aqua science engineers inc.

April 3, 1997

REMEDIAL ACTION PLAN
FOR
REMEDIATION OF HYDROCARBON IMPACTED GROUNDWATER

at
Zima Center Corporation
2951 High Street
Oakland, California

Submitted by:
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1.0 INTRODUCTION

This submittal outlines Aqua Science Engineer's, Inc. (ASE) remedial action plan for groundwater remediation at 2951 High Street in Oakland, California (Figure 1). The proposed remediation activities were initiated by the property owner, Mr. Mohammad Mashhoon, in accordance with the requirements of the Alameda County Health Care Services Agency (ACHCSA). Based on the site history presented below and limitations on other remedial options, ASE is proposing one-time Oxygen Releasing Compound (ORC) application as the preferred remedial option at the site.

2.0 SITE HISTORY

UST

In September 1993, one (1) 300-gallon waste oil underground storage tank (UST) was removed by Alpha Geo Services of Santa Clara, California. One soil sample was collected by Soil Tech Engineering, Inc. (STE) approximately two (2) feet beneath the former UST. This sample contained 40 parts per million (ppm) total petroleum hydrocarbons as gasoline (TPH-G), 120 ppm total oil and grease (TOG), 0.13 ppm benzene, 0.33 ppm toluene, 0.018 ppm ethylbenzene, 0.50 ppm total xylenes, 0.091 ppm 1,1,2,2-tetrachloroethane and 0.034 ppm 1,1,2-trichloroethane. A soil sample collected from the stockpiled soil produced during the UST removal contained 48 ppm TPH-G, 70 ppm TOG, 0.65 ppm benzene, 1.8 ppm toluene, 0.38 ppm ethylbenzene, 2.5 ppm total xylenes, 0.036 ppm 1,1,2,2-tetrachloroethane and 0.085 ppm 1,1,2-trichloroethane. No total petroleum hydrocarbons as diesel (TPH-D), semi-volatile organic compounds (SVOCs) or elevated metal concentrations were detected in these samples.

In October 1993, STE overexcavated approximately 40 cubic yards of contaminated soil from the former waste oil UST area. Confirmation soil samples were then collected from each excavation sidewall as well as from the floor of the excavation. Up to 2.6 ppm TPH-G, 3,700 ppm TOG, 0.014 ppm benzene, 0.013 ppm toluene, 0.005 ppm ethylbenzene, 0.018 ppm total xylenes and 0.042 ppm tetrachloroethylene (PCE) were detected in the confirmation soil samples. The TOG concentration of 3,700 ppm was, however, only in one location. The other samples contained TOG concentrations ranging from non-detectable to 120 ppm. The contaminated soil was subsequently disposed of at the Forward Landfill in Stockton, California under manifest.

In February 1995, STE drilled four (4) soil borings at the site and installed groundwater monitoring wells in the borings. No hydrocarbons were detected in soil samples collected from borings MW-1 and MW-3. Up to 3.5 ppm TPH-G, 21 ppm TOG, 0.005 ppm toluene, 0.0058 ppm ethylbenzene and 0.054 ppm total xylenes were detected in soil samples collected from monitoring well MW-2. Up to 110 ppm TPH-D, 1,900 ppm TPH-G, 200 ppm TOG, 3.5 ppm benzene, 4.7 ppm toluene, 3.9 ppm ethylbenzene and 11 ppm total xylenes were detected in the soil sample collected from 6-feet below ground surface (bgs) in monitoring well MW-4. Much lower hydrocarbon concentrations (4.6 ppm TPH-G, 0.048 ppm benzene, 0.026 ppm toluene, 0.037 ppm ethylbenzene and 0.06 ppm total xylenes) were detected in the soil sample collected from 11-feet bgs in boring MW-4, and no hydrocarbons were detected in the soil sample collected from 16-feet bgs in boring MW-4. Groundwater samples were collected following the installation and development of the monitoring wells. 3,300 parts per billion (ppb) TPH-G, 470 ppb TPH-D, 18,000 ppb TOG, 9.6 ppb benzene, 13 ppm toluene, 8 ppb ethylbenzene and 28 ppb total xylenes were detected in groundwater samples collected from monitoring well MW-2. Only 280 ppb TPH-D and 600 ppb TOG were detected in groundwater samples collected from monitoring well MW-1 with no TPH-G or benzene, toluene, ethylbenzene and total xylenes (BTEX) concentrations detected. No hydrocarbons were detected in the groundwater samples collected from monitoring well MW-3, and no volatile organic compounds (other than BTEX) were detected in groundwater samples collected from any of the monitoring wells. Monitoring well MW-4 contained a sheen and was not sampled. The groundwater flow direction at the time of this initial assessment was to the north.

