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RISK EVALUATION AND CLOSURE REPORT

625 Hegenberger Road
Oakland, California

AEI Project No. 6274

Prepared For

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1.0 INTRODUCTION

AEI Consultants (AEI) has prepared this Site Closure Report on behalf of the Diversified Investments & Management Corporation (Diversified), owners of the property located at 625 Hegenberger Road in the City of Oakland, California (refer to Figures 1 and 3). AEI has been retained by Diversified to provide environmental engineering and consulting services related to the release of fuel hydrocarbons from the former underground storage tank (UST) system at the property. The Alameda County Health Care Services Agency (ACHCSA) is the lead local oversight agency for this site, working under cooperative agreement with the San Francisco Bay Regional Water Quality Control Board (RWQCB), and providing regulatory guidance during the mitigation of the release.

As requested by ACHCSA, this report presents and evaluation of the risk to human health and the environment posed by the release of petroleum hydrocarbons from the site. The evaluation was performed in accordance with the guidance provided by the City of Oakland Public Works Agency, *Oakland Urban Land Redevelopment Program: Guidance Document* (January 2000) and the RWQCB's *Application of Risk Based Screening Levels and Decision Making to Sites with Impacted Soil and Groundwater* (December 2001). A summary of historical site conditions, investigative efforts, and treatment activities is presented.

The evaluations discussed herein conclude that although localized dissolved phase hydrocarbons remain, the case should be eligible for "no further action" status. The following conditions support this recommendation:

- Soil treatment activities successfully removed nearly all hydrocarbon mass from unsaturated zone soils.
- Hydrocarbon mass in the shallow aquifer began to decrease upon completion of soil treatment and continued to decrease as the groundwater treatment program was implemented the former source area. Groundwater monitoring data has proven that the remaining dissolved phase hydrocarbons are localized to the former source area. Modeling confirms that the MTBE plume should not spread past its current extent, and should begin to recede. The vertical extent of the release was confirmed to be limited and a regional aquitard was identified that would limit the potential for impact to deeper aquifers of the area.
- The comparative human health risk evaluation indicates the low concentrations of hydrocarbons remaining in the shallow soil and groundwater does not pose a significant risk to human health or the environmental.
- No existing production wells or surface water were identified that could be impacted by this release.

2.0 SITE DESCRIPTION & BACKGROUND

The site is located on the northwestern corner of Collins Drive and Hegenberger Road in an area of the City of Oakland zoned for commercial and light industrial use. The property is bound on the north by a commercial warehouse and on the west by the Oakland-Alameda County Coliseum Complex. The site is currently vacant and unimproved.

Prior to 1993

The property was reportedly developed as a gasoline service station in the mid 1960s, which was subsequently abandoned in the mid 1970s. Subsurface Consultants performed two phases of site investigation in 1988 and 1990, during which a total of 23 soil borings (labeled 1 through 23) were advanced, five of which were converted to groundwater monitoring wells (labeled MW-8, MW-10, MW-11, MW-12, and MW-16. The borings were located around the former tank hold and dispenser island. The highest concentrations of petroleum hydrocarbons were detected adjacent to and east of the former tank (areas that were subsequently excavated).

Tank Removal - October 1993

In October 1993, three underground gasoline storage tanks (12,000 gallons each), one 260 gallon waste oil tank (also identified as a "sump"), and related underground piping were removed from the site under the observation of Levine Fricke. Approximately 250 cubic yards (cy) of soil was excavated during the tank removal, which was stockpiled onsite. During the tank removal activities, tank and piping failures were evident upon inspection. Seventeen (17) soil samples and two groundwater samples collected by Levine Fricke during the tank removal activities confirmed that impacted soils and groundwater was present at the site. Please refer to the *Tank Closure Report on Removal of Underground Fuel Storage Tanks and Related Structures*, January 24, 1994 by Levine Fricke for details on the tank removal and previous sampling activities. The location of the former tanks and dispensers are presented on Figure 3.

Site Investigation – January 1995

In January 1995, Levine Fricke advanced an additional thirteen (13) soil borings (labeled LF24 though LF36), one of which was converted to a monitoring well (MW-24). Again, soil sample analytical data revealed that impacted soils were located around the former tank hold. Groundwater monitoring of the resulting network of six monitoring wells, which occurred on January 10, 1995, confirmed that a dissolved phase hydrocarbon plume was present, primarily in the area of MW-8. Refer to the *Report on a Supplemental Site Investigation and a Conceptual Remediation Plan 625 Hegenberger Road Oakland, California*, April 5, 1995 by Levine Fricke for details of the investigation.

The quarterly monitoring of the six monitoring wells was performed by Levine Fricke through January 1995. AEI began monitoring the wells in October 1995. In March 1996, AEI destroyed one of the wells (designated MW-24) in anticipation of excavation activities.

Soil Treatment – April to August 1996

Beginning in April 1996, AEI excavated a total of 1,600 cubic yards of impacted soils from around

the former tank hold and dispenser locations. The final extent of the excavation is shown on Figure 3. Soil samples were collected from the sidewalls of the excavation at several stages during the excavation work. The analytical data of samples from the farthest extent of the excavation are presented in Table 1. With the exception of approximately 20 cy of soil impacted with oil range hydrocarbons which was transported to a disposal facility, the excavated soil was aerated onsite. The soil was aerated in two batches, measuring approximately 150' by 180' and 12 inches deep. Baseline samples were collected from the stockpiles. Bi-weekly tilling was performed between April 12, 1996 and June 19, 1996 for the first aeration batch and between July 17, 1996 and September 5, 1996 for the second.

Following aeration, 22 samples collected from the treated soil (refer to Table 2). Petroleum hydrocarbons were detected at very low concentration in only two of the 22 samples (benzene at 0.007 mg/kg, toluene at 0.011 mg/kg, and xylenes at 0.010 mg/kg), and based in these results, Mr. Barney Chan of the ACHCSA authorized the reuse of the treated soil to backfill the excavation.

The excavation was backfilled with pea gravel, to bridge the capillary fringe, to approximately ½ foot above static groundwater. The remainder of the excavation was filled with the treated soil. Refer to the *Phase II Environmental Site Assessment* report, March 3, 1997 prepared by AEI for detailed methods and results of the soil treatment activities.

August 1997 – June 2000

In August 1997, AEI submitted a Remedial Action Plan (RAP) the ACHCSA, which described a plan to enhance in-situ biodegradation to reduce dissolved phase hydrocarbon concentrations within the area of the former excavation. On October 1, 1999, AEI installed one (1) 4" diameter well (EW-01) just west of the former tank hold. The well was placed in the center of the plume and screened from 5 to 22.5 feet bgs, for use as an extraction well for batch groundwater treatment.

Two additional groundwater monitoring wells (MW-26 and MW-27) were installed on the western end of the site (Figure 3) in June 2000. The wells were constructed of 2" diameter well casing, screened from 5 to 15 feet bgs. Also in June 2000, one soil boring (AEI-B28) was advanced (Figure 3). The boring was placed in the apparent center of the dissolved hydrocarbon plume. The boring was advanced to 44.5 feet bgs to determine the vertical extent of the plume. Three groundwater samples were analyzed, the results of which revealed significant attenuation with depth of the hydrocarbon plume (Table 6). Refer to the *Soil Boring and Groundwater Monitoring Well Installation and Sampling Report*, dated September 10, 2000 for detailed results of these activities.

Groundwater Treatment – June 2001 to February 2002

A groundwater treatment program was initiated in June 2001, and was based on the August 1997 RAP, with several modifications. The system was designed to supplement natural bacterial colonies present in the shallow water table aquifer with bacterial colonies cultured to metabolize aromatic hydrocarbons. The system consisted of an extraction well (EW-01), batch treatment tank, batch injection network of 12 batch injection points, and air sparging system consisting of a compressor and 12 sparge points. The goal of the treatment program was to reduce dissolved

hydrocarbon concentrations, specifically TPH-g and BTEX, within the source area. Of particular importance when designing the system was the presence of the pea gravel backfill material placed within the bottom of the former excavation in the source area. This material has a higher porosity and hydraulic conductivity than the native soils, therefore allowing for distribution of the oxygenated water and injected waters.

The system operated from June 2001 through February 2002, during which time 27 batches were treated, totaling approximately 13,000 gallons. The treated water was then re-injected, to "spike" the groundwater system with oxygenated water and active culture. System operation statistics are presented in Table 7 and a site plan with system components is presented on Figure 9. Refer to the *Groundwater Treatment and Site Closure Summary Report*, May 3, 2002 and the *Monitoring and Treatment Report*, dated November 21, 2002, for details on system operation.

Supplemental Treatment (MW-8) – July to September 2002

Due to the remnant hydrocarbons present in this well after treatment had ceased (TPH-g at 32,000 µg/l and benzene at 2,000 µg/l), localized treatment of this well was requested by ACHCSA. On July 29, 2002, MW-8 was purged of approximately 5 gallons and a water sample was collected. Following sample collection, a total of nine (9) socks of Regensis, Inc. Oxygen Release Compound (ORC) were suspended in the well, which were placed to cover the water column exposed by the well. The socks were allowed to remain in the well until September 11, 2002, when the next monitoring event of the entire well network occurred.

Throughout the history of the site, groundwater monitoring and sampling activities have been performed. Historical water table elevation data, groundwater quality data, and sample analytical data are summarized in Tables 3 through 5. Water table contours and dissolved phase hydrocarbon concentrations from the September 11, 2002 event are presented on Figures 4 and 5. Iso-concentration contours for TPH-g, benzene, and MTBE are presented on Figures 6 through 8. Dissolved phase hydrocarbon trends are presented for selected wells MW-8, MW-11 and EW-01 on Figures 10 through 12.

3.0 ENVIRONMENTAL SETTING

3.1 Geology and Hydrology

According to logs of borings advanced by AEI, the near surface sediments beneath the site generally consist of clay soils with silt and fine sand to approximately 10 feet bgs. First encountered groundwater exists beneath the site between 5 and 6.5 feet bgs. The water bearing deposits in this shallow saturated zone consists of clay with fine to medium sand with angular clasts up to 2 cm in size. Sand increases with depth to approximately 16 feet bgs.

The deeper soil boring (AEI-B28) revealed silty clay below 16 feet. Sands and sub-angular to angular gravel increase with depth to approximately 37 feet bgs below which stiff, tight clay was encountered. Refusal conditions were encountered at 44.5 feet bgs. The presence of a clay aquitard in this depth range was confirmed during a review of logs for deep borings performed at the Oakland Coliseum Complex. A geologic cross-section of the site based in borings advanced by AEI is presented on Figure 13.

Water level measurements have been collected from the eight existing wells in order to estimate the groundwater flow direction. Water table contours for the most recent event (September 2002) are presented on Figure 4, along with a rose diagram of historic groundwater flow direction. Although water table contours reveal a complicated water table; a westerly or northwesterly flow direction is observed. Over the course of assessment at this site, groundwater has consistently flowed to the west, with a hydraulic gradient generally of 10^{-3} ft/ft. Water table elevations are summarized in Table 3.

3.2 Exposure Pathways

An exposure pathway analysis has been performed to identify which specific exposure pathways are complete for exposure of human or environmental receptors. Each pathway is discussed in detail in following sections.

Exhibit 1: Exposure Pathway Summary

Medium	Exposure Pathway	Complete at this site (yes / no)	Rationale
Surface Soil	Ingestion, dermal contact, & vapor inhalation	Yes	
Subsurface Soil*	Vapor inhalation – indoor	Yes	Assuming slab-on-grade commercial development
	Vapor inhalation – outdoor	Yes	
	Drinking water impacted by leachate	No	No drinking water wells, resources in area (Sec. 3.2.1)
Groundwater	Vapor inhalation – indoor	Yes	
	Vapor inhalation – outdoor	Yes	
	Ingestion of groundwater	No	No water wells in area and no threat to deeper aquifers (Sec 3.2.1).
Surface Water	Ingestion and dermal contact, ecological concerns	No	No surface waters within 2,600 feet of site (Sec. 3.2.1)

* Subsurface soil: defined as soils greater than 3 feet deep by Oakland (Jan. 2000) and 10 feet deep by RWQCB (Dec. 2001).

3.2.1 Groundwater Exposure Pathways

The site is located approximately 3 miles east of the San Francisco Bay, however several sloughs or channels exist throughout the area, the nearest of which is the a tidal area of the Airport Channel, located approximately 1,600 feet to west of the site. No reservoirs or any other surface water bodies were identified closer to the site. Due to the distance from the property and the fact that western extent of the hydrocarbon plume is confined to beneath the property, these surface waters will not be considered threatened by the release. In addition, no preferential pathways are known to exist within or directly around the former source area that could lead to preferential contaminant migration.

According the San Francisco Bay RWQCB *Water Quality Control Plan – San Francisco Bay Basin* (Basin Plan), the site is located in the Lake Merritt sub-basin of the South Bay Basin. Table 2.4 of the Basin Plan (p. 2-17) indicates that the only beneficial uses of water within the sub-basin are surface water recreation and waters (assumed to be surface waters) for spawning and general wildlife. No beneficial use of groundwater is noted in the plan for this sub-basin. Although no current beneficial use was noted, based on the well survey discussed below, historical groundwater pumping from the area is known. However, all production wells identified in the area are screened 100 to 300 feet below the shallow water table aquifer and below the clay aquitard that exists in the area. Groundwater quality beneath the site has generally been low, with high dissolved solids, as indicated by

specific conductivity measurements of greater than 2,000 µS/cm during many of the monitoring events, precluding these waters from use for municipal purposes.

A survey of deep wells within ½ mile radius of the site was performed at the Department of Water Resources (DWR) in Sacramento. Additionally, information was provided to AEI by ACHCSA regarding several reportedly abandon well field in the site area. Please refer to the following table for information on the wells identified and to Figure 2 for their locations.

Exhibit 2: Offsite Wells

Location	*Distance (feet)*	*Direction*	*Depth (feet)*	*Screen Interval*	*Use*
1) Fitchburg well group (20 wells?)	~ 2,500	Northwest	NA	NA	Municipal
2) Damon well group	~ 4,500	North	NA	NA	Municipal
3) Oakland Coliseum (11 wells)	1,000 – 2,500	Northwest	70 – 112	78 – 98	Observation
4) 7825 San Leandro Street (1 well)	1,250	Northeast	510	324 – 479	Industrial
5) 550 85th Avenue (2 wells?)	1,850	Southeast	448	130 – 240	Industrial

NA – Information not available

Although the screened interval of the Fitchburg and Damon well groups were not available, the other well logs indicate that the wells at the Coliseum site are screened in the 70 to 100 foot bgs range. The other two wells are screened below 100 feet deep. Although these various wells may pose as a conduit to deeper water bearing zones for near surface impacted groundwater vertical migration, these wells are all outside of the limit of impacted groundwater associated with this site. The exact locations of the abandoned former municipal well fields have not been determined; however, the dissolved hydrocarbon plume associated with this site is confined to beneath the property is each direction toward the suspected well fields. Unless further information becomes available regarding currently unknown deep wells, AEI does not consider any of the wells identified to date as threatened by this site.

3.2.2 Soil & Soil Vapor Exposure Pathways

Three forms of exposure pathways warrant consideration: 1) direct contact with impacted surface soil, including dermal contact and ingestion, 2) volatilization of organic compounds to both indoor breathing space and outdoor ambient air, and 3) leaching of contaminants from soils to groundwater. At this site, each on of these potential exposure pathways could be considered complete. Although the property us currently undeveloped, future commercial development will be assumed.

4.0 CONTAMINANT FATE AND TRANSPORT ANALYSIS

Contaminant fate and transport modeling was performed utilizing the Domenico analytical model (Tong, et al, 1999). Modeling for predicted MTBE plume extent was performed because MTBE is the only contaminant detected outside of the source area and, therefore, the only contaminant that could migrate from the site.

The model is an analytical solution to the advection-dispersion partial-differential equation of organic contaminant transport processes in groundwater. The model contains one dimensional groundwater velocity, three-dimensional dispersion (longitudinal, transverse, and vertical), first order degradation rate constant, finite contaminant source dimensions. The result is a predicted contaminant concentration along the centerline of the plume, and therefore estimate plume length.

The use of the model requires contaminant spatial concentrations data at a minimum of one source well and one to two down gradient wells. The data must also show a reasonable plume pattern (contaminant concentration is highest in the source well, decreasing down gradient). After input of well locations and concentrations, the model is calibrated by adjusting three model input parameters to fit the observed groundwater concentration pattern. After calibration, the model is used to predict the horizontal plume length. General model assumptions are as follows:

- The source area is finite
- The source is present at a steady state concentration
- The aquifer is homogeneous
- Groundwater flows in one dimension
- Degradation is determined by a first order decay constant
- The contaminant concentration predictions are along the centerline of bilaterally symmetrical plume
- Chemical transport occurs only as a result of advection
- Molecular diffusion is neglected
- Sorption (retardation) is neglected

The model has been run utilizing MTBE concentrations detected at the site in September 2002. The retardation factor for MTBE is approximately 2, therefore the model is adequately conservative for this use.

Well EW-01 was selected as the source area well, which had MTBE detected at 470 µg/l. Wells MW-16 (250 µg/l MTBE) and MW-27 (0.52 µg/l MTBE) were selected as wells along the plume centerline. This is appropriate based on the fairly consistent westerly groundwater flow direction (rose diagram, Figure 4).

The input and results of the model for the site conditions are presented in Appendix B (Run #1). As can be seen for the logarithmic plot of normalized concentrations vs. distance, the low source area concentration of 470 µg/l does not support the plume configuration present at the site. With these inputs, iterations of the variables for decay, dispersivity, groundwater velocity were varied in an attempt to get a line fit. When a much higher source area concentration (3,000 µg/l MTBE) is

input (Run #2), the other input variables can be iterated to find a plot that strongly agrees with the observed contaminant distribution. This finding supports the argument that the plume MTBE plume will begin to recede, as the effects of reduced source area MTBE concentrations propagate throughout the aquifer.

The values for decay, dispersivity, groundwater velocity that were found by iteration to provide a best fit with the data are within a range that can be expected for groundwater flow through clayey soils. The reader is referred to Domenico Spreadsheet Analytical Model Manual (Tong, et al, 1999) for a detailed sensitivity analysis of these variables.

Based on this model, it is concluded that the very low MTBE concentrations present in the source area cannot support an expanding dissolved phase plume and the plume will not spread down gradient of the site.

5.0 CONTAMINANTS OF CONCERN

The investigation efforts performed to date have identified that the material released from the site is consistent with gasoline range fuel hydrocarbons. For the purpose of identifying and assessing the risk to human health and the environment, a summary of each specific Contaminant of Concern (COC) identified at the site is presented here. As a conservative assumption, the highest concentrations of each COC present, after treatment of soil and water is used, along with arithmetic mean concentrations, which reveal a much lower concentrations representative of the overall subsurface conditions.

