PANGEA

July 20, 2007

Ms. Donna Drogos
Alameda County Health Care Services Agency
Department of Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

Re: **Feasibility Test Report and Interim Remedial Action Plan**
5175 Broadway
Oakland, California
ACEH Fuel Leak Case No. RO0000139

Dear Ms. Drogos:

On behalf of Rockridge Heights, LLC, Pangea Environmental Services, Inc. (Pangea) has prepared this *Feasibility Test Report and Interim Remedial Action Plan (IRAP)* for the site referenced above. The purpose of the feasibility testing was to evaluate potentially applicable remedial alternatives for remediating residual site contaminants. The feasibility testing described herein was originally proposed in Pangea's November 8, 2006 *Addendum to Preliminary Results of Site Characterization: Proposed Additional Activities* letter to the Alameda County Environmental Health (ACEH). The purpose of the IRAP is to provide a method to remediate impacted soil and groundwater beneath the site, potentially to the point where residual hydrocarbons can attenuate naturally. The proposed scope of work outlined in the IRAP is designed allow planned site redevelopment activities to proceed in a timely manner. Presented below are an executive summary, site background, planned site redevelopment, feasibility testing methods and results, evaluated remedial alternatives, and the proposed interim remedial action plan and schedule.

EXECUTIVE SUMMARY

Pangea offers the following overview of the site conditions, planned development, and proposed corrective action:

- Pangea's recent assessment efforts have significantly delineated the onsite extent of contamination.
- The elevated hydrocarbon concentrations in soil and groundwater (which exceed Environmental Screening Levels established by the Regional Water Quality Control Board) and the presence of separate-phase hydrocarbons in two site wells merit corrective action.
- Feasibility testing described herein suggests that *insitu* remedial techniques (e.g., dual phase extraction, groundwater extraction, and soil vapor extraction with air sparging) will have *limited effectiveness*.

- Our evaluation of remedial alternatives suggests that the most appropriate and cost effective remedial alternative is *excavation* of shallower source material followed by *biosparging* to enhance biodegradation of deeper contaminants in fractured bedrock and offsite downgradient contamination.

- Conducting the interim remedial action in conjunction with planned site redevelopment will help control corrective action costs. For example, the site development will include a subsurface garage to approximately 10 feet depth, avoiding the need for import and compaction of clean backfill material. In addition, the planned garage excavation to approximately 10 feet depth across the site (upon completion of contaminated soil excavation) will facilitate the cost-effective installation of a subgrade vapor and/or water collection system, and will minimize the length of any additional wells required for site remediation or monitoring beneath the site.

- Offsite assessment and soil gas sampling (proposed in Pangea's November 8, 2006 Addendum) will be conducted upon obtaining access to the southern downgradient property and will further characterize the extent of contaminants. The proposed soil gas sampling will help evaluate the potential risk to human health due to potential vapor intrusion into indoor air.

SITE BACKGROUND

The site description, site geology/hydrogeology, previous environmental work, and subsurface conditions are summarized below. A site vicinity map is included as Figure 1. A site map showing prior environmental sampling and cross-section locations is shown on Figure 2. Subsurface groundwater conditions and contaminant extent are shown in plan and cross-sectional view on Figures 3 through 6. Soil and groundwater analytical data are summarized on Tables 1 and 2.

Site Description

The subject property is located at 5175 Broadway, at the southwest corner of the intersection of Broadway and Coronado Avenue in Oakland, California in Alameda County (Figure 1). The site is approximately 0.6 miles south-southeast of Highway 24 and approximately 2.3 miles east of Interstate 80 and the San Francisco Bay. The property is relatively flat, with a slight slope to the south-southwest, and lies at an elevation of approximately 160 feet above mean sea level. Topographic relief in the area surrounding the site also slopes generally towards the south-southwest. The western site boundary is the top of an approximately 10 foot high retaining wall that separates the site from an adjacent apartment complex located immediately west of the site.

The property has been vacant since 1979 and was formerly occupied by an Exxon Service Station used for fuel sales and automobile repair. The site is approximately 13,200 square feet in area with about 10% of the area occupied by a vacant station/garage structure. The majority of the ground surface is paved with concrete and/or asphalt. Land use to the west and northwest is residential, including apartment buildings and single family homes. Properties to the northeast, east and south of the site are commercial. The site and adjacent properties are shown on Figure 2.

Previous Environmental Work

Environmental compliance work commenced when three 8,000-gallon steel single-walled USTs, associated piping, and a 500-gallon steel single-walled waste oil tank were removed in January 1990. Tank Protect Engineering, Inc. (TPE) conducted the tank removal and observed holes in all four tanks. Groundwater was reportedly observed to stabilize in the UST excavation between 10.5 and 11 feet below ground surface (bgs). Approximately 700 tons of contaminated soil was excavated during tank removal and was subsequently remediated and reused for onsite backfill by TPE. In April 1990, TPE installed and sampled monitoring wells MW-1, MW-2 and MW-3. In June 1991, Soil Tech Engineering (STE), subsequently renamed Environmental Soil Tech Consultants (ESTC), installed monitoring wells STMW-4 and STMW-5.

In December 2001, the ACEH requested that a Human Health Risk Assessment be conducted to determine whether the site qualified as a low risk groundwater case. ESTC subcontracted SOMA Environmental Engineering, Inc. (SOMA) to prepare their report entitled "*Conducting Human Health Risk Assessment*", which was submitted to the ACEH on February 17, 2004. Based on review of SOMA's February 2004 report, the ACEH, in their letter dated October 6, 2004, informed the responsible party to postpone proposal and review of additional human health screening evaluation until site and source characterization activities are completed.

In January and February 2006, Golden Gate Tank Removal (GGTR) performed additional assessment at the site, which included soil and/or groundwater sampling from ten onsite soil borings.

In June 2006, the property was purchased by Rockridge Heights, LLC.

In January and March 2007, Pangea installed twelve onsite monitoring wells (MW-2C, MW-3A, MW-3C, MW-4A, MW-5A, MW-5B, MW-5C, MW-6A, MW-7B, MW-7C, MW-8A and MW-8C) and installed four offsite soil borings to help define the vertical and lateral extent of groundwater contamination. New wells installed at the site were categorized according to the depths of their screen intervals. Shallow (A-zone) wells have screen intervals of approximately 10 to 15 feet which generally straddle the top of the water table. Intermediate-depth (B-zone) wells are screened at approximately 15 to 20 feet bgs, while deep (C-zone) wells are generally screened at approximately 20 to 25 feet bgs and into fractured bedrock/mudstone. Well MW-1 is screened across both the A-zone and B-zone.

Also, in January and March 2007, Pangea abandoned four monitoring wells (MW-2, MW-3, STMW-4 and STMW-5) to reduce the risk of vertical contaminant migration and improve the quality of monitoring data. In April 2007, Pangea performed a dual-phase extraction (DPE) pilot test (described herein) to evaluate whether DPE is an appropriate remedial technology to remove residual hydrocarbons from beneath the site

Groundwater monitoring was conducted on the site intermittently since 1990.

Site Geology and Hydrogeology

The site lies at the foot of the Oakland Hills on a low ridge composed of Cretaceous sandstone, siltstone, and serpentinite of the Franciscan Complex, as mapped by Graymer (2000). The bedrock is onlapped several hundred feet to the west and southwest of the site by Pleistocene and younger alluvial and fluvial deposits derived from westward flowing streams draining the hills to the east. The Hayward Fault, a major active regional fault of the San Andreas Fault system, lies 1.5 miles northeast of the site.

The site lies immediately east of the East Bay Plain groundwater basin. Most of the East Bay Plain is underlain by deep Tertiary depositional basins whose current depocenters are the San Francisco Bay (the San Francisco Basin) and San Pablo Bay (San Pablo Basin) (Figuers, 1998). The site lies on bedrock forming the eastern boundary of the San Francisco Basin. Groundwater in the San Francisco Basin is designated beneficial for municipal and domestic water supply and industrial process, service water, and agricultural water supply.

Most of the site is underlain at relatively shallow depths by impermeable bedrock composed of fractured Cretaceous sandstone, serpentinite and siltstone of the Franciscan Complex. The bedrock is overlain by variable thicknesses (from 2 to 20+ feet) of native soil and artificial fill, consisting of unconsolidated clay, silt, sand and gravel.

Investigation information indicates that the water table intersects the contact between the unconsolidated units and bedrock units, so in some areas shallow groundwater is present in both the unconsolidated units and the bedrock, and in other areas groundwater is present only within the bedrock. During recent drilling, shallow groundwater was only encountered during drilling of well MW-6A, which was drilled through the backfill of the former UST excavation; groundwater was encountered at approximately 8 ft bgs and was measured at a depth of 7.17 ft on March 26, 2007.

This observation, and similar observations made during prior drilling of shallow wells at the site, indicates that groundwater is present under unconfined conditions within the shallow soil/fill units, and possibly present under unconfined conditions within the shallowest portion of the underlying bedrock. All of the other newly installed wells by Pangea were installed into relatively impermeable clay or bedrock that did not yield evidence of the presence of groundwater during well installation, or were not logged because they were installed within the borings of existing monitoring wells. In general, past investigations have reported that the clay or bedrock sections do not yield appreciable volumes of groundwater, with the exception of thin zones within the bedrock.

Pangea's July 17, 2007 *Site Investigation Report* concluded that the site bedrock is relatively impermeable, and that the thin water-bearing zones within the bedrock are permeable layers or fracture zones (i.e. fracture porosity) of unknown continuity and orientation. Field observations of nearby bedrock outcrops east of the site on the opposite side of Broadway corroborate this interpretation. These thin zones are under confined or semiconfined conditions on the scale of the well borings, but may be unconfined at the scale of the site.

Shallow Groundwater: Based on depth-to-water data collected March 26, 2007, elevation data and the inferred flow directions for shallow A-zone groundwater are shown on Figure 3. As shown on Figure 3, groundwater in A-zone groundwater appears to have mounded in the former UST excavation, and the apparent gradient radiates outwards towards the east, south and west, although regional groundwater flow is generally towards the south and southwest. This observation suggests that the unpaved former UST excavation has acted as a collector for rainwater during the rainy season, and that the asphalt pavement covering the remainder of the site serves to reduce infiltration elsewhere and likely directs rainwater to the unpaved UST excavation area. The current inferred flow direction in A-zone groundwater southwest of the former UST excavation area is generally consistent with previous quarterly monitoring events, while the new A-zone wells provide additional data to infer the radial groundwater flow from the former UST area.

Deep Groundwater: Elevation data for both B-zone and C-zone groundwater and the inferred flow direction for C-zone groundwater are shown on Figure 6. The horizontal component of flow for the C-zone groundwater is westwards to southwestwards, as shown on Figure 6. The elevation of the piezometric surface for deep C-zone wells is lower than elevations for A-zone wells, indicating that a downward gradient is present. No previous data have been collected regarding the direction of flow of C-zone groundwater.

Hydrocarbon Distribution in Soil

Soil analytical results are summarized on Table 1. Soil concentrations above Final Tier 1 ESLs for commercial site use are presented in bold on Table 1. Residual soil contamination detected in soil samples collected from onsite soil borings reported in the GGTR Report was generally less than ESLs for all soil samples except for those collected at a depth of 9 feet in borings B-3, B-4 and B-9. TPHg in these borings ranged from 140 to 180 mg/kg, slightly exceeding the ESL of 100 mg/kg. Benzene was detected at 0.65 mg/kg in B-3, exceeding the ESL of 0.044 mg/kg. Benzene was not detected in either B-4 or B-9, although the detection level for the samples collected at 9 feet bgs was 0.5 mg/kg due to sample dilution, so it is not known whether the ESL for benzene was exceeded in those borings. During Pangea's recent investigation, only TPHg (260 mg/kg) and benzene (0.31 mg/kg) encountered at 12 feet bgs in MW-8A exceeded the ESLs. Based on the results of the soil boring program, residual vadose zone soil contamination only appears to exceed ESLs in samples that lie close to the water table elevation, suggesting that a zone of capillary fringe soil contamination at concentrations slightly exceeding ESLs is probably present throughout much of the site where groundwater impacts are present. Vadose zone soil is relatively uncontaminated and is unlikely to represent a significant threat to human health, although impacts to groundwater are likely to continue while capillary fringe soil contamination is present.

Hydrocarbon and Fuel Oxygenate Distribution in Groundwater

Groundwater analytical results are summarized on Table 2. Groundwater concentrations above Final Tier 1 ESLs for commercial site use are presented in bold on Table 2. The primary contaminants at the site are total petroleum hydrocarbons as gasoline (TPHg) and benzene, which substantially exceed CRWQCB Tier 1 Final ESLs for groundwater that is a potential source of drinking water, as noted in the GGTR Report. Secondary contaminants that also exceed ESLs are toluene, ethylbenzene, xylenes, and 1,2-dichloroethane (EDC). In particular, TPHg concentrations throughout the site exceed the ceiling ESL of 5,000 μg/L, and benzene concentrations exceed the ESL of 540 μg/L for indoor air impacts.

Review of the historical groundwater concentration data indicates that although substantial concentration fluctuations have occurred in site wells since monitoring began in 1989, no consistent concentration trends have been observed, and concentration data collected in 2007 are generally of similar magnitude to concentration data collected at the beginning of monitoring. This observation suggests that groundwater velocities at the site are very low and that natural attenuation mechanisms have not been effective in reducing contaminant concentrations.

Free Product (SPH): A thin layer of SPH has been observed in well STMW-4 during the last three quarters of monitoring. The SPH was often discovered after initiating well purging but not during initial well gauging. SPH was also detected in newly installed deep well MW-3C after initiating well purging during the second quarter of 2007. One possible explanation of the discovery of SPH in these wells is that well purging induces SPH trapped within the fractured bedrock to enter the well casing. One possible explanation for SPH in well MW-3C is that dual phase extraction testing in that well in April 2007 induced downward migration of SPH into the well. No SPH have been detected in any other site wells, including well MW-4A, which was subsequently installed (though with a shallower screened interval) in the drilled out borehole of STMW-4.

Contaminant Distribution in Shallow Groundwater: As shown on Figures 4 and 5, *shallow* (A-zone) unconfined groundwater contains petroleum hydrocarbons at elevated concentrations in the following two primary areas near the former UST excavation: 1) a northern area in the vicinity of well MW-4A (the location where free product has previously been observed), and 2) a southwestern area in the vicinity of wells MW-3A and MW-8A and which extends to the southern site boundary in the vicinity of wells MW-7B and MW-7C. This distribution of hydrocarbons in shallow A-zone groundwater is tentatively interpreted to be due to the mounding of groundwater within the uncapped former UST excavation during the rainy season, likely encouraging plume migration radially away from the excavation area into areas that are protected from infiltration by paved surfaces. The lack of elevated hydrocarbon concentrations in well MW-5A and boring B19, both located downgradient from the former UST excavation, is unexpected, and may be due to the presence of a thick, relatively impermeable clay section observed in boring logs of shallow soil in that area that impedes migration of contaminated groundwater in shallow soil in that area (Figure 10). It should also be noted that the northernmost extent of the northeasternmost area has not been completely defined, since boring B-4 contained elevated hydrocarbon concentrations. Similarly, the southward offsite extent of the southernmost area has not yet been defined, since boring B-11 contained elevated hydrocarbons.

Contaminant Distribution in Deeper Groundwater: As shown on Figure 6, the distribution of *deep* groundwater containing elevated concentrations of petroleum hydrocarbons differs significantly from the distribution of hydrocarbons in shallow groundwater. High levels of contamination within deeper (B- and C-zone) groundwater only appear to be present in the central and southern, downgradient portion of the site, based on elevated hydrocarbon concentrations detected in wells MW-3C, MW-7B and MW-7C. The hydrocarbon impact in the deeper wells may be explained by the apparent downward vertical gradient indicated by elevation data from the clustered shallow and deep wells. The lateral extent of the deeper contamination appears to be well defined, except in the downgradient, offsite direction. It should also be noted that because permeable zones within the bedrock are thin, and discrete permeable layers and fractures, the impacted groundwater within the bedrock shown on the cross sections (Figures 8, 9 and 10) is likely to be less extensive than depicted on the cross sections, and to be present only within narrow permeable preferential pathways within the shown impacted areas.

Vertical Distribution of Contaminants Based on New Well Data: Pangea's evaluation of concentration data from abandoned wells and from the new well clusters suggest that the *shallow groundwater is* <u>*more*</u> *impacted than the deeper groundwater* for much of the site. This evaluation is detailed in Pangea's *Site Investigation Report* dated July 17, 2007. Data comparison generally indicates that little deeper impact is observed or suspected north, west and east of the former source area, although some deeper impact is observed immediately south of the former UST area and further southwards. The *deeper* groundwater zone within the fractured bedrock apparently has limited contaminant mass due to limited permeability and low water yield during well purging (wells MW-5B, MW-7B, MW-7C, and MW-8C all dewatered after purging 1 or 2 well volumes during the first quarter 2007 monitoring event). These wells also produced little water during well development and DPE testing.

MTBE Not a Concern: MTBE was *not* detected in sampled groundwater and it is not a compound of concern at this site.

Conduit Study

To evaluate the potential for contaminant migration via preferential pathways, GGTR surveyed subsurface utilities in the vicinity of the site and compared utility depths to groundwater depth in site monitoring wells. This survey was reported in the GGTR *Workplan for Additional Site Characterization* dated September 12, 2005. The report concluded that no utilities likely serve as preferential pathways for migration of contaminated groundwater.

Potential Receptors

A risk assessment study conducted by SOMA (*Conducting Human Health Risk Assessment*, dated February 17, 2004) concluded that the primary human health risk was inhalation by residential receptors of benzene volatilized from site groundwater, and that concentrations measured in site monitoring wells were below thresholds of concern for those receptors, with the exception of well STMW-4. In an October 6, 2004 letter, Alameda County Environmental Health (ACEH) requested modifications to the risk assessment method used by SOMA and consideration of soil exposure pathways not considered by SOMA in future risk assessment work. ACEH also indicated that further risk assessment efforts should be postponed until additional site characterization work was completed. In addition, the recent grab groundwater sampling data collected by GGTR indicated that chemicals of concern may be present at the downgradient edge of the site at concentrations exceeding those found in site monitoring wells. Therefore, Pangea concurs with the ACEH's statement that additional risk assessment should not be conducted until further downgradient characterization has been completed. It should also be noted that the high levels of petroleum hydrocarbons (230,000 ug/L TPHg, 13,000 ug/L benzene) detected in the GGTR grab groundwater sample (B-11) collected at the downgradient edge of the site significantly exceeded those concentrations previously detected onsite; these results increase the possibility that vapor intrusion hazards may be present for the residential pathway discussed by SOMA, or potentially for workers in commercial buildings, since the California Regional Water Quality Control Board (CRWQCB) Environmental Screening Levels

(ESL) for the commercial or industrial land use vapor intrusion pathway is 540 μg/L for benzene in groundwater.