Following the initial assessment, the site was placed on a quarterly groundwater sampling schedule. During the next two quarters, up to 4,600 ppb TPH-G, 39 ppb benzene, 18 ppb toluene, 21 ppb ethylbenzene and 39 ppb total xylenes were detected in groundwater samples collected from monitoring well MW-2. No hydrocarbons were detected in groundwater samples collected from monitoring wells MW-1 and MW-3 during this period. In addition, no TPH-D, TOG or VOCs (other than BTEX) were detected in any of the groundwater samples during this period. Monitoring well MW-4 contained a sheen throughout this period and was not sampled. During the May and August 1995 sampling periods, the groundwater flow direction was to the south.

In June 1996, ASE drilled five soil borings at the site and collected soil and groundwater samples for analysis. ASE also collected groundwater samples from monitoring well MW-4. 39 ppm TPH-G, 0.43 ppm benzene, 0.086 ppm toluene, 0.47 ppm ethylbenzene, 1 ppm total xylenes and 0.90

ppm MTBE were detected in the soil sample collected from 5.0-feet bgs in boring BH-A. 0.045 ppm benzene, 0.043 ppm toluene, 0.021 ppm total xylenes and 2.0 ppm MTBE were detected in the soil sample collected from 15.0-feet bgs in boring BH-B. No TPH-G or BTEX were detected in the soil samples collected from borings BH-C, BH-D and BH-E. MTBE concentrations in these samples ranged from non-detectable at a detection limit of 0.005 ppm to 1.7 ppm. Relatively high hydrocarbon concentrations were detected in most of the water samples analyzed, especially those from borings BH-A, BH-B and monitoring well MW-4. These borings are to the north or west of the existing USTs. Groundwater concentrations were as high as 23,000 ppb TPH-G, 4,600 ppb benzene, 2,800 ppb toluene, 700 ppb ethylbenzene, 2,700 ppb total xylenes and 13,000 ppb MTBE in boring BH-A. 4,000 ppb TPH-G, 490 ppb benzene, 680 ppb toluene, 100 ppb ethylbenzene, 520 ppb total xylenes and 620 ppb MTBE were detected in groundwater samples collected from boring BH-B. 2,500 ppb TPH-G, 230 ppb benzene, 64 ppb toluene, 99 ppb ethylbenzene, 110 ppb total xylenes and 5,700 ppb MTBE were detected in groundwater samples collected from monitoring well MW-4. Much lower hydrocarbon concentrations were detected in groundwater samples collected from borings BH-C and BH-E. Groundwater was encountered in these borings at 26-feet bgs which is much deeper than in the pre-existing site monitoring wells. No groundwater was encountered in boring BH-D.

In December 1996 and January 1997, ASE drilled two soil borings and installed groundwater monitoring wells MW-5 and MW-6 in the borings. 1,600 ppm TPH-G, 17 ppm benzene, 69 ppm toluene, 39 ppm ethylbenzene and 170 ppm total xylenes were detected in the soil sample collected from 6.0-feet bgs in boring MW-5. 3,600 ppb TPH-G, 180 ppb benzene, 350 ppb toluene, 81 ppb ethylbenzene, 510 ppb total xylenes and 430 ppb MTBE were detected in groundwater samples collected from monitoring well MW-5. No hydrocarbons were detected in either soil or groundwater samples collected from monitoring well MW-6.

Analytical results for all groundwater samples collected from the site are included in Table 1.

The groundwater flow direction is not clear at the site. The flow direction has at times been calculated as northward, southward and eastward. However, since the highest hydrocarbon concentrations lie north of the site's USTs, a groundwater flow direction to the north is assumed for this workplan and risk assessment.

3.0 RISK ASSESSMENT

A risk assessment was performed for the site using criteria outlined by Ms. Madhulla Logan of the ACHCSA at a meeting with ASE on March 11, 1997. This risk assessment was performed by ASE in conjunction with Christopher Palmer, R.G., C.E.G., H.G. The scenarios addressed were (1) vapor intrusion from groundwater to neigboring residence, (2) vapor intrusion from groundwater to commercial building on-site, and (3) exposure of construction workers to vapors. A copy of the risk assessment is included in Appendix A. Based on this risk assessment, a groundwater cleanup level of 34 ppb for the residential vapor point exposure and 110 ppb for commercial vapor point exposure were set as a cleanup goal. No soil cleanup was required for exposure to vapors for construction workers. Since conservative default parameters were used in the risk calculation, soil samples may be collected during the the coarse or this remediation project in order to evaluate actual permeability parameters at the site. This data will allow ASE to better evaluate risk at the site if it is not possible to remediate the groundwater to the initial cleanup goals set in the risk assessment enclosed in this report.

