# Final Risk Management Plan for the 64th and 65th Street Properties

Sybase, Inc.
Emeryville, California
26 October 1995

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Subject: Final Risk Management Plan for the 64th and 65th
Street Properties, Emeryville, California
Sybase, Inc., Emeryville, California
(EKI 940018.03)

Dear Agency Staff Members:

On behalf of Sybase, Inc., Erler & Kalinowski, Inc. ("EKI") is pleased to submit the enclosed report entitled *Risk Management Plan for the 64th and 65th Street Properties*, dated 26 October 1995 for your review and approval.

Thank you for meeting with us on a monthly basis to help us develop this risk management plan. If you have any questions, please do not hesitate to call.

Very truly yours,

ERLER & KALINOWSKI, INC.

Michelle Kriegman King

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Enclosure

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Sybase, Inc., Emeryville, California
(EKI 940018.03)

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for the 64th and 65th Street Properties
Emeryville, California

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# for the 64th and 65th Street Properties
# Emeryville, California

Sybase, Inc., Emeryville, California
(EKI 940018.03)

## EXECUTIVE SUMMARY

This risk management plan has been prepared for the properties at 1410 and 1450 64th Street and 1465 65th Street ("the Site") in Emeryville, California by Erler & Kalinowski, Inc. ("EKI") for Sybase, Inc. Sybase, Inc. is planning to acquire the Site and redevelop it for commercial/office uses. The risk management plan has been prepared in accordance with the recommendations of the Regional Water Quality Control Board, San Francisco Bay Region ("RWQCB") and Alameda County Department of Environmental Health ("ACDEH") to provide a framework to manage residual chemical occurrence in soil and groundwater on the Site in a manner that is consistent with a commercial/industrial land use and is protective of human health and the environment, including water quality. Implementation of the risk management plan is subject to Sybase, Inc.'s acquisition of the Site and will apply to the property acquired by Sybase, Inc.

Petroleum hydrocarbons and low concentrations of volatile organic compounds, polychlorinated biphenyls, arsenic, nickel and zinc were detected in soil and/or groundwater at the Site (EKI, 1995a). The risk management plan contains the following: (1) an introduction to the Site and Sybase, Inc.'s planned redevelopment; (2) a short-term risk management plan to be implemented during Site redevelopment; and (3) a post-construction plan for mitigation of any long-term risks. Also included in the risk management plan is a provision to ensure long-term compliance with this risk management plan.

Sybase, Inc.'s redevelopment plan for the Site includes construction of a road along the west property boundary, a multi-level parking structure, and a U-shaped office building. One existing facility is planned to be converted to office/commercial space.

The short-term risk management plan addresses precautions that will be taken to mitigate any risks to human health and the environment during construction for Sybase, Inc.'s planned redevelopment of the Site. The precautions to be taken are:

- requiring health and safety training for earthwork construction workers;
- requiring the appropriate level of personal protective equipment by earthwork construction personnel to protect human health during construction;
- establishing procedure(s) for earthwork construction workers to manage soil that is obviously affected and to handle abandoned subsurface structures such as tanks, sumps, and pipes;
- abandoning existing monitoring wells in accordance with Alameda County Zone 7 procedures; and
- installing building pilings through affected shallow soil by either: 1) predrilling piling installations through the affected soil layer, and handling the soil appropriately; or 2) using a cone-shaped tip to drive the pilings.

The long-term risk-management plan addresses precautions that will be undertaken to mitigate any risks to human health and the environment after construction and redevelopment of the Site are complete. Precautions to be taken that are included in the long-term risk management plan are:

- capping affected soil with buildings, pavement or clean soil cover in landscaped areas to minimize or prevent exposure of Site occupants or Site visitors to the soil;
- following established procedures to manage soil that is obviously affected and defining appropriate protective measures for on-site workers engaged in subsurface excavation activities;
- not using groundwater beneath the Site without first securing approval from RWQCB and ACDEH staff; and
- monitoring of groundwater to confirm that groundwater quality is stable or improving.

# Risk Management Plan
# for the 64th and 65th Street Properties
# Emeryville, California

Sybase, Inc., Emeryville, California
(EKI 940018.08)

## 1.0 INTRODUCTION

At the request of AMB Corporate Real Estate Advisors, Inc. ("AMB") and its client, Sybase, Inc., Erler & Kalinowski, Inc. ("EKI") has prepared this risk management plan for the properties at 1410 and 1450 64th Street and 1465 65th Street ("the Site") in Emeryville, California (Figure 1). Sybase in planning to acquire the Site and redevelop it to commercial/office uses.

On the basis of the current condition and planned use of the Site, Regional Water Quality Control Board, San Francisco Bay Region ("RWQCB") and Alameda County Department of Environmental Health ("ACDEH") staff have recommended completion of a risk management plan to provide a framework to manage residual chemical occurrence in soil and groundwater on the Site in a manner that is consistent with a commercial/industrial land use and is protective of human health and the environment, including water quality. Implementation of the risk management plan is subject to Sybase, Inc.'s acquisition of the Site and will apply to the property acquired by Sybase, Inc.

Petroleum hydrocarbons and low concentrations of volatile organic compounds, polychlorinated biphenyls, arsenic, nickel and zinc were detected in soil and/or groundwater at the Site (EKI, 1995a). The risk management plan contains the following: (1) an introduction to the Site and Sybase, Inc.'s planned redevelopment; (2) a short-term risk management plan to be implemented during Site redevelopment; and (3) a post-construction plan for mitigation of any long-term risks. Also included in the risk management plan is a provision to ensure long-term compliance with this risk management plan.

## 2.0 SYBASE, INC.'S PLANNED REDEVELOPMENT

The Site is located on the west side of Hollis Street between 64th and 65th Streets in Emeryville, California. The south portion of the Site is occupied by the former Breuner's warehouse ("Lowenberg property") and an asphalt-paved storage area ("Ryerson paved lot property")

(Figure 2). The north portion of the Site is occupied by the Ryerson Steel facility (Figure 2). The Site is bounded to the west by the Southern Pacific Railroad tracks and to the east by Hollis Street.

Sybase, Inc.'s redevelopment plan for the Site includes construction of a road along the west property boundary, a multi-level parking structure in the vicinity of the Ryerson paved lot property, and a U-shaped office building on the Lowenberg property (Figure 3) and the conversion of the existing Ryerson Steel facility to office/commercial space.

Preliminary foundation plans call for use of non-continuous spread footings under the new U-shaped building. The maximum depth below existing grade is expected to be about 2 feet, based on preliminary design calculations. The multilevel parking structure will require a pile foundation. Piles are expected to be from 40 to 70 feet deep, with the pile caps tied together with at-grade beams.

Renovation of the Ryerson Steel facility may require limited foundation modifications, although the design objective is to avoid any such construction. If a sloped-floor auditorium is incorporated into the building plans, it may require shallow excavation into existing grade.

## 3.0 SHORT-TERM RISK MANAGEMENT

The short-term risk management plan addresses precautions that will be taken for mitigation of any risks to human health and the environment during construction for Sybase, Inc.'s redevelopment of the Site. The precautions described in detail below are:

- health and safety training for earthwork construction workers (Section 3.1),
- the use of the appropriate level of personal protective equipment by earthwork construction personnel (e.g., workers who may directly contact soil containing chemicals of concern during Site preparation, grading, or foundation construction) (Section 3.1);
- procedure(s) for earthwork construction personnel to manage soil that is obviously affected, as identified by visual observation or elevated organic vapor readings, and to handle abandoned subsurface structures such as tanks, sumps, and pipes (Section 3.2);

- abandonment of existing monitoring wells in accordance with Alameda County Zone 7 procedures (Section 3.3); and

- installation of pilings through the affected soil by either predrilling the affected soil layer or using a cone-shaped tip at the end of the pile (Section 3.4).

## 3.1 WORKER PROTECTION

During earthwork construction activities, those workers who may directly contact soil (e.g., during site preparation, grading, and foundation construction) will be health and safety trained and will use the appropriate level of personal protective equipment.

Earthwork construction contractors will prepare site-specific health and safety plans consistent with State and Federal Occupational Safety and Health Administration standards for hazardous waste operations (California Code of Regulations, Title 8, Section 5192 and 29 Code of Federal Regulations 1910.120, respectively) and any other applicable health and safety standards. The health and safety plans will be submitted to the ACDEH and the RWQCB for review. Among other things, the health and safety plans will include a description of the level of personal protective equipment to be used and any other applicable precautions to be undertaken to minimize direct contact with soil.

## 3.2 SOIL MANAGEMENT PROCEDURES

The approach to manage soil during Site preparation, grading, foundation construction, and trenching activities ("earthwork activities") is to minimize soil disturbance during Site redevelopment.

The soil management procedures provide the protocol to determine where soil excavated during earthwork activities can be used as backfill on the Site. The soil management procedures also include contingency protocols in the event that abandoned subsurface structures such as pipes, sumps, and storage tanks are encountered during redevelopment.

### 3.2.1 Soil Handling and Re-Use Protocol

In order to manage the soil during earthwork activities, the Site will be separated into 3 areas (Areas A, B, and C) on the basis of historic use and analytical results from soil and groundwater sampling (EKI, 1995a). The approximate boundaries of these areas are depicted on Figure 4. Area A includes the former refinery, the former Ryerson underground storage tank, and the surrounding area (i.e., areas where elevated levels of petroleum hydrocarbons have been detected in soil and groundwater). Area B includes portions of the Site where (1) chemical concentrations in soil samples were low or not detected and (2) there are no known sources of chemicals in soil (EKI, 1995a). Area C includes the former Lowenberg tanks and vicinity (where elevated levels of petroleum hydrocarbons and benzene, toluene, ethylbenzene, and xylenes ("BTEX") compounds have been detected in soil and groundwater samples).

Decision diagrams for handling soil excavated from Areas A, B, and C are presented on Figures 5, 6, and 7, respectively. The decision diagrams present the methodology that will be used to determine where excavated soil can be re-used as backfill on the Site. The decision process illustrated on the diagrams also provides an option to test and appropriately dispose of excavated soil at an off-site location. Soil from the Site will be handled and re-used as backfill in accordance with the following criteria:

- Soil excavated from Area A can remain in Area A without any testing.

- If soil is not visibly stained and organic vapor meter ("OVM") readings (i.e., measured with a photoionization detector) are less than 5 parts per million ("ppm"), soil from any area can be used as backfill in any area on the Site.

- If soil is from Areas A or B and is visibly stained or OVM readings exceed 5 ppm, soil can be used as backfill in Area A only.

- If soil is from Area C and is visibly stained or OVM readings exceed 5 ppm, soil must be analyzed for BTEX. If BTEX concentrations are less than the decision criteria for Area C, then soil can be used as backfill in Areas A or C. If BTEX concentrations exceed the decision criteria for Area C, then soil must be disposed appropriately at an off-site location.

For benzene, the decision criterion for Area C is defined as 10 times the U.S. Environmental Protection Agency's ("EPA") Preliminary Remediation Goal ("PRG") for industrial soil containing benzene (EPA, 1995a). The EPA PRG for industrial soil containing benzene, i.e., 3.2 mg/kg, is adjusted to include the more stringent California Cancer Potency Factor of 0.1 $(mg/kg\text{-}day)^{-1}$ for benzene (Office of Environmental Health Hazard Assessment, 1994), rather than the EPA cancer slope factor of 0.029 $(mg/kg\text{-}day)^{-1}$ (EPA, 1995a). Accounting for this difference, the California-adjusted PRG for benzene is equal to 0.93 mg/kg.

PRGs are calculated based on human health risk estimates that assume an industrial exposure scenario and a target incremental lifetime cancer risk level of $10^{-6}$ or a noncarcinogenic hazard index of unity, whichever is more stringent (EPA, 1995a). Because an incremental lifetime cancer risk level of $10^{-5}$ has been determined to represent an acceptable exposure level (National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300), the decision criterion for benzene in Area C is defined as 10 times the California-adjusted PRG, or 9.3 mg/kg.

For toluene, ethylbenzene, and xylenes, the EPA PRG is based on the soil saturation concentration (i.e., the concentration at which the compound is expected to be present in a free phase) because of the low toxicity of these compounds. Therefore, the decision criteria for toluene, ethylbenzene, and xylenes are defined as the EPA PRG. PRGs and decision criteria for BTEX compounds in Area C are summarized below:

| Compound | PRG for Industrial Soil (mg/kg) | Decision Criteria for Area C (mg/kg) |
|---|---|---|
| Benzene | 0.93* | 9.3 |
| Toluene | 2,700 | 2,700 |
| Ethylbenzene | 3,100 | 3,100 |
| Xylenes | 980 | 980 |

Note:
*The PRG for benzene is the California-adjusted value (see above for discussion).

Efforts will be made to place affected soil within Areas A and C beneath future buildings sites and as shallow as possible. The purpose of placing affected soil beneath buildings is to restrict potential contact with such soil by future Site occupants. By also placing affected soil as shallow as possible, contact of such soil with groundwater will be restricted.

If subsurface conditions encountered during earthwork activities are substantially different than conditions encountered previously, the RWQCB and the ACDEH will be contacted. Under such conditions, soil handling and re-use protocols may be modified.

### 3.2.2 Soil Sampling Frequency

The soil sampling frequency (i.e., the quantity of samples per volume of soil) for excavated soil will be one representative sample per approximately 50 cubic yards ("cy") of material. If desired, representative samples may be collected more frequently. For OVM analyses, a representative sample will consist of up to five discrete samples combined in a zip-closure plastic bag. For BTEX analyses, a representative sample will consist of up to five discrete samples that will be collected in precleaned brass or stainless steel tubes and composited in the laboratory.

### 3.2.3 Sample Collection from Borings or Stockpiles

If the extent of the excavation is known, representative samples may be collected from soil borings installed prior to excavation activities. Otherwise, representative samples may be collected from stockpiles formed during excavation activities.

To collect representative samples from soil borings, a sampling grid that covers the planned excavation area will be used. The size of the grid will depend on the planned excavation area and depth, such that a representative sample consisting of up to five discrete samples will be collected for approximately every 50 cy of soil. The borings will be installed to the depth of the planned excavation. Discrete samples will be collected from random depths within each boring.

To collect representative samples from stockpiles, the volume of soil within each stockpile, at any given time, will be estimated on the basis of either the estimated volume of the equipment used to handle the materials (e.g., counting backhoe bucket loads) or measurements of the stockpile dimensions and height. Stockpiles consisting of greater than 50 cy of soil will be divided into approximate 50 cy sections by means of flagging or other suitable marking device. Each 50 cy section will be distinctly labeled for subsequent identification. A maximum of five discrete samples will be collected from random locations throughout each 50 cy section and combined to form one representative sample.

Procedures to collect and analyze samples from stockpiles and soil borings are described in Appendix A. Results of OVM testing will be recorded in a field notebook. Once soil is tested, the destination of excavated materials (e.g., Area A, B, C, or off-site) will be recorded in a field notebook.

### 3.2.4 Abandoned Subsurface Structures

Abandoned subsurface structures which may contain liquids, e.g., sumps, storage tanks and pipes, may be encountered in the vicinity of the former refinery (Figure 2). Such structures may be on-going sources of petroleum hydrocarbons to soil and groundwater if they were not emptied prior to abandonment. Decision diagrams present protocol to manage subsurface sumps and storage tanks (Figure 8), and pipes (Figure 9) if they are encountered.

The following procedures will be followed if sumps, underground tanks, or pipes are encountered:

- ACDEH will be informed and applicable paperwork, such as the ACDEH Underground Tank Closure Plan (6 April 1995), will be initiated.

- Residual liquids will be removed, contained, tested for hazardous constituents, and appropriately disposed.

- The sump or tank will be cleaned and closed in place or excavated and appropriately disposed.

- Pipes can be cut, the desired portion of the pipe can be removed and appropriately disposed, and ends remaining in place will be capped.

If residual liquids are determined to contain compounds other than petroleum hydrocarbon constituents at significant concentrations or quantities, ACDEH will be contacted and confirmation soil sampling in accordance with ACDEH guidance (ACDEH, November 1992; ACDEH, 6 April 1995) may be required.

## 3.3 MONITORING WELL ABANDONMENT

Prior to or during construction, existing monitoring wells will be abandoned in accordance with Alameda County Zone 7 procedures in order to prevent accidental contamination of groundwater. Appropriate permits will be obtained from Alameda County Zone 7. Alameda County Zone 7 refers to the California Department of Water Resources procedures (December 1981; June 1991).

### 3.4 INSTALLATION OF PILINGS THROUGH AFFECTED SOIL LAYER

As noted in Section 2.0 above, the multi-level parking structure will require a pile foundation. Piles are expected to be 40 to 70 feet deep. Thus, there is the potential to drive shallow affected soil in Area A (see Figure 4 and Section 3.2.1) into deeper clean areas.

To mitigate the potential for driving affected soil towards the deep aquifer, one of two techniques will be used if piles are driven into soil in Area A. These two techniques are: (1) predrilling the affected soil layer (approximately 5 feet below ground surface), or (2) installing pilings using a cone-shaped tip on the end of the pile (see also the letter dated 18 September 1995 from Treadwell & Rollo, Inc. ("T&R"), the geotechnical engineers for the Sybase, Inc. redevelopment project, attached as Appendix B). If the piles are predrilled, the removed soil will be handled as described in Section 3.2.1, above.

Chemicals in the shallow groundwater should not impact the deep aquifer because: (1) the soils along the sides of the pile adhere to the pile and form a low permeability seal, and (2) the pile is of low permeability and, thus, cannot act as groundwater conduit (T&R, 18 September 1995, Appendix B).

## 4.0 LONG-TERM RISK MANAGEMENT

The long-term risk-management plan addresses precautions that will be undertaken for mitigation of any risks to human health and the environment after construction and redevelopment of the Site are complete. The hypothetical risk to on-site personnel after construction is evaluated in a risk analysis included as Appendix C.

As described in the risk analysis, the relevant exposure pathway for on-site personnel is inhalation of chemicals volatilizing from soil and groundwater. The risk analysis confirms that under relevant exposure scenarios, the potential risk to on-site personnel from inhalation of chemicals volatilizing from soil or groundwater is negligible.

Any future construction that may modify potentially affected soil, the clean soil cap, building foundations, or pavement must be completed in a manner that is consistent with the risk management plan. Components of the long-term risk management plan are as follows:

- minimize or prevent exposure of Site occupants or Site visitors to affected soil by capping it with buildings or pavement and a clean soil cover in landscaped areas (Section 4.1);
- establish protocols for on-site workers engaged in subsurface excavation activities (e.g., utility repairs, work on building foundations, changes to paved areas) to define adequate protective measures (Section 4.2);
- preclude use of groundwater beneath the Site unless Sybase, Inc. or succeeding occupants request and the RWQCB and ACDEH staff approves the use of groundwater (Section 4.3); and
- establish a groundwater monitoring plan that includes perimeter groundwater monitoring wells to confirm that groundwater quality is stable or improving (Section 4.4).

## 4.1 CAPPING OF SOIL IN AREAS A AND C

All soil in Areas A and C will be capped with buildings, pavement, or clean soil cover in landscaped areas. The clean soil in landscaped areas will be at least 18 inches thick to minimize or eliminate exposure of gardeners and routine maintenance personnel (e.g., those who repair landscaping irrigation systems) to affected soil.

## 4.2 PROTOCOLS FOR FUTURE SUBSURFACE ACTIVITIES

Workers engaged in on-site subsurface excavation activities in which the cap is removed (e.g., utility repairs, work on building foundations, changes to paved areas) will be required to define adequate protective measures. For subsurface work to be performed on the Site, workers will be health and safety trained and will use the appropriate level of personal protective equipment.

As with earthwork construction contractors (Section 3.1), workers engaged in subsurface excavation activities on the Site will be required to prepare site-specific health and safety plans consistent with State and Federal Occupational Safety and Health Administration standards for hazardous waste operations (California Code of Regulations, Title 8, Section 5192 and 29 Code of Federal Regulations 1910.120, respectively) and any other applicable health and safety standards. The health and safety plans will be submitted to the ACDEH and the RWQCB for review.

Workers excavating soil deeper than the clean 18-inch cover will follow the detailed soil handling protocol outlined in Section 3.2, above. The decision diagrams for handling soil excavated from Areas A, B, and C presented on Figures 5, 6, and 7, respectively, present the methodology that will be used to determine where excavated soil can be re-used as backfill on the Site. The decision process illustrated on the diagrams also provides an option to test and appropriately dispose of excavated soil at an off-site location. Soil from the Site will be handled and re-used as backfill in accordance with the following criteria:

- Soil excavated from Area A can remain in Area A without any testing.
- If soil is not visibly stained and OVM readings are less than 5 ppm from any area, soil can be used as backfill in any area on the Site.
- If soil is from Areas A or B and is visibly stained or OVM readings exceed 5 ppm, soil can be used as backfill in Area A only.
- If soil is from Area C and is visibly stained or OVM readings exceed 5 ppm, soil must be analyzed for BTEX. If BTEX concentrations are less than the decision criteria for Area C, then soil can be used as backfill in Areas A or C. If BTEX concentrations exceed the decision criteria for Area C, then soil must be disposed appropriately at an off-site location. (See page 7 for BTEX decision criteria.)

If desired, the clean cover soil material may be handled separately and not subjected to the soil handling protocol outlined above.

## 4.3 GROUNDWATER USE AT THE SITE

Sybase, Inc. will not use groundwater beneath the Site without first securing approval from RWQCB and ACDEH staff. The City of Emeryville is supplied by a public water distribution system containing imported surface water.

## 4.4 GROUNDWATER MONITORING PLAN

The purpose of the perimeter groundwater monitoring program is to confirm that water quality on the Site is stable or improving. The groundwater monitoring plan described in this section includes the location and number of wells to be installed, the chemical analyses to be performed on groundwater samples, the frequency of monitoring, contingency options if chemical concentration trends significantly increase, and the option to terminate monitoring once it is shown that conditions are stable or improving.

As part of the groundwater investigations on the Site, levels of petroleum hydrocarbons suggestive of a residual free hydrocarbon phase were measured in groundwater samples collected in the vicinity of the former oil refinery (EKI, 1995a). However, soil and groundwater sample analyses indicated that the hydrocarbons are of high molecular weight and they do not contain polycyclic aromatic hydrocarbons ("PAHs"). Ethylbenzene and xylenes were detected in only two groundwater samples collected in the vicinity of the former refinery, at low concentrations (i.e., less than 44 ug/L). Low petroleum hydrocarbon concentrations detected in groundwater samples collected 110 to 160 feet downgradient of the Site (i.e., 110 to 250 ug/L) indicate that migration of petroleum hydrocarbons from the former oil refinery has not occurred or is negligible (EKI, 1995a).

Benzene, ethylbenzene, and xylenes have been detected in groundwater samples collected from two of the monitoring wells in the vicinity of the former Lowenberg tanks (i.e., up to 26 ug/L benzene) (EKI, 1995a). TPH and BTEX concentrations in the vicinity of the former Lowenberg tanks generally have been stable or decreasing with time (EKI, 1995a). In the event that the Lowenberg tank site has not been closed by ACDEH prior to Sybase, Inc.'s redevelopment of the Site, a monitoring well will be installed in the vicinity of the former Lowenberg tanks as part of this groundwater monitoring plan.

The groundwater monitoring detailed below includes monitoring of the more shallow of the two aquifers beneath the Site because, as described in Appendix D, neither significant short-term or long-term migration of petroleum hydrocarbons from the shallow aquifer zone to the deeper aquifer zone is expected.

### 4.4.1 Proposed Monitoring Well Locations

After the Site is redeveloped, four wells proposed for the perimeter groundwater monitoring program (Figure 10) will be constructed, subject to the receipt of necessary permits or approvals. Monitoring wells SMW-1, SMW-2, and SMW-3 will be located in the sidewalk along Bay Street. Well SMW-4 will be located inside the property boundary between the U-shaped office building and parking structure. As discussed above, a fifth well, SMW-5, may be installed in the vicinity of the former Lowenberg tanks.

All wells will be drilled and screened in the shallow aquifer zone (i.e., less that 25 ft bgs). If possible, the well will be screened across the water table-unsaturated zone interface. Monitoring well installation and sampling procedures are described in Appendix E. The data from groundwater collected from the monitoring wells will be evaluated to determine if groundwater quality on the Site is stable or improving.

Proposed wells SMW-1 through SMW-3 are located downgradient and off-site (i.e., outside of the area with hydrocarbon concentrations suggestive of residual free phase hydrocarbons). Well SMW-4 is located downgradient of sampling location P-4, in the vicinity of the former refinery. The likely presence of residual free phase hydrocarbons in well SMW-4 might give rise to significant variation in the groundwater chemical analytical results. Well SMW-5 will be located near the former Lowenberg tanks, in the area where groundwater samples have contained elevated levels of benzene, if the tank site has not been closed prior to Sybase, Inc.'s redevelopment of the Site.

The proposed monitoring schedule, analytical program, and contingency plan are discussed below. The monitoring schedule and analytical program are summarized in Table 1.

### 4.4.2 Well Sampling Schedule

The four or five groundwater monitoring wells will be sampled quarterly during the first year, semi-annually during the second year, and annually thereafter (Table 1). If a statistically significant upward trend in dissolved petroleum hydrocarbon concentrations is identified using the first four quarters of monitoring data or a greater than 10-fold difference in concentrations is measured during the first four quarters of monitoring, the wells will be sampled quarterly in the second year. If significant variations of dissolved petroleum hydrocarbons are present in well SMW-4 due to the presence of residual free-phase hydrocarbons, groundwater monitoring of well SMW-4 will be re-evaluated. Efforts will be made to minimize entrainment of free-phase hydrocarbons in groundwater samples from well SMW-4 by sampling groundwater through a stilling tube, as described by EPA (1992) and summarized in Appendix E.

Once annual monitoring commences, Sybase, Inc. can submit a request to the RWQCB and the ACDEH to discontinue groundwater monitoring if it can be demonstrated that hydrocarbon concentrations are stable or decreasing.

### 4.4.3 Well Sampling Analytical Program

Groundwater samples collected as part of the monitoring program will be analyzed by a State-certified laboratory for total extractable petroleum hydrocarbons using EPA Method 8015, modified. Groundwater samples collected from well SMW-5 will also be analyzed for total petroleum hydrocarbons quantified as gasoline and BTEX compounds using EPA Methods 8015 modified and 8020, respectively. Appropriate quality assurance and quality control measures will be taken in the field (e.g., chain-of-custody records, field duplicates) and in the laboratory (e.g., matrix spike, matrix spike duplicates, method blanks).

Results of sampling and analysis performed for the perimeter groundwater monitoring program will be submitted in reports after each sampling event to the RWQCB and the ACDEH.

### 4.4.4 Contingency Plan

In the event that hydrocarbon concentrations in samples collected as part of the monitoring program exhibit an increasing trend, the contingency plan described below will be implemented.

If hydrocarbon concentrations increase (as defined in Section 4.4.2, above) an additional year of quarterly monitoring will be performed to confirm the increasing trend. Attempts will be made to identify the source of the increasing hydrocarbon concentration if hydrocarbon concentrations continue to increase after a year of quarterly monitoring. Under such circumstances, Sybase, Inc. will contact the RWQCB and the ACDEH. A plan of action will be submitted to the RWQCB and the ACDEH, as appropriate.

It should be noted that potential hydrocarbon sources exist between the Site and proposed monitoring wells SMW-1 through SMW-3. Pipelines carrying petroleum products run parallel to and underneath the Southern Pacific Railroad tracks located immediately west of the Site. Releases of hydrocarbons may occur or may have occurred from these pipelines and/or along the railroad tracks themselves. Thus, if hydrocarbon concentrations measured in downgradient off-site wells SMW-1 through SMW-3 were to increase, it may not be the result of hydrocarbons migrating from the Site. The plan of action submitted to the RWQCB and the ACDEH will address this issue as deemed appropriate.

