RECEIVED

1:41 pm, Aug 10, 2007

Alameda County
Environmental Health

Mr. Jerry Wickham
Hazardous Materials Specialist
Alameda County Health Care Services Agency
Environmental Health Services
Environmental Protection
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502

RE: Eagle Gas Station
4301 San Leandro Street
Oakland, California 94601
LOP StID# 2118
Fuel Leak Case No. RO0000096
USTCF Claim No. 014551
Clearwater Group Project # ZP046I

Dear Mr. Wickham,

As the legally authorized representative of the above-referenced project location, I have reviewed the *Site Data Review and Design of HVDPE Pilot Test Plan* prepared by my consultant of record, Clearwater Group, Inc. I declare, under penalty of perjury, that the information and/or recommendations contained in this report are true and correct to the best of my knowledge.

Sincerely,

Muhammad Jamil

Mr. Muhammad Jamil
Date: 8-8-07

June 18, 2007

Ms. Karel Detterman
Clearwater Group
229 Tewksbury Avenue
Richmond, CA 94801

Subject: Site Date Review and Design of HVDPE Pilot Test Plan
Eagle Gas Station
4301 San Leandro Street
Oakland, California

Dear Ms. Detterman:

CCA has prepared this review of reports for the Eagle Gas Station located at 4301 San Leandro Street, Oakland, California (Site) in accordance with the scope of work outlined in Clearwater Group Purchase Order 719 and following discussions at a site meeting held on May 24, 2007. The Site data review was performed to evaluate potential remedial strategies with the specific objective to design a HVDPE pilot test plan. The following Artesian/Clearwater Group reports were reviewed to assess site conditions and determine the applicability of HVDPE to site conditions:

- Underground Storage Tank Removal Report, dated May 24, 1999
- Notice of Interim Remediation Groundwater Treatment Pilot Test, dated November 1, 2005
- Bench Test for Using Advanced Oxidation – A summary Report, dated March 27, 2006
- Activated Carbon and Organoclay (EC300) Bench Test Report, dated May 9, 2006
- Soil and Groundwater Investigation Report, dated May 30, 2006
- Revised Work Plan, dated December 19, 2006

Petroleum hydrocarbons have been released to Site soil and groundwater, with MTBE and TBA being the main drivers for remediation. TPH-g, TPH-d and BTEX compounds are also present within Site soil and groundwater. This letter report provides a review of the Site Geology, Hydrogeology and Current Groundwater Monitoring Network, Petroleum Hydrocarbon Distribution, Review of Proposed Remediation Options, Design Parameters for HVDPE Pilot Test Plan, and Conclusions and Recommendations.

Site Geology

The site is located in the San Francisco Bay Plain and situated upon Holocene alluvial deposits (the flatland deposits of Helley and Lajoie, USGS Professional Paper 943, 1979). The alluvium encountered in the 21 site boreholes consists mostly of clayey gravel (GC), clayey sand (SC) and clay (CL) with lesser intervals of well graded gravel (GW), poorly graded gravel (GP), silty sand (SM), poorly graded sand (SP) and organic clay (CH) to the maximum depth explored of 48 feet below ground surface (bgs).

The site geology is consistent with a floodplain setting where fluvial channels have traversed the depositional landscape and during times of flooding deposited widespread fine grained floodplain deposits of mostly silt and clay. (The topographic slope and profile of the valley floor does not support the sometimes held view that these deposits are related to alluvial fans). Within the "mud" rich floodplain, stream channels tend to flow within the cohesive mud-rich banks, and changes course during flood events by cutting new pathways by avulsion through the stream banks. As such, lateral continuity between coarse grained channel deposits is variable.

Flood-related deposition of the coarse alluvium (i.e., GC and SC) is supported by the fact that the coarse grained deposits appear to contain significant amounts of fine grained material. This suggests that deposition occurred due to a rapid loss of transport energy, i.e., in the waning stage of a flood. Further during the flood-stage, overtopping of stream banks results in lobate overbank deposits of coarse grained material across the floodplain. During non-flood stages, winnowing of fines occurs within the stream channels and the mud-fraction is removed resulting in cleaner coarser grained residual deposits (GW or SW or SP). These deposits likely represent the more permeable sediments for the migration of fluids within the subsurface.

Unfortunately, the site boring logs have been prepared consistent with the USCS (the industry standard) and little geological detail is provided that would assist in refining the interpretation of the depositional environment and therefore the spatial relationship between sediment types and potential fluid migration pathways. Further, relative percentages of grain sizes for each sediment (soil) type described are not in the recorded boring logs; this information would be useful to assess relative permeability of soil types. It is recommended in future investigations that sieve/hydrometer analysis be performed to verify the interpretations of soil types and grain size ranges.

