	220	0.83	3.4	2.2	14
S-18-B5	<5.0	0.23	0.11	<0.05	0.21
S-24-B5	<5.0	0.086	<0.05	<0.05	<0.05
S-31-B5	<5.0	0.13	<0.05	<0.05	<0.05

Results are in parts per million (ppm).
TPHg: Total petroleum hydrocarbons as gasoline.

<: Below the reporting limits of the laboratory.
*: Sample S-21-B4 also analyzed for TOG (not detected).

Sample designation: S-31.0-B9

- S: Soil sample
- 31.0: Sample depth in feet below ground surface
- B9: Boring number

TABLE 2
ANALYTICAL RESULTS OF GROUND-WATER SAMPLES
ARCO 276
Oakland, California
(March 1989)

Sample	TPHg	Benzene	Toluene	Ethyl-benzene	Xylenes
W-35-MW1	<0.050	<0.00050	<0.00050	<0.00050	<0.00050
W-19-MW2	165	13	21	2.1	12.7
W-35-MW3	0.56	0.00054	0.00075	<0.00050	<0.00050
W-34-MW4	2.5	0.27	0.0014	<0.00050	0.085
W-34-MW5	0.13	0.0067	<0.00050	<0.00050	<0.00050

ADDITIONAL ANALYTICAL RESULTS
(April 24, 1989)

Sample Number	Benzene	Total Xylenes	Tetra-Chloroethene	TOG	1-ethyl-2-methyl-benzene	1,3,5-trimethyl-benzene
W-34-MW4	0.7810	0.130	1.50	<5.0	**	**

Results are in parts per million (ppm).
TPHg: Total petroleum hydrocarbons as gasoline.
TOG: Total oil and grease.

<: Below the reporting limits of the laboratory.
**: Compound identified at concentrations below the reporting limits of the method used.

Sample designation: W-34-MW4
- W-34-MW4 — Monitoring well number
- W-34-MW4 — Sample depth in feet below ground surface
- W-34-MW4 — Water sample

TABLE 3
WATER WELL DATA
ARCO 276
Oakland, California

Well ID	DTW*	Total Depth of Well	Use	Year Drilled and Installed
$B1_1$	42	75	Domestic	1977
$B1_2$	35	102	Domestic	1971
E1	NR	50	Cathodic Protection	1977
E2	NR	120	Cathodic Protection	1976
J1	NR	120	Cathodic Protection	1976
K1	NR	120	Domestic	1974
M1	38	58	Irrigation	1977
N1	40	79	Irrigation	1977
R2	29	60	Destroyed	1977

Source: Alameda County Flood Control and Water Conservation District, Zone 7.
Measurement in feet.
*: Believed to represent depth to static water when well was installed.
NR: Not recorded.
$_1$: Located in quadrant 23
$_2$: Located in quadrant 24

TABLE 4
ANALYTICAL RESULTS OF SOIL VAPOR SURVEY SOIL-GAS SAMPLES
ARCO Station 276, Oakland, California

Probe No.	Depth	Benzene	Toluene	E-Benzene	P,M-Xylene	O-Xylene	THC	Total BTEX
1	14-16	EHI	1,000	45	190	26	31,900	1,300
1	19-21	.8	9.3	40	33	14	20,000	98
2	14-16	EHI	63	9.7	47	16	200	140
2	19-21	3.2	7.3	1.0	4.1	.6	200	16
3	14-16	10	60	7.9	32	5.2	1,000	110
3	19-21	63	9.3	<.1	1.9	<.1	25,000	74
4	14-16	<.1	.8	.4	1.6	.4	200	3.2
4	19-21	.2	.1	.2	1.3	.4	500	2.2
5	17-19	1.3	1.3	<.1	<.1	<.1	300	2.6
5	22-24	130	190	20	17	19	25,300	380
6	17-19	<.1	<.1	<.1	<.1	<.1	80	<.1
6	22-24	130	39	<.1	<.1	<.1	21,500	170
7	17-19	.1	.5	<.1	.2	<.1	10	.8
7	22-24	<.1	<.1	<.1	<.1	<.1	20	<.1
8	17-19	<.1	<.1	<.1	<.1	<.1	45	<.1
8	22-24	<.1	.2	<.1	<.1	<.1	100	.2
9	17-19	<.1	<.1	<.1	<.1	<.1	<5	<.1
9	22-24	6.7	7.8	15	4.5	<.1	2,100	34
10	17-19	.1	.3	<.1	.1	<.1	160	.5
10	22-24	1.2	.8	<.1	<.1	<.1	800	2.0
11	17-19	<.1	<.1	<.1	<.1	<.1	5	<.1
11	22-24	.7	9.7	.1	2.2	1.5	14,000	14
12	17-19	<.1	.4	<.1	<.1	<.1	10	.4
12	22-24	EHI	300	<.1	<.1	<.1	33,500	300
13	17-19	.1	.5	.1	.2	.1	60	1.0
13	22-24	300	190	<.1	24	<.1	24,500	510
14	17-19	.1	.3	.1	.2	.1	50	.8
14	22-24	20	29	1.8	6.3	1.6	5,000	59
15	17-19	100	180	11	7.4	8.7	23,500	300
15	22-24	EHI	2,000	79	230	48	40,000	2,400
16	17-19	3.1	4.1	.5	.5	<.1	500	8.2
16	22-24	.5	1.2	<.1	.4	.1	500	2.2