Exhibit 3: Contaminants of Concern

Contaminant	Maximum and Mean** Concentration Remaining (sample ID)					
	Surface Soil (< 3 ft bgs) in mg/kg*		Subsurface Soil (<water table and >3 ft bgs) in mg/kg*		Groundwater in µg/l (all data as of 9/11/02)	
	Max	Mean	Max	Mean	Max	Mean
Benzene	0.007 (AR8)	0.0027	0.25 (EP7)	0.06	520 (MW-8)	115
Toluene	0.011 (AR8)	0.0029	1.0 (NW14)	0.12	5.4 (MW-8)	1.5
Ethyl benzene	<0.005 (all)	-	0.28 (EW12)	0.03	22 (EW-01)	4.3
Xylenes (total)	0.010 (B9)	0.0052	2.0 (EW12)	0.023	56 (EW-01)	8.3
MTBE	-	-	-	-	470 (EW-01)	156
TPH-g (C6-C12)	<1.0 (all)	-	38 (EW12)	5.1	2,000 (MW-8)	468

* Due to the thin vadose zone at this site (+/-5 feet), highest concentrations of post soil treatment samples are used for surface soils and highest unsaturated zone excavation sidewall samples for subsurface soils (see Tables 1 and 2).
** Arithmetic mean calculated using ½ of the detection limit for samples with non-detect results (not calculated when all samples below detection limits).

The Oakland guidance document defines surface soils as soils from ground surface to 1 meter (3 feet) bgs and subsurface soils as those from 3 feet bgs to the water table. The RWQCB RBSL document defines surface soils as soils from ground surface to 3 meters (10 feet) bgs and

subsurface soils as those between 10 feet bgs and the water table. For most COCs present at this site, screening levels presented by the RWQCB for volatile organics are the same for both surface and subsurface soils, therefore the data presented above is according the Oakland definitions. The water table beneath this site has historically existing at between 4.4 and 8.4 feet bgs since monitoring began in 1993. Based on this and the definition of subsurface soils in the RWQCB RBSL document the highest concentration of each COC remaining in the soil at the site will be used for both surface and subsurface soils, regardless of the depth collected.

In addition to the COCs identified above, the presence of the following have been analyzed for and found to not be significant at the site: lead, diesel and oil range hydrocarbons, and the fuel additives diisopropyl ether (DIPE), ethyl tert-butyl ether (ETBE), tert amyl methyl ether (TAME), 1,2-dibromoethane (EDB), and 1,2-dichloroethane (1,2-DCA). T-butyl alcohol (TBA) was detected in three of the groundwater samples during the September 2002 monitoring event, up to 98 µg/l. TBA is a breakdown product of aerobic MTBE degradation and generally degrades along the same pathway as MTBE.

6.0 RISK ASSESSMENT

Although the City of Oakland Guidance Document and the RWQCB RBSLs each have differing assumptions and exposure parameters, each are based on similar theories of human and environmental exposure to impacted soils and groundwater.

In general, the human health risk posed by an individual chemical is expressed in terms of a non-cancer hazard quotient and a cancer risk (for carcinogenic chemicals). Generally, an acceptable incremental additional cancer risk of 1×10^{-4} to 1×10^{-6} (1 in 10,000 to 1 in 1,000,000) and an overall hazard quotient (sum of all chemicals) of less than 1 are acceptable. The development of screening levels is performed by assuming exposure scenarios along each pathway based on land use, either residential or commercial / industrial, and groundwater use. A reference dose (non-cancer hazard evaluation) and slope factor (cancer evaluation), along with the exposure assumptions, is used in the calculations to determine the screening level for each chemical. With the exception of site-specific conditions discussed in the following section, the calculations used to derive the screening levels are assumed valid and the reader is referred to the referenced guidance documents for details.

6.1 City of Oakland Tiered Analysis

The *Oakland Urban Land Redevelopment Program: Guidance Document* (Guidance Document) outlines a tiered analysis for assisting in the investigation and cleanup of impacted sites. Tier 1 risk based screening levels (RBSLs) are established for sites were minimal historical research and site-specific data are available with respect to a release. Tier 1 RBSL are most conservative to account for unknowns remaining after minimal investigation, and are based on an acceptable cancer risk of 10^{-6}. The Tier 2 RBSLs are intended for sites that have concentrations above Tier 1 RBSL and where additional site-

specific data is available, including a thorough characterization of the release and site geology. In addition, the Tier 2 analyses are based on an incremental additional cancer risk of 10^{-5}. Prior to performing the RBSL comparison, the Eligibility Checklist was completed for the site (Guidance Document p. 5). See Appendix A for a copy of the Checklist.

In this case, sufficient data is available for use of the Tier 2 analysis. Both residential and commercial/industrial RBSLs are presented for comparison. Refer to Tables 7 through 9 for comparison of Tier 2 RBSLS with site concentrations for each complete exposure pathway (Exhibit 3).

Based on the comparison presented in these tables, it is apparent no concentrations of BTEX or MTBE present in the surface or subsurface soils or groundwater are over the Tier 2 screening levels.

6.2 RWQCB RBSL Comparative Analysis

The RWQCB screening levels are similar to the Oakland Guidance document, however several additional components have been added. These additional considerations include evaluation of exposure to construction / trench workers exposed to subsurface soils, a more thorough consideration of impact to aquatic life by discharge of groundwater to surface water bodies, and a consideration of degradation of surface water quality. In addition, screening levels for total petroleum hydrocarbons are presented.

Because exposure scenarios are different for the derivation of residential versus the commercial / industrial land use screening levels, site specific concentrations are compared against levels for both land use scenarios.

6.2.1 Groundwater Screening Levels

For evaluation of risk posed by impacted groundwater to human health and the environment, a total of four individual components are identified for site specific consideration: indoor air impact, based soil type; ceiling levels, based on either nuisance odor at discharge to surface water or an upper limit; aquatic life protection; and general surface water quality considerations. A summary of these screening levels is presented in Table 11, along with site groundwater concentrations.

As stated in Section 3.2.1, no existing beneficial use of groundwater was noted in the Basin Plan or identified during a review of well logs for the area. Therefore, the screening levels presented in Table 11 reflect non-drinking water levels. In addition, no surface water exists within 1,600 feet of the site. Therefore, screening level components for aquatic life protection (which assume no dilution at groundwater discharge to surface water body) and general surface water quality are not considered relevant to this evaluation. This argument is supported by the fact that hydrocarbon concentrations outside of the source area were found to be below detection limits or well below concentrations located within the source area.

Maximum concentrations of benzene, toluene, ethyl-benzene, xylenes, and MTBE concentrations in groundwater beneath the site are below the two remaining screening level components appropriate for the site, indoor air impacts for fine-grained soils and the upper limit. Although indoor air impact screening levels for TPH-g are not presented, the maximum concentration at the site (2,000 µg/l) is below the upper limit stated as 50,000 µg/l.

6.2.2 Soil Screening Levels

The RWQCB Guidance identifies surface soils as less than 3 meters (10 feet) deep, in comparison to 3 feet in the Oakland Guidance. The remaining soils in the vadose zone (unsaturated soils) are identified as subsurface soils. Based on the presence of the water table at a depth of between 4 and 8 feet bgs at this site, maximum concentrations remaining in unsaturated soils will be used for comparison with RWQCB subsurface soil RBSLs.

The surface screening levels include direct exposure scenarios for both residential and commercial/industrial land use and an ecotoxicity level. It should be noted that both indoor air quality screening levels and groundwater protection screening levels are identical for each land use scenario. Subsurface soils screening levels are comprised of four exposure component levels: direct exposure (based on construction / trench worker exposure scenario), indoor air quality (both residential and commercial), protection of groundwater quality, and soil quality ceiling levels. Tables 12 and 13 present the component screening levels for surface and subsurface soils, respectively for comparison against site data.

All COCs are below the commercial/industrial land use screening levels applicable for this site. With the exception of benzene, all other COCs at the site are below residential land use screen levels. However, the average benzene concentration (0.06 mg/kg) in these samples is well below the residential land use RBSL.

The maximum concentration of benzene detected at the site is 0.25 mg/kg, which was detected in one of the sidewall samples, collected at the greatest extent of the excavation. It should be noted that benzene was detected at or below detection limits (0.005 mg/kg) in 8 of the 14 sidewall samples.

7.0 CONCLUSIONS

7.1 Characterization and Treatment

The release was adequately characterized prior to the soil treatment activities undertaken by AEI in April 1997. Approximately 1600 cubic yards of soil excavated from above the water table were treated onsite to nearly non-detect concentrations prior to replacement back into the excavation.

Following soil treatment, dissolved phase hydrocarbon concentrations were observed to decrease significantly due to the removal of source material. In effort to accelerate mass reduction, in-situ groundwater treatment through bio augmentation was undertaken. As can be seen in Figures 10 through 12, hydrocarbon concentrations have decreased significantly since 1997 and are expected to continue to decrease.

The minimal hydrocarbon mass present in the dissolved phase is limited to around the former source area. Mass reduction is expected to continue via natural attenuation mechanism. One dimensional contaminant fate and transport modeling indicates that the plume is not expected to spread beyond the property boundaries and will like recede, as the effects of source area reduction propagate along the flow path.

7.2 Risk Assessment

A comparative risk analysis was performed to evaluate risk to human health and the environment using both the City of Oakland Guidance Document and the RWQCB Risk Based Screening Levels (RBSLs).

The comparative risk analyses did not reveal any elevated significant risk to human health or the environment posed by the low mass of contaminants remaining at the site for the commercial/industrial land use scenario. Although the maximum concentration of benzene detected in 1997 was slightly above the most conservative residential direct exposure and indoor air impact pathway, the majority of soil samples indicate that the highest detection is not representative of the entire property.

7.3 Closing Statement

The evaluations discussed herein conclude that although localized dissolved phase hydrocarbons remain, the case should be eligible for "no further action" status. The following conditions support this recommendation:

- Soil treatment activities successfully removed nearly all hydrocarbon mass from unsaturated zone soils.
- Hydrocarbon mass in the shallow aquifer began to decrease upon completion of soil

treatment and continued to decrease as the groundwater treatment program was implemented the former source area. Groundwater monitoring data has proven that the remaining dissolved phase hydrocarbons are localized to the former source area. Modeling confirms that the MTBE plume should not spread past its current extent, and begin to recede. The vertical extent of the release was confirmed to be limited and a regional aquitard was identified that would limit the potential for impact to deeper aquifers of the area.

- The comparative human health risk evaluation indicates the low concentrations of hydrocarbons remaining in the shallow soil and groundwater does not pose a significant risk to human health or the environmental.
- No existing production wells or surface water were identified that could be impacted by this release.

Once final case closure is granted, the existing wells should be decommissioned according to applicable state and local regulation.

8.0 REFERENCES

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Levine-Fricke, *Report on Supplemental Site Investigation and a Conceptual Remediation Plan 625 Hegenberger Road Oakland, Califronia*, April 5, 1995

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Tong, W., and Rong, Y., Domenico, California Regional Water Quality Control Board – Los Angeles Region, *Spreadsheet Analytical Model Manual*, December 1, 1999

9.0 LIMITATIONS AND SIGNATURES

This report presents a summary of work completed by AEI, including observations and descriptions of site conditions. Where appropriate, it includes analytical results for samples taken during the course of the work. The number and location of samples are chosen to provide required information, but it cannot be assumed that they are entirely representative of all areas not sampled. In addition, where appropriate, mathematical analyses of health risks and/or chemical migration may have been made using equations referenced in this report. Assumptions for the values of applicable physical and physiological constants have been made, where appropriate; the values of which may not be representative of all possible site conditions. Therefore, the results of these estimates cannot be considered to be valid for all possible site conditions. All conclusions and recommendations are based on these analyses, observations, calculations and the governing regulations. Conclusions beyond those stated and reported herein should not be inferred from this document.

These services were performed in accordance with generally accepted practices in the environmental engineering and construction field that existed at the time and location of the work.

Sincerely,
AEI Consultants

Peter McIntyre
Project Manager, Geologist

Joseph P. Derhake, PE
Principal

2.0 SITE DESCRIPTION & BACKGROUND

The site is located on the northwestern corner of Collins Drive and Hegenberger Road in an area of the City of Oakland zoned for commercial and light industrial use. The property is bound on the north by a commercial warehouse and on the west by the Oakland-Alameda County Coliseum Complex. The site is currently vacant and unimproved.

Prior to 1993

The property was reportedly developed as a gasoline service station in the mid 1960s, which was subsequently abandoned in the mid 1970s. Subsurface Consultants performed two phases of site investigation in 1988 and 1990, during which a total of 23 soil borings (labeled 1 through 23) were advanced, five of which were converted to groundwater monitoring wells (labeled MW-8, MW-10, MW-11, MW-12, and MW-16. The borings were located around the former tank hold and dispenser island. The highest concentrations of petroleum hydrocarbons were detected adjacent to and east of the former tank (areas that were subsequently excavated).

Tank Removal - October 1993

In October 1993, three underground gasoline storage tanks (12,000 gallons each), one 260 gallon waste oil tank (also identified as a "sump"), and related underground piping were removed from the site under the observation of Levine Fricke. Approximately 250 cubic yards (cy) of soil was excavated during the tank removal, which was stockpiled onsite. During the tank removal activities, tank and piping failures were evident upon inspection. Seventeen (17) soil samples and two groundwater samples collected by Levine Fricke during the tank removal activities confirmed that impacted soils and groundwater was present at the site. Please refer to the *Tank Closure Report on Removal of Underground Fuel Storage Tanks and Related Structures*, January 24, 1994 by Levine Fricke for details on the tank removal and previous sampling activities. The location of the former tanks and dispensers are presented on Figure 3.

Site Investigation – January 1995

In January 1995, Levine Fricke advanced an additional thirteen (13) soil borings (labeled LF24 though LF36), one of which was converted to a monitoring well (MW-24). Again, soil sample analytical data revealed that impacted soils were located around the former tank hold. Groundwater monitoring of the resulting network of six monitoring wells, which occurred on January 10, 1995, confirmed that a dissolved phase hydrocarbon plume was present, primarily in the area of MW-8. Refer to the *Report on a Supplemental Site Investigation and a Conceptual Remediation Plan 625 Hegenberger Road Oakland, California*, April 5, 1995 by Levine Fricke for details of the investigation.

The quarterly monitoring of the six monitoring wells was performed by Levine Fricke through January 1995. AEI began monitoring the wells in October 1995. In March 1996, AEI destroyed one of the wells (designated MW-24) in anticipation of excavation activities.

Soil Treatment – April to August 1996

Beginning in April 1996, AEI excavated a total of 1,600 cubic yards of impacted soils from around

the former tank hold and dispenser locations. The final extent of the excavation is shown on Figure 3. Soil samples were collected from the sidewalls of the excavation at several stages during the excavation work. The analytical data of samples from the farthest extent of the excavation are presented in Table 1. With the exception of approximately 20 cy of soil impacted with oil range hydrocarbons which was transported to a disposal facility, the excavated soil was aerated onsite. The soil was aerated in two batches, measuring approximately 150' by 180' and 12 inches deep. Baseline samples were collected from the stockpiles. Bi-weekly tilling was performed between April 12, 1996 and June 19, 1996 for the first aeration batch and between July 17, 1996 and September 5, 1996 for the second.

Following aeration, 22 samples collected from the treated soil (refer to Table 2). Petroleum hydrocarbons were detected at very low concentration in only two of the 22 samples (benzene at 0.007 mg/kg, toluene at 0.011 mg/kg, and xylenes at 0.010 mg/kg), and based in these results, Mr. Barney Chan of the ACHCSA authorized the reuse of the treated soil to backfill the excavation.

The excavation was backfilled with pea gravel, to bridge the capillary fringe, to approximately ½ foot above static groundwater. The remainder of the excavation was filled with the treated soil. Refer to the *Phase II Environmental Site Assessment* report, March 3, 1997 prepared by AEI for detailed methods and results of the soil treatment activities.

August 1997 – June 2000

In August 1997, AEI submitted a Remedial Action Plan (RAP) the ACHCSA, which described a plan to enhance in-situ biodegradation to reduce dissolved phase hydrocarbon concentrations within the area of the former excavation. On October 1, 1999, AEI installed one (1) 4" diameter well (EW-01) just west of the former tank hold. The well was placed in the center of the plume and screened from 5 to 22.5 feet bgs, for use as an extraction well for batch groundwater treatment.

Two additional groundwater monitoring wells (MW-26 and MW-27) were installed on the western end of the site (Figure 3) in June 2000. The wells were constructed of 2" diameter well casing, screened from 5 to 15 feet bgs. Also in June 2000, one soil boring (AEI-B28) was advanced (Figure 3). The boring was placed in the apparent center of the dissolved hydrocarbon plume. The boring was advanced to 44.5 feet bgs to determine the vertical extent of the plume. Three groundwater samples were analyzed, the results of which revealed significant attenuation with depth of the hydrocarbon plume (Table 6). Refer to the *Soil Boring and Groundwater Monitoring Well Installation and Sampling Report*, dated September 10, 2000 for detailed results of these activities.

Groundwater Treatment – June 2001 to February 2002

A groundwater treatment program was initiated in June 2001, and was based on the August 1997 RAP, with several modifications. The system was designed to supplement natural bacterial colonies present in the shallow water table aquifer with bacterial colonies cultured to metabolize aromatic hydrocarbons. The system consisted of an extraction well (EW-01), batch treatment tank, batch injection network of 12 batch injection points, and air sparging system consisting of a compressor and 12 sparge points. The goal of the treatment program was to reduce dissolved

hydrocarbon concentrations, specifically TPH-g and BTEX, within the source area. Of particular importance when designing the system was the presence of the pea gravel backfill material placed within the bottom of the former excavation in the source area. This material has a higher porosity and hydraulic conductivity than the native soils, therefore allowing for distribution of the oxygenated water and injected waters.

The system operated from June 2001 through February 2002, during which time 27 batches were treated, totaling approximately 13,000 gallons. The treated water was then re-injected, to "spike" the groundwater system with oxygenated water and active culture. System operation statistics are presented in Table 7 and a site plan with system components is presented on Figure 9. Refer to the *Groundwater Treatment and Site Closure Summary Report*, May 3, 2002 and the *Monitoring and Treatment Report*, dated November 21, 2002, for details on system operation.

Supplemental Treatment (MW-8) – July to September 2002

Due to the remnant hydrocarbons present in this well after treatment had ceased (TPH-g at 32,000 µg/l and benzene at 2,000 µg/l), localized treatment of this well was requested by ACHCSA. On July 29, 2002, MW-8 was purged of approximately 5 gallons and a water sample was collected. Following sample collection, a total of nine (9) socks of Regensis, Inc. Oxygen Release Compound (ORC) were suspended in the well, which were placed to cover the water column exposed by the well. The socks were allowed to remain in the well until September 11, 2002, when the next monitoring event of the entire well network occurred.

