

**RISK-BASED CORRECTIVE ACTION
TIER 2
REPORT**

**Mariner Development
2203 and 2227 Mariner Square Loop
Alameda, California**

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1.0 INTRODUCTION

1.1 Purpose and Scope

The Mariner Development site at 2203 and 2227 Mariner Square Loop in Alameda, California (Figure 1) was initially evaluated in Summer 1994, and has had four quarters of monitoring and sampling results presented in reports prepared by Hydro-Environmental Technologies, Inc. (HETI). In 1996, the results from ground water sampling indicate that hydrocarbon concentrations in ground water are declining to a level where the site is a candidate for closure.

In a letter dated August 1, 1996, the Alameda County Health Care Services Agency (ACHCSA) representative requested that a risk assessment be prepared addressing any potential threats to human health or the environment from an average of the ground water concentrations observed at the site for naphthalene and benzo(a)pyrene, which are the PNAs of most concern, and Total Petroleum Hydrocarbons as Diesel (TPHd). Additionally, the report should include Total Dissolved Solids (TDS) information and a site plan with tidal channel locations.

The risk assessment was based upon a Risk-Based Corrective Action (RBCA) evaluation for the worst case scenario for the site. The risk based approach to corrective action has been developed after more than a decade of experience remediating petroleum contaminated sites, and is recommended by EPA in a memorandum from the Office of Solid Waste and Emergency Response (OSWER) number 9610.17 dated March 1, 1995. This approach allows an applicant to evaluate the potential risk to identifiable, site specific target receptors of known contaminants. The procedures are designed to provide conservative evaluations such that real risk may actually be lower.

The approach is divided into Tiers with the lowest risk Tier (Tier 1) being designed to meet all applicable regulatory criteria. Since, as is the case at the subject site, achievement of Tier 1 criteria is either technically or economically unfeasible, subsequent Tiers have been established by EPA which relate alternative levels of residual risk with specific actions an applicant or property owner must take to allow future use or development of the site.

For this site, a risk assessment was requested by the ACHCSA. A Tier 2 approach is used to show that risk levels protective of human health and the environment have been or will be reached without the need to quantitatively remove all observable contaminants. The scenario of volatilization from ground water to ambient air was used for the evaluation of risk. This scenario is based upon the concentrations remaining in well MW-1, which is located at the edge of the property and over 150 feet from the nearest structures on site. All other well's results were non-detectable for naphthalene, benzo(a)pyrene and TPHd. The RBCA evaluation is prepared with the American Society of Testing and Materials (ASTM) standard ES 1739-95 guidance, as recommended in EPA, OSWER 9610.17. TPHd does not have values within the RBCA guidelines, therefore, the average concentrations for TPHd

were compared to the Tier 1 Human Health levels set for the San Francisco International Airport (SFIA). The airport, SFIA, has similar conditions of fill over Bay Mud.

The tasks performed under the current evaluation included the following:

- Evaluate the site under ASTM Tier 2 guidelines for volatilization from ground water to ambient air .
- Prepare a site plan showing the approximate locations of the former tidal channels.
- Obtain information on the Total Dissolved Solids for ground water at the site.
- Provide recommendation for final closure.

1.2 Site Location and Background

The following narrative is a summary of activity to date at the site:

The subject site is located in Alameda, California in an area of commercial and military usage immediately adjacent to the Alameda Fleet Industrial Supply Center (Figure 1). The site is occupied by Mariner Square Athletic Club which consists of one large building housing a swimming pool, fitness center, dining area and other facilities. A day-care center is also located in the building. Also occupying the site, is a smaller building operated as a restaurant and dance club. The site is located approximately 1,300 feet from Oakland Inner Harbor. The local geology consists of fine grained fill over fine grained estuarine and marsh sediments derived from the East Bay Hills and Bay sedimentation. Regional ground water flow is predominantly westerly, towards San Francisco Bay.

The site was reclaimed from marshlands in the late 1920's. Available maps indicate tidal channels present in the former marshland now occupied by the site (Figure 2). From approximately 1930 to 1960, the San Francisco Airdrome hanger occupied the site. The hanger used to serve as an operations base for commercial and privately owned planes. The hanger housed shop facilities, offices and passenger waiting rooms. Transformers and a steam heating plant were located near the west end of the hanger. In 1960, the hanger building was cut in half and reassembled as part of the Navy's Fleet Industrial Supply Center (FISC), Alameda Annex, on property located west of the site.

Discussions with the consultant (Versar) for the FISC indicate the primary contaminants for the solid waste management unit #1 (SWMU) adjacent to the site are benzene, motor oil and naphthalene. According to the Remedial Investigation Report by Versar, sources for these compounds have reportedly been found both in soils at the SWMU and in sediments underlying the FISC and the subject site. Naphthalene and associated polynuclear aromatic compounds have been reported as associated with industrial activity (refineries) operating on the Alameda west end in the late 1800's. These compounds are

associated with the former tidal channels which were present prior to filling of the area in the early 1900s.

On June 14, 1994, HETI supervised the installation of four two-inch diameter monitoring wells designated MW-1, MW-2, MW-3, and MW-5. Concrete blocks encountered beneath the surface prevented the completion of boring B-4 into well MW-4. Monitoring well locations are shown on Figure 3, the Site Plan.

Sediments encountered during drilling consisted primarily of gravelly clay and sandy fill material overlying silty to clayey sand fill material. The sand was underlain by fat clay with sandy gravel and shell fragments (bay mud).

Total Petroleum Hydrocarbons as diesel (TPHd) were detected in all soil samples collected from all the borings. Total Petroleum Hydrocarbons as gasoline (TPHg) were detected in the soil sample collected from MW-2 only. Total Recoverable Petroleum Hydrocarbons (TRPH) were detected in the soil samples collected from MW-2 and MW-5. Benzene was not detected in any soil sample.