Results in parts per million (ppm) on a volume to volume basis. Depth measured in feet.
THC: Total hydrocarbons recorded by Flame Ionization Detector. All other gasoline constituents recorded by gas chromatograph.
EHI: Not quantified due to Excessive Hydrocarbon Interference (lowest volume of injection and least sensitive gain set for gas chromatograph).
BTEX: Benzene, toluene, ethylbenzene, and total xylene isomers.

TABLE 5
ANALYTICAL RESULTS OF SOIL SAMPLES
ARCO Station 276
Oakland, California
(August 1989)
(Page 1 of 2)

Sample	TPHg	TPHd	B	T	E	X
S-16.5-B1	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-21.5-B1	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-24.0-B1	<1	<10	<0.005	<0.005	<0.005	<0.005
S-29.0-B1	2.3	NA	0.27	0.087	0.054	0.15
S-06.5-B2	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-16.5-B2	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-24.0-B2	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-24/26-B2	NA	<10	NA	NA	NA	NA
S-29.0-B2	<1	NA	<0.005	<0.005	<0.005	<0.005
S-11.5-B3	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-16.5-B3	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-21.5-B3	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-26.5-B3	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-29.0-B3	<1	NA	<0.005	<0.005	<0.005	<0.005
S-06.5-B4	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-16.5-B4	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-21.5-B4	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-26.5-B4	4	<10	0.41	0.07	0.08	0.16
S-29.0-B4	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-06.5-B5	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-16.5-B5	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-21.5-B5	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-26.5-B5	<1	NA	0.032	<0.005	<0.005	<0.005
S-29.0-B5	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-06.5-B6	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-16.5-B6	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-21.5-B6	<2.0	NA	0.22	0.14	0.013	0.56
S-26.5-B6	1,400	320	<2	19	12	63
S-29.0-B6	<2.0	NA	<0.050	<0.050	<0.050	<0.050

See notes on Page 2 of 2.

TABLE 5
ANALYTICAL RESULTS OF SOIL SAMPLES
ARCO Station 276
Oakland, California
(August 1989)
(Page 2 of 2)

Sample	TPHg	TPHd	B	T	E	X
S-16.0-B7	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-21.0-B7	530	NA	1.1	5.8	5.8	30
S-26.0-B7	<2.0	NA	0.084	<0.050	<0.050	<0.050
S-31.0-B7	15	NA	0.61	0.57	0.24	0.29
S-36.0-B7	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-16.0-B8	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-21.0-B8	<2.0	NA	0.18	<0.050	0.72	<0.050
S-23.0-B8	<2.0	NA	0.11	<0.050	<0.050	0.075
S-26.0-B8	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-31.0-B8	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-16.0-B9	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-21.0-B9	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-26.0-B9	<2.0	NA	<0.050	<0.050	<0.050	<0.050
S-31.0-B9	<2.0	NA	<0.050	<0.050	<0.050	<0.050

Results in parts per million (ppm).
TPHg: Total petroleum hydrocarbons as gasoline.
TPHd: Total petroleum hydrocarbons as diesel.
B:Benzene, T: Toluene, E: Ethylbenzene, X: Total xylene isomers
<: Less than laboratory detection limit.
NA: Not analyzed.

Sample designation: S-31.0-B9
- S: Soil sample
- 31.0: Sample depth in feet below ground surface
- B9: Boring number

TABLE 6
COMPOUNDS DETECTED IN SOIL SAMPLES
FOR VOC ANALYSIS
ARCO Station 276
Oakland, California
(August 1989)

Sample	Compound	Amount Detected
B-4	Benzene	0.220
	Toluene	0.040
	Ethylbenzene	0.043
	Total Xylenes	0.100
	* unknown	0.070
	* 2,3-dimethylbutane	0.070
	* unknown	0.060
	* 1-ethyl-2-methylbenzene	0.030
	* 1,3,5-trimethylbenzene	0.040
B-5	Benzene	0.007
B-6	Benzene	5
	Toluene	20
	Ethylbenzene	16
	Total Xylenes	88
	* unknown	110
	* unknown	100
	* methylcyclohexane	30
	* 1-ethyl-2-methylbenzene	40
	* 1,3,5-trimethylbenzene	60

Results in parts per million (ppm).
*: Tentatively Identified Compounds (TICs).
All samples obtained at 26-½ feet below surface grade.