Throughout the history of the site, groundwater monitoring and sampling activities have been performed. Historical water table elevation data, groundwater quality data, and sample analytical data are summarized in Tables 3 through 5. Water table contours and dissolved phase hydrocarbon concentrations from the September 11, 2002 event are presented on Figures 4 and 5. Iso-concentration contours for TPH-g, benzene, and MTBE are presented on Figures 6 through 8. Dissolved phase hydrocarbon trends are presented for selected wells MW-8, MW-11 and EW-01 on Figures 10 through 12.

3.0 ENVIRONMENTAL SETTING

3.1 Geology and Hydrology

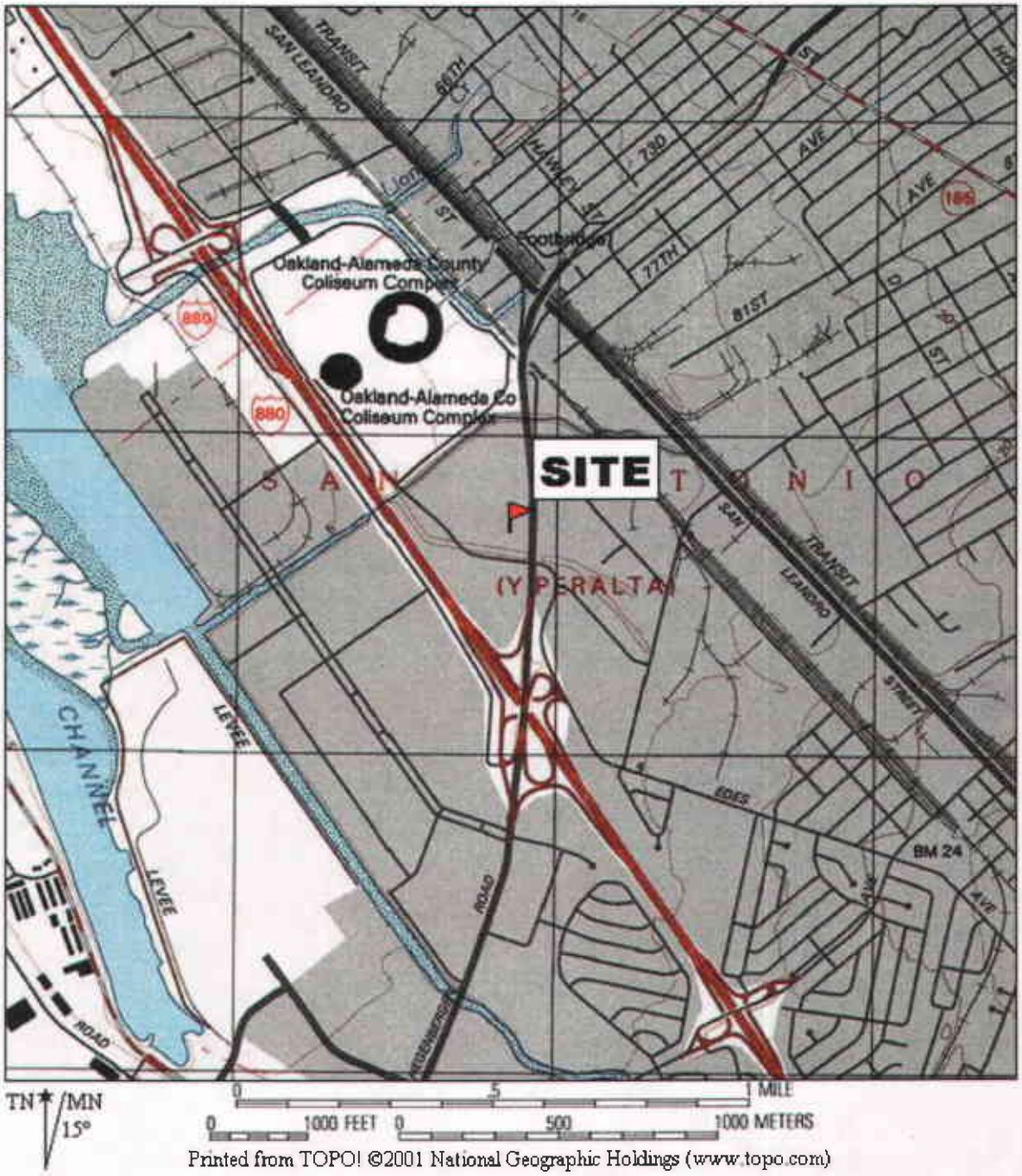
According to logs of borings advanced by AEI, the near surface sediments beneath the site generally consist of clay soils with silt and fine sand to approximately 10 feet bgs. First encountered groundwater exists beneath the site between 5 and 6.5 feet bgs. The water bearing deposits in this shallow saturated zone consists of clay with fine to medium sand with angular clasts up to 2 cm in size. Sand increases with depth to approximately 16 feet bgs.

The deeper soil boring (AEI-B28) revealed silty clay below 16 feet. Sands and sub-angular to angular gravel increase with depth to approximately 37 feet bgs below which stiff, tight clay was encountered. Refusal conditions were encountered at 44.5 feet bgs. The presence of a clay aquitard in this depth range was confirmed during a review of logs for deep borings performed at the Oakland Coliseum Complex. A geologic cross-section of the site based in borings advanced by AEI is presented on Figure 13.

Water level measurements have been collected from the eight existing wells in order to estimate the groundwater flow direction. Water table contours for the most recent event (September 2002) are presented on Figure 4, along with a rose diagram of historic groundwater flow direction. Although water table contours reveal a complicated water table; a westerly or northwesterly flow direction is observed. Over the course of assessment at this site, groundwater has consistently flowed to the west, with a hydraulic gradient generally of 10^{-3} ft/ft. Water table elevations are summarized in Table 3.

3.2 Exposure Pathways

An exposure pathway analysis has been performed to identify which specific exposure pathways are complete for exposure of human or environmental receptors. Each pathway is discussed in detail in following sections.



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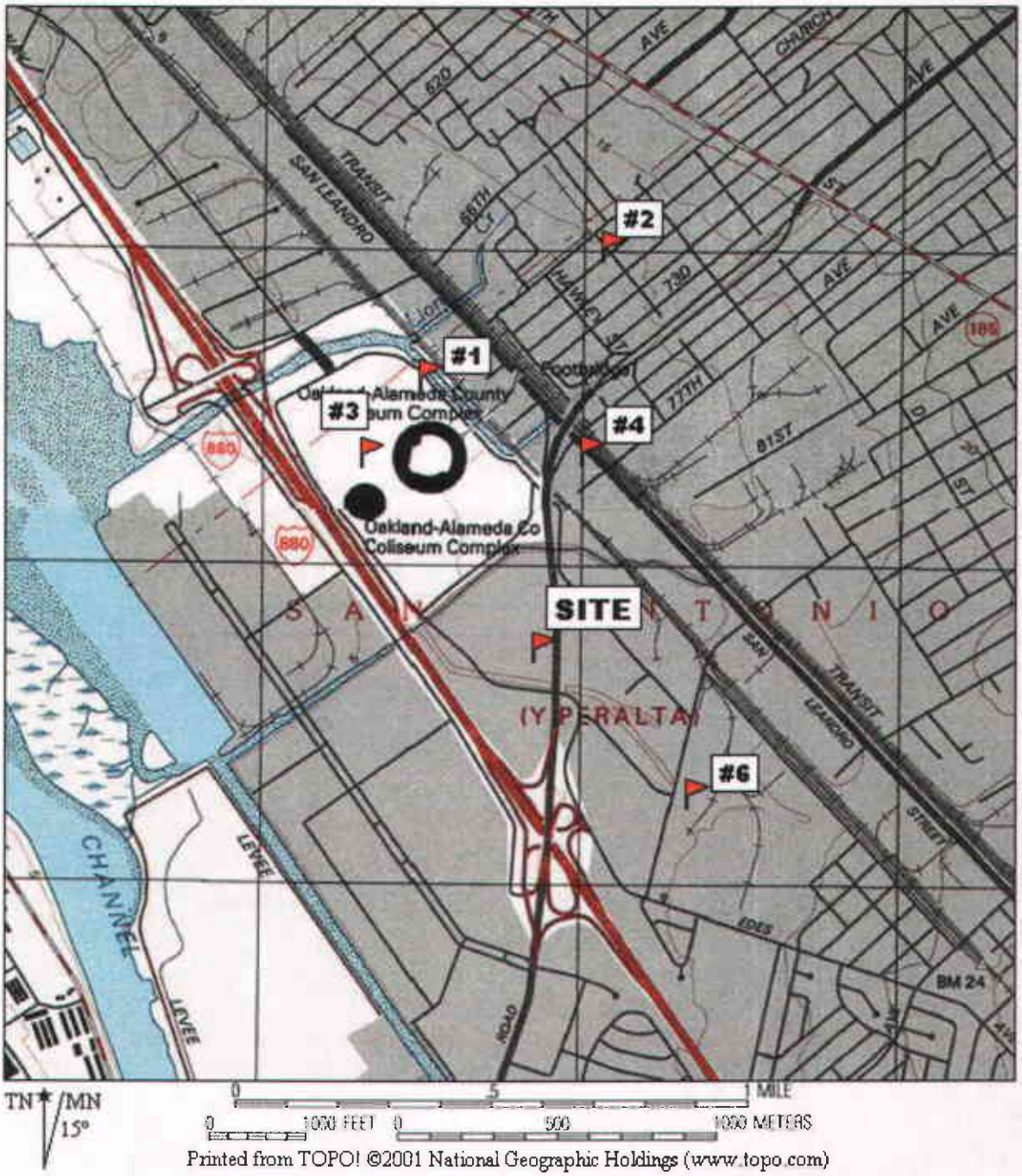
AEI CONSULTANTS 3210 OLD TUNNEL RD, STE B, LAFAYETTE, CA	
SITE LOCATION MAP	
625 HEGENBERGER ROAD OAKLAND, CALIFORNIA	**FIGURE 1** PROJECT NO. 6274



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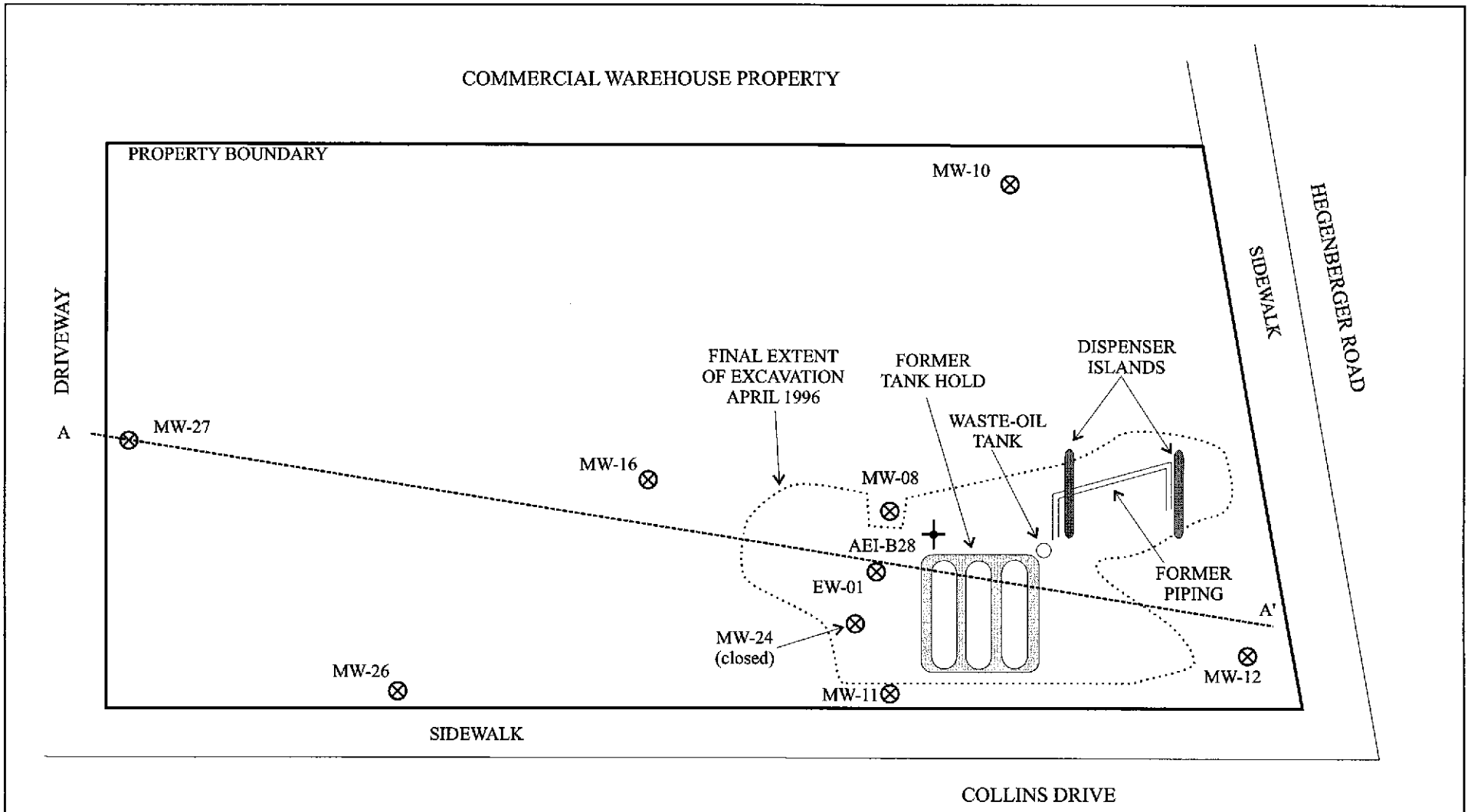
AEI CONSULTANTS 3210 OLD TUNNEL RD, STE B, LAFAYETTE, CA	
OFFSITE WELL LOCATIONS	
625 HEGENBERGER ROAD OAKLAND, CALIFORNIA	**FIGURE 2** PROJECT NO. 6274



N

0' 25' 50'

SCALE: 1 in = 50 ft

KEY

⊗ Monitoring Well Locations

✦ Temporary Soil Boring (June 2000)

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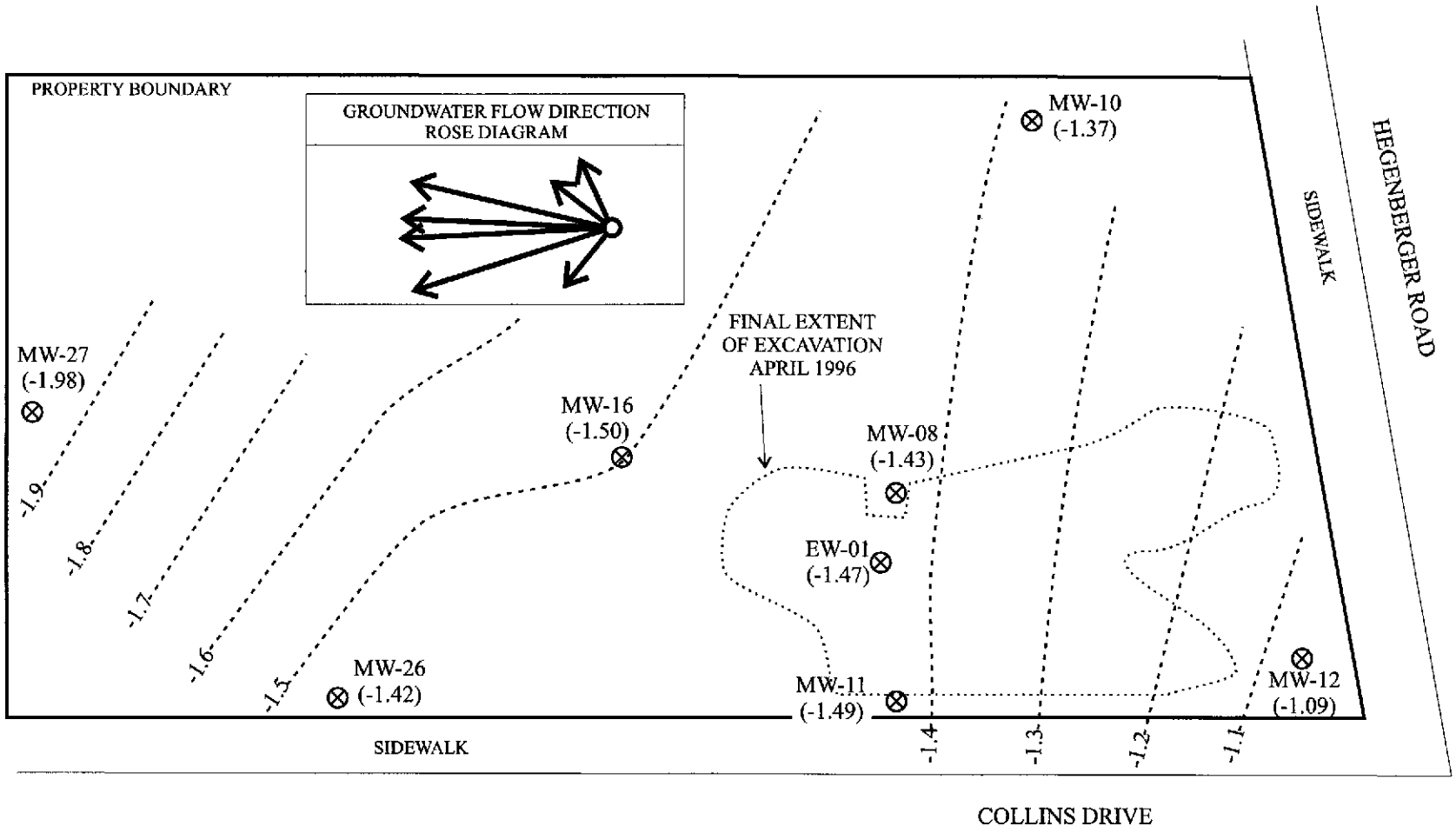
2500 CAMINO DIABLO, Ste. 200, WALNUT CREEK, CA

SITE PLAN

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 3
AEI PROJECT NO 6274



KEY

⊗ Monitoring Well

Water Table contour in feet above mean sea level. Contour interval = 0.1 feet

N

0' 25' 50'