Land use at the site and adjacent buildings along Broadway is currently commercial, so, in the absence of an approved risk assessment, commercial ESLs are applicable for assessing of sampling data immediately downgradient (south) of the site. However, with residential properties located west of the site in the down/crossgradient direction, residential ESLs would apply to contaminants that might migrate west from the site. The Final ESLs for TPHg and benzene, the primary site contaminants, are the same for commercial and residential land use for shallow and deep soil where groundwater is a potential source of drinking water.

PLANNED SITE REDEVELOPMENT

Rockridge Heights, LLC, plans to redevelop the former service station site into a mixed commercial and residential building with subgrade parking. The development will involve excavating the entire site to approximately 10 feet depth to install a parking subgrade parking garage. The redevelopment schedule will follow the excavation phase of the IRAP discussed below, and the building plans will include engineering controls to mitigate the potential impact to human health.

Conducting the interim remedial action in conjunction with planned site redevelopment will help control corrective action costs. For example, the site development will include a subsurface garage to approximately 10 feet depth, avoiding the need for import and compaction of clean backfill material. In addition, the planned garage excavation to approximately 10 feet depth across the site (upon completion of contaminated soil excavation) will facilitate the cost-effective installation of a subgrade vapor and/or water collection system, and will minimize the length of any additional wells required for site remediation or monitoring beneath the site.

Here are additional details about the planned development and schedule. Rockridge Heights, LLC proposes to construct a project which will include (1) a single-story garage accessed off of Coronado Street, and set largely below grade, (2) approximately 3,000 square feet of commercial space at grade, and (3) 28 residential units located at grade and on three stories above grade. The commercial space is intended to be occupied by low-intensity food service (like a coffee shop) and other residential-oriented retail services. We anticipate that the 3,000 square foot space will ultimately be divided into two, or at most three, separate commercial units that front onto Broadway. The residential units will all be condominiums, anticipated to sell in 2009-2010.

The residential units will have one bedroom, two bathrooms and a separate den or office space. Many units will have views of the San Francisco Bay or the Oakland hills. All units on the top three stories will have balconies, and the residential units at grade will come with private patio space. Common open space will include landscaped walkways - one to the commercial space and a separate walkway to access the residential lobby. In addition, the podium (i.e. grade level) will have a landscaped community garden area (with all vegetation to be in imported soil in planters on the podium surface).

Rockridge Heights expects to receive final project entitlements by mid September, and they have been working diligently on design documents with the goal of fast-tracking a foundation-only building permit. It is our intent to begin construction as soon as remediation is complete - currently expected to be in on around mid-October. The City of Oakland Fire Chief plans to interact closely with the ACEH regarding development plans and environmental issues during the initial process.

FEASIBILITY TESTING

Rockridge Heights, LLC, retained Pangea to conduct feasibility testing to evaluate the effectiveness of several insitu remedial techniques. The feasibility testing was conducted to help determine if the site could be remediated with insitu techniques before, during or after site redevelopment. The testing has facilitated the evaluation of the following insitu remedial techniques: dual phase extraction (DPE), soil vapor extraction, groundwater extraction, and air sparging/biosparging.

Between April 17 and 27, 2007, Pangea performed DPE pilot testing from selected site wells to evaluate whether DPE and related insitu remedial technologies effectively remove residual hydrocarbons from beneath the site. DPE is a technology that simultaneously extracts soil vapor and groundwater under high vacuum in the same process stream. DPE testing can also evaluate soil vapor extraction and groundwater extraction techniques. DPE was evaluated as a possible remedial alternative because previous assessments demonstrated that petroleum hydrocarbons are present at depths below the water table and soil vapor extraction without water table depression would not be sufficient to remove these hydrocarbons. While performing DPE testing, Pangea also performed limited air sparge (AS) testing on select site wells.

Specific goals of the DPE pilot test were to determine:

- Groundwater extraction rates under vacuum and the extraction rate necessary for dewatering hydrocarbon-impacted soils below the water table;
- Soil vapor extraction vacuum and flow rates;
- The estimated radius of influence for the applied vacuum;
- Vapor-phase hydrocarbon concentrations and trends in extracted vapor; and

- Contaminant mass removal rates.

Specific goals of the AS pilot test were to determine:

- If air injection improves contaminant removal rates during DPE;
- Air delivery pressure required to induce air flow in the water-bearing zone; and
- The effective radius of influence of air sparging.

Pilot Test Equipment

A 25-horsepower liquid-ring vacuum pump capable of approximately 29 inches of mercury vacuum and 400 cubic foot per minute (cfm) was used to extract soil vapor and groundwater from selected site monitoring wells. Selected site wells were chosen for extraction because of the presence of elevated aqueous-phase hydrocarbon concentrations. Pangea also tested DPE in shallow and deeper wells at different portions of the site due to heterogeneous site conditions. Soil vapor and groundwater were extracted from the wells by applying vacuum to the well casings through a 1.5-inch diameter hose inserted through a rubber coupling installed on top of each of the well heads. After extraction from the well, the soil vapor/groundwater process stream was passed through a vapor/liquid separator, where groundwater was separated out and soil vapor was routed to a thermal oxidizer for abatement. The blower/oxidizer equipment was powered by propane stored in a 499-gallon propane tank. Extracted groundwater was pumped from the vapor/liquid separator to a 4,000-gallon water storage tank and eventual disposal.

For AS testing, a 2-horsepower reciprocating air compressor was used to provide compressed air. An adjustable flow regulator and flow meter were used to regulate air flow and pressure from the compressor to the injection wells.

Data Collection

DPE system operational data was collected periodically during testing. Organic vapor concentrations were measured using a Thermo TVA-1000 flame ionization detector (FID). Vapor samples were collected in Tedlar bags for laboratory analysis. McCampbell Analytical, Inc., of Pittsburg, California, analyzed the samples for total petroleum hydrocarbons as gasoline (TPHg) using EPA Method 8015M and benzene, toluene, ethylbenzene, and xylenes (BTEX) using EPA Method 8020. Site wells were monitored for vacuum influence and groundwater table drawdown before and during DPE testing. The groundwater extraction rate was monitoring by recording the water accumulation in the knockout vessel site tube, and by a flow totalizer on the water discharge line to the storage tank. DPE test data is summarized on Table 3 and in embedded tables below.

Feasibility Test Results

DPE testing was performed for a total of 85 hours on selected site wells. Short-term testing (tests of less than 4 hours in duration) on individual wells was performed from wells MW-3A, MW-4A, MW-7B, MW-7C, MW-8A and MW-8C. Long-term testing was performed from well MW-3C for approximately 28 hours, and simultaneously from wells MW-3C, MW-4A, MW-7B and MW-8A for approximately 24 hours. Applied vacuum rates ranged from 19 to 27 inches of mercury ("Hg). Soil vapor extraction flow rates ranged from 14 cubic feet per minute (cfm) to 77 cfm. DPE test data is summarized below in Table A.

Groundwater extraction rates observed during testing were below 0.5 gallons per minute (gpm) from all wells. Since much of the extracted water was located within the well borehole, the groundwater extraction rates at the end of the test were significantly lower. Given the total water extraction of 899 gallons, the average groundwater extraction over the test duration was approximately 0.1 gpm (Accurate groundwater extraction rates for each well cannot be precisely determined due to the periodic cycling of the transfer pump on the water knockout vessel).

Based on laboratory analytical data and extraction flow rates, vapor-phase hydrocarbon mass removal rates in individual wells ranged from approximately 3.5 to 7 pounds per day (ppd) for tested A-zone wells, and from approximately 0.3 to 2.5 ppd for C-zone wells. A temporary removal rate of 51.2 ppd was observed during initial combined extraction from wells MW-3C, MW-4A, MW-7B and MW-8A. This removal rate is based on the laboratory analysis from the beginning of test near when the corresponding FID reading was >10,000 ppm. Since the FID readings reduced significantly during the test (reduced to 1,787 ppm after 2.7 hours of testing started), the removal rate likely reduced to a corresponding rate of approximately <9 pounds per day. When air sparging commenced the following day, the hydrocarbon concentrations (as measured by FID) increased from 1,787 ppm to a maximum of 2,687 during the hour-long combined DPE/AS test. This suggests that air sparging improved contaminant removal rates approximately 50%. At sites with very effective AS, sparging can increase extracted concentrations and removal about 5 to 10 fold (500% to 1000%).

Table A – DPE Test Data

Extraction Well	Test Duration (total hours)	Applied Vacuum Range ("Hg)	Vapor Flow Rate Range (cfm)	Water Flow Rate (gpm)	Maximum Vapor Conc. (ppmv TPHg)	Max. HC Vapor Removal Rate (lbs/day)
Shallow Wells (A-Zone)						
MW-3A	6.3	24-25	18-40	0.05	312	3.40
MW-4A	3.1	25	14-15	0.26	1400	6.74
MW-8A	1.1	22	34-40	NM	567.4	7.28
Deep Wells (C-zone)						
MW-3C	27.8	23-26	20-23	0.3	360	2.54
MW-7B	1.3	24	22	0.075	139	0.98
MW-7C	2.9	23-27	22-28	0.13	45.3	0.32
MW-8C	17.1	24	25-26	0.3	36.9	0.31
Multiple Wells						
MW-4A, 7B, 8A	2.2	21	55	NM	NM	NM
MW-3C, 4A, 7B, 8A	23.2	19-22	63-77	0.33	2071	51.2

Vacuum Radius of Influence Measurements

During DPE testing, Pangea collected vacuum radius of influence measurements from selected observation wells in the vicinity of the extraction wells. The effective radius of vacuum influence is typically identified where observed vacuum in an observation well is approximately 1% of the vacuum rate applied to the extraction well, and defines the extent at which the DPE system is effective at capturing and removing soil vapor from the subsurface. Radius of influence measurements were collected during DPE testing from wells MW-3A, MW-3C, MW-4A, MW-5A, MW-6A, MW-7B, MW-8A and MW-8C.

Select data is summarized below on Table B, which indicates that vacuum influence measurements above background readings were measured in only two wells during the DPE testing: in MW-1 during extraction from MW-4A, and in MW-8C during extraction from MW-3C. For these wells, the vacuum influence was measured in C-zone wells with the well screens totally submerged beneath several feet of water. The observed vacuum is likely indicative water level drawdown in the observation wells rather than vacuum influence in the contaminant smear zone or vadose zone soil. While the vadose-zone A-zone wells are not nearby to facilitate better evaluation of vacuum influence, other DPE data can be used to evaluate DPE effectiveness. In addition, the presence of the backfill within the former excavation cavity in the center of the site would also encourage short-circuiting of shallow vapor extraction efforts.

Table B – DPE Test Vacuum Influence Data

Extraction Well	Test Duration (total hours)	Applied Vacuum (“Hg)	Vacuum Influence (“H2O)	Distance to Observation Well (ft)	Estimated Effective Radius of Influence (ft)
MW-3A	6.3	25	0	54 (MW-5A)	?
MW-4A	3.1	25	0.5*	31 (MW-1)	21*
			0	40 (MW-6A)	?
MW-8A	1.1	22	0	50 (MW-3A)	?
MW-3C	27.8	24	1.8*	47 (MW-8C)	40*
MW-7B	1.3	24	0	48 (MW-3A)	?
MW-7C	2.9	25	0	54 (MW-3A)	?
MW-8C	17.1	24	0	49 (MW-5A)	?

*Vacuum influence measurements were collected from wells with several feet of submerged well screen. The observed vacuum is likely indicative water level drawdown in the observation wells rather than vacuum influence in the contaminant smear zone or vadose zone soil.

Water Table Drawdown During DPE Testing

Pangea also collected water levels from selected observation wells in the vicinity of the extraction wells. During extraction from MW-3A, the water level in MW-3C (located approximately 13 ft away) dropped 0.11 ft after 3.75 hours of testing, while the water level in well MW-5A (located approximately 54 ft away) rose 0.09 ft during the same time period. The water level decrease in MW-3C seems reasonable, while the increase in well MW-5A may be an aberration. During long-term extraction testing from MW-3C, the water level in well MW-5C (located approximately 60 ft away) dropped 0.71 ft after approximately 24 hours of continuous extraction. This data indicates that limited dewatering via DPE is possible at the site, and that, if DPE were implemented, the extraction well network necessary would need to be closely spaced to ensure adequate dewatering to expose impacted soil to vapor extraction via DPE.

Air Sparging

Short-term air sparge testing was performed on selected site wells to determine the effective radius of influence of air sparging and the air delivery pressures required to induce air flow in the water-bearing zone. Air sparging was also performed to evaluate whether air injection improves contaminant removal rates during DPE. Pangea initially performed air sparge testing without DPE on deep C-zone wells MW-7C and MW-8C to establish air delivery pressures and flow rates necessary to induce a measurable radius of influence in nearby wells. A delivery pressure of 40 pounds per square inch (psi) in well MW-7C yielded a pressure rate of >1 psi in nearby well MW-7B.

Well MW-7B has a 3-foot screened interval installed from 15.5 to 18.5 ft bgs, and approximately 1.5 feet above the screened interval of MW-7C, which is installed from 20 to 25 ft bgs. During air injection in well MW-8C, also screened from 20 to 25 ft bgs, no influence was observed in site observation wells MW-1, MW-3C, MW-6A or MW-8A, located 5 to 71 feet away. Air sparge test data is summarized below in Table C.

To evaluate whether air injection improved contaminant removal rates during DPE, Pangea performed air sparging in wells MW-3C, MW-7C and MW-8C and performed DPE in adjacent wells. Based on organic vapor concentrations in DPE wells measured with a flame-ionization detector (FID), it appears that air sparging does increase contaminant removal rates, but to varying degrees.

In addition, AS results indicated that a relatively high air pressure is required to induce very little air flow rate. This observation is consistent with the limited average groundwater extraction rate of 0.1 gpm or less after initial well dewatering. This result is not surprising given that the prevalence of fractured bedrock/mudstone in the sparged C-zone wells.

Table C – Air Sparging Test Data

Injection Well (date)	Test Time (minutes)	Well Pressure (psig)	Air Flow (scfm)	HC in Extracted Vapor (ppm by FID)	Pressure Influence	Notes
MW-7C (4/25/07)	75	40	1.5	Injection only	>1 psi	Pressure @ >1 psi observed in well MW-7B, approx. 9 ft away.
MW-8C (4/25/07)	80	50	2.5	Injection only	0 psi	No pressure measured in wells MW-1, MW-3C, MW-6A or MW-8A
MW-3C (4/25/07)	1	50	1	294	NM	TPE in MW-3A. Flow rate 31-34 cfm
	30	35	3.5	1775	NM	
	60	35	3.75	1446	NM	
	90	35	3.75	1240	NM	End test
MW-7C (4/27/07)	1	50	2.5	1907	NM	TPE in MW-3C, 4A, 7B, 8A. Flow rate 68 cfm
	15	50	2.5	2687	NM	
	35	50	2.5	2583	NM	
	55	50	2.5	2321	NM	End test
MW-8C (4/27/07)	1	35	1	1743	NM	TPE in well MW-7C. Flow rate 22-23 cfm
	30	40	2	305	NM	
	50	40	2	175	NM	
	70	40	2	139	NM	
	105	40	3	93	NM	End test

EVALUATION OFREMEDIAL ALTERNATIVES

Pangea offers this evaluation of the appropriateness and cost effectiveness of several remedial alternatives for interim site remediation. Our evaluation of remedial alternatives is based on our review of subsurface conditions and recent dual-phase extraction (DPE) feasibility testing described above.

Evaluation of DPE

DPE is a common technique for remediating sites impacted with elevated concentrations of petroleum hydrocarbons and separate-phase hydrocarbons (SPH). This approach targets unsaturated soil, the capillary fringe, and shallow saturated soil. DPE involves the simultaneous extraction of soil vapor and liquid (groundwater/SPH mixture) from site wells using a large above-ground extraction blower. For applications requiring significant groundwater extraction flow rates, submersible groundwater pumps can be used to help dewater the hydrocarbon smear zone and expose hydrocarbons to vapor extraction. DPE requires a network of extraction and discharge piping to extract, treat and dispose of the extracted soil vapor and groundwater. Long-term DPE applications typically require permanently-installed high-amperage electrical service, as well as natural gas or propane for supplemental fuel for vapor treatment via thermal or catalytic oxidizers. Extracted groundwater requires temporary storage and/or treatment prior to discharge to the sanitary sewer or storm drain. For small scale and short-term operations, portable generators and temporary water storage tanks are used. Air sparging or ozone sparging can also be used in conjunction with this technique to accelerate site remediation, to target deeper saturated zone impact, or remediate compounds more responsive to oxidation/biodegradation than extraction. DPE is most appropriate for sites with high to moderate permeability. Extraction and insitu remedial techniques are least effective and commonly considered inappropriate and ineffective in low permeability soil.

Regarding the cost effectiveness of this approach, DPE is typically an expensive alternative due to the large equipment and energy requirements, and labor-intensive operation and maintenance. The benefit of this expensive approach can be fairly rapid and thorough site remediation, thereby reducing ongoing monitoring requirements and controlling lifecycle costs.

Site Specific Evaluation: Feasibility testing conducted at this site indicates DPE would be marginally effective at remediating the soils beneath the site because of the low permeability overlying clay and bedrock and the generally low observed vapor-phase hydrocarbon mass removal rates (removal rates in individual wells ranges from 0.3 to 7 ppd). Based on test results, if DPE were to be implemented at the site, a closely-spaced extraction well network with appropriately screened well casings would be required to target hydrocarbon-impacted areas beneath the site. Even with an extensive extraction well network, it is unlikely that DPE would be more than marginally effective at remediating the site because of the presence of fractures in the subsurface bedrock and the suspected higher permeability materials in the former excavation area that allow for preferential air flow from areas with little or no hydrocarbon impact. The lack of consistent vacuum influence during DPE testing indicates that preferential air flow during DPE could be occurring. Given the cost to implement DPE at this site and the low likelihood of success, other remedial methods with lower lifecycle costs and a higher probability of success are likely more appropriate for this site.

To allow comparison with other alternatives, Pangea offers the following scenario and cost estimate in Table C.

Table C – DPE Approach & Cost Estimate	
Scenario - DPE for 2-3 years from a network of 18 wells and underground piping, with 2-3 years of groundwater monitoring after DPE until closure.	
Estimated DPE Duration	2-3 years
Estimated Effectiveness	Low
Estimated Time until Closure	5 years
Design, Permitting, and Utilities	$60,000
Well Installation (10 new DPE wells)	$52,000
Equipment Procurement	$100,000
System Installation and Startup	$160,000
O&M Labor/Reporting ($3,000/mo)	$72,000-$108,000 (2-3 years)
O&M Utilities/Fees ($2,200/mo)	$52,800-$79,200 (2-3 years)
Quarterly GW Monitoring ($24,000/yr)	$96,000-$144,000 (4-6 years)
Total	$592,800-$703,200 (5 years)

Evaluation of Soil Vapor Extraction

Soil vapor extraction (SVE) is a common approach for remediating unsaturated soil. This approach uses an aboveground vacuum pump to extract vapor-phase hydrocarbons from the site subsurface. SVE can also remediate hydrocarbons adsorbed to unsaturated soil that could pose a risk to groundwater quality. At sites with a fairly permeable capillary fringe and saturated zones, SVE can improve groundwater quality and can remove floating, separate-phase hydrocarbons. When saturated zone remediation is required, SVE is commonly combined with other technologies such as air sparging or groundwater extraction. Extracted vapors are typically treated aboveground with oxidizers or activated carbon.