## 5.0 LONG-TERM COMPLIANCE

The City of Emeryville may establish administrative procedures requiring that this plan be reviewed prior to the issuance of any building, grading, or excavation permits to any owner at the Site, and that this plan be implemented during the permitted activity.

If procedures acceptable to the RWQCB and the ACDEH are not established by the time Sybase, Inc. completes its first phase of development, then Sybase, Inc. will submit to the Alameda County Recorder's Office a Notification to apprise any future owner of the existence of the plan. If approved administrative procedures are developed by the City of Emeryville subsequent to recording a Notification, then such a Notification may be removed.

## REFERENCES

Alameda County Department of Environmental Health ("ACDEH"), November 1992, *Underground Storage Tank Removal Process in Alameda County*.

ACDEH, 6 April 1995, *Underground Tank Closure Plan*.

California Department of Toxic Substances Control, July 1992, *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities*.

California Department of Water Resources, June 1991, *California Well Standards*, Sacramento, California, Bulletin 74-90.

California Department of Water Resources, December 1981, *Water Well Standards: State of California*, Sacramento, California, Bulletin 74-81.

CH2M-Hill, August 1990, VLEACH: A One-Dimensional Finite Difference Vadose Zone Leaching Model, Version 1.1, developed for the U.S. EPA.

Daugherty, S.J., 1991, Regulatory Approaches to Hydrocarbon Contamination from Underground Storage Tanks, In: *Hydrocarbon Contaminated Soils and Groundwater*, Volume I, P.T. Kostecki and E.J. Calabrese, Eds., Lewis Publishers, Chelsea, MI.

Emcon Associates, October 1993, *Westinghouse Emeryville Data Summary Report*, Emeryville, California.

Emcon Associates, 31 March 1995, *Additional Site Assessment Report*, Westinghouse Emeryville Site.

Erler & Kalinowski, Inc. ("EKI"), 10 January 1994, *Preliminary Site Investigation Report BGR and Chapman Properties*, Chiron Corporation, Emeryville, California.

EKI, 1995a (9 September 1995), *Final Site Investigation Report for the 64th and 65th Street Properties*, Sybase, Inc., Emeryville, California.

EKI, 1995b (13 June 1995), *Initial Site Investigation Report for the 64th and 65th Street Properties*, Sybase, Inc., Emeryville, California.

Freeze, R.A. and J.A. Cherry, 1979, *Groundwater*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Gossett, J.M., 1987, Measurement of Henry's Law Constants for C1 and C2 Chlorinated Hydrocarbons, *Environ. Sci. Technol.*, 21: 202-208.

Jury, W.A., W.F. Spencer, and W.J. Farmer, 1983, Behavior Assessment Model for Trace Organics in Soil: I. Model Description, *J. Environ. Qual.*, 12: 558-564.

Jury, W.A., D. Russo, G. Streile, and H. El Abd, 1990, Evaluation of Volatilization by Organic Chemicals Residing Below the Soil Surface, *Water Resources Research*, 26: 13-20.

Levine-Fricke, 4 April 1990, *Results of Second Phase Environmental Investigation, Sherwin-Williams Plant,* Emeryville, California.

Montgomery, J.H. and L.M. Welkom, 1991, *Groundwater Chemicals Desk Reference*, Lewis Publishers, Chelsea, MI.

National Oil and Hazardous Substances Pollution Contingency Plan, 1990, Code of Federal Regulations, Title 40, Part 300, Section 430(e)(2)(I).

Office of Environmental Health Hazard Assessment ("OEHHA"), 1994, *California Cancer Potency Factors: Update*, Standards and Criteria Work Group, Sacramento, CA.

Treadwell & Rollo, Inc., 4 May 1995, *Draft Geotechnical Investigation Report*, Sybase Hollis Street Campus, Emeryville, California.

Treadwell & Rollo, Inc., 18 September 1995, Letter to Sybase, Inc., *Pile Foundations*, Sybase Hollis Street Campus, Emeryville, California.

U.S. Environmental Protection Agency ("EPA"), 1988, *Superfund Exposure Assessment Manual*, Office of Emergency and Remedial Response, Washington, D.C., EPA/540/1-88/001.

EPA, 1989, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)*, Office of Emergency and Remedial Response, Washington, D.C., EPA-540/1-89/002.

EPA, 1990, *Air Superfund National Technical Guidance Series, Volume II, Estimation of Baseline Air Emissions at Superfund Sites*, Office of Air Quality Planning and Standards, Research Triangle Park, NC, EPA/450/1-89-002a.

EPA, 1992a, *RCRA Ground-Water Monitoring: Draft Technical Guidance*, Office of Solid Waste, Washington, D.C., EPA/530-R-93-001.

EPA, 1992b, *Supplemental Guidance to RAGS: Calculating the Concentration Term*, OSWER, Washington, D.C., Intermittent Bulletin, Vol. 1, No. 1, Publication 9285.7-081.

EPA, 1994, *Health Effects Assessment Summary Tables, Annual FY 1994*, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1 September 1995a, *Region IX Preliminary Remediation Goals (PRGs) Second Half 1995*, San Francisco, California.

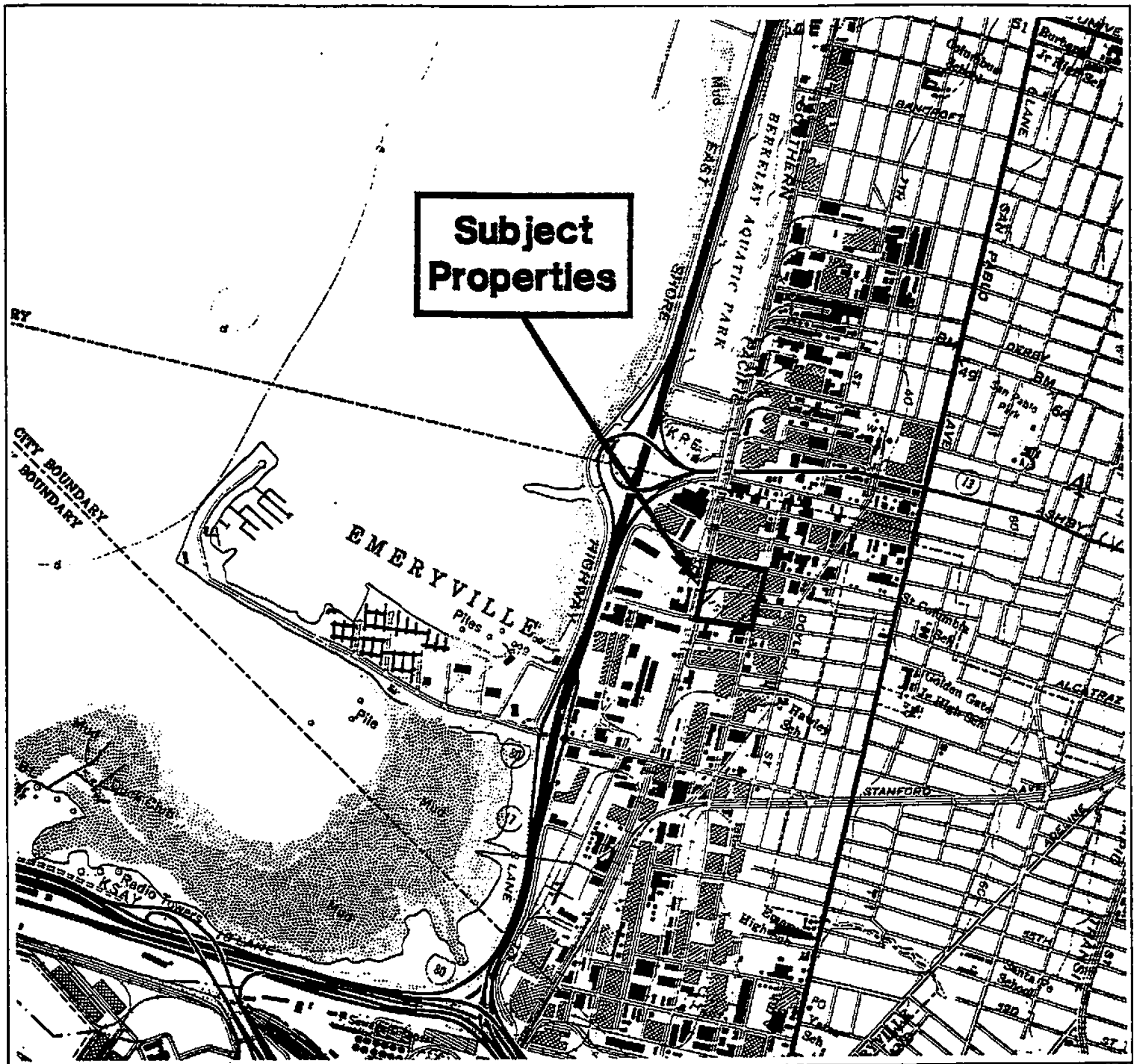
EPA, 1995b, *Integrated Risk Information System (IRIS)*, TOXNET Files, U.S. Department of Health and Human Services. Washington, D.C.

## Table 1
## Schedule and Analytical Requirements for the Perimeter Groundwater Monitoring Program (a)
Sybase, Inc.
64th and 65th Street Properties, Emeryville, California
(EKI 940018.03)

| Monitoring Year | Monitoring Frequency | Analysis (b) | |
|---|---|---|---|
| | | Wells SMW-1 through SMW-4 | Well SMW-5 |
| 1 | Quarterly | TEPH (8015m) | TEPH, TPPH (8015m)<br>BTEX (8020) |
| 2 | Semi-Annually (c) | TEPH (8015m) | TEPH, TPPH (8015m)<br>BTEX (8020) |
| 3 and thereafter | Annually (d) | TEPH (8015m) | TEPH, TPPH (8015m)<br>BTEX (8020) |

Notes:

(a) Up to five wells are to be installed subsequent to Site redevelopment (Figure 10). Well SMW-5 will be installed only if the former Lowenberg tank site has not been closed by the ACDEH prior to Site redevelopment.
(b) Total extractable petroleum hydrocarbons (TEPH) by EPA Method 8015 modified. Total purgeable petroleum hydrocarbons (TPPH) by EPA Method 8015 modified. Benzene, toluene, ethylbenzene, and total xylenes (BTEX) by EPA Method 8020.
(c) If TEPH concentrations show an upward trend or a greater than 10-fold difference in concentration, continue quarterly monitoring for year 2.
(d) Once annual monitoring commences, Sybase, Inc. can submit a request to the RWQCB and the ACDEH to discontinue monitoring if TEPH concentrations are stable or decreasing.



Basemap Source: 1980 U.S.G.S Quad Map, Oakland West, California.

(Approximate Scale in Feet)

**Notes:**

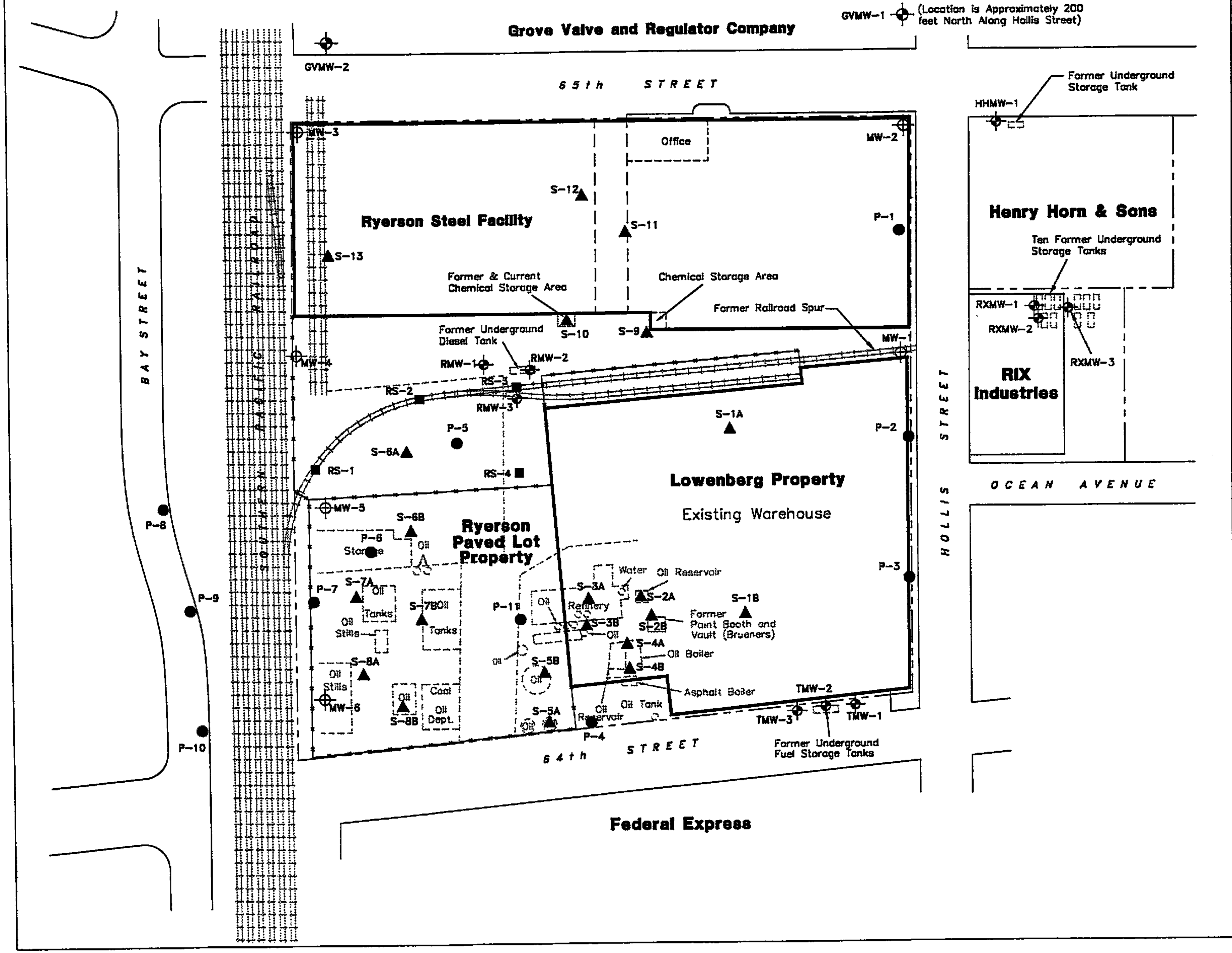
1. All locations are approximate.

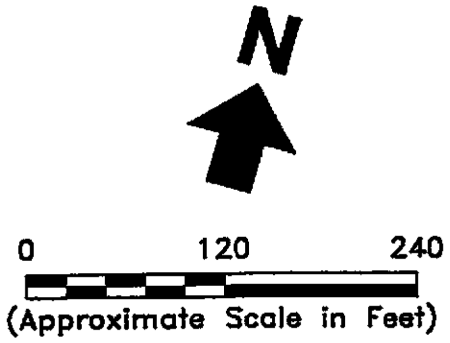
**Erler & Kalinowski, Inc.**

Site Location

64th & 65th Street Properties
Emeryville, CA
October 1995
EKI 940018.03

Figure 1





## LEGEND

| | |
|---|---|
| ┼┼┼┼ | Railroad Tracks |
| — — — | Approximate Property Boundary |
| - - - - - | Historical Site Features (1911 Sanborn Map) |
| ⌖ | Monitoring Well Installed by EKI |
| ▲ | Shallow Soil Boring Installed by EKI |
| ⌖ | Monitoring Well Installed by Others |
| ■ | Soil and Grab Groundwater Sampling Location Collected by Others |
| ● | Soil/Grab Groundwater Sampling Location Collected by EKI, July 1995 |

**Notes:**

1. All locations are approximate.
2. Basemap taken from Sanborn maps dated 1911 and 1967.

**Erler & Kalinowski, Inc.**

Site Plan

64th & 65th Street Properties
Emeryville, CA
October 1995
EKI 940018.03
Figure 2

# APPENDIX B

## Treadwell & Rollo, Inc. Letter Regarding Installation of Building Piles

**Treadwell&Rollo**

18 September 1995
Project 1798.01

Mr. John Bruno
Sybase
6475 Christie Avenue
Emeryville, California 94608

Subject: Pile Foundations
Sybase Hollis Street Campus
Emeryville, California

Dear Mr. Bruno:

We understand that a representative of the California Regional Water Quality Control Board (RWQCB) has expressed concern that the use of driven concrete piles at the Sybase Hollis Street Campus site may adversely the affect the water quality in the aquifer at a depth of 40 to 60 below the site. This letter presents our response to this concern.

**Background**

The parking garage site is blanketed by approximately 3 to 4 feet of fill, some of which is contaminated. Beneath the fill is a 2- to 4-foot-thick layer of overconsolidated Bay Mud (marsh deposit). The marsh deposit is underlain by interbedded alluvial soil consisting primarily of clay and silt with occasional layers of sand and silty sand. The alluvial clay and silt are of moderate to low plasticity. We estimate the permeability of these materials is on the order of $10^{-6}$ to $10^{-7}$ cm/sec.

We have recommended the proposed parking garage be supported on prestressed, precast concrete piles so that foundation settlement will be within acceptable limits. The length of the piles will depend on the size of the pile used (12- or 14-inch-square) and the design pile capacity. We anticipate the piles will be about 65 to 70 feet long. The piles will take their support primarily through skin friction in the interbedded alluvium underlying the site.

**Discussion and Conclusions**

There are three potential contaminant pathways that must be addressed with pile foundations:

- flow of contaminated groundwater alongside the pile
- flow of contaminated groundwater through the pile
- pushing of contaminated soil into underlying soil layers by the pile tip during pile installation.

Each of these potential pathways is addressed as follows:

**Flow Alongside Pile** - During pile installation, the cohesive soil along the sides of the pile is remolded with an accompanying increase in porewater pressure. As the porewater pressure dissipates, the soil gains strength and adheres tightly to the sides of the pile to provide "skin friction" for support of vertical loads. The remolding of the cohesive soil causes a decrease in permeability and an increase in shear strength of the soil. The adhesion to the pile and the lower permeability of this soil should provide an effective seal against downward migration of chemicals.

**Flow Through Pile** - The pile is composed of high-strength concrete with a low-water cement ratio. The 28-day strength of the piles is generally specified to be at least 6,000 pounds per square inch. Because of the low-water cement ratio, the concrete is very dense with a low permeability (between $10^{-5}$ and $10^{-6}$ cm/sec). Considering its high density and low permeability, we judge that contaminated groundwater will not migrate downward through the pile.

**Pushing of Contaminated Soil Downward** - When a friction pile is installed, it punches through the soil layers, causing a temporary shear failure of the soil in front and along the sides of the pile. Therefore, the pile will punch through the contaminated upper fill at the subject site. Any contaminated soil should not be carried downward more than a few feet. Methods to reduce the potential for pushing of contaminated soil in front of the pile include predrilling the contaminated layer prior to pile installation or casting a cone-shaped tip at the end of the pile. Predrilling would not be effective where the fill material is granular and would slough into the hole.

We trust this letter addresses the concerns raised by the RWQCB. If you have any questions, please call.

Sincerely yours,
TREADWELL & ROLLO, INC.

C. S. Shields

Craig S. Shields
Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
CRAIG S. SHIELDS
GE 2116
Exp. 3/31/97
GEOTECHNICAL
STATE OF CALIFORNIA

17980104.CSS

cc: Ms. Michelle King - Erler & Kalinowski

# APPENDIX C

## Estimated Risk to Future On-Site Personnel

# Appendix C
## Estimated Risk to On-Site Personnel After Construction

In this appendix, the hypothetical risk to people on Site in the future (i.e., post-construction) is evaluated. The identified complete exposure pathway for on-site personnel is inhalation of chemicals volatilizing from soil and groundwater. On-site personnel, including indoor and outdoor workers, will not have direct contact with affected soil because of the presence of asphalt paving, concrete, and buildings on most of the Site and at least 18 inches of clean fill soil in landscaped portions of Areas A and C. The City of Emeryville is supplied by a public water distribution system containing imported surface water and Sybase, Inc. does not plan to use groundwater beneath the Site. Thus, inhalation of volatile chemicals from soil and groundwater is the only complete exposure pathway for on-site personnel.

This risk evaluation utilizes the reasonable maximum exposure ("RME") methodology recommended by the California Department of Toxic Substances Control ("DTSC") and U.S. Environmental Protection Agency ("EPA") (DTSC, 1992; EPA, 1989a). Thus, the hypothetical risk calculated and presented below is upper-bound, health conservative. The actual risks may, in fact, be much lower.

The following steps are taken to perform the risk evaluation:

- identify potential chemicals of concern, their representative concentrations, and their toxicity criteria;
- perform the exposure assessment, which provides estimates of the levels of chemical exposure and doses for the relevant population; and
- quantify the hypothetical risk.

## IDENTIFICATION OF POTENTIAL CHEMICALS OF CONCERN

Volatile organic chemicals ("VOCs") are the potential chemicals of concern at the Site because the relevant exposure pathway for on-site personnel is inhalation of chemicals volatilizing from the subsurface. Results of soil and groundwater investigations on the Site are included in the *Final Site Investigation Report for the 64th and 65th*

*Street Properties* (EKI, 1995a). VOCs were detected in soil in only 1 out of 31 samples collected from the Site at low concentrations, i.e., less than 1 mg/kg (EKI 1995a). In groundwater, detectable concentrations of VOCs are much more widespread due to the migration of VOCs onto and across the Site from upgradient sources (EKI, 1995a). Therefore, only VOCs in groundwater are included in the risk evaluation.

VOCs detected in groundwater at the Site are as follows (EKI, 1995a):

- acetone
- benzene
- chloroethane
- 1,1-dichloroethane
- 1,2-dichloroethane
- 1,1-dichloroethene
- c-1,2-dichloroethene
- t-1,2-dichloroethene
- ethylbenzene
- Freon 113
- 1,1,1-trichloroethane
- trichloroethene
- vinyl chloride
- xylenes

For the risk evaluation, these compounds were assumed to be present in groundwater at their maximum concentrations detected in sampling performed from March through July 1995 (Table C1). The maximum concentration detected is thus conservatively assumed to equal the representative concentration (EPA, 1992b). Chemical properties of these compounds to be used in the volatilization modeling are also included in Table C1.

## TOXICITY CRITERIA FOR VOCS

The toxicity criteria provide quantitative estimates of the toxic effects associated with the potential chemicals of concern at the Site (i.e., VOCs in groundwater). The two broad categories of adverse human health effects recognized in the assessment of health risks are non-carcinogenic and carcinogenic effects.

### Non-carcinogenic Health Effects Criteria

Non-carcinogenic effects encompass adverse chronic human health effects that do not result in the production of tumors, but which include both developmental and reproductive effects. Health criteria for non-carcinogenic effects are expressed as reference doses ("RfDs"). An RfD, published in units of mg/kg-day, reflects the maximum chemical dose level that must be exceeded before adverse effects may be expected to occur, but generally incorporates a safety or uncertainty factor of two or more orders of magnitude. This definition provides that an RfD represents the maximum "safe" dosage of a chemical (EPA, 1995b). A low RfD indicates a low threshold dose level, and therefore a high chemical toxicity.

Inhalation toxicity information (i.e., RfDi) for VOCs detected in groundwater is summarized in Table C2. As a conservative assumption, ingestion toxicity information was used in the absence of available inhalation toxicity information.

## Carcinogenic Health Effects Criteria

The health criteria that indicate the potential carcinogenicity of chemicals are called slope factors ("SFs"). EPA defines SFs as the "plausible upper-bound estimates of the probability of a carcinogenic response per unit of chemical intake over a lifetime" (EPA, 1989). SFs are developed using mathematical models and are expressed in reciprocal units of exposure, $(mg/kg\text{-}day)^{-1}$. Chemicals having a higher SF are believed to be inherently more carcinogenic, i.e., potent, than those with a lower SF.

Inhalation toxicity information for carcinogenic VOCs is summarized in Table C2. Again, as a conservative assumption, ingestion carcinogenicity information was used in the absence of available inhalation toxicity information.

## EXPOSURE ASSESSMENT

VOCs in groundwater have the potential to move upward through the interconnected air-filled soil pores in the unsaturated soil zone and to impact the breathing zone of individuals standing outdoors or within structures built on top of chemical-containing groundwater. Exposure to VOCs in air is estimated only for individuals assumed to be located indoors and directly on top of the chemical-containing groundwater (i.e., on-site personnel). The exposure assessment is performed for indoor exposure because Sybase workers are assumed to spend most of their day indoors. These assumptions will provide upper-bound estimates of exposure and potential human health risk for individuals having direct daily access to the properties (i.e., both indoors and outdoors).

The method to estimate the emission flux of VOCs volatilizing from groundwater and the resultant indoor air exposure point concentration ("EPC") of VOCs is summarized below and described in detail in Attachment 1. The daily intakes of VOCs in air by on-Site personnel are calculated from the EPC.

## Volatilization Emission Flux and Exposure Point Concentration

The model VLEACH was used to estimate the emission flux of VOCs volatilizing from groundwater (CH2M-Hill, August 1990). The VLEACH modeling assumptions and site-specific soil parameters used to calculate the emission flux due to volatilization of VOCs are summarized in Tables C3 and C4, respectively. VLEACH input and output files are included in Attachment 2. The emission flux obtained from VLEACH was converted into an air EPC for on-site personnel using an indoor box model (Daugherty, 1991) using a range of fraction of cracks (i.e., infiltration area) to total floor area from 0.001 to 1.0 (bare soil). Assumptions for the indoor box model are summarized in Table C3.

## Estimated Daily Intake of VOCs in Air

This section presents estimates of VOC inhalation intakes for the potentially exposed populations. VOC intakes, called chronic daily intakes ("CDIs"), are provided in units of mg of chemical per kg of human body weight per day (mg/kg-day). General exposure parameters used to calculate CDIs for indoor personnel are included in Table C5.

The CDIs for the inhalation of volatilized VOCs from groundwater are calculated using the estimated indoor air concentrations of VOCs ("Cair") obtained from the volatilization modeling. CDIs for inhalation of VOCs are estimated using the following equation:

$$\begin{array}{c}\text{Chronic Daily}\\ \text{Intake (CDI)}\\ \text{(mg/kg-day)}\end{array} = \frac{(\text{Cair})(\text{CF})(\text{IR})(\text{EF})(\text{ED})}{(\text{BW})(\text{AT})}$$

where:

Cair = Chemical Concentration in Indoor Air (ug/m$^3$), calculated using VLEACH with the indoor box model;

CF = Conversion Factor ($10^{-3}$ mg/ug);

IR = Inhalation Rate, assumed as 20 m$^3$/day (EPA, 1989, 1991; DTSC, 1992);

EF = Exposure Frequency, assumed as 250 days/year (EPA, 1991; DTSC, 1992);

ED = Exposure Duration, assumed as 25 years (EPA 1991; DTSC, 1992);

BW = Lifetime average body weight for an adult, assumed as 70 kg (EPA, 1989, 1991; DTSC, 1992); and

AT = Averaging Time (number of days over which exposure is averaged) assumed as 25,550 days (365 days/year x 70 years) for carcinogens; for non-carcinogens, the averaging time assumed as 6,250 days (250 days/year x 25 years) (EPA, 1989, 1991; DTSC 1992).

CDIs for inhalation of VOCs from groundwater applicable to personnel are included in Table C6.

## RISK QUANTIFICATION

Hypothetical quantitative estimates of incremental lifetime cancer risk for the detected carcinogens and the potential adverse health impacts for the detected non-carcinogens are calculated for the risk quantification. The estimation of human health risks follows the methodology recommended by EPA and DTSC (EPA, 1989; DTSC, 1992). Risk estimates are calculated by mathematically combining the CDI estimates from the exposure assessment with the appropriate health criteria from the toxicity assessment. The health risk estimate for each VOC is summed to derive total lifetime risk for on-site personnel.

