

Juliet Shin
Alameda County Department
of Environmental Health
80 Swan Way, Room 200
Oakland CA 94621

14 November 1994

Project No. P170

Workplan
Soil and Groundwater Investigation
21031 Western Boulevard
Hayward CA

Dear Ms. Shin:

Attached is our workplan describing soil and groundwater investigation activities to be performed at the subject property. We are submitting the report on behalf of William and Kathy Florence, the property owners.

Please call us with any questions or comments.

Sincerely,
STREAMBORN

Keith Beury

Keith D. Beury
Environmental Engineer

Attachment

cc: William and Kathy Florence, Oakland CA

*Approved w/ additional provisions on
12/2/94 (see letter)
albreach*



94 NOV 23 PM 2:51

ALCO
HAZMAT

**Workplan
Soil and Groundwater Investigation
21031 Western Boulevard
Hayward CA**

Prepared For
William and Kathy Florence
Oakland CA



Expires 12/31/96

Prepared By
STREAMBORN
Berkeley CA

Project No. P170

14 November 1994

*Approved w/
additional provisions
on 12/2/94 - see letter.
Abbeech*

KEITH BEURY

Amy,

11/18/94

Please include the
workplan title page
(now signed by P.E.) in
the file for 21031
Western Blvd, Hayward CA.
Please call with any
questions. Thanks.

- Keith Beury

510 - 528 - 4234

MEMO

William and Kathy Florence
6316 Castle Drive
Oakland CA 94611

14 November 1994

Project No. P170

Workplan
Soil and Groundwater Investigation
21031 Western Boulevard
Hayward CA

Dear Mr. and Mrs. Florence:

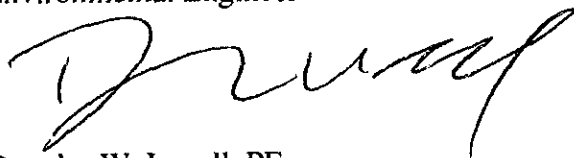
Attached is our workplan describing soil and groundwater investigation activities to be performed at the subject property. The proposed work is designed to determine (1) the extent of soil contamination, and (2) the presence or absence of groundwater contamination associated with releases from the former underground gasoline tank. The workplan has been prepared pursuant to Streamborn's 29 November 1993 proposal.

Please call us with any questions or comments.

Sincerely,
STREAMBORN



Keith D. Beury
Environmental Engineer



Douglas W. Lovell, PE
Geoenvironmental Engineer

Attachment

cc: Juliet Shin, Alameda County Department of Environmental Health, Oakland CA

**Workplan
Soil and Groundwater Investigation
21031 Western Boulevard
Hayward CA**

Prepared For
William and Kathy Florence
Oakland CA

Prepared By
STREAMBORN
Berkeley CA

Project No. P170

14 November 1994

CONTENTS

Introduction	1
Background	1
Purpose and Rationale	1
Scope of Work	2
Drilling, Soil Sampling, and Soil Analysis	2
Grouting of Boreholes Not Completed As Wells	2
Well Completion	3
Surveying	3
Well Development	3
Well Purging, Sampling, and Groundwater Analysis	3
Investigation-Derived Waste	3
Reporting	4
Quality Assurance/Quality Control	4
Quality Control Samples	4
Field Meter Quality Control Procedures	4
Schedule	4
Health and Safety	5
Tables (following text)	
1 - Environmental Chronology	
2 - Analytical Results of Historic Soil Sampling	
3 - Soil Sampling and Testing Requirements During Drilling	
4 - Well Completion Specifications	
5 - Groundwater Sampling and Testing Requirements	
Figures (following tables)	
1 - Location Map	
2 - Facility Layout	
3 - Monitoring Well Completion Schematic	
4 - Anticipated Schedule	
Appendices (following figures)	
A - Standard Operating Procedures	
B - Site Safety Plan	

INTRODUCTION

This workplan describes soil and groundwater investigation activities to be performed at 21031 Western Boulevard, Hayward CA (Figure 1). Planned activities include soil sampling from six borings, installation of three monitoring wells, and groundwater monitoring.

BACKGROUND

A chronology of environmental activities performed at 21031 Western Boulevard is summarized in Table 1.

In April 1989, the property was purchased by William and Kathy Florence. An out-of-service 1,000-gallon underground gasoline tank existed at the property at the time of purchase (Figure 2). The tank was never used by the new owners.

On 21 August 1989, West Coast Tank Testing removed the tank and a release was discovered. Approximately 20 cubic yards of gasoline-contaminated soil were overexcavated and stockpiled onsite. Representatives of the Eden Consolidated Fire Protection District and Alameda County were present during the tank removal. Two soil samples were collected from beneath the north and south ends of the tank (Table 2).

On 22 September 1989, approximately 80 cubic yards of soil were excavated. This soil was reportedly stockpiled with the previously-excavated soil. B & B Associated Services collected a composite sample of soil for analysis (Table 2). It is not documented whether the sample was representative of excavated or unexcavated soil.

On 2 October 1989, B & B Associated Services collected five soil samples for analysis, presumably from the limits of the enlarged excavation (Table 2).

On 13 October 1989, B & B Associated Services collected a composite sample of soil for analysis (Table 2). It is not documented whether the sample was representative of excavated or unexcavated soil.

Analytical results of soil sampling (Table 2) indicate a release of gasoline occurred. Documentation regarding the tank removal and subsequent overexcavation of contaminated soil is limited. West Coast Tank Testing and B & B Associated Services are no longer in business. Accordingly, details regarding overexcavation, soil sampling (including vertical and horizontal locations), and excavation backfilling are not available.

PURPOSE AND RATIONALE

The investigation described by this workplan is designed to:

- Define the extent of gasoline-contaminated soil associated with releases from the former tank.
- Evaluate if groundwater is impacted by releases from the tank.
- Define the depth to groundwater and the direction of the groundwater gradient.

- Provide the data needed to develop a remediation plan and establish site-specific cleanup levels.

To determine the extent of soil contamination, six exploratory borings will be drilled around the former tank. The borings will be drilled to a depth of approximately 7-feet below the groundwater table. Groundwater is estimated at a depth of 15-feet. Samples will be collected at selected depths from each boring and retained for laboratory analysis.

The groundwater investigation will include completion of three borings as monitoring wells. Proposed well locations are shown on Figure 2. Based on the regional topography and informal discussions with local regulatory agencies, the local groundwater gradient is anticipated to generally trend from east to west (toward San Francisco Bay). The local depth to groundwater is anticipated to be approximately 15-feet.

Two wells will be positioned within 10-feet and on the assumed downgradient side of the former tank. A third well will be positioned on the assumed upgradient side of the former tank, to monitor the groundwater gradient.

Groundwater monitoring will be conducted quarterly for one year. The proposed monitoring program will serve to document groundwater quality at the former tank location.

SCOPE OF WORK

Drilling, Soil Sampling, and Soil Analysis

Prior to drilling, permits will be obtained from Zone 7 Water Agency. Underground alert will be notified of the planned boring locations.

Soil borings will be drilled to a depth of approximately 7-feet below the groundwater table, using hollow-stem auger drilling. Drilling and soil sampling will be performed in accordance with Standard Operating Procedure 1A: Hollow-Stem Auger Drilling and Split Spoon Sampling (Appendix A). Boring locations are shown on Figure 2. Soil sampling and testing requirements are delineated in Table 3.

Soil samples will be collected at 5-foot intervals or at discernible changes in strata, whichever is more frequent. Samples will be screened in the field using an organic vapor meter. If contamination is not observed during drilling, two samples from each boring will be analyzed for TPH-gasoline and BTEX. One sample coincident with the groundwater table will be analyzed. A second sample will be collected for analysis from the next-shallowest sampling interval.

If field observations indicate the presence of soil contamination, additional samples may be collected from the contaminated horizon.

Grouting of Boreholes Not Completed As Wells

After soil sampling, the three boreholes that will not be completed as wells, will be backfilled with neat cement grout. Grout will consist of 94-pounds of cement to 5-gallons of water.

Well Completion

Three of the boreholes will be completed as 2-inch diameter groundwater monitoring wells, constructed in accordance with guidelines outlined in Standard Operating Procedure 2A: Completion of Borings as Wells (Appendix A). Well locations are shown on Figure 2. Completion schematics are shown on Figure 3. Well specifications are delineated in Table 4.

The conditions anticipated during preparation of this workplan may not be encountered and modifications to the well completion specifications may be appropriate. For example, if an aquitard or non-water bearing soil horizon is encountered at a depth of five feet below the water table, then drilling should be terminated and the well screen should extend to only five feet below the water table. Such field design modifications preserve the natural integrity of the aquifer system thus reducing the possibility of cross contamination.

Surveying

The well elevations (top of casing, traffic box, and ground surface) will be surveyed relative to site-specific datum.

Well Development

The wells will be developed in accordance with Standard Operating Procedure 3A: Well Development (Appendix A). Well development should produce relatively non-turbid formation water, subject to reasonable time limitations.

Well Purging, Sampling, and Groundwater Analysis

The wells will be sampled for four quarters. Well sampling will conform to Standard Operating Procedure 20: Well Purging and Sampling Using Bailers (Appendix A). Sampling will include purging to draw fresh formation water into the wells. If the wells do not provide sufficient recharge, the purge step may be abbreviated. Groundwater sampling requirements are summarized in Table 5.

The first sampling event will be conducted approximately 1 week after development of the wells.

Groundwater samples will be analyzed for TPH-gasoline and BTEX.

Investigation-Derived Waste

Soil sampling and groundwater monitoring activities will generate the following wastes:

- Soil cuttings and excess soil samples.
- Development and purge water.
- Decontamination wastewater.

Decontamination wastewater will be discharged to the sanitary sewer.

Development and purge water, and soil cuttings will be containerized in clean, steel 55-gallon DOT 17H drums pending receipt of analytical results. Aqueous wastes represented by chemical measurements where chemicals are not detected may be treated as inert. Limited quantities of inert waters may be discharged to sanitary sewer, subject to sanitary district approval. Inert soils may be disposed of at a local Class III landfill or may be reused as fill material.

Non-inert wastes require specific interpretation with respect to current regulations. These regulations require classification of the waste by the generator; accordingly, it will be the responsibility of William and Kathy Florence to classify and arrange for disposal of these wastes.

Reporting

One report and three updates will be submitted. The initial report will document details of drilling and soil sampling, monitoring well construction, well development, initial groundwater analytical results, and disposition of investigation-derived waste. The initial report will describe any variations from the procedures outlined in this workplan.

Updates will be prepared upon receipt of the results of analysis of the quarterly groundwater samples. The quarterly updates will compare the most recent analytical results with results of earlier sampling rounds. The updates will discuss any changes in chemistry or water level.

QUALITY ASSURANCE/QUALITY CONTROL

Specific quality control procedures for sample collection and field testing are discussed in the standard operating procedures (Appendix A).

Quality Control Samples

The laboratory will include laboratory blank, laboratory replicate, and laboratory spike quality control samples during soil and groundwater analysis. Field quality control samples will not be collected or analyzed.