Site Specific Evaluation: Based on the high vacuum required to induce low soil vapor flow rates (and lack of consistent vacuum influence) observed during DPE testing, SVE alone would not be feasible without dewatering via DPE (aboveground vacuum or submersible pumps). This is a common result for sites with low permeability soil types as encountered beneath the site. Also, the fact that significant hydrocarbon impact is present below the water table and therefore not available for removal via SVE, this technology is not an appropriate remedial alternative for the site.

Evaluation of Groundwater Extraction

Groundwater extraction (GWE) is a common approach for remediating hydrocarbon impacts to groundwater, especially where hydraulic control is required. GWE relies on submersible groundwater pumps to extract subsurface groundwater for aboveground treatment and disposal, which can be costly. GWE was used extensively in the 1980's and early 1990's before being displaced by more cost-effective insitu treatment methods, such as soil vapor extraction (SVE), air sparging (AS), oxidation, and enhanced biodegradation. GWE is often implemented to facilitate remediation and hydraulic control of MTBE, given MTBE's high solubility and low adsorption rates. GWE is also conducted in conjunction with SVE (sometimes called dual-phase extraction, or DPE) to help dewater the hydrocarbon smear zone and expose hydrocarbons for vapor extraction. This approach typically requires a network of extraction and discharge piping and equipment to extract, treat and dispose of the extracted water and vapor.

Site Specific Evaluation: Pangea does not recommend GWE as a remedial option at this site for the following reasons: (1) MTBE is not a primary constituent of concern at this site, so GWE is not necessary for plume control of MTBE impacts, and (2) groundwater production rates observed in site wells during DPE testing were extremely low, so hydrocarbon mass removal rates via GWE would be correspondingly low. Like DPE, if GWE were to be implemented at the site, a closely-spaced extraction well network with appropriately screened well casings would be required to target hydrocarbon-impacted areas beneath the site. Even with an extensive extraction well network, it is unlikely that GWE alone would be more than marginally effective at remediating the site because of the presence of fractures in the subsurface bedrock and the suspected higher permeability materials in the former excavation area that allow for preferential air flow from areas with little or no hydrocarbon impact.

Evaluation of Air Sparging and Biosparging

Air sparging (AS) is a common technique for cost-effectively remediating petroleum hydrocarbons from saturated soil and groundwater. AS involves the injection of compressed air into the saturated zone to 'strip' hydrocarbons from saturated soil and groundwater for capture by SVE or DPE. AS also oxygenates groundwater, and thereby stimulates hydrocarbon degradation. AS is generally more cost effective than groundwater extraction because no large extraction and treatment equipment is required with AS, and system operation and maintenance costs are low. AS wells are typically constructed with well screens starting approximately 10 feet or more below the water table, and well screen intervals are carefully selected to allow capture of hydrocarbon vapors created by sparging. Low-flow AS (known a biosparging) can be performed to stimulate hydrocarbon biodegradation for additional cost-effective remediation.

Biosparging, also known as low-flow air sparging, is a technique used to stimulate degradation of residual contaminants that slowly diffuses out of fine-grained materials at a given site. Biosparging can cost effectively remediate petroleum hydrocarbons from saturated soil and groundwater, and can even help remediate vadose zone soil (a process called bioventing). Biosparging involves the injection of compressed air at low flow rates (generally 1 to 2 cubic feet per minute per injection point) into the saturated zone to oxygenate groundwater and thereby stimulate contaminant biodegradation by microbes present in the subsurface. The low air flow rate is designed to oxygenate groundwater within the well and/or surrounding formation while minimizing the potential for causing any significant migration of contaminants in the vapor phase.

Biosparging wells are typically constructed with well screens starting approximately 5 to 10 feet below the water table, with a screened interval of 1 to 2 feet in length. The submerged well screen allows the injection of air directly into the formation for a greater influence area. Biosparging can be conducted into groundwater monitoring wells screened at shallower depths, but this approach provides a more limited influence area and primarily oxygenates the well water and relies on the diffusion of dissolved oxygen from the well into the surrounding soil. Biosparging in existing monitoring wells is also more dependent upon the groundwater velocity at a site.

Biosparging is very cost effective since the remedial approach only involves procurement of a small to medium-sized air compressor to inject air into the subsurface, and use of existing or new wells screened into the water table at appropriate depths. This approach is most cost effective if existing wells are appropriately screened and subsurface piping installation is minimal.

Site Specific Evaluation Air sparging results suggest that air injection could likely influence the deeper fractured bedrock at the site. Biosparging could also be performed to oxygenate groundwater within the permeable excavation backfill material to be used upon excavation of the primary extent of contamination. As described below, horizontal piping could be installed within the permeable backfill to form a biosparge and/or aeration chamber. The chamber would be located beneath the planned subsurface parking garage as shown on Figures 11 and 12. In addition, two biosparge wells could located within deeper bedrock to target deeper contamination, with any created vapors migrating upward for capture beneath the subgrade parking structure. In conjunction with the biosparging chambers, Pangea proposes to install a vapor and/or water collection system and plastic sheeting. This collection system and plastic sheeting will allow the capture of anticipated small volume of air with low concentrations of hydrocarbon vapors. Finally, shallow soil gas monitoring probes proposed nearby can be used to evaluate any migration of hydrocarbon vapors during biosparging. To provide added safeguards, Pangea would also attempt to conduct more aggressive biosparging before the site building is occupied and during the anticipated renovation of the adjacent building on the Poppy Fabric property south of the site. Pangea considers this a very pragmatic and cost-effective remedial alternative to be used in conjunction with the proposed excavation and site development.

Evaluation of Excavation (with Biosparging)

Excavation is a proven and effective technique for remediating shallow petroleum hydrocarbons. Excavation is most appropriate for low permeability soil, where insitu remedial techniques are generally ineffective. Excavation is also a cost effective option for undeveloped sites such as this, where the excavation area is accessible and not beneath site facilities. Excavation can remove unsaturated soil, capillary fringe soil, and saturated soil. Excavated soil is usually transported offsite for disposal, but soil can be treated and reused at the site in accordance with regulatory guidelines and with regulatory approval.

Site Specific Evaluation: As a vacant lot with relatively shallow impacted soil of low permeability, excavation is an appropriate alternative to consider. Especially since insitu techniques such as DPE have limited effectiveness based on site testing. And with the planned site development, the cost to implement excavation can be reduced as follows: 1) no import material would be required for the upper 10 feet of the site due to the planned parking garage, 2) planned shoring will make more impacted soil more readily accessible, and 3) the demolition of the existing vacant structure will help expose the impacted area under the building for excavation, and 4) it will facilitate cost-effective installation of subgrade water/vapor collection systems and vapor barriers.

The evaluated shallow excavation of the northeastern and south-central portions of the site is illustrated in plan view on Figure 7 and in cross-sectional view on Figures 8, 9 and 10. The excavation would remove heavily impacted source material, potentially to the point where residual hydrocarbons can attenuate naturally. To target residual contaminants in deeper soil and groundwater and in offsite groundwater beyond the anticipated extent of the excavation, Pangea recommends considering biosparging. Figures 11 and 12 show the planned biosparging system and associated wells.

To allow comparison with DPE and other alternatives, Pangea offers the following scenario and cost estimate in Table D.

Table D – Excavation and Biosparging Approach & Cost Estimate	
Scenario – Excavation to approximately 15 feet depth to target hydrocarbon-impacted soils above the bedrock in the northeastern and south-central portions of the site. Estimated removal and disposal of 4,300 cubic yards (6,450 tons) of material. After excavation and during site redevelopment activities, a biosparging system will be installed beneath the parking garage to remediate residual hydrocarbons in soil and groundwater.	
Estimated Excavation Duration	4 weeks
Estimated Biosparge Duration	2-3 years
Estimated Effectiveness	High
Estimated Time until Closure	3-4 years
Excavation Oversight/Reporting by Pangea	$25,000
Demolition of Existing Site Structures (cost paid by developer)	<$10,000>
Shoring Costs (Estimated at $60,000 - majority paid by developer, Fund to pay for critical shoring required to access contaminated soil. Estimated 25% of cost.)	$15,000
Sample Analyses – 50 soil samples at $100/sample for rush analysis	$5,000
Excavation Contractor Cost: Excavation equipment, soil loading and labor: 10 days @ $5,000/day	$50,000
Backfill trucking and compaction costs for clean fill from 12-15 ft in excavated areas: Low cost assumes reuse of 700 tons of site soil, high cost assumes 860 cubic yards (1,300 tons) of import x $60/yard	$25,000-$51,600
Transportation and Disposal Costs for Soils 0-9 ft depth, <50 mg/kg TPHg, 3,870 tons @ $33/ton=$127,710 Transportation and Disposal Costs for Soils 9-15 ft depth, >50 mg/kg TPHg, 2,580 tons @ $50/ton=$129,000 Transportation and Disposal Costs for Soils 9-15 ft depth with 2' dia. rock and >50 mg/kg TPHg, 2,580 tons at an additional $10/ton=$25,800 (added to higher cost range) *(Additional soil excavation and disposal not required for remediation to be paid by developer)*	$256,710-$282,510
Installation of a biosparging system and four sparge wells in permeable backfill beneath parking garage slab	$25,000
Operation and Maintenance of biosparging system for 2-3 years @ $600/month.	$14,400 - $21,600
Quarterly GW Monitoring ($24,000/yr)	$96,000 (4 years)
Total	$512,110-$571,710

Conclusion

Based on our understanding of the site conditions and the estimated costs presented above, soil excavation followed by the installation and operation of a biosparging system is the most cost-effective remedial technique for this site. The assessment and feasibility testing of DPE helped confirm this conclusion. The estimated lifecycle cost of excavation and biosparging is $512,110 to $571,710 compared to $592,800 to $703,200 for DPE. Also, excavation is faster and more effective for the low permeability materials prevalent at the site. Given the limited effectiveness of DPE for this site, it is possible that excavation could still be required after DPE implementation to meet regulatory action levels; under this scenario the lifecycle costs would be approximately the sum of both cost estimates, or $1,104,910 to $1,274,910.

PROPOSED INTERIM REMEDIATION – SITE EXCAVATION AND BIOSPARGING

Based on our evaluation presented above, Pangea proposes soil excavation followed by the installation and operation of a biosparging system is the most cost-effective technique to conduct interim remedial action at this site. Figure 7 presents in plan view the proposed extent of excavation for targeting the primary extent of contaminants. The proposed excavation extent in cross-sectional view is shown on Figures 8, 9 and 10. To target residual contaminants in deeper soil and groundwater and in offsite groundwater beyond the anticipated extent of the excavation, Pangea proposes biosparging. Figures 11 and 12 show the planned biosparging system and associated wells.

The planned excavation will be completed to approximately 15 feet bgs to target hydrocarbon-impacted soils above the bedrock in the northeastern and south-central portions of the site. If hydrocarbon-impacted soils are encountered deeper than 15 ft bgs and are accessible for excavation, the excavation will be extended slightly deeper, if necessary, to remove the impacted material. The anticipated maximum final extent of the excavation is shown on the above referenced figures, and will be based on new analytical data, field observations, and direction from representatives of the ACEH.

The estimated excavation volume for the northeastern portion of the site is approximately 1,600 cubic yards (2,400 tons), and for the south-central portion, approximately 2,700 cubic yards (4,050 tons). Groundwater pumping and/or storage may be required if a significant volume of groundwater is encountered during excavation activities. If a significant volume of groundwater is encountered during excavation activities, Pangea will arrange to have groundwater that collects in the excavation cavity pumped out and disposed of properly.

During site redevelopment activities described in the previous *Planned Site Redevelopment* section, and after excavation activities are completed, Pangea will coordinate the installation of a biosparging system. The conceptual biosparging design involves the installation of 2-3 vertically-oriented biosparge wells into native material beneath the site, and 2-3 horizontally-oriented wells installed in the permeable backfill material beneath the subsurface parking garage. Final biosparging system design will be modified based on field observations, final building design, and discussions with the project civil engineer. Biosparge design drawings and an implementation schedule will be submitted to the ACHCSA prior to system installation activities. If aqueous-phase hydrocarbon concentrations remain elevated after excavation activities are completed, Pangea may elect to perform aggressive sparging at higher flow rates (3-4 cfm per well) before the building is occupied to reduce residual hydrocarbon concentrations in groundwater.

Pangea will oversee the following tasks to facilitate excavation:

Pre-Excavation Task – Well Destruction/Replacement: In accordance with ACEH requirements, Pangea will coordinate the destruction of wells MW-1, MW-3A, MW-3C, MW-4A, MW-6A, MW-7B, MW-7C, MW-8A and MW-8C prior to excavation since they are within the planned excavation limit, and extend beyond the excavation floor. These wells will be destroyed properly by completely drilling out the entire casing and well construction materials, and backfilling the boring with grout. Replacement monitoring wells shall be installed within 10 feet downgradient of the excavation limits after completion of the overexcavation work to evaluate the remedial action and onsite groundwater impact.

Task 1 – Permitting: Pangea will obtain permits from local agencies to allow excavation.

Task 2 – Disposal Profiling: Pangea will submit existing soil data to landfill(s) to obtain pre-approval for direct loading and offhauling of soil for disposal at appropriate landfill(s). Pangea anticipates having some relatively 'clean' soil (<50 mg/kg TPHg), and some deeper soil significantly impacted by petroleum hydrocarbons (>50 mg/kg, but <1,000 mg/kg). Disposal efforts should not be affected by lead. To verify the presence or absence of lead in subsurface soils, pre-excavation soil samples will be collected where necessary and analyzed for lead for confirmation.

Task 3 – Excavation Preparation: The excavation contractor shall mark the site for underground service alert (USA), and shall use an underground line locator to clear the planned excavation area. The contractor will mobilize excavation equipment and personnel to perform the excavation. Pangea will meet with ACHCSA representatives as necessary to prepare for excavation.

Task 4 – Soil Excavation: The contractor shall conduct excavate in the northeastern and south-central portions of the site to meet project objectives. These areas will be excavated to a depth of approximately 15 feet bgs, unless otherwise determined in the field based on analytical data, field observations, and direction from representatives of the ACHCSA. Shoring will be provided as required for safety purposes or engineering requirements. The estimated maximum excavation volume is 4,300 cubic yards (6,450 tons). The contractor will make every effort to segregate for reuse any clean fill. If acceptable to the ACHCSA, the contractor will grade any apparent non-impacted overburden soil (shallow soil about 0-3 feet bgs) within the excavation cavity. With ACHCSA approval, any such graded overburden soil would not be considered waste and would not require profiling for 'reuse'.

Pangea will collect soil samples from excavation sidewalls and floor when accessible as directed by the ACHCSA. Soil samples will be analyzed for TPHg/BTEX/MTBE by EPA Method 8015M/8020. Pangea will collect composite or discrete soil samples for any stockpiles to facilitate soil disposal.

<u>Task 5 – Soil Transportation and Disposal:</u> To the extent possible, soil will be loaded directly onto trucks for transportation and offsite disposal during initial excavation activities. If necessary, soil may be segregated and stockpiled for future disposal. The contractor will provide alternate disposal rates for soil with <50 mg/kg TPHg and >50 mg/kg TPHg, and as otherwise provided by appropriately licensed landfills.

<u>Task 6 – Backfilling:</u> The excavation cavity will be filled with drain rock, pea gravel, or self-compacting material that meets engineering requirements for site redevelopment activities. A compaction of 95% will be provided for any non-self-compacting material.

<u>Task 7 – Biosparging System Installation:</u> Upon completion of excavation activities, biosparging system installation activities will take place, and will be coordinated with site construction activities and scheduling.

<u>Additional Excavation Tasks (As Needed):</u> The following tasks will be only be conducted as needed:

- Temporary fence installation and rental;
- Shoring;
- Removal and replacement of any underground utilities;
- Pumping, storage and treatment of any encountered groundwater; and
- Special traffic control.

<u>Task 8 – Remedial Action Completion Report:</u> Upon completing implementation of the IRAP, Pangea will prepare a Remedial Action Completion Report. The report will describe the IRAP activities and results, and will present tabulated analytical results. The report will include site photographs and provide waste manifests for disposed soil.

IRAP SCHEDULE

The IRAP is also designed to allow site remediation before the winter rains, thereby avoiding a six-month delay and potential further migration of hydrocarbons. The proposed IRAP schedule is as follows:

- IRAP submittal to ACEH...July 20, 2007
- Meeting with ACEH to discuss IRAP and Redevelopment Schedule..................August 17, 2007
- IRAP Approval / Development Comfort Letter ....September 17, 2007
- Owner Secures Loan with Agency Approval Letter.................................October 1, 2007
- Site Excavation for IRAP Implementation Begins.................................October 7, 2007
- Owner Commences Site Redevelopment..October 14, 2007
- Complete IRAP Excavation ....October 31, 2007
- Install Biosparge System..November 15, 2007
- Submit IRAP Implementation Report...December 31, 2007

The biosparge system would be operated until residual contaminants are sufficiently remediated.

CLOSING

Pangea appreciates your efforts to review this IRAP in a timely manner. If you have any questions or comments, please contact Bob Clark-Rddell at (510) 435-8664 or briddell@pangeaenv.com.

Sincerely,
Pangea Environmental Services, Inc.