No PCB's, VOCs nor PNAs were detected in any of the soil samples collected. No CAM 17 metals were detected in any of the soil samples collected in concentrations exceeding typical background levels for the San Francisco Bay Area as defined in U.S.G.S. Professional Paper 1270 for the Conterminous United States. Soil sampling results were presented in the *Subsurface Investigation Report* by HETI dated October 5, 1994.

The results from the last quarterly monitoring and sampling event in June 1996 indicate that neither TPHd, TPHg nor BTEX compounds were detected above the indicated laboratory method detection limits in the ground water samples collected from wells MW-2, MW-3 and MW-5. Analytical results indicate that dissolved TPHd, TPHg and benzene were present in the ground water sample collected from well MW-1 in concentrations of 1,400 micrograms per liter ($\mu\text{g}/\text{L}$), 220 $\mu\text{g}/\text{L}$ and 1.1 $\mu\text{g}/\text{L}$, respectively.

Concentrations of polynuclear aromatics were detected above the indicated laboratory method detection limits in the ground water samples collected from wells MW-1 and MW-2. Cumulative analytical results are presented in Tables 1 and 2. These results are presented in the *Quarterly Monitoring Report, Second Quarter 1996* by HETI dated July 26, 1996.

1.3 Tier 2 Method Summary

The Tier 2- Expanded Site Assessment- was used to evaluate a site where hydrocarbon concentrations remain in ground water. The pathways, exposure scenarios, and chemicals are limited to the following, respectively, vapor from ground water at depth rising to the surface, an open space area with landscaped soil, and naphthalene, benzo(a)pyrene and TPHd. The example from the ASTM guidelines is shown in Figure 4. Other potential exposure pathways to structures were eliminated as previously described.

The Tier 2 evaluation was performed using the following equations from the ASTM guideline E 1739-95.

Equation 1 derives the volatilization factors VF_{wamb} for Ground water to ambient (outdoor) vapors. The equations used are listed in Tables X2.2, X2.3 and X2.5 of the ASTM guideline. Associated equations are $D_{eff/s}$ Effective diffusion coefficient in soil based upon vapor-phase concentration, $D_{eff/cap}$ Effective diffusion coefficient through capillary fringe, and $D_{eff/ws}$ Effective diffusion coefficient between ground water and soil surface. These parameters are contained within equation 1 and 1c, and are equations 1a, 1b and 1c, respectively.

Equation 1.

$$VF_{wamb} \left[\frac{\left(\text{mg} / \text{m}^3 \cdot \text{air} \right)}{\left(\text{mg} / \text{L} - \text{H}_2\text{O} \right)} \right] = \frac{H}{1 + \left[\frac{U_{air} \delta_{air} L_{GW}}{WD_{ws}^{eff}} \right]} \times 10^3 \frac{\text{L}}{\text{m}^3}$$

Equation 1a.

$$D_s^{eff} \left[\frac{\text{cm}^2}{\text{s}} \right] = D^{air} \frac{\theta_{as}^{3.33}}{\theta_r^2} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_r^2}$$

Equation 1b.

$$D_{cap}^{eff} \left[\frac{\text{cm}^2}{\text{s}} \right] = D^{air} \frac{\theta_{acap}^{3.33}}{\theta_r^2} + D^{wat} \frac{1}{H} \frac{\theta_{wcap}^{3.33}}{\theta_r^2}$$

Equation 1c.

$$D_{ws}^{eff} \left[\frac{\text{cm}^2}{\text{s}} \right] = (h_{cap} + h_v) \left[\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}} \right]^{-1}$$

A summary of parameters used within the equations is listed in Table 2. The parameters have been adjusted to match the conditions found at the subject site.

Equation 2 develops the Risk-Based Screening Level (RBSL) for Ground water and ambient (outdoor) vapor inhalation. The rate of inhalation for air is included with this section as Equation 2a.

∞

Equation 2.

$$RBSL_w \left[\frac{mg}{L \cdot H_2O} \right] = \frac{RBSL_{air} \left[\frac{\mu g}{m^3 \cdot air} \right]}{VF_{wamb}} \times 10^{-3} \frac{mg}{\mu g}$$

Equation 2a (Naphthalene).

$$RBSL_{air} \left[\frac{\mu g}{m^3 \cdot air} \right] = \frac{THQ \times RfD_i \times BW \times AT_n \times 365 \frac{days}{year} \times 10^3 \frac{\mu g}{mg}}{IR_{air} \times EF \times ED}$$

Equation 2a. (Benzo(a)pyrene)

$$RBSL_{air} \left[\frac{\mu g}{m^3 \cdot air} \right] = \frac{TR \times BW \times AT_c \times 365 \frac{days}{year} \times 10^3 \frac{\mu g}{mg}}{SF_1 \times IR_{air} \times EF \times ED}$$

Based upon the results from equation 2, a value is calculated which is compared to a residential RBSL which corresponds to a certain risk between 10E-4 and 10E-6 for residential developments.

2.0 Tier 2 Evaluation

The Tier 2 Risk evaluation used the above equations with the parameters listed in Table 2. The evaluation is divided into two sections based upon the equations. The first section calculates the volatilization factors for the Naphthalenes and Benzo(a)pyrene. TPHd does not have a chemical specific parameters listed within the guidelines, and will be compared to guidelines developed for similar conditions at SFIA. The second section calculates the associated risk.

The Tier 2 evaluation as defined in the ASTM guidelines makes the following assumptions:

A constant dissolved chemical concentration in ground water

The equations are biased towards predicting exposure concentrations in excess of those likely to occur.

The evaluation was performed with no remediation of soil and ground water at the site.

The exposure pathway is limited to vapors generated from ground water, which migrate through the capillary fringe and the soil to ambient air. The vapor and liquid phase diffusion is steady state.

Juliet,

The only exposure pathway considered is water to ambient air. So I suppose there is no surface or subsurface soil contamination.