### Non-Carcinogenic Effects

Non-carcinogenic risk characterization evaluates the relationship between the chemical doses estimated for the populations of concern and the toxicity of the individual non-carcinogenic VOCs. CDIs, derived in units of mg/kg-day, are combined with the appropriate RfDs (also in units of mg/kg-day) using a Hazard Index ("HI") approach as described below (EPA, 1989; DTSC, 1992):

$$HI_i = CDI_i \div RfD_i$$

where:

$HI_i$ = Hazard Index for chemical i (dimensionless);

$CDI_i$ = Chronic Daily Intake of chemical i (mg/kg-day); and

$RfD_i$ = Chronic Reference Dose for inhalation of chemical i (mg/kg-day).

Note that the HI estimates are dimensionless since the CDI units cancel out the identical RfD units. If the HI exceeds unity (one), the estimated CDI is greater than the "safe" dosage level represented by the RfD, and therefore non-cancer adverse health effects may occur in the potentially exposed population. Specific health impacts should be further assessed. When the HI is less than unity, adverse non-cancer health effects are not expected to occur in the exposed population.

The total Hazard Index is calculated by summing Hazard Indices from all of the VOCs in groundwater. This summing of calculated HIs across all VOCs is a health-conservative screening step because not all VOCs impact the same target organs. Calculated Hazard Indices for all VOCs is included in Table C6. The total estimated Hazard Index for on-site personnel ranges from 0.000042 to 0.0042, which is orders of magnitude less than unity (Table C6). Thus, non-carcinogenic risk due to inhalation of VOCs volatilizing from groundwater is negligible.

## Carcinogenic Effects

Risk characterization for carcinogens includes estimating the incremental probability of developing cancer over a lifetime of 70 years due to exposure to potential human carcinogens. Except for those VOCs for which scientific information supporting a carcinogenic threshold exists, a carcinogen is considered to be a non-threshold agent, such that any exposure to a carcinogen is expected to increase the probability of developing cancer over an individual's lifetime.

The incremental lifetime cancer risk for a potential carcinogen is estimated using the following equation (EPA, 1989; DTSC, 1992):

$$\text{Cancer Risk}_i = (\text{CDI}_i)(\text{SF}_i)$$

where:

$\text{Cancer Risk}_i$ = Incremental lifetime risk of tumor formation from potential human carcinogen, i (dimensionless);

$\text{CDI}_i$ = Chronic Daily Intake of chemical i averaged over 70 years (mg/kg-day); and

$\text{SF}_i$ = Slope Factor of chemical i $(\text{mg/kg-day})^{-1}$.

Note that the incremental lifetime cancer risk estimate is a dimensionless value, since the CDI and SF units cancel. The total incremental lifetime cancer risk is calculated by summing the risk estimates from all of the VOCs.

Estimated incremental lifetime cancer risks for each VOC are presented in Table C6. The total estimated incremental lifetime cancer risk for on-site personnel ranges from 4.2 x $10^{-8}$ to 4.2 x $10^{-5}$ (Table C6). This range of upper-bound, hypothetical risk level is within the range of acceptable incremental cancer risk of $10^{-4}$ to $10^{-6}$ (National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300). Actual risks are likely lower when considering these calculation assume <u>all</u> chemicals of concern are present at their maximum detected concentration, uniformly throughout site groundwater.

## Table C1
## Maximum Concentration and Chemical Properties of VOCs Detected in Groundwater
Sybase, Inc.
64th and 65th Street Properties, Emeryville, California
(EKI 940018.03)

| Compound Detected in Groundwater | Maximum Concentration Detected (mg/L) (a) | Chemical Properties | | | |
|---|---|---|---|---|---|
| | | Henry's Constant (Hc) (-) (b) | Organic Carbon Partition Coeff. (Koc) (mL/g) (c) | Solubility in Water (Cmax) (mg/L) (d) | Diffusion Coefficient in Air (Dair) (m2/d) (e) |
| Acetone | 0.023 | 0.0016 (f) | 0.37 | totally miscible | 0.95 |
| Benzene | 0.0048 | 0.22 (f) | 81 | 1,800 | 0.78 |
| Chloroethane | 0.034 | 0.46 (g) | 3.2 | 4,700 | 0.93 |
| 1,1-Dichloroethane | 0.044 | 0.23 (g) | 30 | 5,100 | 0.81 |
| 1,2-Dichloroethane | 0.0014 | 0.044 (f) | 17 | 8,300 | 0.81 |
| 1,1-Dichloroethene | 0.042 | 1.07 (g) | 65 | 2,800 | 0.71 |
| c-1,2-Dichloroethene | 0.060 | 0.17 (g) | 59 (h) | 6,300 (h) | 0.71 |
| t-1,2-Dichloroethene | 0.041 | 0.38 (g) | 59 | 6,300 | 0.71 |
| Ethylbenzene | 0.021 | 0.29 (f) | 180 | 170 | 0.60 |
| Freon 113 | 0.009 | 13.6 (f) | 390 | 200 | 0.64 (i) |
| 1,1,1-Trichloroethane | 0.0074 | 0.70 (g) | 130 | 830 | 0.71 |
| Trichloroethene | 0.170 | 0.39 (g) | 99 | 1,300 | 0.71 |
| Vinyl Chloride | 0.010 | 1.14 (g) | 2.5 | 4,200 | 0.95 |
| Total Xylenes | 0.044 | 0.25 (f) | 640 | 180 | 0.64 |

Notes:

(a) Data obtained from EKI, 5 September 1995.

(b) Dimensionless Henry's constant at 25 degrees Celsius obtained from reference indicated.

(c) Organic carbon partition coefficients (Koc) obtained from Montgomery and Welkom (1991). Where multiple Koc's were available, the Koc's were averaged.

(d) Solubility in water (Cmax) at 25 degrees Celsius obtained from Montgomery and Welkom (1991). Where multiple Cmax's were available, the Cmax's were averaged.

(e) Except where indicated, diffusion coefficients obtained from U.S. EPA Superfund Exposure Assessment Manual ( SEAM, April 1988). Values were interpolated to 25 degrees Celsius.

## Table C1
## Maximum Concentration and Chemical Properties of VOCs Detected in Groundwater
Sybase, Inc.
64th and 65th Street Properties, Emeryville, California
(EKI 940018.03)

(f) Henry's constant obtained from Montgomery and Welkom (1991). Where multiple Henry's constants were available, the average value was calculated.

(g) Henry's constant obtained from Gossett (1987).

(h) Because Koc and Cmax values for c-1,2-dichloroethene are not available, the Koc and Cmax values for t-1,2-dichloroethene were used.

(i) Diffusion coefficient not available in SEAM. Diffusion coefficient was calculated using Fuller's method recommended in SEAM (U.S. EPA, April 1988).

## Table C2
## Summary of Inhalation Toxicity Information for VOCs Detected in Groundwater
Sybase, Inc.
64th and 65th Street Properties, Emeryville, California
(EKI 940018.03)

| Compound Detected in Groundwater | Non-Carcinogenic Toxicity Information | | | Carcinogenic Toxicity Information | | |
|---|---|---|---|---|---|---|
| | Chronic Reference Dose (RfDi) (mg/kg-day) | Effect of Concern | Source (a) | Slope Factor (SF) (mg/kg-day)$^{-1}$ | Weight-of-Evidence Classification (b) | Source (c) |
| Acetone | 0.1 (d) | Incr. Liver & Kidney Wt. | IRIS | - (e) | D | IRIS |
| Benzene | - | - | - | 0.1 | A | Cal Potency |
| Chloroethane | 2.9 | Delayed Fetal Ossification | IRIS | - | - | - |
| 1,1-Dichloroethane | 0.1 | Kidney Damage | HEAST | 0.0057 | C | Cal Potency |
| 1,2-Dichloroethane | - | - | - | 0.07 | B2 | Cal Potency |
| 1,1-Dichloroethene | 0.009 (d) | Hepatic Lesions | IRIS | 1.2 (d) | C | HEAST |
| c-1,2-Dichloroethene | 0.01 (d) | Decr. Hematocrit | HEAST | - | D | IRIS |
| t-1,2-Dichloroethene | 0.02 (d) | Incr. Serum Alkaline Phosphatase | IRIS | - | - | - |
| Ethylbenzene | 0.29 | Liver & Kidney Toxicity | IRIS | - | D | IRIS |
| Freon 113 | 30 (d) | Psychomotor Impairment | IRIS | - | - | - |
| 1,1,1-Trichloroethane | 0.29 | Reduced body Wt. Gain | ECAO | - | D | IRIS |
| Trichloroethene | - | - | - | 0.01 | under review | Cal Potency |
| Vinyl Chloride | - | - | - | 0.27 | A | Cal Potency |
| Total Xylenes | 2 | Hyperactivity, Decr. Body Wt. | IRIS | - | D | IRIS |

Notes:

(a) Chronic reference doses for inhalation ("RfDi") obtained from EPA's Integrated Risk Information System (IRIS), EPA's Health Effects Assessment Summary Tables (HEAST), dated March 1994, or EPA's Environmental Criteria and Assessment Office (ECAO), in this order of priority.

(b) EPA weight-of-evidence classification is as follows:
A = Human Carcinogen
B1 or B2 = Probable Human Carcinogen; B1 indicates that limited human data are available; B2 indicates that there is sufficient evidence in animals and inadequate or no evidence in humans.

Table C2
Summary of Inhalation Toxicity Information for VOCs Detected in Groundwater
Sybase, Inc.
64th and 65th Street Properties, Emeryville, California
(EKI 940018.03)

C = Possible Human Carcinogen
D = Not Classifiable as to Human Carcinogenicity
E = Evidence of Non-Carcinogenicity for Humans
Weight-of-evidence information obtained from IRIS or HEAST.

(c) Cancer slope factors obtained from California Cancer Potency Factors Updated Memorandum for the Office of Environmental Health Hazard Assessment (1 November 1994), IRIS, or HEAST, in this order of priority.

(d) In the absence of an inhalation chronic reference dose or an inhalation carcinogenic slope factor, the respective oral value was used.

(e) Hyphen ("-") symbol indicates a respective reference dose or cancer slope factor is not available for this compound.

## Table C3
## Assumptions for Modeling Emission Fluxes Using VLEACH and for Calculating Indoor Air Concentrations of VOCs Volatilizing from Groundwater
Sybase, Inc.
64th and 65th Street Properties, Emeryville, California
(EKI 940018.03)

| Parameter | Volatilization from Groundwater |
|---|---|
| **Emission Flux Model Assumptions** | |
| Vadose Zone Thickness | 3 feet (a) |
| Clean Soil Cover | 3 feet |
| VOC Concentration in Groundwater | See Table 1 |
| Cell Thickness (b) | 0.1 foot |
| Timestep | 0.1 year |
| Simulation Duration (c) | 30 years |
| **Indoor Box Model Assumptions** | |
| Emission Flux | VLEACH |
| Air Exchange Velocity | 0.84 cfm/sq.ft. (d) |
| Fraction of Cracks to Total Floor Area | 0.001 to 1.0 (e) |

Notes:

(a) The vadose zone is conservatively assumed to be 3 feet thick. Vadose zone soils were nearly saturated at 3 feet. At least 1 foot of foundation material will be added to the site. Site-specific soil properties used in VLEACH simulations were as follows: porosity=0.37, volumetric water content=0.18, organic carbon content=0.00028, and bulk density=1.68 g/mL (see Table C4).

(b) In VLEACH, the vadose zone is assumed to be composed of a vertical stack of cells with finite thickness. Equilibrium partitioning is assumed within each cell. Because the cell thickness is used to calculate the emission flux to the atmosphere, it is similar to the boundary layer thickness in Jury et al., 1983, 1990.

(c) For volatilization from groundwater, simulations were performed for 30 years to achieve a maximum steady-state flux.

(d) Indoor air exchange velocity represents the minimum value planned for the office buildings (personal communication with Flack + Kurtz, mechanical/electrical engineers for site).

(e) Fraction of cracks in the ground floor relative to the total ground floor area ranges from the most conservative value presented in Daugherty, 1991 (0.001) to bare soil (1.0). This term is also known as the infiltration ratio.

# Table C4
# Summary of Soil Properties Measured in Shallow Samples
Sybase, Inc.
64th and 65th Street Properties, Emeryville, California
(EKI 940018.03)

| Property | Symbol (a) (units) | Number of Analyses | Range of Measured Values (b) | Average Value |
|---|---|---|---|---|
| Organic Carbon Fraction | foc (-) | 4 | 0.000086 - 0.00044 | 0.00028 |
| Dry Bulk Density | rhob (g/cm$^3$) | 3 | 1.62 - 1.75 | 1.68 |
| Porosity (c) | por (-) | 3 | 0.34 - 0.39 | 0.37 |
| Water Content (dry weight) (d) | (-) | 3 | 0.186 - 0.243 | 0.215 |
| Water Content (volumetric) | theta (-) | 3 | 0.32 - 0.39 (e) | 0.36 |

Notes:

(a) Symbol represents the nomenclature used in the text and in the applicable equations. A hyphen ("-") indicates that the units are dimensionless.

(b) Organic carbon fraction obtained from EKI draft report dated 21 August 1995. Dry bulk density and water content obtained from Treadwell & Rollo draft report dated 4 May 1995.

(c) Because porosity was not measured, pororisty ("n") was calculated using the equation: n = 1-(rhob/rhos), where rhob is dry bulk density and rhos is the density of the soil particles (assumed to equal 2.65 g/cm3).

(d) Water content is measured in accordance with ASTM Method D2216, which is relative to the dry weight of solids. For VLEACH modeling, the volumetric water content (volume of water divided by total volume of soil) is used, which is calculated as the dry weight water content multiplied by the dry bulk density.

(e) Because the soil samples collected from 3 feet below ground surface were 95 to 100 percent saturated, it is assumed that vadose zone soils are at a residual saturation of 50 percent, or theta = 0.18.

# Table C5
# Summary of Specific Exposure Parameters Used to Characterize Risks to Future Indoor Personnel via Inhalation of VOCs from Groundwater
Sybase, Inc.
64th and 65th Street Properties, Emeryville, California
(EKI 940018.03)

| Exposure Parameter | Parameter Assumption (a) | Reference |
|---|---|---|
| **Exposure Frequency (EF)** | 250 days/year | EPA (1991); DTSC (1992) |
| **Exposure Duration (ED)** | 25 years | EPA (1991); DTSC (1992) |
| **Averaging Time (AT)** | 6250 days; 25,550 days (b) | EPA (1989, 1991); DTSC (1992) |
| **Body Weight (BW)** | 70 kg | EPA (1989, 1991); DTSC (1992) |
| **Inhalation Rate (IR)** | 20 $m^3$/day | EPA (1989, 1991); DTSC (1992) |

Notes:

(a) Exposure assumptions are compiled from:

- DTSC, July 1992, *Supplemental Guidance for Human Health Multimedia Risk Assessments for Hazardous Waste Sites and Permitted Facilities,* California Environmental Protection Agency, The Office of the Science Advisor.
- EPA, March 1991, *Risk Assessment Guidance for Superfund - Volume I: Human Health Evaluation Manual, Supplemental Guidance, "Standard Default Exposure Factors",* Interim Final, OSWER Directive: 9285.6-03.
- EPA, December 1989, *Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part A),* OERR, EPA/540/12-89/002.

(b) Averaging time for non-carcinogenic effects, which equals the period of exposure in units of days, is listed first. Averaging time for carcinogenic effects, which equals a 70 year lifetime in units of days, is listed second.

Table C6
Characterization of Risks to Future Indoor Personnel Resulting from Inhalation of VOCs from Groundwater
Sybase, Inc.
64th and 65th Street Properties, Emeryville, California
(EKI 940018.03)

| VOCs Detected in Groundwater | Maximum Concentration of Compound in Groundwater (ug/L) (a) | Modeled Chemical Emission Flux from Groundwater (g/m$^2$-day) (b) | Indoor Ambient Air Exposure Point Concentration (ug/m$^3$) (c,f) | Worst-case Indoor Ambient Air Exposure Point Concentration (ug/m$^3$) (d,g) | Non-Carcinogen Chronic Daily Intake (mg/kg-day) (e,f) | Non-Carcinogen Chronic Daily Intake (mg/kg-day) (e,g) | Carcinogen Chronic Daily Intake (mg/kg-day) (e,f) | Carcinogen Chronic Daily Intake (mg/kg-day) (e,g) | Non-Carcinogenic Inhalation RfD (mg/kg-day) (h) | Carcinogenic Inhalation Slope Factor (mg/kg-day)$^{-1}$ (i) | Non-Carcinogenic Hazard Index (f,j) | Non-Carcinogenic Hazard Index (g,j) | Estimated Lifetime Incremental Cancer Risk (f,k) | Estimated Lifetime Incremental Cancer Risk (g,k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acetone | 23 | 1.2E-04 | 3.13E-04 | 3.13E-01 | 8.9E-08 | 8.9E-05 | 2.2E-08 | 2.2E-05 | 0.1 | - | 8.9E-07 | 8.9E-04 | - | - |
| Benzene | 4.8 | 2.2E-05 | 5.87E-05 | 5.87E-02 | 1.7E-08 | 1.7E-05 | 4.1E-09 | 4.1E-06 | - | 0.1 | - | - | 4.1E-10 | 4.1E-07 |
| Chloroethane | 34 | 1.8E-04 | 4.96E-04 | 4.96E-01 | 1.4E-07 | 1.4E-04 | 3.5E-08 | 3.5E-05 | 2.9 | - | 4.9E-08 | 4.9E-05 | - | - |
| 1,1-Dichloroethane | 44 | 2.1E-04 | 5.59E-04 | 5.59E-01 | 1.6E-07 | 1.6E-04 | 3.9E-08 | 3.9E-05 | 0.1 | 0.0057 | 1.6E-06 | 1.6E-03 | 2.2E-10 | 2.2E-07 |
| 1,2-Dichloroethane | 1.4 | 6.5E-06 | 1.77E-05 | 1.77E-02 | 5.1E-09 | 5.1E-06 | 1.2E-09 | 1.2E-06 | - | 0.07 | - | - | 8.7E-11 | 8.7E-08 |
| 1,1-Dichloroethene | 42 | 1.7E-04 | 4.68E-04 | 4.68E-01 | 1.3E-07 | 1.3E-04 | 3.3E-08 | 3.3E-05 | 0.009 | 1.2 | 1.5E-05 | 1.5E-02 | 3.9E-08 | 3.9E-05 |
| c-1,2-Dichloroethene | 60 | 2.5E-04 | 6.71E-04 | 6.71E-01 | 1.9E-07 | 1.9E-04 | 4.7E-08 | 4.7E-05 | 0.01 | - | 1.9E-05 | 1.9E-02 | - | - |
| t-1,2-Dichloroethene | 41 | 1.7E-04 | 4.57E-04 | 4.57E-01 | 1.3E-07 | 1.3E-04 | 3.2E-08 | 3.2E-05 | 0.02 | - | 6.5E-06 | 6.5E-03 | - | - |
| Ethylbenzene | 21 | 7.3E-05 | 1.97E-04 | 1.97E-01 | 5.6E-08 | 5.6E-05 | 1.4E-08 | 1.4E-05 | 0.29 | - | 1.9E-07 | 1.9E-04 | - | - |
| Freon 113 | 9 | 3.3E-05 | 9.02E-05 | 9.02E-02 | 2.6E-08 | 2.6E-05 | 6.3E-09 | 6.3E-06 | 30 | - | 8.6E-10 | 8.6E-07 | - | - |
| 1,1,1-Trichloroethane | 7.4 | 3.0E-05 | 8.22E-05 | 8.22E-02 | 2.3E-08 | 2.3E-05 | 5.7E-09 | 5.7E-06 | 0.29 | - | 8.1E-08 | 8.1E-05 | - | - |
| Trichloroethene | 170 | 7.0E-05 | 1.89E-04 | 1.89E-01 | 5.4E-08 | 5.4E-05 | 1.3E-08 | 1.3E-05 | - | 0.01 | - | - | 1.3E-10 | 1.3E-07 |
| Vinyl Chloride | 10 | 5.5E-05 | 1.49E-04 | 1.49E-01 | 4.3E-08 | 4.3E-05 | 1.0E-08 | 1.0E-05 | - | 0.27 | - | - | 2.8E-09 | 2.8E-06 |
| Total Xylenes | 44 | 1.6E-04 | 4.41E-04 | 4.41E-01 | 1.3E-07 | 1.3E-04 | 3.1E-08 | 3.1E-05 | 2 | - | 6.3E-08 | 6.3E-05 | - | - |
| **Total Risk to Future Office Building Tenants Resulting from Inhalation of Volatile Organic Chemicals of Potential Concern from Groundwater:** | | | | | | | | | | | **4.2E-05** | **4.2E-02** | **4.2E-08** | **4.2E-05** |

Notes:

(a) Refer to Table C1 for compilation of maximum concentrations detected in groundwater.

(b) Modeled baseline chemical emission fluxes were obtained by use of the VLEACH (CH2M-Hill, August 1990). To calculate baseline flux, chemical fate and transport parameters were obtained from Table C1. Site-specific soil assumptions were as follows: 3 feet clean cover (depth to groundwater), porosity=0.37, water content=0.18, bulk density=1.68 g/cm3, and organic carbon fraction=0.00028 (Table C4). Refer to Table C4 for additional assumptions regarding VLEACH.

(c) Exposure point concentrations (EPCs) were obtained by converting modeled chemical emission fluxes into EPCs via a box model (Daugherty, 1991). Mixing assumptions for the box model were as follows: air exchange velocity=0.084 cfm/sq. ft. (site-specific data), and estimated fraction of cracks relative to ground floor area=0.001 (Daugherty, 1991) (Table C3).

(d) Exposure point concentrations (EPCs) were obtained by converting modeled chemical emission fluxes into EPCs via a box model (Daugherty, 1991). Mixing assumptions for the box model were as follows: air exchange velocity=0.084 cfm/sq. ft. (site-specific data), and estimated fraction of cracks relative to ground floor area=1.0 (bare soil) (Table C3), as a worst-case screening assumption.

(e) Chronic daily intakes (CDIs) of non-carcinogens and carcinogens were estimated using methodologies recommended by EPA or Cal-EPA. Refer to text and Table C5 for assumptions to calculate CDIs.

(f) Using estimated fraction of cracks of 0.001 (Table C3).

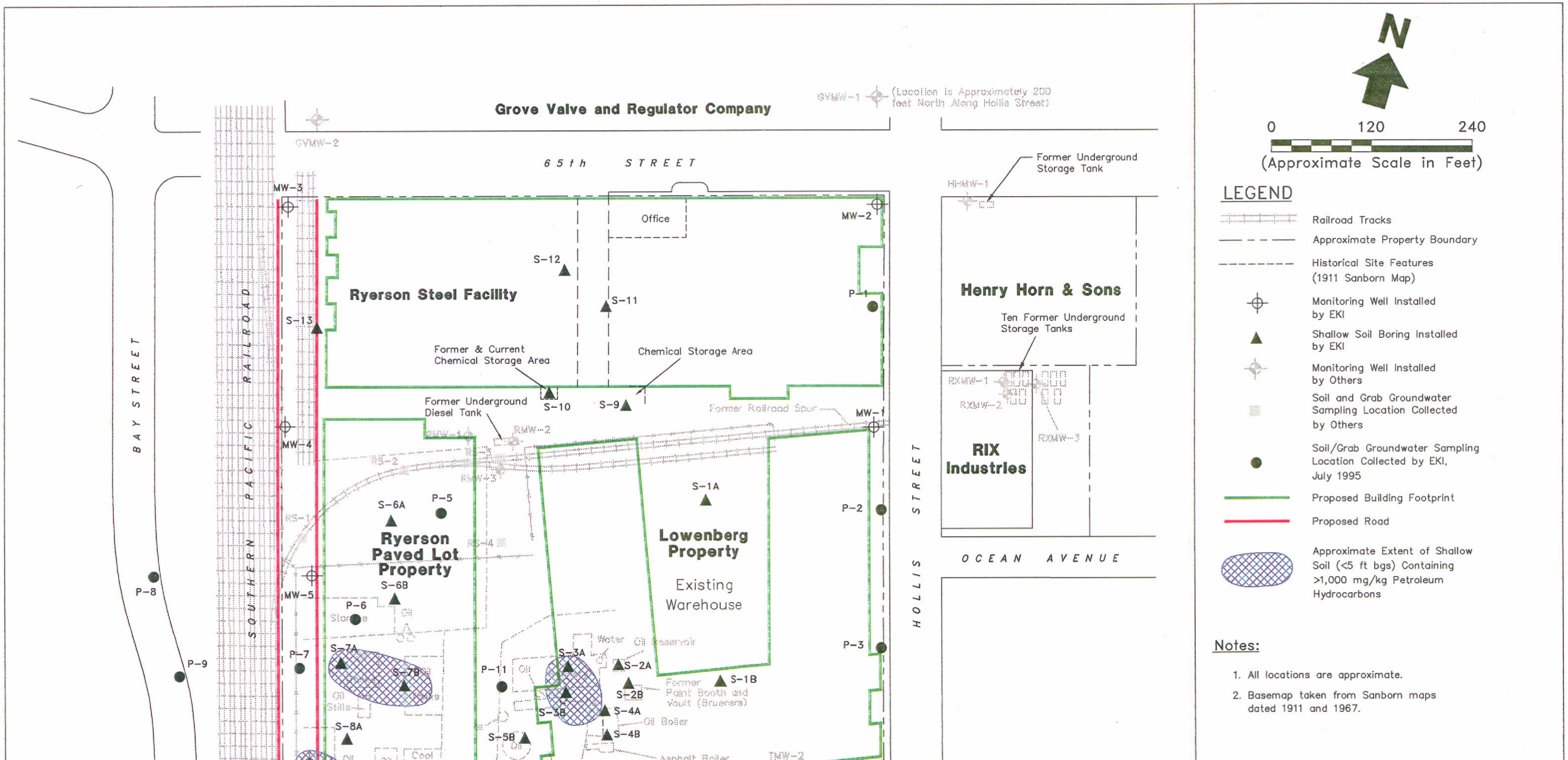
(g) Using estimated fraction of cracks of 1.0 (Table C3).

(h) Chronic reference doses (RfDs) for non-carcinogenic effects obtained from EPA's Integrated Risk Information System (IRIS) computer database in July 1994, EPA's Health Effects Assessment Summary Table (HEAST), March 1994, or EPA's Environmental Criteria and Assessment Office (ECAO). Origin of respective RfDs included in Table C2. Hyphen indicates that an RfD is not available for this compound.

(i) Slope factors (SFs) for carcinogenic effects obtained from Cal-EPA's Cancer Potency Factor Memorandum (June 1992), IRIS, or HEAST, in this order of priority. Origin of respective SFs included in Table 2. Hyphen indicates that an SF is not available for this compound.

(j) Non-carcinogenic hazard index (HI) for compound i is defined as the CDIs/RfDs. The non-carcinogenic HI, summed for all compounds and exposure pathways, assumes that there is a level of exposure (i.e., RfD) below which is unlikely even for sensitive populations to experience adverse health effects (EPA, 1898). If the chronic daily intake (i.e., CDI) exceeds this RfD threshold (i.e., HI greater than 1), there may be concern for potential non-carcinogenic effects.

(k) Estimated lifetime incremental cancer risk for chemical i is defined as CDIs x SFs. The estimated incremental lifetime cancer risk to an individual developing cancer due to VOCs on the 64th and 65th Street Properties is given by the sum of incremental cancer risks for all chemicals and exposure pathways.