4.0 REMEDIAL OPTIONS

The following remedial options were considered for this site:

1) Overexcavation

Overexcavation of contaminated soil and either on-site treatment or off-haul to a disposal facility was considered as a remedial option. However, for the following reasons, overexcavation is not considered a reasonable option for this site: (1) the risk assessment only reveals groundwater (vapor from groundwater into buildings) as being the primary exposure pathway of concern, (2) overexcavation of contaminated soil removes the source of groundwater contamination but does not remediate groundwater contamination itself, and (3) the only soil contaminated with hydrocarbon concentrations of concern lies in the inaccessible narrow area between the existing USTs and the northern property line.

2) Groundwater "Pump and Treat"

Groundwater pump and treat was considered as a groundwater remediation option. Although "pump and treat" is considered an effective method of containing a hydrocarbon plume, "pump and treat" has very limited success in remediating groundwater contamination in the many years it has been used. It is also a very costly method which takes many years for any significant remediation to be realized. For these reasons, it was ruled out as a remedial option at this site.

3) In-Situ Bioremediation

In-situ bioremediation was considered as a remedial option at the site. There are several options to achieve this form of remediation which involves increasing the amount of dissolved oxygen in the groundwater to enhance naturally occurring aerobic bacterial degradation of petroleum hydrocarbons in-situ. It has been known for some time that naturally occurring bacteria readily degrade (digest) petroleum hydrocarbons into harmless byproducts. Although anaerobic bacteria will degrade petroleum hydrocarbons, the rate is much slower then with aerobic bacteria. Depleted levels of oxygen appear to be the primary limiting factor for aerobic bacterial activity. Four methods to increase dissolved oxygen in groundwater to enhance aerobic bacterial degradation are air sparging, injection of hydrogen peroxide, periodic application of Oxygen Releasing Compound (ORC) and one-time application of ORC.

3a) Air Sparging

In-situ air sparging is a proven method of increasing the amount of dissolved oxygen in groundwater. It also forces hydrocarbons from the groundwater into the vadose (unsaturated) zone where they are often removed with vapor extraction. Although ASE likes this technology, there are several factors which would limit its usage at this site. These factors include the required installation of air sparge wells in an unusual pattern around the site's USTs, air sparging requires an air source (usually an air compressor) which may be a noise nuisance in a residential neighborhood, and most importantly the subsurface geology is not conducive to this technology, especially if vapor extraction from the vadose zone is required, since there is a high clay content in soils beneath the site.

3b) Injection of Hydrogen Peroxide

Injection of diluted hydrogen peroxide into well points installed at the site is a relatively low cost method of increasing dissolved oxygen in groundwater. The three main disadvantages for the use of this technology at this site are (1) that the groundwater contamination lies in areas in an unusual pattern around the site's USTs, thus requiring the installation of more wells than typically required for this technology, (2) the uncertainty of the groundwater flow direction beneath the site is more of a critical factor for this technology than other technologies since the hydrogen peroxide needs to flow with the groundwater to areas where the treatment is needed most, and (3) the sediments beneath the site do not have a high hydraulic conductivity which is less than ideal for this treatment.

3c) Periodic application of ORC

Periodic application of ORC to existing monitoring wells is a common, but usually ineffective, means of increasing oxygen in groundwater. To use this type of treatment would require the installation of additional monitoring wells and would have the same limitation as listed for the injection of hydrogen peroxide listed above.

3d) One-time application of ORC

A one-time application of ORC in boreholes installed in a tight pattern in areas of contamination is estimated to be the most effective, lowest cost remedial option for the site. ORC is injected in boreholes located in a close pattern in areas of contamination. This option will make the uncertainty of groundwater flow direction and the low permeability sediments less of a factor since the ORC in each borehole will only need to treat soil a few feet from each boring.

A list of each method (other than overexcavation) with anticipated costs, advantages and disadvantages is included as Table 2.