SCALE: 1 in = 50 ft

ROSE DIAGRAM SCALE: ½ in = 1 episode

NOTE: Rose diagram does not include effects of MW-26 & MW-27

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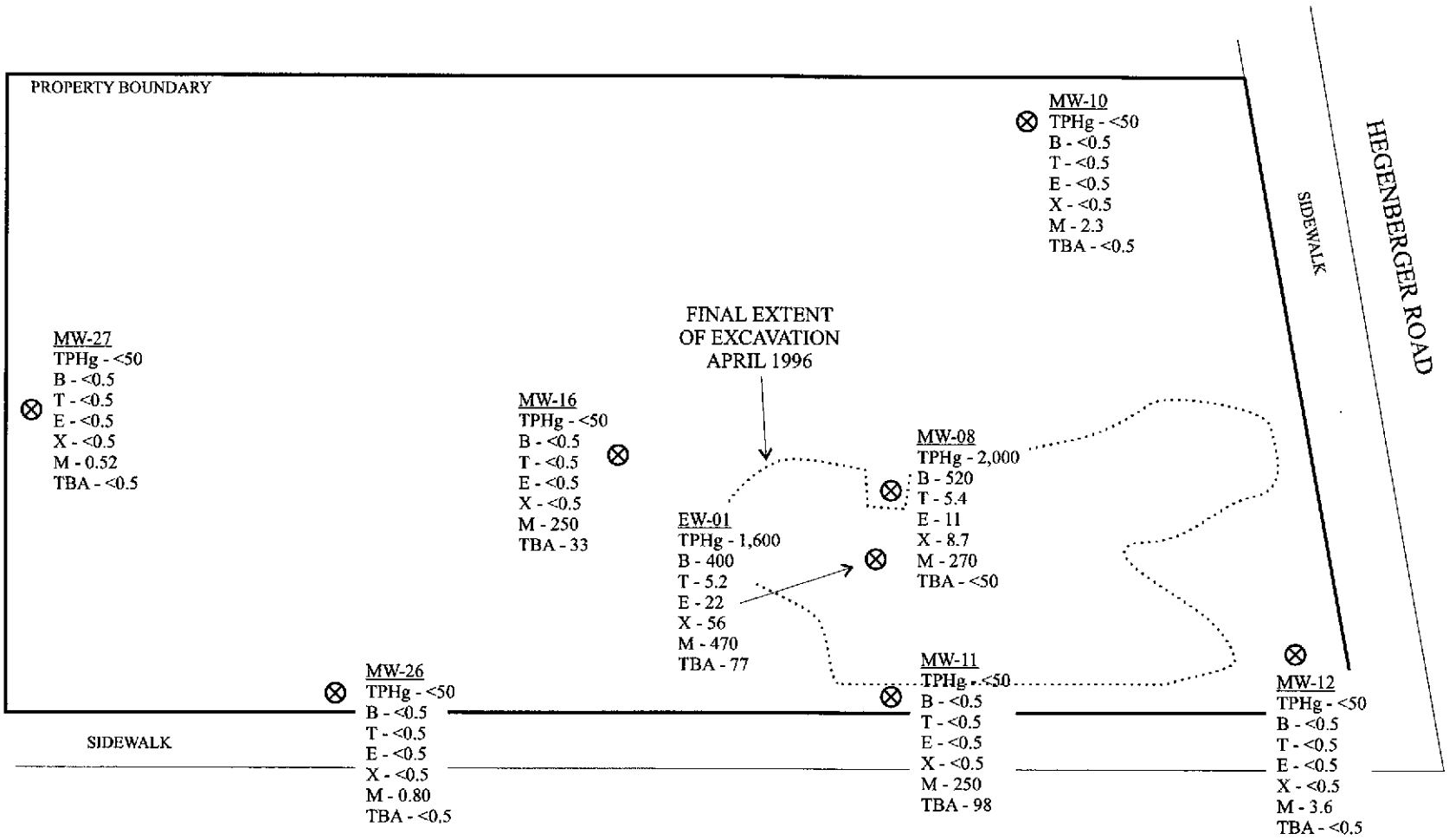
WATER TABLE CONTOURS: 9/11/02

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 4
AEI PROJECT NO 6274



N

0' 25' 50'

SCALE: 1 in = 50 ft

KEY

⊗ Well locations with dissolved phase hydrocarbons in µg/l

TPHg-TPH gasoline
B-Benzene T-Toluene
E-Ethylbenzene X-Xylenes
M-MTBE (8260 result)
TBA - t-Butyl alcohol

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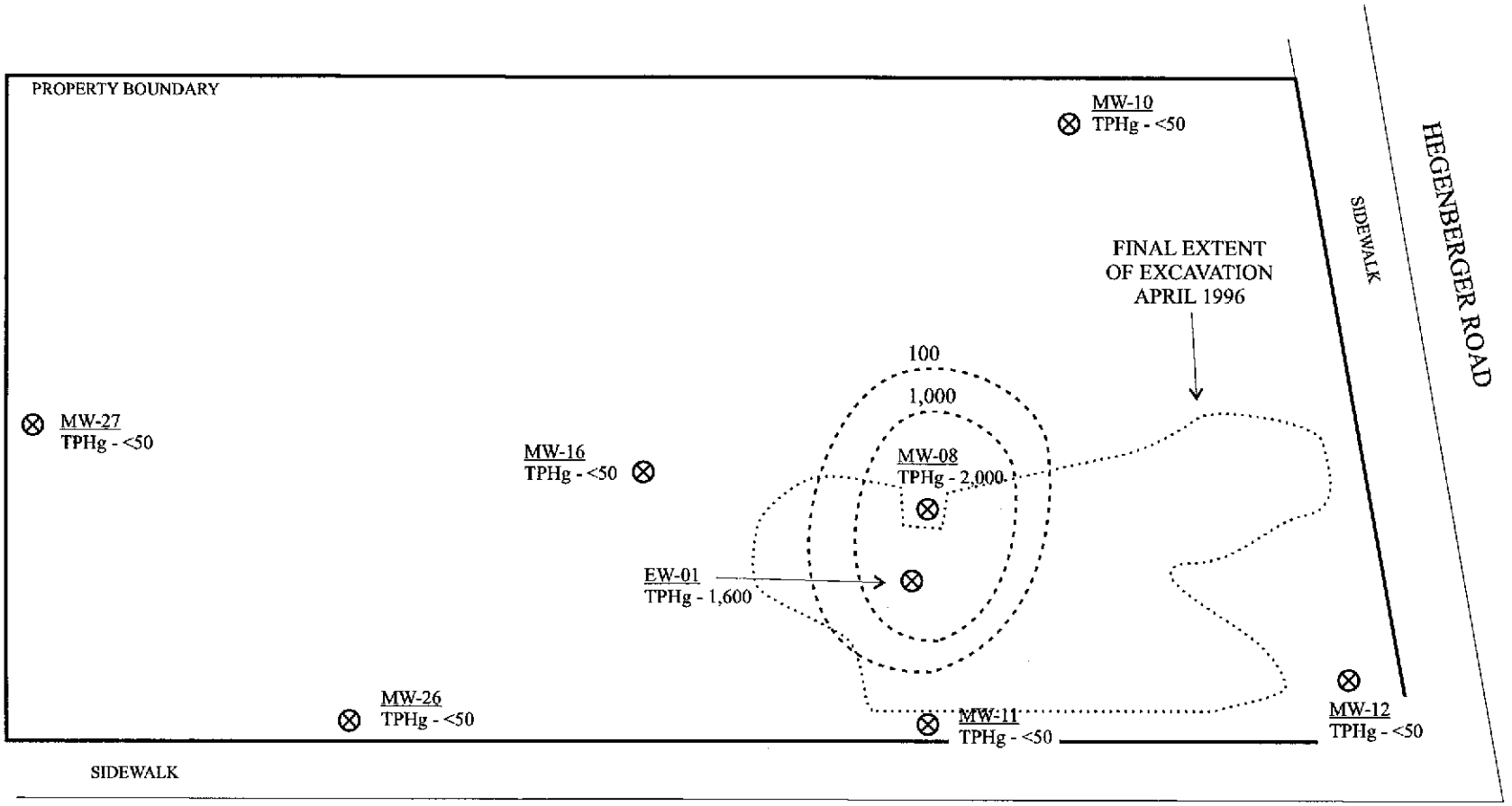
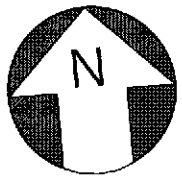
HYDROCARBON CONCENTRATIONS: 9/11/02

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 5
AEI PROJECT NO 6274





SCALE: 1 in = 50 ft

KEY

⊗ Well locations with dissolved TPHg concentrations in µg/l

10 TPHg iso-concentration contour. Data as of 9/11/02 Interval: factor of 10

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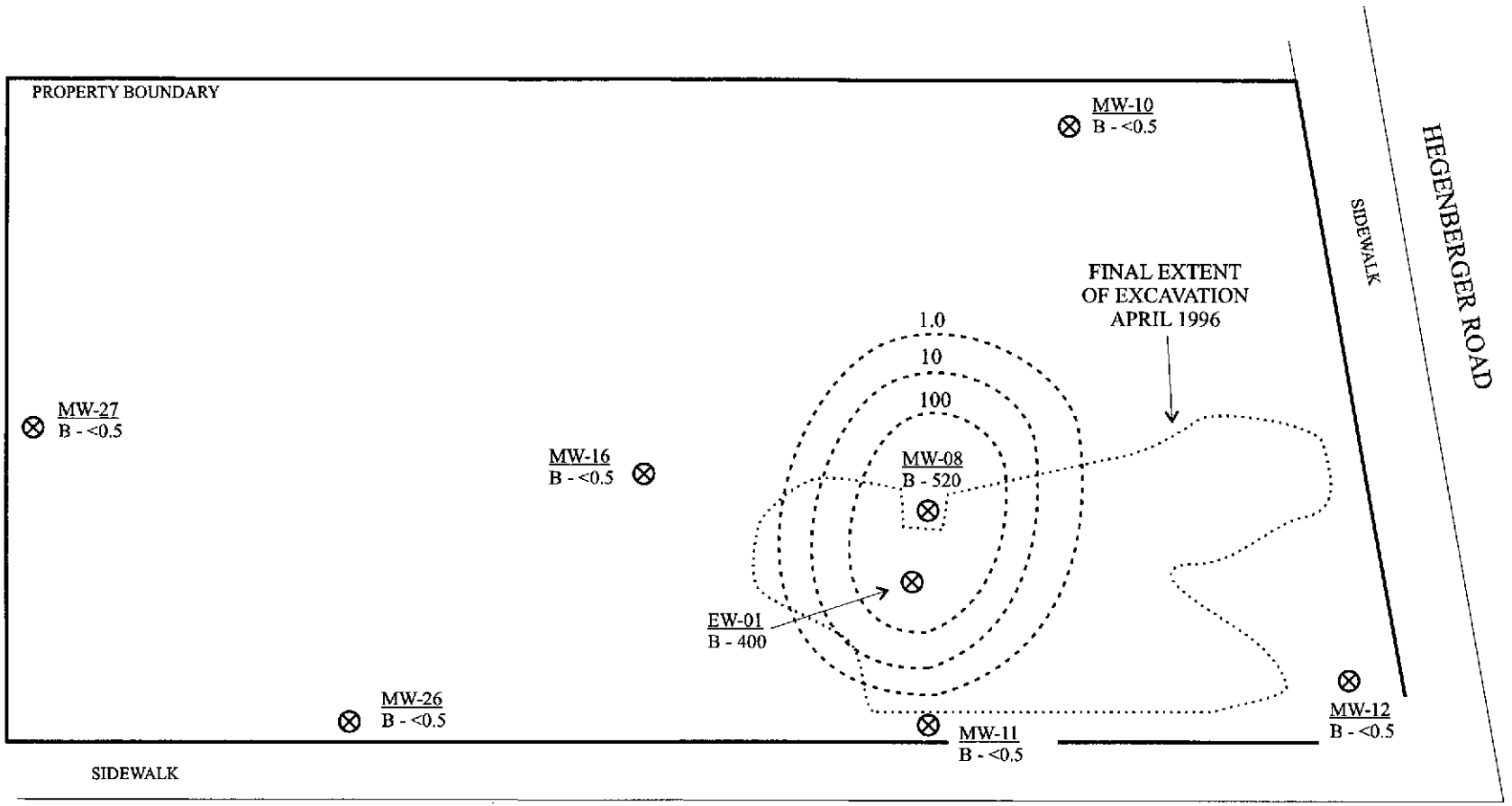
TPHg Concentration Contours

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 6
AEI PROJECT NO 6274



N

0' 25' 50'

SCALE: 1 in = 50 ft

KEY

⊗ Well locations with dissolved Benzene (B) concentrations in µg/l

10 Benzene iso-concentration contour. Data as of 9/11/02 Interval: factor of 10

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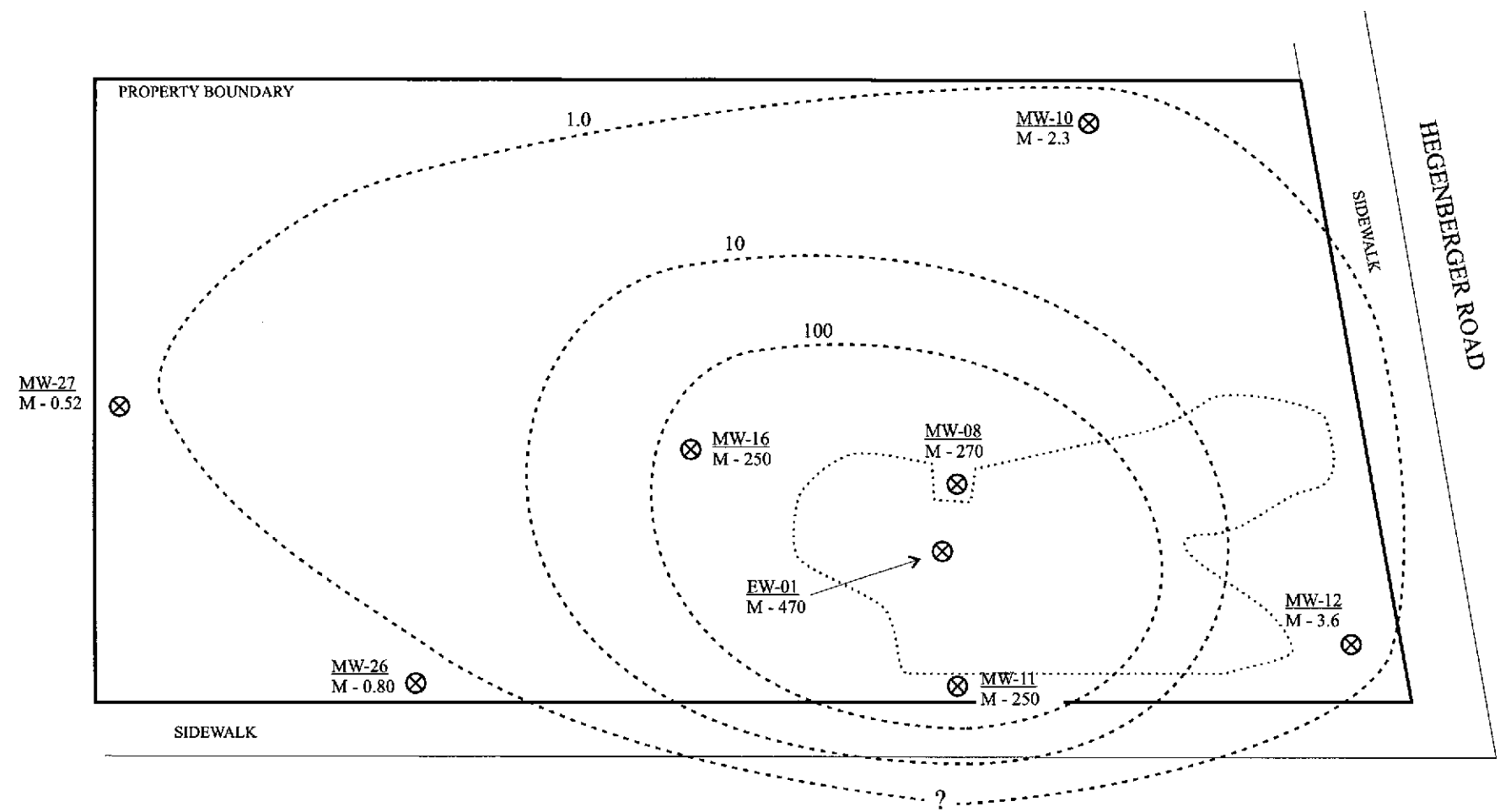
Benzene Concentration Contours

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 7
AEI PROJECT NO 6274



N

0' 25' 50'

SCALE: 1 in = 50 ft

KEY

⊗ Well locations with dissolved MTVE (M) concentrations in µg/l

10 MTBE iso-concentration contour. Data as of 9/11/02 Interval: factor of 10

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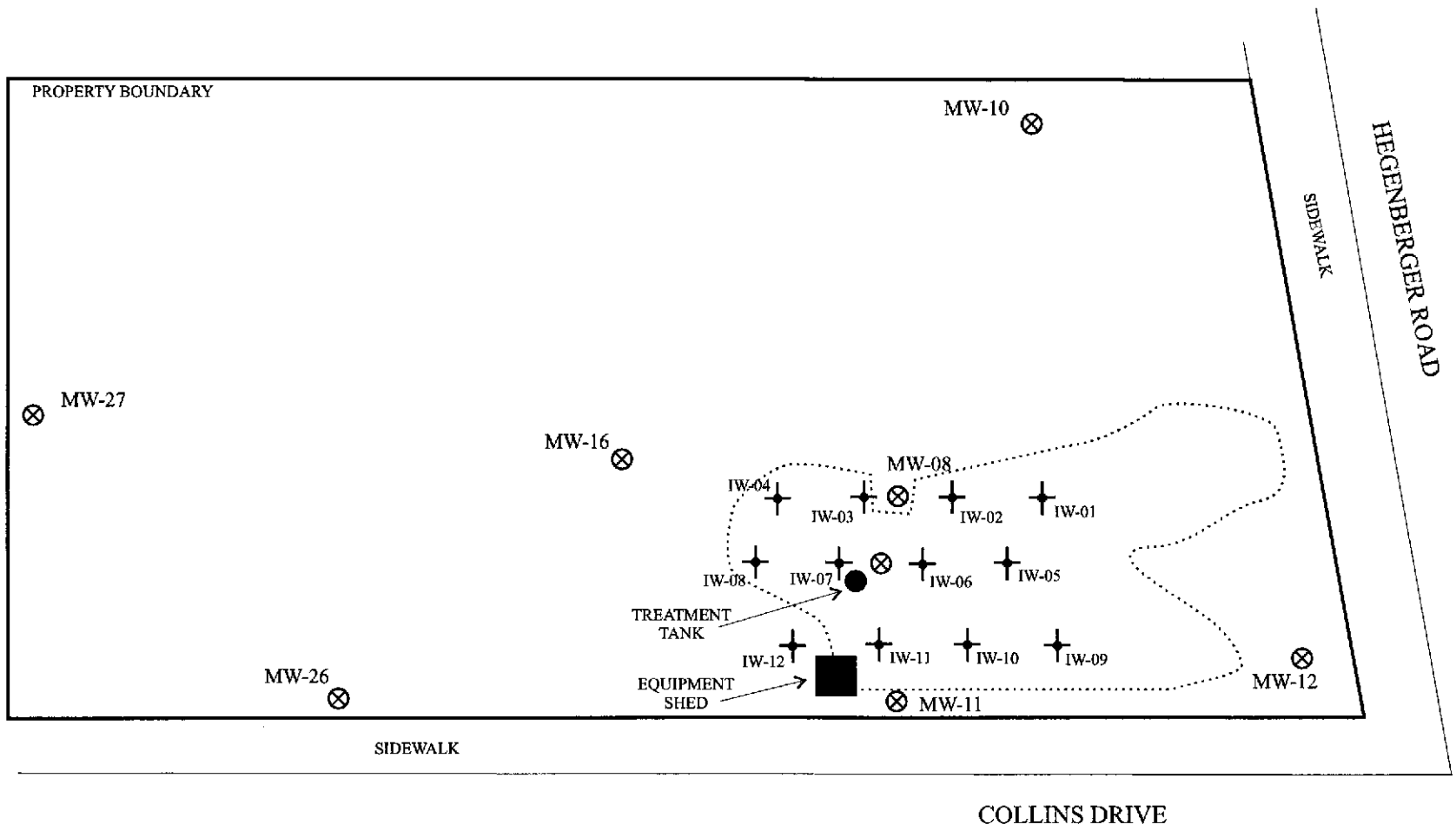
MTBE Concentration Contours

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 8
AEI PROJECT NO 6274



N

0' 25' 50'

SCALE: 1 in = 50 ft

⊗ MONITORING WELL LOCATIONS

✦ DUEL COMPLETION WELLS

SCALE: 1 in. = 45 ft.