Site Hydrogeology and Current Groundwater Monitoring Network

The approximately ¼-acre site (100-feet by 100-feet) is populated with 8 shallow monitoring wells (MW-1 to MW-8), 6 intended oxygen delivery wells (IS-1 to IS-6) and two intended extraction wells (EW-1 and EW-2) and 2 deep monitoring wells (MW-4D and MW-5D).

Based on the site geology and groundwater elevation measurements two water bearing zones (WBZs) have been identified; the Shallow WBZ defined by the extent of clayey gravel and clayey sand deposits and ranging in depth from approximately 5-15 feet bgs (noting that the top and bottom of the coarse units are variable) and the Deep WBZ ranging in depth from approximately 30-45 feet bgs (noting that the top and bottom of the coarse units are variable). Depth to water beneath the site appears to vary seasonally; varying within the Shallow WBZ from about 5 to 14 feet bgs across the site, and varying within the Deep WBZ from about 13 to 16 feet bgs across the site. Vertical head data from well pairs MW-4/MW-4D and MW-5/MW-5D suggest that the two WBZs are hydraulically isolated as a consistent approximately 7.5-foot head difference is measured between the WBZs. However, the boring log from MW-5D would indicate that the two WBZs are possibly connected. The logging of this borehole should be verified with a less invasive technique such as CPT, as the current interpretation may be the result of sloughing during drilling activities. If the boring log for MW-5D is correct then a vertical pathway between the two WBZs likely exists.

The groundwater gradient within the Shallow WBZ is relatively steep at about 0.03 ft/ft and flow is multidirectional due to mounding created by water leakage from Site utilities. Given the position of the Site relative to the uplands and the bay, and if large pumping centers are not located nearby, it would be reasonable to assume that groundwater in the vicinity of the Site would naturally flow to the west or southwest, that is, towards the bay. The groundwater gradient between MW-5D and MW-4D within the Deep WBZ appears much flatter than the Shallow WBZ and based on the latest measurements, a gradient between the wells of 0.0005 ft/ft exists, flow is likely to the west.

The groundwater monitoring network within the Shallow WBZ is relatively dense for such a small site and should provide an accurate picture of groundwater conditions across the Site. However, it is noted that a large portion of many of the well screen intervals are situated within fine-grained sediments. Based on depth to water measurements many of the Shallow WBZ well screens are not screened across the water table interface between vadose soil and permanently saturated soil. Therefore, comparing groundwater elevation data from say wells MW-3 or IS-3 (which are completely screened in clay) with other wells may lead to a distorted view of groundwater flow patterns.

With regard to using existing monitoring wells as observation wells during the HVDPE pilot test, it would appear that large portions of the Shallow WBZ wells will require dewatering to expose the well screens to potential vacuum pressures. For the same reason, the use of existing monitoring wells as soil vapor extraction wells are not optimum choices. It is recommended that purpose-built soil vapor extraction well(s) be constructed for the HVDPE pilot test. Ideally the well should screen only the GC interval of the Shallow WBZ.

Petroleum Hydrocarbon Distribution

Soil data presented in Table 2 of the Soil and Groundwater Investigation Report indicate that TPH-d and TPH-g (and associated compounds) are relatively wide spread across the soil, and not surprisingly, highest in the vicinity of the former UST pit. The highest concentrations (generally > 1000 mg/kg TPH-d or TPH-g) are within vadose soil and at depths that correspond to the seasonal fluctuation of the water table between about 10 to 14 feet bgs. High concentrations of TPH-d or TPH-g are noted in vadose soil from boreholes SB-8, SB-i3, and Sb-i5 suggesting that releases) from the former dispenser island are contributing to soil and groundwater impacts. Also, high TPH concentrations are noted in saturated soil from boreholes SB-6D and SB-8. These data indicate that significant residual TPH impacts still exist at the Site.

TPH impacts to groundwater are observed in all Site groundwater monitoring wells, with MTBE and TBA being the highest. Data from wells MW-1, MW-2 and MW-3 (i.e., wells with a of history of monitoring) show declines in TPH-g and BTEX concentrations over time suggesting natural attenuation processes are active at the Site. Similarly, while MTBE concentrations are declining, TBA concentrations are increasing, again suggesting natural attenuation processes are active at the Site. While high concentrations of hydrocarbon compounds are observed across the Site, some of the highest concentrations are noted in area of wells IS-3 and IS-6, again suggesting that releases from each former dispenser island likely occurred.

Review of Proposed Remediation Options

Clearwater has proposed three remedial options for the Site; Bioremediation, HVDPE and Insitu Chemical Oxidation (ISCO). The following provides a brief discussion to the potential applicability of each technology to Site conditions.