TABLE 7
ANALYTICAL RESULTS OF SOIL SAMPLES
FROM BORINGS TPB-1 THROUGH TPB-3 IN NEW TANK PIT
ARCO Station 276
Oakland, California

Sample	TPHg	Benzene	Toluene	Ethyl-benzene	Xylenes
S-9.5-TPB1	<2	<0.05	<0.05	<0.05	<0.05
S-15-TPB1	290	0.19	0.47	3.3	6.6
S-18.5-TPB1	58	<0.05	0.069	0.14	0.22
S-21-TPB1	<2	<0.05	<0.05	<0.05	<0.05
S-11-TPB2	<2	<0.05	<0.05	<0.05	<0.05
S-16-TPB2	<2	<0.05	<0.05	<0.05	<0.05
S-18.5-TPB2	<2	<0.05	<0.05	<0.05	<0.05
S-5-TPB3	<2	<0.05	<0.05	<0.05	<0.05
S-10-TPB3	<2	0.075	<0.05	<0.05	<0.05
S-15-TPB3	<2	<0.05	<0.05	<0.05	<0.05
S-20-TPB3	2.1	0.46	<0.05	0.086	<0.05

Results in parts per million (ppm).
TPHg: Total petroleum hydrocarbons as gasoline.
<: Less than laboratory detection limit.

Sample designation: S-9.5-TPB1
- Boring number
- Sample depth in feet below ground surface
- Soil sample

TABLE 8
ANALYTICAL RESULTS OF SOIL SAMPLES
FROM FORMER TANK PITS T1, T2, T3, AND T4
ARCO Station 276
Oakland, California

Sample	TPHg	Benzene	Toluene	Ethyl-benzene	Xylenes
S-7-TP1SW-1	<2	0.13	<0.05	<0.05	0.15
S-8-TP1NE-2	<2	0.088	<0.05	<0.05	<0.05
S-13-TP2N-3	45	0.32	0.46	0.083	0.68
S-13-TP2W-4	3.9	0.24	0.15	0.094	0.67
S-13-TP2E-5	23	0.43	0.95	0.36	3.7
S-10-TP2S-6	2.5	0.13	0.10	<0.05	0.29
S-12-TP2S-7	210	1.8	14	3.4	29
S-12-TP2BM-8	42	0.33	1.2	0.77	6.1
S-13-TP2BN-9	360	0.86	5.5	6.7	43

Results in parts per million (ppm).
TPHg: Total petroleum hydrocarbons as gasoline.
<: Less than laboratory detection limit.

Sample designation: S-13-TP2BN-9
- S = Soil sample
- 13 = Sample depth in feet below ground surface
- TP2BN-9 = Sample location

TABLE 9
ANALYTICAL RESULTS OF SOIL SAMPLES
FROM STOCKPILED SOIL PRODUCT-LINE TRENCHES
FROM FORMER TANK PITS T1, T2, T3, AND T4
ARCO Station 276
Oakland, California

Sample	TPHg	Benzene	Toluene	Ethyl-benzene	Xylenes
Stockpile					
S-0322-1(A-D)	9.6	<0.05	<0.05	<0.05	0.054
S-0322-2(A-D)	67	<0.05	<0.05	<0.05	1.6
S-0322-3(A-D)	110	<0.05	<0.05	<0.05	0.071
S-0322-3(A-D)*	59	<0.05	<0.05	<0.05	<0.05
S-0326-4(A-D)	69	<0.05	<0.05	<0.05	0.13
Product Lines					
S-0529-SP1	<2	<0.05	<0.05	<0.05	<0.05
S-0529-SP2	<2	<0.05	<0.05	<0.05	0.076
S-0529-SP3	<2	<0.05	<0.05	<0.05	<0.05
S-0529-SP4	<2	<0.05	<0.05	<0.05	<0.05
S-0529-SP5	14	0.41	0.14	0.17	1.1
S-0530-SP6	6.8	0.19	0.17	0.07	0.24
S-0530-SP7	<1	<0.005	<0.005	<0.005	<0.005
S-0613-SP8	<2	<0.05	<0.05	<0.05	0.062

Results in parts per million (ppm).
TPHg: Total petroleum hydrocarbons as gasoline.
<: Less than laboratory detection limit.
*: Second sample collected after aeration for several days.
1(A-D): Stockpile sample location.
SP4: Product-line trench sample location.