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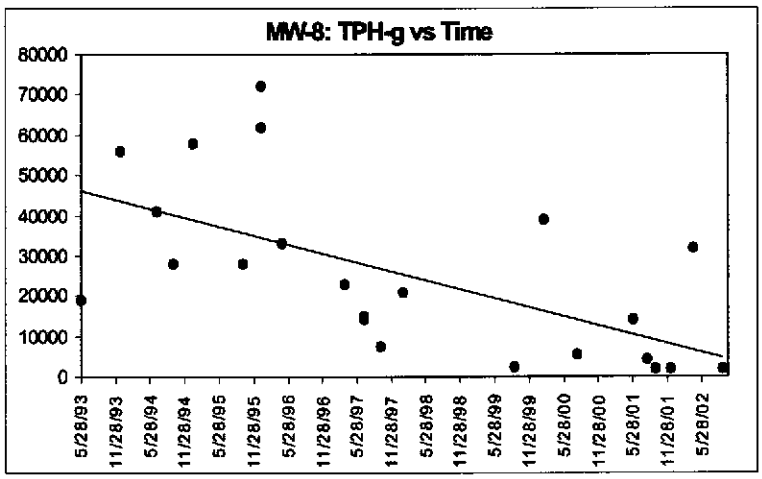
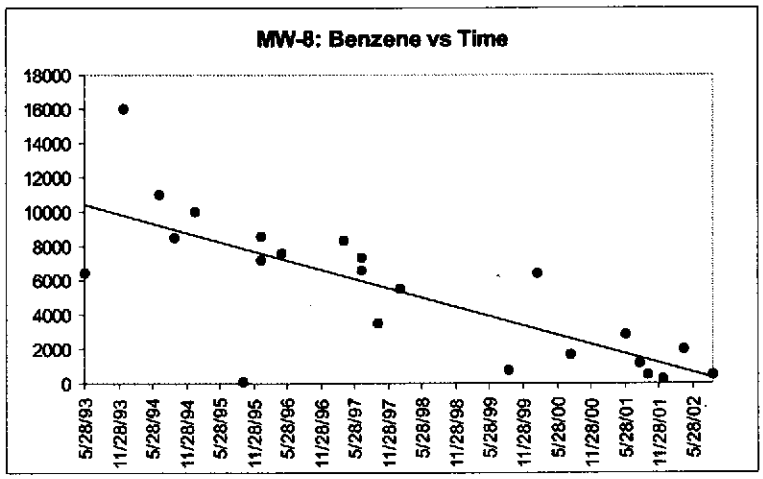
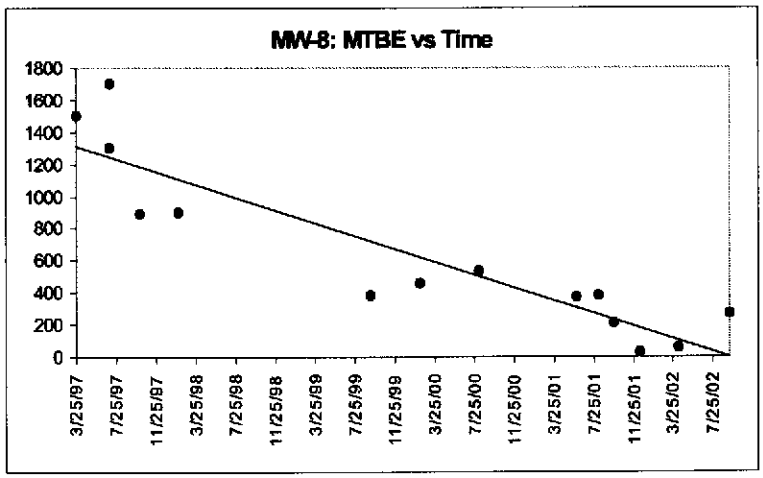
GROUNDWATER TREATMENT SYSTEM COMPONENT LOCATIONS

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 9
AEI PROJECT NO 6274







ALL CONCENTRATIONS (Y-AXES) EXPRESSED IN µg/l. REFER TO TABLE 3 FOR SOURCE DATA PLOTS AND LINEAR TRENDLINES PRODUCED WITH MICROSOFT EXCEL 2000

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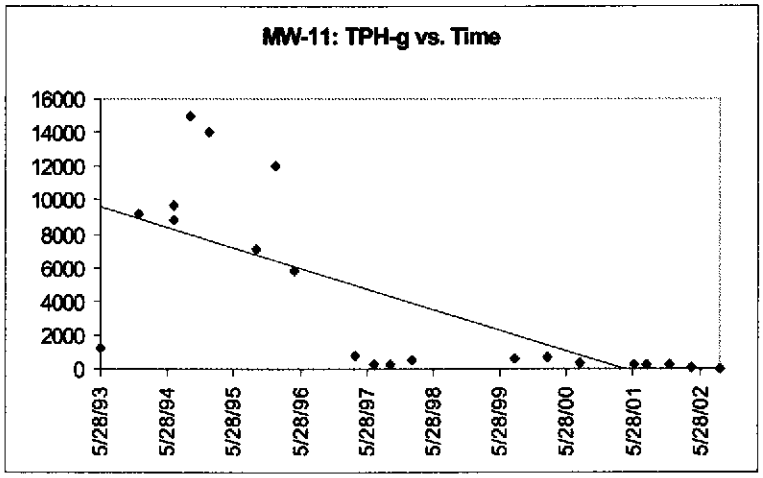
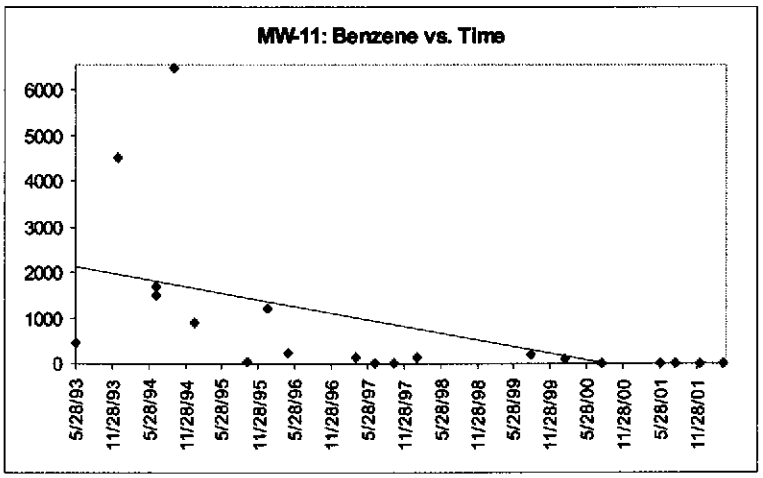
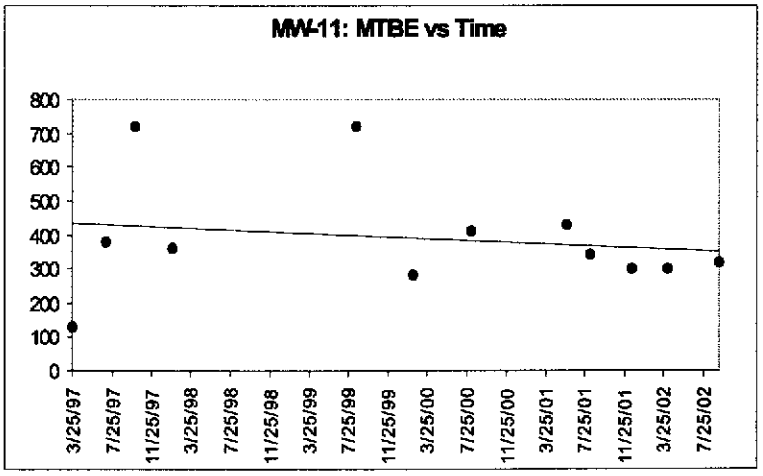
MW-8: Hydrocarbon Concentration Trends

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 10
AEI PROJECT NO 6274







ALL CONCENTRATIONS (Y-AXES) EXPRESSED IN µg/l. REFER TO TABLE 3 FOR SOURCE DATA PLOTS AND LINEAR TRENDLINES PRODUCED WITH MICROSOFT EXCEL 2000

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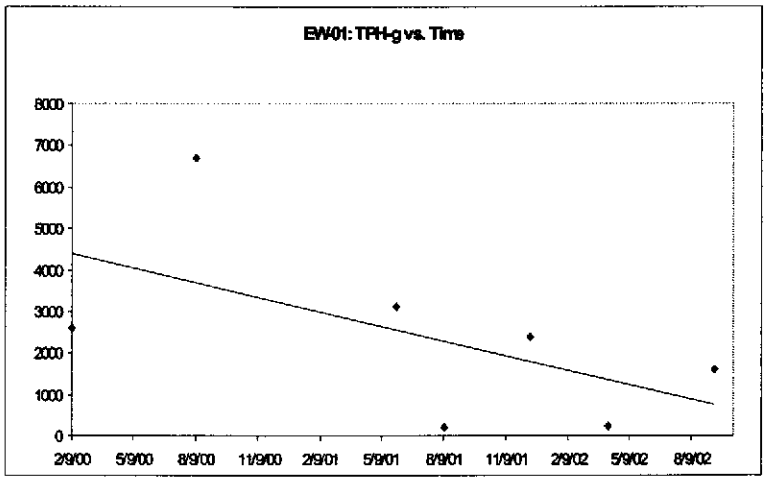
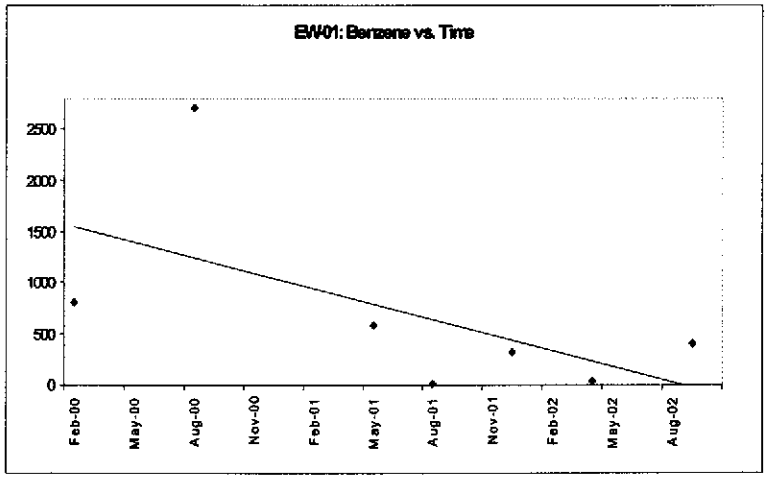
2500 CAMINO DIABLO, Ste. 200, WALNUT CREEK, CA

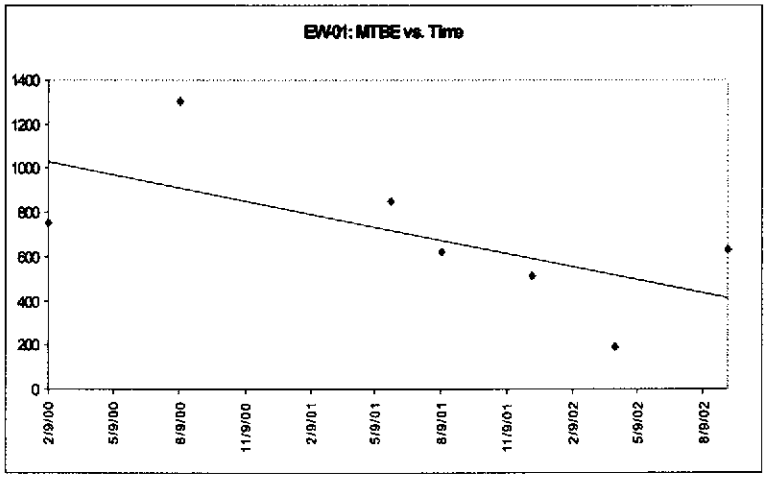
MW-11: Hydrocarbon Concentrations Trends

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 11
AEI PROJECT NO 6274







ALL CONCENTRATIONS (Y-AXES) EXPRESSED IN µg/l. REFER TO TABLE 3 FOR SOURCE DATA PLOTS AND LINEAR TRENDLINES PRODUCED WITH MICROSOFT EXCEL 2000

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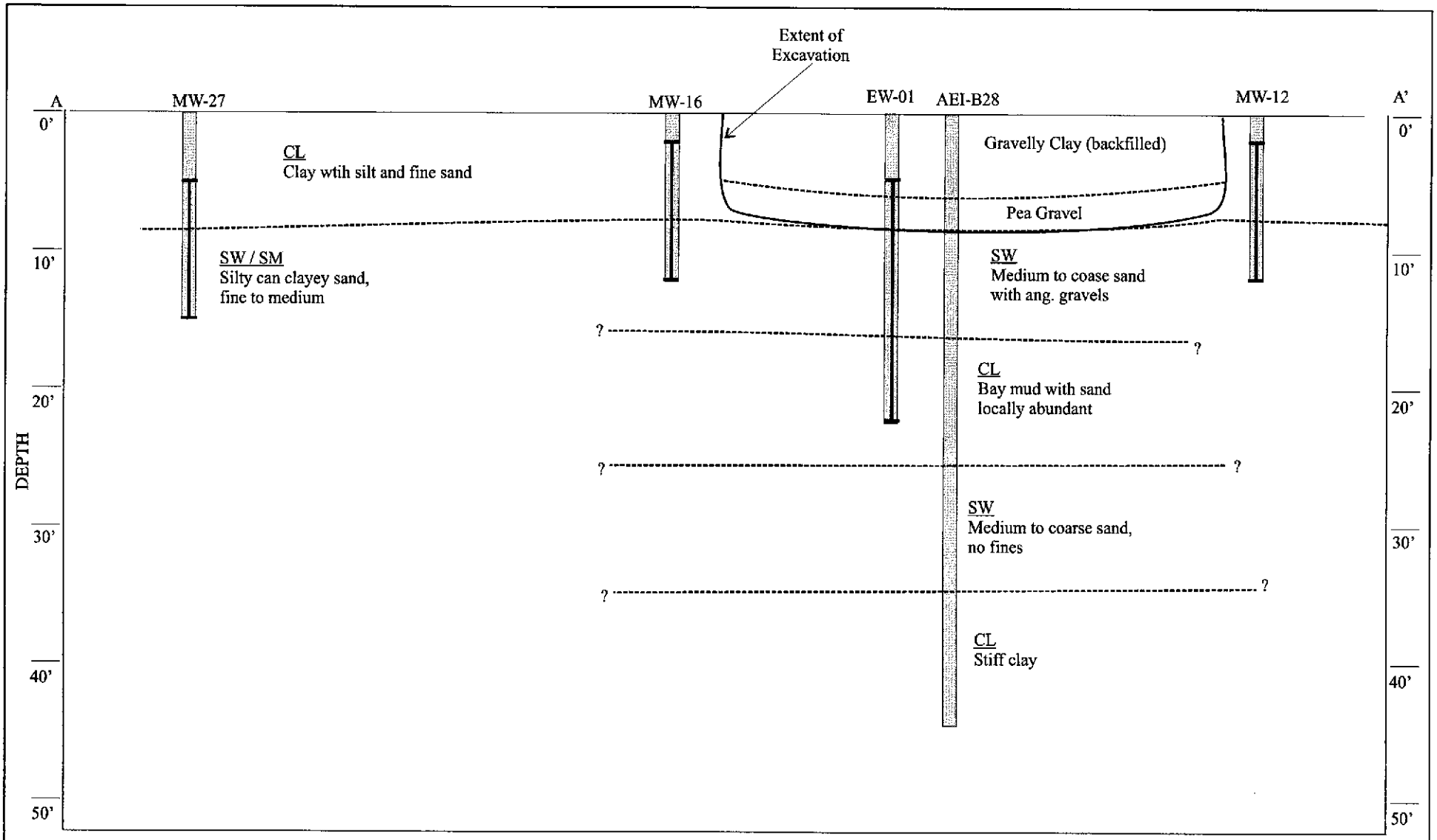
EW-01: Hydrocarbon Concentrations vs. Time

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 12
AEI PROJECT NO 6274



APPROXIMATE SOIL TYPE BOUNDARY

SCREEN INTERVAL

VERTICAL SCALE: 1in = ~ 10 ft
HORIZONTAL SCALE: 1 in = ~50 ft

Abbreviations
SW = Well graded sand, gravelly sand
SM = Silty sand
CL = Clay, silty, sandy, or gravelly clay