<u>Bioremediation:</u> Site conditions appear very favorable for aerobic bioremediation, as indicated by the (surprisingly) high dissolved oxygen (DO) levels measured in monitoring wells. Noted also, is relatively high level of ferrous iron, suggesting anaerobic conditions exist (i.e. within the hydrocarbon plume); ferrous iron tends to oxidize readily in the presence of available oxygen. The presence of both high levels of DO and ferrous iron would suggest that an active biogeochemical environment exists. The identification of leaking sewer lines at the Site likely supply a source of nitrogen compounds to groundwater and further enhances microbial activity.

<u>HVDPE:</u> Site data with respect to soil porosity and permeability is limited and therefore it is difficult to accurately assess the applicability for HVDPE. The one reported incident of groundwater extraction testing (from well MW-2) indicates that groundwater extraction was limited and recharge rates were extremely low, suggesting low permeability soil in the area of well MW-2. Given that biological activity at the Site appears high, biofouling has likely occurred within this well's screen and filter pack causing a reduction in well efficiency. It is recommended that any proposed wells for the HVDPE pilot test be redeveloped and possibly treated with a biocide to improve efficiency prior to initiating the test. The application of a vacuum generally improves the

ability of a well to recover groundwater due to the steepened pressure gradient created by the low pressure created within the well casing.

ISCO: Chemical oxidation is a viable remediation technology; however, experience in the Bay Area has indicated that the method requires injection under pressure or pre-fracturing to obtain an effective area of influence. Further, an assessment of the aquifer's native (soil) oxygen demand should also be performed to accurately estimate oxidant dosage requirement and efficiency. The application of ISCO may be counter-productive to the benefit offered by natural attenuation processes currently active at the Site.

Design Parameters for HVDPE Pilot Test Plan

A HVDPE test can serve two purposes; to the evaluate potential for soil vapor extraction (SVE) and evaluate the potential groundwater extraction (GWE). The SVE portion of the HVDPE pilot test can provide the following benefits and design information: (1) remove free product, (2) evaluate the effectiveness of soil vapor extraction to remove contaminants from vadose soil, (3) develop preliminary design parameters for potential full-scale operation; and (4) provide site-specific data.

Site specific parameters to be evaluated during the HVDPE pilot test are as follows:

- Determine the effectiveness of SVE to remove hydrocarbon compounds from the vadose zone.
- Determine radius of influence as measured from surrounding groundwater monitoring wells. An effective radius of influence (ROI_{SVE}) is typically taken to be the radial distance at which an induced vacuum of 0.10 in. H_2O can be measured (*USEPA, 2004*).
- Determine air flow rates versus applied vacuum at the test well.
- Determine hydrocarbon concentrations in extracted soil vapor using a photo-ionization detector (PID) and laboratory analyses.
- Determine the likelihood of volatilization of free product.
- Estimate hydrocarbon mass removal rates.

A portable high vacuum SVE unit with an attached thermal oxidizer will be used to conduct the pilot test. The vacuum will be applied to each HVDPE pilot test extraction well to draw in soil vapor from the area surrounding the well screen. To avoid upconing groundwater during the HVDPE pilot test, the stringer method will be used. In the stinger method, the vacuum is applied via a 1 or 2-inch stinger tube inserted inside the main 2 or 4-inch diameter extraction well casing. The stinger tube is used to remove both soil vapor and (slurp) groundwater from the area surrounding the extraction well screen. Using this method, an evaluation of both soil vapor flow rates and groundwater extraction rates can be obtained. A portion of the applied vacuum will be utilized to lift groundwater (1-inch mercury (Hg) is required to 1.13 lift feet of water), while the remaining vacuum will draw in soil vapor to the well.

The portable SVE unit will consist of a trailer-mounted, thermal oxidizer and vacuum pump (blower) capable of generating a vacuum up to 29"Hg at 450 cubic feet per minute (cfm) flow rate. The SVE/Treatment unit will be powered with on-site electricity or a portable generator. The HVDPE extraction well will be connected to the SVE/Treatment unit using flexible hosing. Each observation well head will be fitted with a magnehelic gauge to observe changes in subsurface pressure.

Magnehelic gauges fitted to each individual wellhead will measure the induced vacuum at the wellhead. Air-flow will be measured with a portable anemometer. PID readings and vapor samples for laboratory testing will be collected throughout the test period. Data collected during the HVDPE test will include wellhead flow rates, applied wellhead vacuums, petroleum hydrocarbon concentrations in extracted soil vapors, and induced vacuum in nearby observation wells. Each HVDPE pilot test will be performed for approximately 6-hours.