Field Meter Quality Control Procedures

Meters for measurement of field parameters (pH, specific conductance, temperature, and dissolved oxygen) will be calibrated daily. Calibration standards should generally approximate or span the anticipated range of measurements. Recalibration may be appropriate if unusual measurements are noticed.

The field organic vapor monitor (used for site safety and to screen soil samples) will be calibrated using a standard gas prior to the beginning of each field day. Recalibration may be appropriate if unusual measurements are noticed.

SCHEDULE

The workplan will be implemented in accordance with the anticipated schedule shown on Figure 4. The estimated schedule is predicated on favorable weather and timely response from the regulatory agencies (approval of the workplan and issuance of well permits).

HEALTH AND SAFETY

The Site Safety Plan in Appendix B presents the procedures to be followed to protect the safety of onsite workers during planned field work at the subject property. Physical and chemical hazards, such as working around heavy equipment and exposure to chemicals, are addressed. Work is planned in a previously investigated area, with existing data suggesting minimal chemical hazards. Although the proposed investigation does not necessarily require adherence to safety protocols for hazardous waste sites, the procedures in the Site Safety Plan are intended to comply with the pertinent sections of 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.

Table 1
Environmental Chronology

Date	Performed By	Description
April 1989	William and Kathy Florence	<ul style="list-style-type: none"> • Property at 21031 Western Boulevard was purchased by William and Kathy Florence. • An out-of-service 1,000-gallon underground gasoline tank existed at 21031 Western Boulevard at the time of purchase.
21 August 1989	West Coast Tank Testing	<ul style="list-style-type: none"> • The tank was removed from 21031 Western Boulevard. • Approximately 20 cubic yards of gasoline-contaminated soil were overexcavated and stockpiled onsite. • Two soil samples were collected from the excavation. The sample depths and exact locations were not documented. Analytical results indicated elevated concentrations of TPH-gasoline and BTEX.
22 September 1989	West Coast Tank Testing	<ul style="list-style-type: none"> • Approximately 80 cubic yards of gasoline-contaminated soil were excavated and stockpiled onsite.
September and October 1989	B&B Associated Services	<ul style="list-style-type: none"> • Several grab and composite soil samples were apparently collected from the tank excavation. The sample depths and exact locations were not documented. Analytical results indicated elevated concentrations of TPH-gasoline and BTEX.

Table 2
Analytical Results of Historic Soil Sampling

Presumed Sample Location	Depth (feet)	Sample Date	Sample Identification	Collected by	Sample Type	TPH-Gasoline (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-benzene (mg/kg)	Xylenes (mg/kg)
North side of excavation	Not documented	21 August 1989	No. 1 North End	B&B Associated Services	Grab	5,700	30	16	110	630
South side of excavation	Not documented	21 August 1989	No. 2 South End	B&B Associated Services	Grab	3.2	<0.04	0.059	0.077	0.60
Unknown	Not documented	22 September 1989	Composite of No. 1-N No. 2-NE No. 3-S No. 4-NW	B&B Associated Services	Composite	1,500	61	210	52	280
Northwest side of excavation	Not documented	2 October 1989	No. 1 NW	B&B Associated Services	Grab	1.2	<0.01	<0.01	0.038	0.13
Northeast side of excavation	Not documented	2 October 1989	No. 2 NE	B&B Associated Services	Grab	<0.5	<0.01	<0.01	<0.02	<0.06
Southwest side of excavation	Not documented	2 October 1989	No. 3 SW	B&B Associated Services	Grab	7.3	<0.01	0.10	0.07	0.96
Southeast side of excavation	Not documented	2 October 1989	No. 4 SE	B&B Associated Services	Grab	9,500	3.7	370	230	1,500
Center of excavation	Not documented	2 October 1989	No. 5 Center	B&B Associated Services	Grab	2,200	4.3	55	40	220
Unknown	Not documented	13 October 1989	Composite of No. 1 No. 2 No. 3	B&B Associated Services	Composite	<0.5	<0.01	<0.02	<0.02	<0.06

General Notes

- (a) < indicates concentration below detection limit (shaded values).
- (b) Laboratory analysis performed by Trace Analysis Laboratory, Hayward CA.
- (c) Sample locations and depths were not documented.

Table 3
Soil Sampling and Testing Requirements During Drilling

Item	Requirement
Sampling Interval and Sample Type	Collect discrete (grab) samples at selected intervals; typically at 5-foot centers or detectable changes in strata, whichever is more frequent. Collect additional liner samples if elevated organic vapor readings and/or contamination are observed.
Sampler	Split-spoon sampler, 2-inch inside diameter with liners.
Liners	2-inch diameter by 6-inch length, brass or stainless.
Sampler and Liner Decontamination	Wash or steam clean split-spoon between samples and borings. Wash liners with soap, rinse with tap water, rinse with distilled water.
Field Observations and Measurements	Screen samples with field organic vapor monitor. Note staining or odor. Visually classify samples according to ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Measure penetration resistance (blow/foot) during driving of split-spoon.
Hollow Stem Auger	Approximate 4-inch inside diameter, 8-inch outside diameter augers.
Samples Retained for Physical Testing	None.
Sample Handling for Physical Testing	Not applicable.
Samples Retained for Chemical Testing	If contamination is not observed during drilling, two samples from each boring will be analyzed for TPH-gasoline and BTEX. One sample coincident with the groundwater table will be analyzed. A second sample will be collected for analysis from the next-shallowest sampling interval. If field observations indicate the presence of soil contamination, additional soil samples may be analyzed.
Sample Handling for Chemical Testing	Cap liner with Teflon sheet, plastic cap, and duct tape (do not use electrical tape). Label liner, place in ziplock bag, and store on ice in cooler until delivery to the laboratory. Log chemical samples on chain-of-custody form and maintain sample security.
Quality Control Samples for Chemical Testing	None.

General Notes

- (a) TPH-gasoline = total petroleum hydrocarbons as gasoline.
- (b) BTEX = benzene, toluene, ethylbenzene, and xylenes.

Table 4
Well Completion Specifications

Item	Requirement
Number of Wells	Three
Casing Type	Schedule 40 PVC, flush-threaded couplings.
Casing Diameter	Nominal 2-inch inside diameter.
Total Length	Approximately 7-feet below the groundwater table. Assuming the groundwater table is at 15-feet, the well boring will be drilled to approximately 22-feet below ground surface.
Centralizers	None.
Bottom Cap	Threaded or slip-on (use stainless steel screws for slip-on cap, do not use glue).
Sediment Trap	None.
Screen Length	10-feet.
Slots	0.01-inch, factory-slotted.
Casing and Screen Decontamination	Steam clean, pressure wash, or soap wash prior to installation.
Filter Pack	#2/12 or similar silica sand.
Filter Pack Interval	6-inches below bottom cap to approximately 2-feet above top of screened interval.
Bentonite Seal	Natural bentonite chips or pellets, minimum 2-foot layer above filter pack.
Grout	Cement-bentonite (approximately 5% bentonite).
Surface Completion	Flush-mounted traffic-rated box with locking top cap.

Table 5
Groundwater Sampling and Testing Requirements

Item	Requirement
Sampling Frequency and Duration	Quarterly for one year (4 events, 1 every 3 months).
Purge Equipment	Bailer.
Purge Equipment Decontamination	Wash with soap, rinse with tap water, rinse with distilled water.
Field Measurements and Observations During Purging	Water level prior to purge. Turbidity (qualitative clarity and color), pH, temperature, dissolved oxygen, specific conductivity, purge volume.
Purge Criteria	Wells that recharge in a timely manner should be purged of at least 3 static casing volumes and sampled after field parameters stabilize, provided that the wells are sampled before 10 static casing volumes are removed. Wells that recharge slowly may be purged dry once and sampled after recharge is sufficient to submerge the bailer.
Sampler	Teflon bailer with bottom-emptying device.
Sampler Decontamination	Wash with soap, rinse with tap water, rinse with distilled water.
Sample Collection	Lower bailer to midpoint of standing water column to collect sample. Discharge sample from bottom of bailer to bottom of sample containers without aeration.
Sample Analysis	Analyze samples for TPH-gasoline and BTEX.
Sample Containers	Three 40-milliliter glass vials for TPH-gasoline and BTEX.
Sample Handling and Preservation	Verify no headspace in 40 milliliter vials. Label containers, place in ziplock bags, store on ice in cooler, enter onto chain-of-custody, maintain sample custody until sent to laboratory.
Quality Control Samples	None.

General Notes

- (a) TPH-gasoline = total petroleum hydrocarbons as gasoline.
- (b) BTEX = benzene, toluene, ethylbenzene, and xylenes.

