

August 29, 2000

Amended January 7, 2002

Mr. Bill Thompson
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Dear Mr. Thompson:

The following is the amended Workplan for oxygen augmentation into wells R3, RS5, RS7 and trench wells T1, T2, T3 and T4 at former Desert Petroleum Station #793.

1.0 SITE LOCATION AND DESCRIPTION

Former Desert Petroleum #793 is a non-active service station, located on the northwest corner of the intersection of Park Boulevard and Hampel Street at 4035 Park Blvd., Oakland, California. The site is located in projected section 32; T1S; R3W; MDB&M at an approximate elevation of 210 feet above mean sea level.

2.0 INTRODUCTION

The following amends the August 29, 2000 workplan to augment the ongoing natural bioremediation at former Desert Petroleum Inc. station DP 793. Gasoline was discovered trickling into a sewer manway on Brighton Avenue on November 30, 1989. The station was closed and all contents removed from the tanks by December 7, 1989. The UST's were removed on June 23, 1994 and over-excavation of on-site contaminated soils occurred August 14, 1995. Various assessments have delineated the gasoline plume and show that the gasoline release followed the sewer main from the station to Brighton Avenue sewer manway. A receptor trench was installed along Brighton Avenue on August 12, 1999. On August 26, 1999 during the 1/4ly sampling round selected wells were also tested for the potential of natural biodegradation, see Western Geo-Engineers report "Further Assessment, Installation of Brighton Avenue Receptor Trench and 3rd Quarter 1999 Groundwater monitoring". The August 29, 2000 workplan was developed to enhance the natural biodegradation that is occurring along the parameters of the groundwater plume associated with this site. Groundwater pumped from the receptor trench and well RS5 was treated with activated carbon and dumped to the sanitary sewer located at the site (4035 Park Blvd.). Comparing the groundwater plume prior to pumping and sewer discharge (August 1999) to the groundwater plume after pumping and sewer discharge (May 2001) showed a dramatic reduction in the groundwater plume. A meeting to discuss "if further remedial actions were warranted at or near the site" was held at Alameda County Health. Review and discussion of the actions that have been taken and the

results obtained indicated that nutrient augmentation was probably not warranted, but of greater benefit would be enhancement of the dissolved oxygen. This workplan has been developed to provide the means for enhancing dissolved oxygen near and within the hydrocarbon plume.

3.0 BIOREMEDIATION

Bacteria native to the soil at hydrocarbon contamination sites normally degrade hydrocarbons. The most effective hydrocarbon degraders (eaters) are the aerobic (oxygen using) bacteria. The amount of available dissolved oxygen is usually the factor controlling the rate that these bacteria degrade the gasoline.

A much slower degradation process starts when the dissolved oxygen is depleted. The plume begins to become anaerobic and the bacterium commences to reduce nitrate, ferric iron, and sulfate to further degrade the hydrocarbons. Eventually, as these compounds and the oxygen are used, the bacteria begin methogenesis, in which the hydrocarbons are converted to methane.

The results of prior bioremediation sampling (August and September 1999) indicate that natural attenuation/bioremediation is active at this site and methogenesis is occurring. In a number of the wells the biodegradation has proceeded to the point that nearly all of the electron acceptors and the nutrients that bacteria require to degrade gasoline have been consumed while a significant amount of hydrocarbons remain.

The most current bioremediation sampling (December 2001) shows similar results to that of the 1999 sampling but indicate that nutrient augmentation is not necessary at this time and oxygen enhancement would be beneficial.

All of the wells show the impact of active biodegradation. It is not therefore possible to determine a background level of the compounds. The closest approximation for background levels at this site is the highest concentrations of electron acceptors and the lowest levels of by-products.

Compound	Function	Concentration		Well
		1999	2001	
Dissolved Oxygen (O ₂)	Electron Acceptor	4.9 mg/l	5.5 mg/L	MW1 / R3
Nitrate	Electron Acceptor	2.7 mg/l	11.4 mg/L	RS2
Sulfate	Electron Acceptor	>77 mg/l	>77 mg/L	R2 & R3 / RS2, RS6, R2 & R3
Ferrous Iron	By-product	0.25 mg/l	0 mg/L	MW1
Methane	By-product	<0.00001 mg/l		MW1
Carbon Dioxide	By-product	0.058 mg/l		RS8
Aerobic Bacteria	By-product	10 CFU/ml		MW1

mg/L milligrams per liter (parts per million)

CFU/ml plate count per milliliter

All of the tested wells have reduced levels of dissolved oxygen.