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GEOLOGIC CROSS SECTION

625 HEGENBERGER ROAD
OAKLAND, CALIFORNIA

FIGURE 13
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Table 1

Final Excavation Sidewall Soil Sample Analytical Data

Sample ID	Date	Depth	TPH-g mg/kg	Benzene mg/kg	Toluene mg/kg	E'benzene mg/kg	Xylenes mg/kg
EP5	5/8/96	4.5	<1	0.22	0.051	0.008	0.1
EP6	5/8/96	4.5	<1	0.13	0.013	0.006	0.034
EP7	5/8/96	4.5	2.4	0.25	0.19	0.012	0.063
EW17	5/8/96	5	<1	<0.005	<0.005	<0.005	<0.01
EP8	4/12/96	5	<1	<0.005	<0.005	<0.005	<0.01
EP9	4/12/96	5	<1	<0.005	<0.005	<0.005	<0.01
EP10	4/12/96	4.5	<1	<0.005	<0.005	<0.005	<0.01
EP11	4/12/96	4.5	<1	0.005	<0.005	<0.005	<0.01
NW18	4/12/96	5	<1	0.005	<0.005	<0.005	<0.01
EW12	4/12/96	5	38	0.06	0.43	0.28	2.0
NW13	7/12/96	4.5	<1	0.018	<0.005	<0.005	<0.01
NW14	7/12/96	4.5	25	0.21	1.0	0.14	1.0
WW15	7/12/96	5	<1	<0.005	<0.005	<0.005	<0.01
WW16	7/12/96	5	<1	<0.005	<0.005	<0.005	<0.01

Source: *Phase II Environmental Site Assessment* report, AEI March 3, 1997

Table 2

Post Aeration Confirmation Soil Sample Analytical Data

Sample ID	Date	Batch #	TPH-g mg/kg	Benzene mg/kg	Toluene mg/kg	E'benzene mg/kg	Xylenes mg/kg
AR1	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR2	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR3	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR4	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR5	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR6	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR7	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR8	6/19/96	A	<1	0.007	0.011	<0.005	<0.01
AR9	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR10	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR11	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
AR12	6/19/96	A	<1	<0.005	<0.005	<0.005	<0.01
B1	9/5/96	B	<1	<0.005	<0.005	<0.005	<0.01
B2	9/5/96	B	<1	<0.005	<0.005	<0.005	<0.01
B3	9/5/96	B	<1	<0.005	<0.005	<0.005	<0.01
B4	9/5/96	B	<1	<0.005	<0.005	<0.005	<0.01
B5	9/5/96	B	<1	<0.005	<0.005	<0.005	<0.01
B6	9/5/96	B	<1	<0.005	<0.005	<0.005	<0.01
B7	9/5/96	B	<1	<0.005	<0.005	<0.005	<0.01
B8	9/5/96	B	<1	<0.005	<0.005	<0.005	<0.01
B9	9/5/96	B	<1	<0.005	<0.005	<0.005	0.010
B10	9/5/96	B	<1	<0.005	<0.005	<0.005	<0.01

Source: *Phase II Environmental Site Assessment* report, AEI March 3, 1997

Table 3
Water Table Elevations

Well ID	Date	Well Elevation (ft msl)	Depth to Water (ft)	Groundwater Elevation (ft msl)
MW-8	12/22/1993	4.88	6.72	-1.84
MW-10	12/22/1993	4.21	6.00	-1.79
MW-11	12/22/1993	5.04	6.84	-1.80
MW-12	12/22/1993	4.58	6.07	-1.49
MW-16	12/22/1993	5.53	7.48	-1.95
MW-8	6/30/1994	4.88	6.55	-1.67
MW-10	6/30/1994	4.21	5.79	-1.58
MW-11	6/30/1994	5.04	6.73	-1.69
MW-12	6/30/1994	4.58	6.06	-1.48
MW-16	6/30/1994	5.53	7.28	-1.75
MW-8	9/27/1994	4.88	7.20	-2.32
MW-10	9/27/1994	4.21	6.39	-2.18
MW-11	9/27/1994	5.04	7.41	-2.37
MW-12	9/27/1994	4.58	6.57	-1.99
MW-16	9/27/1994	5.53	7.93	-2.40
MW-8	1/4/1995	4.88	6.21	-1.67
MW-10	1/4/1995	4.21	5.42	-1.58
MW-11	1/4/1995	5.04	6.45	-1.69
MW-12	1/4/1995	4.58	5.50	-1.48
MW-16	1/4/1995	5.53	7.03	-1.50
MW-8	1/10/1995	4.88	5.09	-2.32
MW-10	1/10/1995	4.21	4.67	-2.18
MW-11	1/10/1995	5.04	5.72	-2.37
MW-12	1/10/1995	4.58	4.46	-1.99
MW-16	1/10/1995	5.53	6.21	-2.40
MW-24	1/10/1995	5.49	5.97	-0.48
MW-8	10/2/1995	4.88	7.66	-2.78
MW-10	10/2/1995	4.21	6.87	-2.66
MW-11	10/2/1995	5.04	7.85	-2.81
MW-12	10/2/1995	4.58	6.99	-2.41
MW-16	10/2/1995	5.53	8.40	-2.87
MW-24	10/2/1995	5.49	8.31	-2.82
MW-8	1/8/1996	4.88	7.45	-2.57
MW-10	1/8/1996	4.21	6.82	-2.61
MW-11	1/8/1996	5.04	7.91	-2.87
MW-12	1/8/1996	4.58	6.65	-2.07
MW-16	1/8/1996	5.53	8.23	-2.70
MW-24	1/8/1996	5.49	8.08	-2.59
MW-8	4/25/1996	4.88	7.32	-2.44
MW-10	4/25/1996	4.21	7.48	-3.27
MW-11	4/25/1996	5.04	7.51	-2.47
MW-12	4/25/1996	4.58	6.56	-1.98
MW-16	4/25/1996	5.53	8.06	-2.53
MW-8	3/25/1997	4.88	6.75	-1.87
MW-10	3/25/1997	4.21	5.83	-1.62
MW-11	3/25/1997	5.04	6.83	-1.79
MW-12	3/25/1997	4.58	6.03	-1.45
MW-16	3/25/1997	5.53	7.35	-1.82
MW-8	7/3/1997	4.88	8.70	-3.82
MW-10	7/3/1997	4.21	5.87	-1.66
MW-11	7/3/1997	5.04	6.83	-1.79
MW-12	7/3/1997	4.58	6.03	-1.45
MW-16	7/3/1997	5.53	7.35	-1.82

Table 3: Continued

Well ID	Date	Well Elevation (ft msl)	Depth to Water (ft)	Groundwater Elevation (ft msl)
MW-8	10/2/1997	4.88	6.70	-1.82
MW-10	10/2/1997	4.21	5.90	-1.69
MW-11	10/2/1997	5.04	6.85	-1.81
MW-12	10/2/1997	4.58	6.08	-1.50
MW-16	10/2/1997	5.53	7.36	-1.83
MW-8	1/28/1998	4.88	5.20	-0.32
MW-10	1/28/1998	4.21	4.40	-0.19
MW-11	1/28/1998	5.04	5.33	-0.29
MW-12	1/28/1998	4.58	4.54	-0.04
MW-16	1/28/1998	5.53	5.90	-0.37
MW-8	2/9/2000	4.88	5.12	-0.24
MW-10	2/9/2000	4.21	5.25	-1.04
MW-11	2/9/2000	5.04	6.25	-1.21
MW-12	2/9/2000	4.58	5.33	-0.75
MW-16	2/9/2000	5.53	6.81	-1.28
MW-8	8/9/2000*	3.96	5.15	-1.19
MW-10	8/9/2000	4.20	5.33	-1.13
MW-11	8/9/2000	5.01	6.20	-1.19
MW-12	8/9/2000	4.58	5.14	-0.56
MW-16	8/9/2000	5.51	6.74	-1.23
MW-26	8/9/2000	5.12	5.81	-0.69
MW-27	8/9/2000	4.06	5.12	-1.06
EW-01	8/9/2000	5.19	6.38	-1.19
MW-8	5/31/2001	3.96	5.54	-1.58
MW-10	5/31/2001	4.20	5.81	-1.61
MW-11	5/31/2001	5.01	6.65	-1.64
MW-12	5/31/2001	4.58	6.28	-1.70
MW-16	5/31/2001	5.51	7.14	-1.63
MW-26	5/31/2001	5.12	6.25	-1.13
MW-27	5/31/2001	4.06	5.84	-1.78
EW-01	5/31/2001	5.19	6.84	-1.65
MW-8	4/8/2002	3.96	4.85	-0.89
MW-10	4/8/2002	4.20	4.93	-0.73
MW-11	4/8/2002	5.01	5.94	-0.93
MW-12	4/8/2002	4.58	5.08	-0.50
MW-16	4/8/2002	5.51	6.45	-0.94
MW-26	4/8/2002	5.12	5.88	-0.76
MW-27	4/8/2002	4.06	5.32	-1.26
EW-01	4/8/2002	5.19	6.11	-0.92
MW-8	7/29/2002	3.96	5.22	-1.26
MW-8	9/11/2002	3.96	5.39	-1.43
MW-10	9/11/2002	4.20	5.57	-1.37
MW-11	9/11/2002	5.01	6.50	-1.49
MW-12	9/11/2002	4.58	5.67	-1.09
MW-16	9/11/2002	5.51	7.01	-1.50
MW-26	9/11/2002	5.12	6.54	-1.42
MW-27	9/11/2002	4.06	6.04	-1.98
EW-01	9/11/2002	5.19	6.66	-1.47

Notes: All elevations are measured from the top of casing.
ft msl = feet above mean sea level
NA = Not Available
*All well elevations were re-surveyed 9/5/00 by Logan Survey (lic. # 5003)

Table 4

Groundwater Quality Data

Well ID	Date	Volume Withdrawn (gallons)	Temperature (deg. C)	Qualitative Tubidity	pH	Stabilized Disolved Oxygen (mg/L)	Specific Conductivy µSeimens/cm	N (mg/L)	P (mg/L)	K (mg/L)
MW-8	12/22/1993	4.5	19.4	turbid*	-	-	-	-	-	-
MW-10	12/22/1993	7.0	20.8	moderately turbid	-	-	-	-	-	-
MW-11	12/22/1993	4.5	20.2	turbid	-	-	-	-	-	-
MW-12	12/22/1993	5.3	20.3	moderately turbid	-	-	-	-	-	-
MW-16	12/22/1993	4.5	20.5	turbid	-	-	-	-	-	-
MW-8	6/30/1994	8.0	21.0	turbid*	-	-	-	-	-	-
MW-10	6/30/1994	6.0	21.0	turbid	-	-	-	-	-	-
MW-11	6/30/1994	6.0	20.2	turbid	-	-	-	-	-	-
MW-12	6/30/1994	6.0	20.6	moderately turbid	-	-	-	-	-	-
MW-16	6/30/1994	4.5	21.8	turbid	-	-	-	-	-	-
MW-8	9/27/1994	4.5	21.6	turbid*	-	-	-	-	-	-
MW-10	9/27/1994	6.0	22.6	turbid	-	-	-	-	-	-
MW-11	9/27/1994	3.0	21.0	turbid	-	-	-	-	-	-
MW-12	9/27/1994	6.0	22.5	turbid	-	-	-	-	-	-
MW-16	9/27/1994	3.0	22.6	turbid	-	-	-	-	-	-
MW-8	1/10/1995	5.3	17.2	turbid*	-	-	-	-	-	-
MW-10	1/10/1995	6.0	19.5	turbid	-	-	-	-	-	-
MW-11	1/10/1995	5.3	18.6	turbid	-	-	-	-	-	-
MW-12	1/10/1995	6.0	19.3	turbid	-	-	-	-	-	-
MW-16	1/10/1995	6.0	19.3	turbid	-	-	-	-	-	-
MW-24	1/10/1995	41.0	18.9	turbid						
MW-8	10/2/1995	11.0	22.8	moderately turbid	6.49	-	-	-	-	-
MW-10	10/2/1995	11.0	22.6	turbid	7.20	-	-	-	-	-
MW-11	10/2/1995	12.0	22.0	moderately turbid	6.85	-	-	-	-	-
MW-12	10/2/1995	11.0	22.9	turbid	7.20	-	-	-	-	-
MW-16	10/2/1995	11.0	22.6	turbid	7.20	-	-	-	-	-
MW-24	10/2/1995	20.0	22.8	turbid	7.10					
MW-8	1/8/1996	12.0	17.30**	slightly turbid	6.74**	-	-	-	-	-
MW-10	1/8/1996	10.0	17.90**	slightly turbid	6.62**	-	-	-	-	-
MW-11	1/8/1996	5.5	17.60**	slightly turbid	6.65**	-	-	-	-	-
MW-12	1/8/1996	10.0	18.00**	slightly turbid	6.49**	-	-	-	-	-
MW-16	1/8/1996	5.0	19.00**	slightly turbid	7.50**	-	-	-	-	-
MW-24	1/8/1996	35.0	17.60**	slightly turbid	6.67**					
MW-8	4/25/1996	5.0	21.1	clear	6.53	-	-	-	-	-
MW-10	4/25/1996	5.0	22.8	slightly turbid	6.70	-	-	-	-	-
MW-11	4/25/1996	5.5	21.4	clear	6.58	-	-	-	-	-
MW-12	4/25/1996	5.0	22.4	clear	6.50	-	-	-	-	-
MW-16	4/25/1996	5.0	25.3	slightly turbid	7.12	-	-	-	-	-
MW-8	3/25/1997	10.0	18.2	clear	6.67	0.23	-	-	-	-
MW-10	3/25/1997	12.0	19.7	slightly turbid	6.79	0.35	-	-	-	-
MW-11	3/25/1997	10.0	18.6	clear	6.64	0.19	-	-	-	-
MW-12	3/25/1997	10.0	18.4	clear	6.67	0.19	-	-	-	-
MW-16	3/25/1997	10.0	17.9	slightly turbid	7.02	0.10	-	-	-	-
MW-8	7/3/1997	12.0	19.6	clear	6.43	0.04	-	<0.5	1.8	-
MW-10	7/3/1997	12.0	21.5	slightly turbid	6.67	0.17	-	-	-	-
MW-11	7/3/1997	12.0	19.4	clear	6.36	0.05	-	<0.5	1.8	-
MW-12	7/3/1997	12.0	20.6	clear	6.50	0.10	-	-	-	-
MW-16	7/3/1997	12.0	19.7	clear	6.76	0.06	-	-	-	-
MW-8	10/2/1997	4.5	21.2	clear	6.93	-	-	-	-	-
MW-10	10/2/1997	5.0	23.0	slightly turbid	7.26	-	-	-	-	-
MW-11	10/2/1997	7.0	22.9	clear	6.73	-	-	-	-	-
MW-12	10/2/1997	4.5	20.9	clear	7.15	-	-	-	-	-
MW-16	10/2/1997	7.0	19.1	slightly turbid	7.22	-	-	-	-	-
MW-8	1/28/1998	15.0	18.5	slightly greenish	6.86	0.10	-	-	-	-
MW-10	1/28/1998	15.0	20.9	moderately turbid	7.05	0.09	-	-	-	-
MW-11	1/28/1998	15.0	20.1	slightly greenish	6.74	0.11	-	-	-	-
MW-12	1/28/1998	14.0	19.8	moderately turbid	6.90	0.11	-	-	-	-
MW-16	1/28/1998	16.0	19.1	slightly turbid	7.20	0.18	-	-	-	-

TABLE 4: Continued

Well ID	Date	Volume Withdrawn (gallons)	Stabilized Temperature (deg. C)	Qualitative Tubidity	Stabilized pH	Stabilized Disolved Oxygen (mg/L)	Specific Conductivy µSeimens/cm	N (mg/L)	P (mg/L)	K (mg/L)
MW-8	2/9/2000	5.0	63.00***	slightly greenish	8.35	1.24	3120	19	3.4	35
MW-10	2/9/2000	5.0	67.7	slightly turbid	8.56	0.70	5610	15	6.4	66
MW-11	2/9/2000	5.0	63.5	slightly turbid	8.35	0.62	2980	<0.2	2.1	49
MW-12	2/9/2000	5.0	62.8	clear	8.41	1.28	2150	10	3.1	33
MW-16	2/9/2000	5.0	63.2	slightly turbid	8.63	3.13	1640	<0.2	1.8	12
EW-01	2/9/2000	32.0	60.0	slightly turbid	8.48	0.51	3190	21	1.7	51
MW-8	8/9/2000	5.0	18.9	Slightly turbid	6.68	1.55	365	-	-	-
MW-10	8/9/2000	5.0	21.9	Turbid - clears	6.68	1.63	565	-	-	-
MW-11	8/9/2000	5.5	19.7	Slightly turbid	6.48	1.48	268	-	-	-
MW-12	8/9/2000	5.0	21.3	clear	6.72	1.69	217	-	-	-
MW-16	8/9/2000	4.0	20.5	Turbid - clears	6.62	1.33	286	-	-	-
MW-26	8/9/2000	5.0	21.3	Turbid - clears	6.99	2.78	123	-	-	-
MW-27	8/9/2000	5.0	24.4	clear	6.93	2.21	146	-	-	-
EW-01	8/9/2000	31.0	18.4	Turbid - clears	6.69	1.32	471	-	-	-
MW-8	5/31/2001	4.25	18.8	clears	7.09	0.93	1339	-	-	-
MW-10	5/31/2001	4.75	20.6	clears quickly	6.98	0.86	>2000	-	-	-
MW-11	5/31/2001	5.0	18.8	clears quickly	7.09	1.28	1331	-	-	-
MW-12	5/31/2001	5.0	19.8	clears quickly	7.07	1.47	962	-	-	-
MW-16	5/31/2001	3.0	20.3	Slightly turbid	7.03	1.44	1307	-	-	-
MW-26	5/31/2001	5.0	19.6	clears quickly	7.01	1.20	615	-	-	-
MW-27	5/31/2001	5.0	22.1	clears quickly	7.06	1.74	790	-	-	-
EW-01	5/31/2001	30.0	17.8	clears quickly	7.09	1.50	>2000	-	-	-
MW-8	4/8/2002	5.0	17.3	Clears	7.30	1.02	>4000	-	-	-
MW-10	4/8/2002	5.5	19.2	Clears	7.31	1.15	>4000	-	-	-
MW-11	4/8/2002	5.0	18.0	Clears quickly	7.28	0.96	2645	-	-	-
MW-12	4/8/2002	5.0	17.9	Clears quickly	7.29	2.86	2604	-	-	-
MW-16	4/8/2002	3.0	18.0	Clear	7.29	0.81	3293	-	-	-
MW-26	4/8/2002	5.0	17.5	Greyish, clear by 2 g	7.31	0.88	1428	-	-	-
MW-27	4/8/2002	6.0	15.9	Black, clear by 3 g	7.32	1.13	1290	-	-	-
EW-01	4/8/2002	32.0	17.6	Clears quickly	7.32	1.30	>4000	-	-	-
MW-8	9/11/2002	10.0	19.8	clears quickly	6.97	3.41	>3999	-	-	-
MW-10	9/11/2002	6.0	21.4	clears quickly	7.19	1.73	>3999	-	-	-
MW-11	9/11/2002	5.0	20.0	clears quickly	7.00	1.77	2686	-	-	-
MW-12	9/11/2002	5.0	21.1	clears quickly	7.32	1.30	2488	-	-	-
MW-16	9/11/2002	3.0	20.2	Black, clear by 1 g	7.34	1.21	3123	-	-	-
MW-26	9/11/2002	4.5	2.8	Greyish, clear by 2 g	6.97	0.42	1367	-	-	-
MW-27	9/11/2002	6.0	21.0	Greyish, clear by 1 g	7.31	1.64	3990	-	-	-
EW-01	9/11/2002	31.0	19.8	clears quickly	7.03	0.60	>3999	-	-	-