Sample designation: S-0613-SP8
- S-0613-SP8 — Sample location
- S-0613-SP8 — Sample date
- S-0613-SP8 — Soil sample

TABLE 10
ANALYTICAL RESULTS OF SOIL SAMPLES
FROM THE NEW TANK PIT EXCAVATION
ARCO Station 276
Oakland, California

Sample	TPHg	Benzene	Toluene	Ethyl-benzene	Xylenes
Tank Pit NE	<1.0	0.005	0.010	<0.005	<0.005
Tank Pit SE	<1.0	<0.005	0.022	<0.005	<0.005
Tank Pit NW	<1.0	0.029	0.014	<0.005	<0.005
Tank Pit SW	<1.0	0.035	0.013	<0.005	0.005

Results in parts per million (ppm).
TPHg: Total petroleum hydrocarbons as gasoline.
<: Less than laboratory detection limit.

Sample designation: Tank Pit SW
└——— Sample location

TABLE 11
ANALYTICAL RESULTS OF SOIL SAMPLES
FROM NEW TANK PIT EXCAVATION STOCKPILED SOILS
ARCO Station 276
Oakland, California

Sample	TPHg	Benzene	Toluene	Ethyl-benzene	Xylenes
S-0507-SP2(A-D)	<1	<0.005	<0.005	<0.005	0.005
S-0507-SP5(A-D)	<1	<0.005	<0.005	<0.005	<0.005
S-0509-SP3(A-D)	16	<0.05	<0.05	<0.05	0.13
S-0509-SP4(A-D)	610	0.5	<0.5	3.1	25
S-0509-SP6(A-D)	<1	<0.005	<0.005	<0.005	<0.005
S-0509-SP6(E-H)	<1	<0.005	<0.005	<0.005	<0.005
S-0509-SP11(A-D)	49	<0.1	<0.1	<0.1	0.69
S-0509-SP12(A-D)	40	<0.1	<0.1	<0.1	0.69
S-0509-SP13A-D)	9.0	<0.05	<0.05	<0.05	0.13
S-0509-SP14(A-D)	33	<0.1	<0.1	<0.1	0.45
S-0509-SP15(A-D)	25	<0.2	4.9	<0.2	0.34
S-0509-SP16(A-D)	13	<0.05	<0.05	<0.05	0.13
S-0517-SP4(A-D)	120	<0.2	1.8	0.7	6.7
S-0525-SP4(A-D)	<2.0	<0.05	<0.05	<0.05	<0.05
S-0525-SP7(A-D)	34	<0.05	0.16	0.082	2.4
S-0530-CP1(1-4)	66	0.20	1.1	0.54	3.2
S-0530-CP2(1A-D)	43	<0.05	0.093	0.095	0.39
S-0530-CP2(2A-D)	<1.0	<0.005	<0.005	<0.005	<0.005
S-0530-CP2(3A-D)	1.2	<0.005	<0.005	<0.005	0.021
S-0530-CP2(4A-D)	<1.0	<0.005	<0.005	<0.005	<0.005
S-0530-CP2(5A-D)	<1.0	<0.005	<0.005	<0.005	<0.005
S-0530-CP2(6A-D)	30	<0.05	<0.05	0.16	0.11

Results in parts per million (ppm).
TPHg: Total petroleum hydrocarbons as gasoline.
<: Less than laboratory detection limit.

Sample designation: S-0530-CP2(6A-D)
- Sample location
- Sample date
- Soil sample

TABLE 12
ANALYTICAL RESULTS OF ORGANIC LEAD IN SOIL SAMPLES
FROM NEW TANK PIT EXCAVATION STOCKPILED SOILS
ARCO Station 276
Oakland, California

Sample	Organic Lead
S-0530-CP2	<0.08
S-0530-CP2 (Control sample ID# 9005347-02, 88.7% recovery)	<0.08
S-0509-SP6 (Control sample ID# 9005094, 102.8% recovery)	<0.08

TABLE 13
CUMULATIVE GROUND-WATER MONITORING DATA
ARCO Station 276
Oakland, California
(Page 1 of 2)