Since the 1999 sampling Both Nitrate and Sulfate have rebounded, with Nitrate increasing from 0.8 to 6 mg/L in down gradient well RS7 and Sulfate increasing from non-detectable levels to 49 mg/L in well RS8.

The presence of Ferrous Iron and Methane in the wells indicates that biodegradation has progressed to the point that the system is oxygen deficient and the bacteria have started to reduce the iron to provide oxygen for the degradation. The Ferrous Iron outline has been reduced in size, indicating the groundwater near and associated with the hydrocarbon plume is not as oxygen deficient.

The carbon dioxide (CO₂) levels in the groundwater indicate that a portion of the hydrocarbons have been degraded. CO₂ and water are the final byproducts of the biodegradation of hydrocarbons. The carbon in CO₂ results from the oxidation of the hydrocarbon radical CH₂ and as such 1 mg of CO₂ = 0.41 mg of CH₂ (CH₂ (12+1+1 = 14) / (CO₂ (12+16+16=34).

The presence of methane (CH₄) indicates that a number of the wells have progressed into methogenesis.

The levels of electron acceptors present and the presence of the reaction products, carbon dioxide, methane and ferrous iron indicate that the bacteria in the soil and the compounds in the groundwater have the capability to consume a significant amount of hydrocarbons.

Comparison of the hydrocarbon degrader counts (amount of bacteria) to the TPHg concentration, electron acceptors, byproducts, and nutrients, indicate that the addition of oxygen can have a significant effect on the bioactivity, see Table 3 of Third Quarter 2000 report and Table 2 of Fourth Quarter 2001 report.

The current TPHg concentrations show that only two of the wells, compared to five wells in 1999, contain greater than 10 mg/l of TPHg with a high of 48 mg/L at T1. This indicates that it would be beneficial to increase the biodegradation capacity of the aquifer. The most cost beneficial way to do this is by adding dissolved oxygen.

The current groundwater plume covers an area of approximately 10160 square feet. The affected water bearing strata is an estimated 16 feet thick and extends from 10 to 26 feet below the surface at well RS5. The plume volume is 162,560 cubic feet. Assuming a porosity of 0.3, the plume contains 48,768 cubic feet, 364,785 gallons or 1,380,711 liters of water.

4.0 BIO -AUGMENTATION

4.1.1 Air Sparging

Due to the close proximity of residential multistory apartments to the treatment compound, mechanical equipment, such as air pumps, compressors, etc would create a noise problem. The alternative is to chemically add the oxygen to the groundwater.

4.1.2 Hydrogen Peroxide

A 21% solution of hydrogen peroxide can be handled without special permits. The solution would be metered and/or batch dumped into select wells. Special personnel protective equipment would be necessary for the individual monitoring and/or handling the hydrogen peroxide. Due to the highly oxidizing nature of hydrogen peroxide care against splash/spillage of the solution would be necessary along with labeling for emergency response personnel, i.e. fire and police etc. A special compound would need to be constructed to store the hydrogen peroxide containers, metering pumps and distribution lines.

4.1.3 Oxygen Release Compound

Oxygen Release Compound "(ORC) is a proprietary formulation of magnesium peroxide intercalated with food-grade phosphates." The ORC socks are placed into select wells and once exposed to the groundwater allow for a continual release of oxygen for a period of up to a year (dependent upon the groundwater conditions). These socks once placed do not need maintenance and special handling protective equipment is not required.

R2? R52? R3?

Oxygen augmentation is suggested upgradient the station building at R1, upgradient of RS8 at RS5, along the receptor trench at T1, T2, T3 and T4 and upgradient of RS9 at RS7. Ideally this will cause the water near the well to become saturated with oxygen.

RS8, 60?

4.1.4 NUTRIENT ADDITION

As found during the September 2, 1999 sampling round the phosphate and ammonia levels are reduced to levels that negatively effects the biodegradation rate. After approximately 6 months using ORC an evaluation will be made to whether additional nutrient augmentation is necessary. If it is necessary to augment with supplemental nutrients sodium hexametaphosphate and ammonium sulfate maybe added to the wells in order to augment the levels of these compounds.