Notes:
* A slight hydrocarbon sheen was reported.
** Only one measurement collected.
*** Temperature expressed in degrees Farenheight
N = Nitrogen (total)
P = Phosphorous (total)
K = Potassium
- = Data not obtained or available

Table 5
Groundwater Sample Analytical Data

	Date	TPH-g µg/L	TPH-d µg/L	TPH-o µg/L	Benzene µg/L	Toluene µg/L	Ethyl-benzene µg/L	Xylenes µg/L	MTBE µg/L	MTBE µg/L	DIPE µg/L	ETBE µg/L	TAME µg/L	TBA µg/L	EBD µg/L	1,2-DCA µg/L
		EPA method 8015M			EPA method 8020					EPA method 8260B						
MW-8	5/28/1993	19000	1000	-	6400	28	160	36	-	-	-	-	-	-	-	-
	12/22/1993	56000	300	<200	16000	5999.3	650	2700	-	-	-	-	-	-	-	-
	6/30/1994	41000	<500	500	11000	4800	2200	8200	-	-	-	-	-	-	-	-
	9/27/1994	28000	620	<200	8500	260	1600	5300	-	-	-	-	-	-	-	-
	1/10/1995	58000	70	<200	10000	11000	2400	12000	-	-	-	-	-	-	-	-
	10/2/1995	28000	<50	<500	51	16	54	80	-	-	-	-	-	-	-	-
	1/8/1996	72000	3700	<250	8600	13000	2200	12000	-	-	-	-	-	-	-	-
	1/8/1996	62000	-	-	7200	9500	1600	8000	-	-	-	-	-	-	-	-
	4/25/1996	33000	3100	-	7600	2300	1500	4800	-	-	-	-	-	-	-	-
	3/25/1997	23000	1900	-	8300	80	350	380	1500	-	-	-	-	-	-	-
	7/3/1997	14000	1400	-	6600	32	190	100	1300	-	-	-	-	-	-	-
	7/3/1997	15000	1400	-	7300	34	160	110	1700	-	-	-	-	-	-	-
	10/2/1997	7600	810	-	3500	14	37	21	890	-	-	-	-	-	-	-
	1/28/1998	21000	2700	-	5500	270	730	780	900	-	-	-	-	-	-	-
	9/9/1999	2500	-	-	790	2.8	4.7	8	380	-	-	-	-	-	-	-
	2/9/2000	39000	-	-	6400	4300	950	390	460	-	-	-	-	-	-	-
	8/9/2000	5500	-	-	1700	15	130	370	540	-	-	-	-	-	-	-
	5/31/2001	14,000	-	-	2,800	63	610	540	370	-	-	-	-	-	-	-
	8/10/2001	4,400	-	-	1,200	41	160	170	380	-	-	-	-	-	-	-
	9/25/2001	2,100	-	-	470	7.2	6.5	7.1	210	-	-	-	-	-	-	-
	12/14/2001	1800	-	-	230	34	67	150	26	-	-	-	-	-	-	-
	4/8/2002	32000	-	-	2000	820	1100	2300	62	-	-	-	-	-	-	-
	7/29/2002	4300	-	-	1200	21	58	69	280	-	-	-	-	-	-	-
	9/11/2002	**2000**	-	-	**520**	**5.4**	**11**	**8.7**	**430**	**270**	**<5.0**	**<5.0**	**<5.0**	**<50**	**<5.0**	**<5.0**
MW-10	5/28/1993	<50	54	-	<0.3	<0.3	<0.3	<0.9	-	-	-	-	-	-	-	-
	12/22/1993	<50	580	<200	<0.5	<0.7	<0.5	<0.2	-	-	-	-	-	-	-	-
	6/30/1994	<50	<50	600	<0.5	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	9/27/1994	<50	610	<200	<0.5	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	1/10/1995	<50	600	<200	<0.5	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	10/2/1995	350	<50	<500	4.4	2.6	2.3	6.4	-	-	-	-	-	-	-	-
	1/8/1996	50	<50	<250	5.8	7.1	1.2	6.4	-	-	-	-	-	-	-	-
	4/25/1996	<50	<50	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-
	3/25/1997	<50	<50	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	7/3/1997	<50	<50	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	10/2/1997	<50	110	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	1/28/1998	<50	<50	-	5.7	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	8/19/1999	<50	-	-	5.7	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	2/9/2000	<50	-	-	5.7	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	8/9/2000	<50	-	-	5.7	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	5/31/2001	<50	-	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	8/10/2001	<50	-	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	9/25/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12/14/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4/8/2002	<50	-	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	9/11/2002	**<50**	-	-	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<5.0**	**2.3**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**

Table 5: Continued

	Date	TPH-g µg/L	TPH-d µg/L	TPH-o µg/L	Benzene µg/L	Toluene µg/L	Ethyl-benzene µg/L	Xylenes µg/L	MTBE µg/L	MTBE µg/L	DIPE µg/L	ETBE µg/L	TAME µg/L	TBA µg/L	EBD µg/L	1,2-DCA µg/L
		EPA method 8015M			EPA method 8020					EPA method 8260B						
MW-11	5/28/1993	1200	<50	-	450	17	1.5	2.1	-	-	-	-	-	-	-	-
	12/22/1993	9200	530	<200	4500	38.3	12	43	-	-	-	-	-	-	-	-
	6/30/1994	8800	<50	1100	1500	13	690	1200	-	-	-	-	-	-	-	-
	6/30/1994	9700	-	-	1700	14	730	1300	-	-	-	-	-	-	-	-
	9/27/1994	15000	910	<200	6500	26	870	590	-	-	-	-	-	-	-	-
	1/10/1995	14000	1100	<200	890	220	840	2400	-	-	-	-	-	-	-	-
	10/2/1995	7100	<50	<500	47	5.7	11	36	-	-	-	-	-	-	-	-
	1/8/1996	12000	2000	<250	1200	99	790	1400	-	-	-	-	-	-	-	-
	4/25/1996	5800	1400	-	230	59	200	770	-	-	-	-	-	-	-	-
	3/25/1997	760	490	-	130	49	2.9	1	130	-	-	-	-	-	-	-
	7/3/1997	290	<50	-	<0.5	<0.5	600	<0.5	380	-	-	-	-	-	-	-
	10/2/1997	220	220	-	8.8	0.73	<0.5	0.67	720	-	-	-	-	-	-	-
	1/28/1998	540	160	-	140	0.81	<0.5	<0.5	360	-	-	-	-	-	-	-
	8/19/1999	590	-	-	180	3.2	<0.5	<0.5	720	-	-	-	-	-	-	-
	2/9/2000	680	-	-	100	3.1	<0.5	2.9	280	-	-	-	-	-	-	-
	8/9/2000	350	-	-	1.7	2.6	<0.5	0.84	410	-	-	-	-	-	-	-
	5/31/2001	280	-	-	1.1	1.6	0.25	0.25	430	-	-	-	-	-	-	-
	8/10/2001	300	-	-	0.95	1.6	0.25	0.66	340	-	-	-	-	-	-	-
	9/25/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12/14/2001	250	-	-	2.8	1.7	0.25	0.9	300	-	-	-	-	-	-	-
	4/8/2002	86	-	-	0.7	0.77	<0.5	<0.5	300							
	9/11/2002	**<50**	-	-	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**320**	**250**	**<2.5**	**<2.5**	**<2.5**	**98**	**<2.5**	**<2.5**
MW-12	5/28/1993	<50	<50	-	<0.3	<0.3	<0.3	<0.9	-	-	-	-	-	-	-	-
	12/22/1993	50	300	<200	<0.5	<0.7	<0.5	<0.2	-	-	-	-	-	-	-	-
	6/30/1994	<50	<50	400	<0.5	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	9/27/1994	<50	400	<200	<0.5	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	9/27/1994	<50	-	-	<0.5	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	1/10/1995	<50	300	<200	<0.5	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	10/2/1995	<50	<50	<500	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-
	1/8/1996	<50	<50	<250	2.4	2.7	0.54	2.8	-	-	-	-	-	-	-	-
	4/25/1996	<50	<50	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-
	3/25/1997	<50	<50	-	<0.5	<0.5	<0.5	<0.5	16	-	-	-	-	-	-	-
	7/3/1997	<50	<50	-	<0.5	<0.5	<0.5	<0.5	16	-	-	-	-	-	-	-
	10/2/1997	<50	120	-	<0.5	<0.5	<0.5	<0.5	17	-	-	-	-	-	-	-
	1/28/1998	<50	<50	-	1.3	<0.5	<0.5	<0.5	13	-	-	-	-	-	-	-
	8/19/1999	<50	-	-	<0.5	<0.5	<0.5	<0.5	9.1	-	-	-	-	-	-	-
	2/9/2000	<50	-	-	<0.5	<0.5	<0.5	<0.5	6.2	-	-	-	-	-	-	-
	8/9/2000	<50	-	-	<0.5	<0.5	<0.5	<0.5	6.4	-	-	-	-	-	-	-
	5/31/2001	<50	-	-	<0.5	<0.5	<0.5	<0.5	6.5	-	-	-	-	-	-	-
	8/10/2001	<50	-	-	<0.5	<0.5	<0.5	<0.5	5.3	-	-	-	-	-	-	-
	9/25/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12/14/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4/8/2002	51	-	-	3.1	0.98	1.2	2	<5.0	-	-	-	-	-	-	-
	9/11/2002	**<50**	-	-	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**6.2**	**3.6**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**

Table 5: Continued

	Date	TPH-g µg/L	TPH-d µg/L	TPH-o µg/L	Benzene µg/L	Toluene µg/L	Ethyl-benzene µg/L	Xylenes µg/L	MTBE µg/L	MTBE µg/L	DIPE µg/L	ETBE µg/L	TAME µg/L	TBA µg/L	EBD µg/L	1,2-DCA µg/L
		EPA method 8015M			EPA method 8020					EPA method 8260B						
MW-16	5/28/1993	<50	<50	-	2.8	0.3	<0.7	<0.9	-	-	-	-	-	-	-	-
	12/22/1993	2200	520	<200	<0.5	<0.7	<0.5	<0.2	-	-	-	-	-	-	-	-
	6/30/1994	<50	<50	900	8	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	9/27/1994	70	590	<200	17	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	1/10/1995	300	700	<200	190	<0.5	<0.5	<0.2	-	-	-	-	-	-	-	-
	10/2/1995	550	<50	<500	7.7	0.7	3.5	13	-	-	-	-	-	-	-	-
	1/8/1996	360	140	<250	<0.5	<0.5	4	9.7	-	-	-	-	-	-	-	-
	4/25/1996	1100	330	-	390	3.7	3.2	14	-	-	-	-	-	-	-	-
	3/25/1997	310	120	-	<0.5	<0.5	<0.5	1.4	2100	-	-	-	-	-	-	-
	7/3/1997	250	130	-	<0.5	<0.5	<0.5	<0.5	1900	-	-	-	-	-	-	-
	10/2/1997	290	180	-	<0.5	<0.5	<0.5	<0.5	2000	-	-	-	-	-	-	-
	1/28/1998	150	130	-	<0.5	<0.5	<0.5	<0.5	1900	-	-	-	-	-	-	-
	9/9/1999	<50	-	-	<0.5	<0.5	<0.5	<0.5	880	-	-	-	-	-	-	-
	2/9/2000	<50	-	-	<0.5	0.6	<0.5	8.7	88	-	-	-	-	-	-	-
	8/9/2000	<50	-	-	<0.5	<0.5	<0.5	<0.5	800	-	-	-	-	-	-	-
	5/31/2001	<50	-	-	<0.5	<0.5	<0.5	<0.5	69	-	-	-	-	-	-	-
	8/10/2001	<50	-	-	<0.5	<0.5	<0.5	<0.5	300	-	-	-	-	-	-	-
	9/25/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12/14/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4/8/2002	<50	-	-	1.7	0.61	0.78	1.4	45	-	-	-	-	-	-	-
	9/11/2002	**<50**	-	-	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**280**	**250**	**<2.5**	**<2.5**	**<2.5**	**33**	**<2.5**	**<2.5**
EW-01	2/9/2000	2600	-	-	800	48	21	91	750	-	-	-	-	-	-	-
	8/9/2000	6700	-	-	2700	19	120	31	1300	-	-	-	-	-	-	-
	5/31/2001	3,100	-	-	580	24	36	32	850	-	-	-	-	-	-	-
	8/10/2001	210	-	-	14	2.2	1.0	1.1	620	-	-	-	-	-	-	-
	9/25/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12/14/2001	2,400	-	-	320	57	23	70	510	-	-	-	-	-	-	-
	4/8/2002	230	-	-	37	3.1	1.5	1	190	-	-	-	-	-	-	-
	9/11/2002	**1600**	-	-	**400**	**5.2**	**22**	**56**	**630**	**470**	**<5.0**	**<5.0**	**<5.0**	**77**	**<5.0**	**<5.0**
MW-26	8/9/2000	<50	-	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	5/31/2001	<50	-	-	<0.5	<0.5	<0.5	<0.5	8.3	-	-	-	-	-	-	-
	8/10/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	9/25/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12/14/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4/8/2002	<50	-	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	9/11/2002	**<50**	-	-	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<5.0**	**0.80**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**
MW-27	8/9/2000	<50	-	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	5/31/2001	<50	-	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	8/10/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	9/25/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12/14/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4/8/2002	<50	-	-	<0.5	<0.5	<0.5	<0.5	<5.0	-	-	-	-	-	-	-
	9/11/2002	**<50**	-	-	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<5.0**	**0.52**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**

TPH-g = TPH as gasoline
TPH-d = TPH as diesel
TPH-o = TPH as motor oil

Table 6
Groundwater Sample Analytical Data: AEI-B28
June 8, 2000

Sample ID	TPH as gasoline µg/L	MTBE µg/L	Benzene µg/L	Toluene µg/L	Ethyl-benzene µg/L	Xylenes µg/L
DB-6'	150,000	<3,300	13,000	15,000	3,400	23,000
DB-20'	80,000	<600	3,500	8,900	1,800	13,000
DB-27'	1,700	<5	29	82	28	220
MDL	50	5	0.5	0.5	0.5	0.5

MDL = Method Detection Limit

ND = Not detected above the Method Detection Limit (unless otherwise noted)

µg/L = micrograms per liter (ppb)

Table 7
Groundwater Treatment System Operation Summary

Week of	Extraction	Injection		Sparging	
	volume (gallons)	Volume (gallons)	Target (IW-X)	Target (IW-X)	Duration (hours)
6/18/2001	500	0	-	-	0
6/25/2001	400	400	3,4,7,8	3,4,7,8	36
7/2/2001	700	400	1,2,5,6	3,4,7,8	38
7/9/2001	400	700	1,2,5,6	1,2,5,6	18
7/16/2001	375	400	7,8,11,12	7,8,11,12	28
7/23/2001	400	350	3,4,7,8	7,8,11,12	36
7/30/2001	700	400	3,4,7,8	3,4,7,8	32
8/6/2001	400	700	1,2,5,6	3,4,7,8	32
8/13/2001	450	400	1,2,5,6	1,2,5,6	21
8/20/2001	500	500	5,6,9,10	1,2,5,6	28
8/27/2001	750	400	5,6,9,10	5,6,9,10	35
9/3/2001	800	750	1,2,3,6	5,6,9,10	36
9/10/2001	400	0	-	1,2,3,6	9
11/12/2001*	500	0	-	-	0
11/19/2001	800	400	10,11,6,7	10,11,12,7	36
11/26/2001	400	700	3,4,7,8	3,4,7,8	27
12/3/2001	400	400	1,2,5,6	3,4,7,8	27
12/10/2001	450	400	5,6,9,10	1,2,5,6	36
12/17/2001	400	450	5,6,9,10	5,6,9,10	27
1/7/2002	500	400	1,2,3,6	5,6,9,10	36
1/14/2002	400	450	1,2,3,6	1,2,3,6	27
1/21/2002	400	400	2,3,6,7	1,2,3,6	18
1/28/2002	350	400	2,3,6,7	2,3,6,7	27
2/4/2002	0	400	7,8,11,12	2,3,6,7	9
2/11/2002	500	400	7,10,11	7,8,11,12	28
2/18/2002	400	400	7,8,11,12	7,8,11,12	36
2/25/2002	400	400	7,8,11,12	3,4,6,7	27
3/4/2002	450	850	1,2,3 & 6,7	2,3,6,7	36
Totals (approx):	**13125**	**11850**			**746**

*Equipment stolen, vandalism occurred between September 15 and 21, 2001

Table 8

Tier 2 Groundwater RBSLs (Oakland)

Pathway		*Risk Type (Cancer / Hazard)*	*Tier 2 RBSL*		*Site Maximum / Mean*[1] *µg/l*
			Residential µg/l	*Com. / Ind. µg/l*	
Benzene	Inhalation of indoor air vapors	Cancer	5600	89000	520 / 115
		Hazard	19000	540000	
	Inhalation of outdoor air vapors	Cancer	>SOL	>SOL	
		Hazard	>SOL	>SOL	
Toluene	Inhalation of indoor air vapors	Cancer	nc	nc	5.4 / 1.5
		Hazard	>SOL	>SOL	
	Inhalation of outdoor air vapors	Cancer	nc	nc	
		Hazard	>SOL	>SOL	
E-benzene	Inhalation of indoor air vapors	Cancer	nc	nc	22 / 4.3
		Hazard	>SOL	>SOL	
	Inhalation of outdoor air vapors	Cancer	nc	nc	
		Hazard	>SOL	>SOL	
Xylenes	Inhalation of indoor air vapors	Cancer	nc	nc	56 / 8.3
		Hazard	>SOL	>SOL	
	Inhalation of outdoor air vapors	Cancer	nc	nc	
		Hazard	>SOL	>SOL	
MTBE	Inhalation of indoor air vapors	Cancer	nc	nc	470 / 156
		Hazard	36000	>SOL	
	Inhalation of outdoor air vapors	Cancer	nc	nc	
		Hazard	>SOL	>SOL	

nc - chemical not considered carcinogenic

>SOL: RBLS exceeds the solubility of chemical in water

SAT: RBSL exceeds the saturation of chemical in soil

Source: Oakland, 2000.