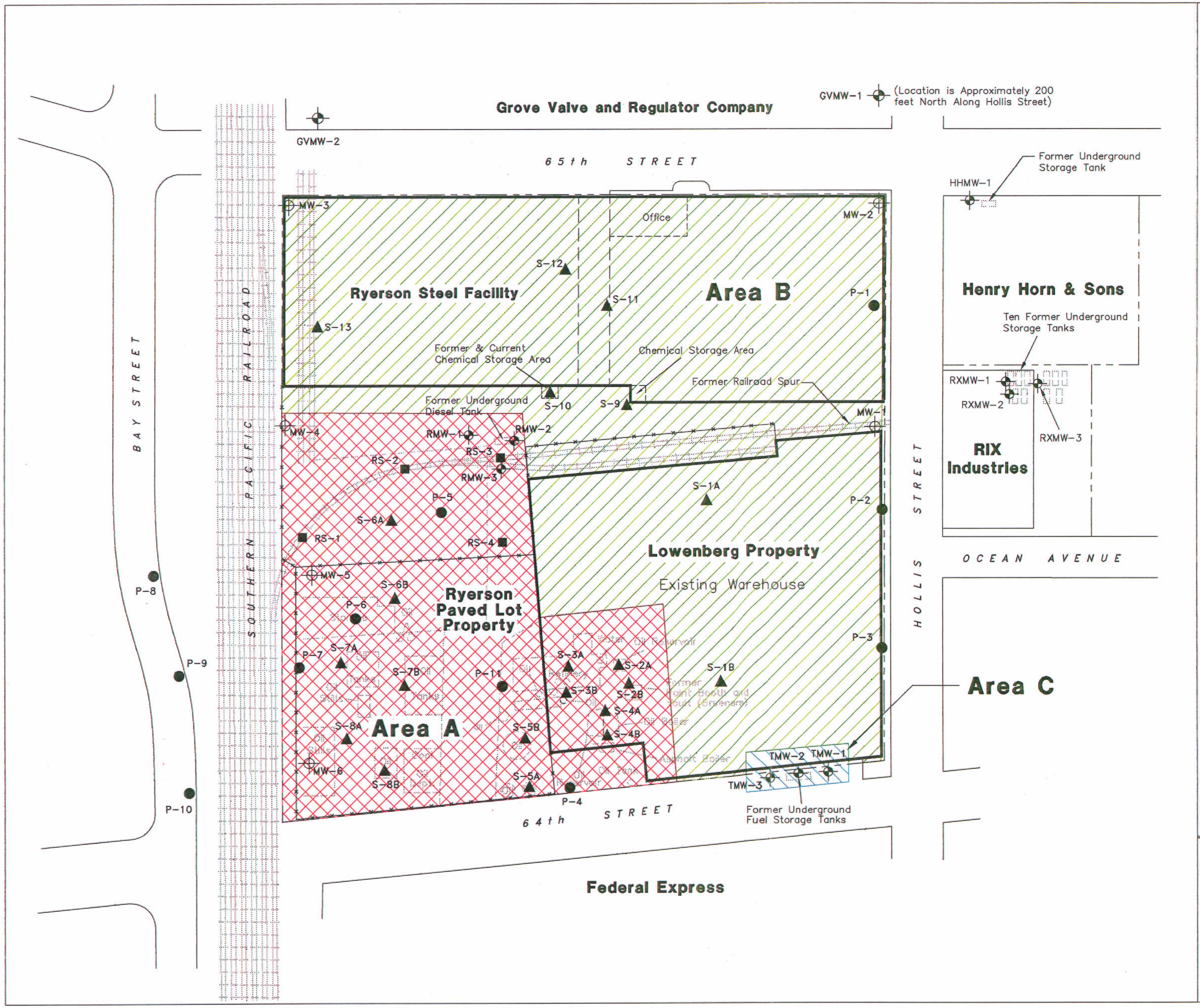
Notes:

1. All locations are approximate.
2. Basemap taken from Sanborn maps dated 1911 and 1967.

**Erler & Kalinowski, Inc.**

Overlay of Proposed Building Footprint with Current Site Plan

64th & 65th Street Properties
Emeryville, CA
October 1995
EKI 940018.03
Figure 3



N

0 120 240

(Approximate Scale in Feet)

LEGEND

| | |
|---|---|
| ┼┼┼ | Railroad Tracks |
| — — — | Approximate Property Boundary |
| - - - - | Historical Site Features (1911 Sanborn Map) |
| ⌖ | Monitoring Well Installed by EKI |
| ▲ | Shallow Soil Boring Installed by EKI |
| ⌖ | Monitoring Well Installed by Others |
| ■ | Soil and Grab Groundwater Sampling Location Collected by Others |
| ● | Soil/Grab Groundwater Sampling Location Collected by EKI, July 1995 |
| 🟥 | **Area A** |
| 🟩 | **Area B** |
| 🟦 | **Area C** |

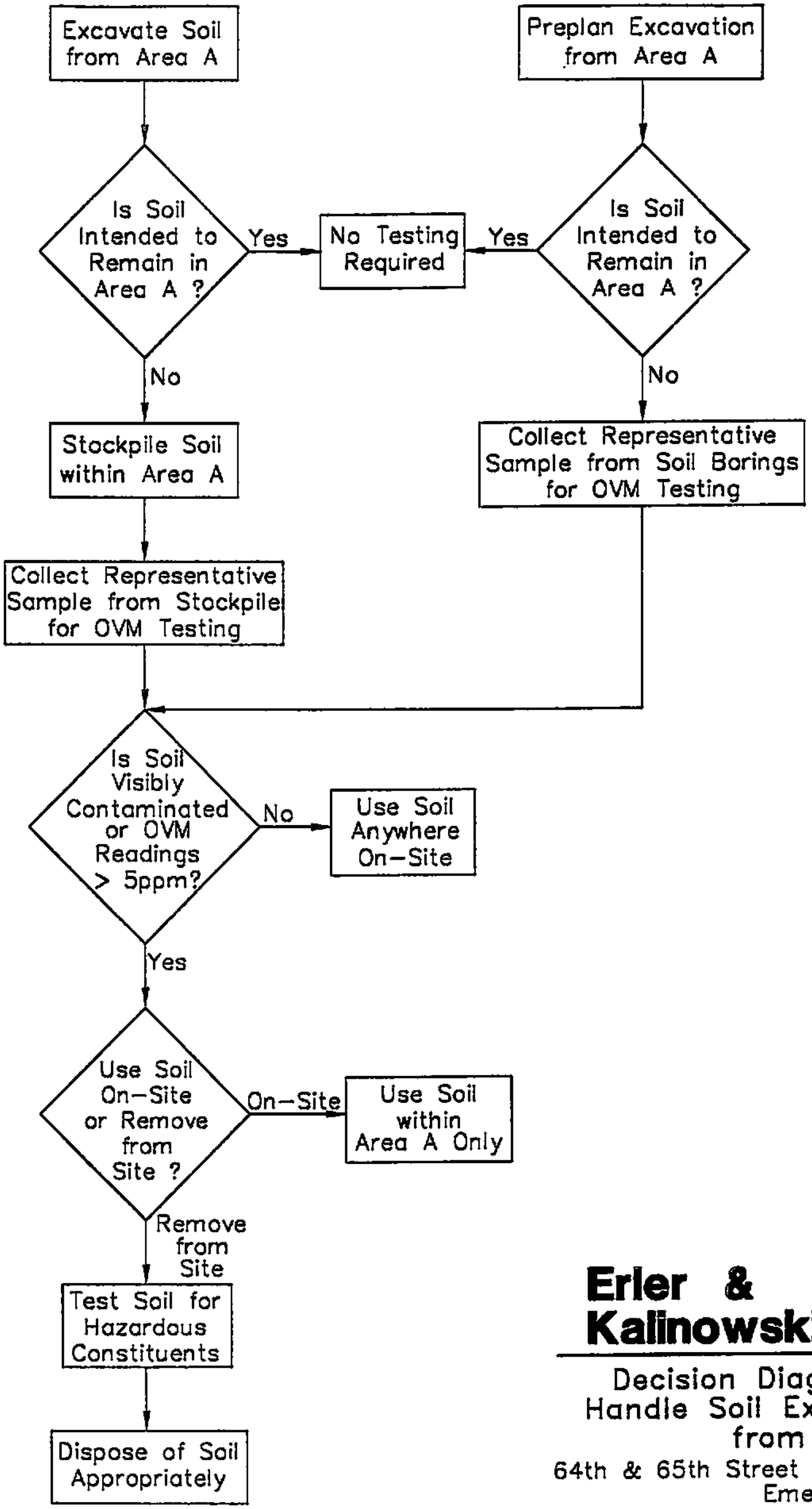
Notes:

1. All locations are approximate.
2. Basemap taken from Sanborn maps dated 1911 and 1967.

**Erler & Kalinowski, Inc.**

Soil Management Areas
for Earthwork Activities

64th & 65th Street Properties
Emeryville, CA
October 1995
EKI 940018.03
Figure 4



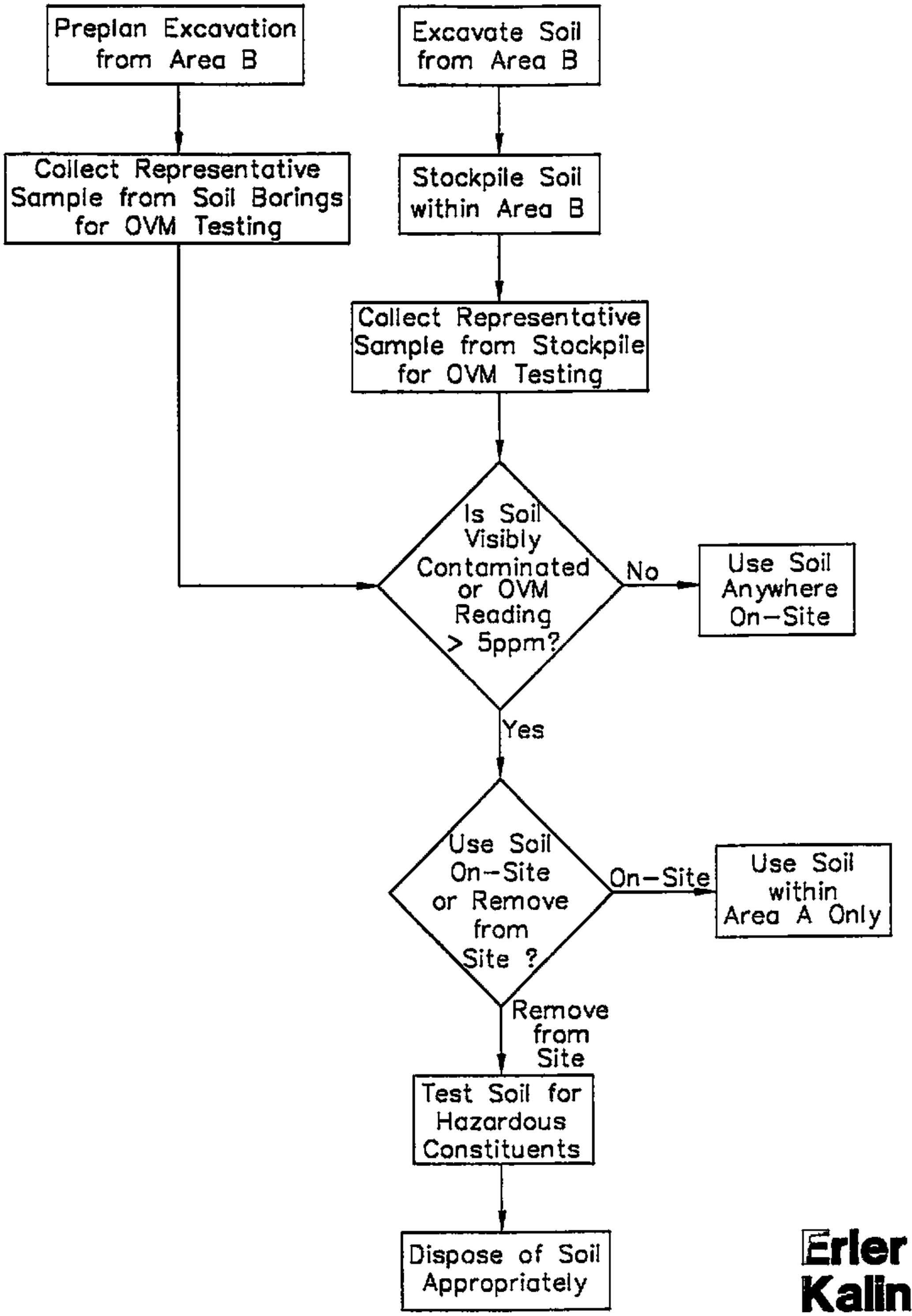
**Erler & Kalinowski, Inc.**

Decision Diagram to Handle Soil Excavated from Area A

64th & 65th Street Properties
Emeryville, CA

October 1995
EKI 940018.03

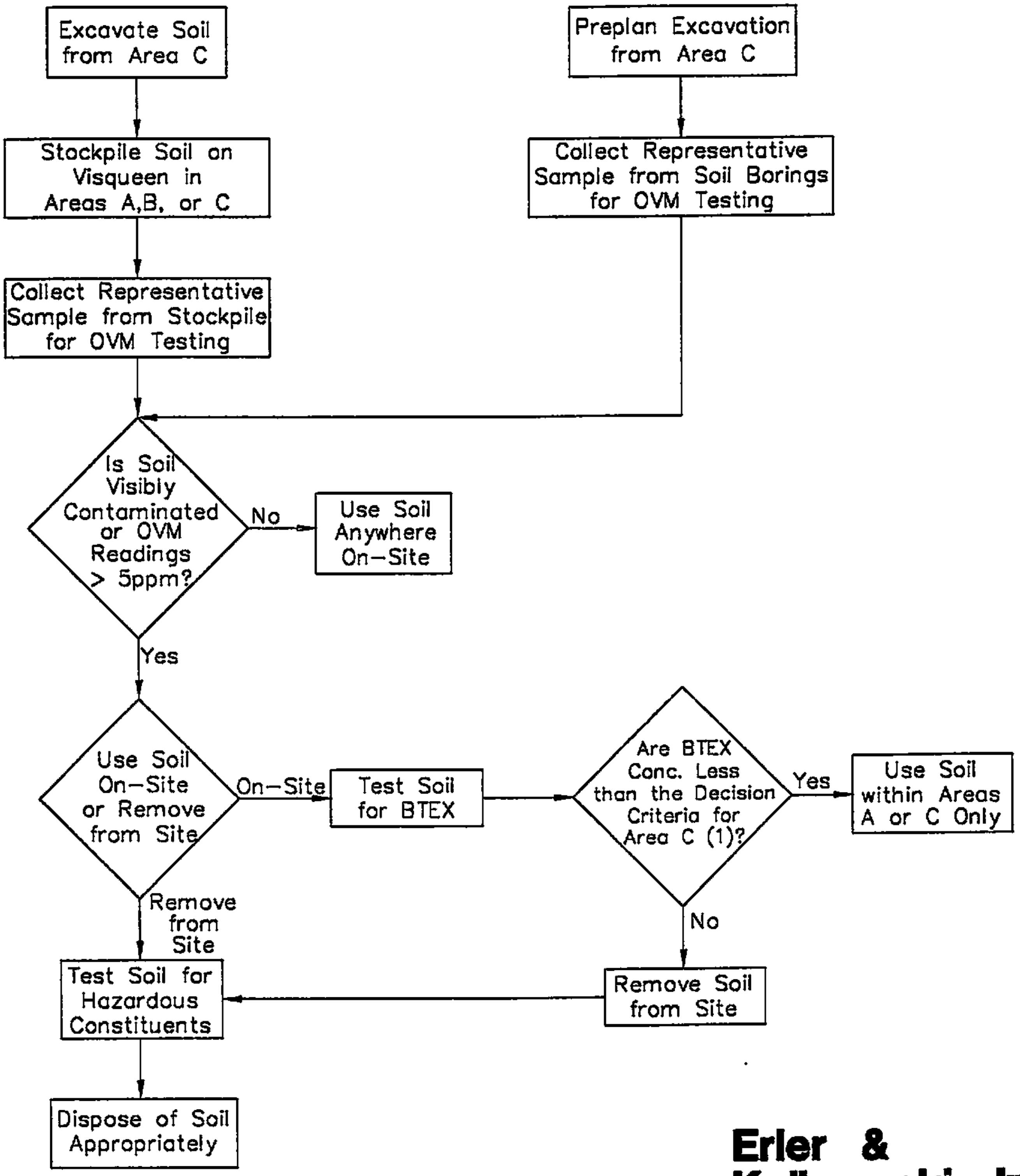
Figure 5



**Erler & Kalinowski, Inc.**

Decision Diagram to
Handle Soil Excavated
from Area B

64th & 65th Street Properties
Emeryville, CA
October 1995
EKI 940018.03
Figure 6



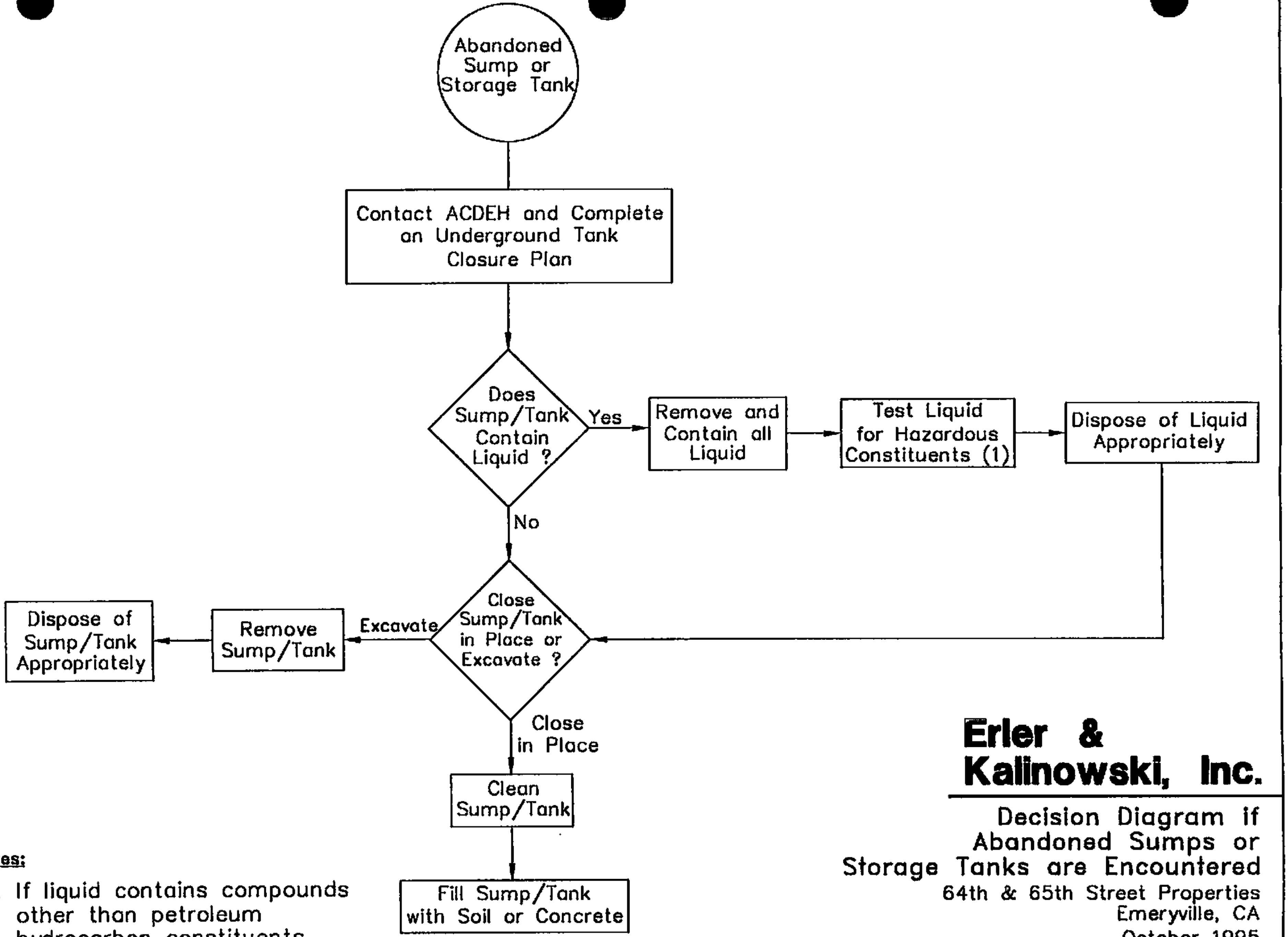
**Notes:**

1. The decision criteria for BTEX compounds in Area C are as follows:

| | |
|---|---|
| Benzene | 9.3 mg/kg |
| Toluene | 2,700 mg/kg |
| Ethylbenzene | 3,100 mg/kg |
| Xylenes | 980 mg/kg |

**Erler & Kalinowski, Inc.**

Decision Diagram to Handle Soil Excavated from Area C
64th & 65th Street Properties
Emeryville, CA
October 1995
EKI 940018.03
Figure 7

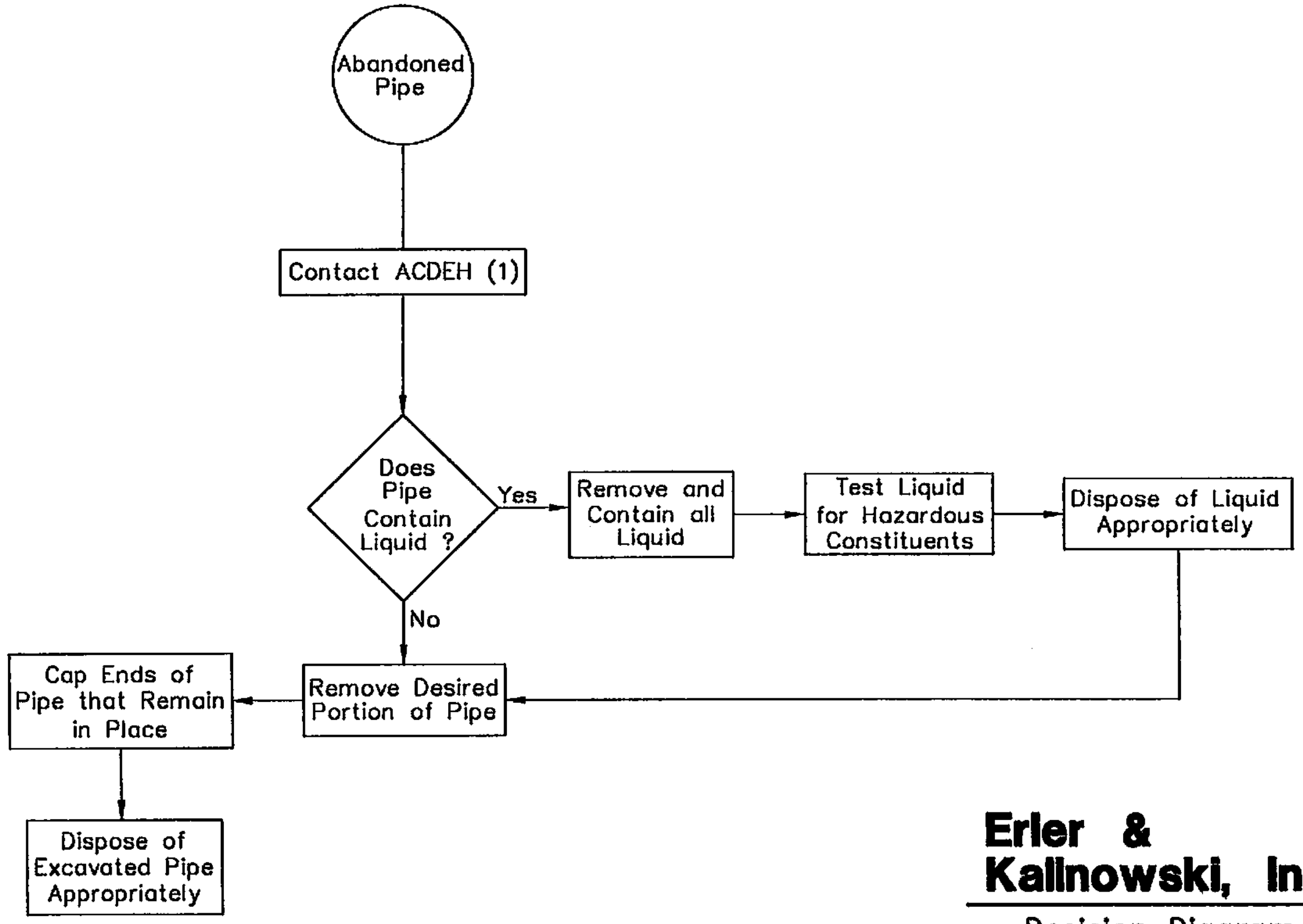


**Notes:**

1. If liquid contains compounds other than petroleum hydrocarbon constituents, contact ACDEH as confirmation soil sampling may be required.

**Erler & Kalinowski, Inc.**

Decision Diagram if
Abandoned Sumps or
Storage Tanks are Encountered
64th & 65th Street Properties
Emeryville, CA
October 1995
EKI 940018.03
Figure 8

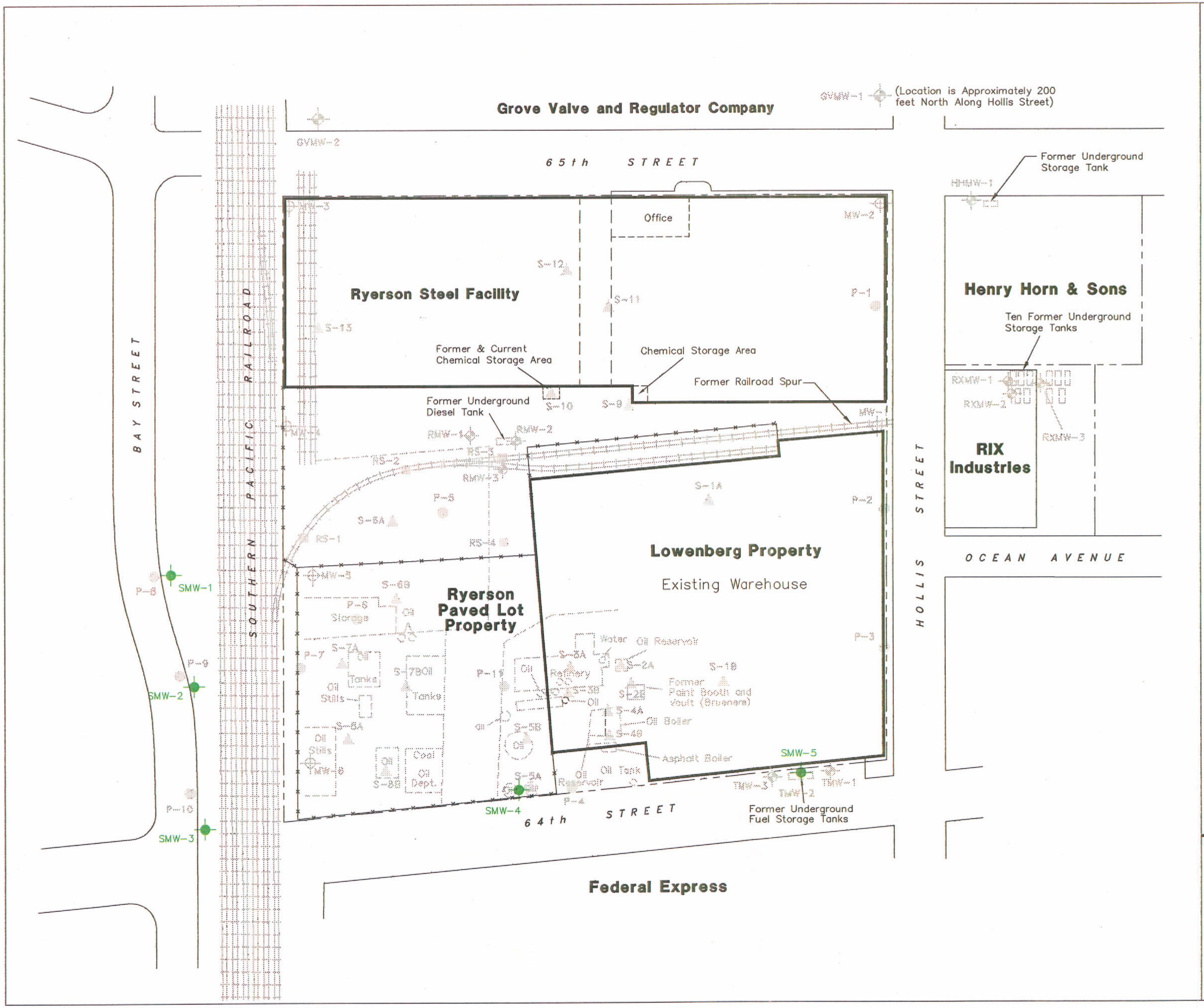


**Notes:**

1. If liquid contains compounds other than petroleum hydrocarbon constituents, contact ACDEH as confirmation soil sampling may be required.