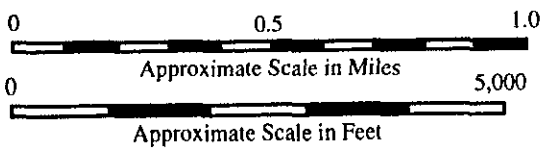
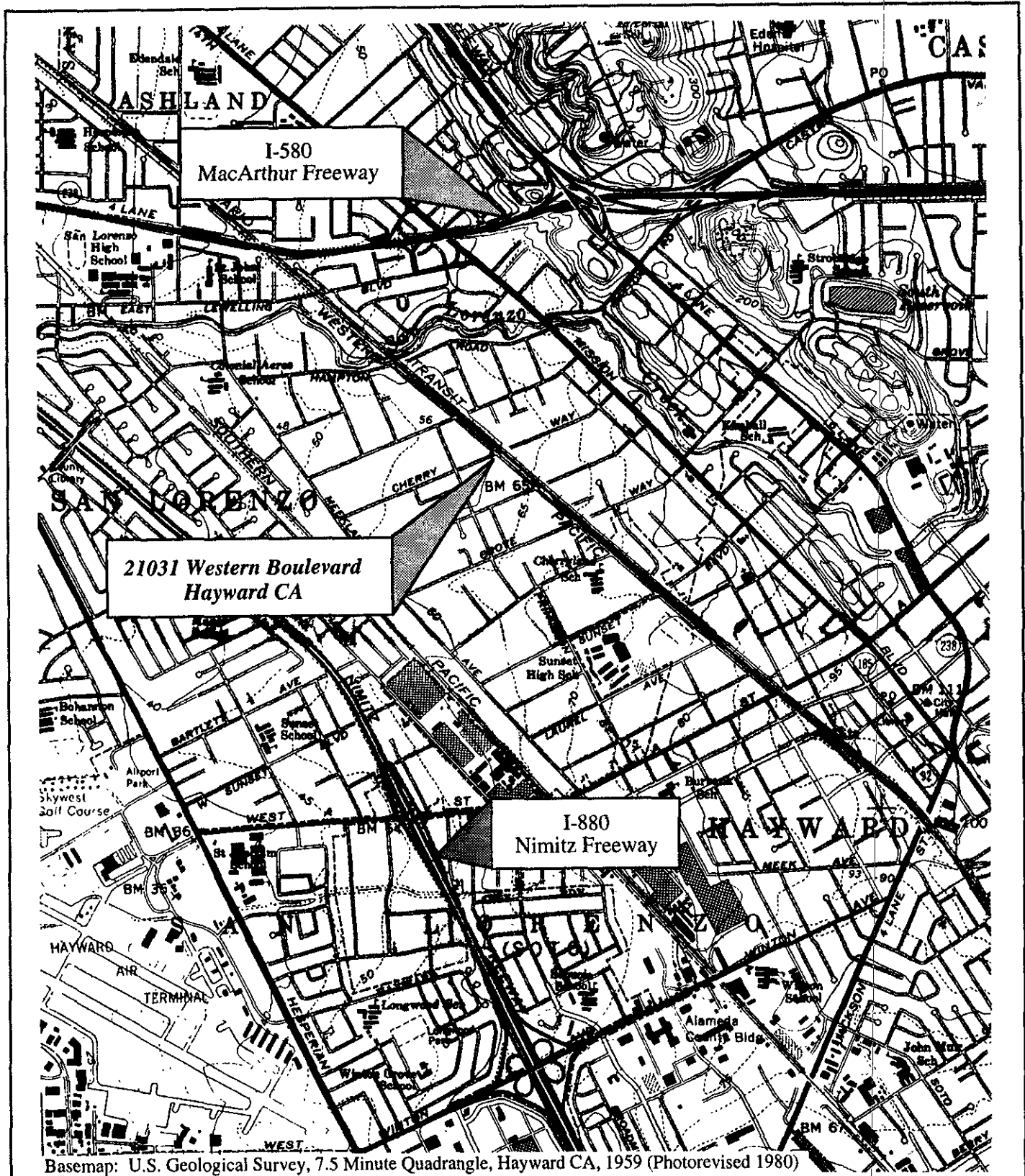
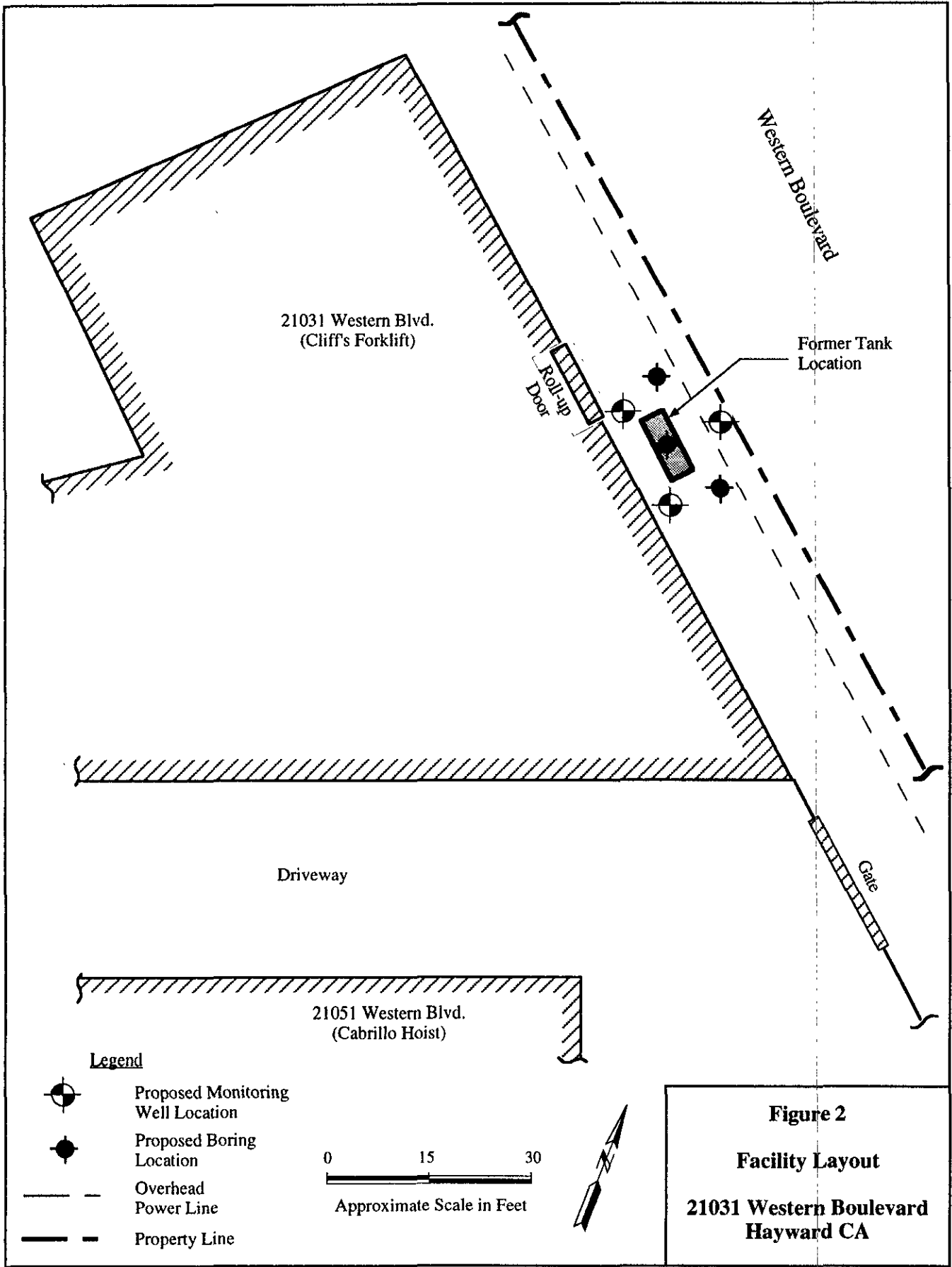
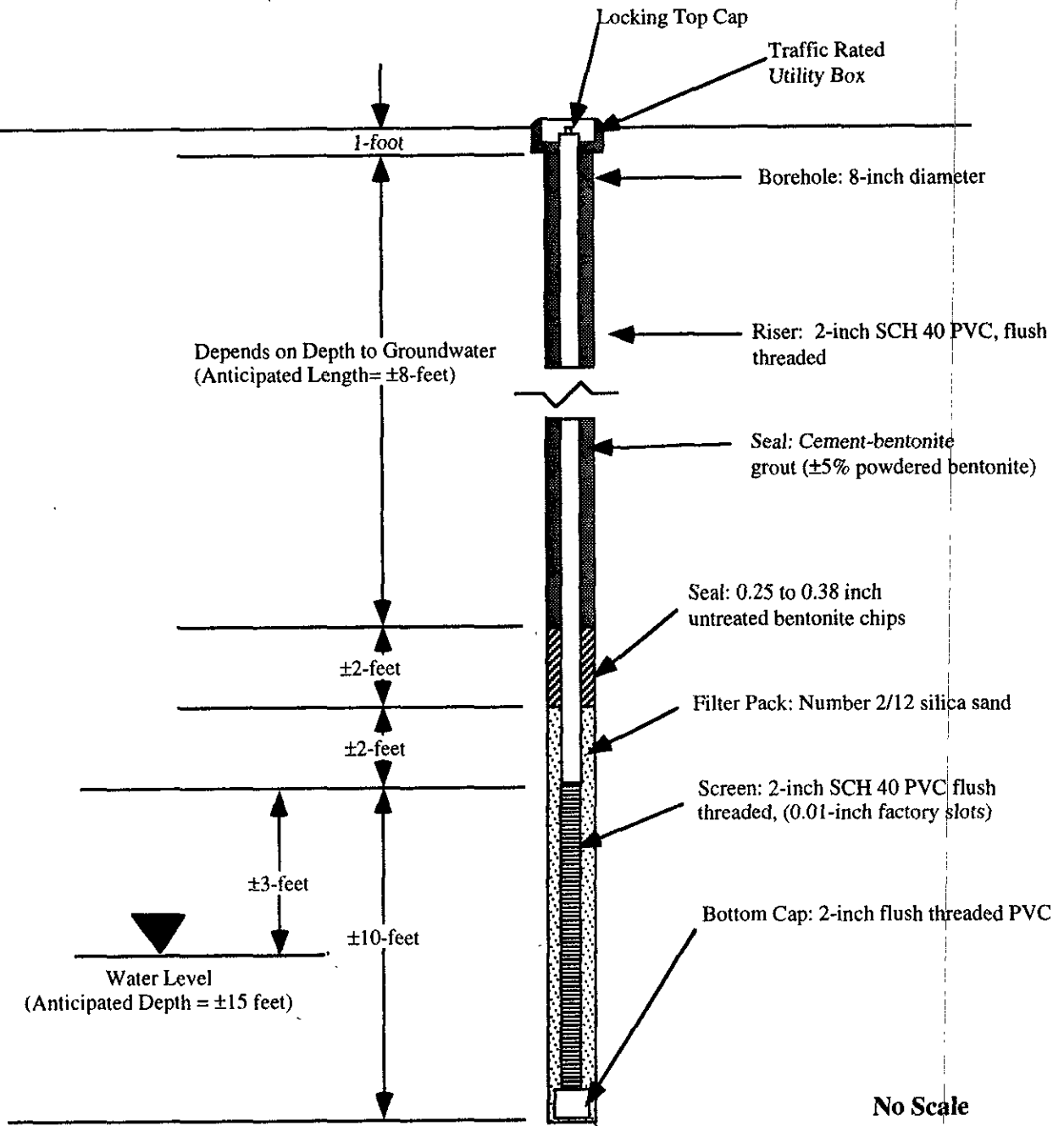


Figure 1
Location Map
21031 Western Boulevard
Hayward CA





Note: This design should be modified to conform to site-specific conditions observed during drilling.

Figure 3
Monitoring Well
Completion Schematic
 21031 Western Boulevard
 Hayward CA

Soil and Groundwater Investigation

Schedule Item	Nov 1994				Dec 1994				Jan 1995					Feb 1995			
	7	14	21	28	5	12	19	26	2	9	16	23	30	6	13	20	27
Regulatory Review of Workplan (assumed timeframe)																	
Obtain Drilling Permits/Scheduling																	
Well Installation																	
Well Development and Surveying																	
Groundwater Sampling and Laboratory Analysis																	
Prepare Summary Report Report																	
Submittal of Summary Report																	

General Note

(a) Second, third, and fourth groundwater monitoring episodes are not shown.

Figure 4
Anticipated Schedule
21031 Western Boulevard
Hayward CA

APPENDIX A

Standard Operating Procedures

STANDARD OPERATING PROCEDURE (SOP) 1A HOLLOW-STEM AUGER DRILLING AND SPLIT-SPOON SOIL SAMPLING

1.0 INTRODUCTION AND SUMMARY

This SOP describes methods for drilling with the use of hollow-stem augers and soil sampling with the use of split-spoon samplers. Drilling activities covered by this SOP may be conducted to obtain soil samples or to create a borehole within which a well may be constructed. Soil samples may be obtained to log subsurface materials, to collect samples for chemical characterization, or to collect samples for physical parameter characterization.