Brian Busch
Senior Project Scientist

Bob Clark-Riddell
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
ROBERT G. CLARK-RIDDELL
No. C 049629
Exp. SEPT 2008
CIVIL
STATE OF CALIFORNIA

CC: Rockridge Heights, LLC, C/O Gary Feiner, 34 Schooner Hill, Oakland, California, 94618
RWQCB – SF Bay Region, Cherie McCaulou, 1515 Clay Street, Oakland, California 94612
Vera Stanovich, 1956 Stratton Circle, Walnut Creek, California, 94598
SWRCB Geotracker (Electronic copy)

Bob Clark-Riddell
Principal Engineer

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SWRCB Geotracker (Electronic copy)

FIGURES

TABLES

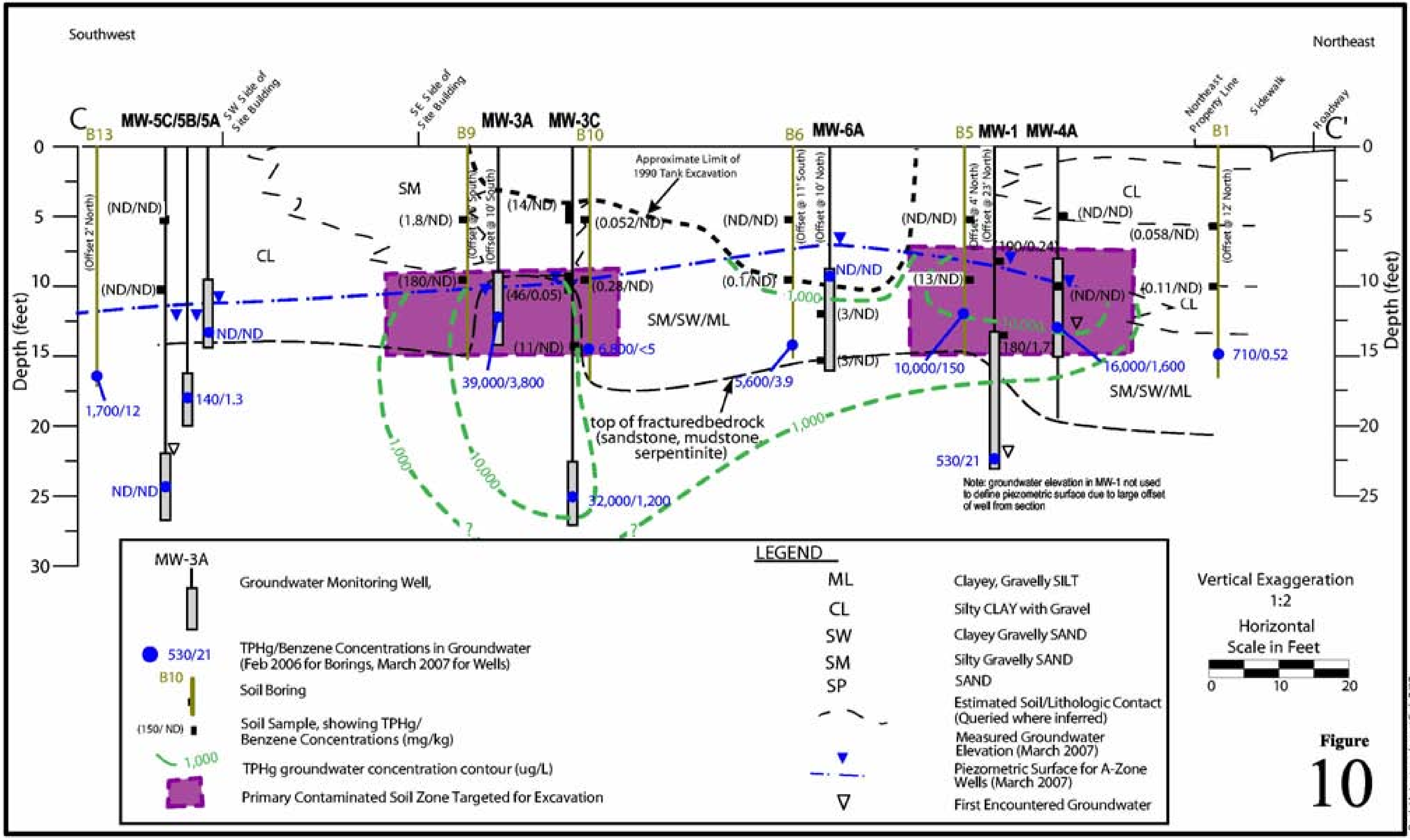

Figure
10

Former Exxon Station
5175 Broadway
Oakland, California

Proposed Excavation on Geologic Cross Section C-C'

PANGEA

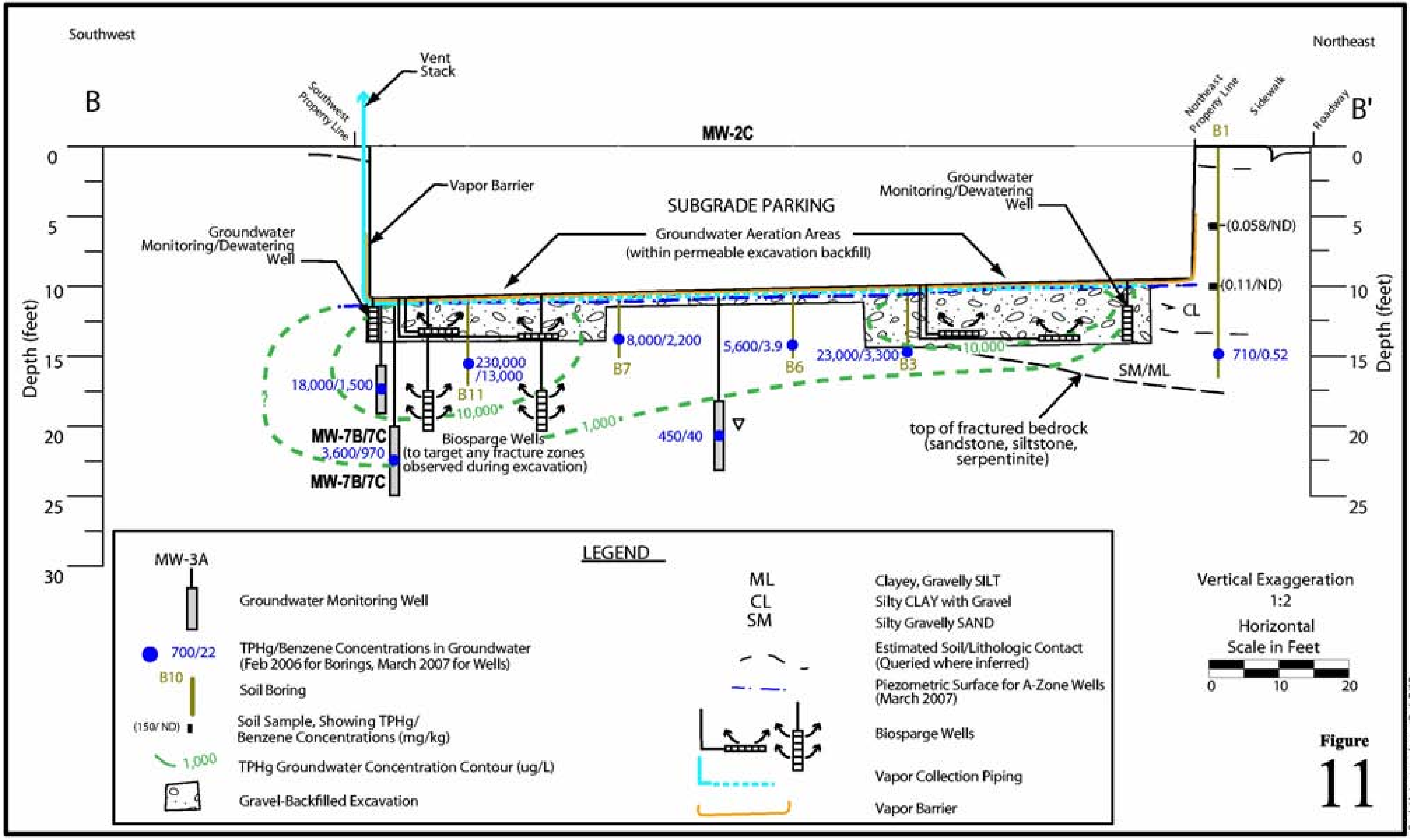

Figure 11

Former Exxon Station
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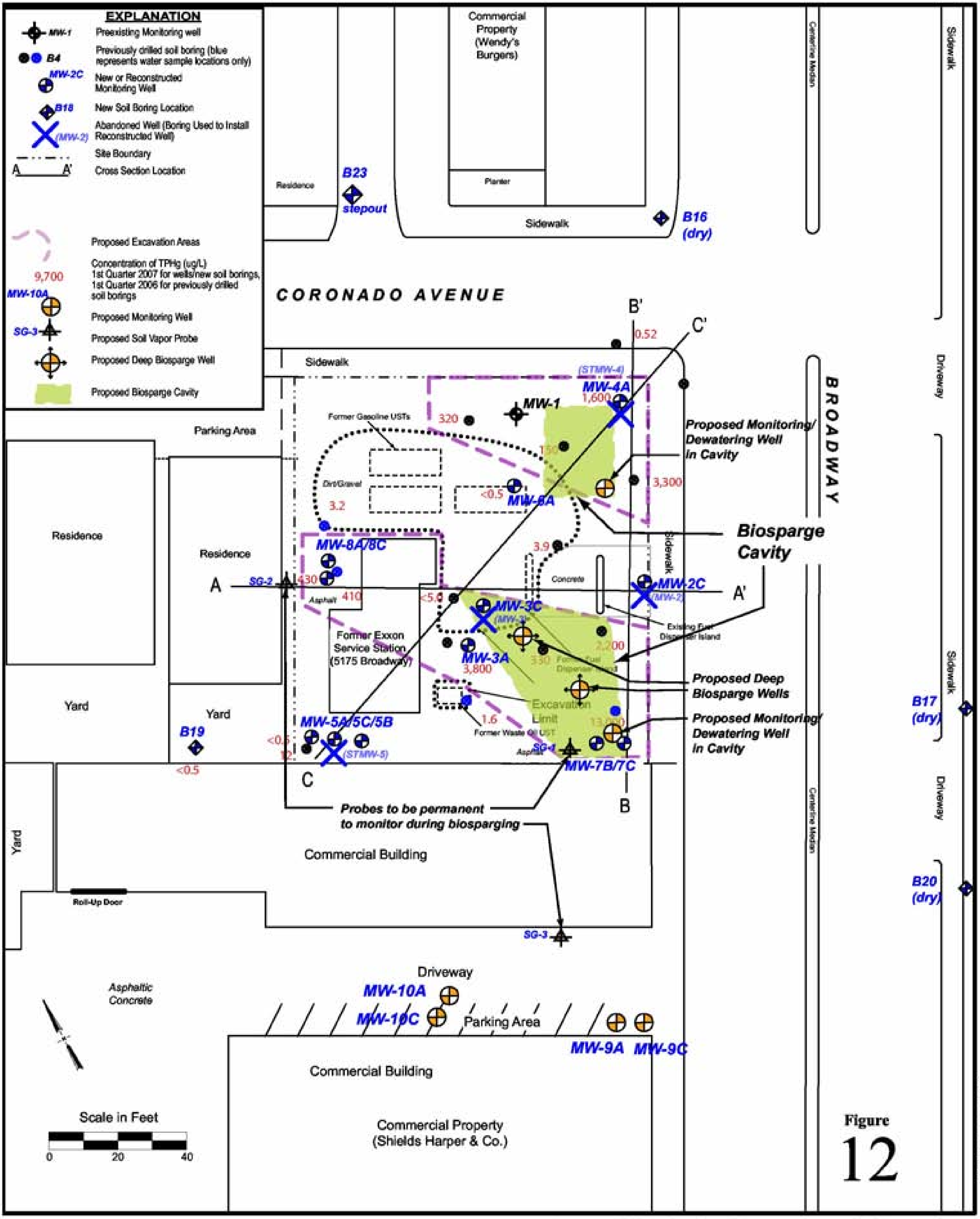
Proposed Biosparging Beneath Planned Subgrade Parking Garage

PANGEA



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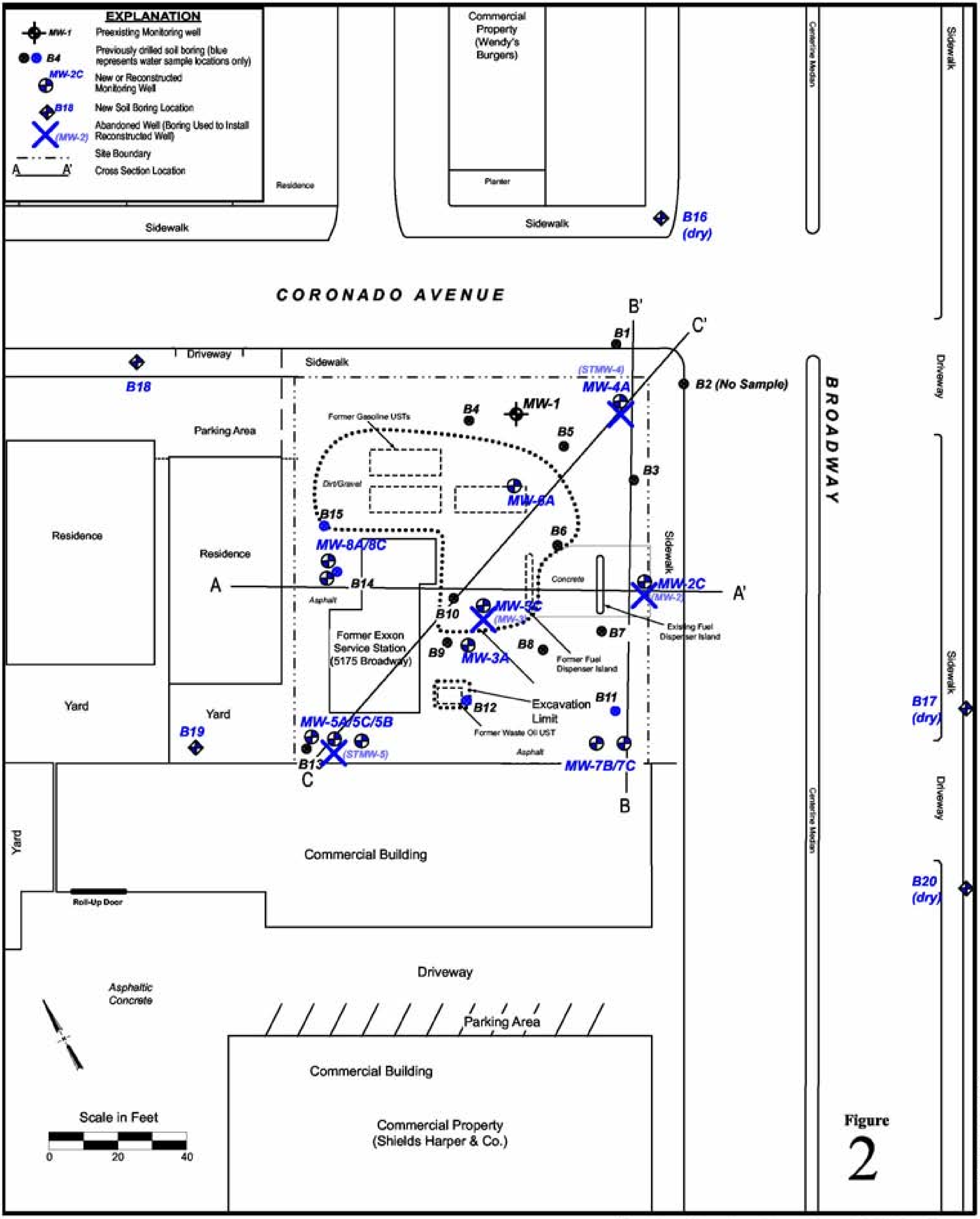
Oakland, California

Proposed Monitoring, Dewatering and Biosparging Well and Soil Vapor Probe Locations

PANGEA



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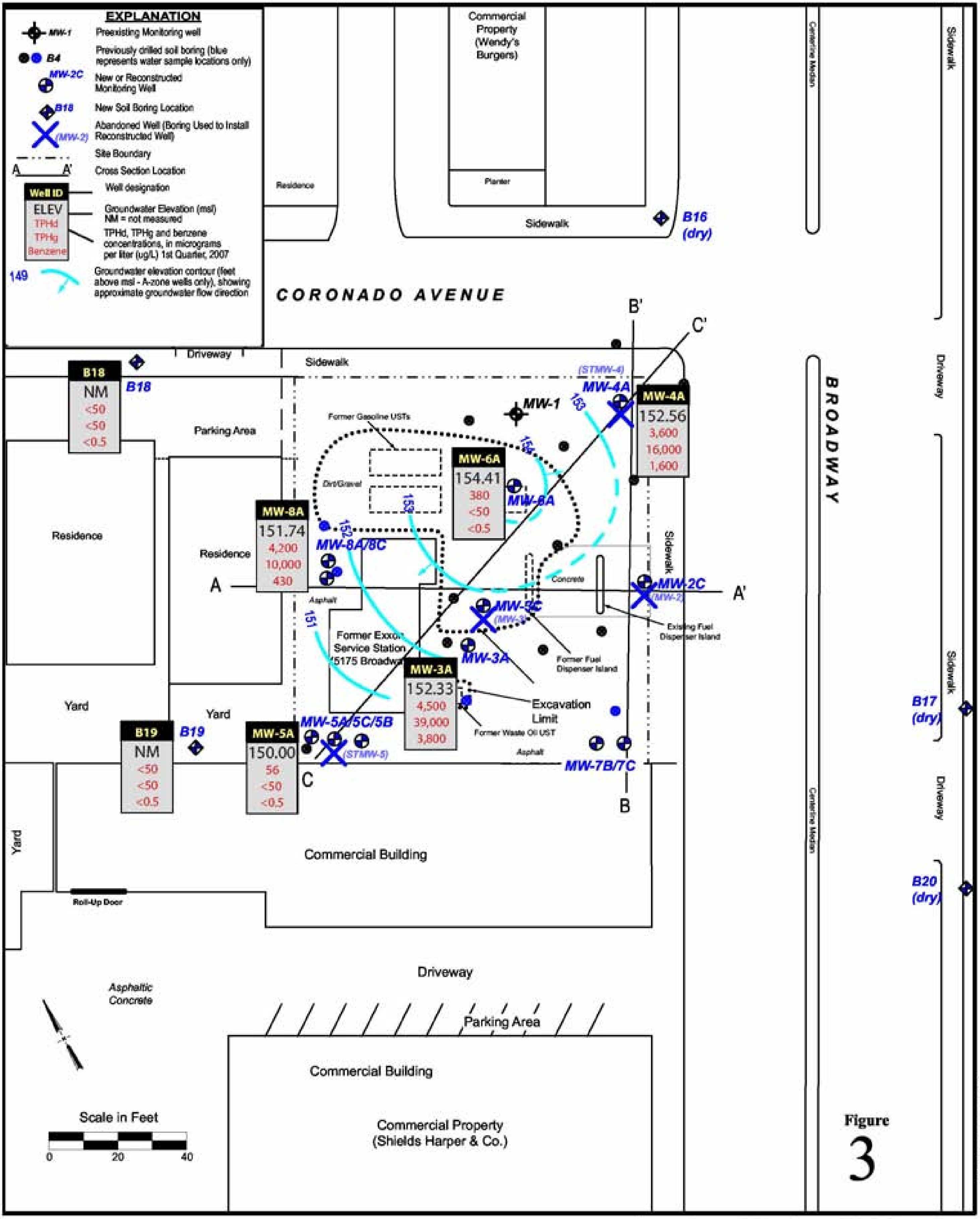
Oakland, California

Site Map Showing Locations of Soil Borings, Monitoring Wells and Cross Sections

PANGEA



Former Exxon Station
5175 Broadway
Oakland, California

Groundwater Elevation and Hydrocarbon Concentration Map (Shallow)