On page 6, for the D_{eff}/cap calculation for naphthalene (end of the page), 0.038 has been used as water porosity concentration instead of 0.342. But I think they mistakenly typed the wrong concentration although they used the right number for calculation. Maybe you could ask them to retype just that page and then clip it on

Just for your information, they did not have to calculate the the groundwater to ambient air pathyway for benzopyrene or for naphthalene since if you look at Tier 1, the risk cannot be exceeded for any levels of naphthalene or benzopyrene. He just had to mention this instead of doing a whole risk assessment.

Madhulla Logan

That vapor concentrations remains constant over the duration of exposure, and all inhaled chemicals are absorbed. No loss of chemical occurs as it diffuses toward the ground surface.

A steady well-mixed atmospheric dispersion of the emanating vapors within the breathing zone.

2.1 Volatilization factor calculations

The volatilization factors were calculated with the parameters as follows:

Effective diffusion coefficient in soil based on vapor-phase concentration (Equation 1a)

For Naphthalene:

$$D_s^{eff} = 0.072 \frac{0.26^{3.33}}{0.38^2} + 9.4 \times 10^{-6} \frac{1}{0.049} \frac{0.12^{3.33}}{0.38^2}$$

$$= 0.0056$$

For Benzo(a)pyrene:

$$D_s^{eff} = 0.050 \frac{0.26^{3.33}}{0.38^2} + 5.8 \times 10^{-6} \frac{1}{5.8 \times 10^{-8}} \frac{0.12^{3.33}}{0.38^2}$$

$$= 0.6224$$

Solving for effective diffusion coefficient through capillary fringe (Equation 1b) resulted in the following:

For Naphthalene:

$$D_{cap}^{eff} = 0.072 \frac{0.038^{3.33}}{0.38^2} + 9.4 \times 10^{-6} \frac{1}{0.049} \frac{0.038^{3.33}}{0.38^2}$$

$$= 4.45 \times 10^{-5}$$

Handwritten notes: 0.342, 3.33, 4.29 x 10^-6, 2.4, 3.729 x 10^-5

For Benzo(a)pyrene:

$$D_{cap}^{eff} = 0.050 \frac{0.038^{3.33}}{0.38^2} + 5.8 \times 10^{-6} \frac{1}{5.8 \times 10^{-8}} \frac{0.038^{3.33}}{0.38^2}$$

$$= 19.4$$

Handwritten notes: 1.0, 0.342, 2.8079 x 10^-2, 9.314 x 10^-6

Solving for the effective diffusion coefficient between ground water and soil surface (Equation 1c) resulting in the following:

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For Naphthalene:

$$D_{ws}^{eff} = 136 \left[\frac{15}{4.45 \times 10^{-5}} + \frac{121}{0.0056} \right]^{-1}$$
$$= 488.66$$

For Benzo(a)pyrene:

$$D_{ws}^{eff} = 136 \left[\frac{15}{19.4} + \frac{121}{.6224} \right]$$
$$= 230.45$$

Using the solution for naphthalene and benzo(a)pyrene, VF_{wamb} was solved with equation 1, as follows:

For naphthalene

$$VF_{wamb} = \frac{0.049}{1 + \left[\frac{225 \cdot 200 \cdot 136}{1500 \cdot 488.66} \right]} \times 10^3$$
$$= 5.25$$

For benzo(a)pyrene

$$VF_{wamb} = \frac{5.8 \times 10^{-8}}{1 + \left[\frac{225 \cdot 200 \cdot 136}{1500 \cdot 230.45} \right]} \times 10^3$$
$$= 3.1 \times 10^{-6}$$

2.2 Risk calculations.

Using the above result for chemicals, the $RBSL_W$ for naphthalene and benzo(a)pyrene was calculated using Equation 2. The $RBSL_{air}$ was calculated first to derive this parameter for equation 2.

The $RBSL_{air}$ is calculated as follows:

For Naphthalene (noncarcinogenic)

$$RBSL_{air} \left[\frac{\mu g}{m^3 \cdot air} \right] = \frac{1.0 \times .004 \times 70 \times 30 \times 365 \times 10^3}{20 \times 350 \times 30}$$
$$= 14.57$$

For Benzo(a)pyrene (carcinogenic)

$$RBSL_{air} \left[\frac{\mu g}{m^3 \cdot air} \right] = \frac{10^{-6} \times 70 \times 70 \times 365 \times 10^3}{6.1 \times 20 \times 350 \times 30}$$
$$=.0014$$

Solving for $RBSL_w$ yields the following:

For Naphthalene

$$RBSL_w = \frac{14.57}{5.25} \times 10^{-3}$$
$$= 0.0028 \text{ mg/L} \cdot H_2O$$

For Benzo(a)pyrene

$$RBSL_w = \frac{.0014}{3.1 \times 10^{-6}} \times 10^{-3}$$
$$= .45 \text{ mg/L} \cdot H_2O$$

3.0 Risk Evaluation and Results

The $RBSL_w$ result for exposure to naphthalene is 0.0028 milligrams per liter (mg/L) or 2.8 $\mu\text{g/L}$ and for Benzo(a)pyrene is .45 mg/L or 450 $\mu\text{g/L}$ which were compared to the values listed on the example Tier 1 RBSL look up table. The values for residential cancer risk are derived from similar parameters used in this study. The table X2.1 states that the selected risk level is not exceeded for all possible dissolved levels.

The latest quarterly report concentrations for naphthalene and benzo(a)pyrene are 36 $\mu\text{g/L}$ and 0.8 $\mu\text{g/L}$, respectively. The $RBSL_w$ results for naphthalene would be exceeded by the last quarterly concentration. Since concentrations are declining and contact with ground water is restricted to monitoring and sampling activities, the risk to human health and the environment will meet the derived value within a one year.

The result of evaluation indicates that risk is within the 1E-06 or 1 cancer in one million range. This risk is considered very low to negligible.

