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October 8, 2012

Mr. Louis Johnston
Managing Director
Signal Hill Holding Company
1900 South Norfolk Street, Suite 350
San Mateo, CA 94404

SUBJECT: Second Update to Vapor Intrusion Evaluation for Southern Boundary Former Chemoil Refinery, Signal Hill, California

Dear Mr. Johnston:

This letter report presents the results of a second update to an evaluation of potential health risks to offsite residents living south or southwest of the former Chemoil Refinery, located in Signal Hill, California (see Figure 1 in Attachment A), associated with potential intrusion of volatile chemicals in soil vapor and groundwater into indoor air. Results of an initial soil vapor intrusion evaluation were reported in a letter dated November 23, 2009 (Exponent 2009),[1] and results of an updated evaluation were reported in a letter dated May 5, 2010 (Exponent 2010).[2] Both evaluations concluded that potential soil vapor intrusion is not likely to be of concern for current off-site residents living south or southwest of the property, pending collection of additional soil vapor and groundwater samples. The Office of Human Health and Environmental Assessment (OEHHA) of the California Environmental Protection Agency (Cal-EPA) reviewed the May 5, 2010, evaluation and generally concurred with this conclusion, also pending collection of additional samples and resolution of several comments (Cal-EPA 2010).[3] A comprehensive soil vapor and groundwater investigation was conducted earlier this year, and the results from that investigation have been incorporated into this second updated evaluation. As discussed further below, the results of this updated evaluation indicate that potential soil vapor intrusion should not be of concern for current or future residents living south or southwest of the property.

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[1] Exponent. 2009. Letter to Mr. Stephen Testa, Testa Environmental Corporation, from Mr. Gregory P. Brorby, re: Initial soil vapor intrusion evaluation, former Chemoil refinery, Signal Hill, California. November 23.

[2] Exponent. 2010. Letter to Mr. Stephen Testa, Testa Environmental Corporation, from Mr. Gregory P. Brorby, re: Updated soil vapor intrusion evaluation for southern boundary, former Chemoil refinery, Signal Hill, California. May 5.

[3] Cal-EPA. 2011. Memorandum to Ms. Ann Lin, California Regional Water Quality Control Board Los Angeles Region, from Dr. Hristo Hristov, re: Review of "Updated soil vapor intrusion evaluation for southern boundary, former Chemoil refinery, Signal Hill, California." California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. January 21.

Background

Based on information provided in the "Report of Phase III Additional Site Characterization," which was conducted by Testa Environmental Corporation (TEC) on behalf of the current property owner, Signal Hill Holding Company (TEC 2011),[4] the site was used as a dairy farm prior to 1922, and was operated as a refinery from 1922 until early 1994. From 1994 to 1997, there was limited operation of the wastewater treatment facility, after which all aboveground structures were dismantled. The site is currently vacant (TEC 2011).

The site is divided into the Western Parcel, which is situated immediately west of Walnut Avenue, and the Eastern Parcel, which is situated east of Walnut Avenue (TEC, 2011; see Figure 1 in Attachment A). Groundwater flow beneath the site is generally toward the south and southeast (TEC 2011). With regard to current offsite land use, commercial/ industrial developments are located to the north, east, and west of the site, an elementary school is also located north of the site, beyond the commercial/industrial area, and a residential development is located south and southwest of the site. A visual survey of the residential area indicates that some homes are built "slab on grade" whereas others are built over a crawl space.[5]

This second updated evaluation is confined to receptors in the residential development south and southwest of the site, because additional soil vapor and groundwater samples have been obtained within this area since the May 2010 letter report (Exponent 2010). The purpose of this updated evaluation is to assess the potential for vapor intrusion into indoor air associated with the presence of volatile chemicals dissolved in groundwater potentially migrating from the site toward this residential area.

Data Included in Evaluation

Soil vapor samples were collected at six locations south and southwest of the Western Parcel (SGP-WD-01 through SGP-WD-06) by TEC in March 2010 (see Figure 2 in Attachment A) (TEC 2011). Soil vapor samples were collected from 5 and 10 ft below ground surface (bgs) at each location—except for SGP-WD-1, where a 10-ft sample was not collected due to the shallow water table. Samples were analyzed for volatile organic compounds (VOCs) by EPA Method 8260B. In addition, duplicate soil vapor samples were collected from two locations (SGP-WD-2 from 5 ft bgs and SGP-WD-4 from10 ft bgs) and analyzed by EPA Method TO-15 (TEC 2011). These soil vapor data were the basis for the May 2010 evaluation and are presented in Table 1. Soil vapor samples were collected at ten additional locations south, southwest, and west of the Western Parcel (GW/SV-20 through GW/SV-29) by Geosyntec Consultants (Geosyntec) in May and June 2012 (see Figure 2 in Attachment A) to provide more widespread coverage of the residential area (Geosyntec 2012).[6] Soil vapor samples were collected from 5 and 10 ft

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[4] TEC. 2011. Report on phase III additional site characterization, former Chemoil Refinery, SLIC No. 453A, Signal Hill, California. Testa Environmental Corporation. June 30.

[5] Personal communication, Tom Graf, GrafCon, September 11, 2012.

[6] Geosyntec. 2012. Additional off-site environmental investigation report, former Chemoil refinery, Signal Hill, California. Geosyntec Consultants. July 11.

bgs at each location, and analyzed for VOCs by EPA Method TO-15 (Geosyntec 2012). These soil vapor data are also presented in Table 1.

Because the 2012 sampling locations were not intended to replace the data collected in 2010, data from both investigations are included in this second updated evaluation. Data from 5 ft and 10 ft bgs were evaluated separately. In total, the data from these 16 locations are considered sufficiently representative of soil vapor conditions that potentially exist beneath residences south and southwest of the Western Parcel.

It should be noted that soil vapor samples collected by TEC in 2010 were also analyzed for total petroleum hydrocarbons (TPH) quantified as gasoline (TPHg; defined as C4–C12 hydrocarbons) by the California Leaking Underground Fuel Tank (LUFT) manual method (gas chromatography/mass spectrometry) (TEC 2011). Such measurements represent mixtures of chemicals that, because of their highly variable composition, do not have descriptive health criteria. Therefore, the toxicity of these mixtures is best described by the aggregate toxicity of key individual chemicals in the mixture, as quantified by EPA Method 8260B or TO-15. However, it is worthwhile to note that relatively high concentrations of C4–C12 hydrocarbons were detected in samples collected from SGP-WD-3 from 5 ft and 10 ft bgs and from SGP-WD-4 from 10 ft bgs. The presence of high concentrations of C4–C12 hydrocarbons in these samples may indicate an offsite source, especially because these samples were taken at locations that are separated from the site by an unlined drainage culvert, which would prevent lateral migration of soil vapor. Further, these high concentrations mean that the samples had to be diluted prior to analysis, resulting in elevated detection limits (by an order of magnitude) for these samples. A few soil vapor samples collected by Geosyntec in 2012 also had to be diluted, thus resulting in elevated detection limits in these samples (Geosyntec 2012).

At present, groundwater samples are collected from a total of 16 groundwater monitoring wells (MW-1, MW-1A, MW-3, and MW-8 through MW-19) (see Figure 2 in Attachment A) and are analyzed for VOCs by EPA Method 8260B, and semivolatile organic compounds (SVOCs) by EPA Method 8270C (TEC 2012).[7] Of these groundwater monitoring wells, MW-1 and MW-13 through MW-19 are closest to the southern property boundary and/or located south, southwest, or west of the Western Parcel. For the purposes of this evaluation, data from these monitoring wells from the previous four quarters (third and fourth quarters 2011 and first and second quarters 2012) were included.[8] These data are presented in Table 2. In addition, Geosyntec collected grab groundwater samples from 10 additional locations south, southwest, and west of the Western Parcel (GW/SV-20 through GW/SV-29) in May and June 2012 (see Figure 2 of Attachment A) (Geosyntec 2012). These samples were analyzed for VOCs by EPA Method 8260B, and the results are also presented in Table 2.

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[7] TEC. 2012. Report on quarterly groundwater quality monitoring program June 2012, Former Chemoil refinery, SLIC No. 453A, Signal Hill, California. Testa Environmental Corporation. July 15.

[8] Groundwater data from the third and fourth quarters of 2011 and the first quarter of 2012 were downloaded from Geotracker; data from the second quarter of 2012 were taken from the quarterly groundwater monitoring report (TEC 2012).

Chemicals of Potential Concern

All chemicals detected in soil vapor and groundwater were selected as chemicals of potential concern (COPCs), except as noted below. In addition, if a chemical was not detected in soil vapor, but was detected in groundwater south, southwest, or west of the Western Parcel, then that chemical was also identified as a COPC in soil vapor. For example, n-butylbenzene was not detected in any soil vapor sample, but was detected at very low concentrations in groundwater collected from monitoring well MW-16. Therefore, n-butylbenzene was conservatively identified as a COPC in soil vapor.

Two chemicals detected in soil vapor were not identified as COPCs, i.e., ethanol and 4-ethyltoluene. Ethanol was detected in three soil vapor samples at a maximum concentration of 60 micrograms per cubic meter ($\mu g/m^3$) and 4-ethyltoluene was detected in a single soil vapor sample at a concentration of 4.2 $\mu g/m^3$. Toxicity criteria have not been developed for these chemicals by regulatory agencies; however, the detection of ethanol and 4-ethyltoluene in a small number of soil vapor samples at low concentrations is not expected to pose a potential risk from vapor intrusion.

Exposure Point Concentrations

For detected chemicals in soil vapor or groundwater, the maximum detected concentration was used as the exposure-point concentration (EPC), regardless of whether the maximum concentrations were detected in the same sample. For chemicals that were not detected in soil vapor at one or both sampling depths, one-half the limit of detection was used as the EPC. It should be noted, however, that the detection limits reported by the laboratory varied for several reasons. First, samples were analyzed by different methods, collected at different time periods and submitted to different analytical laboratories. Additionally, a few samples had to be diluted prior to analysis, thus resulting in elevated detection limits in those samples, in some cases by an order of magnitude or more. Therefore, depending on data from groundwater or other soil vapor samples, the detection limit upon which the EPC was based was selected according to one of three methods as described below.

- Method 1: Naphthalene is an example of a chemical that was not detected in any soil vapor sample, but has been detected in groundwater samples from several monitoring wells over the past four quarters. The detection limits for naphthalene in soil vapor range from <26 to <32 micrograms per cubic meter ($\mu g/m^3$) in undiluted samples and from <53 to <2600 $\mu g/m^3$ in diluted samples. For purposes of this assessment, one-half the maximum detection limit from undiluted samples (<32 $\mu g/m^3$) was used as the EPC because soil vapor samples collected from locations in the vicinity of monitoring wells near the site boundaries in which naphthalene has been detected in contemporaneous groundwater samples (e.g., MW-13 and SGP-4 and SGP-5; MW-12 and GDY-2; MW-1A and GDY-1)[9] were

[9] Soil vapor sampling locations SGP-4, SGP-5, GDY-1, and GDY-2 are located onsite and are, therefore, not included in Table 1 of this report. These data were summarized in the initial vapor intrusion evaluation (Exponent 2009) and are reproduced in Attachment C of this second updated evaluation report.

not diluted. The same approach was applied to n-butylbenzene, tert-butylbenzene, n-propylbenzene, 1,1,2,2-tetrachloroethane, and 1,1,2-trichloroethane.

- Method 2: Bromodichlormethane is an example of a chemical that was detected in only soil vapor samples collected at a single depth, in this case, two samples from 5 ft bgs. Because the maximum detected concentration was in an undiluted sample, one-half the maximum detection limit from undiluted samples collected at the other sampling depth (10 ft bgs) was used as the EPC for this depth. This approach was also applied to chloromethane, dibromochloromethane, methyl t-butyl ether, 4-methyl-2-pentanone, 1,2,4-trimethylbenzene, 1,3,5-trimethyl benzene, vinyl chloride, and m,p-xylenes.

- Method 3: Sec-butylbenzene is another example of a chemical that was detected in only soil vapor samples collected at a single depth (i.e., two samples from10 ft bgs); however, because the maximum detected concentration was in a diluted sample, one-half the maximum detection limit from diluted samples collected at the other depth (5 ft bgs) was used as the EPC for this depth. The same approach was applied to tert-butyl alcohol (TBA) and isopropylbenzene.

The soil vapor EPCs are presented in Table 3.

Risk Calculations

Evaluating potential exposure to COPCs in soil vapor or groundwater via inhalation of vapors in indoor air requires estimating vapor emissions and resulting indoor air concentrations. The Johnson and Ettinger model (J&E Model; Johnson and Ettinger 1991)[10] was used as prescribed by Cal-EPA guidance for evaluating vapor intrusion (Cal-EPA 2011a).[11] This model, which provides an estimated attenuation factor that relates vapor concentration in the indoor space to the vapor concentration in the subsurface, has been parameterized by the U.S. Environmental Protection Agency (EPA) (EPA 2004)[12] and was modified to reflect Cal-EPA-specific toxicity criteria, as appropriate (Cal-EPA 2011b).[13] The toxicity criteria for the COPCs are presented in Table 4. It should be noted that one COPC, i.e., tert-butyl alcohol (TBA), was not included in the EPA or Cal-EPA J&E model spreadsheets. For purposes of this assessment, the chemical physical constants for TBA were taken from the New Jersey Department of Environmental Protection (NJDEP) J&E model spreadsheets (NJDEP 2006),[14] and the toxicity criterion

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[10] Johnson, P.C., and R.A. Ettinger. 1991. Heuristic model for predicting the intrusion rate of contaminant vapors in buildings. Environ. Sci. Technol. 25:1445–1452.