**Erler & Kalinowski, Inc.**

Decision Diagram if Abandoned Pipes are Encountered
64th & 65th Street Properties
Emeryville, CA
October 1995
EKI 940018.03
Figure 9



N

0 120 240

(Approximate Scale in Feet)

## LEGEND

| | |
|---|---|
| ┼┼┼┼ | Railroad Tracks |
| — — — | Approximate Property Boundary |
| - - - - - | Historical Site Features (1911 Sanborn Map) |
| ⌖ | Monitoring Well Installed by EKI |
| ▲ | Shallow Soil Boring Installed by EKI |
| ⌖ | Monitoring Well Installed by Others |
| ▨ | Soil and Grab Groundwater Sampling Location Collected by Others |
| ● | Soil/Grab Groundwater Sampling Location Collected by EKI, July 1995 |
| ⌖ | Proposed Location of Perimeter Monitoring Well |

Notes:

1. All locations are approximate.
2. Basemap taken from Sanborn maps dated 1911 and 1967.
3. Well SMW-5 will be installed only if the Lowenberg tank site has not been closed prior to development of the Lowenberg Property by Sybase, Inc.

**Erler & Kalinowski, Inc.**

Proposed Locations of Perimeter Monitoring Wells

64th & 65th Street Properties
Emeryville, CA
October 1995
EKI 940018.03

Figure 10

# APPENDIX A

## Soil Sample Collection and Analysis during Earthwork Activities

# Appendix A
# Soil Sample Collection and Analysis during Earthwork Activities

Procedures to collect soil samples from stockpiles and soil borings are described in this Appendix. The methodology to analyze samples with the organic vapor meter ("OVM"), which is equipped with a photoionization detector, is also included.

## SAMPLE COLLECTION PROCEDURES FOR STOCKPILED SOIL

Soil samples from stockpiles to be analyzed using the OVM will be collected using a clean stainless steel trowel or disposable plastic spoon. Each representative sample will be formed by combining scoops of material into a zip-closure plastic bag. Once the representative sample is collected, the soil in the bag will be mixed. The OVM probe will then be placed in the bag to take a reading. The OVM, which is equipped with a photoionization detector, will be calibrated to an isobutylene standard. For each representative sample, the stockpile name and location, the date, the time the sample was collected, and the OVM reading will be documented in a field notebook.

Soil samples from stockpiles to be analyzed for benzene, toluene, ethylbenzene, and xylenes ("BTEX") will be collected by scraping the top few inches of soil from the stock pile and manually driving a precleaned brass or stainless steel tube into the stockpile. Both ends of the tube containing the soil sample will be covered with Teflon sheets and capped with plastic end caps. A sample label will be attached to each brass liner and the label will include a unique sample identification number, the stockpile number and location, and the time and date the sample was collected. Sealed liners will be placed in zip-closure plastic bags, then placed on ice in a cooler for temporary storage and transport to the laboratory for chemical analysis. Chain-of-custody records will be initiated. Samples will be composited in the laboratory to make a representative sample that will be analyzed for BTEX compounds using EPA Method 8020.

## SAMPLE COLLECTION PROCEDURES FROM SOIL BORINGS

Borings will be installed using a hand auger to bore to the desired sampling depth. A manually-operated slide-hammer sampler will be used to obtain an undisturbed sample in a precleaned brass or stainless steel tube. Samples to be analyzed for BTEX compounds will be handled in the manner described above. For samples to be analyzed with an OVM, a portion of the sample will be transferred to a zip-closure plastic bag. Once a representative sample is obtained, the bag will be analyzed with the OVM, as described above. For each discrete sample included in the representative sample; the boring location, sampling depth, the date, and the time the sample was collected will be recorded in a field notebook. The OVM reading of the representative sample will also be recorded in the field notebook.

# ATTACHMENT 1

## Calculation of Hypothetical Emission Fluxes and Air Concentrations

# Attachment 1

## Calculation of Hypothetical Emission Fluxes and Air Concentrations

The methodology to calculate the hypothetical volatilization emission flux and indoor air concentration is presented below. The results of this evaluation were used to estimate the hypothetical risk to on-site personnel in Appendix C.

### VOLATILIZATION EMISSION FLUX

To estimate the emission flux of VOCs volatilizing from groundwater, the model VLEACH was used (CH2M-Hill, August 1990). VLEACH and the assumptions used to calculate the emission flux due to volatilization of VOCs are summarized in Table C3 and discussed in more detail below. The emission flux obtained from VLEACH was converted into an exposure point concentration ("EPC") using a box model. To calculate EPCs for post-construction indoor personnel, an indoor box model was used (Daugherty, 1991). Assumptions for the indoor box model are summarized in Table C3 and are discussed below.

VLEACH is a vadose zone model that can be used to calculate chemical volatilization flux from groundwater. VLEACH, developed by CH2M-Hill for the EPA, is a one-dimensional vadose zone model that includes transport via diffusion through air-filled pore space and via leaching to groundwater (CH2M-Hill, August 1990). For volatilization simulations used in this risk evaluation, leaching was eliminated from VLEACH by setting the rainwater infiltration rate equal to zero.

The vapor diffusion equation in VLEACH is based on Fick's law. In VLEACH, the vadose zone is assumed to be composed of a vertical stack of cells with finite thickness. Within each cell, the model assumes that the VOC can reside in three phases within the soil: an adsorbed phase, a dissolved phase (in pore water), and in the gaseous phase (in air-filled pore space). As with other widely used volatilization models (e.g., the Jury Model, Jury et al., 1983, 1990), equilibrium within these three phases within a given cell is assumed. At each timestep, the VOC is allowed to diffuse upward and downward, to areas of lower concentration, and the equilibrium partitioning within a cell is re-calculated. Diffusion to the atmosphere occurs across the thickness of the top cell. Because the cell thickness is used to calculate the emission flux to the atmosphere, it is similar to the stagnant boundary layer in the Jury Model (Jury et al., 1983, 1990).

The compound-specific parameters, including dimensionless Henry's constant and organic carbon partition coefficient ("Koc"), and the soil-specific parameters, including organic carbon content ("foc"), porosity ("por"), volumetric water content ("theta"), and the bulk density ("rhob"), are used to calculate the equilibrium partitioning among the adsorbed, aqueous, and gas phases within a cell. The compound-specific solubility in water is also included as a parameter in VLEACH to determine if the VOC exceeds its solubility, i.e., if free product is present. Compound-specific parameters are shown in Table C1.

Site specific soil property, foc, was measured in four soil samples collected from the Site and its vicinity (EKI, 5 September 1995). The site-specific properties, theta and rhob, were measured in three shallow soil samples collected from the Site (Treadwell & Rollo, Inc., May 1995). Results are summarized in Table C4. As indicated in Table C4, porosity was calculated from the measured bulk density (rhob). Because soil collected from depths of 3 feet was 95 to 100 percent saturated, vadose zone soils were assumed to be at a residual saturation of 50 percent, or theta = 0.18. Thus, the following site-specific average parameters were used in the volatilization modeling: foc = 0.00028, por = 0.37, theta = 0.18, and rhob = 1.68 g/mL.

To calculate the emission flux from VOCs in shallow groundwater, the concentration of VOCs in the vadose zone was assumed to equal zero. Post-construction, the vadose zone thickness was assumed to equal 3 feet (Table C3). The VOC concentration in groundwater was constant at its respective maximum concentration (Table C1) throughout the simulation duration (i.e., it is modeled as a non-diminishing source).

At user-specified computational timesteps for a given simulation duration, VLEACH solves the diffusion equation and calculates the equilibrium soil gas, pore water, and soil concentrations. VLEACH also calculates the mass of VOC emitted from the ground surface to the atmosphere per square foot ($g/ft^2$) at each computational timestep. Externally from the model, the volatilization emission flux is then calculated as follows:

$$J = \frac{(\text{VLEACH emission mass } \frac{g}{ft^2})(10^6 \frac{ug}{g})}{(\text{delta t years})(365 \frac{day}{year})(0.093 \frac{m^2}{ft^2})}$$

where:

J = Volatilization Emission Flux (ug/m$^2$-day);

VLEACH emission mass = Mass of VOC Emitted from Ground Surface to Atmosphere per Square Foot (g/ft$^2$), obtained from VLEACH output (simulation time of 30 years); and

delta t = User-Specified Time between Output Printouts (year), set equal to 1 year.

When calculating emission fluxes of VOCs from groundwater using VLEACH, the VOC concentration in groundwater is assumed to remain constant throughout the entire simulation, i.e., the source is non-diminishing. Because the VOC concentration in soil is assumed to equal zero when calculating the flux from groundwater, there is a finite time associated with the diffusion of VOCs from the water table to the ground surface. Eventually, the emission flux reaches a maximum, constant, steady-state value. VLEACH simulations were performed for the VOCs detected in groundwater on the Site to determine the length of time to reach a steady-state emission flux. For the VOCs present in groundwater on the Site, steady state was reached after 3 to 30 years of volatilization, depending upon the specific VOC. The simulation duration for volatilization from groundwater was 30 years, with a 0.1 year timestep. The emission flux calculated at year 30, i.e., steady state, was used for all VOCs. VLEACH input and output files are included in Attachment 2.

## BOX MODEL FOR ESTIMATION OF INDOOR AIR EXPOSURE POINT CONCENTRATIONS

The volatilization emission flux calculated via VLEACH was converted to an exposure point concentration ("EPC"), i.e., indoor airborne chemical concentration, via an indoor box model. The following assumptions apply to the box model: (1) the volatilization emission rates remain constant over the entire exposure duration; (2) the VOCs are uniformly mixed inside the box; and (3) the air-exchange velocity is uniform within the box. General parameter assumptions for the indoor box model are summarized in Table C3.

The box model to calculate EPCs for indoor air from an emission flux from soil and groundwater through cracks in a building floor was obtained from the Orange County Model (Daugherty, 1991). The EPC for VOCs was calculated as follows:

$$\text{Cair} = \frac{(J)\,(A)}{(Q)\,(0.0284\,\frac{m^3}{ft^3})\,(1440\,\frac{min}{day})} = \frac{(J)\,(I)}{(V)\,(0.305\,\frac{m}{ft})\,(1440\,\frac{min}{day})}$$

where:

Cair = EPC for VOC in air (ug/$m^3$);

J = Volatilization Emission Flux (ug/$m^2$-day), from groundwater, calculated using VLEACH;

A = Area through which Flux Occurs ($m^2$);

Q = Ventilation Rate ($ft^3$/min);

I = Fraction of Crack to Floor Area (Infiltration Ratio) (dimensionless), assumed to equal 0.001, the most conservative value presented in the Orange County Model (Daugherty, 1991) to 1.0 (bare soil); and

V = Air Exchange Velocity ($ft^3$/min-$ft^2$); a value of 0.84 $ft^3$/min-$ft^2$ is the lowest planned for the Site (EKI personal communication with Flack + Kurtz, mechanical/electrical engineers for the Site development).

The ambient air concentration, Cair, represents the EPC for inhalation of VOCs. Calculated indoor ambient air concentrations for on-site personnel are included in Table C6.

# ATTACHMENT 2

## VLEACH Volatilization Calculation Input Files and Modeling Results

Note:

Output files have been edited to show only the chemical distribution in the vadose zone at time=0 and the chemical distribution and flux at time=25 through 30 years.

Review of the chemical flux from years 25 through 30 indicates that the volatilization rates from groundwater through the vadose zone have reached steady state.

**Vinyl Chloride Input File** **vl01.inp**

```
VLEACH Model, Volatilization of vinyl chloride from gw, Sybase
  1
    0.1     30.     1.0     5.0
    2.5     1.14    4200.    0.95
Default area of 1 ft^2, uncapped, no infiltration
     1.     0.1     0.0     1.68     .37     .18  0.00028
     0.      0.    0.01
  30   1
   0   30    0.000
```

## Vinyl Chloride Parameter Output File vl01.prm

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of vinyl chloride from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =      2.5000     ml/g,      0.88286E-04cu.ft./g
Kh =      1.1400     (dimensionless).
Aqueous solubility =     4200.0     mg/l,      118.93     g/cu.ft
Free air diffusion coefficient = .95000     sq. m/day,  3732.6     sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =      1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800     g/ml,       47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000    mg/l,      0.00000     g/cu.ft
Atmospheric concentration =     0.00000     mg/l,      0.00000     g/cu.ft
Water table has a fixed concentration of     0.10000E-01mg/l,      0.28317E-03g/cu.ft.
   with respect to gas diffusion.
```

## Vinyl Chloride Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of vinyl chloride from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase     =      0.00000    g/sq.ft.
Mass in liquid phase  =      0.00000    g/sq.ft.
Mass sorbed          =      0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.14821E-03g/sq.ft.
Mass in gas phase     =      0.80703E-04g/sq.ft.
Mass in liquid phase  =      0.67067E-04g/sq.ft.
Mass sorbed          =      0.43817E-06g/sq.ft.

Since last printout at time =      24.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.18659E-02g/sq.ft.
             Diffusion in from water table =   0.18659E-02g/sq.ft.
          Total inflow at boundaries =    -0.17462E-08g/sq.ft.
          Mass discrepancy =     0.17462E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =     0.14821E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.46596E-01g/sq.ft.
             Diffusion in from water table =   0.46744E-01g/sq.ft.
          Total inflow at boundaries =     0.14817E-03g/sq.ft.
          Mass discrepancy =     0.42215E-07g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.14821E-03g/sq.ft.
Mass in gas phase     =      0.80703E-04g/sq.ft.
Mass in liquid phase  =      0.67067E-04g/sq.ft.
Mass sorbed          =      0.43817E-06g/sq.ft.

Since last printout at time =      25.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.18659E-02g/sq.ft.
             Diffusion in from water table =   0.18659E-02g/sq.ft.
          Total inflow at boundaries =    -0.17462E-08g/sq.ft.
          Mass discrepancy =     0.17462E-08g/sq.ft.
```

## Trichloroethene Input File

**vl02.inp**

```
VLEACH Model, Volatilization of trichloroethene from gw, Sybase
  1
    0.1      30.      1.0      5.0
    99.    0.39    1300.     0.71
Default area of 1 ft^2, uncapped, no infiltration
     1.      0.1      0.0      1.68      .37      .18  0.00028
     0.       0.     0.17
  30   1
   0  30    0.000
```

## Trichloroethene Parameter Output File vl02.prm

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of trichloroethene from gw, Sybase
  1 polygons.
Timestep =  0.10 years.  Simulation length =  30.00 years.
Printout every  1.00 years.  Vertical profile stored every  5.00 years.
Koc =    99.000   ml/g,    0.34961E-02cu.ft./g
Kh =    0.39000    (dimensionless).
Aqueous solubility =    1300.0    mg/l,    36.812    g/cu.ft
Free air diffusion coefficient = .71000    sq. m/day,  2789.6    sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =     1.0000    sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =    1.6800    g/ml,      47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =    0.00000    mg/l,     0.00000    g/cu.ft
Atmospheric concentration =    0.00000    mg/l,     0.00000    g/cu.ft
Water table has a fixed concentration of    0.17000    mg/l,     0.48139E-02g/cu.ft.
   with respect to gas diffusion.
```

```
               Diffusion in from atmosphere =    -0.52194E-01g/sq.ft.
               Diffusion in from water table =    0.52342E-01g/sq.ft.
            Total inflow at boundaries =    0.14817E-03g/sq.ft.
            Mass discrepancy =    0.42215E-07g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =   0.14821E-03g/sq.ft.
Mass in gas phase     =     0.80703E-04g/sq.ft.
Mass in liquid phase  =     0.67067E-04g/sq.ft.
Mass sorbed           =     0.43817E-06g/sq.ft.

Since last printout at time =      28.00
            Change in Total Mass =     0.00000    g/sq.ft.
               Advection in from atmosphere =     0.00000    g/sq.ft.
               Advection in from water table =    0.00000    g/sq.ft.
               Diffusion in from atmosphere =    -0.18659E-02g/sq.ft.
               Diffusion in from water table =    0.18659E-02g/sq.ft.
            Total inflow at boundaries =   -0.17462E-08g/sq.ft.
            Mass discrepancy =    0.17462E-08g/sq.ft.

Since beginning of run at time = 0.0
            Change in Total Mass =    0.14821E-03g/sq.ft.
               Advection in from atmosphere =     0.00000    g/sq.ft.
               Advection in from water table =    0.00000    g/sq.ft.
               Diffusion in from atmosphere =    -0.54060E-01g/sq.ft.
               Diffusion in from water table =    0.54208E-01g/sq.ft.
            Total inflow at boundaries =    0.14817E-03g/sq.ft.
            Mass discrepancy =    0.42215E-07g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =   0.14821E-03g/sq.ft.
Mass in gas phase     =     0.80703E-04g/sq.ft.
Mass in liquid phase  =     0.67067E-04g/sq.ft.
Mass sorbed           =     0.43817E-06g/sq.ft.

Since last printout at time =      29.00
            Change in Total Mass =     0.00000    g/sq.ft.
               Advection in from atmosphere =     0.00000    g/sq.ft.
               Advection in from water table =    0.00000    g/sq.ft.
               Diffusion in from atmosphere =    -0.18659E-02g/sq.ft.
               Diffusion in from water table =    0.18659E-02g/sq.ft.
            Total inflow at boundaries =   -0.17462E-08g/sq.ft.
            Mass discrepancy =    0.17462E-08g/sq.ft.

Since beginning of run at time = 0.0
            Change in Total Mass =    0.14821E-03g/sq.ft.
               Advection in from atmosphere =     0.00000    g/sq.ft.
               Advection in from water table =    0.00000    g/sq.ft.
               Diffusion in from atmosphere =    -0.55926E-01g/sq.ft.
               Diffusion in from water table =    0.56074E-01g/sq.ft.
            Total inflow at boundaries =    0.14817E-03g/sq.ft.
            Mass discrepancy =    0.42215E-07g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.14821E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.48462E-01g/sq.ft.
             Diffusion in from water table =    0.48610E-01g/sq.ft.
          Total inflow at boundaries =    0.14817E-03g/sq.ft.
          Mass discrepancy =    0.42215E-07g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =    0.14821E-03g/sq.ft.
Mass in gas phase     =     0.80703E-04g/sq.ft.
Mass in liquid phase  =     0.67067E-04g/sq.ft.
Mass sorbed           =     0.43817E-06g/sq.ft.

Since last printout at time =      26.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.18659E-02g/sq.ft.
             Diffusion in from water table =    0.18659E-02g/sq.ft.
          Total inflow at boundaries =   -0.17462E-08g/sq.ft.
          Mass discrepancy =    0.17462E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.14821E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.50328E-01g/sq.ft.
             Diffusion in from water table =    0.50476E-01g/sq.ft.
          Total inflow at boundaries =    0.14817E-03g/sq.ft.
          Mass discrepancy =    0.42215E-07g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =    0.14821E-03g/sq.ft.
Mass in gas phase     =     0.80703E-04g/sq.ft.
Mass in liquid phase  =     0.67067E-04g/sq.ft.
Mass sorbed           =     0.43817E-06g/sq.ft.

Since last printout at time =      27.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.18659E-02g/sq.ft.
             Diffusion in from water table =    0.18659E-02g/sq.ft.
          Total inflow at boundaries =   -0.17462E-08g/sq.ft.
          Mass discrepancy =    0.17462E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.14821E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
```

**Trichloroethene Output File**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of trichloroethene from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase     =     0.00000    g/sq.ft.
Mass in liquid phase  =     0.00000    g/sq.ft.
Mass sorbed           =     0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.55669E-02g/sq.ft.
Mass in gas phase     =     0.13720E-02g/sq.ft.
Mass in liquid phase  =     0.33327E-02g/sq.ft.
Mass sorbed           =     0.86223E-03g/sq.ft.

Since last printout at time =      24.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.23707E-01g/sq.ft.
             Diffusion in from water table =    0.23707E-01g/sq.ft.
          Total inflow at boundaries =   -0.65193E-07g/sq.ft.
          Mass discrepancy =    0.65193E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.55669E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.59075    g/sq.ft.
             Diffusion in from water table =    0.59632    g/sq.ft.
          Total inflow at boundaries =    0.55659E-02g/sq.ft.
          Mass discrepancy =    0.10058E-05g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.55669E-02g/sq.ft.
Mass in gas phase     =     0.13720E-02g/sq.ft.
Mass in liquid phase  =     0.33327E-02g/sq.ft.
Mass sorbed           =     0.86223E-03g/sq.ft.

Since last printout at time =      25.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.23707E-01g/sq.ft.
             Diffusion in from water table =    0.23707E-01g/sq.ft.
          Total inflow at boundaries =   -0.65193E-07g/sq.ft.
          Mass discrepancy =    0.65193E-07g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.55669E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.61446    g/sq.ft.
             Diffusion in from water table =    0.62002    g/sq.ft.
          Total inflow at boundaries =    0.55659E-02g/sq.ft.
          Mass discrepancy =    0.10058E-05g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =   0.55669E-02g/sq.ft.
Mass in gas phase     =     0.13720E-02g/sq.ft.
Mass in liquid phase  =     0.33327E-02g/sq.ft.
Mass sorbed           =   0.86223E-03g/sq.ft.

Since last printout at time =      26.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.23707E-01g/sq.ft.
             Diffusion in from water table =    0.23707E-01g/sq.ft.
          Total inflow at boundaries =   -0.65193E-07g/sq.ft.
          Mass discrepancy =    0.65193E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.55669E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.63816    g/sq.ft.
             Diffusion in from water table =    0.64373    g/sq.ft.
          Total inflow at boundaries =    0.55659E-02g/sq.ft.
          Mass discrepancy =    0.10058E-05g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =   0.55669E-02g/sq.ft.
Mass in gas phase     =     0.13720E-02g/sq.ft.
Mass in liquid phase  =     0.33327E-02g/sq.ft.
Mass sorbed           =   0.86223E-03g/sq.ft.

Since last printout at time =      27.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.23707E-01g/sq.ft.
             Diffusion in from water table =    0.23707E-01g/sq.ft.
          Total inflow at boundaries =   -0.65193E-07g/sq.ft.
          Mass discrepancy =    0.65193E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.55669E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
```

```
          Diffusion in from atmosphere =    -0.66187    g/sq.ft.
          Diffusion in from water table =    0.66744    g/sq.ft.
       Total inflow at boundaries =    0.55659E-02g/sq.ft.
       Mass discrepancy =    0.10058E-05g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =   0.55669E-02g/sq.ft.
Mass in gas phase    =     0.13720E-02g/sq.ft.
Mass in liquid phase  =     0.33327E-02g/sq.ft.
Mass sorbed          =    0.86223E-03g/sq.ft.

Since last printout at time =      28.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.23707E-01g/sq.ft.
          Diffusion in from water table =    0.23707E-01g/sq.ft.
       Total inflow at boundaries =   -0.65193E-07g/sq.ft.
       Mass discrepancy =    0.65193E-07g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.55669E-02g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.68558    g/sq.ft.
          Diffusion in from water table =    0.69114    g/sq.ft.
       Total inflow at boundaries =    0.55659E-02g/sq.ft.
       Mass discrepancy =    0.10058E-05g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =   0.55669E-02g/sq.ft.
Mass in gas phase    =     0.13720E-02g/sq.ft.
Mass in liquid phase  =     0.33327E-02g/sq.ft.
Mass sorbed          =    0.86223E-03g/sq.ft.

Since last printout at time =      29.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.23707E-01g/sq.ft.
          Diffusion in from water table =    0.23707E-01g/sq.ft.
       Total inflow at boundaries =   -0.65193E-07g/sq.ft.
       Mass discrepancy =    0.65193E-07g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.55669E-02g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.70928    g/sq.ft.
          Diffusion in from water table =    0.71485    g/sq.ft.
       Total inflow at boundaries =    0.55659E-02g/sq.ft.
       Mass discrepancy =    0.10058E-05g/sq.ft.
```

**1,1-Dichloroethene Parameter Output File** **vl03.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of 1,1-dichloroethene from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =      65.000    ml/g,      0.22954E-02cu.ft./g
Kh =      1.0700     (dimensionless).
Aqueous solubility =      2800.0     mg/l,       79.288      g/cu.ft
Free air diffusion coefficient = .71000     sq. m/day,  2789.6     sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =      1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800    g/ml,       47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000    mg/l,       0.00000    g/cu.ft
Atmospheric concentration =     0.00000    mg/l,       0.00000    g/cu.ft
Water table has a fixed concentration of     0.42000E-01mg/l,     0.11893E-02g/cu.ft.
  with respect to gas diffusion.
```

## 1,1-Dichloroethene Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of 1,1-dichloroethene from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase     =     0.00000    g/sq.ft.
Mass in liquid phase  =     0.00000    g/sq.ft.
Mass sorbed           =     0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.69004E-03g/sq.ft.
Mass in gas phase     =     0.33895E-03g/sq.ft.
Mass in liquid phase  =     0.30011E-03g/sq.ft.
Mass sorbed           =     0.50978E-04g/sq.ft.

Since last printout at time =      24.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.58569E-02g/sq.ft.
             Diffusion in from water table =    0.58569E-02g/sq.ft.
          Total inflow at boundaries =   -0.11176E-07g/sq.ft.
          Mass discrepancy =    0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.69004E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.14619    g/sq.ft.
             Diffusion in from water table =    0.14688    g/sq.ft.
          Total inflow at boundaries =    0.68922E-03g/sq.ft.
          Mass discrepancy =    0.81683E-06g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.69004E-03g/sq.ft.
Mass in gas phase     =     0.33895E-03g/sq.ft.
Mass in liquid phase  =     0.30011E-03g/sq.ft.
Mass sorbed           =     0.50978E-04g/sq.ft.

Since last printout at time =      25.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.58569E-02g/sq.ft.
             Diffusion in from water table =    0.58569E-02g/sq.ft.
          Total inflow at boundaries =   -0.11176E-07g/sq.ft.
          Mass discrepancy =    0.11176E-07g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.69004E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.15204    g/sq.ft.
             Diffusion in from water table =    0.15273    g/sq.ft.
          Total inflow at boundaries =    0.68922E-03g/sq.ft.
          Mass discrepancy =    0.81683E-06g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =   0.69004E-03g/sq.ft.
Mass in gas phase    =     0.33895E-03g/sq.ft.
Mass in liquid phase  =     0.30011E-03g/sq.ft.
Mass sorbed          =     0.50978E-04g/sq.ft.

Since last printout at time =      26.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.58569E-02g/sq.ft.
             Diffusion in from water table =    0.58569E-02g/sq.ft.
          Total inflow at boundaries =   -0.11176E-07g/sq.ft.
          Mass discrepancy =    0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.69004E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.15790    g/sq.ft.
             Diffusion in from water table =    0.15859    g/sq.ft.
          Total inflow at boundaries =    0.68922E-03g/sq.ft.
          Mass discrepancy =    0.81683E-06g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =   0.69004E-03g/sq.ft.
Mass in gas phase    =     0.33895E-03g/sq.ft.
Mass in liquid phase  =     0.30011E-03g/sq.ft.
Mass sorbed          =     0.50978E-04g/sq.ft.

Since last printout at time =      27.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.58569E-02g/sq.ft.
             Diffusion in from water table =    0.58569E-02g/sq.ft.
          Total inflow at boundaries =   -0.11176E-07g/sq.ft.
          Mass discrepancy =    0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.69004E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
```

```
             Diffusion in from atmosphere =   -0.16376   g/sq.ft.
             Diffusion in from water table =   0.16445   g/sq.ft.
          Total inflow at boundaries =   0.68922E-03g/sq.ft.
          Mass discrepancy =   0.81683E-06g/sq.ft.


Polygon   1
At time =    29.00, total mass in vadose zone =   0.69004E-03g/sq.ft.
Mass in gas phase    =    0.33895E-03g/sq.ft.
Mass in liquid phase  =    0.30011E-03g/sq.ft.
Mass sorbed         =   0.50978E-04g/sq.ft.

Since last printout at time =      28.00
          Change in Total Mass =   0.00000   g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.58569E-02g/sq.ft.
             Diffusion in from water table =   0.58569E-02g/sq.ft.
          Total inflow at boundaries =  -0.11176E-07g/sq.ft.
          Mass discrepancy =   0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =   0.69004E-03g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.16961   g/sq.ft.
             Diffusion in from water table =   0.17030   g/sq.ft.
          Total inflow at boundaries =   0.68922E-03g/sq.ft.
          Mass discrepancy =   0.81683E-06g/sq.ft.


Polygon   1
At time =    30.00, total mass in vadose zone =   0.69004E-03g/sq.ft.
Mass in gas phase    =    0.33895E-03g/sq.ft.
Mass in liquid phase  =    0.30011E-03g/sq.ft.
Mass sorbed         =   0.50978E-04g/sq.ft.

Since last printout at time =      29.00
          Change in Total Mass =   0.00000   g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.58569E-02g/sq.ft.
             Diffusion in from water table =   0.58569E-02g/sq.ft.
          Total inflow at boundaries =  -0.11176E-07g/sq.ft.
          Mass discrepancy =   0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =   0.69004E-03g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.17547   g/sq.ft.
             Diffusion in from water table =   0.17616   g/sq.ft.
          Total inflow at boundaries =   0.68922E-03g/sq.ft.
          Mass discrepancy =   0.81683E-06g/sq.ft.
```