The results were compared to the SFIA risk assessment derived levels. Since no parameters are available with the RBCA guidelines for TPHd, the SFIA Human Health Protection Zone Tier 1 Standards from the Regional Water Quality Control Board was used. The maximum ground water concentrations for the compounds of concern are listed as follows:

Benzo(a)pyrene:	On-site Maintenance worker-	0.11 $\mu\text{g/L}$
	Temporary Construction Earth Worker	0.44 $\mu\text{g/L}$

Naphthalene:	On-site Maintenance worker-	17,000 µg/L
	Temporary Construction Earth Worker	3,200 µg/L
TPHd:	On-site Maintenance worker-	5,000 µg/L
	Temporary Construction Earth Worker	5,000 µg/L
	Day Care Child	5,000 µg/L

Concentrations of TPHd range from 1,400 to 15,000 µg/L, with an average of 6,575 µg/L. The latest monitoring and sampling results indicate TPHd concentrations have declined to 1,400 µg/L. The latest results for benzo(a)pyrene would exceed the SFIA Tier 1 standard.

4.0 Total Dissolved Solids Information

The consultant for FISC was contacted for TDS information. Mr. John Bird of Versar, Inc. reported that the TDS test results for the FISC adjacent site indicated concentrations greater than 3,000 mg/L for the shallow ground water bearing zone. Concentrations for TDS reportedly ranged up to seawater levels, which are greater than 30,000 mg/L. Based upon this information, similar levels are anticipated present at the site.

5.0 Former Tidal Channel Discussion

The location of the former tidal channels are shown in Figure 2. The locations are approximate and are based upon map of Oakland West Quadrangle prepared by Radbruch, 1957. A review of the boring log results indicates that three wells, MW-2, MW-3, and MW-5, were drilled through sand possibly related to the tidal channels. MW-1 was drilled through fill and clay, and may represent the edge of the channel.

6.0 SUMMARY AND EVALUATION OF RESULTS

The results of the risk assessment are discussed below.

- The results of the assessment and quarterly monitoring indicate that concentrations of hydrocarbons have declined with time. The remaining levels of hydrocarbons are limited to well MW-1. The location of the well is greater than 150 feet from the nearest building. The other three wells have results indicating non-detectable for the chemicals of concern.
- The risk assessment calculations indicate that vapors from remaining hydrocarbons in ground water have a risk at $1E-06$. The values derived in the study and the SFIA risk assessment levels compared to the remaining concentration at the site indicate that the remaining risk is above Human Health Tier 1 standards for benzo(a)pyrene, but below the RSBA levels.
- Based upon available TDS information, ground water at the site has concentrations greater than 3,000 mg/L and more likely approaching seawater levels.
- The tidal channel map indicates that MW-1 is the only well outside a channel. The location of the well in the channel bank sediment may explain the remaining hydrocarbon concentrations observed in the ground water samples. The sample results are consistent with the observations of the FISC consultant for historical contamination along tidal channels.

7.0 CERTIFICATION

This report was prepared under the supervision of a registered geologist. All statements, conclusions and recommendations are based solely upon confirmation boring evaluation and review of available reports by Hydro-Environmental Technologies, Inc.

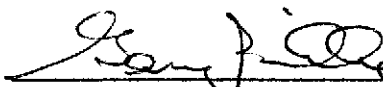
It is possible that variations in soil or ground water conditions exist beyond the points explored in past investigations. Also, site conditions are subject to change with time due to variations in rainfall, temperature, regional water usage, or other factors.

The service performed by Hydro-Environmental Technologies, Inc. has been conducted in a manner consistent with the level of care and skill ordinarily exercised by members of our profession currently practicing under similar conditions in the area of the site. No other warranty, expressed or implied, is made.

Please note that contamination of soil and ground water contamination must be reported to the appropriate agencies in a timely manner.

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

Prepared by:


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Senior Geologist

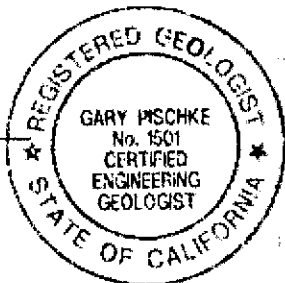


Table 1

GROUND WATER ELEVATIONS AND SAMPLE ANALYTICAL RESULTS

Mariner Development
2203 and 2227 Mariner Square Loop
Alameda, CA

Well I.D. #	Sample Date	TOC (feet)	DTW (feet)	GWE (feet)	TPHg (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	TPHd (µg/L)	TRPH (µg/L)	Cr (µg/L)
MW-1	8/11/94	98.43	7.30	91.13	390	2.2	0.91	2.1	7.8	15,000	ND<1,000	---
	12/21/95	98.43	3.80	94.63	ND<100	ND<0.5	ND<1.0	ND<1.0	ND<2.0	7,200 (1) (2)	---	ND<30
	3/19/96	98.43	3.88	94.55	270	1.3	<1.0	1.2	3.7	2,700	---	ND<30
	6/14/96	98.43	3.90	94.53	220	1.1	<0.5	1.4	2.5	1,400	---	ND<30
MW-2	8/11/94	96.68	4.59	92.09	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<1.5	ND<50	1200	---
	12/20/95	96.68	3.68	93.00	ND<100	ND<0.5	ND<1.0	ND<1.0	ND<2.0	390 (1) (2)	---	---
	3/19/96	96.68	3.93	92.75	ND<100	ND<0.5	ND<1.0	ND<1.0	ND<2.0	ND<200 (4)	---	ND<30
	6/14/96	96.68	3.04	93.64	ND<50	ND<0.5	ND<1.0	ND<1.0	ND<2.0	ND<50	---	---
MW-3	8/11/94	96.58	2.63	93.95	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<1.5	ND<50	ND<1,000	---
	12/20/95	96.58	1.91	94.67	ND<100	ND<0.5	ND<1.0	ND<1.0	ND<2.0	320 (1) (2)	---	---
	3/16/96	96.58	0.90	95.68	ND<100	ND<0.5	ND<1.0	ND<1.0	ND<2.0	ND<150 (4)	---	---
	6/14/96	96.58	1.62	94.96	ND<50	ND<0.5	ND<1.0	ND<1.0	ND<2.0	ND<50	---	---
MW-5	8/11/94	98.78	5.14	93.64	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<1.5	ND<50	ND<1,000	---
	12/20/95	98.78	4.29	94.49	ND<100	ND<0.5	ND<1.0	ND<1.0	ND<2.0	90 (1) (2)	---	---
	3/16/96	98.78	3.93	94.85	ND<100	ND<0.5	ND<1.0	ND<1.0	ND<2.0	ND<50 (4)	---	---
	6/14/96	98.78	4.08	94.70	ND<50	ND<0.5	ND<1.0	ND<1.0	ND<2.0	ND<50	---	---