[11] Cal-EPA. 2011a. Guidance for the evaluation of subsurface vapor intrusion to indoor air (Vapor intrusion guidance). Final. California Environmental Protection Agency, Department of Toxic Substances Control, Sacramento, CA. October.

[12] U.S. EPA. 2004. User's guide for evaluating subsurface vapor intrusion into buildings. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Toxics Integration Branch, Washington, DC. Revised February 22.

[13] Cal-EPA. 20011b. Screening model spreadsheets. California Environmental Protection Agency, Department of Toxic Substances Control. http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm.

[14] NJDEP. 2006. New Jersey Johnson & Ettinger spreadsheets. New Jersey Department of Environmental Protection. http://www.state.nj.us/dep/srp/guidance/vaporintrusion/njje.htm.

for sec-butyl alcohol was used as a surrogate based on guidance from the Nevada Division of Environmental Protection (NDEP 2012).[15] Default model input assumptions were used for the majority of the model parameters; however, site-specific information was used for some parameters (e.g., soil vapor and groundwater sampling depth and soil type). Model output sheets and additional information regarding site-specific parameter assumptions are included in Attachment B.

As previously noted, houses in the residential area south and southwest of the Western Parcel were observed to be built slab-on-grade or over crawl spaces. Although the J&E model is not designed to evaluate vapor intrusion into houses with crawl spaces (U.S. EPA 2004), per Cal-EPA guidance (Gallagher 2012),[16] site-specific attenuation factors predicted by the J&E Model for slab-on-grade homes can be applied to homes built over a crawl space.

Results

Potential noncancer risks are expressed in terms of a hazard index, and potential cancer risks are expressed in terms of a theoretical lifetime excess cancer risk. A hazard index less than 1 is generally considered acceptable by regulatory agencies. Theoretical lifetime excess cancer risks are generally compared to an acceptable risk range of 1×10^{-6} to 1×10^{-4}; cancer risk estimates of less than 1×10^{-6} are considered to be so low as to warrant no further investigation or analysis. As stated previously, several chemicals that were not detected in the soil vapor samples were identified as COPCs in soil vapor because they were detected in groundwater. For these chemicals, a value of one-half the limit of detection was used as the EPC; otherwise, maximum detected concentrations in soil vapor or groundwater were used, regardless of whether the maximum concentrations were detected in the same sample.

The estimated noncancer hazard indexes associated with exposure to COPCs in indoor air due to chemicals in soil vapor and groundwater south, southwest, and west of the Western Parcel, assuming a residential exposure scenario, are summarized in Table 5. The total hazard index due to vapors in indoor air based on soil vapor data is 0.02 for samples collected from 5 or 10 ft bgs. The total hazard index due to exposure to vapors in indoor air based on groundwater data is 0.5. These values are below 1, indicating that potential exposure to COPCs in indoor air by residents located south or southwest of the Western Parcel poses a negligible noncancer health risk under the conditions evaluated.

The estimated excess cancer risks associated with exposure to COPCs in indoor air due to chemicals in soil vapor and groundwater south, southwest, and west of the Western Parcel, assuming a residential exposure scenario, are also summarized in Table 5. The

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[15] NDEP. 2012. User's guide and background technical document for the Nevada Division of Environmental Protection (NDEP) basic comparison levels for human health for the BMI complex and common areas. Nevada Division of Environmental Protection. Revision 8. May.

[16] Gallagher, D. 2012. Electronic mail message to Mr. Robert Cheung, Geosyntec Consults, Inc. California Environmental Protection Agency, Department of Toxic Substances Control, Sacramento, CA. September 24.

total excess cancer risk due to vapors in indoor air based on soil vapor data is 2×10^{-6} for samples collected at 5 or 10 ft bgs. The total excess cancer risk due to vapors in indoor air based on groundwater data is 6×10^{-6}. These values are at the low end of the generally acceptable risk range. With regard to the results based on soil vapor, one of the primary contributors to the total estimated excess cancer risk is 1,1,2,2-tetrachloroethane. This chemical was not detected in any soil vapor sample collected south, southwest, or west of the Western Parcel and was detected at a very low concentration (2.2 micrograms per liter [µg/L]) in only one groundwater sample collected from within this area over the past four quarters (monitoring well MW-16 in February 2012), and was not detected in the sample collected from this location during the most recent quarterly groundwater monitoring event in June 2012. Furthermore, the estimated cancer risk for this chemical based on the maximum detected groundwater concentration is substantially lower than that based on one-half the limit of detection in soil vapor, indicating that a value of one-half the limit of detection overstates the concentration of 1,1,2,2-trichloroethane in soil vapor, if it is present at all. If 1,1,2,2-tetrachloroethane is removed from the soil vapor calculations, the estimated excess cancer risk is 1×10^{-6} based on samples collected from 5 or 10 ft bgs, which is equal to the lower end of the risk range.

With regard to the results based on groundwater data, the largest contributors to the estimated excess cancer risk are benzene and naphthalene. Importantly, benzene was detected in only one sample collected from monitoring well MW-13 in September 2011. This monitoring well is actually located on the Western Parcel, along the southern boundary (see Figure 2). Benzene has not been detected in samples collected from this monitoring well since that time, nor has it been detected in any of the groundwater samples collected south, southwest, or west of the Western Parcel during the past four quarters or in the grab groundwater samples collected in May or June of 2012. Furthermore, naphthalene was not detected in any soil vapor sample, and the excess cancer risk estimates for both of these chemicals based on soil vapor data are substantially lower (and below 1×10^{-6}) than those based on groundwater data.

The difference between the estimated cancer risk based on soil vapor data and that based on groundwater data is likely due to a number of factors, including (1) benzene and naphthalene are aromatic hydrocarbons that may be biodegrading in the vadose zone, and (2) there is greater uncertainty in the groundwater model relative to the soil vapor model, because the soil vapor concentration must be estimated from groundwater concentrations in the groundwater model, whereas measured soil vapor concentrations are used in the soil vapor model. During the most recent site investigation, Geosyntec analyzed soil vapor samples for fixed gases, including oxygen, carbon dioxide, and methane. Based on the distribution of these gases in relation to petroleum hydrocarbons in soil vapor, Geosyntec concluded that there is evidence of both aerobic and anaerobic biodegradation in the vadose zone (Geosyntec 2012). As such, the estimated excess cancer risks based on the maximum COPC concentrations in groundwater likely overstate the potential health risks to residents south or southwest of the Western Parcel under the conditions evaluated.

Supplemental Evaluation of Vapor Intrusion Pursuant to SWRCB Low-Threat Closure Policy

On May 1, 2012, the State Water Resources Control Board (SWRCB) adopted a Low-Threat Underground Storage Tank (UST) Case Closure Policy (the Policy),[17] which became effective on August 17, 2012. One of the components of the Policy is the evaluation of vapor intrusion of petroleum hydrocarbons into indoor air. The Policy identifies four potential exposure scenarios depending on site characteristics and identifies media-specific criteria that, if met, demonstrate that the site should be considered a low-threat for the vapor intrusion-to-indoor air pathway. Two of the four scenarios are applicable to this evaluation:

- Scenario 3 – Dissolved Phase Benzene Concentrations in Groundwater, and
- Scenario 4 – Direct Measurements of Soil Gas Concentrations.

Data necessary to evaluate these scenarios include benzene concentrations in groundwater and benzene, ethylbenzene, and naphthalene concentrations in soil vapor, which were described previously. In addition, data for TPH concentrations (sum of TPHg and TPH as diesel) in the upper 5 ft of soil and oxygen concentrations in soil vapor at 5 ft bgs are used to establish the presence of a "bioattenuation zone." The Policy defines a bioattenuation zone as "an area of soil with conditions that support biodegradation of petroleum hydrocarbon vapors" (SWRCB 2012a). Geosyntec collected these latter data as part of their recent investigation (Geosyntec 2012). As noted in their report, TPH concentrations were below 100 milligrams per kilogram (mg/kg) in soil samples collected from 1, 3, and 4.5 ft bgs, except in three 1-ft samples impacted by surficial spills unrelated to historical operations at the former Chemoil Refinery, and oxygen concentrations were greater than or equal to 4% in soil vapor samples collected from 5 ft bgs (Geosyntec 2012). These conditions have been shown to attenuate soil vapor concentrations between a soil vapor source at 5 ft bgs and the building foundation by at least a factor of 1000 (SWRCB 2012b).[18]

For both scenarios, site data meet the media-specific criteria established in the Policy assuming TPH in the upper 5 ft of soil is <100 mg/kg and oxygen in soil gas at 5 ft is ≥4%. Specifically, the maximum benzene concentration in groundwater of 17 µg/L is well below the 1000 µg/L criterion specified in Scenario 3. In addition, the maximum detected concentrations of benzene (71 $\mu g/m^3$) and ethylbenzene (1000 $\mu g/m^3$) in soil vapor are more than three orders of magnitude below the criteria specified in Scenario 4 (85,000 and 1,100,000 $\mu g/m^3$, respectively). Naphthalene was not detected in any soil vapor samples; however, even the maximum detection limit in a diluted sample (2,600 $\mu g/m^3$) is well below the criterion specified in Scenario 4 (93,000 $\mu g/m^3$). Based on this evaluation, the residential area south and southwest of the former Chemoil Refinery

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17 SWRCB. 2012a. State Water Resources Control Board Resolution No. 2012-0016, Approve a substitute environmental document and adopt a proposed water quality control policy for low-threat underground storage tank case closure. May 1.

18 SWRCB. 2012b. Technical justification for vapor intrusion media-specific criteria. State Water Resources Control Board. March 21.

would be considered a low-threat for the vapor intrusion-to-indoor air pathway under the Policy.

Uncertainty Analysis

Uncertainty is inherent in many aspects of the risk assessment process. As described above, assumptions were generally selected in a manner that purposely biases the process toward health protection. For example, chemicals detected in groundwater, but not detected in soil vapor, were nevertheless identified as COPCs in soil vapor. In addition, the maximum detected concentration in soil vapor or groundwater was used as the EPC, regardless of whether the maximum concentration was detected in the same sample. Furthermore, EPCs based on recently collected data were assumed to be representative of concentrations to which offsite residents would be exposed for 30 years despite the evidence of biodegradation in the vadose zone. In combination, these assumptions likely overestimate the potential health risks associated with vapor intrusion, likely to a significant degree. One assumption with the potential to underestimate potential health risks was the use of detection limits from undiluted samples as the basis for the EPCs for some non-detected chemicals in soil vapor despite higher detection limits in a few diluted samples. However, the potential underestimation associated with this approach is low relative to the aforementioned assumptions that overestimate potential health risks.

Summary and Conclusions

This letter report presents the results of an updated evaluation of potential health risks to offsite residents living south or southwest of the former Chemoil Refinery site. This updated evaluation includes soil vapor and groundwater data recently collected across the residential area (Geosyntec 2012), as well as previous soil vapor samples collected near the southern boundary of the Western Parcel by TEC in 2010 and groundwater samples collected during the previous four quarter from monitoring wells along the southern boundary and south, southwest, and west of the Western Parcel by TEC in 2011 and 2012. In total, these data are considered representative of soil vapor and groundwater conditions within this residential area. It is important to note that this evaluation is based on maximum detected concentrations, which are assumed to be representative of concentrations to which offsite residents would be exposed for 30 years. This latter assumption is particularly conservative, because aromatic hydrocarbons are known to biodegrade over time, and data collected by Geosyntec suggest that biodegradation is occurring in the vadose zone.

Indoor air concentrations resulting from potential intrusion of volatile chemicals in soil vapor or groundwater were estimated using the J&E Model. Estimated noncancer hazard indexes, assuming a residential scenario, were below levels generally considered acceptable by regulatory agencies under the conditions evaluated. The estimated excess cancer risks are in the lower end of the risk range based on maximum COPC concentrations and one-half the limits of detection in soil vapor, or based on maximum COPC concentrations in groundwater. One of the largest contributors to the estimated excess cancer risk based on soil vapor data is 1,1,2,2-tetrachloroethane; however, this chemical was not detected in any soil vapor sample and was included as a COPC only because it was detected at a very low concentration in a single groundwater sample. If this chemical is eliminated from the evaluation, the estimated excess cancer risk based on soil vapor data is equal to the lower end of the risk range under the conditions evaluated. The estimated risks based on groundwater data are driven by naphthalene and benzene. Naphthalene was not detected in the soil vapor samples, and benzene, which was detected in only one sample collected from monitoring well MW-13 on the former Chemoil Refinery property, has not been subsequently detected in groundwater south, southwest, or west of the Western Parcel during the past four quarters, or in grab groundwater samples collected during the most recent off-site investigation. Estimated health risks based on groundwater data are likely more uncertain than those based on soil vapor data because of additional assumptions required in the model and potential biodegradation of the COPCs in the vadose zone. In summary, potential soil vapor intrusion is not likely to be of concern for current offsite residents south or southwest of the former Chemoil Refinery property under the conditions evaluated.