Date Well Measured	Well Elevation	Depth to Water	Water Elevation	Floating Product
MW-1				
04/17/89		33.04	22.87	None
04/24/89		33.84	22.07	None
10/13/89	55.91	37.19	18.72	None
02/01/90		36.73	19.18	None
07/31/90		36.42	19.49	None
08/01/90		36.41	19.50	None
08/28/90		36.88	19.03	None
10/30/90		37.73	18.18	None
11/20/90		37.92	18.37	None
12/19/90		37.90	18.01	None
1/30/91		38.06	17.85	None
MW-2				
04/17/89		17.20	38.15	None
04/24/89		17.83	37.52	None
10/13/89	55.35	20.17	35.18	0.03
02/01/90		NM	NM	None
07/31/90		18.90	36.45	None
08/01/90		19.15	36.20	1.04
08/28/90		21.91	33.44	0.83
10/30/90		25.04	30.31	1.04
11/20/90		25.56	29.79	0.60
12/19/90		18.23	37.12	Odor
1/30/91		19.49	35.86	0.03
MW-3				
04/24/89		34.47	22.08	None
10/13/89	56.55	37.60	18.95	None
02/01/90		37.20	19.35	None
07/31/90		36.90	19.65	None
08/01/90		36.87	19.68	None
08/28/90		37.33	19.22	None
10/30/90		38.15	18.40	None
11/20/90		38.33	18.58	None
12/19/90		38.30	18.25	None
1/30/91			Well Dry	
MW-4				
04/17/89		33.87	22.07	None
04/24/89		33.76	22.18	None
10/13/89	55.94	37.03	18.91	None
02/01/90		36.57	19.37	None
07/31/90		36.39	19.55	None

See notes on page 2.

TABLE 13
CUMULATIVE GROUND-WATER MONITORING DATA
ARCO Station 276
Oakland, California
(Page 2 of 2)

Date Well Measured	Well Elevation	Depth to Water	Water Elevation	Floating Product
MW-4 (continued)				
08/01/90		36.32	19.62	None
08/28/90		36.79	19.15	None
10/30/90		37.62	18.32	None
11/20/90		37.82	18.52	None
12/19/90		37.74	18.20	None
1/30/91		37.97	17.97	None
MW-5				
04/17/89		33.17	22.26	None
04/24/89		33.06	22.37	None
10/13/89	55.43	36.33	19.10	None
02/01/90		35.96	19.47	None
07/31/90		35.70	19.73	None
08/01/90		35.69	19.74	None
08/28/90		36.14	19.29	None
10/30/90		36.94	18.49	None
11/20/90		37.09	18.64	None
12/19/90		37.05	18.38	None
1/30/91		37.26	18.17	None

Depths are in feet below top of each well casing.
Elevations are referenced in feet above mean sea level.
Floating product reported in feet.

TABLE 14
CUMULATIVE RESULTS OF LABORATORY ANALYSIS OF WATER SAMPLES
ARCO Station 276
Oakland, California
(Page 1 of 2)

Date/Well	TPHg	TPHd	B	T	E	X	TOG
MW-1							
04/24/89	<50	NA	<0.50	<0.50	<0.50	<0.50	NA
10/13/89	<20	NA	<0.50	<0.50	<0.50	<0.50	NA
02/01/90	91	NA	<0.30	<0.30	<0.30	0.36	NA
07/31/90	<20	NA	<0.50	<0.50	<0.50	<0.50	NA
10/30/90	<50	NA	<0.5	<0.5	<0.5	<0.5	NA
1/30/91	<50	NA	<0.5	<0.5	<0.5	<0.5	NA
MW-2							
04/24/89	165,000	NA	13,000	21,000	2,100	12,700	NA
10/13/89			FLOATING PRODUCT				
02/01/90			SHEEN PRESENT				
07/31/90	240,000	NA	14,000	24,000	3,000	17,000	NA
10/30/90			FLOATING PRODUCT				
1/30/91			FLOATING PRODUCT				
MW-3							
04/24/89	560	NA	0.54	0.75	<0.50	<0.50	NA
10/13/89	450	NA	<0.50	<0.50	<0.50	<0.50	NA
02/01/90	360	NA	<0.30	<0.30	<0.30	0.85	NA
08/01/90	440	NA	<0.50	<0.50	<0.50	<0.50	NA
10/30/90	340	NA	<0.5	<0.5	<0.5	<0.5	NA
1/30/91	NS	NS	NS	NS	NS	NS	NS
MW-4							
04/24/89	2,500	NA	270	1.4	<0.50	85	NA
10/13/89	760	NA	0.86	<0.50	1.2	<0.50	NA
02/01/90	680	NA	<0.30	<0.30	<0.30	1.6	NA
07/31/90	470	240	<0.50	<0.50	<0.50	<0.50	<5,000
10/30/90	430	<100	<0.5	<0.5	<0.5	<0.5	<5,000
1/30/91	<50	<100	<0.5	<0.5	1.2	<0.5	<5,000
MW-5							
04/24/89	130	NA	0.67	<0.50	<0.50	<0.50	NA
10/13/89	75	NA	<0.50	<0.50	<0.50	<0.50	NA
02/01/90	81	NA	0.94	0.88	<0.30	1.8	NA
07/31/90	110	NA	<0.50	<0.50	<0.50	<0.50	NA
10/30/90	<50	NA	<0.5	<0.5	<0.5	<0.5	NA
1/30/91	<50	NA	<0.5	<0.5	<0.5	<0.5	NA