Table 1

GROUND WATER ELEVATIONS AND SAMPLE ANALYTICAL RESULTS

Mariner Development
2203 and 2227 Mariner Square Loop
Alameda, CA

Notes:

- TOC : Top of well casing referenced to arbitrary elevation. Benchmark elevation approximately 11 feet above sea level.
- DTW : Depth to water.
- GWE : Ground water elevation.
- TPHg : Total petroleum hydrocarbons as gasoline by EPA Method 8015 (modified).
- BTEX : Benzene, toluene, ethylbenzene and total xylenes by EPA Method 8020.
- TPHd : Total petroleum hydrocarbons as diesel by EPA Method 8015 (modified).
- TRPH : Total Recoverable Petroleum Hydrocarbons by EPA Method 418.1.
- Cr : Chromium by EPA Method 3010A.
- µg/L : Micrograms per Liter.
- ND : Not detected above the indicated laboratory method detection limit.
- (1) : Result is estimated because the surrogate spike recovery is outside of acceptability limits.
- (2) : The material present is qualitatively uncertain. Therefore, all material in the C9 to C22 range was quantified against diesel fuel without respect to pattern.
- (3) : Qualitative identification is uncertain because the material present does not match laboratory standards.
- (4) : Data indicates the presence of hydrocarbon material heavier than diesel fuel.
- : Not analyzed.

Table 2

POLYNUCLEAR AROMATICS SAMPLE ANALYTICAL RESULTS

Mariner Development
2203 and 2227 Mariner Square Loop
Alameda, CA

Well I.D. #	Sample Date	Naphthalene µg/L	Acenaphthalene µg/L	Acenaphthene µg/L	Fluorene µg/L	Phenanthrene µg/L	Anthracene µg/L	Fluoranthene µg/L	Pyrene µg/L
MW-1	12/20/95	390	33	93	57	31	6.1	9.8	7.4
	3/19/96	78	38	88	33	32	3.1	9.6	7.3
	6/14/96	36	13	75	29	30	3.9	8.9	5.2
MW-2	12/20/95	ND<2.0	ND<2.0	ND<2.0	ND<2.0	ND<1.0	ND<1.0	ND<0.5	0.59
	3/19/96	ND<2.0	ND<2.0	ND<2.0	ND<2.0	ND<1.0	ND<1.0	ND<0.5	ND<0.5
	6/14/96	ND<2.0	ND<2.0	ND<2.0	ND<2.0	ND<1.0	ND<1.0	ND<0.5	ND<0.5
MW-3	12/20/95	ND<2.0	ND<2.0	ND<2.0	ND<2.0	ND<1.0	ND<1.0	ND<0.5	ND<0.5
	3/16/96	ND<2.0	ND<2.0	ND<2.0	ND<2.0	ND<1.0	ND<1.0	1.0	1.5
	6/14/96	ND<2.0	ND<2.0	ND<2.0	ND<2.0	ND<1.0	ND<1.0	ND<0.5	ND<0.5
MW-5	12/20/95	ND<2.0	ND<2.0	ND<2.0	ND<2.0	ND<1.0	ND<1.0	ND<0.5	ND<0.5
	3/16/96	ND<2.0	ND<2.0	ND<2.0	ND<2.0	ND<1.0	ND<1.0	ND<0.5	ND<0.5
	6/14/96	ND<2.0	ND<2.0	ND<2.0	ND<2.0	ND<1.0	ND<1.0	ND<0.5	ND<0.5

Table 2

POLYNUCLEAR AROMATICS SAMPLE ANALYTICAL RESULTS

Mariner Development
2203 and 2227 Mariner Square Loop
Alameda, CA

Well I.D. #	Sample Date	Benzo[a]-anthracene µg/L	Chrysene µg/L	Benzo[b]fluor-anthene µg/L	Benzo[k]fluor-anthene µg/L	Benzo[a]-pyrene µg/L	Dibenzo[a,h]-anthracene µg/L	Benzo[g,h,i]-perylene µg/L	Indeno[1,2,3-cd]pyrene µg/L
MW-1	12/20/95	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
	3/19/96	0.69	ND<0.5	0.57	ND<0.5	0.97	ND<0.5	1.3	1.1
	6/14/96	0.66	ND<0.5	ND<0.5	ND<0.5	0.8	ND<0.5	0.98	0.82
MW-2	12/20/95	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
	3/19/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
	6/14/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	1.1	ND<0.5
MW-3	12/20/95	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
	3/16/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
	6/14/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
MW-5	12/20/95	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
	3/16/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
	6/14/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5

Notes:

Well I.D. # : Well identification number used by HETI.

Date: Date ground water sample was collected.

µg/L : Micrograms per liter.

ND : Not detected in concentrations exceeding the laboratory method detection limit.

Polynuclear

Aromatics: Polynuclear Aromatics by EPA Method 8310.