4.1.4.1 Phosphate

Research of the current literature indicates that the direct addition of orthophosphate may cause the precipitation of insoluble phosphate salts, thus plugging the infiltration wells and the surrounding aquifer.

In sodium hexametaphosphate (SHMP), the phosphate is in the form of polyphosphate which and forms complex ions with the calcium and iron ions and does not precipitate out of solution. Additional sodium SHMP has a neutral pH of 7 and may be used in the treatment of potable water.

4.1.4.2 Ammonium Sulfate

In addition to the SHMP, ammonium sulfate as an ammonia source could be used. In addition to ammonia, this will also supply some sulfate, an important electron acceptor, to the system.

5.0 HYDROCARBON CONTAMINATION

The primary mass of hydrocarbon contamination remaining after the over-excavating and the installation of the receptor trench was found to be 2885 pounds in the soil with significant amounts (102 pounds) to be found in the groundwater, August 1999. The soil contamination is present in three phases; absorbed onto the soil, vapor and free phase. The free phase product has been found either coating the sand grains or as a floating product layer. Presently there is no significant floating product plume associated with this site.

The amount bound to the soil (2885 pounds) was found by contouring the results of the soil samples taken during test borings to find the resulting areas and volumes, see Table 5 and Figures 5 - 9 of Third Quarter 2000 report.

The mass in groundwater (102 pounds, August 1999) was found by contouring the August 24, 1999 ground water results and calculating the volume of contaminated water, as shown in Table 5 and Figures 10 and 11 of Third Quarter 2000 report. Current conditions (December 2001) indicate that this mass has been significantly reduced to 20.14 pounds TPHg and 1.77 pounds Benzene, see Figures 5 and 5-1 and Table 5.

Past experience has shown that significant levels of soil hydrocarbons can be removed through vapor extraction. Examinations of lithology beneath this site and along Brighton Avenue show that the formation is too clayey for this technology to have any degree of success.

Groundwater remediation will greatly benefit from elevating the dissolved oxygen levels in the groundwater within and near the plume. The least intrusive means to accomplish this would be to place socks containing ORC into selected wells (R3, RS5, RS7, T1, T2, T3 and T4) and monitor the levels of dissolved oxygen in the wells associated with the site periodically to evaluate if additional wells should be used for ORC placement.

6.0 INTERESTED PARTIES

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<p>Mr. Leroy Griffin Oakland Fire Dept. OES Haz Mat Mgmt Program 1605 Martin Luther King Jr. Drive Oakland, CA 94612</p>	<p>Steve Marquez SWRCB, Cleanup Fund 2014 T Street Sacramento, CA 95814</p>
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4.0 LIMITATIONS

This report is based upon the following:

- The observations of field personnel.
- The results of laboratory analyses performed by a state certified laboratory.
- Referenced documents.
- Our understanding of the regulations of the State of California and Alameda County, Hazardous Materials Section and/or City of Oakland, California.


Changes in groundwater conditions can occur due to variations in rainfall, temperature, local and regional water usage and local construction practices. In addition, variations in the soil and groundwater conditions could exist beyond the points explored in this investigation.

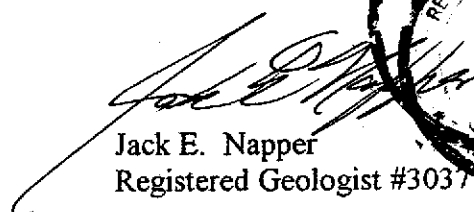
State certified analytical results are included in this report. This laboratory follows EPA and State of California approved procedures; however, WEGE is not responsible for errors in these laboratory results.

The services performed by Western Geo-Engineers, a corporation, under California Registered Geologist #3037 and/or Contractors License #513857, have 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 State of California and the Oakland area. Our work and/or supervision of remediation and/or abatement operations, active or preliminary, at this site is in no way meant to imply that we are owners or operators of this site. Please note that known contamination of soil and/or groundwater must be reported to the appropriate agencies in a timely manner. No other warranty, expressed or implied, is made.

If you have any questions concerning this report or if we can be of further assistance, please don't hesitate to contact us at (530) 668-5300.

Respectfully,


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