Results in micrograms per liter (ug/L) = parts per billion (ppb).
TPHg: Total petroleum hydrocarbons as gasoline by EPA method 8015.
TPHd: Total petroleum hydrocarbons as diesel by EPA method 3550/3510.
B: Benzene, T: Toluene, E: Ethylbenzene, T: Total Xylene isomers
BTEX: Measured by EPA method 8020/602.
TOG: Measured by Standard Method 503A/E.
<: Results reported as less than the detection limit. NA:Not analyzed

TABLE 14
CUMULATIVE RESULTS OF LABORATORY ANALYSIS OF WATER SAMPLES
ARCO Station 276
Oakland, California
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Date/Well		HVOs	MCLs
MW-4			
07/31/90	Trichloroethene	7.5	5.0
	Tetrachloroethene	1600	5.0
	1,2 Dichloroethene	0.7	6.0
10/30/90	Trichloroethene	8.1	5.0
	Tetrachloroethene	3600	5.0
	1,2 Dichloroethene	0.7	6.0
1/30/91	Trichloroethene	12	5.0
	Tetrachloroethene	4,900	5.0

Results in micrograms per liter (ug/L) = parts per billion (ppb).
Halogenated Volatile Organics: Measured by EPA method 601/8010.
Compounds not shown not detected.
NA: Not analyzed
Maximum Contaminant Levels (MCL's) as reported by the California Department of Health Services 10/24/90.
Trichloroethene: TCE. Tetrachloroethene: PCE.

FIELD PROTOCOL

The following presents Applied GeoSystems' protocol for a typical site investigation involving gasoline hydrocarbon-impacted soil and/or ground water.

Site Safety Plan

The Site Safety Plan describes the safety requirements for the evaluation of gasoline hydrocarbons in soil, ground-water, and the vadose-zone at the site. The site Safety Plan is applicable to personnel of Applied GeoSystems and its subcontractors. Applied GeoSystems personnel and subcontractors of Applied GeoSystems scheduled to perform the work at the site are be briefed on the contents of the Site Safety Plan before work begins. A copy of the Site Safety Plan is available for reference by appropriate parties during the work. A site Safety Officer is assigned to the project.

Soil Excavation

Permits are acquired prior to the commencement of work at the site. Excavated soil is evaluated using a field calibrated (using isobutylene) Thermo-Environmental Instruments Model 580 Organic Vapor Meter (OVM). This evaluation is done upon arrival of the soil at the ground surface in the excavator bucket by removing the top portion of soil from the bucket, and then placing the intake probe of the OVM against the surface of the soil in the bucket. Field instruments such as the OVM are useful for measuring relative concentrations of vapor content, but cannot be used to measure levels of hydrocarbons with the accuracy of laboratory analysis. Samples are taken from the soil in the bucket by driving laboratory-cleaned brass sleeves into the soil. The samples are sealed in the sleeves using aluminum foil, plastic caps, and aluminized duct tape; labeled; and promptly placed in iced storage. If field subjective analyses suggest the presence of hydrocarbons in the soil, additional excavation and soil sampling is performed, using similar methods. If ground water is encountered in the excavation, ground water samples are collected from the excavation using a clean Teflon® bailer. The ground water samples are collected as described below under "Ground-Water Sampling". The excavation is backfilled or fenced prior to departure from the site.

Sampling of Stockpiled Soil

One composite soil sample is collected for each 50 cubic yards of stockpiled soil, and for each individual stockpile composed of less than 50 cubic yards. Composite soil samples are obtained by first evaluating relatively high, average, and low areas of hydrocarbon concentration by digging approximately one to two feet into the stockpile and placing the

APPENDIX A

FIELD PROTOCOL

intake probe of a field calibrated OVM against the surface of the soil; and then collecting one sample from the "high" reading area, and three samples from the "average" areas. Samples are collected by removing the top one to two feet of soil, then driving laboratory-cleaned brass sleeves into the soil. The samples are sealed in the sleeves using aluminum foil, plastic caps, and aluminized duct tape; labeled; and promptly placed in iced storage for transport to the laboratory, where compositing will be performed.

Soil Borings

Prior to the drilling of borings and construction of monitoring wells, permits are acquired from the appropriate regulatory agency. In addition to the above-mentioned permits, encroachment permits from the City or State are acquired if drilling of borings offsite in the City or State streets is necessary. Copies of the permits are included in the appendix of the project report. Prior to drilling, Underground Services Alert is notified of our intent to drill, and known underground utility lines and structures are approximately marked.