PANGEA

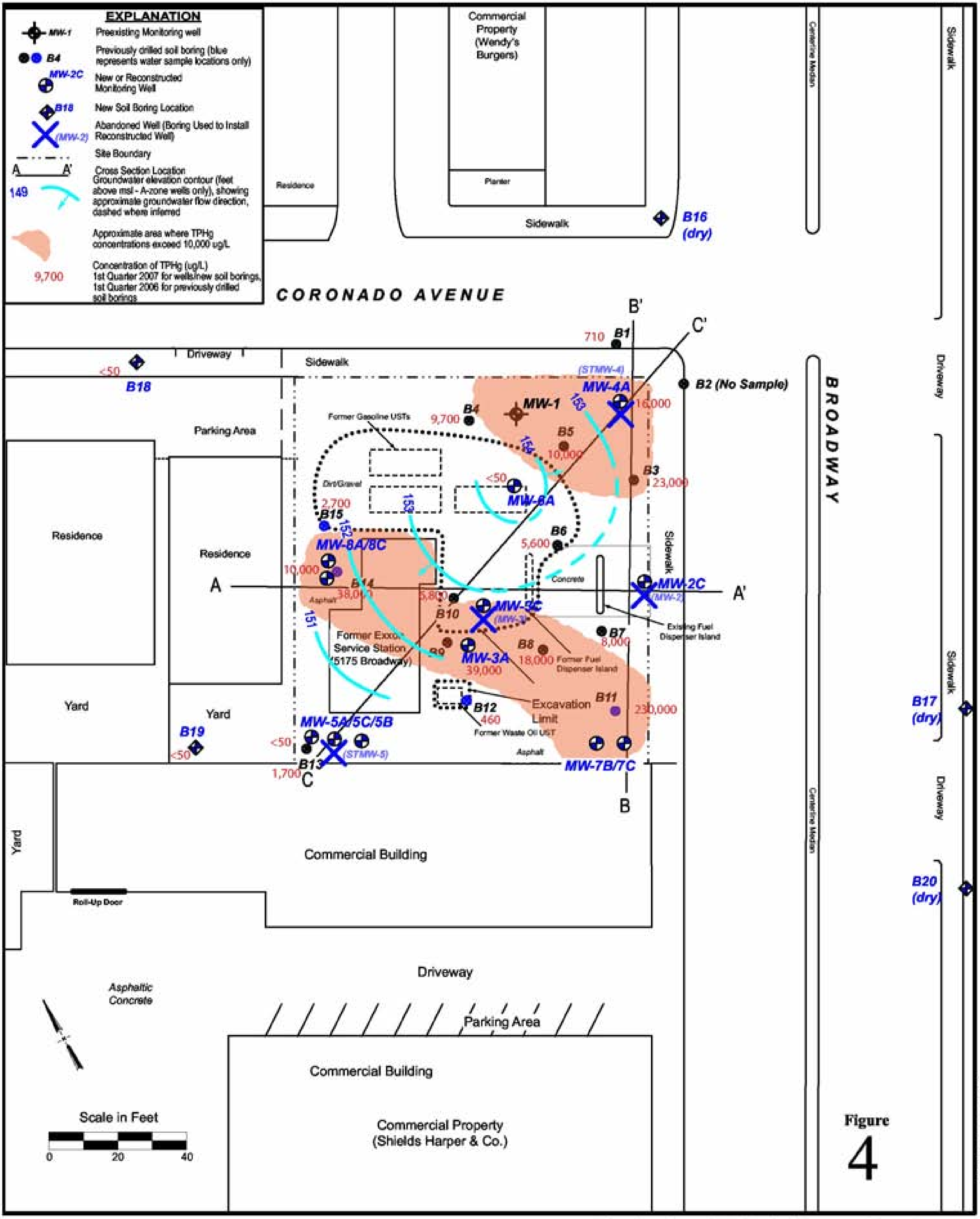


Figure 4

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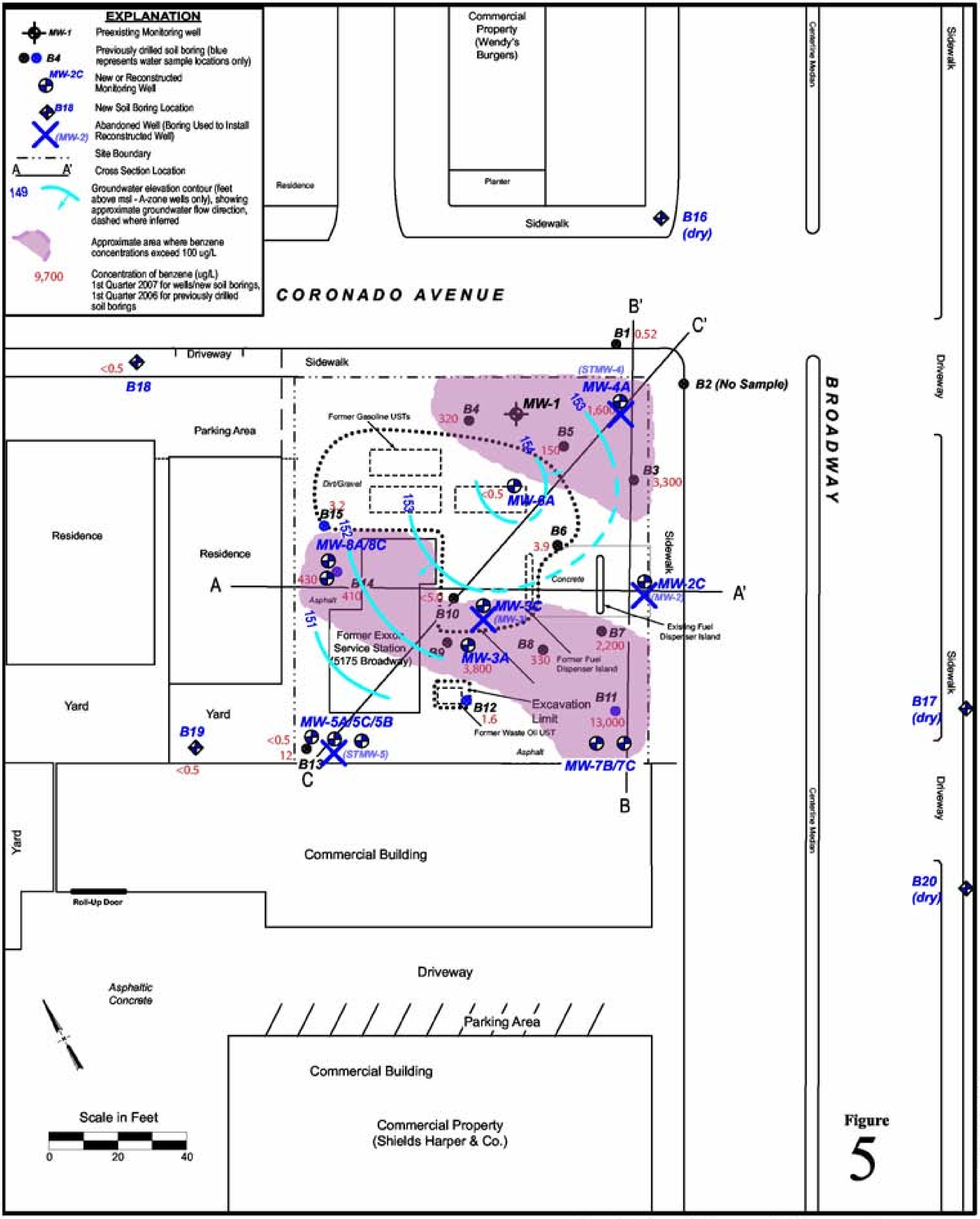
Oakland, California

Distribution of TPHg in Shallow Groundwater

PANGEA



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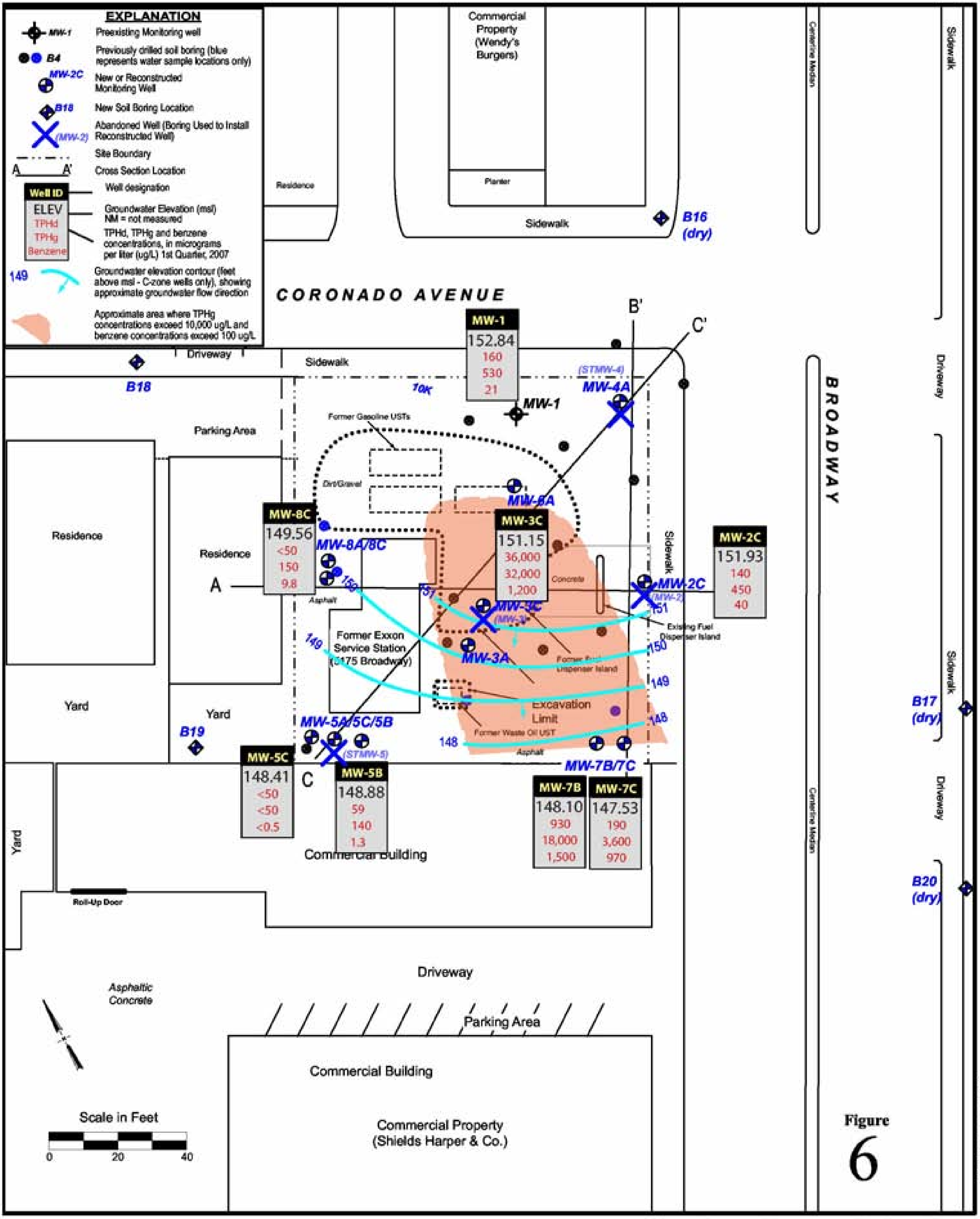
Distribution of Benzene in Shallow Groundwater

PANGEA



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Oakland, California

Groundwater Elevations, Hydrocarbon Concentrations and TPHg Distribution in Deep Groundwater

PANGEA

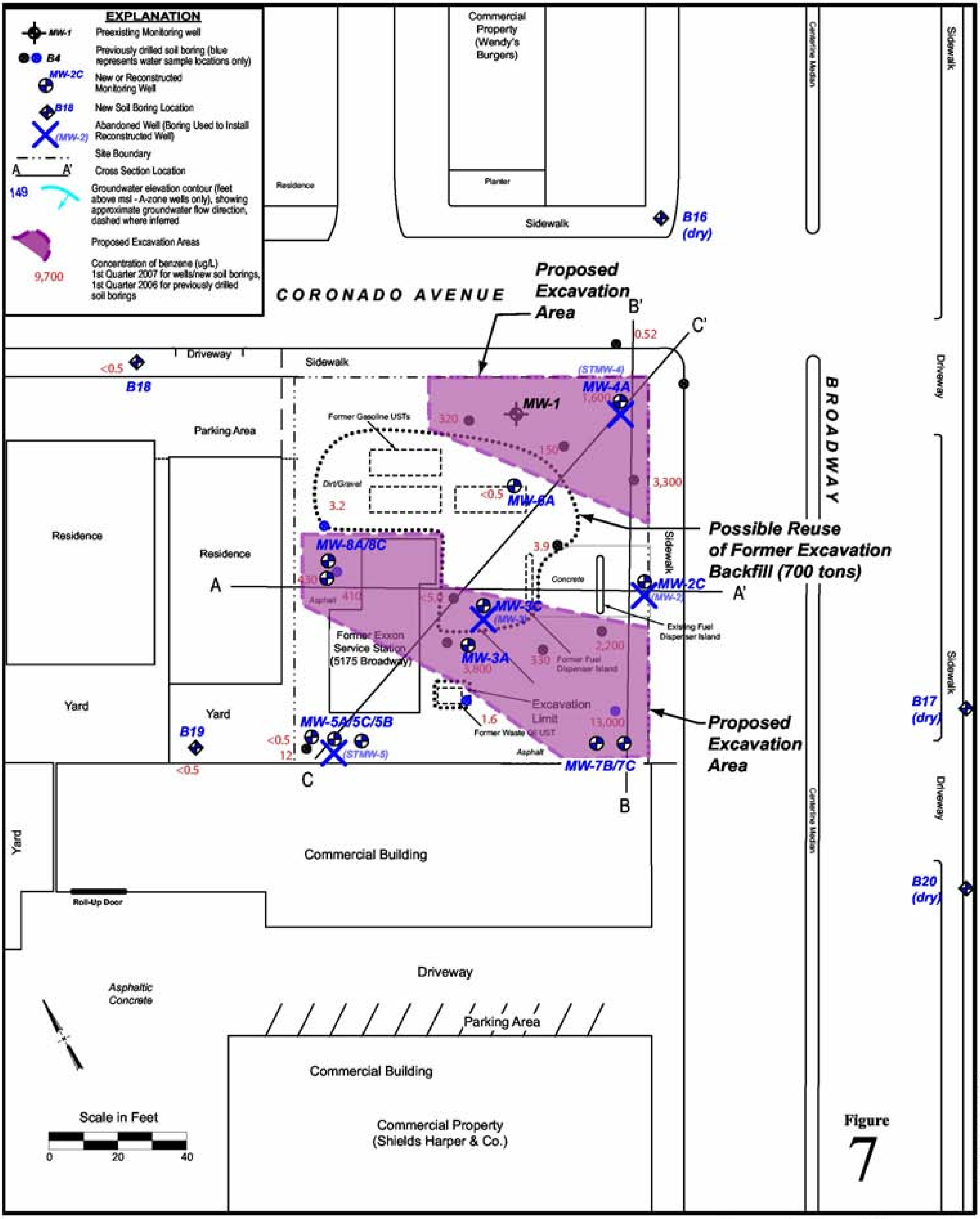

Figure 7

Proposed Extent of Excavation

Former Exxon Station
5175 Broadway
Oakland, California

PANGEA

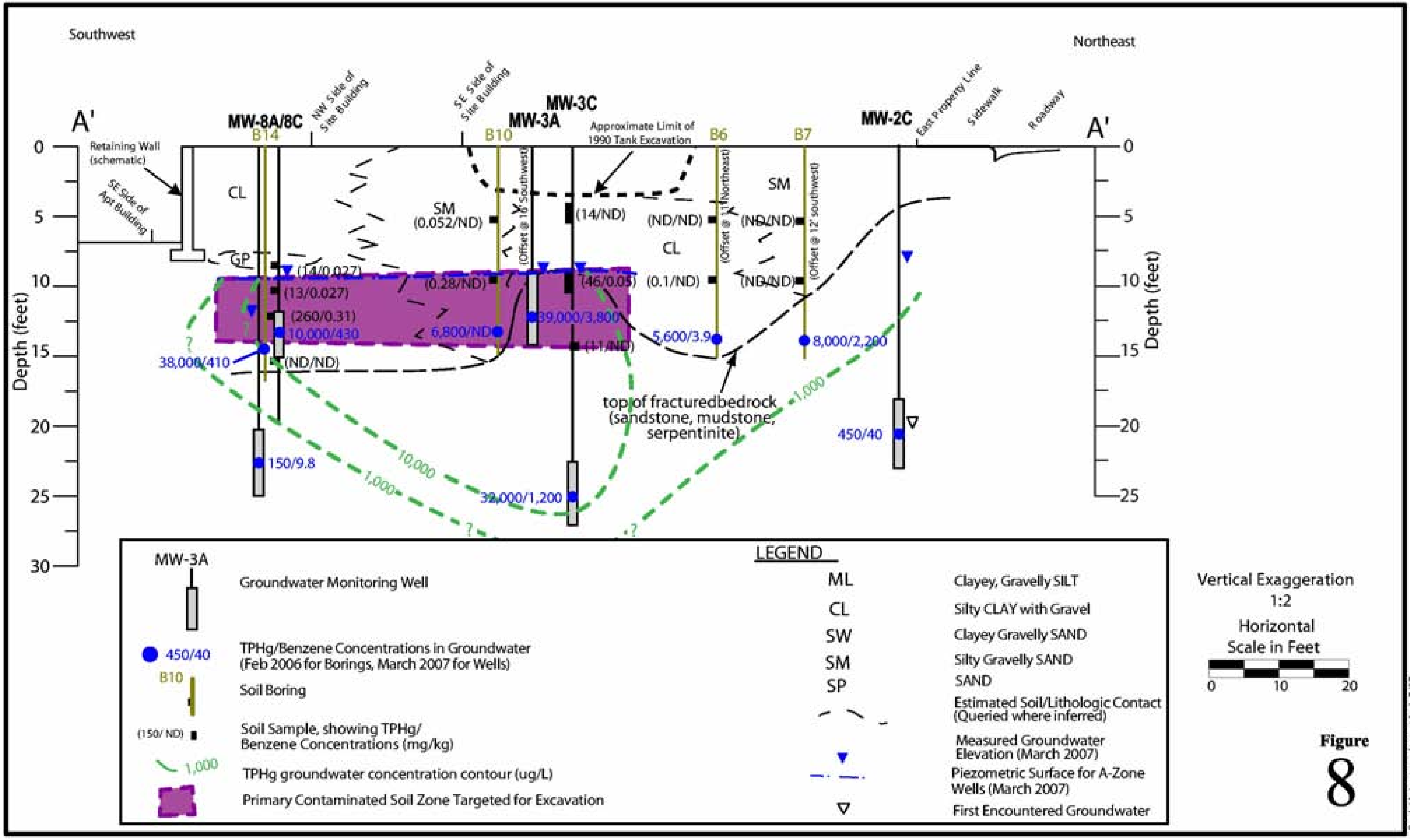

Figure 8

Former Exxon Station
5175 Broadway
Oakland, California

Proposed Excavation on Geologic Cross Section A-A'