Table 3
Risk Evaluation Parameters

Tier 2 Soil, Building, Surface and Subsurface Parameters

Parameter	Definition (Units)	Residential
η	Areal fraction of cracks in foundations/walls (cm^2 cracks/ cm^2 total area)	0.01 cm^2 cracks/ cm^2 total area
ρ_s	Soil Bulk Density (g soil/ cm^3 soil)	1.7 g / cm^3
θ_c	Total Soil porosity (cm^3/cm^3 soil)	0.38 cm^3/cm^3 soil
θ_{as}	Volumetric air content in vadose zone soils (cm^3 air/ cm^3 total volume)	0.26 cm^3 air/ cm^3 total volume
θ_{acap}	Volumetric air content in capillary fringe soils (cm^3 air/ cm^3 soil)	0.038 cm^3 air/ cm^3 soil
θ_{wcap}	Volumetric water content in capillary fringe soils (cm^3 H ₂ O/ cm^3 total volume)	0.342 cm^3 H ₂ O/ cm^3 total volume
θ_{ws}	Volumetric water content in vadose zone soils (cm^3 H ₂ O/ cm^3 soil)	0.12 cm^3 H ₂ O/ cm^3 soil
f_{oc}	Fraction of organic carbon in soil (g-C/g soil)	0.01
δ	Soil-water sorption coefficient (g. H ₂ O/ g. soil)	$f_{oc} \times k_{oc}$
h_{cap}	Thickness of capillary fringe capillary fringe (cm)	5 cm
h_v	Thickness of vadose zone (cm)	295 cm
$D_{eff/s}$	Effective diffusion coefficient for soil (cm^2/s)	Calculation
D_{air}	Diffusion coefficient in air (cm^2/sec)	Benzene- 0.093 cm^2/sec Toluene- 0.085 cm^2/sec Ethyl benzene- 0.076 cm^2/sec Mixed xylenes- 0.072 cm^2/sec
D_{wat}	Diffusion coefficient in water (cm^2/sec)	Chemical specific
$D_{eff/ws}$	Effective diffusion coefficient between ground water and soil surface(cm^2/sec)	Calculation
ER	Enclosed space air exchange rate (L/s)	0.00014 s^{-1}
H	Henry's Law constant (cm^3 H ₂ O/ cm^3 air)	Benzene used - 0.22 L H ₂ O/L air or 5.5×10^{-3} $\text{m}^3\text{atm}/\text{mol}$
LB	Enclosed space volume/infiltration area ratio (cm)	200 cm
δ_{air}	Ambient air mixing zone height (cm)	200 cm

Tier 2 Soil, Building, Surface and Subsurface Parameters

Parameter	Definition (Units)	Residential
U_{air}	Wind speed above ground surface in ambient mixing zone (cm/sec)	225 cm/s
L_{crack}	Enclosed-space foundation or wall thickness (cm)	15 cm
L_{gw}	Depth to ground water = ($h_{cap} + h_v$, cm)	15cm
k_{oc}	Carbon-water sorption coefficient (g. H_2O/g C)	Benzene- $\log = 1.92$
VF_{wamb}	Volatilization Factor vapor in ground water to outdoor vapor (mg/m^3 air/ mg/l water)	Calculation

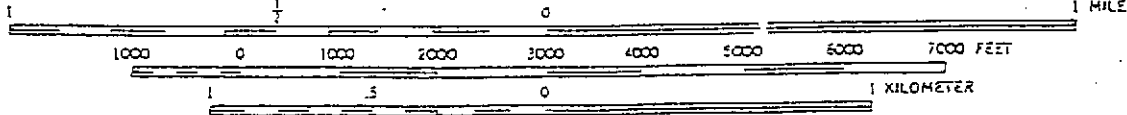
Tier 2 Exposure Parameters

Parameter	Definition (Units)	Residential
AT_c	Averaging time for carcinogens (year)	30 years
BW	Adult body weight (kg)	70 kg
ED	Exposure duration (years)	30 years
EF	Exposure frequency (days/year)	350 days/year
IR_{air}	Daily indoor inhalation rate (m^3/day)	$15 m^3/day$
$RBSL_{air}$	Risk-Based screening level for enclosed space vapor inhalation (air) ($\mu g/m^3$ air)	Calculation
$RBSL_w$	Risk-Based screening level for ground water (mg/l s)	Calculation
SF_i	Inhalation cancer slope factor ($(mg/kg \text{ day})^{-1}$)	Benzene- 0.029 $kg \text{ day}/mg$
TR	Target excess individual lifetime cancer risk (unitless)	1.0