5.0 PROPOSED SCOPE OF WORK

ASE's proposed SOW is as follows:

1) Prepare a site safety plan;

2) Obtain all necessary permits from the appropriate agencies;

3) Drill 18 soil borings at the locations shown on Figure 2;

4) Inject ORC slurry into each boring;

5) After a drop in hydrocarbon concentrations is noted in groundwater samples collected during quarterly groundwater monitoring, collect confirmation groundwater samples at the site;

6) Report the subsurface investigation results.

Each of these tasks are described in detail below.

TASK 1 - PREPARE A SITE SAFETY PLAN

Based on the site history and the analytical results of the soil and groundwater samples collected during the previous site investigations, a site-specific safety plan will be prepared. The safety plan will identify potential site hazards and specifies procedures to protect site workers and the public. This safety plan will also specifically identify procedures on handling ORC. A nearby hospital will be designated in the site safety plan as the emergency medical facility of first choice.

TASK 2 - OBTAIN ALL NECESSARY PERMITS FROM THE APPROPRIATE AGENCIES

Drilling permits will be obtained from the Alameda County Flood Control and Water Conservation District (Zone 7). A notification card will also be sent to the California Department of Water Resources (DWR). Underground Service Alert (USA) will also be contacted at least 48 hours prior to drilling to have all known utilities marked in the immediate site vicinity.

TASK 3 - DRILL SOIL BORINGS AT THE SITE

A total of 18 soil borings to a depth of 35-feet bgs will be drilled at the site in the locations shown in Figure 2 using a Geoprobe or other similar type drill rig. All drilling will be directed by a qualified geologist. Undisturbed soil samples may be collected as deemed appropriate. If samples are collected, the samples will be collected in stainless steel or acetate tubes using a drive sampler. Selective soil samples may be prepared for analyses. These samples will be immediately removed from the sampler, trimmed, sealed with Teflon tape and plastic caps, secured with duct tape, labeled with the site location, sample designation, date and time the sample was collected, and the initials of the person collecting the sample. The samples will be placed into an ice chest containing ice for delivery under chain of custody to a CAL-EPA certified analytical laboratory. Soil from the remaining tubes not sealed for laboratory analysis may be removed for hydrogeologic description and screened for volatile compounds with an organic vapor meter (OVM). The soil will be screened by emptying soil from one of the tubes into a plastic bag. The bag will be sealed and placed in the sun for approximately 10 minutes. After the hydrocarbons have been allowed to volatilize, the OVM will measure the vapor through a small hole, punched in the bag. These OVM readings will be used to decide if samples will be analyzed at the analytical laboratory.

All sampling equipment will be cleaned in buckets with brushes and a TSP or Alconox solution, then rinsed twice with tap water. All downhole equipment will be steam cleaned between borings and prior to departure. Rinsates will be contained on-site in sealed and labeled Department of Transportation approved 55-gallon (DOT 17H) drums for disposal by the client at a later date.

TASK 4 - BACKFILL THE BORINGS WITH ORC

The ORC will be mixed and injected into the borings using a grout pump. Specific instructions on this injection method provided by Regenesis, the manufacturer of ORC, is included as Appendix B. The slurry will be mixed with a 40% ORC solid content using approximately 26.5-gallons of water per boring. This percentage may be modified as the project progresses to maximize efficiency. The ORC will be placed in the borings between 5-feet bgs to 35-feet bgs. The remainder of the boreholes will be backfilled with neat cement to the ground surface.

TASK 5 - COLLECT CONFIRMATION SAMPLES

After a drop in hydrocarbon concentrations is noted in groundwater samples collected during quarterly groundwater monitoring, confirmation groundwater samples will be collected from the site. Three borings will be drilled at the site with a Geoprobe or similar type drill rig for the collection of groundwater samples (Figure 3). Drilling will be halted at the water table and a Powerpunch or similar type device will be utilized to collect groundwater samples from the boring. The groundwater samples will be contained in 40-ml volatile organic analysis (VOA) vials without headspace, preserved with hydrochloric acid, labeled with the site location, sample designation, date and time the samples were collected, and the initials of the person collecting the samples, placed in protective foam sleeves, and cooled in an ice chest with wet ice for transport to a state-certified analytical laboratory under chain-of-custody. Following collection of the groundwater samples, the boreholes will be backfilled with neat cement.

A groundwater sample collected from each boring will be analyzed at a CAL-EPA certified analytical laboratory for TPH-G by modified EPA Method 5030/8015 and BTEX and MTBE by EPA Method 8020.