PANGEA

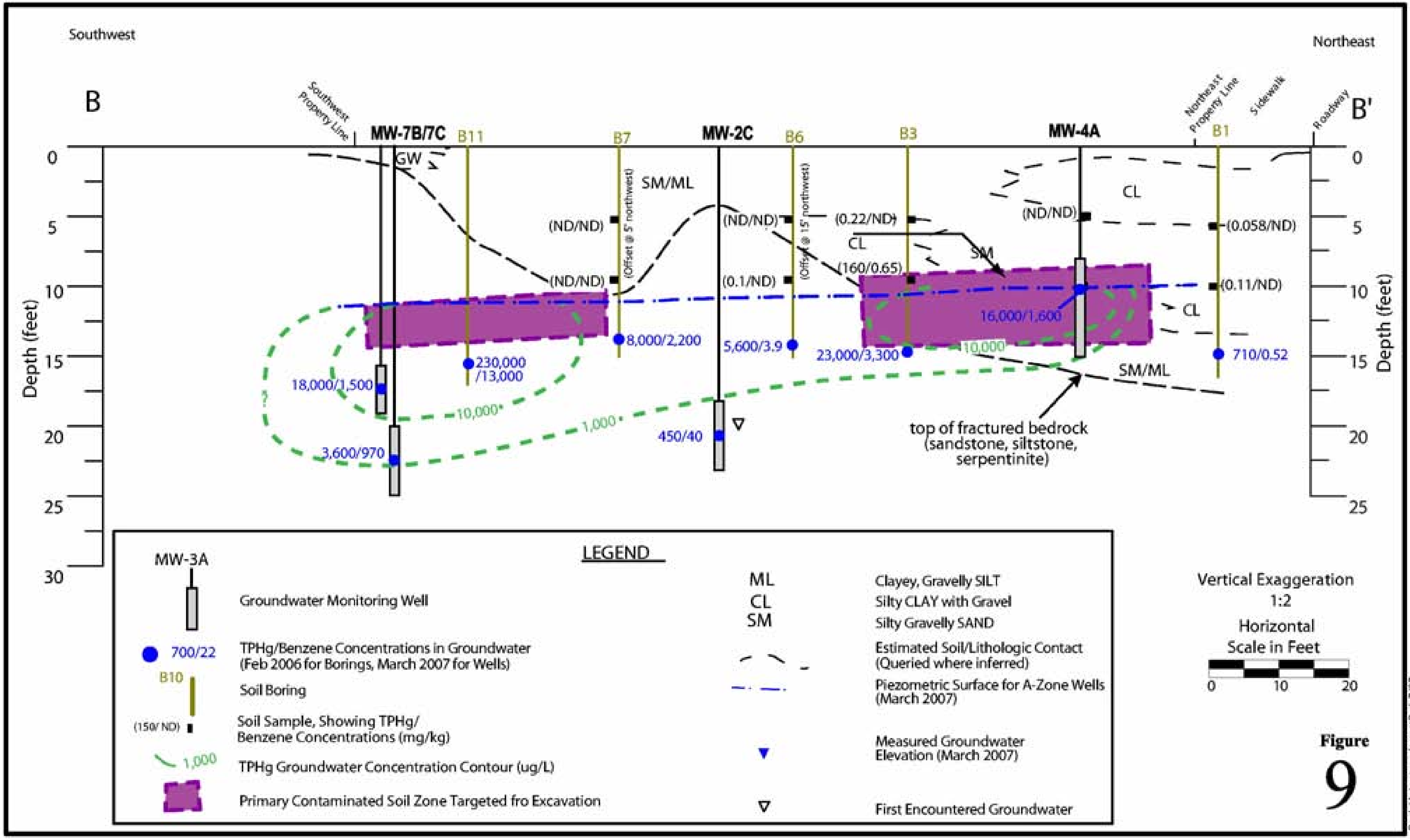

Figure
9

Former Exxon Station
5175 Broadway
Oakland, California

Proposed Excavation on Geologic Cross Section B-B'

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Table 1. Soil Analytical Data - Rockridge Heights, 5175 Broadway, Oakland, California

Sample ID	Date Sampled	Sample Depth (ft bgs)	TPHd (mg/kg)	TPHg (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl benzene (mg/kg)	Xylenes (mg/kg)	MTBE (mg/kg)	TBA (mg/kg)
Commercial ESL, drinking water			**100**	**100**	**0.044**	**2.9**	**3.3**	**2.3**	**0.023**	**0.073**
Commercial ESL, non-drinking water			500	400	0.38	9.3	32	11	5.6	110
Commercial ESL, vapor pathway			NV	NV	0.51	310	390	420	5.6	NV
WELL INSTALLATION & BORINGS - 2007										
MW-6B-12	1/22/2007	12.0	--	<50	<0.5	<0.5	<0.5	<0.5	<5.0	--
MW-6B-15	1/22/2007	15.0	--	3	<0.5	0.0087	<0.5	<0.5	<5.0	--
MW-8A-8.5	1/22/2007	8.5	--	14	0.027	0.027	0.013	0.072	<5.0	--
MW-8A-10	1/22/2007	10.0	--	13	0.027	<0.5	<0.5	0.039	<5.0	--
MW-8A-12	1/22/2007	12.0	--	**260**	**0.31**	0.16	0.083	0.73	<0.25	--
MW-8A-15	1/22/2007	15.0	--	<50	<0.5	<0.5	<0.5	<0.5	<5.0	--
BORINGS - 2006										
B1-6	2/1/2006	6.0	<100	0.058	<0.005	<0.005	<0.005	<0.01	<0.005	--
B1-10	2/1/2006	10.0	<100	0.11	<0.005	<0.005	<0.005	<0.01	<0.005	--
B2-6	2/1/2006	6.0	--	0.15	<0.005	<0.005	<0.005	<0.01	<0.005	--
B2-9	2/1/2006	9.0	--	<0.05	<0.005	<0.005	<0.005	<0.01	<0.005	--
B3-5	2/6/2006	5.0	--	0.22	<0.005	<0.005	<0.005	<0.01	<0.005	--
B3-9	2/6/2006	9.0	--	**160**	<0.65	<0.500	<0.500	<1.000	<0.500	--
B4-5	2/6/2006	5.0	--	<0.05	<0.005	<0.005	<0.005	<0.01	<0.005	--
B4-9	2/6/2006	9.0	--	**140**	<0.500	<0.500	0.66	<1.000	<0.500	--
B5-5	2/6/2006	5.0	--	<0.05	<0.005	<0.005	<0.005	<0.01	<0.005	--
B5-9	2/6/2006	9.0	<2.5	13	<0.25	<0.25	<0.25	<0.5	<0.25	--
B6-5	2/6/2006	5.0	--	<0.05	<0.005	<0.005	<0.005	<0.01	<0.005	--
B6-9	2/6/2006	9.0	<2.5	0.10	<0.005	<0.005	<0.005	<0.01	<0.005	--
B7-5	2/6/2006	5.0	--	<0.05	<0.005	<0.005	<0.005	<0.01	<0.005	--
B7-9	2/6/2006	9.0	<2.5	<0.05	<0.005	<0.005	<0.005	<0.01	<0.005	--
B8-5	2/6/2006	5.0	--	0.053	<0.005	<0.005	<0.005	<0.01	<0.005	--
B8-9	2/6/2006	9.0	--	22	<0.25	<0.25	<0.25	<0.5	<0.25	--
B9-5	2/6/2006	5.0	--	1.8	<0.005	<0.005	<0.005	<0.01	<0.005	--
B9-9	2/6/2006	9.0	<2.5	**180**	<0.500	<0.500	<0.500	<1.000	<0.500	--
B10-5	2/6/2006	5.0	--	0.052	<0.005	<0.005	<0.005	<0.01	<0.005	--
B10-9	2/6/2006	9.0	--	0.28	<0.005	<0.005	<0.005	<0.01	<0.005	--
WELL INSTALLATION - 1990 & 1991										
MW-1	4/17/1990	8.0-8.5	--	**190**	**0.24**	0.21	0.92	0.6	--	--
MW-1	4/17/1990	13.5-14	--	**180**	**1.7**	1.4	2.4	**6.4**	--	--
MW-2	4/24/1990	3.0-4.5	--	≤5	0.0061	0.005	0.0057	0.026	--	--
MW-2	4/24/1990	8.0-9.0	--	≤5	0.006	0.005	0.0089	0.013	--	--
MW-3	4/17/1990	4.0-5.5	--	14	≤5.0	≤5.0	≤5.0	0.1	--	--
MW-3	4/17/1990	9.0-10.0	--	46	**0.05**	≤5.0	0.4	0.2	--	--
MW-3	4/17/1990	14.0-14.5	--	11	≤5.0	≤5.0	≤5.0	0.1	--	--
STMW-4	6/21/1991	5.0	--	≤5	≤5.0	≤5.0	≤5.0	≤5.0	--	--
STMW-4	6/21/1991	10.0	--	≤5	≤5.0	≤5.0	≤5.0	≤5.0	--	--
STMW-5	6/21/1991	5.0	--	≤5	≤5.0	≤5.0	≤5.0	≤5.0	--	--
STMW-5	6/21/1991	10.0	--	≤5	≤5.0	≤5.0	≤5.0	≤5.0	--	--

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Table 1. Soil Analytical Data - Rockridge Heights, 5175 Broadway, Oakland, California

Sample ID	Date Sampled	Sample Depth (ft bgs)	TPHd (mg/kg)	TPHg (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl benzene (mg/kg)	Xylenes (mg/kg)	MTBE (mg/kg)	TBA (mg/kg)
Commercial ESL, drinking water			**100**	**100**	**0.044**	**2.9**	**3.3**	**2.3**	**0.023**	**0.073**
Commercial ESL, non-drinking water			500	400	0.38	9.3	32	11	5.6	110
Commercial ESL, vapor pathway			NV	NV	0.51	310	390	420	5.6	NV
TANK REMOVAL & OVEREXCAVATION										
S-1-W	1/10/1990	7.0	10	≤5	≤5.0	≤5.0	≤5.0	≤5.0	--	--
S-2-N	1/10/1990	10.0	--	**970**	≤5.0	≤5.0	13	15	--	--
S-3-N	1/10/1990	10.0	--	**120**	≤5.0	≤5.0	≤5.0	≤5.0	--	--
S-3-S	1/10/1990	10.0	--	**930**	≤5.0	≤5.0	≤5.0	14	--	--
S-4-N	1/10/1990	10.0	--	12	≤5.0	≤5.0	≤5.0	0.13	--	--
S-4-S	1/10/1990	10.0	--	55	≤5.0	≤5.0	≤5.0	0.8	--	--
L1-L4 (water)	1/10/1990	10.5	--	6.9	**0.053**	≤5.0	≤5.0	0.81	--	--
S-P-1	1/31/1990	2.0-3.0	--	≤5	≤5.0	≤5.0	≤5.0	≤5.0	--	--
S-P-2	1/31/1990	2.0-3.0	--	≤5	≤5.0	≤5.0	≤5.0	≤5.0	--	--
S-P-3	1/31/1990	2.0-3.0	--	34	≤5.0	≤5.0	≤5.0	≤5.0	--	--

Abbreviations and Methods:

Commercial ESL, drinking water = Table A - Environmental Screening Levels for Shallow Soil (<3 meters) where groundwater **is** a current or potential source of drinking water, as established by the RWQCB-SFBR, Interim Final February 2005 (Revised November 2006).

Commercial ESL, non-drinking water = Table B - Environmental Screening Levels for Shallow Soil (<3 meters) where groundwater is not a current or potential source of drinking water, as established by the RWQCB-SFBR, Interim Final February 2005 (Revised November 2006).

Commercial ESL, Vapor Pathway / Intrusion Into Building Concerns = Table A-2 Environmental Screening Levels for Soil (<3 meters) where groundwater **is** a current or potential source of drinking water, as established by the RWQCB-SFBR, Interim Final February 2005 (Revised November 2006).

7.1 = Concentrations in **bold** are soil exceeding the commercial ESL protective of groundwater as a drinking water resource.

NV = No ESL value, use soil gas ESL and compare to soil gas concentrations.

ft bgs = feet below ground surface.

mg/kg = milligrams per kilogram.

TPHd = Total petroleum hydrocarbons as diesel by modified EPA Method 8015C.

TPHg = Total petroleum hydrocarbons as gasoline by modified EPA Method 8015C.

Benzene, toluene, ethylbenzene, and xylenes by EPA Method 8020.

MTBE = Methyl tertiary butyl ether by EPA Method 8260.

-- = Not collected, not analyzed, or not applicable.

ND = Not detected above laboratory reporting limits.

See analytical report for notes.

Table 2. Groundwater Analytical Data - Former Exxon Station, 5175 Broadway, Oakland, CA

Well ID *TOC Elev* *(ft)*	Date Sampled	SPH (ft)	Groundwater Elevation (ft)	Depth to Water (ft)	TPHd	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	DIPE	1,2-DCA	Dissolved Oxygen mg/L
					←				μg/L				→	
Commercial ESL, drinking water					**100**	**100**	**1**	**40**	**30**	**20**	**5**	**--**	**0.50**	**--**
Commercial ESL, non-drinking water					640	500	46	130	290	100	1,800	--	200	--
Commercial ESL, vapor pathway					NV	NV	540	380,000	170,000	160,000	24,000	--	200	--
GRAB GROUNDWATER SAMPLING - 2007														
B-18	01/23/07	--	--	7.1	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
B-19	03/19/07	--	--	4	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
GRAB GROUNDWATER SAMPLING - 2006														
B1-W	02/01/06	--	--	9.5	<84	**710**	(0.52)	(0.59)	(<0.50)	(0.66)	<1.0	<5.0	<0.50	--
B3-W	02/08/06	--	--	9.63	<280	**23,000**	**(3,300)**	**(660)**	**(170)**	**(910)**	<50	380	<25	--
B4-W	02/08/06	--	--	8.24	--	**9,700**	**(320)**	(13)	**(200)**	**(180)**	<20	1,300	**12**	--
B5-W	02/08/06	--	--	6.96	--	**10,000**	**(150)**	(11)	**(210)**	**(190)**	<10	<50	<5.0	--
B6-W	02/06/06	--	--	12.1	--	**5,600**	**(3.9)**	(3.1)	**(54)**	**(61)**	<5.0	<25	<2.5	--
B7-W	02/08/06	--	--	11.72	--	**8,000**	**(2,200)**	**(300)**	**(240)**	**(830)**	<20	<100	**53**	--
B8-W	02/08/06	--	--	9.97	--	**18,000**	**(330)**	**(53)**	**(440)**	**(1,200)**	<20	<100	**11**	--
B10-W	02/06/06	--	--	13.3	--	**6,800**	(<5.0)	(5.7)	**(170)**	**(69)**	<10	<50	<5.0	--
B11-W	02/10/06	--	--	14.3	--	**230,000**	**(13,000)**	**(19,000)**	**(960)**	**(20,000)**	<200	<1,000	**150**	--
B12-W	02/03/06	--	--	7.92	--	**460**	**(1.6)**	(2.1)	(1.6)	(3.5)	<1.0	<5.0	**0.62**	--
B13-W	02/03/06	--	--	11.67	<60	**1,700**	**(12)**	(9.4)	(18)	**(22)**	<5.0	<25	<2.5	--
B14-W	02/06/06	--	--	13.1	--	**38,000**	**(410)**	(25)	**(290)**	**(95)**	<50	<250	<25	--
B15-W	02/01/06	--	--	8.75	<620	**2,700**	**(3.2)**	(2.7)	(22)	(4.3)	<5.0	<25	<2.5	--
GROUNDWATER MONITORING WELLS														
MW-1	04/30/89	--	--	--	--	**200**	**18**	5	2	12	--	--	--	--
(97.71)	05/17/90	--	88.45	9.26	--	--	--	--	--	--	--	--	--	--
	09/26/90	--	87.79	9.92	--	**1,300**	**55**	31	**120**	**100**	--	--	--	--
	01/14/91	--	88.17	9.54	--	**3,100**	**350**	**83**	**86**	**130**	--	--	--	--
(102.04)	07/03/91	--	92.62	9.42	--	**580**	**32**	**41**	**40**	**55**	--	--	--	--
	11/11/91	--	92.59	9.45	--	**330**	**20**	2	2	11	--	--	--	--
(101.83)	03/04/92	--	93.90	7.93	--	**810**	**11**	5	10	**23**	--	--	--	--
	06/02/92	--	92.85	8.98	--	**2,200**	**93**	32	**40**	**120**	--	--	--	--
	09/28/92	--	92.54	9.29	--	**2,900**	**24**	**78**	19	**37**	--	--	--	--
	01/11/93	--	94.27	7.56	--	**1,700**	**5.7**	6	11	**28**	--	--	--	--
	08/15/94	--	92.64	9.19	--	**2,000**	**120**	3	6	16	--	--	--	--
(97.50)	11/07/96	--	88.77	8.73	**270**	**1,200**	**3**	1.1	1.5	3.8	<0.5	--	--	--
	02/12/97	--	89.58	7.92	<50	**1,800**	**13**	5.7	4.8	17	<0.5	--	--	--
	06/16/97	--	88.46	9.04	<50	**330**	**27**	<0.5	<0.5	1.2	<0.5	--	--	--
	09/30/97	--	89.94	7.56	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
(97.50)	01/27/98	--	89.54	7.96	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--

Table 2. Groundwater Analytical Data - Former Exxon Station, 5175 Broadway, Oakland, CA