Parameters derived ASTM guideline ES 38



SCALE 1:24 000



QUADRANGLE LOCATION

SOURCE: USGS 7.5 MINUTE SERIES (TOPOGRAPHIC)
 TITLED: OAKLAND WEST QUADRANGLE
 PHOTOREVISED 1980

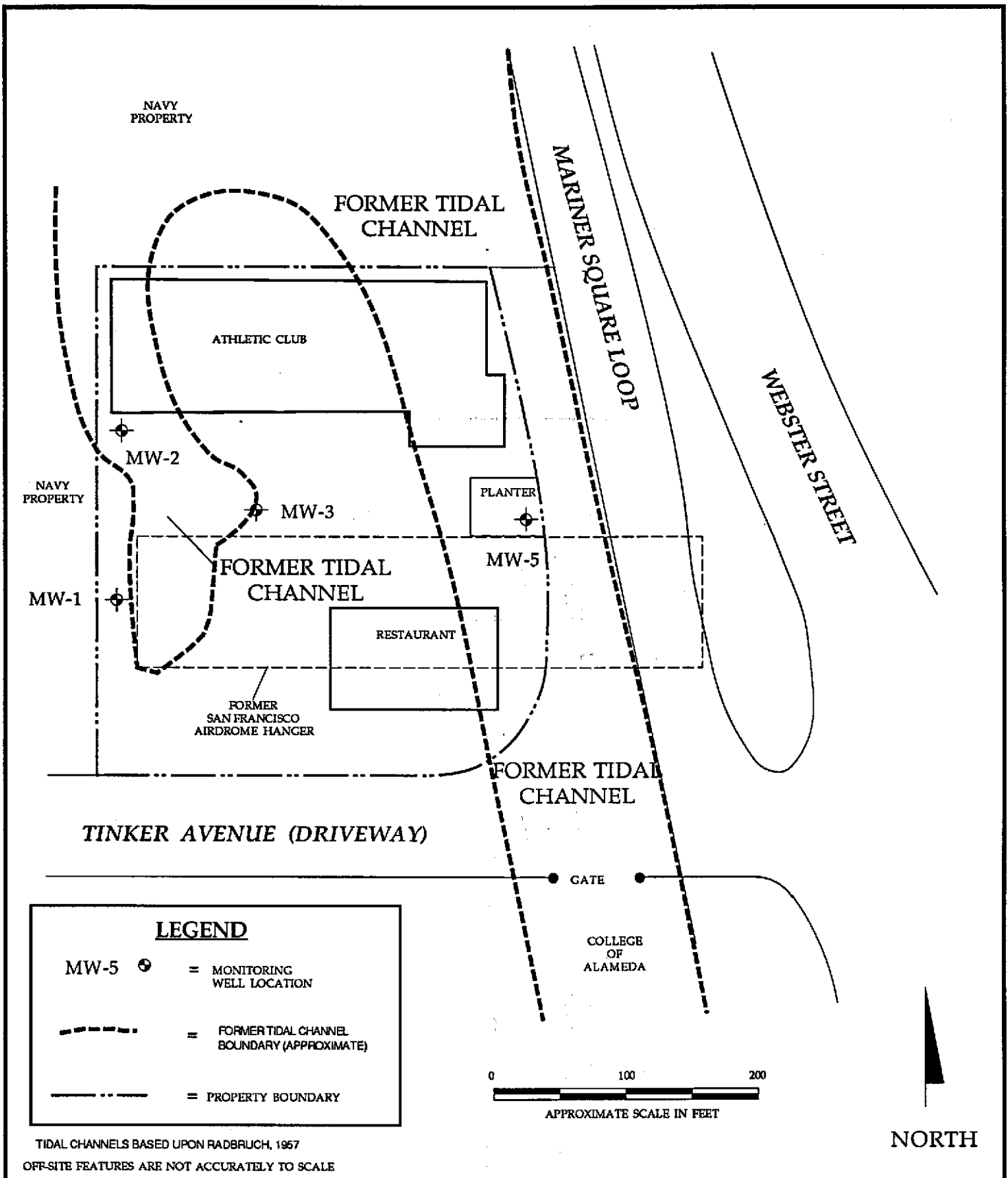
NORTH

HYDR -
 ENVIR -
 ENVIRONMENTAL
 TECHN -
 LOGIES, INC.

SITE LOCATION MAP
 Mariner Development Company
 2203 and 2227 Mariner Square Loop
 Alameda, California

Figure
 1

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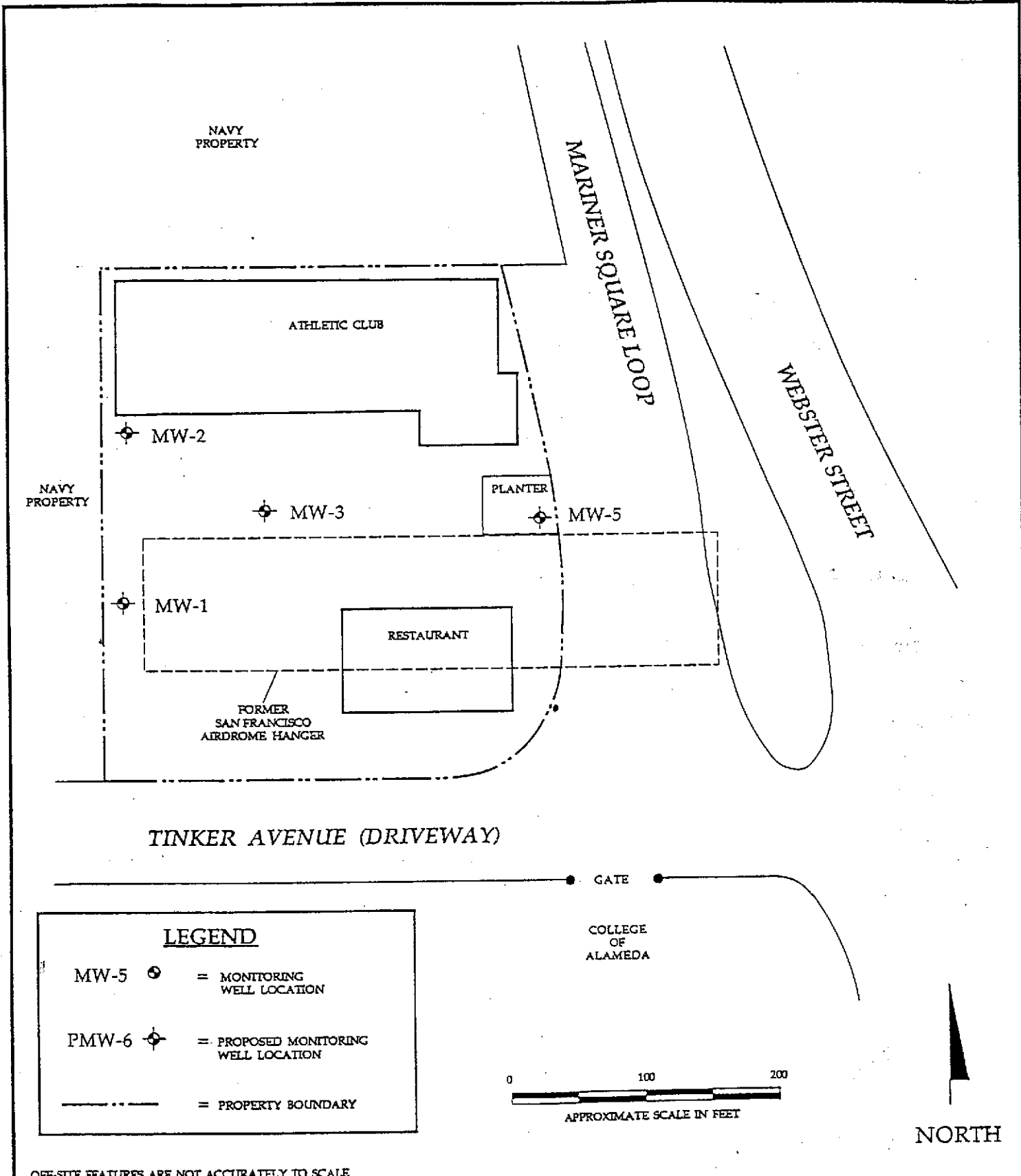