TASK 6 - PREPARE A REPORT OUTLINING THE REMEDIATION EFFECTIVENESS

A report outlining the methods and effectiveness of this remediation will be prepared following the collection of the confirmation groundwater samples. The report will be submitted under the seal of a California registered engineer or geologist. This report will include a summary of all relevant work performed at the site.

6.0 SCHEDULE

It appears at this time that this project will have to be placed out to bid in order to be eligible for reimbursement from the California State Underground Storage Tank Cleanup Fund. The successful bidder will set the schedule once the contract is awarded; however, since there are time limitations on this cleanup, it is expected that the cleanup will take place within a couple weeks of the completion of the bidding process.

Should you have any questions or comments, please feel free to call us at (510) 820-9391.

Respectfully submitted,

AQUA SCIENCE ENGINEERS, INC.

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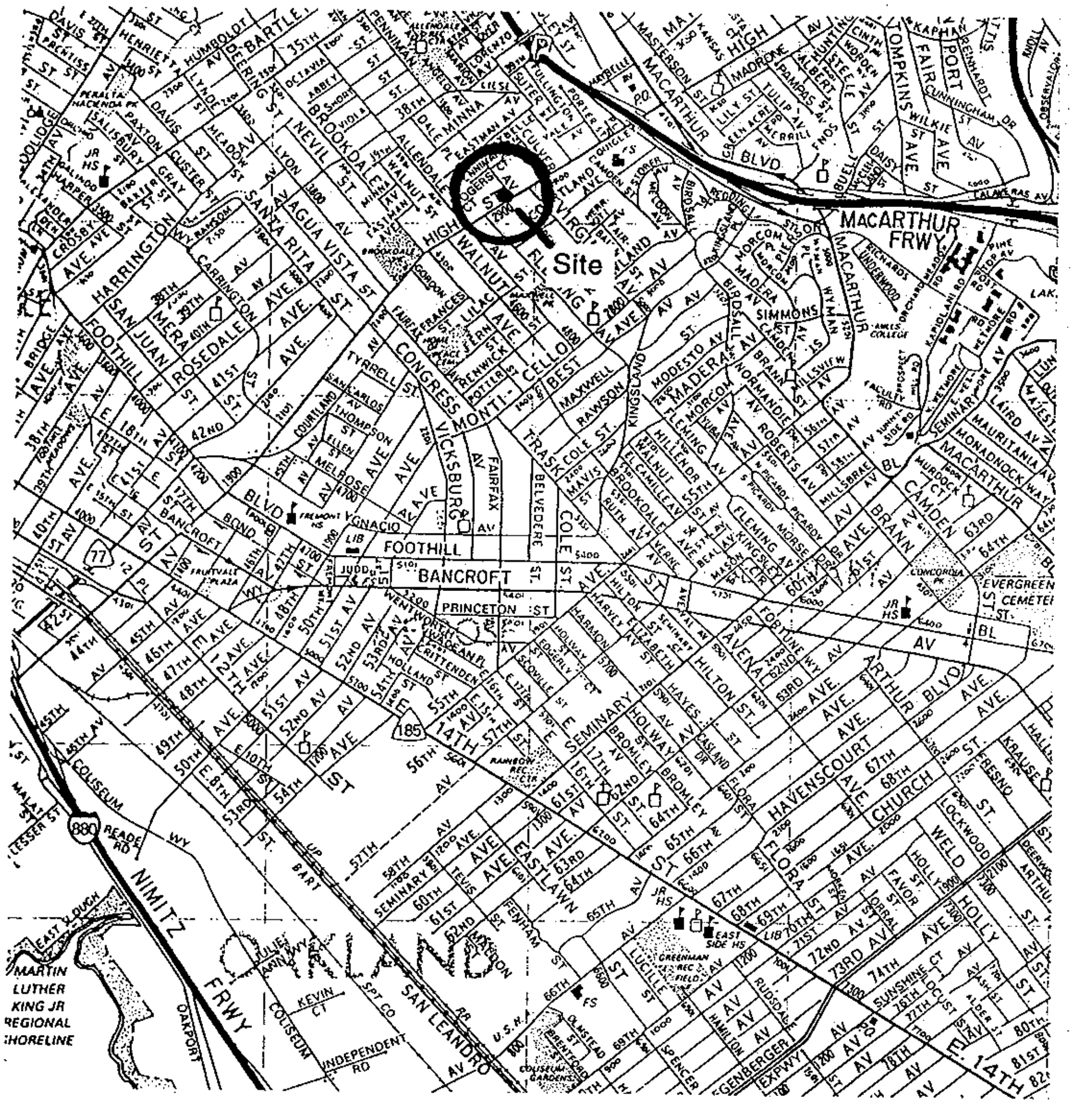
Mr. Kevin Graves, RWQCB, San Francisco Bay Region, 2101 Webster Street, Suite 500, Oakland, CA 94612