The soil sampling techniques described in this SOP are generally suitable for chemical characterization and physical classification tests; because a driven split-spoon sampler is employed, the resulting soil samples should generally be considered "disturbed" with respect to physical structure and may not be suitable for measuring sensitive physical parameters, such as strength and compressibility. The augering techniques described in this SOP generally produce a borehole with a diameter corresponding to the outside diameter of the auger flights, a relatively small annulus of remoulded soil surrounding the outside diameter of the auger flights, and limited capability for cross-contamination between subsurface strata as the leading flights of the augers pass from contaminated strata to uncontaminated underlying strata. However, should conditions require strict measures to help prevent cross-contamination or maintain the integrity of an aquitard, consideration should be given to augmenting the procedures of this SOP, for example, by using pre-drilled and grouted isolation casing.

The procedures for hollow-stem auger drilling and split-spoon soil sampling generally consist of initial decontamination, advancement of the augers, driving and recovery of the split-spoon sampler, logging and packaging of the soil samples, decontamination of the split-spoon, and continued augering and sampling until the total depth of the borehole is reached. Withdrawal of the augers upon reaching the total depth requires completion of the borehole by grouting, by constructing a well, or other measures; borehole completion is not covered in this SOP.

2.0 EQUIPMENT AND MATERIALS

- Drill rig, drill rods, hollow-stem augers, and drive-weight assembly (for driving the split-spoon sampler) should conform to ASTM D 1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils, except: (1) hollow-stem augers may exceed 6.5 inches inside diameter as may be necessary for installing 4-inch diameter well casing, (2) hollow-stem augers should have a center bit assembly (end plug), (3) alternative drive-weight assemblies or downhole hammers are acceptable as long as the type, weight, and equivalent free fall are noted on the boring log.
- Split-spoon sampler should conform to ASTM D 1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils, except: (1) split-spoon should be fitted with liners for collection of chemical

characterization sample, and (2) allowable split-spoon diameters include nominal 1-1/2-inch inside diameter by nominal 2-inch outside diameter (Standard Penetration Test split-spoon), nominal 2-inch inside diameter by nominal 2-1/2-inch outside diameter (California Modified split-spoon), or nominal 2-1/2-inch inside diameter by nominal 3-inch outside diameter (Dames & Moore split-spoon). The split-spoon type and length of the split-barrel portion of the sampler should be noted on the boring log, as should the use of a sample catcher if employed.

- Liners should be 3- to 6-inch length, fitted with plastic end-caps, brass or stainless steel, with a nominal diameter corresponding to that of the inside diameter of the split-spoon sampler. The boring log should note whether brass or stainless steel liners were used.
- Teflon sheets, approximate 6-mil thickness, precut to a diameter or width of the liner diameter plus approximately 1 inch
- 1/2-pint widemouth glass jars, laboratory cleaned
- Kimwipes, certified clean silica sand, or deionized water (for blank sample preparation)
- Duct tape
- Sample labels, boring log forms, chain-of-custody forms, hazardous waste labels, and daily report forms
- Ziploc plastic bags of size to accommodate a liner
- Stainless steel spatula and knife
- Cooler with ice or dry ice (do not use blue ice)
- Field organic vapor monitor. The make, model, and calibration information of the field organic vapor monitor (including compound and concentration of calibration gas) should be noted on the boring log.
- Aluminum foil, and rubber bands
- Pressure washer or steam cleaner
- Large trough (such as a water tank for cattle), plastic-lined pit, or equivalent for decontamination of hollow-stem augers, drill rod, and end plug
- Buckets and bristle brushes for decontamination of liners, split-spoon sampler, and other small gear
- Low residue, organic free soap such as Liquinox or Alconox
- Distilled water
- Steel, 55-gallon, open-top drums conforming to the requirements of DOT 17H

As specified in the Site Safety Plan, additional safety and personnel decontamination equipment and materials may be needed.

3.0 TYPICAL PROCEDURES

The following typical procedures are intended to cover the majority of drilling and sampling conditions. However, normal field practice requires re-evaluation of these procedures and implementation of alternate procedures upon encountering unusual or unexpected subsurface conditions. Deviations from the following typical procedures may be expected and should be noted on the boring log.

1. Decontaminate drill rig, drill rods, hollow-stem augers, split-spoon sampler and other drilling equipment immediately prior to mobilization to the site.
2. Investigate the location of the proposed boreholes for buried utilities and obstructions. At least 48 hours before drilling, contact known or suspected utility services individually or through collective services such as "USA" and "Underground Alert". As appropriate, retain private buried utility location services or geophysical investigation services to search for buried utilities and obstructions. Also as appropriate, pothole suspect utility locations prior to drilling or relocate boreholes. During initial advancement of each borehole, drill cautiously and have the driller pay particular attention to the "feel" of the hollow-stem auger. The suspected presence of an obstruction, buried pipeline or cable, utility trench backfill, or similar may be cause for suspension of drilling, subject to further investigation.
3. Advance the hollow-stem auger, fitted with end plug, to the desired sampling depth. Note depth interval, augering conditions, and driller's comments on boring log. Samples should be taken at intervals of 5 feet or less in homogeneous strata and at detectable changes of strata.
4. Remove drill rod and end plug from the hollow stem and note presence of water mark on drill rod, if any. If below the groundwater table in clean sand, allow water level in hollow-stem to equilibrate prior to removing end plug and remove plug slowly so as to minimize suction at the base of the plug. Also, monitor top of hollow-stem using field organic vapor monitor, as appropriate.
5. Decontaminate split-spoon, liners, spatulas and knives, and other equipment that may directly contact the chemical characterization sample. Fit split-spoon with liners and attach to drill rod.
6. Lower split-spoon sampler through hollow-stem of auger until sampler is resting on soil. Note discrepancy between elevation of tip of sampler and leading edge of augers, if any. If more than 6-inches of slough exists inside the hollow-stem augers, consider the conditions unsuitable

and re-advance the hollow-stem augers and end plug to a new sampling depth.

7. Drive and recover the split-spoon according to the requirements of ASTM D 1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils. Record depth interval, hammer blows for each 6-inches, and sample recovery on boring log. Monitor the recovered split-spoon with the field organic vapor monitor, as appropriate.
8. Remove either bottom-most or second-from-bottom liner (or both) from split-spoon for purposes of chemical characterization and physical parameter testing. Observe soil at each end of liner(s) for purposes of completing sample description. Place teflon sheet at each end of liner, cover with plastic caps, and tape plastic caps with duct tape (do not use electrical tape) to further minimize potential loss of moisture or volatile compounds. Label liner(s) and place in ziploc bag on ice or dry ice inside cooler.
9. Extrude soil from remaining liner(s) and subsample representative 1-inch cube (approximate dimensions). Place subsample in widemouth glass jar, cover jar with aluminum foil and seal foil to jar with rubber band. Allow jar to equilibrate at ambient conditions for approximately 5 minutes and screen for organic vapors by inserting the probe of the field organic vapor monitor through the aluminum foil. Record depth interval, observed sample reading, and ambient (background) reading on the boring log. Glass jars may be reused by discarding the soil subsample and wiping any residue from the jar using a paper towel.
10. Visually classify soil sample in approximate accordance with ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Descriptions should include moisture content, color, textural information, group symbol, group name, and odor. Optional descriptions, especially if classification is performed with protective gloves, include particle angularity and shape, clast composition, plasticity, dilatancy, dry strength, toughness, and reaction with HCl. Add notes on geologic structure of sample, as appropriate. Record depth interval, visual classification, and other notes to the boring log.
11. Repeat steps 3 through 10 until total depth of borehole is reached.
12. Complete borehole according to the requirements specified elsewhere.
13. Decontaminate hollow-stem augers, drill rod, and end plug between boreholes and after finishing last borehole prior to drill rig leaving site.
14. Change decontamination solutions and clean decontamination trough, buckets, and brushes between boreholes.
15. Containerize soil cuttings, excess soil sample, and decontamination wastewaters in steel drums. Affix hazardous waste labels to the drums.

16. Complete pertinent portion of the chain-of-custody form and daily activity report.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality control sampling consists of sequential replicates, collected at an approximate frequency of 1 sequential replicate for every 10 natural samples. Sequential replicates are collected by packaging two adjacent liners of soil from a selected split-spoon drive. Each sample is labeled according to normal requirements. The replicate samples obtained in such a manner are suitable for assessing the reproducibility of both chemical and physical parameters. Interpretations of data reproducibility should recognize the potential for significant changes in soil type, even over 6-inch intervals. Accordingly, sequential replicates do not supply the same information as normally encountered duplicate or split samples. Duplicate or split samples are better represented by the laboratory performing replicate analyses on adjacent subsamples of soil from the same liner.

Optional quality control samples may be collected to check for cross-contamination using field blanks. Field blanks may be prepared by (1) swipe sampling decontaminated liners and split-spoon with kimwipes, (2) pouring clean silica sand into a decontaminated split-spoon sampler that has been fitted with liners, or (3) pouring deionized water over the decontaminated liners and split-spoon and collecting the water that contacts the sampling implements for aqueous analysis. Field blanks may be prepared at the discretion of the field staff given reasonable doubt regarding the efficacy of the decontamination procedures.

The comparability of the field visual classification may be checked by conducting laboratory classification tests. Requests for laboratory testing verification of the field classification should be left to the discretion of the field staff.

Field decisions that may also affect the quality of collected data include the frequency of sampling and the thoroughness of documentation. Subject to reasonable limitations of budget and schedule, the completeness, comparability, and representativeness of data obtained using this SOP will be enhanced by decreasing the sampling interval (including collecting continuous samples with depth) and increasing the level of detail for sample classification and description of drilling conditions. More frequent sampling and more detailed documentation may be appropriate in zones of chemical concentration or in areas of critical geology (for example, zones of changing strata or cross-correlation of confining strata).

5.0 DOCUMENTATION

Observations, measurements, and other documentation of the drilling and soil sampling effort should be recorded on the following:

- Daily Report
- Field Notebook
- Boring Log

- Sample Label
- Chain-of-Custody

Documentation should include any deviations from this SOP, notations of unusual or unexpected conditions, and documentation of the containerization and disposition/disposal of investigation-derived waste. Specific instructions for selected forms are provided below.

5.1 Sample Label

- Project name and project number
- Boring or well number
- Sample depth interval (feet below ground surface), record the depth interval using notation similar to "19.2-19.7", generally do not record just one depth "19.2" because of uncertainty regarding the location such depth corresponds to (midpoint, top, etc.)
- Sample date and sample time
- Sampler
- Optional designation of orientation of sample within the subsurface, for example, an arrow with "up" or "top" designated

5.2 Boring Log

- Project name and project number
- Boring number
- Description of boring location, including taped or paced measurements to noticeable topographic features (a location sketch should be considered)
- Date and time drilling started and completed
- Drilling company and name of drilling supervisor, optional names and responsibilities of drillers helpers
- Manufacturer and model number of drill rig
- Inside diameter of the hollow stem and outside diameter of the auger flights of the hollow-stem augers, optional description of type of bit on end plug and leading edge of auger, optional description of the size of drill rod
- Depth at which groundwater was first encountered with the notation "during drilling"
- Method of borehole completion

- Other notations and recordings described previously in 2. EQUIPMENT AND MATERIALS and 3. TYPICAL PROCEDURES

6.0 DECONTAMINATION

Prior to entering the site, the drill rig and appurtenant items (drill rod, hollow-stem augers, end plug, split-spoon sampler, shovels, troughs and buckets, drillers stand, etc.) should be decontaminated by steam cleaning or pressure washing. Between each borehole, appurtenant items that contacted downhole soil (essentially all appurtenant items including drill rod, hollow-stem augers, end plug, split spoon sampler, shovels, troughs and buckets, etc.) should be decontaminated by steam cleaning or pressure washing. Prior to leaving the site, the drill rig and appurtenant items should be decontaminated by steam cleaning and pressure washing. Onsite decontamination should be conducted within the confines of a trough or lined pit to temporarily contain the wastewater. Between each borehole and prior to demobilization, the trough or lined pit should be decontaminated by steam cleaning or pressure washing. If a rack or other support is used to suspend appurtenant items over the trough or lined pit during decontamination, only the rack or other support needs to be decontaminated between boreholes.