Well ID *TOC Elev* *(ft)*	Date Sampled	SPH (ft)	Groundwater Elevation (ft)	Depth to Water (ft)	TPHd	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	DIPE	1,2-DCA	Dissolved Oxygen mg/L
					←				μg/L				→	
Commercial ESL, drinking water					**100**	**100**	**1**	**40**	**30**	**20**	**5**	--	**0.50**	--
Commercial ESL, non-drinking water					640	500	46	130	290	100	1,800	--	200	--
Commercial ESL, vapor pathway					NV	NV	540	380,000	170,000	160,000	24,000	--	200	--
MW-1	04/24/98	--	89.52	7.98	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
(continued)	08/17/98	--	88.52	8.98	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
	11/16/98	--	88.60	8.90	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
	02/16/99	--	88.86	8.64	<50	**110**	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
	05/17/99	--	89.00	8.50	--	**280**	**1.1**	0.6	<0.5	<0.5	<0.5	--	--	--
	08/17/99	--	88.26	9.24	86	**790**	**5.6**	4.3	4.5	11	<5.0	--	--	--
	11/17/99	--	87.06	10.44	--	**1,300**	**3.6**	1.9	2.7	6.6	<1.0	--	--	--
	02/17/00	--	89.02	8.48	--	**580**	**1.1**	2.3	3.6	4.9	<5.0	--	--	--
	05/17/00	--	89.26	8.24	--	**1,500**	**130**	6.8	6.1	<5.0	<5.0	--	--	--
	08/17/00	--	88.73	8.77	--	**550**	**160**	<25	<25	**<25**	<25	--	--	--
	11/15/00	--	88.46	9.04	--	**130**	<5.0	<5.0	<5.0	<5.0	<5.0	--	--	--
	02/16/01	--	89.90	7.60	--	**400**	**26**	<5.0	<5.0	<5.0	<5.0	--	--	--
	01/11/02	--	89.42	8.08	**160**	**600**	**74**	**53**	14	**52**	**110**	--	--	--
(161.03)	07/01/02	--	152.01	9.02	**280**	**670**	**25**	<5.0	<5.0	<5.0	<5.0	--	--	--
	10/04/02	--	151.29	9.74	**520**	**1,800**	**130**	7.8	8.1	14	<5.0	--	--	--
	07/28/06	--	151.93	9.10	86	**250**	**42**	1.7	1.4	3.1	<1.0	51	**1.5**	0.21
	10/16/06	--	151.98	9.05	**110**	**390**	**16**	<0.5	1.5	2.2	<0.5	41	**1.6**	0.17
(161.10)	01/09/07	--	152.90	8.20	**160**	**530**	**21**	1.7	2.8	5.1	--	--	--	0.22
	03/26/07	--	152.84	8.26	--	--	--	--	--	--	--	--	--	--
MW-2	04/30/89	--	--	--	--	**230**	**39**	18	5	**23**	--	--	--	--
(97.78)	05/17/90	--	87.78	10.00	--	--	--	--	--	--	--	--	--	--
	09/29/90	--	86.95	10.83	--	**850**	**970**	5	25	**47**	--	--	--	--
	01/14/91	--	87.15	10.63	--	**3,100**	**30**	**52**	24	**34**	--	--	--	--
(102.02)	07/03/91	--	91.94	10.08	--	**1,590**	**30**	**52**	24	**34**	--	--	--	--
	11/11/91	--	91.81	10.21	--	**960**	**320**	15	4	**29**	--	--	--	--
	03/04/92	--	93.32	8.70	--	**1,500**	**9.5**	8.4	9.8	**22**	--	--	--	--
	06/02/92	--	92.50	9.52	--	**2,800**	**84**	**41**	**59**	**95**	--	--	--	--
	09/28/92	--	91.93	10.09	--	**1,600**	**47**	20	**47**	**97**	--	--	--	--
	01/11/93	--	93.50	8.52	--	**2,500**	**8.6**	10	17	**32**	--	--	--	--
(97.49)	08/15/94	--	87.58	9.91	--	**6,000**	**450**	**60**	**100**	**95**	--	--	--	--
	11/07/96	--	87.47	10.02	**780**	**4,200**	**25**	4.9	8.1	14	<0.5	--	--	--
	02/12/97	--	88.58	8.91	**5,700**	**1,800**	**16**	3.1	3.4	8.8	<0.5	--	--	--
	06/16/97	--	87.74	9.75	<50	**2,500**	**22**	5.1	7.8	11	<0.5	--	--	--
	09/30/97	--	89.60	7.89	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
	01/27/98	--	89.11	8.38	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
	04/24/98	--	88.81	8.68	**1,400**	**2,100**	**18**	6.5	4.8	**21**	<0.5	--	--	--
	08/17/98	--	87.75	9.74	<50	**2,900**	**5.1**	4.5	5.8	17	<0.5	--	--	--
	11/16/98	--	87.35	10.14	<50	**1,400**	**2.1**	1.9	2.3	4.8	<0.5	--	--	--

Table 2. Groundwater Analytical Data - Former Exxon Station, 5175 Broadway, Oakland, CA

Well ID *TOC Elev* *(ft)*	Date Sampled	SPH (ft)	Groundwater Elevation (ft)	Depth to Water (ft)	TPHd (μg/L)	TPHg (μg/L)	Benzene (μg/L)	Toluene (μg/L)	Ethylbenzene (μg/L)	Xylenes (μg/L)	MTBE (μg/L)	DIPE (μg/L)	1,2-DCA (μg/L)	Dissolved Oxygen mg/L
Commercial ESL, drinking water					**100**	**100**	**1**	**40**	**30**	**20**	**5**	**--**	**0.50**	**--**
Commercial ESL, non-drinking water					640	500	46	130	290	100	1,800	--	200	--
Commercial ESL, vapor pathway					NV	NV	540	380,000	170,000	160,000	24,000	--	200	--
MW-2	02/16/99	--	88.57	8.92	<50	**1,600**	**82**	16	<2.5	**40**	**59**	--	--	--
(continued)	05/17/99	--	88.23	9.26	--	**8,200**	**43**	**73**	**140**	**100**	<250	--	--	--
	08/17/99	--	87.45	10.04	**260**	**2,900**	**20**	**81**	17	**38**	<5.0	--	--	--
	11/17/99	--	85.97	11.52	<50	**2,600**	**7**	3.7	5.3	12.9	<1.0	--	--	--
	02/17/00	--	87.99	9.50	--	**1,700**	**3.2**	6.8	11	12.3	<5.0	--	--	--
	05/17/00	--	88.65	8.84	--	**3,800**	**450**	**65**	**110**	**80**	<25	--	--	--
	08/17/00	--	88.99	8.50	--	**4,300**	**440**	<50	**78**	<50	<50	--	--	--
	11/15/00	--	87.55	9.94	--	**5,800**	**320**	**41**	**78**	**64**	**<25**	--	--	--
	02/16/01	--	88.97	8.52	--	**2,200**	**110**	20	**38**	**33**	<5.0	--	--	--
	01/11/02	--	88.67	8.82	**620**	**3,100**	**280**	**86**	**84**	**110**	<50	--	--	--
(160.98)	07/01/02	--	151.34	9.64	**940**	**2,600**	**300**	29	**45**	**27**	<10	--	--	--
	10/04/02	--	150.46	10.52	**390**	**4,000**	**440**	**66**	**140**	**120**	<25	--	--	--
	07/28/06	--	150.96	10.02	**340**	**1,300**	**150**	9.9	6	18	<0.5	3.6	<0.5	0.17
	10/16/06	--	150.45	10.53	76	**150**	**16**	1.0	3.5	2.2	<0.5	1.2	<0.5	0.19
	01/09/07	--	151.65	9.33	84	**210**	**27**	2.6	8.1	6.8	--	--	--	0.14
MW-3	04/30/90	--	--	--	--	**56,000**	**3,600**	**8,600**	**1,300**	**7,200**	--	--	--	--
(98.14)	05/17/90	--	85.72	12.42	--	--	--	--	--	--	--	--	--	--
	09/26/90	--	84.64	13.50	--	**54,000**	**5,100**	**420**	**1,600**	**8,000**	--	--	--	--
	01/14/91	--	85.56	12.58	--	**35,000**	**2,600**	**6,600**	**1,500**	**5,700**	--	--	--	--
(102.46)	07/03/91	--	90.38	12.08	--	**33,000**	**4,120**	**4,300**	**1,400**	**4,800**	--	--	--	--
	11/11/91	--	90.17	12.29	--	**57,000**	**3,900**	**8,400**	**2,100**	**14,000**	--	--	--	--
(102.18)	03/04/92	--	91.92	10.26	--	**57,000**	**720**	**870**	**81**	**3,100**	--	--	--	--
(97.94)	06/02/92	--	86.54	11.40	--	**50,000**	**240**	**240**	**220**	**740**	--	--	--	--
	09/28/92	--	85.30	12.64	--	**64,000**	**110**	**93**	**97**	**250**	--	--	--	--
	01/11/93	--	87.84	10.10	--	**68,000**	**210**	**280**	**360**	**990**	--	--	--	--
	08/15/94	--	85.74	12.20	--	**50,000**	**870**	**1,200**	**1,300**	**3,000**	--	--	--	--
	11/07/96	--	85.54	12.40	**470**	**68,000**	**33**	27	**63**	**120**	<0.5	--	--	--
	02/12/97	--	87.71	10.23	**3,500**	**25,000**	**39**	**43**	15	**91**	<0.5	--	--	--
	06/16/97	--	86.15	11.79	<50	**9,700**	**26**	29	**45**	**81**	<0.5	--	--	--
	09/30/97	--	88.54	9.40	**1,600**	**6,000**	**43**	36	12	11	<0.5	--	--	--
	01/27/98	--	88.14	9.80	**560**	**380**	**5.7**	4.1	1.7	9.1	<0.5	--	--	--
	04/24/98	--	88.04	9.90	**680**	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
	08/17/98	--	86.48	11.46	<50	**16,000**	**200**	18	**31**	**82**	<0.5	--	--	--
	11/16/98	--	85.54	12.40	<50	**68,000**	**86**	**54**	**69**	**130**	<0.5	--	--	--
	02/16/99	--	87.22	10.72	<50	**33,000**	**270**	**110**	<5.0	**770**	**170**	--	--	--
	05/17/99	--	87.40	10.54	--	**72,000**	**280**	**230**	**320**	**890**	<250	--	--	--
	08/17/99	--	85.99	11.95	**1,800**	**20,000**	**51**	**41**	**61**	**130**	<5.0	--	--	--
	11/17/99	--	84.34	13.60	--	**1,700**	**39**	22	**31**	**84**	<1.0	--	--	--

Table 2. Groundwater Analytical Data - Former Exxon Station, 5175 Broadway, Oakland, CA

Well ID *TOC Elev* *(ft)*	Date Sampled	SPH (ft)	Groundwater Elevation (ft)	Depth to Water (ft)	TPHd	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	DIPE	1,2-DCA	Dissolved Oxygen mg/L
					←				μg/L				→	
Commercial ESL, drinking water					**100**	**100**	**1**	**40**	**30**	**20**	**5**	--	**0.50**	--
Commercial ESL, non-drinking water					640	500	46	130	290	100	1,800	--	200	--
Commercial ESL, vapor pathway					NV	NV	540	380,000	170,000	160,000	24,000	--	200	--
MW-3	02/17/00	--	87.26	10.68	--	**8,800**	**16**	**39**	**74**	**90**	<5.0	--	--	--
(continued)	05/17/00	--	87.69	10.25	--	**22,000**	**300**	**260**	**410**	**940**	<5.0	--	--	--
	08/17/00	--	86.10	11.84	--	**15,000**	**230**	**140**	**470**	**750**	<50	--	--	--
	11/15/00	--	86.12	11.82	--	**12,000**	**250**	**210**	**390**	**700**	<25	--	--	--
	02/16/01	--	88.26	9.68	--	**7,400**	**40**	**72**	**700**	**250**	<25	--	--	--
	01/11/02	--	88.36	9.58	**1,900**	**9,300**	**230**	**200**	**290**	**580**	<25	--	--	--
(161.43)	07/01/02	--	150.29	11.14	**5,200**	**13,000**	**230**	**220**	**450**	**890**	<13	--	--	--
	10/04/02	--	148.61	12.82	**4,900**	**11,000**	**280**	**170**	**450**	**730**	<25	--	--	--
	07/28/06	--		Not Sampled - Unable to locate well										
	10/16/06	--		Not Sampled - Unable to locate well										
	01/09/07	--		Not Sampled - Unable to locate well										
	01/22/07	--	149.81	11.62	**93,000**	**34,000**	**770**	**250**	**760**	**2,000**	<1,000	--	--	--
STMW-4	07/03/91	--	92.58	11.00	--	**3,100**	**610**	**62**	**39**	**150**	--	--	--	--
(103.58)	11/11/91	--	92.50	11.08	--	**3,600**	**990**	15	2.6	**180**	--	--	--	--
(101.08)	03/04/92	--	91.64	9.44	--	**5,000**	**35**	20	22	**71**	--	--	--	--
(98.80)	06/02/92	--	88.48	10.32	--	**13,000**	**140**	**45**	**63**	**210**	--	--	--	--
	09/28/92	--	88.04	10.76	--	**40,000**	**35**	20	**48**	**110**	--	--	--	--
	01/11/93	--	89.52	9.28	--	**24,000**	**26**	**88**	**92**	**280**	--	--	--	--
	08/15/94	--	88.26	10.54	--	**9,000**	**500**	34	**46**	**130**	--	--	--	--
	11/07/96	--	88.43	10.37	**180**	**13,000**	**40**	2.9	7.8	19	<0.5	--	--	--
	02/12/97	--	89.44	9.36	**5,700**	**5,300**	**95**	5.3	5.9	18	<0.5	--	--	--
	06/16/97	--	88.40	10.40	<50	**5,300**	**37**	6.2	1.7	11	<0.5	--	--	--
	09/30/97	--	90.30	8.50	<50	**2,700**	**42**	7.7	5.7	**26**	<0.5	--	--	--
	01/27/98	--	89.90	8.90	**300**	**3,000**	**60**	17	12	**49**	<0.5	--	--	--
	04/24/98	--	89.30	9.50	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
	08/17/98	--	88.44	10.36	<50	**29,000**	**36**	24	**59**	**160**	<0.5	--	--	--
	11/16/98	--	88.24	10.56	<50	**13,000**	**26**	21	20	**41**	--	--	--	--
	02/16/99	--	89.16	9.64	<50	**32,000**	**660**	16	16	**150**	<100	--	--	--
	05/17/99	--	88.84	9.96	--	**13,000**	**1600**	30	**45**	**78**	<250	--	--	--
	08/17/99	--	88.16	10.64	**990**	**12,000**	**260**	22	**33**	**72**	<5.0	--	--	--
	11/17/99	--	86.78	12.02	--	**7,900**	**21**	12	17	**40**	<1.0	--	--	--
	02/17/00	--	89.48	9.32	--	**4,900**	**8.9**	21	**38**	**50**	<5.0	--	--	--
	05/17/00	--	89.15	9.65	--	**9,600**	**840**	<50	**61**	**<50**	<50	--	--	--
	08/17/00	--	88.46	10.34	--	**5,100**	**680**	<50	**62**	**<50**	<50	--	--	--
	11/15/00	--	88.28	10.52	--	**3,900**	**640**	<25	26	**27**	<25	--	--	--
	02/16/01	--	89.60	9.20	--	**5,700**	**560**	<25	<25	**<25**	<25	--	--	--
	01/11/02	--	89.22	9.58	**930**	**4,900**	**560**	**59**	25	**<25**	<250	--	--	--
(162.13)	07/01/02	--	151.85	10.28	**6,700**	**6,700**	**470**	18	**32**	**45**	<13	--	--	--

Table 2. Groundwater Analytical Data - Former Exxon Station, 5175 Broadway, Oakland, CA

Well ID *TOC Elev* *(ft)*	Date Sampled	SPH (ft)	Groundwater Elevation (ft)	Depth to Water (ft)	TPHd	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	DIPE	1,2-DCA	Dissolved Oxygen mg/L
					←				μg/L				→	
Commercial ESL, drinking water					**100**	**100**	**1**	**40**	**30**	**20**	**5**	--	**0.50**	--
Commercial ESL, non-drinking water					640	500	46	130	290	100	1,800	--	200	--
Commercial ESL, vapor pathway					NV	NV	540	380,000	170,000	160,000	24,000	--	200	--
STMW-4	10/04/02	--	151.05	11.08	**2,900**	**13,000**	**590**	26	**65**	**110**	<25	--	--	--
(continued)	07/28/06	0.04	151.53	10.60	**39,000**	**25,000**	**960**	21	**73**	**130**	<5.0	65	<5.0	0.22
	10/16/06	0.06	151.30	10.83	**14,000**	**14,000**	**790**	28	**81**	**130**	<5.0	30	<5.0	0.26
	01/09/07	0.03	152.20	9.93			**Not Sampled - SPH**							0.24
STMW-5	07/03/91	--	88.70	13.29	--	**690**	**99**	**81**	19	**98**	--	--	--	--
(101.99)	11/11/91	--	87.99	14.00	--	**410**	**61**	2.4	1.4	20	--	--	--	--
(101.36)	03/04/92	--	89.56	11.80	--	**460**	**13**	6.5	11	18	--	--	--	--
	06/02/92	--	88.30	13.06	--	**1,800**	**27**	20	21	**43**	--	--	--	--
	09/28/92	--	87.32	14.04	--	**1,500**	**14**	6.1	18	**22**	--	--	--	--
	01/11/93	--	89.75	11.61	--	**800**	**1.8**	3	3.1	9.4	--	--	--	--
	08/15/94	--	87.51	13.85	--	**3,000**	**320**	**62**	**34**	**220**	--	--	--	--
(97.14)	11/07/96	--	83.47	13.67	**330**	**1,200**	**11**	1.7	4.4	13	<0.5	--	--	--
	02/17/97	--	85.07	12.07	**3,700**	**1,000**	**11**	17	1.7	9.7	<0.5	--	--	--
	06/19/97	--	83.81	13.33	**2,300**	**950**	**7.4**	1	1	7.2	<0.5	--	--	--
	09/30/97	--	85.90	11.24	**1,100**	**710**	**5.8**	4	1	1	<0.5	--	--	--
	01/27/98	--	85.50	11.64	**1,100**	**340**	**2**	1.8	1.6	8.2	<0.5	--	--	--
	04/24/98	--	85.30	11.84	<50	**3,300**	**12**	9.4	8.5	**37**	<0.5	--	--	--
	08/17/98	--	83.94	13.20	<50	**5,300**	**26**	17	14	**39**	<0.5	--	--	--
	11/16/98	--	83.40	13.74	<50	<50	<0.5	<0.5	<0.5	<0.5	<0.5	--	--	--
	02/16/99	--	84.92	12.22	<50	**950**	**150**	3.8	1.4	14	**11**	--	--	--
	05/17/99	--	84.56	12.58	--	**2,800**	**67**	9.4	<2.5	16	**30**	--	--	--
	08/17/99	--	83.66	13.48	**230**	**2,800**	**18**	17	18	**36**	<5.0	--	--	--
	11/17/99	--	82.26	14.88	--	**1,600**	**3.9**	2.3	3.2	7.5	<1.0	--	--	--
	02/17/00	--	84.58	12.56	--	**770**	**1.5**	3.2	5.8	7	<5.0	--	--	--
	05/17/00	--	85.06	12.08	--	**4,500**	<25	<25	<25	**<25**	**<25**	--	--	--
	08/17/00	--	83.58	13.56	--	**2,900**	**170**	**64**	**100**	**250**	<10	--	--	--
	11/15/00	--	83.86	13.28	--	**2,100**	**120**	24	**40**	**54**	<5.0	--	--	--
	02/16/01	--	85.54	11.60	--	**850**	**58**	9.8	9.4	18	<5.0	--	--	--
	01/11/02	--	85.42	11.72	<50	**920**	**76**	16	16	**28**	**13**	--	--	--
(160.65)	07/01/02	--	147.51	13.14	**1,500**	**4,300**	**71**	14	14	**36**	<5.0	--	--	--
	10/04/02	--	146.13	14.52	60	**1,400**	**71**	17	26	**35**	<5.0	--	--	--
	07/28/06	--	147.30	13.35	**370**	**700**	**22**	4.3	1.2	6.6	<0.5	<0.5	<0.5	0.24
	10/16/06	--	146.91	13.74	**240**	**590**	**14**	1.6	1.3	3.2	<0.5	<0.5	<0.5	0.21
	01/09/07	--	148.19	12.46	**180**	**390**	**30**	3.2	1.8	3.2	--	--	--	0.17
MW-2C	03/09/07	--	152.24	8.41	**140**	**450**	**40**	9.3	2.9	16	<10	--	--	--
(160.65)	03/26/07	--	151.93	8.72	--	--	--	--	--	--	--	--	--	--