Ms. Linda Sanborn, California State Underground Storage Tank Cleanup Fund, P.O. Box 944212, Sacramento, CA 94244-2120

FIGURES

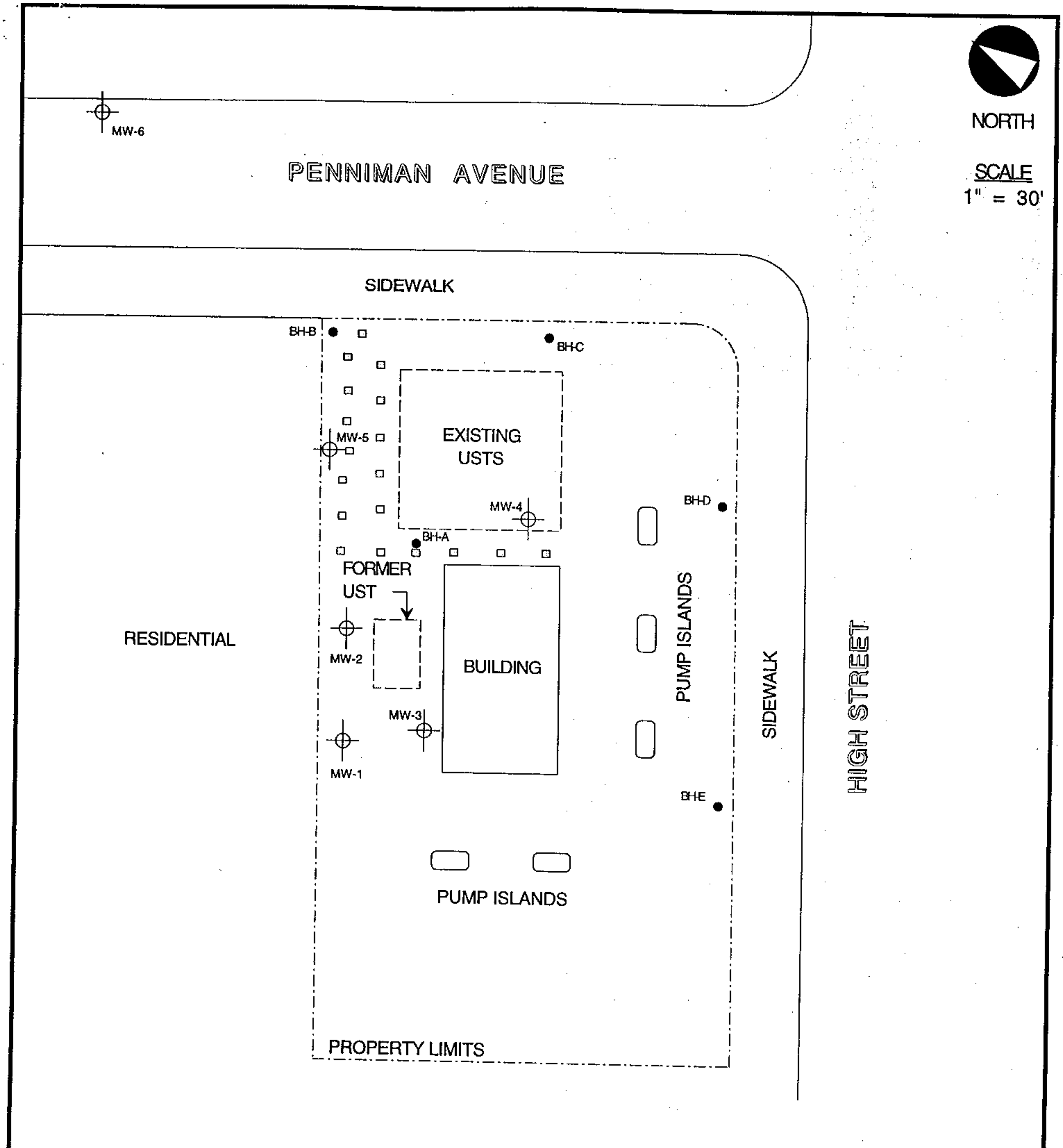


SITE LOCATION MAP

ZIMA CENTER CORPORATION
2951 HIGH STREET
OAKLAND, CALIFORNIA

AQUA SCIENCE ENGINEERS, INC.