## 1,1-Dichloroethane Input File

**vl04.inp**

```
VLEACH Model, Volatilization of 1,1-dichloroethane from gw, Sybase
  1
    0.1     30.     1.0     5.0
    30.     0.23    5100.    0.81
Default area of 1 ft^2, uncapped, no infiltration
     1.     0.1     0.0     1.68     .37     .18   0.00028
     0.      0.    0.044
 30   1
  0  30    0.000
```

**1,1-Dichloroethane Parameter Output File** **vl04.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of 1,1-dichloroethane from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =      30.000    ml/g,      0.10594E-02cu.ft./g
Kh =     0.23000     (dimensionless).
Aqueous solubility =     5100.0     mg/l,       144.42      g/cu.ft
Free air diffusion coefficient = .81000     sq. m/day,  3182.5      sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =       1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800     g/ml,        47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000     mg/l,      0.00000     g/cu.ft
Atmospheric concentration =     0.00000     mg/l,      0.00000     g/cu.ft
Water table has a fixed concentration of    0.44000E-01mg/l,      0.12459E-02g/cu.ft.
   with respect to gas diffusion.
```

## 1,1-Dichloroethane Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of 1,1-dichloroethane from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =    0.00000    g/sq.ft.
Mass in gas phase    =      0.00000    g/sq.ft.
Mass in liquid phase  =      0.00000    g/sq.ft.
Mass sorbed          =     0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =    0.19324E-02g/sq.ft.
Mass in gas phase    =      0.35509E-03g/sq.ft.
Mass in liquid phase  =      0.14626E-02g/sq.ft.
Mass sorbed          =     0.11467E-03g/sq.ft.

Since last printout at time =     24.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =      0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.70000E-02g/sq.ft.
             Diffusion in from water table =    0.70001E-02g/sq.ft.
          Total inflow at boundaries =     0.11176E-07g/sq.ft.
          Mass discrepancy =    -0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.19324E-02g/sq.ft.
             Advection in from atmosphere =      0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.17434    g/sq.ft.
             Diffusion in from water table =    0.17627    g/sq.ft.
          Total inflow at boundaries =     0.19336E-02g/sq.ft.
          Mass discrepancy =    -0.11604E-05g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =    0.19324E-02g/sq.ft.
Mass in gas phase    =      0.35509E-03g/sq.ft.
Mass in liquid phase  =      0.14626E-02g/sq.ft.
Mass sorbed          =     0.11467E-03g/sq.ft.

Since last printout at time =     25.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =      0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.70000E-02g/sq.ft.
             Diffusion in from water table =    0.70001E-02g/sq.ft.
          Total inflow at boundaries =     0.11176E-07g/sq.ft.
          Mass discrepancy =    -0.11176E-07g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =   0.19324E-02g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.18134   g/sq.ft.
             Diffusion in from water table =   0.18327   g/sq.ft.
          Total inflow at boundaries =   0.19337E-02g/sq.ft.
          Mass discrepancy =  -0.13094E-05g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =   0.19324E-02g/sq.ft.
Mass in gas phase    =    0.35509E-03g/sq.ft.
Mass in liquid phase  =    0.14626E-02g/sq.ft.
Mass sorbed          =    0.11467E-03g/sq.ft.

Since last printout at time =     26.00
          Change in Total Mass =   0.00000   g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.70000E-02g/sq.ft.
             Diffusion in from water table =   0.70001E-02g/sq.ft.
          Total inflow at boundaries =   0.11176E-07g/sq.ft.
          Mass discrepancy =  -0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =   0.19324E-02g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.18834   g/sq.ft.
             Diffusion in from water table =   0.19027   g/sq.ft.
          Total inflow at boundaries =   0.19339E-02g/sq.ft.
          Mass discrepancy =  -0.14585E-05g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =   0.19324E-02g/sq.ft.
Mass in gas phase    =    0.35509E-03g/sq.ft.
Mass in liquid phase  =    0.14626E-02g/sq.ft.
Mass sorbed          =    0.11467E-03g/sq.ft.

Since last printout at time =     27.00
          Change in Total Mass =   0.00000   g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.70000E-02g/sq.ft.
             Diffusion in from water table =   0.70001E-02g/sq.ft.
          Total inflow at boundaries =   0.11176E-07g/sq.ft.
          Mass discrepancy =  -0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =   0.19324E-02g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
```

```
            Diffusion in from atmosphere =    -0.19534    g/sq.ft.
            Diffusion in from water table =    0.19727    g/sq.ft.
         Total inflow at boundaries =    0.19340E-02g/sq.ft.
         Mass discrepancy =   -0.16075E-05g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =    0.19324E-02g/sq.ft.
Mass in gas phase     =     0.35509E-03g/sq.ft.
Mass in liquid phase  =     0.14626E-02g/sq.ft.
Mass sorbed           =     0.11467E-03g/sq.ft.

Since last printout at time =      28.00
         Change in Total Mass =    0.00000    g/sq.ft.
            Advection in from atmosphere =     0.00000    g/sq.ft.
            Advection in from water table =    0.00000    g/sq.ft.
            Diffusion in from atmosphere =    -0.70000E-02g/sq.ft.
            Diffusion in from water table =    0.70001E-02g/sq.ft.
         Total inflow at boundaries =    0.11176E-07g/sq.ft.
         Mass discrepancy =   -0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
         Change in Total Mass =    0.19324E-02g/sq.ft.
            Advection in from atmosphere =     0.00000    g/sq.ft.
            Advection in from water table =    0.00000    g/sq.ft.
            Diffusion in from atmosphere =    -0.20234    g/sq.ft.
            Diffusion in from water table =    0.20427    g/sq.ft.
         Total inflow at boundaries =    0.19342E-02g/sq.ft.
         Mass discrepancy =   -0.17565E-05g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =    0.19324E-02g/sq.ft.
Mass in gas phase     =     0.35509E-03g/sq.ft.
Mass in liquid phase  =     0.14626E-02g/sq.ft.
Mass sorbed           =     0.11467E-03g/sq.ft.

Since last printout at time =      29.00
         Change in Total Mass =    0.00000    g/sq.ft.
            Advection in from atmosphere =     0.00000    g/sq.ft.
            Advection in from water table =    0.00000    g/sq.ft.
            Diffusion in from atmosphere =    -0.70000E-02g/sq.ft.
            Diffusion in from water table =    0.70001E-02g/sq.ft.
         Total inflow at boundaries =    0.11176E-07g/sq.ft.
         Mass discrepancy =   -0.11176E-07g/sq.ft.

Since beginning of run at time = 0.0
         Change in Total Mass =    0.19324E-02g/sq.ft.
            Advection in from atmosphere =     0.00000    g/sq.ft.
            Advection in from water table =    0.00000    g/sq.ft.
            Diffusion in from atmosphere =    -0.20934    g/sq.ft.
            Diffusion in from water table =    0.21127    g/sq.ft.
         Total inflow at boundaries =    0.19343E-02g/sq.ft.
         Mass discrepancy =   -0.19055E-05g/sq.ft.
```

## 1,2-Dichloroethane Input File

**vl05.inp**

```
VLEACH Model, Volatilization of 1,2-dichloroethane from gw, Sybase
  1
    0.1      30.      1.0      5.0
    17.    0.044    8300.     0.81
Default area of 1 ft^2, uncapped, no infiltration
     1.      0.1      0.0     1.68     .37      .18   0.00028
     0.       0.    0.0014
 30   1
  0  30    0.000
```

**1,2-Dichloroethane Parameter Output File** **vl05.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of 1,2-dichloroethane from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =      17.000    ml/g,      0.60035E-03cu.ft./g
Kh =     0.44000E-01 (dimensionless).
Aqueous solubility =     8300.0      mg/l,       235.03      g/cu.ft
Free air diffusion coefficient = .81000      sq. m/day,  3182.5      sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =      1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800     g/ml,        47573.     g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000     mg/l,       0.00000     g/cu.ft
Atmospheric concentration =     0.00000     mg/l,       0.00000     g/cu.ft
Water table has a fixed concentration of     0.14000E-02mg/l,      0.39644E-04g/cu.ft.
   with respect to gas diffusion.
```

## 1,2-Dichloroethane Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of 1,2-dichloroethane from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase     =     0.00000    g/sq.ft.
Mass in liquid phase  =     0.00000    g/sq.ft.
Mass sorbed           =     0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.26536E-03g/sq.ft.
Mass in gas phase     =     0.11298E-04g/sq.ft.
Mass in liquid phase  =     0.24326E-03g/sq.ft.
Mass sorbed           =     0.10807E-04g/sq.ft.

Since last printout at time =      24.00
          Change in Total Mass =     0.63155E-08g/sq.ft.
             Advection in from atmosphere =      0.00000    g/sq.ft.
             Advection in from water table =     0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.22273E-03g/sq.ft.
             Diffusion in from water table =    0.22273E-03g/sq.ft.
          Total inflow at boundaries =     0.66939E-08g/sq.ft.
          Mass discrepancy =    -0.37835E-09g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =     0.26536E-03g/sq.ft.
             Advection in from atmosphere =      0.00000    g/sq.ft.
             Advection in from water table =     0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.54769E-02g/sq.ft.
             Diffusion in from water table =    0.57423E-02g/sq.ft.
          Total inflow at boundaries =     0.26537E-03g/sq.ft.
          Mass discrepancy =    -0.11234E-07g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.26537E-03g/sq.ft.
Mass in gas phase     =     0.11298E-04g/sq.ft.
Mass in liquid phase  =     0.24326E-03g/sq.ft.
Mass sorbed           =     0.10807E-04g/sq.ft.

Since last printout at time =      25.00
          Change in Total Mass =     0.42783E-08g/sq.ft.
             Advection in from atmosphere =      0.00000    g/sq.ft.
             Advection in from water table =     0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.22273E-03g/sq.ft.
             Diffusion in from water table =    0.22273E-03g/sq.ft.
          Total inflow at boundaries =     0.44820E-08g/sq.ft.
          Mass discrepancy =    -0.20373E-09g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.26537E-03g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.56996E-02g/sq.ft.
             Diffusion in from water table =    0.59650E-02g/sq.ft.
          Total inflow at boundaries =    0.26538E-03g/sq.ft.
          Mass discrepancy =    -0.11612E-07g/sq.ft.


Polygon    1
At time =     27.00, total mass in vadose zone =    0.26537E-03g/sq.ft.
Mass in gas phase     =      0.11298E-04g/sq.ft.
Mass in liquid phase  =      0.24326E-03g/sq.ft.
Mass sorbed           =    0.10807E-04g/sq.ft.

Since last printout at time =      26.00
          Change in Total Mass =    0.28813E-08g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.22273E-03g/sq.ft.
             Diffusion in from water table =    0.22273E-03g/sq.ft.
          Total inflow at boundaries =    0.32014E-08g/sq.ft.
          Mass discrepancy =    -0.32014E-09g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.26537E-03g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.59224E-02g/sq.ft.
             Diffusion in from water table =    0.61877E-02g/sq.ft.
          Total inflow at boundaries =    0.26538E-03g/sq.ft.
          Mass discrepancy =    -0.13388E-07g/sq.ft.


Polygon    1
At time =     28.00, total mass in vadose zone =    0.26537E-03g/sq.ft.
Mass in gas phase     =      0.11298E-04g/sq.ft.
Mass in liquid phase  =      0.24326E-03g/sq.ft.
Mass sorbed           =    0.10807E-04g/sq.ft.

Since last printout at time =      27.00
          Change in Total Mass =    0.19209E-08g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.22273E-03g/sq.ft.
             Diffusion in from water table =    0.22273E-03g/sq.ft.
          Total inflow at boundaries =    0.24302E-08g/sq.ft.
          Mass discrepancy =    -0.50932E-09g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.26537E-03g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
```

```
            Diffusion in from atmosphere =   -0.61451E-02g/sq.ft.
            Diffusion in from water table =   0.64105E-02g/sq.ft.
         Total inflow at boundaries =   0.26539E-03g/sq.ft.
         Mass discrepancy =   -0.16124E-07g/sq.ft.


Polygon  1
At time =    29.00, total mass in vadose zone =   0.26537E-03g/sq.ft.
Mass in gas phase    =    0.11298E-04g/sq.ft.
Mass in liquid phase  =    0.24327E-03g/sq.ft.
Mass sorbed         =    0.10808E-04g/sq.ft.

Since last printout at time =     28.00
         Change in Total Mass =   0.12806E-08g/sq.ft.
            Advection in from atmosphere =     0.00000    g/sq.ft.
            Advection in from water table =    0.00000    g/sq.ft.
            Diffusion in from atmosphere =   -0.22273E-03g/sq.ft.
            Diffusion in from water table =   0.22273E-03g/sq.ft.
         Total inflow at boundaries =   0.14697E-08g/sq.ft.
         Mass discrepancy =   -0.18917E-09g/sq.ft.

Since beginning of run at time = 0.0
         Change in Total Mass =   0.26537E-03g/sq.ft.
            Advection in from atmosphere =     0.00000    g/sq.ft.
            Advection in from water table =    0.00000    g/sq.ft.
            Diffusion in from atmosphere =   -0.63678E-02g/sq.ft.
            Diffusion in from water table =   0.66332E-02g/sq.ft.
         Total inflow at boundaries =   0.26539E-03g/sq.ft.
         Mass discrepancy =   -0.19034E-07g/sq.ft.


Polygon  1
At time =    30.00, total mass in vadose zone =   0.26537E-03g/sq.ft.
Mass in gas phase    =    0.11298E-04g/sq.ft.
Mass in liquid phase  =    0.24327E-03g/sq.ft.
Mass sorbed         =    0.10808E-04g/sq.ft.

Since last printout at time =     29.00
         Change in Total Mass =   0.87311E-09g/sq.ft.
            Advection in from atmosphere =     0.00000    g/sq.ft.
            Advection in from water table =    0.00000    g/sq.ft.
            Diffusion in from atmosphere =   -0.22273E-03g/sq.ft.
            Diffusion in from water table =   0.22273E-03g/sq.ft.
         Total inflow at boundaries =   0.12806E-08g/sq.ft.
         Mass discrepancy =   -0.40745E-09g/sq.ft.

Since beginning of run at time = 0.0
         Change in Total Mass =   0.26537E-03g/sq.ft.
            Advection in from atmosphere =     0.00000    g/sq.ft.
            Advection in from water table =    0.00000    g/sq.ft.
            Diffusion in from atmosphere =   -0.65905E-02g/sq.ft.
            Diffusion in from water table =   0.68559E-02g/sq.ft.
         Total inflow at boundaries =   0.26539E-03g/sq.ft.
         Mass discrepancy =   -0.18161E-07g/sq.ft.
```

```
VLEACH Model, Volatilization of c-1,2-dichloroethene from gw, Sybase
  1
    0.1      30.      1.0      5.0
    59.    0.17   6300.     0.71
Default area of 1 ft^2, uncapped, no infiltration
     1.      0.1      0.0     1.68     .37      .18  0.00028
     0.       0.    0.060
  30   1
   0  30    0.000
```

**c-1,2-Dichloroethene Parameter Output File** **vl06.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of c-1,2-dichloroethene from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =      59.000    ml/g,      0.20836E-02cu.ft./g
Kh =     0.17000     (dimensionless).
Aqueous solubility =     6300.0     mg/l,       178.40      g/cu.ft
Free air diffusion coefficient = .71000      sq. m/day,  2789.6      sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =       1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800     g/ml,       47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000     mg/l,      0.00000     g/cu.ft
Atmospheric concentration =     0.00000     mg/l,      0.00000     g/cu.ft
Water table has a fixed concentration of     0.60000E-01mg/l,      0.16990E-02g/cu.ft.
   with respect to gas diffusion.
```

**t-1,2-Dichloroethene Input File** **vl07.inp**

```
VLEACH Model, Volatilization of t-1,2-dichloroethene from gw, Sybase
   1
     0.1      30.      1.0      5.0
     59.     0.38    6300.     0.71
Default area of 1 ft^2, uncapped, no infiltration
      1.      0.1      0.0      1.68      .37      .18   0.00028
      0.       0.    0.041
  30    1
   0   30     0.000
```

**t-1,2-Dichloroethene Parameter Output File** **vl07.prm**

```
V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of t-1,2-dichloroethene from gw, Sybase
  1 polygons.
Timestep =  0.10 years.  Simulation length =  30.00 years.
Printout every  1.00 years.  Vertical profile stored every  5.00 years.
Koc =     59.000   ml/g,    0.20836E-02cu.ft./g
Kh =    0.38000    (dimensionless).
Aqueous solubility =    6300.0    mg/l,     178.40    g/cu.ft
Free air diffusion coefficient = .71000    sq. m/day,  2789.6    sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =     1.0000    sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =    1.6800    g/ml,       47573.   g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =    0.00000    mg/l,     0.00000    g/cu.ft
Atmospheric concentration =    0.00000    mg/l,     0.00000    g/cu.ft
Water table has a fixed concentration of    0.41000E-01mg/l,     0.11610E-02g/cu.ft.
   with respect to gas diffusion.
```

## t-1,2-Dichloroethene Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of t-1,2-dichloroethene from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase    =     0.00000   g/sq.ft.
Mass in liquid phase  =     0.00000    g/sq.ft.
Mass sorbed          =     0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.12830E-02g/sq.ft.
Mass in gas phase    =     0.33088E-03g/sq.ft.
Mass in liquid phase  =     0.82492E-03g/sq.ft.
Mass sorbed          =     0.12719E-03g/sq.ft.

Since last printout at time =      24.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.57175E-02g/sq.ft.
             Diffusion in from water table =    0.57175E-02g/sq.ft.
          Total inflow at boundaries =    -0.32596E-08g/sq.ft.
          Mass discrepancy =     0.32596E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =     0.12830E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.14250    g/sq.ft.
             Diffusion in from water table =    0.14378    g/sq.ft.
          Total inflow at boundaries =     0.12829E-02g/sq.ft.
          Mass discrepancy =     0.64494E-07g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.12830E-02g/sq.ft.
Mass in gas phase    =     0.33088E-03g/sq.ft.
Mass in liquid phase  =     0.82492E-03g/sq.ft.
Mass sorbed          =     0.12719E-03g/sq.ft.

Since last printout at time =      25.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.57175E-02g/sq.ft.
             Diffusion in from water table =    0.57175E-02g/sq.ft.
          Total inflow at boundaries =    -0.32596E-08g/sq.ft.
          Mass discrepancy =     0.32596E-08g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.12830E-02g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.14821   g/sq.ft.
             Diffusion in from water table =   0.14950   g/sq.ft.
          Total inflow at boundaries =    0.12829E-02g/sq.ft.
          Mass discrepancy =   0.64494E-07g/sq.ft.


Polygon   1
At time =    27.00, total mass in vadose zone =   0.12830E-02g/sq.ft.
Mass in gas phase     =    0.33088E-03g/sq.ft.
Mass in liquid phase  =     0.82492E-03g/sq.ft.
Mass sorbed           =    0.12719E-03g/sq.ft.

Since last printout at time =     26.00
          Change in Total Mass =    0.00000   g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.57175E-02g/sq.ft.
             Diffusion in from water table =   0.57175E-02g/sq.ft.
          Total inflow at boundaries =  -0.32596E-08g/sq.ft.
          Mass discrepancy =   0.32596E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.12830E-02g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.15393   g/sq.ft.
             Diffusion in from water table =   0.15521   g/sq.ft.
          Total inflow at boundaries =    0.12829E-02g/sq.ft.
          Mass discrepancy =   0.64494E-07g/sq.ft.


Polygon   1
At time =    28.00, total mass in vadose zone =   0.12830E-02g/sq.ft.
Mass in gas phase     =    0.33088E-03g/sq.ft.
Mass in liquid phase  =     0.82492E-03g/sq.ft.
Mass sorbed           =    0.12719E-03g/sq.ft.

Since last printout at time =     27.00
          Change in Total Mass =    0.00000   g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
             Diffusion in from atmosphere =   -0.57175E-02g/sq.ft.
             Diffusion in from water table =   0.57175E-02g/sq.ft.
          Total inflow at boundaries =  -0.32596E-08g/sq.ft.
          Mass discrepancy =   0.32596E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.12830E-02g/sq.ft.
             Advection in from atmosphere =    0.00000   g/sq.ft.
             Advection in from water table =   0.00000   g/sq.ft.
```

```
          Diffusion in from atmosphere =    -0.15965    g/sq.ft.
          Diffusion in from water table =    0.16093    g/sq.ft.
       Total inflow at boundaries =    0.12829E-02g/sq.ft.
       Mass discrepancy =    0.64494E-07g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =    0.12830E-02g/sq.ft.
Mass in gas phase    =    0.33088E-03g/sq.ft.
Mass in liquid phase  =    0.82492E-03g/sq.ft.
Mass sorbed          =    0.12719E-03g/sq.ft.

Since last printout at time =     28.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =    0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.57175E-02g/sq.ft.
          Diffusion in from water table =    0.57175E-02g/sq.ft.
       Total inflow at boundaries =   -0.32596E-08g/sq.ft.
       Mass discrepancy =    0.32596E-08g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.12830E-02g/sq.ft.
          Advection in from atmosphere =    0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.16537    g/sq.ft.
          Diffusion in from water table =    0.16665    g/sq.ft.
       Total inflow at boundaries =    0.12829E-02g/sq.ft.
       Mass discrepancy =    0.64494E-07g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =    0.12830E-02g/sq.ft.
Mass in gas phase    =    0.33088E-03g/sq.ft.
Mass in liquid phase  =    0.82492E-03g/sq.ft.
Mass sorbed          =    0.12719E-03g/sq.ft.

Since last printout at time =     29.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =    0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.57175E-02g/sq.ft.
          Diffusion in from water table =    0.57175E-02g/sq.ft.
       Total inflow at boundaries =   -0.32596E-08g/sq.ft.
       Mass discrepancy =    0.32596E-08g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.12830E-02g/sq.ft.
          Advection in from atmosphere =    0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.17108    g/sq.ft.
          Diffusion in from water table =    0.17237    g/sq.ft.
       Total inflow at boundaries =    0.12829E-02g/sq.ft.
       Mass discrepancy =    0.64494E-07g/sq.ft.
```

**Chloroethane Input File** **vl08.inp**

```
VLEACH Model, Volatilization of chloroethane from gw, Sybase
  1
    0.1     30.     1.0     5.0
    3.2     0.46    4700.    0.93
Default area of 1 ft^2, uncapped, no infiltration
      1.      0.1     0.0     1.68     .37     .18  0.00028
      0.       0.    0.034
  30   1
   0  30    0.000
```