Table 2. Groundwater Analytical Data - Former Exxon Station, 5175 Broadway, Oakland, CA

Well ID *TOC Elev* *(ft)*	Date Sampled	SPH (ft)	Groundwater Elevation (ft)	Depth to Water (ft)	TPHd	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	DIPE	1,2-DCA	Dissolved Oxygen
					←				μg/L				→	mg/L
Commercial ESL, drinking water					**100**	**100**	**1**	**40**	**30**	**20**	**5**	--	**0.50**	--
Commercial ESL, non-drinking water					640	500	46	130	290	100	1,800	--	200	--
Commercial ESL, vapor pathway					NV	NV	540	380,000	170,000	160,000	24,000	--	200	--
MW-3A	03/09/07	--	152.20	9.35	**4,500**	**39,000**	**3,800**	**220**	**830**	**2,800**	<500	--	--	--
(161.55)	03/26/07	--	152.33	9.22	--	--	--	--	--	--	--	--	--	--
MW-3C	03/26/07	--	151.15	10.64	--	--	--	--	--	--	--	--	--	--
(161.79)	04/16/07	--	150.87	10.92	**36,000**	**32,000**	**1,200**	**710**	**600**	**1,900**	<500	--	--	--
MW-4A	03/09/07	--	152.88	9.56	**3,600**	**16,000**	**1,600**	36	**37**	**150**	<250	--	--	--
(162.44)	03/26/07	--	152.56	9.88	--	--	--	--	--	--	--	--	--	--
MW-5A	03/09/07	--	150.40	10.42	56	<50	<0.5	<0.5	<0.5	<0.5	<5.0	--	--	--
(160.82)	03/26/07	--	150.00	10.82	--	--	--	--	--	--	--	--	--	--
MW-5B	03/09/07	--	146.42	15.08	59	**140**	**1.3**	0.77	<0.5	1.6	<5.0	--	--	--
(161.50)	03/26/07	--	148.88	12.62	--	--	--	--	--	--	--	--	--	--
MW-5C	03/09/07	--	148.12	12.91	<50	<50	<0.5	<0.5	<0.5	<0.5	<5.0	--	--	--
(161.03)	03/26/07	--	148.41	12.62	--	--	--	--	--	--	--	--	--	--
MW-6A	03/09/07	--	154.91	6.67	**380**	<50	<0.5	<0.5	<0.5	<0.5	<5.0	--	--	--
(161.58)	03/26/07	--	154.41	7.17	--	--	--	--	--	--	--	--	--	--
MW-7B	03/09/07	--	147.97	11.18	**930**	**18,000**	**1,500**	**1,600**	**140**	**1,800**	<600	--	--	--
(159.15)	03/26/07	--	148.10	11.05	--	--	--	--	--	--	--	--	--	--
MW-7C	03/09/07	--	145.44	13.09	**190**	**3,600**	**970**	**100**	12	**90**	<120	--	--	--
(158.53)	03/26/07	--	147.53	11.00	--	--	--	--	--	--	--	--	--	--
MW-8A	03/09/07	--	152.05	9.52	**4,200**	**10,000**	**430**	18	<10	**88**	<100	--	--	--
(161.57)	03/26/07	--	151.74	9.83	--	--	--	--	--	--	--	--	--	--
MW-8C	03/09/07	--	149.18	12.15	<50	**150**	**9.8**	1.3	2.0	3.9	<5.0	--	--	--
(161.33)	03/26/07	--	149.56	11.77	--	--	--	--	--	--	--	--	--	--

Table 2. Groundwater Analytical Data - Former Exxon Station, 5175 Broadway, Oakland, CA

Well ID *TOC Elev* *(ft)*	Date Sampled	SPH (ft)	Groundwater Elevation (ft)	Depth to Water (ft)	TPHd	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	DIPE	1,2-DCA	Dissolved Oxygen mg/L
					←				μg/L				→	
Commercial ESL, drinking water					**100**	**100**	**1**	**40**	**30**	**20**	**5**	--	**0.50**	--
Commercial ESL, non-drinking water					640	500	46	130	290	100	1,800	--	200	--
Commercial ESL, vapor pathway					NV	NV	540	380,000	170,000	160,000	24,000	--	200	--

Abbreviations:

Commercial ESL, drinking water = Table A - Environmental Screening Levels for Shallow Soil (<3 meters) where groundwater **is** a current or potential source of drinking water, as established by the RWQCB-SFBR, Interim Final February 2005 (Revised November 2006).

Commercial ESL, non-drinking water = Table B - Environmental Screening Levels for Shallow Soil (<3 meters) where groundwater is a not current or potential source of drinking water, as established by the RWQCB-SFBR, Interim Final February 2005 (Revised November 2006).

Commercial ESL, Vapor Intrusion / Pathway Into Building Concerns = Table F-1A Environmental Screening Levels for Soil (<3 meters) where groundwater **is** a current or potential source of drinking water, as established by the RWQCB-SFBR, Interim Final February 2005 (Revised November 2006).

NV = No ESL value, use soil gas ESL and compare to soil gas concentrations.

7.1 = Concentrations in **bold** are soil exceeding the commercial ESL protective of groundwater as a drinking water resource.

μg/L = micrograms per liter - approximately equal to parts per billion = ppb

mg/L = milligrams per liter - approximately equal to parts per million = ppm

SPH = Separate-phase hydrocarbons encountered in well (value in parentheses is thickness in feet)

Groundwater elevation is calculated according to the relationship: groundwater elevation = TOC (elevation) - (depth to water) + (0.8)(SPH thickness)

TPHg = Total petroleum hydrocarbons as gasoline by EPA Method 8015Cm.

TPHd = Total petroleum hydrocarbons as diesel by EPA Method 8015C.

BTEX by EPA Method 8021B.(Concentrations in parentheses are by EPA Method 8260B).

MTBE = Methyl tertiary-butyl ether by EPA Method 8260B prior to January 1, 2007. MTBE analyses after January 1, 2007 by EPA Method 8021B.

DIPE = Diisopropyl ether by EPA Method 8260B.

1,2-DCA = 1,2-Dichloroethane by EPA Method 8260B.

Table 3 - DPE Pilot Test - SVE Performance Data, 5175 Brodaway, Oakland, California

Date	Well	Hour Meter Reading (hours)	Elapsed Time (minutes)	Interval Time (minutes)	Totalizer Readin (GW) (GPM)	Groundwater Flow Rate (GPM)	System Vapor Flow Rate (cfm)	Applied Vacuum ("Hg)	Lab Sample ID	TPHg Lab Data (ppmv)	Benzene Lab Data (ppmv)	Influent FID Reading (ppm)	SVE TPHg Removal Rate (lbs/day)	SVE benzene Removal Rate (lbs/day)	Cumulative SVE Hydrocarbon Remova (lbs)	Cumulative SVE Benzene Removal (lbs)
04/17/07	MW-3A	3213.5	0	0	96,861	0.000	23	25	---	---	---	230	0.00	0.00	0	0
04/17/07	MW-3A	3214.0	30	30	96,861	0.000	22	25	MW-3A	89	0.6	175	0.63	0.00	0.01	0.00
04/17/07	MW-3A	3214.5	60	30	96,861	0.000	19	24	"	89	0.6	150	0.54	0.00	0.02	0.00
04/17/07	MW-3A	3215.0	90	30	96,861	0.000	18	24	"	89	0.6	136	0.51	0.00	0.04	0.00
04/17/07	MW-3A	3215.5	120	30	96,861	0.000	18	25	"	89	0.6	128	0.51	0.00	0.05	0.00
04/17/07	MW-3A	3216.5	180	60	96,861	0.000	20	25	"	89	0.6	108	0.57	0.00	0.07	0.00
04/17/07	MW-4A	3217.3	228	48	96,861	0.000	15	25	MW-4A at 1400	890	9.6	4,400	4.28	0.04	0.21	0.00
04/17/07	MW-4A	3217.8	258	30	96,861	0.000	14	25	"	890	9.6	4,300	4.00	0.04	0.30	0.00
04/17/07	MW-4A	3218.2	282	24	96,861	0.000	14	25	"	890	9.6	3,200	4.00	0.04	0.36	0.00
04/17/07	MW-4A	3218.3	288	6	96,861	0.000	14	25	MW-4A at 1500	1400	9.5	3,050	6.29	0.04	0.39	0.00
04/17/07	MW-4A	3218.8	318	30	96,861	0.000	15	25	"	1400	9.5	2,422	6.74	0.04	0.53	0.00
04/17/07	MW-4A	3219.3	348	30	96,861	0.000	15	25	"	1400	9.5	2,015	6.74	0.04	0.67	0.01
04/17/07	MW-4A	3220.1	396	48	96,861	0.000	15	25	MW-4A at 1645	630	4.3	1,625	3.03	0.02	0.77	0.01
04/17/07	MW-3C	3220.4	414	18	96,890	1.611	22	24	"	630	4.3	1,471	4.45	0.03	0.83	0.01
04/17/07	MW-3C	3220.7	432	18	96,890	0.000	22	24	MW-3C at 1730	360	2.4	780	2.54	0.02	0.86	0.01
04/18/07	MW-3C	3223.8	618	186	96,953	0.339	20	24	"	360	2.4	580	2.31	0.01	1.16	0.01
04/18/07	MW-3C	3224.1	636	18	96,953	0.000	20	24	"	360	2.4	420	2.31	0.01	1.18	0.01
04/18/07	MW-3C	3227.2	822	186	96,972	0.102	20	26	"	360	2.4	385	2.31	0.01	1.48	0.01
04/18/07	MW-3C	3227.7	852	30	96,972	0.000	20	25	"	360	2.4	500	2.31	0.01	1.53	0.01
04/18/07	MW-3C	3228.2	882	30	96,972	0.000	20	25	"	360	2.4	423	2.31	0.01	1.58	0.01
04/18/07	MW-3C	3228.7	912	30	96,972	0.000	20	25	"	360	2.4	465	2.31	0.01	1.63	0.01
04/18/07	MW-3C	3229.2	942	30	96,972	0.000	20	25	"	360	2.4	440	2.31	0.01	1.68	0.01
04/18/07	MW-3C	3229.7	972	30	96,972	0.000	20	25	"	360	2.4	425	2.31	0.01	1.72	0.01
04/18/07	MW-3C	3230.2	1002	30	96,972	0.000	22	24	"	360	2.4	415	2.54	0.02	1.78	0.01
04/19/07	MW-3C	3247.3	2028	1026	97,097	0.122	23	23	"	360	2.4	182	2.66	0.02	3.67	0.02
04/19/07	MW-3C	3247.8	2058	30	97,097	0.000	23	23	MW-3C at 1000	76.6	0.8	194	0.57	0.01	3.68	0.02
04/19/07	MW-8A	3248.2	2082	24	97,097	0.000	34	22	"	76.6	0.8	2,253	0.84	0.01	3.70	0.02
04/19/07	MW-8A	3248.4	2094	12	97,097	0.000	36	22	"	76.6	0.8	2,401	0.88	0.01	3.70	0.02
04/19/07	MW-8A	3248.8	2118	24	97,097	0.000	39	22	"	76.6	0.8	1,930	0.96	0.01	3.72	0.02
04/19/07	MW-8A	3249.2	2142	24	97,097	0.000	40	22	MW-8A at 1300	567.4	1.2	1,750	7.28	0.01	3.84	0.02
04/19/07	MW-7B	3249.3	2148	6	97,131	5.667	22	24	"	567.4	1.2	795	4.00	0.01	3.86	0.02
04/19/07	MW-7B	3249.5	2160	12	97,131	0.000	22	24	"	567.4	1.2	NM	4.00	0.01	3.89	0.02
04/19/07	MW-7B	3249.8	2178	18	97,131	0.000	22	24	"	567.4	1.2	576	4.00	0.01	3.94	0.02
04/19/07	MW-7B	3250.3	2208	30	97,137	0.200	22	24	MW-7B at 1400	139	1.1	425	0.98	0.01	3.96	0.02
04/19/07	MW-7C	3250.6	2226	18	97,137	0.000	28	23	"	139	1.1	303	1.25	0.01	3.98	0.02
04/19/07	MW-7C	3251.6	2286	60	97,145	0.133	22	23	MW-7C at 1530	45.3	0.14	78	0.32	0.00	3.99	0.02
04/19/07	MW-8C	3251.7	2292	6	97,145	0.000	26	24	"	45.3	0.14	77	0.38	0.00	3.99	0.02
04/19/07	MW-8C	3252.2	2322	30	97,145	0.000	25	24	"	45.3	0.14	73	0.36	0.00	4.00	0.02
04/19/07	MW-8C	3252.7	2352	30	97,163	0.600	26	24	MW-8C at 1630	36.9	0.07	68	0.31	0.00	4.00	0.02
04/20/07	4A, 7B, 8A	3268.8	3318	966	97,178	0.016	55	21	"	36.9	0.07	1,000	0.65	0.00	4.44	0.03
04/20/07	4A, 7B, 8A	3270.8	3438	120	97,178	0.000	55	21	"	36.9	0.07	942	0.65	0.00	4.50	0.03
04/25/07	MW-3A	3271.0	3450	12	97,244	5.500	40	24	"	36.9	0.07	450	0.47	0.00	4.50	0.03
04/25/07	MW-3A	3271.2	3462	12	97,244	0.000	35	24	"	36.9	0.07	327	0.41	0.00	4.50	0.03
04/25/07	MW-3A	3271.4	3474	12	97,244	0.000	31	24	"	36.9	0.07	294	0.37	0.00	4.51	0.03
04/25/07	MW-3A	3271.6	3486	12	97,244	0.000	31	24	MW-3A at 1545	235.5	1.2	1,754	2.34	0.01	4.53	0.03
04/25/07	MW-3A	3271.9	3504	18	97,244	0.000	31	24	"	235.5	1.2	1,775	2.34	0.01	4.56	0.03
04/25/07	MW-3A	3272.2	3522	18	97,244	0.000	32	24	"	235.5	1.2	1,735	2.42	0.01	4.59	0.03
04/25/07	MW-3A	3272.4	3534	12	97,244	0.000	34	24	"	235.5	1.2	1,446	2.57	0.01	4.61	0.03
04/25/07	MW-3A	3272.6	3546	12	97,244	0.000	33	24	"	235.5	1.2	1,252	2.49	0.01	4.63	0.03
04/25/07	MW-3A	3272.9	3564	18	97,244	0.000	34	24	MW-3A at 1700	312	1.7	1,240	3.40	0.02	4.67	0.03
04/25/07	3C, 4A, 7B, 8A	3273.5	3600	36	97,244	0.000	77	19	MW-3A at 1730	2071	6.2	>10,000	51.16	0.14	5.95	0.03
04/26/07	3C, 4A, 7B, 8A	3274.8	3678	78	97,323	1.013	63	22	"	2071	6.2	3,990	41.86	0.11	8.22	0.04
04/26/07	3C, 4A, 7B, 8A	3275.0	3690	12	97,323	0.000	63	21	"	2071	6.2	3,333	41.86	0.11	8.57	0.04
04/26/07	3C, 4A, 7B, 8A	3275.4	3714	24	97,323	0.000	63	22	"	2071	6.2	2,517	41.86	0.11	9.26	0.04
04/26/07	3C, 4A, 7B, 8A	3275.6	3726	12	97,323	0.000	63	21	"	2071	6.2	2,226	41.86	0.11	9.61	0.04
04/26/07	3C, 4A, 7B, 8A	3275.9	3744	18	97,323	0.000	63	21	"	2071	6.2	1,872	41.86	0.11	10.14	0.04

Table 3 - DPE Pilot Test - SVE Performance Data, 5175 Brodaway, Oakland, California

Date	Well	Hour Meter Reading (hours)	Elapsed Time (minutes)	Interval Time (minutes)	Totalizer Reading (GW) (GPM)	Groundwater Flow Rate (GPM)	System Vapor Flow Rate (cfm)	Applied Vacuum ("Hg)	Lab Sample ID	TPHg Lab Data (ppmv)	Benzene Lab Data (ppmv)	Influent FID Reading (ppm)	SVE TPHg Removal Rate (lbs/day)	SVE benzene Removal Rate (lbs/day)	Cumulative SVE Hydrocarbon Removal (lbs)	Cumulative SVE Benzene Removal (lbs)
04/26/07	3C, 4A, 7B, 8A	3276.2	3762	18	97,323	0.000	63	21	"	2071	6.2	1,787	41.86	0.11	10.66	0.04
04/27/07	3C, 4A, 7B, 8A	3295.4	4914	1152	97,702	0.329	68	22	"	2071	6.2	1,907	45.18	0.12	46.80	0.14
04/27/07	3C, 4A, 7B, 8A	3295.7	4932	18	97,702	0.000	68	22	"	2071	6.2	2,687	45.18	0.12	47.37	0.14
04/27/07	3C, 4A, 7B, 8A	3296.1	4956	24	97,702	0.000	68	22	"	2071	6.2	2,583	45.18	0.12	48.12	0.14
04/27/07	3C, 4A, 7B, 8A	3296.4	4974	18	97,702	0.000	68	22	"	2071	6.2	2,321	45.18	0.12	48.69	0.15
04/27/07	MW-7C	3296.7	4992	18	97,702	0.000	22	26	"	2071	6.2	1,743	14.62	0.04	48.87	0.15
04/27/07	MW-7C	3297.2	5022	30	97,702	0.000	23	27	"	2071	6.2	305	15.28	0.04	49.19	0.15
04/27/07	MW-7C	3297.5	5040	18	97,702	0.000	23	27	"	2071	6.2	175	15.28	0.04	49.38	0.15
04/27/07	MW-7C	3297.8	5058	18	97,702	0.000	23	27	"	2071	6.2	139	15.28	0.04	49.57	0.15
04/27/07	MW-7C	3298.5	5100	42	97,760	1.381	23	27	MW-3C at 1305	68	0.2	93	0.50	0.00	49.58	0.15

Notes:

NM = not measured
cfm = cubic feet per minute.
ppm = Parts per million
ppmv = parts per million by volume
lbs = Pounds
"Hg = Inches of mercury
DPE = Dual-phase extraction
FID = Flame Ionization Detector.
Hydrocarbon Removal/Emission Rate = Rate based on Bay Area Air Quality Management District's Manual of Procedures for Soil Vapor Extraction dated July 17, 1991.
Rate = lab concentration (ppmv) x system flowrate (scfm) x (1lb-mole/386 ft³) x molecular weight (86 lb/lb-mole for TPH-Gas hexane) x 1440 min/day x 1/1,000,000.