FIGURE 1



LEGEND

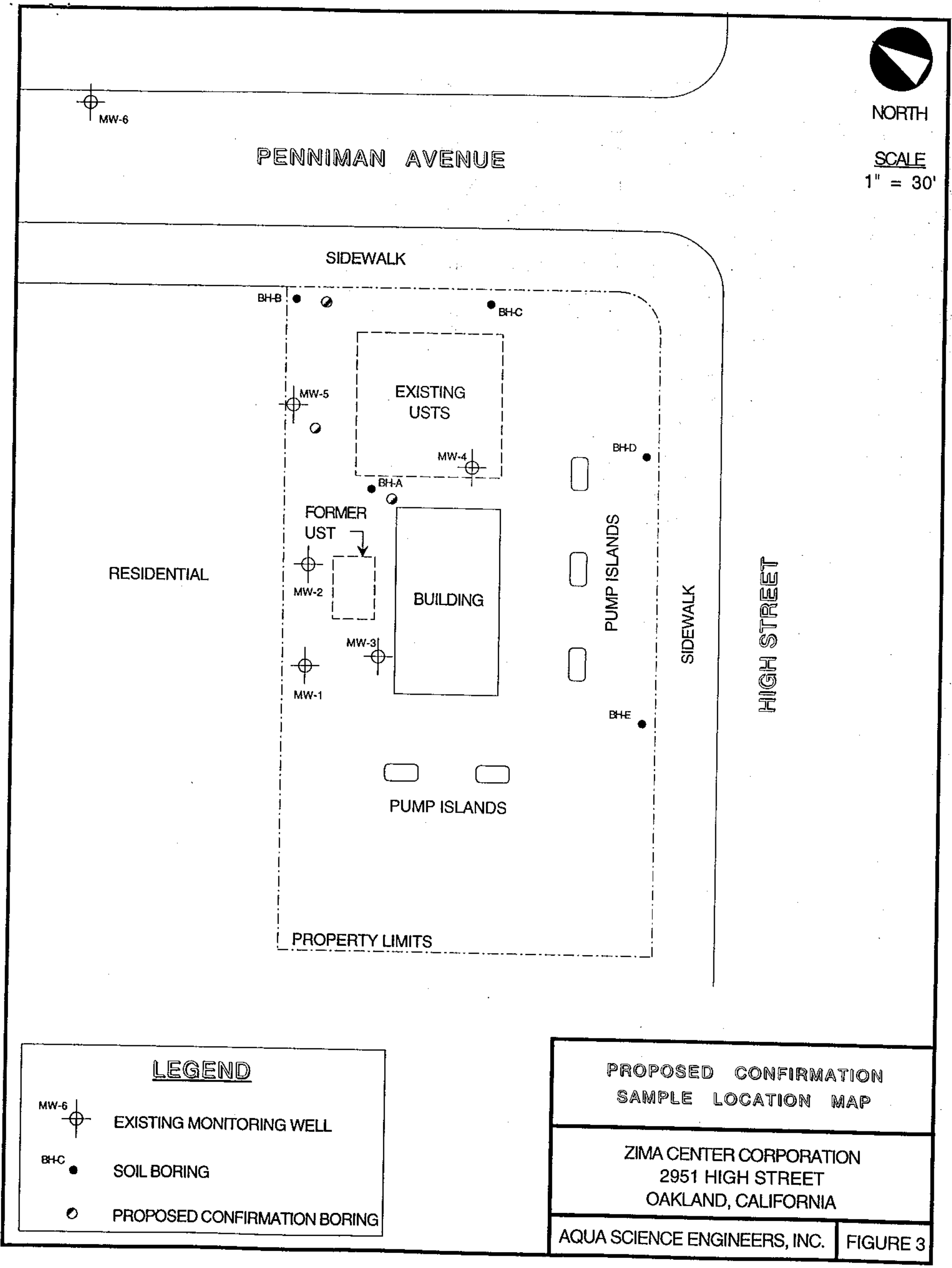
MW-6 ⊕	EXISTING MONITORING WELL
BH-C ●	SOIL BORING
☐	PROPOSED ORC BORING

PROPOSED ORC BORING LOCATION MAP

ZIMA CENTER CORPORATION
2951 HIGH STREET
OAKLAND, CALIFORNIA

AQUA SCIENCE ENGINEERS, INC.