The borings are drilled by a truck-mounted drill rig equipped with 8- or 10-inch-diameter, hollow-stem augers. The augers are steam-cleaned prior to drilling each boring to minimize the possibility of cross-contamination. After drilling the borings, monitoring wells are constructed in the borings, or neat-cement grout with bentonite is used to backfill the borings to the ground surface.

Borings for ground-water monitoring wells are drilled to a depth of no more than 20 feet below the depth at which a saturated zone is first encountered, or a short distance into a stratum beneath the saturated zone which is of sufficient moisture and consistency to be judged as a perching layer by the field geologist, whichever is shallower. Drilling into a deeper aquifer below the shallowest aquifer can begin only after a conductor casing is properly installed and allowed to set, to seal the shallow aquifer.

Drill Cuttings

Drill cuttings subjectively evaluated as having hydrocarbon contamination at levels greater than 100 parts per million (ppm) are separated from those subjectively evaluated as having hydrocarbon contamination levels less than 100 ppm. Evaluation is based either on subjective evidence of soil discoloration, or on measurements made using a field calibrated OVM. Readings are taken by placing a soil sample into a ziplock type plastic bag and allowing volatilization to occur. The intake probe of the OVM is then inserted into the headspace created in the plastic bag immediately after opening it. The drill cuttings from the borings are placed in labeled 55-gallon drums approved by the Department of

Transportation; or on plastic at the site, and covered with plastic. The cuttings remain the responsibility of the client.

Soil Sampling in Borings

Soil samples are collected at no greater than 5-foot intervals from the ground surface to the total depth of the borings. The soil samples are collected by advancing the boring to a point immediately above the sampling depth, and then driving a California-modified, split-spoon sampler containing brass sleeves through the hollow center of the auger into the soil. The sampler and brass sleeves are laboratory-cleaned, steam-cleaned, or washed thoroughly with Alconox® and water, prior to each use. The sampler is driven with a standard 140-pound hammer repeatedly dropped 30 inches. The number of blows to drive the sampler each successive six inches are counted and recorded to evaluate the relative consistency of the soil.

The samples selected for laboratory analysis are removed from the sampler and quickly sealed in their brass sleeves with aluminum soil, plastic caps, and aluminized duct tape. The samples are then be labeled, promptly placed in iced storage, and delivered to a laboratory certified by the State of California to perform the analyses requested.

One of the samples in brass sleeves not selected for laboratory analysis at each sampling interval is tested in the field using an OVM that is field calibrated at the beginning of each day it is used. This testing is performed by inserting the intake probe of the OVM into the headspace created in the plastic bag containing the soil sample as described in the Drill Cuttings section above. The OVM readings are presented in Logs of Borings included in the project report.

Logging of Borings

A geologist is present to log the soil cuttings and samples using the Unified Soil Classification System. Samples not selected for chemical analysis, and the soil in the sampler shoe, are extruded in the field for inspection. Logs include texture, color, moisture, plasticity, consistency, blow counts, and any other characteristics noted. Logs also include subjective evidence for the presence of hydrocarbons, such as soil staining, noticeable or obvious product odor, and OVM readings.

Monitoring Well Construction

Monitoring wells are constructed in selected borings using clean 2- or 4-inch-diameter, thread-jointed, Schedule 40 polyvinyl chloride (PVC) casing. No chemical cements, glues,

or solvents are used in well construction. Each casing bottom is sealed with a threaded end-plug, and each casing top with a locking plug. The screened portions of the wells are constructed of machine-slotted PVC casing with 0.020-inch-wide (typical) slots for initial site wells. Slot size for subsequent wells may be based on sieve analysis and/or well development data. The screened sections in ground-water monitoring wells are placed to allow monitoring during seasonal fluctuations of ground-water levels.

The annular space of each well is backfilled with No. 2 by 12 sand, or similar sorted sand, to approximately two feet above the top of the screened casing for initial site wells. The sand pack grain size for subsequent wells may be based on sieve analysis and/or well development data. A 1- to 2-foot-thick bentonite plug is placed above the sand as a seal against cement entering the filter pack. The remaining annulus is then backfilled with a slurry of water, neat cement, and bentonite to approximately one foot below the ground surface.

An aluminum utility box with a PVC apron is placed over each wellhead and set in concrete placed flush with the surrounding ground surface. Each wellhead cover has a seal to protect the monitoring well against surface-water infiltration and requires a special wrench to open. The design discourages vandalism and reduces the possibility of accidental disturbance of the well.