Prior to each sample, the split-spoon sampler, liners, sample catcher, spatulas and knives, and other equipment or materials that may directly contact the sample should be decontaminated. Decontamination for these items should consist of a soap wash (Alconox, Liquinox, or other organic free - low residue soap), followed by a tap water rinse, followed by a distilled water rinse. Wastewater from the soap wash should be temporarily contained. Wastewater from the tap water and distilled water rinses may be discharged to the ground surface or a sanitary sewer.

Between each borehole, buckets and brushes should be decontaminated by steam cleaning or pressure washing. Before each borehole, fresh decontamination solutions should be prepared.

7.0 INVESTIGATION-DERIVED WASTE

Wastes resulting from the activities of this SOP may include soil cuttings, excess soil sample, decontamination wastewaters, and miscellaneous waste (paper, plastic, gloves, jars, aluminum foil, etc.) Unless otherwise prohibited by the Site Safety Plan, miscellaneous waste should be double-bagged in plastic garbage bags and disposed of as municipal waste.

Soil cuttings and excess soil sample from each borehole should be placed in individual steel drums with hazardous waste labels affixed. Solids from multiple boreholes may be combined within a single drum if field observations (presence or absence of chemical staining and field organic vapor monitoring) indicate the solids are similarly uncontaminated or similarly contaminated. Given sufficient drums and reasonable doubt, separate drums should be used for each borehole.

Decontamination wastewaters for each borehole should be placed in individual steel drums with hazardous waste labels affixed. Wastewaters from multiple boreholes may be combined, subject to the same limitations as solids.

8.0 SAFETY

Normal and special safety precautions are described in the Site Safety plan. The Site Safety plan should be reviewed periodically during drilling to keep mindful of important safety measures. Physical hazards typically prevail because the drill rig contains exposed rotating and hammering equipment and because drill rod and augers are heavy material with sharp edges.

Chemical hazards are typically discovered upon withdrawal of the end plug or withdrawal of the soil-filled split-spoon sampler from the hollow-stem auger, as well as removal of the soil-filled liners from the split-barrel. Opportune monitoring for volatile chemicals may be conducted at these times. Splash protection and direct contact protection are also essential measures to minimize the potential for chemical exposure.

9.0 REFERENCES

- American Society for Testing and Materials, 1989. 1989 Annual Book of ASTM Standards, Section 4 - Construction, Volume 4.08 - Soil and Rock, Building Stones; Geotextiles. ASTM, Philadelphia, PA. 1989.
- Aller, L., T.W. Bennett, G. Hackett, R.J. Petty, J.H. Lehr, H. Sedoris, and D.M. Nielsen, 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH. 1989.
- U.S. Environmental Protection Agency, 1989a. A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, OSWER Directive 9355.0-14. USEPA, Office of Emergency and Remedial Response, Washington, DC. December 1989.
- U.S. Environmental Protection Agency, 1989b. Soil Sampling Quality Assurance User's Guide - Second Edition. National Technical Information Service, PB 89-189 864/AS, Springfield, VA. 1989.

STANDARD OPERATING PROCEDURE (SOP) 2A COMPLETION OF BORINGS AS WELLS

1.0 INTRODUCTION AND SUMMARY

This SOP describes methods for installation of a monitoring well within an existing borehole. The well construction techniques discussed in this SOP are generally suitable for construction of wells screened in one groundwater zone which will be used for water quality sampling and/or observations of groundwater elevation (piezometers). Typically, 2- or 4-inch diameter wells, with total depths less than 80-feet will be installed using this SOP. Large diameter or deep wells may require modification of the methods described herein. Discussion of specific well casing and screen material is beyond the scope of this SOP, and well casing and screen material should be selected on a site specific basis. The permitting activities of this SOP apply in California and different permits are needed in other locations.

The procedures for construction of wells generally consist of well permitting, well design, decontamination of well casing and screen, simultaneous assembly and lowering of casing and screen into the borehole, placement of the filter-pack around the screen, installation of a bentonite seal above the filter pack, sealing of the remaining annular space with grout, and surface completion. The procedures described below are intended to conform to accepted practices (Aller et al. 1989, USEPA 1989, and DWR 1990).

2.0 EQUIPMENT AND MATERIALS

- Pressure washer or steam cleaner
- Grout mixing equipment
- Tap water
- Hand tools (pipe wrenches, chain wrenches, pipe vise, shovels, rubber mallet, etc.)
- Tape measure long enough to reach the bottom of the boring
- Well casing, screen, and end caps
- Centralizers (generally not required)
- Buckets and bristle brushes for decontamination
- Low residue, organic free soap such as Liquinox or Alconox
- Filter pack material (typically clean sand of specified gradation)
- Bentonite pellets (or powder) for seal above filter pack, unaltered sodium bentonite
- Cement for grout
- Locking hasp
- Protective surface casing
- Well construction log and daily report forms

- Calculator

Site specific conditions may require other specialized equipment.

3.0 TYPICAL PROCEDURES

The following procedures apply to most well installations. However, normal field practice requires re-evaluation and modification of these procedures upon encountering unexpected situations during well construction. Deviations from the following procedures may occur and should be documented.

1. Determine local jurisdiction charged with regulation of wells and apply for required local permits. Local jurisdictions may include county, water district, or city. Determine special design considerations (such as minimum length of grout seal) and inspection requirements (such as witnessing the placement of the grout seal). Also file notice of intent to construct well with the California Department of Water Resources using its standardized form.
2. Well design begins with the conception of the purpose for the well, and should include consideration of the analytes of interest, anticipated subsurface conditions at the intended well location, and the soil conditions encountered during drilling and recorded on the boring log.

Design considerations discussed in this SOP are limited to portions of the well subject to modification by information gathered during drilling. Such information includes depth to groundwater, thickness of water bearing strata, and grain size distribution of the water bearing strata. Conceptual well designs should be modified as required in the field to prevent connection of naturally separate groundwater zones, to allow an adequate surface seal to be installed, and to maximize the chance for detection of the contaminants of concern.

3. Prior to installation in the borehole, well casing and screen should be decontaminated and inspected.

Decontamination may consist of steam cleaning/pressure washing, hand washing, or equivalent. A tap water rinse should be employed after washing. If oil or grease is observed on the casing or screen, a soap wash and tap water rinse should be employed. This procedure should be applied to both the outside and the inside of well casing and screen immediately before assembly and well installation.

4. Assembly of the well screen and blank casing is accomplished simultaneously with insertion into the boring. Initially, a bottom plug is attached to the bottom of the screen and the screen is lowered into the boring. The next length of casing (screen or blank depending on the specific well design) is attached and the process is repeated until the well extends from the ground surface to the bottom of the boring. Various types of mechanical clamps are used to prevent dropping of the well screen into the well during assembly. It is useful to leave surplus blank casing extending above grade at this point to facilitate subsequent construction activities.

Measure the length of well screen and blank casing inserted into the boring and record the quantities on the well construction log. The total length of well screen and casing should be confirmed by taping.

5. Install the filter pack by pouring filter pack material into the annulus between the casing and borehole. Unless otherwise delineated in the Workplan, Quality Assurance Project Plan, or Sampling Plan, install filter pack from (1) an elevation approximately 6-inches beneath the elevation of the bottom cap of the well casing to (2) approximately 2-feet above the top of the screened interval.

If augers or drill casing remain in the ground during well construction, the annulus between the well material and the casing may be used as a tremie. If the well is constructed in an open borehole that (1) exceeds 30-foot depth or (2) is below the groundwater table, then the filter pack should be placed using a tremie pipe. The filter pack should be poured slowly into the borehole and the depth to the top of the filter pack should be "tagged" periodically with a tape. Adequate time should be allowed for the filter pack material to settle through standing water prior to tagging or the tape may be lost by burial. Tagging may be time consuming, but provides reasonable checks of filter pack bridging during installation.

If augers or other temporary casing are being used as a tremie, they should be withdrawn as the filter pack is placed. During placement, the elevation of the tip of the augers/temporary casing should be kept slightly above the top of the filter pack. Minimizing the separation between the top of the filter pack and tip of the augers/temporary casing during filter pack placement will help prevent inclusions of formation material or slough within the filter pack. However, if the tip of the augers/temporary casing is not kept above the top of the filter pack and the filter pack is allowed to settle within the augers/temporary casing, a filter pack bridge may occur and the well casing may become "locked" inside the augers/temporary casing.

The theoretical quantity of filter pack material required to fill the annulus should be calculated. The quantity of filter pack material actually installed in the well should be measured and compared to the calculated quantity. Both quantities should be recorded on the well construction log.

6. The bentonite seal is installed by pouring bentonite pellets or slurried bentonite powder onto the top of the filter pack. Unless otherwise delineated in the Workplan, Quality Assurance Project Plan, or Sampling Plan, the bentonite seal should extend approximately two feet above the top of the filter pack. The quantity and type of bentonite used should be recorded on the well construction log. The top of the bentonite seal should be measured by taping. If bentonite pellets are used and the seal exists above the groundwater table, water should be poured on top of the pellets after their installation and the pellets should be allowed to hydrate for approximately 10 minutes before proceeding with installation of the overlying grout seal.

7. The grout seal should be tremied into the well to prevent inclusions of formation material or slough in the annular seal. Unless otherwise delineated in the Workplan, Quality Assurance Project Plan, or Sampling Plan, grout seal may consist of (1) neat cement grout, using 1 sack (94 pounds dry weight) of Type I/II Portland cement to 5 gallons of water, or (2) cement-bentonite grout using the same basic formula but substituting approximately 5% powdered bentonite for part of the cement. Local requirements may require inspection of grout seal placement by the regulating authority.

If augers or temporary casing remain in the borehole during grouting, the level of the grout should be kept above the tip of the augers or casing to help prevent inclusions of formation material in the grout seal.

The volume of the grout actually used should be recorded on the well construction log and compared to the theoretical annular volume of the sealed interval. Any discrepancies should be noted on the well construction log.