Please feel free to contact me at (510) 455-4769 (office), (707) 319-1741 (cell), or e-mail me at gbrorby@toxstrategies.com.

Sincerely,

Gregory P. Brorby, DABT
Senior Managing Scientist

Attachments (3)

cc: Tom Graf, GrafCon
Ravi Arulanantham, Geosytec Consultants
Robert Cheung, Geosyntec Consultants

Tables

Table 1. Analytical data for chemicals detected in soil vapor (µg/m^3) using EPA Method TO-15 (unless otherwise noted)

Sample Location	Sample Depth (ft bgs)	Sample Date	Acetone	Benzene	Bromo-dichloro-methane	2-Butanone	tert-Butyl alcohol (TBA)	n-Butyl-benzene	sec-Butyl-benzene	tert-Butyl-benzene	Carbon Disulfide	Chloro-benzene	Chloroform	Chloro-methane
SGP-WD-1-5-1V*	5	3/29/10	<5000	<36	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-1-5-3V*	5	3/29/10	<5000	56	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-1-5-7V*	5	3/29/10	<5000	39	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-2-5*	5	3/29/10	<5000	47	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-2-5-Dup*	5	3/29/10	<5000	47	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-2-5	5	3/29/10	270	47	<38	52	NA	NA	NA	NA	<70	180	<27	<12
SGP-WD-2-10*	10	3/29/10	<5000	<36	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-3-5*	5	3/29/10	<50000	<360	<500	<5000	<5000	<500	<500	<500	<5000	<500	<500	<1000
SGP-WD-3-10*	10	3/29/10	<50000	<360	<500	<5000	<5000	<500	1500	<500	<5000	<500	<500	<1000
SGP-WD-4-5*	5	3/29/10	<5000	<36	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-4-10*	10	3/29/10	<50000	<360	<500	<5000	<5000	<500	510	<500	<5000	<500	<500	<1000
SGP-WD-4-10	10	3/29/10	<700	<230	<490	<650	NA	NA	NA	NA	<920	2500	<360	<150
SGP-WD-5-5*	5	3/29/10	<5000	39	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-5-10*	10	3/29/10	<5000	<36	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-6-5*	5	3/29/10	<5000	71	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
SGP-WD-6-10*	10	3/29/10	<5000	53	<50	<500	<500	<50	<50	<50	<500	<50	<50	<100
GW/SV-20-5	5	5/30/12	54	3.2	3.6	10	<6.1	NA	NA	NA	<6.2	<2.3	200	<1
GW/SV-20-10	10	5/30/12	6.9	<1.6	<3.4	4.9	<6.1	NA	NA	NA	<6.2	<2.3	220	<1
GW/SV-21-5	5	6/13/12	45	2.4	<3.4	8.7	<6.1	NA	NA	NA	<6.2	<2.3	6.3	<1.3
GW/SV-21-10	10	6/13/12	100	<3.3	<6.8	25	<12	NA	NA	NA	<13	<4.7	<5.0	<2.7
GW/SV-22-5	5	5/30/12	<220	<74	<150	<200	<280	NA	NA	NA	<290	<110	<110	<48
GW/SV-22-10	10	5/30/12	1,400	<160	<340	<440	1500	NA	NA	NA	<620	<230	<240	<100
GW/SV-22-10/Dup	10	5/30/12	1,800	<160	<340	<440	<610	NA	NA	NA	<620	<230	310	<100
GW/SV-23-5	5	6/13/12	38	<1.6	<3.4	9.1	<6.1	NA	NA	NA	<6.2	<2.3	<2.4	<1.3
GW/SV-23-10	10	6/13/12	100	34	<3.4	40	<6.1	NA	NA	NA	71	<2.3	<2.4	<1.3
GW/SV-23-10/Dup	10	6/13/12	95	11	<11	29	<19	NA	NA	NA	51	<7.3	<7.8	<4.2
GW/SV-24-5	5	6/13/12	13	<1.6	<3.4	<4.4	<6.1	NA	NA	NA	<6.2	<2.3	<2.4	<1.3
GW/SV-24-10	10	6/13/12	22	4.1	<3.4	9.3	<6.1	NA	NA	NA	<6.2	<2.3	17	<1.3
GW/SV-25-5	5	5/30/12	16	19	<3.4	18	<6.1	NA	NA	NA	<6.2	<2.3	3.5	<1
GW/SV-25-10	10	5/30/12	<4.8	1.9	<3.4	8.1	<6.1	NA	NA	NA	<6.2	<2.3	<2.4	<1
GW/SV-26-5	5	5/31/12	17	3.6	<3.4	<4.4	<6.1	NA	NA	NA	<6.2	<2.3	<2.4	<1
GW/SV-26-10	10	5/31/12	14	<1.6	<3.4	<4.4	<6.1	NA	NA	NA	<6.2	<2.3	<2.4	<1
GW/SV-27-5	5	5/31/12	45	9.3	<3.4	13	<6.1	NA	NA	NA	<6.2	<2.3	5.2	<1
GW/SV-27-10	10	5/31/12	21	2.8	<3.4	10	<6.1	NA	NA	NA	<6.2	<2.3	22	<1
GW/SV-28-5	5	5/31/12	25	3.9	7.5	6.9	<6.1	NA	NA	NA	<6.2	<2.3	12	<1
GW/SV-28-10	10	5/31/12	29	2.3	<3.4	8.3	<6.1	NA	NA	NA	<6.2	<2.3	11	<1
GW/SV-29-5	5	5/31/12	220	11	5.2	64	<6.1	NA	NA	NA	13	<2.3	14	1.2
GW/SV-29-10	10	5/31/12	15	<1.6	<3.4	6.2	<6.1	NA	NA	NA	<6.2	<2.3	<2.4	<1

Notes:

* = Analyzed by EPA Method 8260B

Abbreviations:

µg/m^3 = micrograms per cubic meter

Dup = Duplicate sample

< indicates that the compound was not detected at or above the laboratory reporting limit shown.

Table 1. Cont.

Sample Location	Sample Depth (ft bgs)	Sample Date	Dibromo-chloro-methane	Dichloro-difluoro-methane	cis-1,2-Dichlor-ethane	Ethanol	Ethyl-benzene	4-Ethyl-toluene	Isopropyl-benzene	4-Methyl-2-Pentanone	Methyl tert-butyl ether (MTBE)	Naphthalene	n-Propyl-benzene	1,1,2,2-Tetrachloro-ethane
SGP-WD-1-5-1V*	5	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
SGP-WD-1-5-3V*	5	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
SGP-WD-1-5-7V*	5	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
SGP-WD-2-5*	5	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
SGP-WD-2-5-Dup*	5	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
SGP-WD-2-5	5	3/29/10	<48	<28	<22	NA	81	<28	NA	77	<81	NA	NA	<77
SGP-WD-2-10*	10	3/29/10	<50	<50	<50	NA	<50	NA	62	<500	150	<32	<50	<100
SGP-WD-3-5*	5	3/29/10	<500	<500	<500	NA	<500	NA	<500	<5000	<500	<320	<500	<1000
SGP-WD-3-10*	10	3/29/10	<500	<500	<500	NA	<500	NA	4900	<5000	<500	<320	<500	<1000
SGP-WD-4-5*	5	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
SGP-WD-4-10*	10	3/29/10	<500	<500	<500	NA	<500	NA	<500	<5000	<500	<320	<500	<1000
SGP-WD-4-10	10	3/29/10	<630	<360	<290	NA	<320	<360	NA	<900	<1100	NA	NA	<1000
SGP-WD-5-5*	5	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
SGP-WD-5-10*	10	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
SGP-WD-6-5*	5	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
SGP-WD-6-10*	10	3/29/10	<50	<50	<50	NA	<50	NA	<50	<500	<50	<32	<50	<100
GW/SV-20-5	5	5/30/12	<4.3	2.5	<2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-20-10	10	5/30/12	<4.3	<2.5	<2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-21-5	5	6/13/12	<4.3	<2.5	<2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-21-10	10	6/13/12	<8.7	<5.0	<4	60	<4.4	<5.0	NA	<13	<15	<53	NA	<14
GW/SV-22-5	5	5/30/12	<200	<110	<92	<440	<100	<110	NA	<280	<330	<1200	NA	<320
GW/SV-22-10	10	5/30/12	<430	<250	<200	<940	1000	<250	NA	<610	<720	<2600	NA	<690
GW/SV-22-10/Dup	10	5/30/12	<430	<250	<200	<940	970	<250	NA	<610	<720	<2600	NA	<690
GW/SV-23-5	5	6/13/12	<4.3	<2.5	<2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-23-10	10	6/13/12	<4.3	<2.5	<2	<9.4	3.8	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-23-10/Dup	10	6/13/12	<14	<7.9	<6.3	<30	<6.9	<7.8	NA	<20	<23	<83	NA	<22
GW/SV-24-5	5	6/13/12	<4.3	<2.5	<2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-24-10	10	6/13/12	<4.3	<2.5	<2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-25-5	5	5/30/12	<4.3	<2.5	<2	<9.4	11	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-25-10	10	5/30/12	<4.3	<2.5	<2	<9.4	<2.2	<2.5	NA	<6.1	9	<26	NA	<6.9
GW/SV-26-5	5	5/31/12	<4.3	<2.5	4.2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-26-10	10	5/31/12	<4.3	<2.5	<2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-27-5	5	5/31/12	<4.3	2.6	<2	<9.4	3.3	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-27-10	10	5/31/12	<4.3	<2.5	3.3	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-28-5	5	5/31/12	<4.3	<2.5	<2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-28-10	10	5/31/12	<4.3	<2.5	<2	12	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9
GW/SV-29-5	5	5/31/12	4.8	3.3	<2	13	2.8	4.2	NA	8.4	<7.2	<26	NA	<6.9
GW/SV-29-10	10	5/31/12	<4.3	2.9	<2	<9.4	<2.2	<2.5	NA	<6.1	<7.2	<26	NA	<6.9

Notes:

* = Analyzed by EPA Method 8260B

Abbreviations:

$\mu g/m^3$ = micrograms per cubic meter

Dup = Duplicate sample

< indicates that the compound was not detected at or above the laboratory reporting limit shown.

Table 1. Cont.

Sample Location	Sample Depth (ft bgs)	Sample Date	Tetrachloro-ethene	Toluene	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Trichloro-fluoro-methane	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	Vinyl-Chloride	m,p-Xylene	o-Xylene
SGP-WD-1-5-1V*	5	3/29/10	<50	77	<50	<50	<50	<50	<50	<13	<100	<50
SGP-WD-1-5-3V*	5	3/29/10	<50	160	100	<50	<50	<50	<50	<13	<100	<50
SGP-WD-1-5-7V*	5	3/29/10	<50	140	<50	<50	<50	<50	<50	<13	<100	<50
SGP-WD-2-5*	5	3/29/10	<50	160	350	<50	<50	<50	<50	<13	130	<50
SGP-WD-2-5-Dup*	5	3/29/10	<50	160	340	<50	<50	<50	<50	<13	120	<50
SGP-WD-2-5	5	3/29/10	<38	170	250	<31	<63	<83	<28	<14	120	43
SGP-WD-2-10*	10	3/29/10	<50	71	50	<50	<50	<50	<50	<13	<100	<50
SGP-WD-3-5*	5	3/29/10	<500	<500	<500	<500	<500	<500	<500	<130	<1000	<500
SGP-WD-3-10*	10	3/29/10	<500	<500	<500	<500	<500	<500	<500	<130	<1000	<500
SGP-WD-4-5*	5	3/29/10	<50	66	270	<50	<50	<50	<50	<13	<100	<50
SGP-WD-4-10*	10	3/29/10	<500	530	<500	<500	<500	<500	<500	<130	<1000	<500
SGP-WD-4-10	10	3/29/10	<500	<280	<400	<400	<830	<1100	<360	<190	<1300	<320
SGP-WD-5-5*	5	3/29/10	<50	130	380	<50	<50	<50	<50	<13	<100	<50
SGP-WD-5-10*	10	3/29/10	<50	<50	<50	<50	<50	<50	<50	<13	<100	<50
SGP-WD-6-5*	5	3/29/10	<50	200	420	<50	<50	<50	<50	<13	100	<50
SGP-WD-6-10*	10	3/29/10	<50	130	170	<50	<50	<50	<50	<13	<100	<50
GW/SV-20-5	5	5/30/12	9.3	2.7	<2.7	<2.7	68	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-20-10	10	5/30/12	7.3	<1.9	<2.7	<2.7	69	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-21-5	5	6/13/12	<3.4	<1.9	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-21-10	10	6/13/12	<5.5	<3.8	<5.6	<5.6	<5.5	<15	<5.0	<2.6	<18	<4.4
GW/SV-22-5	5	5/30/12	<160	<87	<130	<130	<260	<340	<110	<59	<400	<100
GW/SV-22-10	10	5/30/12	<340	510	<270	<270	<560	<740	<250	<130	<870	240
GW/SV-22-10/Dup	10	5/30/12	<340	320	<270	<270	<560	<740	<250	<130	<870	240
GW/SV-23-5	5	6/13/12	<3.4	2.9	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-23-10	10	6/13/12	7.4	14	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-23-10/Dup	10	6/13/12	<11	11	<8.7	<8.7	<18	<23	<7.8	<4.1	<28	<6.9
GW/SV-24-5	5	6/13/12	<3.4	2.4	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-24-10	10	6/13/12	9.9	<1.9	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-25-5	5	5/30/12	<3.4	20	<2.7	<2.7	<5.6	8	2.8	<1.3	30	14
GW/SV-25-10	10	5/30/12	<3.4	<1.9	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-26-5	5	5/31/12	25	3.3	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-26-10	10	5/31/12	28	<1.9	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-27-5	5	5/31/12	67	16	3.6	<2.7	<5.6	<7.4	<2.5	<1.3	12	4.6
GW/SV-27-10	10	5/31/12	84	2	<2.7	<2.7	<5.6	<7.4	<2.5	2.9	<8.7	<2.2
GW/SV-28-5	5	5/31/12	<3.4	5.2	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	2.9
GW/SV-28-10	10	5/31/12	<3.4	<1.9	<2.7	<2.7	<5.6	<7.4	<2.5	<1.3	<8.7	<2.2
GW/SV-29-5	5	5/31/12	6.8	11	7	<2.7	13	30	8.6	<1.3	9.4	4.2
GW/SV-29-10	10	5/31/12	150	<1.9	<2.7	<2.7	15	<7.4	<2.5	<1.3	<8.7	<2.2

Notes:

* = Analyzed by EPA Method 8260B

Abbreviations:

μg/m^3 = micrograms per cubic meter

Dup = Duplicate sample

< indicates that the compound was not detected at or above the laboratory reporting limit shown.