**Chloroethane Parameter Output File** **vl08.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of chloroethane from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =      3.2000    ml/g,      0.11301E-03cu.ft./g
Kh =     0.46000     (dimensionless).
Aqueous solubility =     4700.0      mg/l,      133.09      g/cu.ft
Free air diffusion coefficient = .93000     sq. m/day,  3654.0      sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =       1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800     g/ml,       47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000     mg/l,      0.00000     g/cu.ft
Atmospheric concentration =     0.00000     mg/l,      0.00000     g/cu.ft
Water table has a fixed concentration of     0.34000E-01mg/l,      0.96278E-03g/cu.ft.
   with respect to gas diffusion.
```

## Chloroethane Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of chloroethane from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase     =     0.00000    g/sq.ft.
Mass in liquid phase  =     0.00000    g/sq.ft.
Mass sorbed           =     0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.84423E-03g/sq.ft.
Mass in gas phase     =     0.27439E-03g/sq.ft.
Mass in liquid phase  =     0.56511E-03g/sq.ft.
Mass sorbed           =     0.47258E-05g/sq.ft.

Since last printout at time =      24.00
           Change in Total Mass =     0.00000     g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.62105E-02g/sq.ft.
              Diffusion in from water table =    0.62105E-02g/sq.ft.
           Total inflow at boundaries =    0.42375E-07g/sq.ft.
           Mass discrepancy =    -0.42375E-07g/sq.ft.

Since beginning of run at time = 0.0
           Change in Total Mass =     0.84423E-03g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.15497    g/sq.ft.
              Diffusion in from water table =    0.15582    g/sq.ft.
           Total inflow at boundaries =    0.84536E-03g/sq.ft.
           Mass discrepancy =    -0.11324E-05g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.84423E-03g/sq.ft.
Mass in gas phase     =     0.27439E-03g/sq.ft.
Mass in liquid phase  =     0.56511E-03g/sq.ft.
Mass sorbed           =     0.47258E-05g/sq.ft.

Since last printout at time =      25.00
           Change in Total Mass =     0.00000     g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.62105E-02g/sq.ft.
              Diffusion in from water table =    0.62105E-02g/sq.ft.
           Total inflow at boundaries =    0.42375E-07g/sq.ft.
           Mass discrepancy =    -0.42375E-07g/sq.ft.
```

```
Since beginning of run at time = 0.0
        Change in Total Mass =    0.84423E-03g/sq.ft.
           Advection in from atmosphere =    0.00000    g/sq.ft.
           Advection in from water table =   0.00000    g/sq.ft.
           Diffusion in from atmosphere =   -0.16118    g/sq.ft.
           Diffusion in from water table =   0.16203    g/sq.ft.
        Total inflow at boundaries =   0.84536E-03g/sq.ft.
        Mass discrepancy =   -0.11324E-05g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =   0.84423E-03g/sq.ft.
Mass in gas phase    =     0.27439E-03g/sq.ft.
Mass in liquid phase  =     0.56511E-03g/sq.ft.
Mass sorbed          =     0.47258E-05g/sq.ft.

Since last printout at time =     26.00
        Change in Total Mass =    0.00000    g/sq.ft.
           Advection in from atmosphere =    0.00000    g/sq.ft.
           Advection in from water table =   0.00000    g/sq.ft.
           Diffusion in from atmosphere =   -0.62105E-02g/sq.ft.
           Diffusion in from water table =   0.62105E-02g/sq.ft.
        Total inflow at boundaries =   0.42375E-07g/sq.ft.
        Mass discrepancy =   -0.42375E-07g/sq.ft.

Since beginning of run at time = 0.0
        Change in Total Mass =    0.84423E-03g/sq.ft.
           Advection in from atmosphere =    0.00000    g/sq.ft.
           Advection in from water table =   0.00000    g/sq.ft.
           Diffusion in from atmosphere =   -0.16739    g/sq.ft.
           Diffusion in from water table =   0.16824    g/sq.ft.
        Total inflow at boundaries =   0.84536E-03g/sq.ft.
        Mass discrepancy =   -0.11324E-05g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =   0.84423E-03g/sq.ft.
Mass in gas phase    =     0.27439E-03g/sq.ft.
Mass in liquid phase  =     0.56511E-03g/sq.ft.
Mass sorbed          =     0.47258E-05g/sq.ft.

Since last printout at time =     27.00
        Change in Total Mass =    0.00000    g/sq.ft.
           Advection in from atmosphere =    0.00000    g/sq.ft.
           Advection in from water table =   0.00000    g/sq.ft.
           Diffusion in from atmosphere =   -0.62105E-02g/sq.ft.
           Diffusion in from water table =   0.62105E-02g/sq.ft.
        Total inflow at boundaries =   0.42375E-07g/sq.ft.
        Mass discrepancy =   -0.42375E-07g/sq.ft.

Since beginning of run at time = 0.0
        Change in Total Mass =    0.84423E-03g/sq.ft.
           Advection in from atmosphere =    0.00000    g/sq.ft.
           Advection in from water table =   0.00000    g/sq.ft.
```

```
          Diffusion in from atmosphere =    -0.17360    g/sq.ft.
          Diffusion in from water table =    0.17445    g/sq.ft.
       Total inflow at boundaries =    0.84536E-03g/sq.ft.
       Mass discrepancy =   -0.11324E-05g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =   0.84423E-03g/sq.ft.
Mass in gas phase     =     0.27439E-03g/sq.ft.
Mass in liquid phase  =     0.56511E-03g/sq.ft.
Mass sorbed           =     0.47258E-05g/sq.ft.

Since last printout at time =     28.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.62105E-02g/sq.ft.
          Diffusion in from water table =    0.62105E-02g/sq.ft.
       Total inflow at boundaries =    0.42375E-07g/sq.ft.
       Mass discrepancy =   -0.42375E-07g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.84423E-03g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.17981    g/sq.ft.
          Diffusion in from water table =    0.18066    g/sq.ft.
       Total inflow at boundaries =    0.84536E-03g/sq.ft.
       Mass discrepancy =   -0.11324E-05g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =   0.84423E-03g/sq.ft.
Mass in gas phase     =     0.27439E-03g/sq.ft.
Mass in liquid phase  =     0.56511E-03g/sq.ft.
Mass sorbed           =     0.47258E-05g/sq.ft.

Since last printout at time =     29.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.62105E-02g/sq.ft.
          Diffusion in from water table =    0.62105E-02g/sq.ft.
       Total inflow at boundaries =    0.42375E-07g/sq.ft.
       Mass discrepancy =   -0.42375E-07g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.84423E-03g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.18602    g/sq.ft.
          Diffusion in from water table =    0.18687    g/sq.ft.
       Total inflow at boundaries =    0.84536E-03g/sq.ft.
       Mass discrepancy =   -0.11324E-05g/sq.ft.
```

**1,1,1-Trichloroethane Input File** **vl09.inp**

```
VLEACH Model, Volatilization of 1,1,1-trichloroethane from gw, Sybase
  1
    0.1     30.     1.0     5.0
   130.    0.70    830.    0.71
Default area of 1 ft^2, uncapped, no infiltration
     1.     0.1     0.0     1.68     .37     .18  0.00028
     0.      0.   0.0074
 30   1
  0  30    0.000
```

## 1,1,1-Trichloroethane Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of 1,1,1-trichloroethane from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase    =     0.00000    g/sq.ft.
Mass in liquid phase  =     0.00000    g/sq.ft.
Mass sorbed          =    0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.16800E-03g/sq.ft.
Mass in gas phase    =     0.59721E-04g/sq.ft.
Mass in liquid phase  =     0.80825E-04g/sq.ft.
Mass sorbed          =    0.27459E-04g/sq.ft.

Since last printout at time =      24.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.10319E-02g/sq.ft.
             Diffusion in from water table =   0.10319E-02g/sq.ft.
          Total inflow at boundaries =   -0.58208E-09g/sq.ft.
          Mass discrepancy =    0.58208E-09g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.16800E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.25741E-01g/sq.ft.
             Diffusion in from water table =   0.25909E-01g/sq.ft.
          Total inflow at boundaries =    0.16800E-03g/sq.ft.
          Mass discrepancy =    0.67521E-08g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.16800E-03g/sq.ft.
Mass in gas phase    =     0.59721E-04g/sq.ft.
Mass in liquid phase  =     0.80825E-04g/sq.ft.
Mass sorbed          =    0.27459E-04g/sq.ft.

Since last printout at time =      25.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.10319E-02g/sq.ft.
             Diffusion in from water table =   0.10319E-02g/sq.ft.
          Total inflow at boundaries =   -0.58208E-09g/sq.ft.
          Mass discrepancy =    0.58208E-09g/sq.ft.
```

**1,1,1-Trichloroethane Parameter Output File** **vl09.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of 1,1,1-trichloroethane from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =      130.00    ml/g,      0.45909E-02cu.ft./g
Kh =     0.70000     (dimensionless).
Aqueous solubility =     830.00     mg/l,      23.503     g/cu.ft
Free air diffusion coefficient = .71000     sq. m/day,  2789.6     sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =      1.0000    sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800    g/ml,       47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000    mg/l,      0.00000    g/cu.ft
Atmospheric concentration =     0.00000    mg/l,      0.00000    g/cu.ft
Water table has a fixed concentration of     0.74000E-02mg/l,      0.20955E-03g/cu.ft.
   with respect to gas diffusion.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.16800E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.26773E-01g/sq.ft.
             Diffusion in from water table =    0.26941E-01g/sq.ft.
          Total inflow at boundaries =    0.16800E-03g/sq.ft.
          Mass discrepancy =    0.67521E-08g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =    0.16800E-03g/sq.ft.
Mass in gas phase     =     0.59721E-04g/sq.ft.
Mass in liquid phase  =     0.80825E-04g/sq.ft.
Mass sorbed           =    0.27459E-04g/sq.ft.

Since last printout at time =      26.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.10319E-02g/sq.ft.
             Diffusion in from water table =    0.10319E-02g/sq.ft.
          Total inflow at boundaries =   -0.58208E-09g/sq.ft.
          Mass discrepancy =    0.58208E-09g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.16800E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.27805E-01g/sq.ft.
             Diffusion in from water table =    0.27973E-01g/sq.ft.
          Total inflow at boundaries =    0.16800E-03g/sq.ft.
          Mass discrepancy =    0.67521E-08g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =    0.16800E-03g/sq.ft.
Mass in gas phase     =     0.59721E-04g/sq.ft.
Mass in liquid phase  =     0.80825E-04g/sq.ft.
Mass sorbed           =    0.27459E-04g/sq.ft.

Since last printout at time =      27.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.10319E-02g/sq.ft.
             Diffusion in from water table =    0.10319E-02g/sq.ft.
          Total inflow at boundaries =   -0.58208E-09g/sq.ft.
          Mass discrepancy =    0.58208E-09g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.16800E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
```

```
          Diffusion in from atmosphere =    -0.28836E-01g/sq.ft.
          Diffusion in from water table =   0.29004E-01g/sq.ft.
       Total inflow at boundaries =   0.16800E-03g/sq.ft.
       Mass discrepancy =    0.67521E-08g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =    0.16800E-03g/sq.ft.
Mass in gas phase    =     0.59721E-04g/sq.ft.
Mass in liquid phase  =     0.80825E-04g/sq.ft.
Mass sorbed          =    0.27459E-04g/sq.ft.

Since last printout at time =      28.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.10319E-02g/sq.ft.
          Diffusion in from water table =   0.10319E-02g/sq.ft.
       Total inflow at boundaries =   -0.58208E-09g/sq.ft.
       Mass discrepancy =    0.58208E-09g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.16800E-03g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.29868E-01g/sq.ft.
          Diffusion in from water table =   0.30036E-01g/sq.ft.
       Total inflow at boundaries =    0.16800E-03g/sq.ft.
       Mass discrepancy =    0.67521E-08g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =    0.16800E-03g/sq.ft.
Mass in gas phase    =     0.59721E-04g/sq.ft.
Mass in liquid phase  =     0.80825E-04g/sq.ft.
Mass sorbed          =    0.27459E-04g/sq.ft.

Since last printout at time =      29.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.10319E-02g/sq.ft.
          Diffusion in from water table =   0.10319E-02g/sq.ft.
       Total inflow at boundaries =   -0.58208E-09g/sq.ft.
       Mass discrepancy =    0.58208E-09g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.16800E-03g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.30900E-01g/sq.ft.
          Diffusion in from water table =   0.31068E-01g/sq.ft.
       Total inflow at boundaries =    0.16800E-03g/sq.ft.
       Mass discrepancy =    0.67521E-08g/sq.ft.
```

## Freon 113 Input File

**vl10.inp**

```
VLEACH Model, Volatilization of Freon 113 from gw, Sybase
   1
     0.1      30.      1.0      5.0
    390.     13.6     200.     0.64
Default area of 1 ft^2, uncapped, no infiltration
      1.     0.1      0.0     1.68     .37     .18   0.00028
      0.      0.    0.009
  30    1
   0   30     0.000
```

**Freon 113 Parameter Output File** **vl10.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of Freon 113 from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =     390.00    ml/g,     0.13773E-01cu.ft./g
Kh =      13.600     (dimensionless).
Aqueous solubility =     200.00      mg/l,      5.6634      g/cu.ft
Free air diffusion coefficient = .64000     sq. m/day,  2514.6      sq.ft./yr


Polygon    1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =       1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800     g/ml,        47573.     g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000    mg/l,      0.00000     g/cu.ft
Atmospheric concentration =     0.00000     mg/l,     0.00000     g/cu.ft
Water table has a fixed concentration of     0.90000E-02mg/l,      0.25485E-03g/cu.ft.
   with respect to gas diffusion.
```

## Freon 113 Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of Freon 113 from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase     =      0.00000    g/sq.ft.
Mass in liquid phase  =      0.00000    g/sq.ft.
Mass sorbed           =    0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.82849E-04g/sq.ft.
Mass in gas phase     =      0.72633E-04g/sq.ft.
Mass in liquid phase  =      0.50596E-05g/sq.ft.
Mass sorbed           =    0.51567E-05g/sq.ft.

Since last printout at time =      24.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =      0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.11313E-02g/sq.ft.
             Diffusion in from water table =    0.11313E-02g/sq.ft.
          Total inflow at boundaries =   -0.40745E-08g/sq.ft.
          Mass discrepancy =     0.40745E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =     0.82849E-04g/sq.ft.
             Advection in from atmosphere =      0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.28254E-01g/sq.ft.
             Diffusion in from water table =    0.28337E-01g/sq.ft.
          Total inflow at boundaries =     0.82754E-04g/sq.ft.
          Mass discrepancy =     0.95890E-07g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.82849E-04g/sq.ft.
Mass in gas phase     =      0.72633E-04g/sq.ft.
Mass in liquid phase  =      0.50596E-05g/sq.ft.
Mass sorbed           =    0.51567E-05g/sq.ft.

Since last printout at time =      25.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =      0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.11313E-02g/sq.ft.
             Diffusion in from water table =    0.11313E-02g/sq.ft.
          Total inflow at boundaries =   -0.40745E-08g/sq.ft.
          Mass discrepancy =     0.40745E-08g/sq.ft.
```

```
Since beginning of run at time = 0.0
        Change in Total Mass =   0.82849E-04g/sq.ft.
           Advection in from atmosphere =    0.00000   g/sq.ft.
           Advection in from water table =   0.00000   g/sq.ft.
           Diffusion in from atmosphere =   -0.29386E-01g/sq.ft.
           Diffusion in from water table =   0.29469E-01g/sq.ft.
        Total inflow at boundaries =    0.82754E-04g/sq.ft.
        Mass discrepancy =   0.95890E-07g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =   0.82849E-04g/sq.ft.
Mass in gas phase     =     0.72633E-04g/sq.ft.
Mass in liquid phase  =     0.50596E-05g/sq.ft.
Mass sorbed          =     0.51567E-05g/sq.ft.

Since last printout at time =     26.00
        Change in Total Mass =    0.00000   g/sq.ft.
           Advection in from atmosphere =    0.00000   g/sq.ft.
           Advection in from water table =   0.00000   g/sq.ft.
           Diffusion in from atmosphere =   -0.11313E-02g/sq.ft.
           Diffusion in from water table =   0.11313E-02g/sq.ft.
        Total inflow at boundaries =   -0.40745E-08g/sq.ft.
        Mass discrepancy =   0.40745E-08g/sq.ft.

Since beginning of run at time = 0.0
        Change in Total Mass =   0.82849E-04g/sq.ft.
           Advection in from atmosphere =    0.00000   g/sq.ft.
           Advection in from water table =   0.00000   g/sq.ft.
           Diffusion in from atmosphere =   -0.30517E-01g/sq.ft.
           Diffusion in from water table =   0.30600E-01g/sq.ft.
        Total inflow at boundaries =    0.82754E-04g/sq.ft.
        Mass discrepancy =   0.95890E-07g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =   0.82849E-04g/sq.ft.
Mass in gas phase     =     0.72633E-04g/sq.ft.
Mass in liquid phase  =     0.50596E-05g/sq.ft.
Mass sorbed          =     0.51567E-05g/sq.ft.

Since last printout at time =     27.00
        Change in Total Mass =    0.00000   g/sq.ft.
           Advection in from atmosphere =    0.00000   g/sq.ft.
           Advection in from water table =   0.00000   g/sq.ft.
           Diffusion in from atmosphere =   -0.11313E-02g/sq.ft.
           Diffusion in from water table =   0.11313E-02g/sq.ft.
        Total inflow at boundaries =   -0.40745E-08g/sq.ft.
        Mass discrepancy =   0.40745E-08g/sq.ft.

Since beginning of run at time = 0.0
        Change in Total Mass =   0.82849E-04g/sq.ft.
           Advection in from atmosphere =    0.00000   g/sq.ft.
           Advection in from water table =   0.00000   g/sq.ft.
```

```
             Diffusion in from atmosphere =    -0.31648E-01g/sq.ft.
             Diffusion in from water table =   0.31731E-01g/sq.ft.
          Total inflow at boundaries =    0.82754E-04g/sq.ft.
          Mass discrepancy =    0.95890E-07g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =   0.82849E-04g/sq.ft.
Mass in gas phase     =     0.72633E-04g/sq.ft.
Mass in liquid phase  =     0.50596E-05g/sq.ft.
Mass sorbed           =     0.51567E-05g/sq.ft.

Since last printout at time =      28.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.11313E-02g/sq.ft.
             Diffusion in from water table =    0.11313E-02g/sq.ft.
          Total inflow at boundaries =   -0.40745E-08g/sq.ft.
          Mass discrepancy =    0.40745E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.82849E-04g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.32780E-01g/sq.ft.
             Diffusion in from water table =    0.32863E-01g/sq.ft.
          Total inflow at boundaries =    0.82754E-04g/sq.ft.
          Mass discrepancy =    0.95890E-07g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =   0.82849E-04g/sq.ft.
Mass in gas phase     =     0.72633E-04g/sq.ft.
Mass in liquid phase  =     0.50596E-05g/sq.ft.
Mass sorbed           =     0.51567E-05g/sq.ft.

Since last printout at time =      29.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.11313E-02g/sq.ft.
             Diffusion in from water table =    0.11313E-02g/sq.ft.
          Total inflow at boundaries =   -0.40745E-08g/sq.ft.
          Mass discrepancy =    0.40745E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.82849E-04g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.33911E-01g/sq.ft.
             Diffusion in from water table =    0.33994E-01g/sq.ft.
          Total inflow at boundaries =    0.82754E-04g/sq.ft.
          Mass discrepancy =    0.95890E-07g/sq.ft.
```

**Acetone Input File** **vl11.inp**

```
VLEACH Model, Volatilization of acetone from gw, Sybase
  1
    0.1     30.     1.0     5.0
   0.37   0.0016   10000.    0.95
Default area of 1 ft^2, uncapped, no infiltration
     1.     0.1     0.0     1.68     .37     .18  0.00028
     0.      0.    0.023
 30   1
  0   30    0.000
```

**Acetone Parameter Output File** **vl11.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of acetone from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =     0.37000    ml/g,      0.13066E-04cu.ft./g
Kh =     0.16000E-02 (dimensionless).
Aqueous solubility =     10000.     mg/l,      283.17     g/cu.ft
Free air diffusion coefficient = .95000     sq. m/day,  3732.6     sq.ft./yr


Polygon    1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =      1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800     g/ml,        47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =      0.00000     mg/l,       0.00000     g/cu.ft
Atmospheric concentration =      0.00000     mg/l,       0.00000     g/cu.ft
Water table has a fixed concentration of     0.23000E-01mg/l,       0.65129E-03g/cu.ft.
   with respect to gas diffusion.
```

## Acetone Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of acetone from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase     =     0.00000    g/sq.ft.
Mass in liquid phase  =     0.00000    g/sq.ft.
Mass sorbed           =     0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.35708E-01g/sq.ft.
Mass in gas phase     =     0.60147E-04g/sq.ft.
Mass in liquid phase  =     0.35613E-01g/sq.ft.
Mass sorbed           =     0.34436E-04g/sq.ft.

Since last printout at time =     24.00
           Change in Total Mass =    0.11758E-02g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.38935E-02g/sq.ft.
              Diffusion in from water table =    0.50693E-02g/sq.ft.
           Total inflow at boundaries =    0.11758E-02g/sq.ft.
           Mass discrepancy =   -0.51223E-08g/sq.ft.

Since beginning of run at time = 0.0
           Change in Total Mass =    0.35708E-01g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.95267E-01g/sq.ft.
              Diffusion in from water table =    0.13097    g/sq.ft.
           Total inflow at boundaries =    0.35708E-01g/sq.ft.
           Mass discrepancy =    0.10803E-06g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.36866E-01g/sq.ft.
Mass in gas phase     =     0.62097E-04g/sq.ft.
Mass in liquid phase  =     0.36768E-01g/sq.ft.
Mass sorbed           =     0.35552E-04g/sq.ft.

Since last printout at time =     25.00
           Change in Total Mass =    0.11576E-02g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.38995E-02g/sq.ft.
              Diffusion in from water table =    0.50570E-02g/sq.ft.
           Total inflow at boundaries =    0.11575E-02g/sq.ft.
           Mass discrepancy =    0.10477E-07g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.36866E-01g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =   0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.99167E-01g/sq.ft.
             Diffusion in from water table =   0.13603    g/sq.ft.
          Total inflow at boundaries =    0.36865E-01g/sq.ft.
          Mass discrepancy =    0.12293E-06g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =   0.38005E-01g/sq.ft.
Mass in gas phase     =     0.64016E-04g/sq.ft.
Mass in liquid phase  =     0.37904E-01g/sq.ft.
Mass sorbed           =     0.36651E-04g/sq.ft.

Since last printout at time =      26.00
          Change in Total Mass =    0.11395E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =   0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.39054E-02g/sq.ft.
             Diffusion in from water table =   0.50449E-02g/sq.ft.
          Total inflow at boundaries =    0.11395E-02g/sq.ft.
          Mass discrepancy =    0.20955E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.38005E-01g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =   0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.10307    g/sq.ft.
             Diffusion in from water table =   0.14108    g/sq.ft.
          Total inflow at boundaries =    0.38005E-01g/sq.ft.
          Mass discrepancy =    0.13411E-06g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =   0.39127E-01g/sq.ft.
Mass in gas phase     =     0.65906E-04g/sq.ft.
Mass in liquid phase  =     0.39023E-01g/sq.ft.
Mass sorbed           =     0.37733E-04g/sq.ft.

Since last printout at time =      27.00
          Change in Total Mass =    0.11218E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =   0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.39112E-02g/sq.ft.
             Diffusion in from water table =   0.50331E-02g/sq.ft.
          Total inflow at boundaries =    0.11218E-02g/sq.ft.
          Mass discrepancy =    0.27940E-08g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.39127E-01g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =   0.00000    g/sq.ft.
```

```
           Diffusion in from atmosphere =    -0.10698    g/sq.ft.
           Diffusion in from water table =    0.14611    g/sq.ft.
        Total inflow at boundaries =    0.39127E-01g/sq.ft.
        Mass discrepancy =    0.13784E-06g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =   0.40231E-01g/sq.ft.
Mass in gas phase     =     0.67766E-04g/sq.ft.
Mass in liquid phase  =     0.40125E-01g/sq.ft.
Mass sorbed           =     0.38798E-04g/sq.ft.

Since last printout at time =     28.00
        Change in Total Mass =    0.11044E-02g/sq.ft.
           Advection in from atmosphere =     0.00000    g/sq.ft.
           Advection in from water table =    0.00000    g/sq.ft.
           Diffusion in from atmosphere =    -0.39170E-02g/sq.ft.
           Diffusion in from water table =    0.50214E-02g/sq.ft.
        Total inflow at boundaries =    0.11044E-02g/sq.ft.
        Mass discrepancy =    0.79162E-08g/sq.ft.

Since beginning of run at time = 0.0
        Change in Total Mass =    0.40231E-01g/sq.ft.
           Advection in from atmosphere =     0.00000    g/sq.ft.
           Advection in from water table =    0.00000    g/sq.ft.
           Diffusion in from atmosphere =    -0.11090    g/sq.ft.
           Diffusion in from water table =    0.15113    g/sq.ft.
        Total inflow at boundaries =    0.40231E-01g/sq.ft.
        Mass discrepancy =    0.15274E-06g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =   0.41318E-01g/sq.ft.
Mass in gas phase     =     0.69597E-04g/sq.ft.
Mass in liquid phase  =     0.41209E-01g/sq.ft.
Mass sorbed           =     0.39846E-04g/sq.ft.

Since last printout at time =     29.00
        Change in Total Mass =    0.10872E-02g/sq.ft.
           Advection in from atmosphere =     0.00000    g/sq.ft.
           Advection in from water table =    0.00000    g/sq.ft.
           Diffusion in from atmosphere =    -0.39227E-02g/sq.ft.
           Diffusion in from water table =    0.50099E-02g/sq.ft.
        Total inflow at boundaries =    0.10872E-02g/sq.ft.
        Mass discrepancy =    0.37253E-08g/sq.ft.

Since beginning of run at time = 0.0
        Change in Total Mass =    0.41318E-01g/sq.ft.
           Advection in from atmosphere =     0.00000    g/sq.ft.
           Advection in from water table =    0.00000    g/sq.ft.
           Diffusion in from atmosphere =    -0.11482    g/sq.ft.
           Diffusion in from water table =    0.15614    g/sq.ft.
        Total inflow at boundaries =    0.41318E-01g/sq.ft.
        Mass discrepancy =    0.16391E-06g/sq.ft.
```

**Benzene Input File** **vl12.inp**

```
VLEACH Model, Volatilization of benzene from gw, Sybase
  1
    0.1      30.      1.0      5.0
    81.     0.22    1800.     0.78
Default area of 1 ft^2, uncapped, no infiltration
     1.     0.1      0.0     1.68     .37     .18  0.00028
     0.       0.   0.0048
 30   1
  0  30    0.000
```

**Benzene Parameter Output File** **vl12.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of benzene from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =     81.000    ml/g,     0.28605E-02cu.ft./g
Kh =     0.22000     (dimensionless).
Aqueous solubility =     1800.0     mg/l,      50.971     g/cu.ft
Free air diffusion coefficient = .78000     sq. m/day,  3064.6     sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =      1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800     g/ml,       47573.     g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000     mg/l,      0.00000     g/cu.ft
Atmospheric concentration =     0.00000     mg/l,      0.00000     g/cu.ft
Water table has a fixed concentration of     0.48000E-02mg/l,     0.13592E-03g/cu.ft.
   with respect to gas diffusion.
```

**Benzene Output File**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of benzene from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase     =      0.00000    g/sq.ft.
Mass in liquid phase  =      0.00000    g/sq.ft.
Mass sorbed           =     0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.24086E-03g/sq.ft.
Mass in gas phase     =      0.38738E-04g/sq.ft.
Mass in liquid phase  =      0.16681E-03g/sq.ft.
Mass sorbed           =     0.35311E-04g/sq.ft.

Since last printout at time =     24.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.73536E-03g/sq.ft.
             Diffusion in from water table =   0.73536E-03g/sq.ft.
          Total inflow at boundaries =     0.11642E-09g/sq.ft.
          Mass discrepancy =   -0.11642E-09g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.24086E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.18301E-01g/sq.ft.
             Diffusion in from water table =   0.18542E-01g/sq.ft.
          Total inflow at boundaries =     0.24086E-03g/sq.ft.
          Mass discrepancy =   -0.29249E-08g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.24086E-03g/sq.ft.
Mass in gas phase     =      0.38738E-04g/sq.ft.
Mass in liquid phase  =      0.16681E-03g/sq.ft.
Mass sorbed           =     0.35311E-04g/sq.ft.

Since last printout at time =     25.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.73536E-03g/sq.ft.
             Diffusion in from water table =   0.73536E-03g/sq.ft.
          Total inflow at boundaries =     0.11642E-09g/sq.ft.
          Mass discrepancy =   -0.11642E-09g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.24086E-03g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.19036E-01g/sq.ft.
             Diffusion in from water table =    0.19277E-01g/sq.ft.
          Total inflow at boundaries =    0.24086E-03g/sq.ft.
          Mass discrepancy =    -0.29249E-08g/sq.ft.


Polygon    1
At time =      27.00, total mass in vadose zone =    0.24086E-03g/sq.ft.
Mass in gas phase     =      0.38738E-04g/sq.ft.
Mass in liquid phase  =      0.16681E-03g/sq.ft.
Mass sorbed           =      0.35311E-04g/sq.ft.

Since last printout at time =      26.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.73536E-03g/sq.ft.
             Diffusion in from water table =    0.73536E-03g/sq.ft.
          Total inflow at boundaries =    0.11642E-09g/sq.ft.
          Mass discrepancy =    -0.11642E-09g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.24086E-03g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.19772E-01g/sq.ft.
             Diffusion in from water table =    0.20013E-01g/sq.ft.
          Total inflow at boundaries =    0.24086E-03g/sq.ft.
          Mass discrepancy =    -0.29249E-08g/sq.ft.


Polygon    1
At time =      28.00, total mass in vadose zone =    0.24086E-03g/sq.ft.
Mass in gas phase     =      0.38738E-04g/sq.ft.
Mass in liquid phase  =      0.16681E-03g/sq.ft.
Mass sorbed           =      0.35311E-04g/sq.ft.

Since last printout at time =      27.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.73536E-03g/sq.ft.
             Diffusion in from water table =    0.73536E-03g/sq.ft.
          Total inflow at boundaries =    0.11642E-09g/sq.ft.
          Mass discrepancy =    -0.11642E-09g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.24086E-03g/sq.ft.
             Advection in from atmosphere =    0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
```

```
          Diffusion in from atmosphere =    -0.20507E-01g/sq.ft.
          Diffusion in from water table =   0.20748E-01g/sq.ft.
       Total inflow at boundaries =   0.24086E-03g/sq.ft.
       Mass discrepancy =   -0.29249E-08g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =   0.24086E-03g/sq.ft.
Mass in gas phase     =    0.38738E-04g/sq.ft.
Mass in liquid phase  =    0.16681E-03g/sq.ft.
Mass sorbed           =    0.35311E-04g/sq.ft.

Since last printout at time =      28.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.73536E-03g/sq.ft.
          Diffusion in from water table =   0.73536E-03g/sq.ft.
       Total inflow at boundaries =   0.11642E-09g/sq.ft.
       Mass discrepancy =   -0.11642E-09g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.24086E-03g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.21242E-01g/sq.ft.
          Diffusion in from water table =   0.21483E-01g/sq.ft.
       Total inflow at boundaries =   0.24086E-03g/sq.ft.
       Mass discrepancy =   -0.29249E-08g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =   0.24086E-03g/sq.ft.
Mass in gas phase     =    0.38738E-04g/sq.ft.
Mass in liquid phase  =    0.16681E-03g/sq.ft.
Mass sorbed           =    0.35311E-04g/sq.ft.

Since last printout at time =      29.00
       Change in Total Mass =    0.00000    g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.73536E-03g/sq.ft.
          Diffusion in from water table =   0.73536E-03g/sq.ft.
       Total inflow at boundaries =   0.11642E-09g/sq.ft.
       Mass discrepancy =   -0.11642E-09g/sq.ft.

Since beginning of run at time = 0.0
       Change in Total Mass =    0.24086E-03g/sq.ft.
          Advection in from atmosphere =     0.00000    g/sq.ft.
          Advection in from water table =    0.00000    g/sq.ft.
          Diffusion in from atmosphere =    -0.21978E-01g/sq.ft.
          Diffusion in from water table =   0.22219E-01g/sq.ft.
       Total inflow at boundaries =   0.24086E-03g/sq.ft.
       Mass discrepancy =   -0.29249E-08g/sq.ft.
```