8. Complete the surface of the well by installing a protective surface casing and locking mechanism around the top of the well casing.
9. The completed well should be protected from disturbance while bentonite seal hydrates and grout cures. Further well activities, such as development or sampling, should be withheld for a period of 3 to 7 days to allow these materials to obtain an initial set.
10. Complete and file form DWR 188 plus reports or forms required by local agencies.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance checks for well completion include comparison of theoretical versus actual volumes of filter pack, bentonite seal, and grout seal. Discrepancies that indicate actual "take" was less than theoretical may indicate inclusions of formation material or slough within the annulus. Specific attention to such discrepancies is necessary if the bentonite seal and grout seal are needed to separate contaminated from uncontaminated zones that may be penetrated by the well.

Other quality assurance details include accurate measurement and documentation of the lengths and types of materials used to complete the well.

5.0 DOCUMENTATION

Observations, measurements, and other documentation of the well completion effort should be recorded on the following:

- Daily Report
- Field Notebook
- Well Completion Log

- DWR 188

Documentation should include any deviations from this SOP, as well as documentation of the containerization and disposition/disposal of investigation-derived waste.

6.0 DECONTAMINATION

Materials used for filter pack, bentonite seal, and grout seal should be new at the beginning of each project. Typically, damaged or partially-used containers of material that are brought onsite by drillers or other material suppliers should not be used for well completion. If there is sufficient question regarding contamination of materials, obtain representative samples for later laboratory testing.

Well casing and screen should be decontaminated immediately prior to insertion within the borehole.

If augers or temporary casing are removed during well construction, these materials should be decontaminated by steam cleaning, pressure washing, or equivalent.

7.0 INVESTIGATION-DERIVED WASTE

Wastewater from casing and screen decontamination may be discharged to the ground surface near the well subject to the landowner's permission. Otherwise, these wastewaters may be discharged to the sanitary sewer.

Borehole fluids displaced during well completion, excess grout, and decontamination wastes from the cleaning of augers or temporary casing should be placed in steel drums. The drums should be labeled indicating the generator's name, accumulation date, contents, and well number.

8.0 SAFETY

Primary chemical hazards during well completion are associated with dermal exposure to borehole fluids that may be displaced during completion. Primary protection against dermal exposure includes splash protection and gloves.

Other specific site safety guidance is provided in the Site Safety Plan.

9.0 REFERENCES

Aller, L., T.W. Bennett, G. Hackett, R.J. Petty, J.H. Lehr, H. Sedoris, and D.M. Nielsen, 1989. *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells*. National Water Well Association, Dublin, OH. 1989.

DWR, 1990. *California Well Standards, Bulletin 74-90 (Supplement to Bulletin 74-81), Final Draft*. California Department of Water Resources, Sacramento CA. January 1990.

USEPA, 1989. *A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, OSWER Directive 9355.0-14*. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. December 1989.

STANDARD OPERATING PROCEDURE (SOP) 3A WELL DEVELOPMENT

1.0 INTRODUCTION AND SUMMARY

This SOP describes procedures to develop wells that have been properly installed. Typically, fine soil particles are entrained within the filter pack and adjacent formation during well installation. The well development procedures described herein are intended to help remove the fine soil particles, resulting in enhanced hydraulic response of the well and increased representativeness of water quality samples collected from the well.

Typically, this SOP will be used to develop 2- or 4-inch diameter monitoring wells and occasionally larger diameter monitoring or pumping wells; all screened within a single groundwater zone. The procedures described herein should be modified for domestic wells. The procedures described herein may also need modification if product is observed in the well.

Well development activities generally include decontaminating the downhole equipment, repetitive combinations of surging/swabbing and overpumping/bailing, measurement and observation of well yield, turbidity, and field parameters, and containerizing the development wastewater. Development is typically conducted until (1) no further improvement in well response and turbidity is observed, or (2) a reasonable time has been devoted to development.

2.0 EQUIPMENT AND MATERIALS

- Pressure washer or steam cleaner
- Buckets and bristle brushes for decontamination
- Low residue, organic free soap such as Liquinox or Alconox
- Tap water
- Steel, 55-gallon, open-top drums conforming to the requirements of DOT 17H
- Field organic vapor monitor. The make, model, and calibration information of the field organic vapor monitor (including compound and concentration of calibration gas) should be documented.
- Glass beaker, ± 250 milliliter for measurement of field parameters. A similar flow-through cell may also be used.
- Water level meter
- pH, temperature, and specific conductivity instruments, including pH and specific conductivity standards approximating or spanning the natural groundwater parameters.
- Vented surge block or swab of appropriate diameter for the screened interval of the well casing.

- Bailing and/or overpumping equipment consisting of one or a combination of the following:

Bailer: Steel or PVC. Dedicated or new bailer rope. Generally as large a diameter as will fit down well.

Surface Centrifugal Pump: Limited to water lift of approximately 20-feet. Dedicated or new flexible plastic suction hose. Foot valve and flow control valve optional.

Air-Lift Pump: Dual-casing assembly with eductor casing (outer casing) to extend at least 2-feet beyond inner casing. Foot valve should be provided at the bottom of the eductor casing to prevent release of aerated water into the well when the air lift pump is turned off. Air from compressor should be dual-filtered to remove oil.

As specified in the Site Safety Plan, additional safety and personnel decontamination equipment and materials may be needed.

3.0 TYPICAL PROCEDURES

The following procedures are intended to cover the majority of well development conditions. However, normal field practice requires re-evaluation of these procedures upon encountering unusual or unexpected conditions such as observation of free product, measuring elevated pH in the development water, or observing dramatic increases in turbidity as development progresses. Deviations from the following procedures may be expected and should be documented.

1. Development should generally be initiated after the well sealing materials (grout) have obtained an initial cure. Typically, development may begin 3 to 7 days after well completion.
2. Remove top cap and perform field organic vapor monitoring of well casing.
3. Measure static water level and total depth of well. Compare total depth to well completion diagram. Calculate volume of standing water in casing.
4. Decontaminate downhole equipment (see section DECONTAMINATION in this SOP).
5. Begin bailing or overpumping using as high an evacuation rate as possible. Record the following at the beginning of development and during each bail/overpump cycle:
 - Volume removed and time
 - pH, temperature, and specific conductance
 - Turbidity (clarity and color)
 - Approximate drawdown and well yield
 - Whether well was bailed/pumped dry
 - Other observations (such as presence of product) as appropriate

Bail/overpump until at least one casing volume of standing water has been removed. Continue bailing/overpumping if the removed water remains very turbid, indicating removal of fines from the screened interval. Terminate bailing/overpumping upon improvement of clarity.

6. Surge/swab the well to loosen fines from the screened interval. Position vented surge block several feet above the screened interval and surge/swab with upward motion. Lower the surge/swab several feet and repeat, keep surging/swabbing progressively lower intervals until the bottom of the screened interval is reached. For each interval, surge/swab for several minutes or as indicated by field experimentation.
7. Repeat items 5 and 6 until evacuated water at the end of the bailing/overpumping cycle is low or non-turbid, field parameters are representative of natural groundwater conditions, and well yield has stabilized at a value representative of the intercepted groundwater zone. Terminate development after a reasonable period of time even if these conditions are not observed. Unless otherwise specified in the Workplan, Quality Assurance Project Plan, or Sampling Plan, 4 hours may typically be taken as a reasonable time effort.
8. Terminate development by bailing or overpumping for an extended period of time to remove fines that have been loosened by the last cycle of surging/swabbing. Record final observations.
9. Containerize development water and decontamination wastewater in steel drum(s). Label drum(s) with hazardous waste label, description of contents, and well number from which waste originated.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Meters for measurement of field parameters should be calibrated at least once per day. Calibration standards should generally approximate or span natural groundwater characteristics. Recalibration may be appropriate if unusual measurements are noticed. Calibration activities should be documented on the instrument calibration log.

Quantitative turbidity measurements may be taken with a turbidity meter (both field and laboratory versions are available). If qualitative descriptions of turbidity are used, these terms (very-, moderate-, low-turbidity) may be further defined on the development log. Representative samples may also be collected and returned to the laboratory for measurement with a turbidity meter.

Because well development is typically the first activity of a newly completed well and because the activity is fairly vigorous, the following precautions may be appropriate:

- If product is observed but not anticipated within the groundwater zone intercepted by a well, and the well penetrated a contaminated overlying groundwater zone, well development may be interrupted subject to further consideration or study. Faulty well sealing may result in

migration of product from overlying to underlying groundwater zones, which is exacerbated during development.

- If elevated pH is observed but not anticipated, and the well is being developed soon after completion, well development may be interrupted subject to further consideration or study. Elevated pH may originate from grout that has not yet cured, or from grout contamination of the filter pack.
- If turbidity increases dramatically after surging/swabbing and does not return to previously observed levels, the cause may be a broken well casing, broken screen, or dislodged end cap, which allows soil to enter the casing unretarded by the filter pack. Probing the well may disclose a break or faulty joint. Consider interrupting well development if this condition is suspected.

5.0 DOCUMENTATION

The well completion schematic should be taken into the field to serve as reference information. Observations, measurements, and other documentation of the development effort should be recorded on the following:

- Daily Report
- Field Notebook
- Instrument Calibration Log
- Well Development Log

Documentation should include any deviations from this SOP, as well as the documentation of the containerization and disposition/disposal of investigation-derived waste.

6.0 DECONTAMINATION

Prior to entering the site, well development equipment should be decontaminated by steam cleaning, pressure washing, or equivalent.

Prior to development of each well, down-well equipment should be decontaminated by steam cleaning or pressure washing, washing with soap, and rinsing with tap water, or equivalent.

Prior to leaving the site, equipment should be steam cleaned, pressure washed, or equivalent.

7.0 INVESTIGATION-DERIVED WASTE

Development water and decontamination wastewater should be containerized in steel drums. Drums should be labeled with hazardous waste labels, including: generator's name and accumulation date. The drums should also be labeled with a description of contents and well number of waste origination. Waste from different wells may be combined in single drums, but chemically-affected and clean wastes should not be mixed.

8.0 SAFETY

Primary chemical hazards during well development are associated with dermal exposure. Primary protection against dermal exposure includes splash protection and gloves. Air-lift pumping may also exacerbate the release of volatile organic compounds from groundwater to air, thus increasing the risk of exposure; frequent monitoring with the field organic vapor monitor may be employed to mitigate this risk.

Other specific site safety guidance is provided in the Site Safety Plan.

9.0 REFERENCES

Aller, L., T.W. Bennett, G. Hackett, R.J. Petty, J.H. Lehr, H. Sedoris, and D.M. Nielsen, 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH. 1989.

U.S. Environmental Protection Agency, 1989. A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, OSWER Directive 9355.0-14. USEPA, Office of Emergency and Remedial Response, Washington, DC. December 1989.

STANDARD OPERATING PROCEDURE (SOP) 20 WELL PURGING AND SAMPLING USING BAILERS

1.0 INTRODUCTION AND SUMMARY

This SOP describes standard procedures to purge and sample groundwater monitoring wells using bailers. This SOP will be typically be used for 2- or 4-inch diameter wells which have been properly installed and developed. The sampling described herein is appropriate for a variety of groundwater analyses, including: total and dissolved metals, volatile and semivolatile organic compounds, and general minerals. For newly installed and developed wells, the purging and sampling described in this SOP is typically performed at least 7 days after well development to allow ambient groundwater conditions to re-establish in the vicinity of the well.