Table 2. Analytical data for chemicals detected in groundwater (µg/L) using EPA Method 8260B (unless otherwise noted)

Sample Location	Date Collected	Benzene	tert-Butyl-alcohol (TBA)	n-Butyl-benzene	sec-Butyl-benzene	tert-Butyl-benzene	Carbon Disulfide	Chloro-benzene	Chloro-form	Ethyl-benzene	Isopropyl-benzene	Methyl tert-butyl ether (MTBE)	2-Methyl-naphthalene (8270)
MW-1	9/13/11	<5	250	<5	<5	<5	N/A	<5	<5	<5	22	<5	<100
MW-1	12/13/11	<5	<100	<5	<5	<5	<5	<5	<5	<5	6.7	<5	<100
MW-1	2/24/12	<0.5	18	<0.5	<0.5	<0.5	3.1	<0.5	<0.5	<0.5	2.8	<0.5	<10
MW-1	6/8/12	<0.5	37	<0.5	0.55	<0.5	<2	<0.5	<0.5	<0.5	9	<0.5	<10
MW-13	9/13/11	17	<100	<5	8	<5	N/A	<5	<5	3.6	47	16	<100
MW-13	12/13/11	<5	<100	<5	8.1	<5	<5	<5	<5	<5	36	22	110
MW-13	2/24/12	<1.0	50	<1.0	5.8	1.6	<4	<1.0	<1.0	<1	30	17	37
MW-13	6/8/12	<0.5	30	<0.5	8.5	1.7	<2	<0.5	<0.5	<0.5	41	21	<25
MW-14	9/13/11	<5	<100	<5	<5	<5	N/A	<5	<5	<5	<5	<5	<10
MW-14	12/12/11	<5	<100	<5	<5	<5	<5	<5	<5	<5	<5	<5	<10
MW-14	2/23/12	<0.5	14	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<10
MW-14	6/7/12	<0.5	<10	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<10
MW-15	9/13/11	<5	<100	<5	8.5	<5	N/A	<5	<5	<5	48	<5	<10
MW-15	12/12/11	<5	<100	<5	9.1	<5	<5	<5	<5	<5	45	<5	70
MW-15	2/23/12	<0.5	16	<0.5	8	1.6	<2	<0.5	<0.5	<0.5	43	<0.5	58
MW-15	6/7/12	<0.5	<10	<0.5	8	1.6	<2	<0.5	<0.5	<0.5	47	<0.5	39
MW-16	9/13/11	<5	<100	<5	29	3.2	N/A	<5	<5	<5	110	26	24
MW-16	2/24/12	<2	<40	<2	28	2.9	<8	<2	<2	<2	110	60	41
MW-16	6/8/12	<0.5	<10	1.4	30	3.3	<2	<0.5	<0.5	<0.5	110	74	43
MW-17	9/12/11	<5	<100	<5	<5	<5	N/A	<5	<5	<5	<5	82	<10
MW-17	12/13/11	<5	<100	<5	<5	<5	<5	<5	<5	<5	<5	140	<100
MW-17	2/23/12	<0.5	<10	<0.5	<0.5	<0.5	<2	2	<0.5	<0.5	<0.5	170	<10
MW-17	6/7/12	<0.5	<10	<0.5	<0.5	<0.5	<2	1.8	<0.5	<0.5	<0.5	180	<10
MW-18	9/13/11	<5	<100	<5	<5	<5	N/A	<5	<5	<5	<5	<5	<10
MW-18	12/12/11	<5	<100	<5	<5	<5	<5	<5	<5	<5	<5	<5	<10
MW-18	2/23/12	<0.5	<10	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<10
MW-18	6/7/12	<0.5	<10	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<10
MW-19	9/13/11	<5	110	<5	12	<5	N/A	<5	<5	<5	73	<5	<100
MW-19	12/12/11	<5	<100	<5	15	<5	<5	<5	<5	<5	65	<5	81
MW-19	2/23/12	<0.5	28	<1.0	11	1.7	<4	<1.0	<1.0	<1	73	<1.0	64
MW-19	6/8/12	<0.5	38	<0.5	9.8	1.5	<1	<0.5	<0.5	1.4	52	<0.5	<25
GW/SV-20	6/1/12	<0.5	<10	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<1.0	NA
GW/SV-21	6/4/12	<0.5	<10	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<1.0	NA
GW/SV-22	6/1/12	<0.5	38	<1.0	4.1	<1.0	<10	<1.0	<1.0	<1.0	17	<1.0	NA
GW/SV-23	6/4/12	<0.5	17	<1.0	2.5	<1.0	<10	<1.0	<1.0	<1.0	4.5	10	NA
GW/SV-24	6/4/12	<0.5	<10	<1.0	<1.0	<1.0	<10	<1.0	1.0	<1.0	<1.0	<1.0	NA
GW/SV-25	5/31/12	<0.5	14	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	1.2	NA
GW/SV-25-Dup	5/31/12	<0.5	17	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	1.7	NA
GW/SV-26	5/31/12	<0.5	<10	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<1.0	NA
GW/SV-27	6/1/12	<0.5	<10	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<1.0	NA
GW/SV-28	5/30/12	<0.5	<10	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<1.0	NA
GW/SV-29	6/1/12	<0.5	<10	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<1.0	NA

Abbreviations:

µg/L = micrograms per liter

Dup = Duplicate sample

NA = Not analyzed

< indicates that the compound was not detected at or above the laboratory reporting limit shown.

Table 2. Cont.

Sample Location	Date Collected	Naph-thalene (8260/8270)	n-Propyl-benzene	1,1,2,2-Tetrachloro-ethane	1,1,2-Trichloro-ethane	1,2,4-Trimethyl-benzene	o-Xylene
MW-1	9/13/11	14/<100	8.6	<5	<5	<5	<5
MW-1	12/13/11	<5/<100	<5	<5	<5	<5	<5
MW-1	2/24/12	<0.5/<10	1.1	<0.5	<0.5	<0.5	<0.5
MW-1	6/8/12	3.5/<10	3.6	<0.5	<0.5	<0.5	<0.5
MW-13	9/13/11	220/<100	37	<5	<5	<5	<5
MW-13	12/13/11	180/100	28	<5	<5	<5	<5
MW-13	2/24/12	150/35	22	<1.0	<1.0	<1.0	<1.0
MW-13	6/8/12	210/<25	31	<0.5	<0.5	<0.5	<0.5
MW-14	9/13/11	<5/<10	<5	<5	<5	<5	<5
MW-14	12/12/11	<5/<10	<5	<5	<5	<5	<5
MW-14	2/23/12	<0.5/<10	<0.5	<0.5	<0.5	<0.5	<0.5
MW-14	6/7/12	<0.5/<10	<0.5	<0.5	<0.5	<0.5	<0.5
MW-15	9/13/11	11/<10	11	<5	<5	<5	<5
MW-15	12/12/11	<5/<50	10	<5	<5	<5	<5
MW-15	2/23/12	<0.5/<10	9.2	<0.5	<0.5	<0.5	<0.5
MW-15	6/7/12	<0.5/<10	9.7	<0.5	<0.5	<0.5	<0.5
MW-16	9/13/11	28/8.2	71	<5	<5	<5	<5
MW-16	2/24/12	72/22	76	2.2	5.4	<2	<2
MW-16	6/8/12	65/26	73	<0.5	<0.5	<0.5	0.55
MW-17	9/12/11	<5/<10	<5	<5	<5	<5	<5
MW-17	12/13/11	6.6/<100	<5	<5	<5	<5	<5
MW-17	2/23/12	0.77/<10	<0.5	<0.5	<0.5	<0.5	<0.5
MW-17	6/7/12	<0.5/<10	<0.5	<0.5	<0.5	<0.55	<0.5
MW-18	9/13/11	<5/<10	<5	<5	<5	<5	<5
MW-18	12/12/11	<5/<10	<5	<5	<5	<5	<5
MW-18	2/23/12	<0.5/<10	<0.5	<0.5	<0.5	<0.5	<0.5
MW-18	6/7/12	<0.5/<10	<0.5	<0.5	<0.5	<0.5	<0.5
MW-19	9/13/11	200/<100	14	<5	<5	<5	<5
MW-19	12/12/11	330/130	11	<5	<5	<5	<5
MW-19	2/23/12	240/110	8.3	<1.0	<1.0	<1.0	<1.0
MW-19	6/8/12	210/<25	6.5	<0.5	<0.5	2.8	<0.5
GW/SV-20	6/1/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0
GW/SV-21	6/4/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0
GW/SV-22	6/1/12	<10	2.9	<1.0	<1.0	<1.0	<1.0
GW/SV-23	6/4/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0
GW/SV-24	6/4/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0
GW/SV-25	5/31/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0
GW/SV-25-Dup	5/31/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0
GW/SV-26	5/31/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0
GW/SV-27	6/1/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0
GW/SV-28	5/30/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0
GW/SV-29	6/1/12	<10	<1.0	<1.0	<1.0	<1.0	<1.0

Abbreviations:

μg/L = micrograms per liter

Dup = Duplicate sample

NA = Not analyzed

< indicates that the compound was not detected at or above the laboratory reporting limit shown.

Table 3. Exposure-point concentrations for chemicals of potential concern

Chemical	Maximum Detected Concentration South, Southwest, or West of Western Parcel		
	Soil Vapor (µg/m^3)		Groundwater (µg/L)
	5 ft	10 ft	
Acetone	270	1800	N/A
Benzene	71	53	17
Bromodichloromethane	7.5	25*	N/A
2-Butanone	64	40	N/A
tert-Butyl alcohol	2500*	1500	250
n-Butylbenzene	25*	25*	1.4
sec-Butylbenzene	250*	1500	30
tert-Butylbenzene	25*	25*	3.3
Carbon disulfide	13	71	3.1
Chlorobenzene	180	2500	2
Chloroform	200	310	1
Chloromethane	1.2	50*	N/A
Dibromochloromethane	4.8	25*	N/A
Dichlorodifluoromethane	3.3	2.9	N/A
cis-1,2-Dichloroethene	4.2	3.3	N/A
Ethylbenzene	81	1000	3.6
Isopropylbenzene	250*	4900	110
2-Methylnaphthalene	N/A	N/A	110
4-Methyl-2-Pentanone	77	250*	N/A
Methyl tert-butyl ether	41*	150	180
Naphthalene	16*	16*	330
n-Propylbenzene	25*	25*	76
1,1,2,2-Tetrachloroethane	50*	50*	2.2
Tetrachloroethene	67	150	N/A
Toluene	200	530	N/A
1,1,1-Trichloroethane	420	170	N/A
1,1,2-Trichloroethane	25*	25*	5.4
Trichlorofluoromethane	68	69	N/A
1,2,4-Trimethylbenzene	30	42*	2.8
1,3,5-Trimethylbenzene	8.6	25*	N/A
Vinyl Chloride	7*	2.9	N/A
m,p-Xylenes	130	50*	N/A
o-Xylene	43	240	0.55

Notes:

N/A = Not applicable

* = Detected in groundwater or the corresponding soil gas sample at another depth; half the detection limit used (see text)

Abbreviations:

µg/m^3 = micrograms per cubic meter

µg/L = micrograms per liter

Table 4. Summary of toxicity criteria for chemicals of potential concern

Chemical	Inhalation IUR $(\mu g/m^3)^{-1}$		Inhalation RfC (mg/m^3)	
Acetone	N/A		3.10E+01	d
Benzene	2.90E-05	o	3.00E-02	i
Bromodichloromethane	3.70E-05	o	7.00E-02	d
2-Butanone	N/A		5.00E+00	i
tert-Butyl alcohol	N/A		3.00E+01	s
n-Butylbenzene	N/A		1.40E-01	d
sec-Butylbenzene	N/A		1.40E-01	d
tert-Butylbenzene	N/A		1.40E-01	d
Carbon disulfide	N/A		7.00E-01	i
Chlorobenzene	N/A		1.00E+00	o
Chloroform	5.30E-06	o	3.00E-01	o
Chloromethane	1.80E-06	d	9.00E-02	i
Dibromochloromethane	2.70E-05	o	7.00E-02	d
Dichlorodifluoromethane	N/A		2.00E-01	d
cis-1,2-Dichloroethene	N/A		3.50E-02	d
Ethylbenzene	2.50E-06	o	1.00E+00	i
Isopropylbenzene	N/A		4.00E-01	i
2-Methylnaphthalene	N/A		1.40E-02	d
4-Methyl-2-Pentanone	N/A		3.00E+00	i
Methyl tert-butyl ether	2.60E-07	o	3.00E+00	i
Naphthalene	3.40E-05	o	3.00E-03	i
n-Propylbenzene	N/A		1.40E-01	d
1,1,2,2-Tetrachloroethane	5.80E-05	o	1.40E-02	d
Tetrachloroethene	5.90E-06	o	3.50E-02	d
Toluene	N/A		3.00E-01	o
1,1,1-Trichloroethane	N/A		5.00E+00	i
1,1,2-Trichloroethane	1.60E-05	o	1.40E-02	d
Trichlorofluoromeethane	N/A		7.00E-01	d
1,2,4-Trimethylbenzene	N/A		7.00E-03	d
1,3,5-Trimethylbenzene	N/A		6.00E-03	d
Vinyl chloride	7.80E-05	o	1.00E-01	i
p-Xylene (surrogate for m/p-xylene)	N/A		1.00E-01	i
o-Xylene	N/A		1.00E-01	i

Note:
d - DTSC J&E Spreadsheets (2011)
EPA - U.S. Environmental Protection Agency
i - EPA Integrated Risk Information System (IRIS) database
IUR - inhalation unit risk
N/A - not applicable
NDEP - Nevade Division of Environmental Protection
o - OEHHA Toxicity Criteria Database
OEHHA - Office of Environmental Health Hazard Assessment
RfC - reference concentration
s - surrogate [sec-butyl alcohol (NDEP, 2012)]

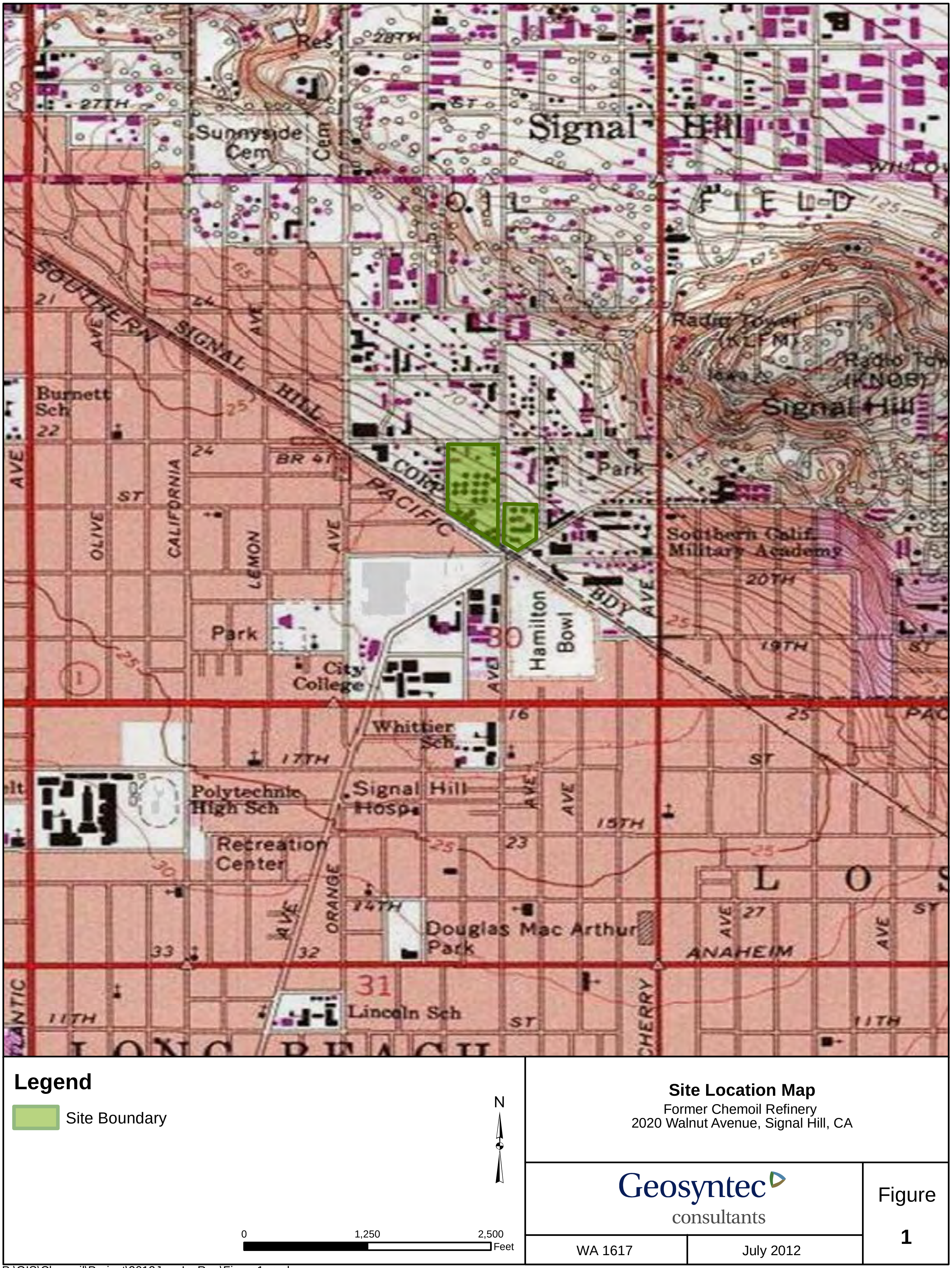
Table 5. Results for resident using data south of southern property boundary

Chemical	Exposure to Indoor Air Using Maximum Soil Vapor Concentrations at 5 ft		Exposure to Indoor Air Using Maximum Soil Vapor Concentrations at 10 ft		Exposure to Indoor Air Using Maxiumum Groundwater Concentrations	
	Estimated Excess Cancer Risk	Non-Cancer Hazard Quotient	Estimated Excess Cancer Risk	Estimated Non-Cancer Hazard Quotient	Estimated Excess Cancer Risk	Estimated Non-Cancer Hazard Quotient
Acetone	N/A	8.0E-06	N/A	3.2E-05	N/A	N/A
Benzene	6.4E-07	1.7E-03	2.7E-07	7.2E-04	2.1E-06	5.7E-03
Bromodichloromethane	3.7E-08	8.9E-06	6.2E-08	3.1E-06	N/A	N/A
2-Butanone	N/A	8.9E-06	N/A	3.1E-06	N/A	N/A
tert-Butyl alcohol	N/A	7.1E-05	N/A	2.5E-05	N/A	9.5E-07
n-Butylbenzene	N/A	9.4E-05	N/A	5.0E-05	N/A	1.3E-04
sec-Butylbenzene	N/A	9.4E-04	N/A	3.0E-03	N/A	1.9E-04
tert-Butylbenzene	N/A	9.4E-05	N/A	5.0E-05	N/A	3.1E-04
Carbon disulfide	N/A	1.5E-05	N/A	4.8E-05	N/A	2.9E-04
Chlorobenzene	N/A	1.1E-04	N/A	8.8E-04	N/A	1.1E-05
Chloroform	3.7E-07	5.4E-04	3.3E-07	4.8E-04	1.8E-08	2.7E-05
Chloromethane	8.5E-10	1.2E-05	2.1E-08	3.0E-04	N/A	N/A
Dibrormochloromethane	1.2E-08	1.5E-05	3.1E-08	3.8E-05	N/A	N/A
Dichlorodifluoromethane	N/A	9.8E-06	N/A	4.7E-06	N/A	N/A
cis-1,2-Dichloroethane	N/A	7.7E-05	N/A	3.3E-05	N/A	N/A
Ethylbenzene	5.6E-08	5.3E-05	3.8E-07	3.6E-04	4.3E-08	4.1E-05
Isopropylbenzene	N/A	3.6E-04	N/A	3.9E-03	N/A	3.5E-01
2-Methylnaphthalene	N/A	N/A	N/A	N/A	N/A	5.9E-03
4-Methyl-2-Pentanone	N/A	1.7E-05	N/A	3.0E-05	N/A	N/A
Methyl tert-butyl ether	3.7E-09	1.1E-05	7.8E-09	2.3E-05	3.6E-08	1.1E-04
Naphthalene	1.3E-07	2.9E-03	6.8E-08	1.6E-03	3.9E-06	9.0E-02
n-Propylbenzene	N/A	9.8E-05	N/A	5.3E-05	NA	6.4E-03
1,1,2,2-Tetrachloroethane	7.8E-07	2.2E-03	4.3E-07	1.2E-03	4.3E-08	1.2E-04
Tetrachloroethene	1.1E-07	1.2E-03	1.3E-07	1.5E-03	N/A	N/A
Toluene	N/A	4.8E-04	N/A	7.2E-04	N/A	N/A
1,1,1-Trichloroethane	N/A	5.6E-05	N/A	1.3E-05	N/A	N/A
1,1,2-Trichloroethane	1.1E-07	1.2E-03	6.4E-08	6.6E-04	6.5E-08	6.7E-04
Trichlorofluoromethane	N/A	7.0E-05	N/A	4.0E-05	N/A	N/A
1,2,4-Trimethylbenzene	N/A	2.4E-03	N/A	1.8E-03	N/A	2.8E-03
1,3,5-Trimethylbenzene	N/A	8.0E-04	N/A	1.2E-03	N/A	N/A
Vinyl chloride	1.9E-07	5.8E-05	4.6E-08	1.4E-05	N/A	N/A
m,p-Xylenes	N/A	8.6E-04	N/A	1.8E-04	N/A	N/A
o-Xylene	N/A	3.1E-04	N/A	9.7E-04	N/A	4.8E-05
TOTAL	**2E-06**	**2E-02**	**2E-06**	**2E-02**	**6E-06**	**5E-01**

Note: N/A - Not Applicable

Attachment A

Figures from Geosyntec (2012)



Site Location Map
Former Chemoil Refinery
2020 Walnut Avenue, Signal Hill, CA

Geosyntec consultants

WA 1617	July 2012	Figure 1

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Legend

- Monitoring Well
- Soil Gas Probe (TEC, 2009 and 2010)
- Soil, Soil Gas, and Grab Goundwater Sampling Locations (Geosyntec, 2012)

NOTE:
Approximate locations of monitoring well and soil gas probes from Testa Environmental Corporation's (TEC) June 2011 Report on Phase II and Phase III Additional Site Characterization

N

0 300 600 Feet

Soil, Soil Gas, and Grab Groundwater Sampling Locations

Former Chemoil Refinery
2020 Walnut Avenue, Signal Hill, CA

Geosyntec consultants

WA 1617	July 2012	Figure 2

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Attachment B

Johnson & Ettinger Modeling Output

Johnson & Ettinger Modeling Sheets

This attachment includes the model output sheets from the Johnson and Ettinger model (Johnson and Ettinger 1991), which was used to estimate infiltration of chemicals in soil vapor into indoor air. This model has been has been parameterized by U.S. EPA (2004) and was modified to reflect Cal-EPA-specific toxicity criteria, as appropriate (Cal-EPA 2011a and b). Default model input parameters recommended by U.S. EPA were used, except as follows.

- The soil vapor sampling depth was set to 152 cm (5 ft) or 305 cm (10 ft) depending on the depth indicated in the analytical report.

- The depth to groundwater was set to 360 cm (11.8 ft), which is based on the average depth to groundwater in monitoring wells located in the residential area south and southwest of the Western Parcel (MW-14, MW-15, MW-16, MW-18, and MW-19) for the last four quarterly monitoring events (third and fourth quarter 2011 and first and second quarter 2011; TEC 2011 and TEC 2012a-c). These data are summarized in Table B-1. As shown in the table, there is relatively little fluctuation in groundwater depth in these monitoring wells over the four quarters.

- Based on information provided by Stephen Testa of Testa Environmental Corporation (TEC: Testa, 2009), a single soil stratum extends from ground surface to approximately 13 ft below ground surface (bgs), which is below the depth to groundwater south and southwest of the Western Parcel. The soil type in this stratum ("Soil stratum A SCS soil type" and "SCS soil type directly above water table" in the J&E Model spreadsheets) is typical of a "silt loam." Input soil parameters for dry bulk density, total soil porosity, and water-filled soil porosity were based on default values for silt loam provided in the J&E Model spreadsheet.