Soil vapor extracted from each HVDPE well will be collected for laboratory analysis. Soil vapor samples will be collected using 1-liter SUMMA® canisters and submitted for analyses to a State of California certified laboratory. The submitted vapor samples will be analyzed for the following using the indicated test method:

- EPA TO-3/15 for TPH-g/BTEX/MTBE/TBA

Site wells have not been constructed in a fashion that readily lends their use in a HVDPE pilot test. To perform an optimum HVDPE pilot test, construction of extraction wells and observation wells across the GC-soils of the Shallow WBZ would be ideal. Groundwater elevations depicted on geological cross-sections indicate that, in most instances, at least 3 to 4 feet of groundwater overlie the top of well screens; thus, for any existing well to be used as an effective observation point in a HVDPE pilot test, the well screen will need to be exposed. The planned 6-hour pilot test duration may not be sufficient to create an effective cone of depression around each extraction well point. The pilot test should be planned for a period of seasonal low water levels, thereby reducing the required amount of dewatering to expose the well screens.

While it can be expected that water levels will drop significantly in the extraction well; the shape of the propagating cone of depression will be dependent on the surrounding formation permeabilities. If sediment is permeable, then a flat-broad cone of depression will develop; with the disadvantage that it will take some time to dewater over the broad area. However, if sediment is tight, then a steep-narrow cone of depression will develop, with the disadvantage that it will take some-time to propagate away from the extraction well, and is the like scenario for this site.

However, based on the site well construction details and encountered geology, the following rationale for the HVDPE pilot test layouts are provided:

Extraction Well	Observation Wells	Comment
MW-5 Screen 10-25 ft bgs	IS-6 Screen 10-25 ft bgs	Well MW-5 is screened across coarse grained material and has the best chance to dewater, and allow the applied vacuum to radiate. Observation well IS-6 is located 8-feet from MW-5 and has 5-feet of screen in GC.
	IS-5 Screen 10-25 ft bgs	Located 25 ft from extraction well and an area of high TPH concentrations. Only has 2-feet of screen in GC.
	IS-4 Screen 10-25 ft bgs	Located 33 ft from extraction well and an area of high TPH concentrations. Only has 4-feet of screen in GC.
EW-1 Screen 10-25 ft bgs	MW-4 Screen 10-25 ft bgs	Well EW-1 is 4-inch well and will have better well efficiency than 2-inch wells to dewater, and allow the applied vacuum to radiate. Only has 3-feet of screen in GC. Observation well MW-4 is 16 ft from extraction well and location of high TPH concentrations. Only has 3-feet of screen in GC.
	Purpose built vapor monitoring well near MW-2 Screen not determined	Located 5 ft from extraction well. Monitoring ports to be install into GC
	MW-7 Screen 10-25 ft bgs	Located 30 ft from extraction well. Has 12-feet of screen in GW, may not dewater sufficiently allow for vacuum readings.
MW-1 Screen 10-25 ft bgs	IS-1 Screen 10-25 ft bgs	Well MW-1 is surrounded by coarse grained material including former the UST pit, and should dewater readily and allow vacuum to radiate; coarse material in the area of the well is located near ground surface, which may allow short-circuiting of vacuum pressures. Well IS-1 located 35 ft from extraction well. Only has 3-feet of screen in GC.
	Purpose built vapor monitoring well near MW-1 Screen not determined	Located 8 ft from extraction well. Monitoring ports to be install into GC
	MW-6 Screen 10-25 ft bgs	Located 45 ft from extraction well. Lower GW elevation requiring less dewatering to expose screen.

Conclusions and Recommendations

Soil and groundwater across the site are impacted with significant concentrations of TPH and related compounds. Two WBZs are recognized to exist, with the Shallow WBZ and overlying vadose soil containing the majority of hydrocarbon mass. Natural attenuation processes appear to be active at the Site, and are evidenced by reduced concentrations of hydrocarbons, including MTBE, over time. However, degradation of MTBE has lead to a significant build up of TBA which is more recalcitrant to aerobic biodegradation.

Due to the high clay content of WBZs many remedial technologies have been demonstrated to have restricted value at similar site conditions. HVDPE does offer a proven remedial technology for apparent low permeability Site conditions. Hydrocarbon compounds BTEX, MTBE and TBA are volatile compounds and readily amenable to HVDPE remediation. Current onsite monitoring wells are not ideally suited to perform a HVDPE pilot test as many of the wells are screened across fine-grained sediments and the tops of many well screens are below year-round water levels. However, HVDPE offers many benefits for the site remediation and purpose-built extraction wells should be constructed if full scale implementation is to be initiated.

The proposed design using current site wells, while not optimum, should provide relevant and valuable data to contrast against the proposed ISCO bench scale test. Mass removal will be more readily quantified using HVDPE than other methods. It is recommended that proposed wells for the HVDPE pilot test be redeveloped to remove any buildup of bio-matter from within the well screens and filter packs to improve the efficiency of the wells. Further the pilot test should be conducted during a period of low water levels (likely late summer) to limit the amount of dewatering required to expose observation well screens to improve the potential value of the HVDPE pilot test.

If you have any questions or comments, please call me at 650-270-8741 or email at warrentas@aol.com.

Sincerely,

Warren B. Chamberlain, P.G., C.H.G., P.E.