The procedures described in this SOP should be modified for domestic wells or wells with dedicated sampling equipment. The procedures should also be modified if product is observed in the well.

Typical well sampling and purging activities include decontaminating the bailer, purging the stagnant water from the well casing and filter pack, measuring field parameters and evacuated volume of groundwater during purging, terminating the purging process when field parameters stabilize, collecting groundwater samples, and labeling and preserving the collected samples.

2.0 EQUIPMENT AND MATERIALS

- Buckets and bristle brushes for decontamination
- Low residue, organic free soap such as Liquinox or Alconox
- If sampling is to be performed for metals, dilute (10%) reagent-grade nitric acid (for decontamination)
- Tap water (for decontamination)
- Distilled water (for decontamination and quality control blank samples)
- Cooler with ice (do not use blue ice or dry ice)
- Ziplock bags of size to accommodate sample containers
- Steel, 55-gallon, open-top drums, DOT 17H
- Field organic vapor monitor. The make, model, and calibration information of the field organic vapor monitor (including compound and concentration of calibration gas) should be documented.
- Laboratory-cleaned containers of proper type and size for the analytical parameters (refer to Table 1)
- Reagent-grade chemicals for sample preservation, as required for the analytical parameters (refer to Table 1)
- If field filtration will be performed for dissolved metals analyses, 45-micron cellulose acetate filters and filtering device. Alternate filter type and size (cellulose nitrate, Teflon, or glass-fiber pre-filters) may be

required. The make, type, and size of filter, including disposable filters, should be documented.

- Glass beaker, ± 250 milliliter for measurement of field parameters. A similar flow-through cell may also be used.
- Water level meter
- pH, temperature, and specific conductivity instruments, including pH and specific conductivity standards approximating or spanning the natural groundwater parameters. Oxidation-reduction potential (ORP) or dissolved oxygen meters may also be required.
- Bailers: PVC, Teflon, or stainless steel. Dedicated or new bailer rope. If samples are collected for volatile organic compound analysis, bailer should also be fitted with bottom-emptying device.

As specified in the Site Safety Plan, additional safety and personnel decontamination equipment and materials may be needed.

3.0 TYPICAL PROCEDURES

The following procedures are intended to cover the majority of purging and sampling conditions. However, normal field practice requires re-evaluation of these procedures and implementation of alternate procedures upon encountering unusual or unexpected conditions. Deviations from the following procedures may be expected and should be documented.

1. Remove top cap and perform field organic vapor monitoring of well casing
2. Measure static water level and total depth and compare to historic measurements. Remeasure if discrepancies are noted with historic data. Document observations of product, if appropriate. Calculate volume of standing water in casing.
3. Decontaminate purging and sampling equipment (see section DECONTAMINATION in this SOP)
4. Purge well by repeatedly lowering the bailer into the well, allowing the bailer to fill, removing the bailer, and emptying the collected groundwater into a 55-gallon drum or other suitable container. Record the following observations at the beginning of purge, periodically during purge, and during sampling:
 - Purge volume and time
 - pH, temperature, and specific conductivity
 - Turbidity (clarity and color)
 - Approximate drawdown and well yield during purge
 - Whether well was purged dry
 - Other observations (such as presence of product) as appropriate

5. Terminate purging when one of the following conditions is observed:

Quick Recharge Wells: Well shows stabilized field parameters and at least 4 casing volumes of standing water have been removed - ready for sampling. If field parameters have not stabilized after removal of 10 casing volumes of standing water, terminate purging anyway. Wells should be allowed to recover to at least 1/2 the original standing water depth prior to sampling.

Slow Recharge Wells: Wells that are initially purged dry, and do not recover to 1/2 of the original standing water depth within 2 hours, should be purged dry again and then sampled when sufficient recovery has occurred to submerge the sampling bailer. Generally, 3 feet of recovery may be considered sufficient recovery for normal bailer submergence.

6. If recharge has submerged the entire screened interval, sample from mid-depth of screened interval. Otherwise, sample from mid-depth of water column at time of sampling.
7. If field filtration will be performed for dissolved metals analyses, filter sample. If the sample is moderately turbid or very turbid, collect companion filtered and unfiltered samples.
8. Fill sample containers and add preservative according to the requirements of Table 1. Containers should generally be filled to capacity. 40 milliliter glass vials should be filled from the bottom using a sample discharge tube (bottom-emptying device for bailer or discharge tube of bladder pump). 40 milliliter vials should not have headspace.
9. Label sample containers, place in ziplock bag, and place on ice in cooler.
10. Log samples onto chain-of-custody form and maintain sample custody until shipped to laboratory.
11. Containerize purge water, excess sample, and decontamination wastewater in steel drum(s). Label drum(s) with hazardous waste label, contents, and well number from which waste originated.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Depending on the level of data validation required on a given project, quality control sampling may consist of none, one, or any combination of the following samples, to be collected at a pre-established frequency (i.e., one quality control sample for every 10 natural samples):

- Duplicate samples.
- Cross-contamination blank - prepared by collecting a sample of deionized water which has been passed over and through decontaminated sampling equipment.
- Travel blanks - typically if analyses require collection of samples in 40 milliliter vials (typical frequency of 1 per day of sampling).
- Other quality control samples include standard reference materials and natural matrix spikes.

Meters for measurement of field parameters should be calibrated at least once per day. Calibration standards should generally approximate or span natural groundwater characteristics. Recalibration may be appropriate if unusual measurements are noticed. Calibration activities should be documented on the instrument calibration log.

5.0 DOCUMENTATION

The following information should be compiled prior to sampling and taken into the field for reference:

- Well completion schematic
- Summary of historic water level, total depth, and field parameter measurements

Observations, measurements, and other documentation of the purging and sampling effort should be recorded on the following:

- Daily Report
- Field Notebook
- Instrument Calibration Log
- Well Purge and Sample Log
- Chain-of-Custody

Documentation should include any deviations from this SOP, as well as documentation of the containerization and disposition/disposal of investigation-derived waste.

6.0 DECONTAMINATION

Prior to purging and sampling each well, down-well equipment and equipment that will contact the sample (except sample containers) should be decontaminated according to the following procedure:

- Steam clean or pressure wash (optional unless oily contamination covers equipment)
- Wash with soap
- Rinse with tap water
- Double rinse with distilled water

If metals are included in the analytical parameters, the decontamination procedures should include (1) a dilute nitric acid rinse and (2) a second tap water rinse, prior to rinsing with distilled water.

Prior to leaving the site, purging and sampling equipment should be decontaminated.

7.0 INVESTIGATION-DERIVED WASTE

Purge water, excess sample, and decontamination wastewater should be containerized in steel drums. Drums should be labeled with hazardous waste labels, including: Generator's name and accumulation date. Wastes from different wells may be combined, but wastes that are anticipated to contain chemical should not be mixed with waste that are not thought to be contaminated.

8.0 SAFETY

Primary chemical hazards during well purging and sampling are associated with dermal exposure. Acids used for decontamination and sample preservation may also present chemical hazards. Primary protection against dermal exposure includes splash protection and gloves. Special chemical hazards may be associated with the presence of product, if discovered during sampling. Water quality samples are not generally considered representative in the presence of product. Accordingly, it may be appropriate to abandon sampling efforts if product is discovered.

Other specific site safety guidance is provided in the Site Safety Plan.

9.0 REFERENCES

- Aller, L., T.W. Bennett, G. Hackett, R.J. Petty, J.H. Lehr, H. Sedoris, and D.M. Nielsen, 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH. 1989.
- U.S. Environmental Protection Agency, 1989a. A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, OSWER Directive 9355.0-14. USEPA, Office of Emergency and Remedial Response, Washington, DC. December 1989.

Table 1
Sampling and Preservation for Groundwater Samples

Parameter	Analytical Method	Container	Preservation	Maximum Holding Time
Purgeable Halocarbons by GC	EPA 8010	Two 40-ml glass vials	HCl to pH<2, cool to 4 degrees Celsius	14 days after collection
Purgeable Aromatics by GC	EPA 8020	Two 40-ml glass vials	HCl to pH<2, cool to 4 degrees Celsius	14 days after collection
Organochlorine Pesticides and PCB's	EPA 8080	Two 1-liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Organophosphorus Pesticides	EPA 8140	Two 1-liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Chlorinated Herbicides (Phenoxy Herbicides)	EPA 8150	Two 1-liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Volatile Organic Compounds by GC/MS	EPA 8240	Two 40-ml glass vials	Cool to 4 degrees Celsius	14 days after collection
Semivolatile Organic Compounds by GC/MS (Base/Neutral/Acid Extractable Organics)	EPA 8270	Two 1-liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Dibromoethane (EDB) and 1,2-Dibromo-3-Chloropropane (DBCP)	EPA 504	Two 1-liter amber glass	Cool to 4 degrees Celsius	Extract 7 days after collection Analyze 40 days after extraction
Total Petroleum Hydrocarbons as Diesel	Extract by EPA 3550 and analyze by GCFID	Two 40-ml glass vials	HCl to pH<2, cool to 4 degrees Celsius	Extract 7 days after collection Analyze 7 days after extraction
Oil & Grease	SM 503	One 1-liter glass with aluminum foil-lined cap	H ₂ SO ₄ to pH<2, cool to 4 degrees Celsius	28 days after collection
Total Metals	EPA 7000 Series	One 1/2 liter poly	HNO ₃ to pH<2, cool to 4 degrees Celsius	6 months after acidification (28 days for mercury)
Dissolved Metals (field filtration)	EPA 7000 Series	One 1/2 liter poly	After field filtration, add HNO ₃ to pH<2, cool to 4 degrees Celsius	6 months after acidification (28 days for mercury)
Dissolved Metals (laboratory filtration)	EPA 7000 Series	One 1/2 liter poly	No field acidification, cool to 4 degrees Celsius	1 day for filtration, 6 months after acidification (28 days for mercury)
General Minerals	Various	Two 1-liter poly	Cool to 4 degrees Celsius	7 days after collection

APPENDIX B

Site Safety Plan

**Site Safety Plan
Soil and Groundwater Investigation
21031 Western Boulevard
Hayward CA**

Anticipated Field Work The anticipated field work includes: (1) drilling, (2) soil sampling, (3) monitoring well construction and development, (4) surveying, and (5) groundwater sampling.

Chemical Hazard Evaluation Chemical compounds, which may be present at the property, are summarized in Table 1.

Physical Hazard Evaluation Physical hazards which may be encountered include: heavy machinery, heavy lifting, slip-trip-fall, loud noise, and heat exposure.

Health and Safety Responsibilities This site safety plan will be implemented by the site safety officer under the supervision of the project manager and in coordination with an appropriate client representative. Safety personnel and their responsibilities are presented in Table 2.

Work Zone A work zone will be established around the area of work. The work zone is an area of sufficient size to allow safe completion of the work while maintaining control of access to the work area. The work zone will be restricted by requesting people not directly involved in the work to stay out of the immediate work area, and/or by restricting access by other suitable means, such as with a work fence, traffic cones, or barricades.