Ground-Water Monitoring Well Development

The monitoring wells are developed by bailing or over-pumping and surge-block techniques. The wells are either bailed or pumped, allowed to recharge, and bailed or pumped again until the water removed from the wells is determined to be clear. Turbidity measurements (in NTU's) are recorded during well development and are used in evaluating well development. The development method used, initial turbidity measurement, volume of water removed, final turbidity measurement, and other pertinent field data and observations are included in reports. The wells are allowed to equilibrate for at least 48 hours after development prior to sampling. Water generated by well development will be stored in 17E Department of Transportation (DOT) 55-gallon drums on site and will remain the responsibility of the client.

Ground-Water Sampling

The static water level in each well is measured to the nearest 0.01-foot using a Solinst® electric water-level sounder or oil/water interface probe (if the wells contain floating product) cleaned with Alconox® and water before use in each well. The liquid in the onsite wells is examined for visual evidence of hydrocarbons by gently lowering approximately half

the length of a Teflon® bailer (cleaned with Alconox® and water) past the air/water interface. The sample is then retrieved and inspected for floating product, sheen, emulsion, color, and clarity. The thickness of floating product detected is recorded to the nearest 1/8-inch.

Wells which do not contain floating product are purged using a submersible pump. The pump, cables, and hoses are cleaned with Alconox® and water prior to use in each well. The wells are purged until withdrawal is of sufficient duration to result in stabilized pH, temperature, and electrical conductivity of the water, as measured using portable meters calibrated to a standard buffer and conductivity standard. If the well becomes dewatered, the water level is allowed to recover to at least 80 percent of the initial water level. Prior to the collection of each ground water sample, the Teflon® bailer is cleaned with Alconox® and rinsed with tap water and deionized water, and the latex gloves worn by the sampler changed. Hydrochloric acid is added to the sample vials as a preservative (when applicable). A sample method blank is collected by pouring distilled water into the bailer and then into sample vials. A sample of the formation water is then collected from the surface of the water in each of the wells using the Teflon® bailer. The water samples are then gently poured into laboratory-cleaned, 40-milliliter (ml) glass vials, 500 ml plastic bottles or 1-liter glass bottles (as required for specific laboratory analysis) and sealed with Teflon®-lined caps, and inspected for air bubbles to check for headspace, which would allow volatilization to occur. The samples are then labeled and promptly placed in iced storage. A field log of well evacuation procedures and parameter monitoring is maintained. Water generated by the purging of wells is stored in 17E DOT 55-gallon drums onsite and remains the responsibility of the client.

Vadose-Zone Sampling

Vapor readings are made with a field calibrated OVM, which has a lower detection limit of 0.1 ppm. Prior to purging each vadose-zone monitoring well, an initial reading is taken inside the well by connecting the tubing of the OVM to a tight fitting at the top of the well. Each vadose-zone monitoring well is then purged for approximately 60 seconds using an electric vacuum pump connected to the tight fitting. Ambient readings of the air at the site are taken with the OVM after each well is purged. The OVM is then connected to the well fitting, and the reading recorded. The well is then again purged for approximately 30 seconds, and again measured using the OVM. These purging and measuring procedures are repeated until two consecutive OVM readings are within ten percent of each other.

Sample Labeling and Handling

Sample containers are labeled in the field with the job number, sample location and depth, and date, and promptly placed in iced storage for transport to the laboratory. A Chain of Custody Record is initiated by the field geologist and updated throughout handling of the samples, and accompanies the samples to a laboratory certified by the State of California for the analyses requested. Samples are transported to the laboratory promptly to help ensure that recommended sample holding times are not exceeded. Samples are properly disposed of after their useful life has expired.

Aquifer Testing

Bailer Test

The initial water level is measured in the test well, and water bailed from the test well using a Teflon® bailer and cable cleaned with Alconox® and water. Pressure transducers are used to measure water levels in the test well during drawdown and partial recovery phases, over a minimum period of approximately one to two hours. The bailing rate for the designated test well is recorded.

Pumping Test

The initial water levels in wells to be used during the test are measured prior to commencement of pumping. The flow rate of the pump is adjusted to the desired pumping rate, and water levels allowed to recover to initial levels. Pumping then begins, and the starting time of pumping is recorded. Drawdowns in observation wells are recorded at intervals throughout pumping using pressure transducers. Evacuated water is stored in a storage tank at the site and remains the responsibility of the client. After the pump is shut off, recovery measurements are taken in the wells until recovery is at least 80 percent of the initial water level. Barometric pressure and tidal information are collected for the time interval of the pumping test to allow screening of possible effects of atmospheric pressure and tidal fluctuations on the ground water levels.