- The average soil temperature was assumed to be 19°C, based on Figure 8 of U.S. EPA's (2003) guidance.

- The crack-to-total area ratio (η) was set at 0.005 (rather than calculated) to be consisted with Cal-EPA guidance (Cal-EPA 2011a).

The choice of soil type and use of default soil input parameters, which can have a substantial effect on the predicted indoor air concentrations, is supported by the results of soil property analyses included in the comprehensive soil vapor and groundwater investigation conducted by Geosyntec Consultants (Geosyntec) in 2012 (Geosyntec 2012). Specifically, Geosyntec collected soil samples from locations GW/SV-22 and GW/SV-29 at 3.5 to 4 ft and 7 to 8 ft bgs. These samples were analyzed for grain size distribution using ASTM Method D422/D4464M, dry bulk density and total porosity using API RP 40, and moisture content using API RP 40/ASTM D2216. The results of these analyses are summarized in Table B-2; the original laboratory reports are provided in Appendix E of the Geosyntec (2012) report.

Soil Type
Based on the particle size analysis, the weight percent of sand, silt, and clay was plotted on the U.S. Soil Conservation Service Classification Chart provided in the J&E Model User's Guide (U.S. EPA 2004). The result is shown in Figure B-1. According to this classification, two samples are " loam," one sample is "silt loam," and one sample is on the border between "loam" and "silt loam." The mean of the four results falls slightly within the boundary of "silt loam." In total, these results support the choice of silt loam as the soil type for soil stratum A.

Dry Bulk Density, Total Soil Porosity, and Water-filled Soil Porosity
The default values for dry bulk density, total soil porosity, and water-filled soil porosity for silt loam in the J&E Model spreadsheets are 1.49 grams per cubic centimeter (g/cm3), 0.439 (43.9%), and 0.18 (18.0%), respectively. These values are reasonably similar to the mean values for the four samples tested, i.e., 1.68 g/cm3, 37.7%, and 20.9%, respectively.[1] Of these parameters, the water-filled soil porosity has the greatest effect on the predicted indoor air concentration; therefore, the fact that the measured values are generally slightly higher than the default value means that use of the default value is conservative (i.e., results in higher predicted indoor air concentrations). Overall, these results are also supportive of the choice of silt loam as the soil type.

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[1] Water-filled porosity was calculated from measurements of dry bulk density and moisture contect as described by the State of Alaska Department of Environmental Conservation (http://dec.alaska.gov/applications/spar/webcalc/definitions.htm).

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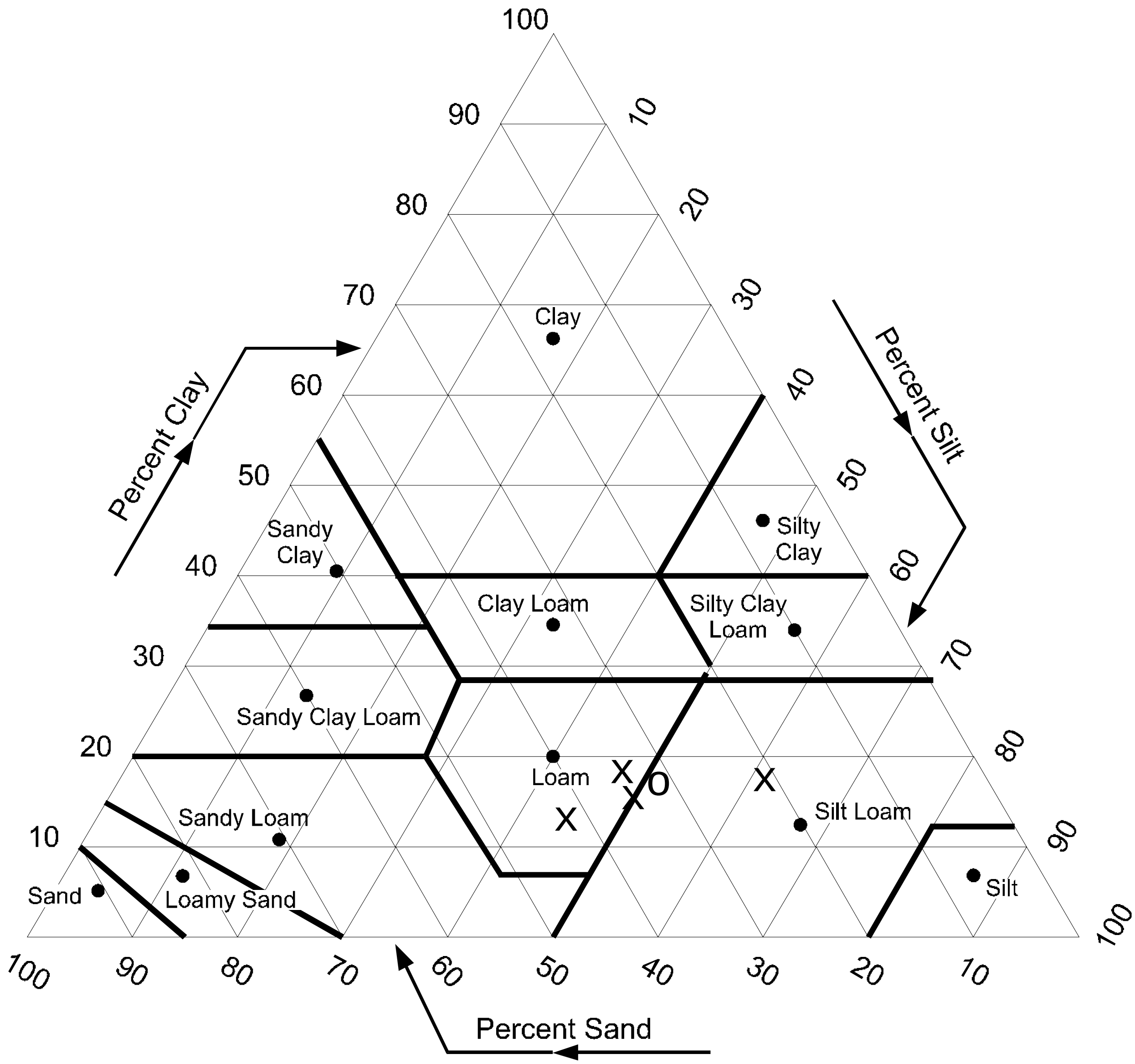
U.S. EPA. 2004. User's guide for evaluating subsurface vapor intrusion into buildings. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Toxics Integration Branch, Washington, DC. Revised February 22.



x = individual sample
o = mean of 4 samples

Figure B-1 Soil Type Classifcation

Table B-1. Summary of Depth to Groundwater Data for Wells South and Southwest of the Western Parcel (ft)

Monitoring Well	Sep-11	Dec-11	Feb-12	12-Jun
MW-14	11.3	11.6	11.5	11.5
MW-15	11.4	11.6	11.6	11.6
MW-16	12.5	No data	12.8	12.6
MW-18	12.3	12.4	12.4	12.4
MW-19	11.1	11.2	11.3	11.3
Mean	11.7	11.7	11.9	11.9
Overall Mean (ft)				11.8
Overall Mean (cm)				360

Table B-2. Soil physical properties

Sample Location	Sample Depth (ft bgs)	Particle Size Distribution (wt. percent) ASTM D422/D4464M			Moisture Content (% weight) API RP 40/ASTM D2216	Dry Bulk Density (g/cm^3) API RP40	Water-Filled Porosity (calculated)	Total Porosity (% bulk vol.) API RP 40
		Sand	Silt	Clay				
GW/SV-22-3'-4'	3.5-4.0	33.11	48.17	18.71	9.7	1.56	15.1	42.2
GW/SV-29-3'-4'	3.5-4.0	40.98	45.06	13.96	13.2	1.64	21.6	39.0
GW/SV-22-7'-8'	7-8	32.67	50.34	17.00	12.5	1.77	22.1	34.6
GW/SV-29-7'-8'	7-8	20.73	61.33	17.94	14.3	1.74	24.9	35.0
Mean		31.87	51.23	16.90	12.4	1.68	20.9	37.7

Notes:

Water-filled porosity = Moisture content x Dry bulk density (http://dec.alaska.gov/applications/spar/webcalc/definitions.htm).

Abbreviations:

g/cm^3 = grams per cubic centimeter

Resident using 5 ft. soil vapor data south, southwest, and west of the Western Parcel

SG-ADV
Version 3.1; 02/04

Reset to Defaults

Program modified to accommodate multiple chemicals

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical	
67641	2.70E+02			Acetone	
71432	7.10E+01			Benzene	
75274	7.50E+00			Bromodichloromethane	
78933	6.40E+01			Methylethylketone (2-butanone)	
75650	2.50E+03			tert-Butyl alcohol	
104518	2.50E+01			n-Butylbenzene	
135988	2.50E+02			sec-Butylbenzene	
98066	2.50E+01			tert-Butylbenzene	
75150	1.30E+01			Carbon disulfide	
108907	1.80E+02			Chlorobenzene	
67663	2.00E+02			Chloroform	
74873	1.20E+00			Methyl chloride (chloromethane)	
124481	4.80E+00			Chlorodibromomethane	Note: Same as Dibromochloromethane
75718	3.30E+00			Dichlorodifluoromethane	
156592	4.20E+00			cis-1,2-Dichloroethylene	
100414	8.10E+01			Ethylbenzene	
98828	2.50E+02			Cumene	Note: Same as isopropylbenzene
108101	7.70E+01			Methylisobutylketone (4-methyl-2-pentanone)	
1634044	4.10E+01			MTBE	
91203	1.60E+01			Naphthalene	
103651	2.50E+01			n-Propylbenzene	
79345	5.00E+01			1,1,2,2-Tetrachloroethane	
127184	6.70E+01			Tetrachloroethylene	
108883	2.00E+02			Toluene	
71556	4.20E+02			1,1,1-Trichloroethane	
79005	2.50E+01			1,1,2-Trichloroethane	
75694	6.80E+01			Trichlorofluoromethane	
95636	3.00E+01			1,2,4-Trimethylbenzene	
108678	8.60E+00			1,3,5-Trimethylbenzene	
75014	7.00E+00			Vinyl chloride (chloroethene)	
106423	1.30E+02			p-Xylene	Note: results reported as "m,p-xylenes"; p-xylene has the most conservative physical constants
95476	4.30E+01			o-Xylene	

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of Ls (cell F24)					
15	152	19	152	0	0	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)		ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
15	40	1000	1000	244	0.1	0.5		5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
70	30	30	350

END

Resident using 5 ft. soil vapor data south, southwest, and west of the Western Parcel

	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Molecular weight, MW (g/mol)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
Acetone	1.24E-01	1.14E-05	3.87E-05	25	6,955	329.20	508.10	58.08	0.0E+00	3.1E+01
Benzene	8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	78.11	2.9E-05	3.0E-02
Bromodichloromethane	2.98E-02	1.06E-05	1.60E-03	25	7,800	363.15	585.85	163.83	3.7E-05	7.0E-02
Methylethylketone (2-butanor	8.08E-02	9.80E-06	5.58E-05	25	7,481	352.50	536.78	72.11	0.0E+00	5.0E+00
tert-Butyl alcohol	9.85E-02	1.14E-05	9.05E-06	25	9,338	355.41	508.00	74.12	0.0E+00	3.0E+01
n-Butylbenzene	5.70E-02	8.12E-06	1.31E-02	25	9,290	456.46	660.50	134.22	0.0E+00	1.4E-01
sec-Butylbenzene	5.70E-02	8.12E-06	1.39E-02	25	88,730	446.50	679.00	134.22	0.0E+00	1.4E-01
tert-Butylbenzene	5.65E-02	8.02E-06	1.19E-02	25	8,980	442.10	1220.00	134.22	0.0E+00	1.4E-01
Carbon disulfide	1.04E-01	1.00E-05	3.02E-02	25	6,391	319.00	552.00	76.13	0.0E+00	7.0E-01
Chlorobenzene	7.30E-02	8.70E-06	3.69E-03	25	8,410	404.87	632.40	112.56	0.0E+00	1.0E+00
Chloroform	1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	119.38	5.3E-06	3.0E-01
Methyl chloride (chloromethar	1.26E-01	6.50E-06	8.80E-03	25	5,115	249.00	416.25	50.49	1.8E-06	9.0E-02
Chlorodibromomethane	1.96E-02	1.05E-05	7.81E-04	25	5,900	416.14	678.20	208.28	2.7E-05	7.0E-02
Dichlorodifluoromethane	6.65E-02	9.92E-06	3.42E-01	25	9,421	243.20	384.95	120.92	0.0E+00	2.0E-01
cis-1,2-Dichloroethylene	7.36E-02	1.13E-05	4.07E-03	25	7,192	333.65	544.00	96.94	0.0E+00	3.5E-02
Ethylbenzene	7.50E-02	7.80E-06	7.86E-03	25	8,501	409.34	617.20	106.17	2.5E-06	1.0E+00
Cumene	6.50E-02	7.10E-06	1.16E+00	25	10,335	425.56	631.10	120.19	0.0E+00	4.0E-01
Methylisobutylketone (4-meth	7.50E-02	7.80E-06	1.38E-04	25	8,243	389.50	571.00	100.16	0.0E+00	3.0E+00
MTBE	1.02E-01	1.05E-05	6.23E-04	25	6,678	328.30	497.10	88.15	2.6E-07	3.0E+00
Naphthalene	5.90E-02	7.50E-06	4.82E-04	25	10,373	491.14	748.40	128.18	3.4E-05	3.0E-03
n-Propylbenzene	6.01E-02	7.83E-06	1.07E-02	25	9,123	432.20	630.00	120.19	0.0E+00	1.4E-01
1,1,2,2-Tetrachloroethane	7.10E-02	7.90E-06	3.44E-04	25	8,996	419.60	661.15	167.85	5.8E-05	1.4E-02
Tetrachloroethylene	7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	165.83	5.9E-06	3.5E-02
Toluene	8.70E-02	8.60E-06	6.62E-03	25	7,930	383.78	591.79	92.14	0.0E+00	3.0E-01
1,1,1-Trichloroethane	7.80E-02	8.80E-06	1.72E-02	25	7,136	347.24	545.00	133.40	0.0E+00	5.0E+00
1,1,2-Trichloroethane	7.80E-02	8.80E-06	9.11E-04	25	8,322	386.15	602.00	133.41	1.6E-05	1.4E-02
Trichlorofluoromethane	8.70E-02	9.70E-06	9.68E-02	25	5,999	296.70	471.00	137.36	0.0E+00	7.0E-01
1,2,4-Trimethylbenzene	6.06E-02	7.92E-06	6.14E-03	25	9,369	442.30	649.17	120.20	0.0E+00	7.0E-03
1,3,5-Trimethylbenzene	6.02E-02	8.67E-06	5.87E-03	25	9,321	437.89	637.25	120.20	0.0E+00	6.0E-03
Vinyl chloride (chloroethene)	1.06E-01	1.23E-05	2.69E-02	25	5,250	259.25	432.00	62.50	7.8E-05	1.0E-01
p-Xylene	7.69E-02	8.44E-06	7.64E-03	25	8,525	411.52	616.20	106.17	0.0E+00	1.0E-01
o-Xylene	8.70E-02	1.00E-05	5.18E-03	25	8,661	417.60	630.30	106.17	0.0E+00	1.0E-01