No smoking, chewing of tobacco or gum, eating, or drinking will be allowed in the work zone.

Personal Protective Equipment Field work will begin in modified Level-D personal protection (Table 3). If air monitoring results of the work zone exceed the action levels specified below, then personal protective equipment will be upgraded to modified Level-C (Table 3).

Monitoring Visual monitoring should be routinely conducted by the workers. Workers should evaluate themselves and co-workers for signs of fatigue as the work progresses. Work breaks should be taken as reasonably required to maintain safety and efficiency.

The breathing zone in the work area will be monitored using a field organic vapor monitor (Thermo Environmental Instruments Model 580B, 10.0 eV photoionization detector, calibrated to 100 ppm v/v isobutylene).

If continual readings greater than 5 ppm above background are detected in the breathing zone, personal protection should be upgraded to modified Level-C from modified Level-D. 5 ppm was selected using the exposure criteria in Table 1.

If continual readings greater than 50 ppm above background are recorded in the breathing zone, work should stop. Work should be resumed after consultation with the project manager and possibly the client, and may include additional safety precautions.

Emergency Procedures. These procedures are designed to allow rapid treatment of workers for injuries or exposure to hazardous substances occurring on the worksite. A secondary purpose of these procedures is to allow documentation of emergencies.

Emergency information is summarized in Table 4. The location of the nearest hospital is shown on Figure 1.

If required, first aid will be provided for injured workers.

The site safety officer will be notified immediately of an emergency. It is the site safety officer's responsibility to document the emergency and report it to the project manager and client in a timely manner.

Decontamination Decontamination refers to removal of potential chemical contamination from worker's clothing and from health and safety monitoring equipment. In many instances, removal and thorough cleaning of work clothing is adequate for worker decontamination. However, if skin contact with chemical-containing material occurs during field work, the affected area will be washed thoroughly with soap and water.

Monitoring equipment should be kept clean by wiping as required with a paper towel or other suitable material.

Health and Safety Wastes Wastes generated by health and safety practices include disposable protective equipment such as gloves, tyvek-coveralls, and boot covers, as well as used paper towels. These items may be disposed of with normal municipal refuse.

Liquid wastes from washing may be disposed of in the sanitary sewer.

Table 1
Chemical Hazard Evaluation

Chemical	Measured in Soil (mg/kg)	Measured in Groundwater (mg/L)	Odor Threshold (ppm v/v)	Lower Explosive Limit (ppm v/v)	Permissible Exposure Limit (ppm v/v)	Time Weighted Average (ppm v/v)	Immediately Dangerous to Life and Health (ppm v/v)
Total Petroleum Hydrocarbons as Gasoline	<0.5 to 9,500	Not measured	NA	14,000	300	300	NA
Benzene	<0.01 to 61	Not measured	12	13,000	1	10	2,000
Toluene	<0.01 to 370	Not measured	2.9	13,000	100	100	2,000
Ethylbenzene	<0.02 to 230	Not measured	2.3	10,000	100	100	2,000
Xylenes	<0.02 to 1,500	Not measured	1.1	10,000	100	100	10,000

General Notes

(a) Exposure criteria from: (1) American Conference of Governmental Industrial Hygienists, *1990-1991 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*, (2) National Institute for Occupational Safety and Health, *Pocket Guide to Chemical Hazards*, 1985, (3) American Conference of Governmental Industrial Hygienists, *Guide to Occupational Exposure Values*, Undated (circa 1990), (4) Amoores, J. E. and Hautala, E., *Odor as an Aid to Chemical Safety: Odor Thresholds Compared with Threshold Limit Values and Volatilities for 214 Industrial Chemicals in Air and Water Dilution*, Journal of Applied Toxicology, Volume 3, Number 6, 1983, and (5) *Material Safety Data Sheet, Chevron Unleaded Gasoline*, Chevron Environmental Health Center, Richmond CA, 12 September 1991.

(b) NA = no applicable value listed in cited references.

Table 2
Safety Personnel and Responsibilities

Personnel	Responsibilities
<p style="text-align: center;">Project Manager (Keith Beury)</p>	<p>Development and overall implementation of Site Safety Plan, provide properly trained onsite personnel to complete the work, coordination of safety issues with client.</p>
<p style="text-align: center;">Site Safety Officer (Ken Chiang)</p>	<p>Onsite implementation of Site Safety Plan, coordination and documentation of field safety procedures, communication of safety issues to project manager, delineate work zone, atmospheric monitoring, review site safety procedures with subcontractors, contact Underground Service Alert, clear underground utilities, maintain adequate supply of safety equipment onsite for Streamborn personnel.</p>
<p style="text-align: center;">Subcontractor's Site Safety Officer (to be determined)</p>	<p>Understand and obtain subcontracting crews' compliance with Site Safety Plan, maintain onsite supply of safety equipment for subcontractor's personnel, relay safety concerns to Site Safety Officer.</p>

Table 3
Personnel Protective and Monitoring Equipment

Item	Requirement
Modified Level-D Personal Protective Equipment	Hardhat, dedicated work clothing (cotton coveralls or tyveks), water repellent steel-toed boots, work gloves, latex gloves (as appropriate), nitrile gloves (as appropriate), first aid kit, fire extinguisher, warning tape, optional eye and hearing protection.
Modified Level-C Personal Protective Equipment	Add Half-face respirator with OV-HEPA cartridges and mandatory tyveks to modified Level-D protective equipment. Change respirator cartridges upon detection of breakthrough (by smell), increase in breathing resistance, or daily (whichever is more frequent).
Atmospheric Monitoring	<p>Field organic vapor monitor capable of detecting organic vapor concentrations of 1 ppm (v/v). Field organic vapor monitor to be calibrated to known reference gas daily.</p> <p>Action levels (measurement in the breathing zone of work area): >5 ppm for 10 minutes: upgrade to modified Level C >50 ppm for 10 minutes: stop work, consult with project manager</p>
Visual Monitoring	Evaluate yourself and co-workers for signs of fatigue and visual signs of distress (that may be caused by physical labor and possible chemical exposure).

Table 4
Emergency Information

Emergency Service or Contact	Telephone	Address and Directions
Eden Medical Center	(510) 537-1234	<ul style="list-style-type: none"> • Eden Medical Center 20103 Lake Chabot Road Castro Valley CA 94546 • From property, proceed east on Cherry Way. • Turn left on Mission Boulevard. • Turn right on Mattox Road and continue past Interstate 580 (turns into Castro Valley Boulevard). • Turn left on Lake Chabot Road. Eden Medical Center is on the left. • See Figure 1 for the route.
Ambulance	911	
Fire Department	911	
Police Department	911	
Onsite Telephone	To be determined	
Site Safety Officer	Ken Chiang 510/528-4234 (work) 510/724-9216 (home)	
Project Manager	Keith Beury 510/528-4234 (work) 415/863-3853 (home)	
Property Owner (or Representative)	Kathy Florence 510/482-1874	
Subcontractors	To be determined	

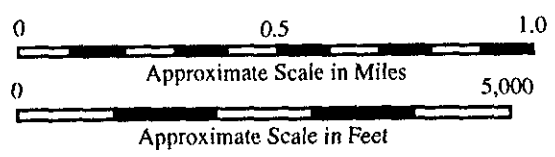
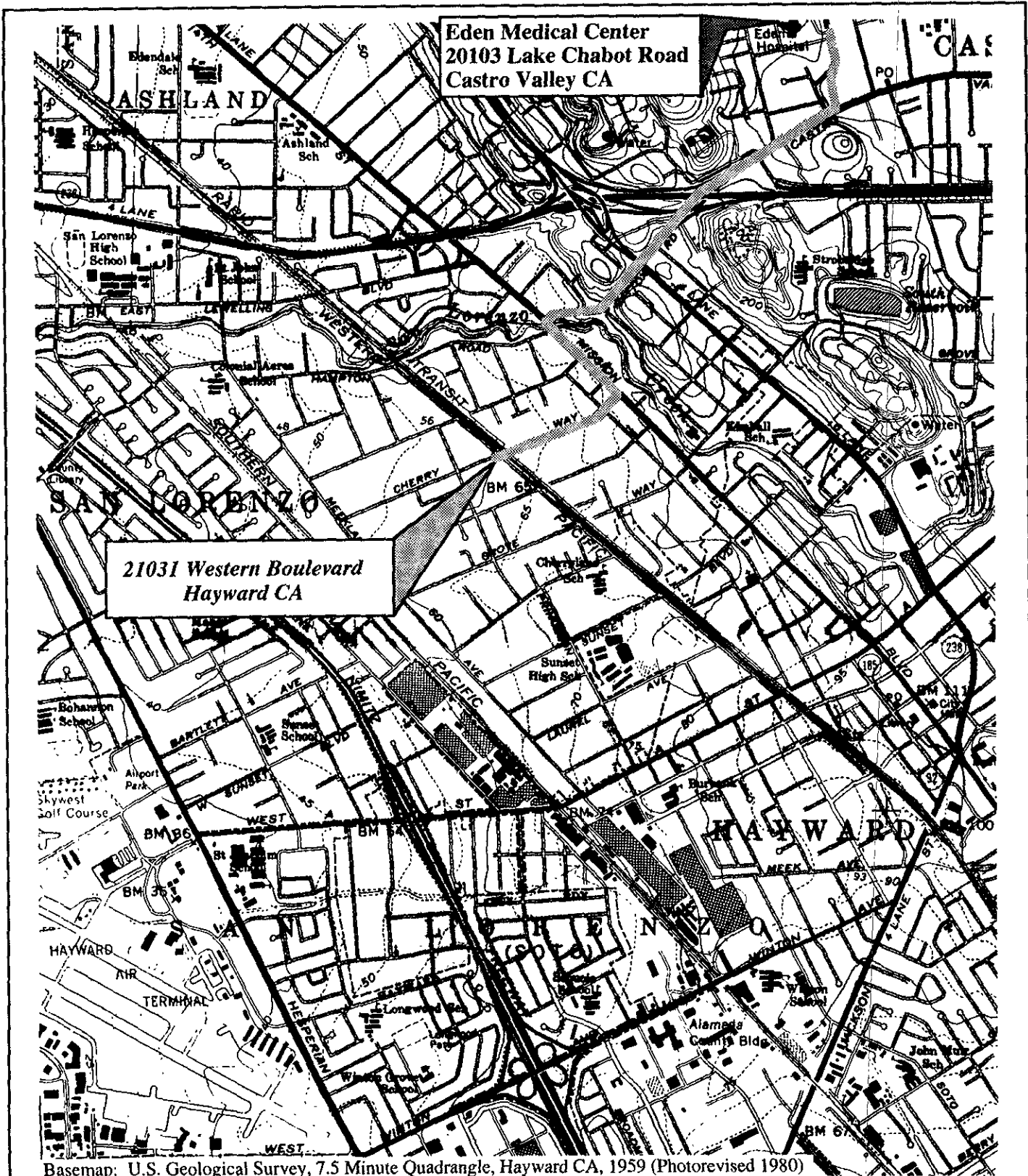


Figure 1
Hospital Map
21031 Western Boulevard
Hayward CA