**Ethylbenzene Input File** **vl13.inp**

```
VLEACH Model, Volatilization of ethylbenzene from gw, Sybase
  1
    0.1     30.     1.0     5.0
   180.    0.29    170.    0.60
Default area of 1 ft^2, uncapped, no infiltration
     1.     0.1     0.0    1.68    .37    .18  0.00028
     0.      0.   0.021
  30   1
   0  30    0.000
```

**Ethylbenzene Parameter Output File** **vl13.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of ethylbenzene from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =      180.00    ml/g,      0.63566E-02cu.ft./g
Kh =     0.29000     (dimensionless).
Aqueous solubility =     170.00     mg/l,      4.8139     g/cu.ft
Free air diffusion coefficient = .60000     sq. m/day,  2357.4     sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =      1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800    g/ml,       47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =      0.00000    mg/l,      0.00000    g/cu.ft
Atmospheric concentration =     0.00000    mg/l,      0.00000    g/cu.ft
Water table has a fixed concentration of     0.21000E-01mg/l,      0.59466E-03g/cu.ft.
   with respect to gas diffusion.
```

## Ethylbenzene Output File

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of ethylbenzene from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =    0.00000    g/sq.ft.
Mass in gas phase     =      0.00000    g/sq.ft.
Mass in liquid phase  =      0.00000    g/sq.ft.
Mass sorbed           =    0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =    0.98356E-03g/sq.ft.
Mass in gas phase     =      0.16948E-03g/sq.ft.
Mass in liquid phase  =      0.55365E-03g/sq.ft.
Mass sorbed           =    0.26043E-03g/sq.ft.

Since last printout at time =     24.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.24748E-02g/sq.ft.
             Diffusion in from water table =    0.24748E-02g/sq.ft.
          Total inflow at boundaries =    0.12806E-07g/sq.ft.
          Mass discrepancy =   -0.12806E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.98356E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.61530E-01g/sq.ft.
             Diffusion in from water table =    0.62515E-01g/sq.ft.
          Total inflow at boundaries =    0.98412E-03g/sq.ft.
          Mass discrepancy =   -0.56718E-06g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =    0.98356E-03g/sq.ft.
Mass in gas phase     =      0.16948E-03g/sq.ft.
Mass in liquid phase  =      0.55365E-03g/sq.ft.
Mass sorbed           =    0.26043E-03g/sq.ft.

Since last printout at time =     25.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.24748E-02g/sq.ft.
             Diffusion in from water table =    0.24748E-02g/sq.ft.
          Total inflow at boundaries =    0.12806E-07g/sq.ft.
          Mass discrepancy =   -0.12806E-07g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.98356E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.64005E-01g/sq.ft.
             Diffusion in from water table =    0.64989E-01g/sq.ft.
          Total inflow at boundaries =    0.98414E-03g/sq.ft.
          Mass discrepancy =   -0.58208E-06g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =   0.98356E-03g/sq.ft.
Mass in gas phase     =     0.16948E-03g/sq.ft.
Mass in liquid phase  =     0.55365E-03g/sq.ft.
Mass sorbed           =     0.26043E-03g/sq.ft.

Since last printout at time =      26.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.24748E-02g/sq.ft.
             Diffusion in from water table =    0.24748E-02g/sq.ft.
          Total inflow at boundaries =    0.12806E-07g/sq.ft.
          Mass discrepancy =   -0.12806E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.98356E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.66480E-01g/sq.ft.
             Diffusion in from water table =    0.67464E-01g/sq.ft.
          Total inflow at boundaries =    0.98414E-03g/sq.ft.
          Mass discrepancy =   -0.58208E-06g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =   0.98356E-03g/sq.ft.
Mass in gas phase     =     0.16948E-03g/sq.ft.
Mass in liquid phase  =     0.55365E-03g/sq.ft.
Mass sorbed           =     0.26043E-03g/sq.ft.

Since last printout at time =      27.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.24748E-02g/sq.ft.
             Diffusion in from water table =    0.24748E-02g/sq.ft.
          Total inflow at boundaries =    0.12806E-07g/sq.ft.
          Mass discrepancy =   -0.12806E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.98356E-03g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
```

```
              Diffusion in from atmosphere =    -0.68955E-01g/sq.ft.
              Diffusion in from water table =   0.69939E-01g/sq.ft.
          Total inflow at boundaries =    0.98414E-03g/sq.ft.
          Mass discrepancy =   -0.58208E-06g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =   0.98356E-03g/sq.ft.
Mass in gas phase    =     0.16948E-03g/sq.ft.
Mass in liquid phase  =    0.55365E-03g/sq.ft.
Mass sorbed         =    0.26043E-03g/sq.ft.

Since last printout at time =     28.00
          Change in Total Mass =    0.00000    g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.24748E-02g/sq.ft.
              Diffusion in from water table =   0.24748E-02g/sq.ft.
          Total inflow at boundaries =    0.12806E-07g/sq.ft.
          Mass discrepancy =   -0.12806E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.98356E-03g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.71430E-01g/sq.ft.
              Diffusion in from water table =   0.72414E-01g/sq.ft.
          Total inflow at boundaries =    0.98414E-03g/sq.ft.
          Mass discrepancy =   -0.58208E-06g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =   0.98356E-03g/sq.ft.
Mass in gas phase    =     0.16948E-03g/sq.ft.
Mass in liquid phase  =    0.55365E-03g/sq.ft.
Mass sorbed         =    0.26043E-03g/sq.ft.

Since last printout at time =     29.00
          Change in Total Mass =    0.00000    g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.24748E-02g/sq.ft.
              Diffusion in from water table =   0.24748E-02g/sq.ft.
          Total inflow at boundaries =    0.12806E-07g/sq.ft.
          Mass discrepancy =   -0.12806E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.98356E-03g/sq.ft.
              Advection in from atmosphere =     0.00000    g/sq.ft.
              Advection in from water table =    0.00000    g/sq.ft.
              Diffusion in from atmosphere =    -0.73904E-01g/sq.ft.
              Diffusion in from water table =   0.74889E-01g/sq.ft.
          Total inflow at boundaries =    0.98414E-03g/sq.ft.
          Mass discrepancy =   -0.58208E-06g/sq.ft.
```

**Xylenes Input File** **vl14.inp**

```
VLEACH Model, Volatilization of xylenes from gw, Sybase
  1
    0.1     30.     1.0     5.0
   640.    0.25    180.    0.64
Default area of 1 ft^2, uncapped, no infiltration
      1.     0.1     0.0     1.68     .37     .18  0.00028
      0.      0.   0.044
  30   1
  0   30    0.000
```

## Xylenes Parameter Output File

**vl14.prm**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of xylenes from gw, Sybase
  1 polygons.
Timestep =   0.10 years.  Simulation length =   30.00 years.
Printout every   1.00 years.  Vertical profile stored every   5.00 years.
Koc =     640.00    ml/g,     0.22601E-01cu.ft./g
Kh =    0.25000     (dimensionless).
Aqueous solubility =     180.00     mg/l,      5.0971     g/cu.ft
Free air diffusion coefficient = .64000     sq. m/day,  2514.6     sq.ft./yr


Polygon   1
Default area of 1 ft^2, uncapped, no infiltration
Polygon area =      1.0000     sq. ft.
 30 cells, each cell  0.100 ft. thick.
Soil Properties:
 Bulk density =     1.6800     g/ml,       47573.    g/cu.ft.
 Porosity = 0.3700 Volumetric water content = 0.1800
 Organic carbon content = 0.00028000
Recharge Rate = 0.00000000 ft/yr
Conc. in recharge water =     0.00000    mg/l,      0.00000    g/cu.ft
Atmospheric concentration =     0.00000    mg/l,      0.00000    g/cu.ft
Water table has a fixed concentration of     0.44000E-01mg/l,      0.12459E-02g/cu.ft.
   with respect to gas diffusion.
```

**Xylenes Output File**

```
 V-Leach, VER 1.1
 Jake Turin, 11/91
VLEACH Model, Volatilization of xylenes from gw, Sybase


Polygon   1
At time =      0.00, total mass in vadose zone =   0.00000    g/sq.ft.
Mass in gas phase    =      0.00000    g/sq.ft.
Mass in liquid phase  =     0.00000    g/sq.ft.
Mass sorbed          =     0.00000    g/sq.ft.


Polygon   1
At time =     25.00, total mass in vadose zone =   0.39513E-02g/sq.ft.
Mass in gas phase    =      0.35510E-03g/sq.ft.
Mass in liquid phase  =     0.13456E-02g/sq.ft.
Mass sorbed          =     0.22506E-02g/sq.ft.

Since last printout at time =      24.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.55309E-02g/sq.ft.
             Diffusion in from water table =    0.55309E-02g/sq.ft.
          Total inflow at boundaries =    -0.32596E-07g/sq.ft.
          Mass discrepancy =     0.32596E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =     0.39513E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.13691    g/sq.ft.
             Diffusion in from water table =    0.14086    g/sq.ft.
          Total inflow at boundaries =     0.39504E-02g/sq.ft.
          Mass discrepancy =     0.88895E-06g/sq.ft.


Polygon   1
At time =     26.00, total mass in vadose zone =   0.39513E-02g/sq.ft.
Mass in gas phase    =      0.35510E-03g/sq.ft.
Mass in liquid phase  =     0.13456E-02g/sq.ft.
Mass sorbed          =     0.22506E-02g/sq.ft.

Since last printout at time =      25.00
          Change in Total Mass =     0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.55309E-02g/sq.ft.
             Diffusion in from water table =    0.55309E-02g/sq.ft.
          Total inflow at boundaries =    -0.32596E-07g/sq.ft.
          Mass discrepancy =     0.32596E-07g/sq.ft.
```

```
Since beginning of run at time = 0.0
          Change in Total Mass =    0.39513E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.14244    g/sq.ft.
             Diffusion in from water table =    0.14639    g/sq.ft.
          Total inflow at boundaries =    0.39504E-02g/sq.ft.
          Mass discrepancy =    0.88895E-06g/sq.ft.


Polygon   1
At time =     27.00, total mass in vadose zone =   0.39513E-02g/sq.ft.
Mass in gas phase     =    0.35510E-03g/sq.ft.
Mass in liquid phase  =     0.13456E-02g/sq.ft.
Mass sorbed           =    0.22506E-02g/sq.ft.

Since last printout at time =     26.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.55309E-02g/sq.ft.
             Diffusion in from water table =    0.55309E-02g/sq.ft.
          Total inflow at boundaries =   -0.32596E-07g/sq.ft.
          Mass discrepancy =    0.32596E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.39513E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.14797    g/sq.ft.
             Diffusion in from water table =    0.15193    g/sq.ft.
          Total inflow at boundaries =    0.39504E-02g/sq.ft.
          Mass discrepancy =    0.88895E-06g/sq.ft.


Polygon   1
At time =     28.00, total mass in vadose zone =   0.39513E-02g/sq.ft.
Mass in gas phase     =    0.35510E-03g/sq.ft.
Mass in liquid phase  =     0.13456E-02g/sq.ft.
Mass sorbed           =    0.22506E-02g/sq.ft.

Since last printout at time =     27.00
          Change in Total Mass =    0.00000    g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
             Diffusion in from atmosphere =    -0.55309E-02g/sq.ft.
             Diffusion in from water table =    0.55309E-02g/sq.ft.
          Total inflow at boundaries =   -0.32596E-07g/sq.ft.
          Mass discrepancy =    0.32596E-07g/sq.ft.

Since beginning of run at time = 0.0
          Change in Total Mass =    0.39513E-02g/sq.ft.
             Advection in from atmosphere =     0.00000    g/sq.ft.
             Advection in from water table =    0.00000    g/sq.ft.
```

```
                Diffusion in from atmosphere =    -0.15351    g/sq.ft.
                Diffusion in from water table =    0.15746    g/sq.ft.
             Total inflow at boundaries =    0.39504E-02g/sq.ft.
             Mass discrepancy =    0.88895E-06g/sq.ft.


Polygon   1
At time =     29.00, total mass in vadose zone =   0.39513E-02g/sq.ft.
Mass in gas phase    =     0.35510E-03g/sq.ft.
Mass in liquid phase  =     0.13456E-02g/sq.ft.
Mass sorbed          =    0.22506E-02g/sq.ft.

Since last printout at time =     28.00
             Change in Total Mass =    0.00000    g/sq.ft.
                Advection in from atmosphere =     0.00000    g/sq.ft.
                Advection in from water table =    0.00000    g/sq.ft.
                Diffusion in from atmosphere =    -0.55309E-02g/sq.ft.
                Diffusion in from water table =    0.55309E-02g/sq.ft.
             Total inflow at boundaries =   -0.32596E-07g/sq.ft.
             Mass discrepancy =    0.32596E-07g/sq.ft.

Since beginning of run at time = 0.0
             Change in Total Mass =    0.39513E-02g/sq.ft.
                Advection in from atmosphere =     0.00000    g/sq.ft.
                Advection in from water table =    0.00000    g/sq.ft.
                Diffusion in from atmosphere =    -0.15904    g/sq.ft.
                Diffusion in from water table =    0.16299    g/sq.ft.
             Total inflow at boundaries =    0.39504E-02g/sq.ft.
             Mass discrepancy =    0.88895E-06g/sq.ft.


Polygon   1
At time =     30.00, total mass in vadose zone =   0.39513E-02g/sq.ft.
Mass in gas phase    =     0.35510E-03g/sq.ft.
Mass in liquid phase  =     0.13456E-02g/sq.ft.
Mass sorbed          =    0.22506E-02g/sq.ft.

Since last printout at time =     29.00
             Change in Total Mass =    0.00000    g/sq.ft.
                Advection in from atmosphere =     0.00000    g/sq.ft.
                Advection in from water table =    0.00000    g/sq.ft.
                Diffusion in from atmosphere =    -0.55309E-02g/sq.ft.
                Diffusion in from water table =    0.55309E-02g/sq.ft.
             Total inflow at boundaries =   -0.32596E-07g/sq.ft.
             Mass discrepancy =    0.32596E-07g/sq.ft.

Since beginning of run at time = 0.0
             Change in Total Mass =    0.39513E-02g/sq.ft.
                Advection in from atmosphere =     0.00000    g/sq.ft.
                Advection in from water table =    0.00000    g/sq.ft.
                Diffusion in from atmosphere =    -0.16457    g/sq.ft.
                Diffusion in from water table =    0.16852    g/sq.ft.
             Total inflow at boundaries =    0.39504E-02g/sq.ft.
             Mass discrepancy =    0.88895E-06g/sq.ft.
```

# APPENDIX D

## Restricted Migration of Hydrocarbons to the Deeper Aquifer

## Appendix D

## Restricted Migration of Hydrocarbons to the Deeper Aquifer

This appendix describes the hydrogeology of the Site and its vicinity, and its relationship to the site-specific factors restricting migration of hydrocarbons in the shallow aquifer zone to the deep aquifer zone. Information on the Site geology was obtained from soil borings installed by EKI (EKI, 1995a; 1995b) and from cone penetrometer testing ("CPT") and borings installed by Treadwell & Rollo, Inc. ("T&R", 4 May 1995).

Soil at the surface of the Site (i.e., 1 to 4 ft bgs) consists of various fill materials ranging from loose clayey sand to clay. Beneath the fill material is olive gray to black native clay (up to approximately 7 ft bgs). The native clay is believed to be an old marsh deposit. The native clay is underlain by interbedded alluvial and marine deposits that consist of clay and silt with varying sand content (T&R, 4 May 1995).

Two aquifer zones have been identified within the uppermost 50 feet of alluvial sediments at nearby properties (Levine-Fricke, 4 April 1990; Emcon Associates, October 1993; EKI, 10 January 1994). On the basis of available boring logs, the first of the two aquifer zones identified nearby extends from approximately 5 to 25 ft bgs, or 11 to -14 feet above mean sea level ("ft msl") at the Site.

Test holes recently installed by T&R indicate that free-flowing groundwater is present as shallow as 4.5 ft bgs on the south portion of the Site (EKI oral communication with T&R, September 1995). Groundwater in the first aquifer zone on the Site appears to be semi-confined.

The two aquifer zones are separated by a confining layer. Deep CPT and boring logs from the Site indicate that the confining layer is a 10 to 18 ft thick clay to silt and is present throughout the Site from approximately 30 to 48 ft bgs, or -20 to -37 ft msl (T&R, 4 May 1995). The deeper of the two aquifer zones appears to consist of sand with gravel extending from 42 to 53 ft bgs, or -27 to -38 ft msl at the Site.

Because groundwater elevation data are not available for the deep aquifer zone on the Site, reports from other properties in the vicinity of the Site were reviewed. The extent of hydraulic communication between the shallow and deep aquifer zones at the Site is not known. Groundwater elevation data from shallow and deep monitoring well pairs at two nearby properties indicate that vertical gradients vary and have been observed to be both upward and downward (Levine-Fricke, 4 April 1990; Emcon Associates, October 1993).

As noted above, the confining layer on the Site contains at least 10 feet of clay. The hydraulic conductivity of unweathered marine clay ranges from $5 \times 10^{-7}$ to $10^{-10}$ cm/sec (Freeze and Cherry, 1979). Because the clay was deposited in a marine environment, clay particles typically come to rest on their flat side. This layering effect results in significantly lower hydraulic conductivities in the vertical direction (Freeze and Cherry, 1979) that inhibits flow between the aquifers.

Significant migration of petroleum hydrocarbons from the shallow aquifer zone to the deeper aquifer zone is not expected for the following reasons:

(1) hydrocarbons have been present at the Site for at least 50 years and they have not migrated significantly off-site in the shallow aquifer zone (horizontally), and

(2) the hydrocarbons are of high molecular weight and adsorb strongly to natural organic matter, resulting in retardation that restrict their migration through the aquitard.

# APPENDIX E

## Groundwater Monitoring Well Installation and Sampling Procedures

# Appendix E

## Groundwater Monitoring Well Installation and Sampling Procedures

As part of the perimeter groundwater monitoring program, the general procedures for monitoring well installation, development, and sampling described below should be followed.

Necessary permits will be obtained before well construction commences. Well construction will be observed by a qualified person who is either:

- a professional geologist, engineering geologist, or civil engineer who is registered or certified by the State of California and who is trained and experienced in the use of the Unified Soil Classification System; or

- a geologist or engineer who is trained and experienced in the use of the Unified Soil Classification System and who is working under the supervision of one of the registered or certified professionals listed above.

### WELL CONSTRUCTION

### Hollow-Stem Auger Drilling

A drill rig with eight-inch outside diameter continuous-flight hollow-stem augers will be used for drilling the soil borings. Soil borings that are to be completed as monitoring wells will be drilled using augers at least 4 inches greater in diameter than the diameter of the well casing (i.e., 4 inches), so as to allow for a minimum of 2 inches of sand pack to surround the casing. Prior to and between each boring, the augers will be steam cleaned to minimize to potential of contamination.

Soil samples will be collected in the borings at predetermined depth intervals by driving a clean California split-spoon sampler into the undisturbed soil ahead of the augers. The split-spoon sampler will be fitted with precleaned brass or stainless steel tubes to retain samples. The sampler will be driven using a hammer having a weight of 140 lbs and a drop of 30 inches, or equivalent. Blow counts for each six inches that the sampler is driven will be noted on the boring log.

Upon completion of sampling activities, each boring will completed as a monitoring well. This procedure is discussed in following section.

## Well Installation

The borings will be converted to monitoring wells upon reaching the designated depth. Monitoring wells will be constructed by installing 4-inch diameter, pre-cleaned PVC well casing through the hollow-stem auger. The soil boring will be of a diameter at least 4 inches greater than that of the well casing, so as to allow for a minimum of 2 inches of sand pack to surround the casing.

The well casing will be composed of flush-joint, threaded, Schedule 40 PVC casing. No solvents or glues will be used in the construction of monitoring wells. The lower part of the well casing will consist of factory-slotted PVC or stainless steel well screen extending upward through the upper shallow water-bearing zone. The lower end of PVC well screens will be plugged with a threaded PVC end cap or a slip cap. Slip caps will be permanently attached to the PVC screen using a stainless steel screw or rivet. The lower end of stainless steel well screens will be factory sealed. The upper part of all wells will consist of blank PVC casing. To complete the well at grade, the well casing will extend to approximately four inches below grade. The top of the casing will be fitted with a watertight, locking well cap.

Well construction includes placing a continuous filter pack in the annular space between the well screen and the wall of the boring. The filter pack will consist of pre-washed, packaged sand. The sand is sized according to the slot size of the well screen and available information on grain size in the formation at nearby borings. The filter pack will extend from the bottom of the boring to not more than two feet above the top of the well screen. The sand will be placed slowly through the hollow-stem augers and the augers will periodically be raised to allow the sand to fill the annulus between the well screen and the wall of the boring. The level of the sand will be monitored using a weighted tape.

Above the filter pack, a 1- to 2-foot-thick layer of bentonite pellets or chips will be placed to prevent downward migration of the grout seal into the filter pack. The bentonite pellets or chips will be placed through the augers in the same manner as the sand. Cement-and-bentonite grout, placed using a hose or tremie pipe, will extend continuously from the top of the bentonite layer to approximately six inches below grade. The grout will be composed of neat cement containing up to 5 percent bentonite powder to control shrinkage. The grout seal will be at least 5 feet thick, unless prior approval is obtained from the local well permitting agency.

Monitoring wells will be completed at the surface. Surface completion will be accomplished using a traffic-rated steel and/or concrete utility box set in concrete so that it is slightly above grade.

The identification number of each well will be permanently marked on the well casing and/or the well enclosure.

## WELL DEVELOPMENT

Prior to development of any well, all tools and equipment that are to be used in the well will be thoroughly decontaminated. Decontamination may be accomplished by either (1) steam cleaning or (2) washing in a solution of Liquinox® or equivalent non-phosphate detergent, followed by rinsing with clean water, then rinsing with distilled water.

Following the completion a monitoring well, the grout and concrete will be allowed to cured for at least 24 hours. The well will be developed to remove fine-grained materials inside the filter pack and casing, to stabilize the filter pack around the well screen and to help produce more representative samples form the water-bearing zone. The well will be developed by bailing, pumping, surging, swabbing, or a combination of methods until (a) the extracted water flows clear, and pH, temperature, and conductivity of the extracted groundwater stabilize, or (b) 5 casing volumes are removed. Surging can be performed by a Smeal rig or by hand.

For surging using a Smeal rig, the Smeal rig will be fitted with a surge block that is designed to snugly fit the inside diameter of the well casing. The rig operator will proceed to surge the well with shallow, smooth strokes forcing the water back and forth through the sand pack and screen. The surge block will then be removed, and the well will be pumped to remove the sediment. The operator will then alternately surge and pump the well until a minimum of 5 casing volumes have been removed or field parameters stabilize.

Development by hand is accomplished by using a hand held surge block and a hand bailer or pump. The well is developed when parameters stabilize or 5 casing volumes have been removed.

Well development water will be temporarily contained in steel drums pending receipt of results of analyses of groundwater from the respective well(s). The development will then be disposed of properly.

## WELL SAMPLING

Monitoring wells will be sampled in a sequence beginning with the well that has the lower anticipated hydrocarbon concentration and proceeding to the well exhibiting higher hydrocarbon concentrations, based on the most recent chemical analyses of water samples from the wells.

Prior to sampling any well, all tools and equipment that are to be used in the well will be thoroughly decontaminated. Decontamination may be accomplished by either (1) steam cleaning or (2) washing in a solution of Liquinox® or equivalent non-phosphate detergent, followed by rinsing with clean water, then rinsing with distilled water.

At each well to be sampled, the depth to water and the depth to the bottom of the well will be measured and recorded. This information will be used to calculate the volume of water in the well casing. Each well will also be checked for the presence of floating product on the water surface in the well.

Prior to sampling, a pump, a Teflon® bailer, and/or a disposable bailer will be used to purge each well. A different disposable bailer will be used for each well that is purged with a disposable bailer. Each well will be purged by removing a minimum of 3 well casing volumes of water from the well. If a well dewaters during purging, it will be allowed to recharge to at least 75 percent of original volume before sampling. If a well contain less than one foot of water, a grab water sample will be collected instead. During purging, each well will be monitored for temperature, conductivity, and pH. Purging will be considered complete when these parameters stabilize or a minimum of 3 casing volumes of water have been removed. The water level will be measured again immediately upon completion of purging.

Following purging, each well will be sampled with a Teflon® or disposable bailer. The sample will be collected from the midpoint of the water column. Upon retrieval of the bailer, the water samples will be transferred to the appropriate laboratory-supplied bottles.

For well SMW-4, which may contain free-phase hydrocarbons, groundwater samples will be collected through a chemically-inert stilling tube, as described by EPA (EPA, 1992) and summarized below. The end of the stilling tube will be covered with a membrane or other material that will be ruptured by the pump. The stilling tube will be inserted into the well to a depth that is significantly below the upper portion of the screened interval where free-phase hydrocarbons may be entering the well. Groundwater samples will be collected by inserting a pump through the stilling tube. Water samples will be transferred to the appropriate laboratory-supplied bottles.

A sample label will be attached to each sample container. The label will include a unique sample identification number, the well number, the time, and the date when the sample was collected. The sealed containers will be placed in zip-closure plastic bags, then placed on ice in a cooler for temporary storage and transport to the laboratory for chemical analysis. Chain-of-custody records will be initiated.

Well development water will be temporarily contained in steel drums pending receipt of results of analyses of groundwater from the respective well(s). The development water will then be disposed of properly.