HYDR -
ENVIR **NMENTAL**
TECHN **LOGIES, INC.**


SITE PLAN WITH FORMER TIDAL CHANNELS
Mariner Development Company
2203 and 2227 Mariner Square Loop
Alameda, California

Figure
2

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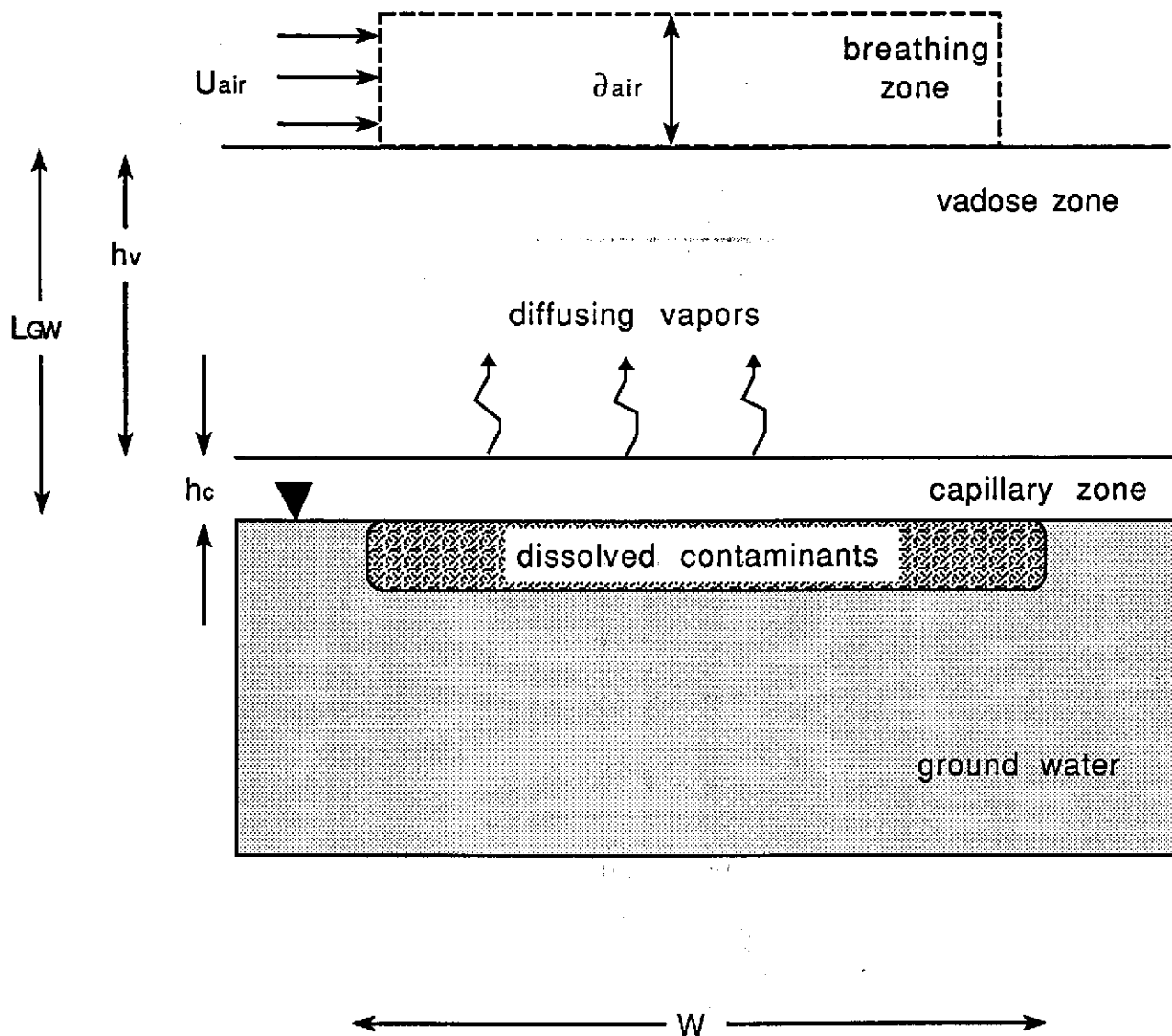


OFF-SITE FEATURES ARE NOT ACCURATELY TO SCALE

HYDR  **ENVIR**  **NMENTAL**
TECHN  **LOGIES, INC.**

SITE PLAN
 Mariner Development Company
 2203 and 2227 Mariner Square Loop
 Alameda, California

Figure
3
 7-284.1 12/95



From ASTM Fig. X2.1

HYDR-
ENVIRONMENTAL
TECHNOLOGIES, INC.

Volatilization Diagram
 Mariner Development Company
 2203 and 2227 Mariner Square Loop
 Alameda, California

Figure
 4

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