[1] Data from monitoring event, September 11, 2002

Table 9

Tier 2 Surface Soil RBSLs (Oakland)

Pathway		*Risk Type (Cancer / Hazard)*	*Tier 2 RBSL*		*Site Maximum / mean mg/kg*
			Residential mg/kg	*Com. / Ind. mg/kg*	
Benzene	Soil Ingestion, dermal contact, and vapor inhallatoin	Cancer	19	49	0.007 (1) / 0.0027
		Hazard	63	300	
Toluene	Soil Ingestion, dermal contact, and vapor inhallatoin	Cancer	nc	nc	0.011 (1) / 0.0029
		Hazard	7,100	34,000	
E-benzene	Soil Ingestion, dermal contact, and vapor inhallatoin	Cancer	nc	nc	<0.005
		Hazard	3,900	18,000	
Xylenes	Soil Ingestion, dermal contact, and vapor inhallatoin	Cancer	nc	nc	0.010 (2) / 0.0052
		Hazard	53,000	260,000	
MTBE	Soil Ingestion, dermal contact, and vapor inhallatoin	Cancer	nc	nc	na
		Hazard	200	930	

nc - chemical not considered carcinogenic

>SOL: RBLS exceeds the solubility of chemical in water

SAT: RBSP exceeds the saturation of chemical in soil

Source: Oakland, 2000.

(1) data from post aeration analyses Batch #A

(2) data from post aeration analyses Batch #B

Mean not presented if all samples were below detection limits

Table 10

Tier 2 Subsurface Soil RBSLs (Oakland)

Pathway		*Risk Type (Cancer / Hazard)*	*Tier 2 RBSL*		*Site Maximum / Mean mg/kg*
			Residential mg/kg	*Com. / Ind. mg/kg*	
Benzene	Inhalation of indoor air vapors	Cancer	1.9	30	0.25 (1) / 0.06
		Hazard	6.2	180	
	Inhalation of outdoor air vapors	Cancer	160	620	
		Hazard	650	SAT	
Toluene	Inhalation of indoor air vapors	Cancer	nc	nc	1.0 (2) / 0.12
		Hazard	930	SAT	
	Inhalation of outdoor air vapors	Cancer	nc	nc	
		Hazard	SAT	SAT	
E-benzene	Inhalation of indoor air vapors	Cancer	nc	nc	0.28 (3) / 0.03
		Hazard	SAT	SAT	
	Inhalation of outdoor air vapors	Cancer	nc	nc	
		Hazard	SAT	SAT	
Xylenes	Inhalation of indoor air vapors	Cancer	nc	nc	2.0 (3) / 0.23
		Hazard	SAT	SAT	
	Inhalation of outdoor air vapors	Cancer	nc	nc	
		Hazard	SAT	SAT	
MTBE	Inhalation of indoor air vapors	Cancer	nc	nc	na
		Hazard	14,000	SAT	
	Inhalation of outdoor air vapors	Cancer	nc	nc	
		Hazard	SAT	SAT	

nc - chemical not considered carcinogenic

>SOL: RBLS exceeds the solubility of chemical in water

SAT: RBSP exceeds the saturation of chemical in soil

Source: Oakland, 2000.

<LDL - less than laboratory detection limits, generally 0.1 to 0.05 for MTBE

(1) - Sample EP7 (sidewall sample) 5/8/96

(2) - Sample NW14 (sidewall sample) 4/12/96

(3) - Sample EW12 (sidwall sample) 4/12/96

Table 11

Groundwater RBSLs (RWQCB): Drinking Water Resource Not Threatened

(All Concentrations Expressed in mg/l)

Chemical	Site Maximum*	Site Mean*	Ceiling Level		Indoor Air Impacts		Aquatic Life Protection (upon discharge to surface water)	Surface Water Concentration
			Nuisance Odor (upon discharge to surface)	Upper Limit	Coarse Soils	Fine Soils		
TPH-gasoline	**2,000**	**468**	5000	**50000**	na	**na**	500	na
Benzene	**520**	**115**	20000	50000	84	**5800**	46	71
Toluene	**5.4**	**1.5**	400	**50000**	76000	**530000 (sol)**	130	200000
Ethyl-Benzene	**22**	**4.3**	300	**50000**	170000 (sol)	**170000 (sol)**	290	29000
Xylenes	**56**	**8.3**	5300	**50000**	150000	**160000 (sol)**	13	na
MTBE	**470**	**156**	1800	**50000**	50000	**490000**	8000	na

Components Shown in Red are not considered valid or complete for this site (see text)

* Data from 9/11/02 groundwater monitoring event

Source: RWQCB, 2000

Table 12
Surface Soil RBSLs (RWQCB)
(All Concentrations Expressed in mg/kg)

Chemical	Site Maximum ****	Site Mean *****	Ceiling	Urban Area Ecotoxicity	Direct Exposure				Indoor Air				Groundwater Protection		
					Residential		Com. / Ind.		Residential		Com. / Ind.				
					Cancer	Non-cancer (HQ = 0.2)	Cancer	Non-cancer (HQ = 0.2)	Coarse Soils	Fine Soils	Coarse Soils	Fine Soils	Target GW Conc** (µg/l)	DAF	Soil Level
TPH-gasoline	38	5.1	500	na	na	na	na	na	na	na	na	na	500	834	**400**
Benzene	0.25	0.06	500	25	0.18	1.4	0.39	4.8	0.18*	**0.18***	0.39*	**0.39***	46	44.8	2.1
Toluene	1.0	0.12	500	150	na	120	na	400	30	310	89	520 (sat)	130	64.2	**8.4**
Ethyl-Benzene	0.28	0.03	230	na	na	300(sat=230)	na	1200(sat=230)	76	230 (sat)	220	230 (sat)	290	82.1	**24**
Xylenes	2.0	0.23	210	na	na	270(sat=210)	na	890(sat=210)	210 (sat)	210 (sat)	210 (sat)	210 (sat)	13	78.5	**1**
MTBE	na	na	100	na	34	140	79	2100	3.4	68	12	290	1800	5.59	**10**

Components Shown in Red are not considered valid or complete for this site (see text)
* Indoor Air exposure pathway levels for benzene set as direct exposure levels (RWQCB, 2001)
** Target groundwater concentration based on lowest component of Table 9, rather than lowest relevant component
*** No MTBE detected in soil above water table. Highest laboratory detection limit shown.
Groundwater Protection Soil Level = Dilution-attenuation factor (DAF) x Target Groundwater Concentration x 0.001 mg/ml

Table 13

Subsurface Soil RBSLs (RWQCB)

(All Concentrations Expressed in mg/kg)

Chemical	Site Maximum ****	Site Mean *****	Ceiling		Direct Exposure Construction/Trenchworker		Indoor Air Residential		Indoor Air Com. / Ind.		Groundwater Protection		
			Res.	Com./Ind.	Cancer	Non-cancer (HQ = 0.2)	Coarse Soils	Fine Soils	Coarse Soils	Fine Soils	Target GW Conc** (µg/l)	DAF	Soil Level
TPH-gasoline	38	5.1	5000	5000	na	na	na	na	na	na	500	834	**400**
Benzene	0.25	0.06	1000	1100	16	58	0.18	**0.18**	0.39	0.39	46	44.8	2.1
Toluene	1.0	0.12	520	520	na	4700(sat=520)	30	310	89	520(sat)	130	64.2	**8.4**
Ethyl-Benzene	0.28	0.03	230	230	na	12000(sat=230)	76	230(sat)	220	230(sat)	290	82.1	**24**
Xylenes	2.0	0.23	210	210	na	11000(sat=210)	210(sat)	210(sat)	210(sat)	210(sat)	13	78.5	**1**
MTBE	na	na	500	1000	2900	4900	3.4	68	12	290	1800	5.59	**10**

Components Shown in Red are not considered valid or complete for this site (see text)

* Indoor Air exposure pathway levels for benzene set as direct exposure levels (RWQCB, 2001)

** Target groundwater concentration based on lowest component of Table 9, rather than lowest relevant component

*** No MTBE detected in soil above water table. Highest laboratory detection limit shown.

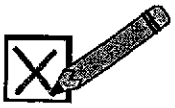
Groundwater Protection Soil Level = Dilution-attenuation factor (DAF) x Target Groundwater Concentration x 0.001 mg/ml

**** Highest concentrations remaining used for both surface and subsurface soils for RWQCB RBSL comparision

***** Highest mean or either surface or subsurface soil, see text Exhibit 3

Source: RWQCB, 2000

2.2 Qualifying for the Oakland RBCA Levels



The Oakland Tier 1 RBSLs and Tier 2 SSTLs are intended to address human health concerns at the majority of sites in Oakland where commonly-found contaminants are present. Complicated sites—especially those with continuing releases, ecological concerns or unusual subsurface conditions—will likely require a Tier 3 analysis. The checklist that comprises Table 1 is designed to assist you in determining your site's eligibility for the Oakland RBCA levels.[6]

Table 1. Oakland RBCA Eligibility Checklist

CRITERIA	YES	NO
1. Is there a continuing, *primary* source of a chemical of concern, such as a leaking container, tank or pipe? (This does *not* include residual sources.)	☐	☒
2. Is there any mobile or potentially-mobile free product?	☐	☒
3. Are there more than five chemicals of concern at the site at a concentration greater than the lowest applicable Oakland RBCA level?	☐	☒
4. Is there a preferential vapor migration pathway—such as a gravel channel or a utility corridor—that is less than 1 meter from *both* of the following? (a) A source area containing a volatile chemical of concern (b) A structure where inhalation of indoor air vapors is of concern	☐	☒
5. Do *both* of the following conditions exist? (a) Groundwater is at depths less than 300 cm (10 feet) (b) Inhalation of volatilized chemicals of concern from groundwater in indoor or outdoor air is a pathway of concern but groundwater ingestion is *not**	☐	☒
6. Are there any existing on-site or off-site structures intended for future use where inhalation of indoor air vapors from either soil or groundwater is of concern *and* one or more of the following four conditions is present? (a) Chemicals of concern located less than one meter below the structure (b) A slab-on-grade foundation less than 15 cm (6 inches) thick (c) An enclosed, below-grade space (e.g., a basement) that has floors or walls less than 15 cm (6 inches) thick (d) A crawl space that is not ventilated	☐	☒
7. Are there any immediate, acute health risks to humans associated with contamination at the site, including explosive levels of a chemical?	☐	☒
8. Are there any existing or potential exposure pathways to nearby ecological receptors, such as endangered species, wildlife refuge areas, wetlands, surface water bodies or other protected areas?	☐	☒

*If groundwater ingestion *is* a pathway of concern, the associated Oakland RBCA levels will be more stringent than those for any groundwater-related inhalation scenario, rendering depth to groundwater irrelevant in the risk analysis.

If the answer to all questions is "no", your site is eligible for both the Oakland Tier 1 RBSLs and Tier 2 SSTLs. Proceed to Section 2.3 for guidance on meeting the minimum Tier 1 and Tier 2 site characterization requirements.

RUN # 1

625 Hegenberger Road, Oakland: MTBE

				Range
Source concentration	C_0	470	ppb	
X axis dispersivity	α_x	0.10	ft	0.1 - 4
Y axis dispersivity	α_y	0.05	ft	α_y=(0.33~0.65)α_x
Z axis dispersivity	α_z	0.01	ft	
Distance to source well	x	340	ft	
Groundwater velocity	u	0.03	ft/day	0.1 - 10
Source dimension Y	Y	100		
Source dimension Z	Z	10		
First order attenuation rate	λ	0.001	1/day	0.01 - 0.001
	$x/(2*\alpha_x)$	1700.0		
[1-(1+(4laL/u))^(1/2)]	[...]	-0.0066		
Y/4(aTx)^(1/2)	Y/...	6.0634		
	erf(Y)	1.0000		
Z/4(a_vx)^(1/2)	Z/....	5.7294		
	erf(Z)	1.0000		
	exp()	0.0000		
C = C_0 * exp() * erf(Y) * erf(	**C**	**0**	ug/L	
	λ/u	0.03333333		

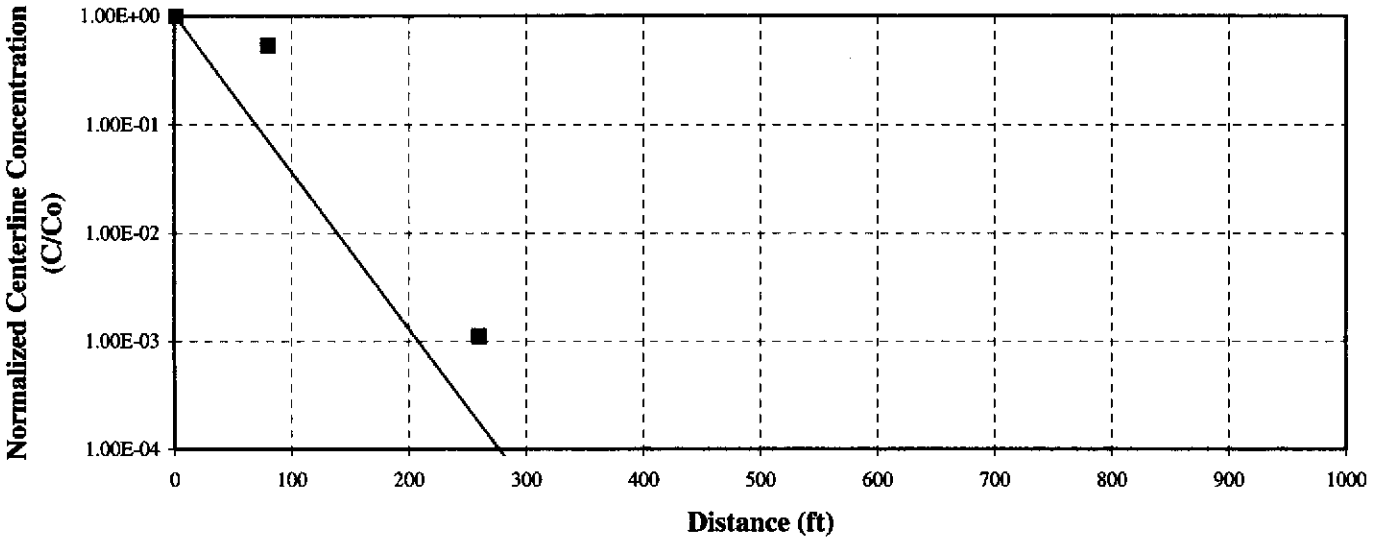
Well Name	Well No	Distance	C	C/C0
Source Well	**MW-8**	**1**	**470**	**1**
Downgradient Well 1	**MW-16**	**80**	**250**	**0.531914894**
Downgradient Well 2	**MW-27**	**260**	**0.52**	**0.001106383**

Distance	x/(2*a_L)	exp()	erf(Y)	erf(Z)	C	C/C_0
0						1
50	250	0.18992	1	1	89	0.1899
100	500	0.03607	1	1	17	0.0361
150	750	0.00685	1	1	3	0.0069
200	1000	0.0013	1	1	1	0.0013
250	1250	0.00025	1	1	0	0.0002
300	1500	4.7E-05	1	1	0	0.0000
350	1750	8.9E-06	1	1	0	0.0000
400	2000	1.7E-06	1	1	0	0.0000
450	2250	3.2E-07	1	1	0	0.0000
500	2500	6.1E-08	1	1	0	0.0000
550	2750	1.2E-08	1	1	0	0.0000
600	3000	2.2E-09	1	1	0	0.0000
650	3250	4.2E-10	1	1	0	0.0000
700	3500	7.9E-11	1	1	0	0.0000
750	3750	1.5E-11	1	1	0	0.0000
800	4000	2.9E-12	1	1	0	0.0000
850	4250	5.4E-13	1	1	0	0.0000
900	4500	1E-13	1	1	0	0.0000
950	4750	2E-14	1	1	0	0.0000
1000	5000	3.7E-15	1	1	0	0.0000

Values in GREEN are site specific
Values in RED are iterated

RUN # 1

SPREADSHEET MODEL EVALUATION



RUN # 2

625 Hegenberger Road, Oakland: MTBE

				Range
Source concentration	C_0	3,000	ppb	
X axis dispersivity	α_x	0.10	ft	0.1 - 4
Y axis dispersivity	α_y	0.05	ft	α_y=(0.33~0.65)α_x
Z axis dispersivity	α_z	0.01	ft	
Distance to source well	x	340	ft	
Groundwater velocity	u	0.03	ft/day	0.1 - 10
Source dimension Y	Y	100		
Source dimension Z	Z	10		
First order attenuation rate	λ	0.001	1/day	0.01 - 0.001
	$x/(2*\alpha_x)$	1700.0		
[1-(1+(4laL/u))^(1/2)]	[...]	-0.0066		
Y/4(aTx)^(1/2)	Y/...	6.0634		
	erf(Y)	1.0000		
Z/4(a_vx)^(1/2)	Z/....	5.7294		
	erf(Z)	1.0000		
	exp()	0.0000		
C = C_0 * exp() * erf(Y) * erf(	**C**	**0**	ug/L	
	λ/u	0.03333333		

Well Name	Well No	Distance	C	C/C0
Source Well	**MW-8**	**1**	**3000**	1
Downgradient Well 1	**MW-16**	**80**	**250**	0.083333333
Downgradient Well 2	**MW-27**	**260**	**0.52**	0.000173333

Distance	x/(2*a_L)	exp()	erf(Y)	erf(Z)	C	C/C_0
0						1
50	250	0.18992	1	1	570	0.1899
100	500	0.03607	1	1	108	0.0361
150	750	0.00685	1	1	21	0.0069
200	1000	0.0013	1	1	4	0.0013
250	1250	0.00025	1	1	1	0.0002
300	1500	4.7E-05	1	1	0	0.0000
350	1750	8.9E-06	1	1	0	0.0000
400	2000	1.7E-06	1	1	0	0.0000
450	2250	3.2E-07	1	1	0	0.0000
500	2500	6.1E-08	1	1	0	0.0000
550	2750	1.2E-08	1	1	0	0.0000
600	3000	2.2E-09	1	1	0	0.0000
650	3250	4.2E-10	1	1	0	0.0000
700	3500	7.9E-11	1	1	0	0.0000
750	3750	1.5E-11	1	1	0	0.0000
800	4000	2.9E-12	1	1	0	0.0000
850	4250	5.4E-13	1	1	0	0.0000
900	4500	1E-13	1	1	0	0.0000
950	4750	2E-14	1	1	0	0.0000
1000	5000	3.7E-15	1	1	0	0.0000

Values in GREEN are site specific
Values in RED are iterated

RUN # 2

SPREADSHEET MODEL EVALUATION