FIGURE 2



PROPOSED CONFIRMATION SAMPLE LOCATION MAP

ZIMA CENTER CORPORATION
2951 HIGH STREET
OAKLAND, CALIFORNIA

AQUA SCIENCE ENGINEERS, INC.

FIGURE 3

TABLES

TABLE ONE

Summary of Chemical Analysis of **GROUNDWATER** Samples
All results are in **parts per billion**

Date Sampled	TPH-G	Benzene	Toluene	Ethyl Benzene	Total Xylenes	MTBE
BH-A						
06-26-96	23,000	4,600	2,800	700	2,700	13,000
BH-B						
06-26-96	4,000	490	680	100	520	620
BH-C						
06-26-96	200	4.8	1.4	3.8	5.8	16,000
BH-E						
06-26-96	220	38	5.8	9.0	16	340
MW-1						
02-23-95	<50	<0.5	<0.5	<0.5	<0.5	---
05-26-95	<50	<0.5	<0.5	<0.5	<0.5	---
08-23-95	<50	<0.5	<0.5	<0.5	<0.5	---
MW-2						
02-23-95	3,300	9.6	13	8	28	---
05-26-95	4,600	39	18	21	39	---
08-23-95	<50	15	6	10	15	---
12-13-96	1,900	110	110	120	330	65
MW-3						
02-23-95	<50	<0.5	<0.5	<0.5	<0.5	---
05-26-95	<50	<0.5	<0.5	<0.5	<0.5	---
08-23-95	<50	<0.5	<0.5	<0.5	<0.5	---
MW-4						
06-26-96	2,500	230	64	99	110	5,700
MW-5						
12-13-96	3,600	180	350	81	510	430
MW-6						
01-13-97	<50	<0.5	<0.5	<0.5	<0.5	<5

Notes:

Non-detectable concentrations are noted by the less than sign (<) followed by the detection limit.

Table 2: Summary of Groundwater Remediation Alternatives for Zima Center Corporation, 2951 High Street, Oakland, CA

METHOD	DURATION	COST	ADVANTAGES	DISADVANTAGES
Pump and treat using air-stripping and thermal oxidation. Treated water discharge by NPDES	Unknown, possibly 2 to 5 years.	$100,000 to $200,000 first year.	• Prevents further migration of contamination (plume capture)	• High cost and high maintenance • Primarilly useful for plume capture and not aquifer restoration • No longer considered an efficent or cost effective remediation alternative • Noise • Water discharge point needed for NPDES • Monthly electrical and gas costs • Large area needed for equipment • Long remediation time-frame
Air-sparging for enhanced insitu biodegradation.	Unknown, possibly 2 to 5 years	$40,000 to $60,000 first year	• Considered a proven method for aquifer restoration • Relatively low maintenance once established • No treatment or discharge of water needed • Relatively small area needed for equipment	• Does not prevent migration of contamination. May enhance migration • AQMD may require vapor extraction and treatment of air • Noise • High monthly electrical cost • Air sparging wells needed • Possibly long remediation time-frame
Injection of hydrogen peroxide for enhanced insitu biodegradation.	Unknown, possibly 2 to 5 years	$25,000 to $30,000 first year	• Relatively low cost • Relatively low maintenance once established • No treatment or discharge of water needed • Existing wells can be used • Relatively small area needed for equipment • Low monthly utilities cost • Does not enhance migration of contamination • Low noise	• Does not prevent migration of contamination • Possibly long remediation time-frame • Experimental technology
Periodic appliction of Oxygen Releasing Compound (ORC) to groundwater	Unknown, possibly 2 to 5 years	$20,000 to $30,000 first year	• Relatively low cost • Low maintenance once established • No treatment or discharge of water needed • No permanant equipment needed • Low monthly utilities cost • Does not enhance migration of contamination • No on-going noise	• Does not prevent migration of contamination • Possibly long remediation time-frame • Experimental technology • Additional wells needed • Sole-source supplier of ORC
One-time application of Oxygen Releasing Compound (ORC) to groundwater	Unknown, possibly 3-4 months	$20,000 to $30,000	• Low cost • No maintenance • No treatment or discharge of water needed • No monthly utilities cost • Does not enhance migration of contamination • No on-going noise	• Does not prevent migration of contamination • Unknown remediation time-frame • Experimental technology • Multiple borings needed • Sole-source supplier of ORC • May need to re-apply if first application is not adequate

APPENDIX A

Risk Assessment