Resident using 5 ft. soil vapor data south, southwest, and west of the Western Parcel

	Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil ;ffective vapo permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Soil gas conc. ($\mu g/m^3$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
Acetone	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.70E+02	3.39E+04
Benzene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	7.10E+01	3.39E+04
Bromodichloromethane	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	7.50E+00	3.39E+04
Methylethylketone (2-butar	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	6.40E+01	3.39E+04
tert-Butyl alcohol	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+03	3.39E+04
n-Butylbenzene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
sec-Butylbenzene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+02	3.39E+04
tert-Butylbenzene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
Carbon disulfide	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.30E+01	3.39E+04
Chlorobenzene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.80E+02	3.39E+04
Chloroform	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.00E+02	3.39E+04
Methyl chloride (chlorometh	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.20E+00	3.39E+04
Chlorodibromomethane	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	4.80E+00	3.39E+04
Dichlorodifluoromethane	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	3.30E+00	3.39E+04
cis-1,2-Dichloroethylene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	4.20E+00	3.39E+04
Ethylbenzene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	8.10E+01	3.39E+04
Cumene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+02	3.39E+04
Methylisobutylketone (4-me	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	7.70E+01	3.39E+04
MTBE	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	4.10E+01	3.39E+04
Naphthalene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.60E+01	3.39E+04
n-Propylbenzene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
1,1,2,2-Tetrachloroethane	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	5.00E+01	3.39E+04
Tetrachloroethylene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	6.70E+01	3.39E+04
Toluene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.00E+02	3.39E+04
1,1,1-Trichloroethane	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	4.20E+02	3.39E+04
1,1,2-Trichloroethane	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
Trichlorofluoromethane	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	6.80E+01	3.39E+04
1,2,4-Trimethylbenzene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	3.00E+01	3.39E+04
1,3,5-Trimethylbenzene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	8.60E+00	3.39E+04
Vinyl chloride (chloroethene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	7.00E+00	3.39E+04
p-Xylene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.30E+02	3.39E+04
o-Xylene	9.46E+08	137	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	4.30E+01	3.39E+04

	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
Acetone	1.00E+06	5.00E-03	15	7,447	2.99E-05	1.25E-03	1.78E-04	7.31E-03	0.00E+00	0.00E+00	7.31E-03	137
Benzene	1.00E+06	5.00E-03	15	8,030	4.19E-03	1.75E-01	1.78E-04	5.08E-03	0.00E+00	0.00E+00	5.08E-03	137
Bromodichloromethane	1.00E+06	5.00E-03	15	8,576	1.19E-03	4.95E-02	1.78E-04	1.72E-03	0.00E+00	0.00E+00	1.72E-03	137
Methylethylketone (2-butar	1.00E+06	5.00E-03	15	8,307	4.18E-05	1.74E-03	1.78E-04	4.76E-03	0.00E+00	0.00E+00	4.76E-03	137
tert-Butyl alcohol	1.00E+06	5.00E-03	15	10,734	6.24E-06	2.60E-04	1.78E-04	6.44E-03	0.00E+00	0.00E+00	6.44E-03	137
n-Butylbenzene	1.00E+06	5.00E-03	15	11,734	8.74E-03	3.65E-01	1.78E-04	3.29E-03	0.00E+00	0.00E+00	3.29E-03	137
sec-Butylbenzene	1.00E+06	5.00E-03	15	107,157	3.38E-04	1.41E-02	1.78E-04	3.30E-03	0.00E+00	0.00E+00	3.30E-03	137
tert-Butylbenzene	1.00E+06	5.00E-03	15	9,468	8.55E-03	3.57E-01	1.78E-04	3.26E-03	0.00E+00	0.00E+00	3.26E-03	137
Carbon disulfide	1.00E+06	5.00E-03	15	6,612	2.40E-02	1.00E+00	1.78E-04	6.00E-03	0.00E+00	0.00E+00	6.00E-03	137
Chlorobenzene	1.00E+06	5.00E-03	15	9,712	2.64E-03	1.10E-01	1.78E-04	4.22E-03	0.00E+00	0.00E+00	4.22E-03	137
Chloroform	1.00E+06	5.00E-03	15	7,461	2.83E-03	1.18E-01	1.78E-04	6.00E-03	0.00E+00	0.00E+00	6.00E-03	137
Methyl chloride (chlorometh	1.00E+06	5.00E-03	15	4,640	7.49E-03	3.12E-01	1.78E-04	7.27E-03	0.00E+00	0.00E+00	7.27E-03	137
Chlorodibromomethane	1.00E+06	5.00E-03	15	6,726	6.19E-04	2.58E-02	1.78E-04	1.14E-03	0.00E+00	0.00E+00	1.14E-03	137
Dichlorodifluoromethane	1.00E+06	5.00E-03	15	8,118	2.58E-01	1.08E+01	1.78E-04	3.84E-03	0.00E+00	0.00E+00	3.84E-03	137
cis-1,2-Dichloroethylene	1.00E+06	5.00E-03	15	7,643	3.12E-03	1.30E-01	1.78E-04	4.25E-03	0.00E+00	0.00E+00	4.25E-03	137
Ethylbenzene	1.00E+06	5.00E-03	15	10,052	5.55E-03	2.31E-01	1.78E-04	4.33E-03	0.00E+00	0.00E+00	4.33E-03	137
Cumene	1.00E+06	5.00E-03	15	12,518	7.50E-01	3.13E+01	1.78E-04	3.75E-03	0.00E+00	0.00E+00	3.75E-03	137
Methylisobutylketone (4-me	1.00E+06	5.00E-03	15	9,741	9.82E-05	4.10E-03	1.78E-04	4.36E-03	0.00E+00	0.00E+00	4.36E-03	137
MTBE	1.00E+06	5.00E-03	15	7,179	4.86E-04	2.03E-02	1.78E-04	5.92E-03	0.00E+00	0.00E+00	5.92E-03	137
Naphthalene	1.00E+06	5.00E-03	15	12,820	3.09E-04	1.29E-02	1.78E-04	3.42E-03	0.00E+00	0.00E+00	3.42E-03	137
n-Propylbenzene	1.00E+06	5.00E-03	15	11,251	7.21E-03	3.01E-01	1.78E-04	3.47E-03	0.00E+00	0.00E+00	3.47E-03	137
1,1,2,2-Tetrachloroethane	1.00E+06	5.00E-03	15	10,450	2.40E-04	9.99E-03	1.78E-04	4.11E-03	0.00E+00	0.00E+00	4.11E-03	137
Tetrachloroethylene	1.00E+06	5.00E-03	15	9,462	1.32E-02	5.52E-01	1.78E-04	4.16E-03	0.00E+00	0.00E+00	4.16E-03	137
Toluene	1.00E+06	5.00E-03	15	9,056	4.84E-03	2.02E-01	1.78E-04	5.02E-03	0.00E+00	0.00E+00	5.02E-03	137
1,1,1-Trichloroethane	1.00E+06	5.00E-03	15	7,787	1.31E-02	5.46E-01	1.78E-04	4.50E-03	0.00E+00	0.00E+00	4.50E-03	137
1,1,2-Trichloroethane	1.00E+06	5.00E-03	15	9,474	6.56E-04	2.74E-02	1.78E-04	4.51E-03	0.00E+00	0.00E+00	4.51E-03	137
Trichlorofluoromethane	1.00E+06	5.00E-03	15	6,053	7.84E-02	3.27E+00	1.78E-04	5.02E-03	0.00E+00	0.00E+00	5.02E-03	137
1,2,4-Trimethylbenzene	1.00E+06	5.00E-03	15	11,579	4.11E-03	1.72E-01	1.78E-04	3.50E-03	0.00E+00	0.00E+00	3.50E-03	137
1,3,5-Trimethylbenzene	1.00E+06	5.00E-03	15	11,561	3.93E-03	1.64E-01	1.78E-04	3.48E-03	0.00E+00	0.00E+00	3.48E-03	137
Vinyl chloride (chloroethene	1.00E+06	5.00E-03	15	4,898	2.27E-02	9.48E-01	1.78E-04	6.12E-03	0.00E+00	0.00E+00	6.12E-03	137
p-Xylene	1.00E+06	5.00E-03	15	10,143	5.38E-03	2.24E-01	1.78E-04	4.44E-03	0.00E+00	0.00E+00	4.44E-03	137
o-Xylene	1.00E+06	5.00E-03	15	10,302	3.62E-03	1.51E-01	1.78E-04	5.02E-03	0.00E+00	0.00E+00	5.02E-03	137

Resident using 5 ft. soil vapor data south, southwest, and west of the Western Parcel

	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
Acetone	15	2.70E+02	1.25	8.33E+01	7.31E-03	5.00E+03	6.96E+14	9.60E-04	2.59E-01	NA	3.1E+01
Benzene	15	7.10E+01	1.25	8.33E+01	5.08E-03	5.00E+03	2.34E+21	7.57E-04	5.38E-02	2.9E-05	3.0E-02
Bromodichloromethane	15	7.50E+00	1.25	8.33E+01	1.72E-03	5.00E+03	9.61E+62	3.23E-04	2.42E-03	3.7E-05	7.0E-02
Methylethylketone (2-butar	15	6.40E+01	1.25	8.33E+01	4.76E-03	5.00E+03	6.40E+22	7.24E-04	4.63E-02	NA	5.0E+00
tert-Butyl alcohol	15	2.50E+03	1.25	8.33E+01	6.44E-03	5.00E+03	7.29E+16	8.87E-04	2.22E+00	NA	3.0E+01
n-Butylbenzene	15	2.50E+01	1.25	8.33E+01	3.29E-03	5.00E+03	9.87E+32	5.50E-04	1.38E-02	NA	1.4E-01
sec-Butylbenzene	15	2.50E+02	1.25	8.33E+01	3.30E-03	5.00E+03	7.93E+32	5.51E-04	1.38E-01	NA	1.4E-01
tert-Butylbenzene	15	2.50E+01	1.25	8.33E+01	3.26E-03	5.00E+03	1.93E+33	5.46E-04	1.37E-02	NA	1.4E-01
Carbon disulfide	15	1.30E+01	1.25	8.33E+01	6.00E-03	5.00E+03	1.22E+18	8.47E-04	1.10E-02	NA	7.0E-01
Chlorobenzene	15	1.80E+02	1.25	8.33E+01	4.22E-03	5.00E+03	5.72E+25	6.63E-04	1.19E-01	NA	1.0E+00
Chloroform	15	2.00E+02	1.25	8.33E+01	6.00E-03	5.00E+03	1.21E+18	8.48E-04	1.70E-01	5.3E-06	3.0E-01
Methyl chloride (chlorometh	15	1.20E+00	1.25	8.33E+01	7.27E-03	5.00E+03	8.45E+14	9.57E-04	1.15E-03	1.8E-06	9.0E-02
Chlorodibromomethane	15	4.80E+00	1.25	8.33E+01	1.14E-03	5.00E+03	2.37E+95	2.23E-04	1.07E-03	2.7E-05	7.0E-02
Dichlorodifluoromethane	15	3.30E+00	1.25	8.33E+01	3.84E-03	5.00E+03	1.92E+28	6.19E-04	2.04E-03	NA	2.0E-01
cis-1,2-Dichloroethylene	15	4.20E+00	1.25	8.33E+01	4.25E-03	5.00E+03	3.52E+25	6.67E-04	2.80E-03	NA	3.5E-02
Ethylbenzene	15	8.10E+01	1.25	8.33E+01	4.33E-03	5.00E+03	1.19E+25	6.76E-04	5.48E-02	2.5E-06	1.0E+00
Cumene	15	2.50E+02	1.25	8.33E+01	3.75E-03	5.00E+03	8.65E+28	6.08E-04	1.52E-01	NA	4.0E-01
Methylisobutylketone (4-me	15	7.70E+01	1.25	8.33E+01	4.36E-03	5.00E+03	7.77E+24	6.80E-04	5.23E-02	NA	3.0E+00
MTBE	15	4.10E+01	1.25	8.33E+01	5.92E-03	5.00E+03	2.19E+18	8.40E-04	3.44E-02	2.6E-07	3.0E+00
Naphthalene	15	1.60E+01	1.25	8.33E+01	3.42E-03	5.00E+03	6.11E+31	5.66E-04	9.06E-03	3.4E-05	3.0E-03
n-Propylbenzene	15	2.50E+01	1.25	8.33E+01	3.47E-03	5.00E+03	1.96E+31	5.73E-04	1.43E-02	NA	1.4E-01
1,1,2,2-Tetrachloroethane	15	5.00E+01	1.25	8.33E+01	4.11E-03	5.00E+03	2.54E+26	6.51E-04	3.26E-02	5.8E-05	1.4E-02
Tetrachloroethylene	15	6.70E+01	1.25	8.33E+01	4.16E-03	5.00E+03	1.32E+26	6.56E-04	4.40E-02	5.9E-06	3.5E-02
Toluene	15	2.00E+02	1.25	8.33E+01	5.02E-03	5.00E+03	4.13E+21	7.51E-04	1.50E-01	NA	3.0E-01
1,1,1-Trichloroethane	15	4.20E+02	1.25	8.33E+01	4.50E-03	5.00E+03	1.30E+24	6.96E-04	2.92E-01	NA	5.0E+00
1,1,2-Trichloroethane	15	2.50E+01	1.25	8.33E+01	4.51E-03	5.00E+03	1.21E+24	6.96E-04	1.74E-02	1.6E-05	1.4E-02
Trichlorofluoromethane	15	6.80E+01	1.25	8.33E+01	5.02E-03	5.00E+03	4.16E+21	7.51E-04	5.11E-02	NA	7.0E-01
1,2,4-Trimethylbenzene	15	3.00E+01	1.25	8.33E+01	3.50E-03	5.00E+03	1.07E+31	5.77E-04	1.73E-02	NA	7.0E-03
1,3,5-Trimethylbenzene	15	8.60E+00	1.25	8.33E+01	3.48E-03	5.00E+03	1.72E+31	5.74E-04	4.94E-03	NA	6.0E-03
Vinyl chloride (chloroethene	15	7.00E+00	1.25	8.33E+01	6.12E-03	5.00E+03	5.54E+17	8.58E-04	6.01E-03	7.8E-05	1.0E-01
p-Xylene	15	1.30E+02	1.25	8.33E+01	4.44E-03	5.00E+03	2.85E+24	6.89E-04	8.95E-02	NA	1.0E-01
o-Xylene	15	4.30E+01	1.25	8.33E+01	5.02E-03	5.00E+03	4.12E+21	7.51E-04	3.23E-02	NA	1.0E-01

END

RESULTS SHEET

Resident using 5 ft. soil vapor data south, southwest, and west of the Western Parcel

INCREMENTAL RISK CALCULATIONS:

	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
Acetone	NA	8.0E-06
Benzene	6.4E-07	1.7E-03
Bromodichloromethane	3.7E-08	8.9E-06
Methylethylketone (2-butanone)	NA	8.9E-06
tert-Butyl alcohol	NA	7.1E-05
n-Butylbenzene	NA	9.4E-05
sec-Butylbenzene	NA	9.4E-04
tert-Butylbenzene	NA	9.4E-05
Carbon disulfide	NA	1.5E-05
Chlorobenzene	NA	1.1E-04
Chloroform	3.7E-07	5.4E-04
Methyl chloride (chloromethane)	8.5E-10	1.2E-05
Chlorodibromomethane	1.2E-08	1.5E-05
Dichlorodifluoromethane	NA	9.8E-06
cis-1,2-Dichloroethylene	NA	7.7E-05
Ethylbenzene	5.6E-08	5.3E-05
Cumene	NA	3.6E-04
Methylisobutylketone (4-methyl-2-pentanone)	NA	1.7E-05
MTBE	3.7E-09	1.1E-05
Naphthalene	1.3E-07	2.9E-03
n-Propylbenzene	NA	9.8E-05
1,1,2,2-Tetrachloroethane	7.8E-07	2.2E-03
Tetrachloroethylene	1.1E-07	1.2E-03
Toluene	NA	4.8E-04
1,1,1-Trichloroethane	NA	5.6E-05
1,1,2-Trichloroethane	1.1E-07	1.2E-03
Trichlorofluoromethane	NA	7.0E-05
1,2,4-Trimethylbenzene	NA	2.4E-03
1,3,5-Trimethylbenzene	NA	8.0E-04
Vinyl chloride (chloroethene)	1.9E-07	5.8E-05
p-Xylene	NA	8.6E-04
o-Xylene	NA	3.1E-04
	2E-06	2E-02

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

Resident using 10 ft. soil vapor data south, southwest, and west of the Western Parcel

SG-ADV
Version 3.1; 02/04

Reset to Defaults

Program modified to accommodate multiple chemicals

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical	
67641	1.80E+03			Acetone	
71432	5.30E+01			Benzene	
75274	2.50E+01			Bromodichloromethane	
78933	4.00E+01			Methylethylketone (2-butanone)	
75650	1.50E+03			tert-Butyl alcohol	
104518	2.50E+01			n-Butylbenzene	
135988	1.50E+03			sec-Butylbenzene	
98066	2.50E+01			tert-Butylbenzene	
75150	7.10E+01			Carbon disulfide	
108907	2.50E+03			Chlorobenzene	
67663	3.10E+02			Chloroform	
74873	5.00E+01			Methyl chloride (chloromethane)	
124481	2.50E+01			Chlorodibromomethane	Note: Same as Dibromochloromethane
75718	2.90E+00			Dichlorodifluoromethane	
156592	3.30E+00			cis-1,2-Dichloroethylene	
100414	1.00E+03			Ethylbenzene	
98828	4.90E+03			Cumene	Note: Same as isopropylbenzene
108101	2.50E+02			Methylisobutylketone (4-methyl-2-pentanone)	
1634044	1.50E+02			MTBE	
91203	1.60E+01			Naphthalene	
103651	2.50E+01			n-Propylbenzene	
79345	5.00E+01			1,1,2,2-Tetrachloroethane	
127184	1.50E+02			Tetrachloroethylene	
108883	5.30E+02			Toluene	
71556	1.70E+02			1,1,1-Trichloroethane	
79005	2.50E+01			1,1,2-Trichloroethane	
75694	6.90E+01			Trichlorofluoromethane	
95636	4.20E+01			1,2,4-Trimethylbenzene	
108678	2.50E+01			1,3,5-Trimethylbenzene	
75014	2.90E+00			Vinyl chloride (chloroethene)	
106423	5.00E+01			p-Xylene	Note: results reported as "m,p-xylenes"; p-xylene has the most conservative physical constants
95476	2.40E+02			o-Xylene	

MORE ↓

Totals must add up to value of Ls (cell F24)

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	305	19	305	0	0	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)		ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
15	40	1000	1000	244	0.1	0.5		5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
70	30	30	350

END

Resident using 10 ft. soil vapor data south, southwest, and west of the Western Parcel

	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Molecular weight, MW (g/mol)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
Acetone	1.24E-01	1.14E-05	3.87E-05	25	6,955	329.20	508.10	58.08	0.0E+00	3.1E+01
Benzene	8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	78.11	2.9E-05	3.0E-02
Bromodichloromethane	2.98E-02	1.06E-05	1.60E-03	25	7,800	363.15	585.85	163.83	3.7E-05	7.0E-02
Methylethylketone (2-butanor	8.08E-02	9.80E-06	5.58E-05	25	7,481	352.50	536.78	72.11	0.0E+00	5.0E+00
tert-Butyl alcohol	9.85E-02	1.14E-05	9.05E-06	25	9,338	355.41	508.00	74.12	0.0E+00	3.0E+01
n-Butylbenzene	5.70E-02	8.12E-06	1.31E-02	25	9,290	456.46	660.50	134.22	0.0E+00	1.4E-01
sec-Butylbenzene	5.70E-02	8.12E-06	1.39E-02	25	88,730	446.50	679.00	134.22	0.0E+00	1.4E-01
tert-Butylbenzene	5.65E-02	8.02E-06	1.19E-02	25	8,980	442.10	1220.00	134.22	0.0E+00	1.4E-01
Carbon disulfide	1.04E-01	1.00E-05	3.02E-02	25	6,391	319.00	552.00	76.13	0.0E+00	7.0E-01
Chlorobenzene	7.30E-02	8.70E-06	3.69E-03	25	8,410	404.87	632.40	112.56	0.0E+00	1.0E+00
Chloroform	1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	119.38	5.3E-06	3.0E-01
Methyl chloride (chloromethar	1.26E-01	6.50E-06	8.80E-03	25	5,115	249.00	416.25	50.49	1.8E-06	9.0E-02
Chlorodibromomethane	1.96E-02	1.05E-05	7.81E-04	25	5,900	416.14	678.20	208.28	2.7E-05	7.0E-02
Dichlorodifluoromethane	6.65E-02	9.92E-06	3.42E-01	25	9,421	243.20	384.95	120.92	0.0E+00	2.0E-01
cis-1,2-Dichloroethylene	7.36E-02	1.13E-05	4.07E-03	25	7,192	333.65	544.00	96.94	0.0E+00	3.5E-02
Ethylbenzene	7.50E-02	7.80E-06	7.86E-03	25	8,501	409.34	617.20	106.17	2.5E-06	1.0E+00
Cumene	6.50E-02	7.10E-06	1.16E+00	25	10,335	425.56	631.10	120.19	0.0E+00	4.0E-01
Methylisobutylketone (4-meth	7.50E-02	7.80E-06	1.38E-04	25	8,243	389.50	571.00	100.16	0.0E+00	3.0E+00
MTBE	1.02E-01	1.05E-05	6.23E-04	25	6,678	328.30	497.10	88.15	2.6E-07	3.0E+00
Naphthalene	5.90E-02	7.50E-06	4.82E-04	25	10,373	491.14	748.40	128.18	3.4E-05	3.0E-03
n-Propylbenzene	6.01E-02	7.83E-06	1.07E-02	25	9,123	432.20	630.00	120.19	0.0E+00	1.4E-01
1,1,2,2-Tetrachloroethane	7.10E-02	7.90E-06	3.44E-04	25	8,996	419.60	661.15	167.85	5.8E-05	1.4E-02
Tetrachloroethylene	7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	165.83	5.9E-06	3.5E-02
Toluene	8.70E-02	8.60E-06	6.62E-03	25	7,930	383.78	591.79	92.14	0.0E+00	3.0E-01
1,1,1-Trichloroethane	7.80E-02	8.80E-06	1.72E-02	25	7,136	347.24	545.00	133.40	0.0E+00	5.0E+00
1,1,2-Trichloroethane	7.80E-02	8.80E-06	9.11E-04	25	8,322	386.15	602.00	133.41	1.6E-05	1.4E-02
Trichlorofluoromethane	8.70E-02	9.70E-06	9.68E-02	25	5,999	296.70	471.00	137.36	0.0E+00	7.0E-01
1,2,4-Trimethylbenzene	6.06E-02	7.92E-06	6.14E-03	25	9,369	442.30	649.17	120.20	0.0E+00	7.0E-03
1,3,5-Trimethylbenzene	6.02E-02	8.67E-06	5.87E-03	25	9,321	437.89	637.25	120.20	0.0E+00	6.0E-03
Vinyl chloride (chloroethene)	1.06E-01	1.23E-05	2.69E-02	25	5,250	259.25	432.00	62.50	7.8E-05	1.0E-01
p-Xylene	7.69E-02	8.44E-06	7.64E-03	25	8,525	411.52	616.20	106.17	0.0E+00	1.0E-01
o-Xylene	8.70E-02	1.00E-05	5.18E-03	25	8,661	417.60	630.30	106.17	0.0E+00	1.0E-01

Resident using 10 ft. soil vapor data south, southwest, and west of the Western Parcel

	Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Soil gas conc. ($\mu g/m^3$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
Acetone	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.80E+03	3.39E+04
Benzene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	5.30E+01	3.39E+04
Bromodichloromethane	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
Methylethylketone (2-butar	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	4.00E+01	3.39E+04
tert-Butyl alcohol	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.50E+03	3.39E+04
n-Butylbenzene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
sec-Butylbenzene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.50E+03	3.39E+04
tert-Butylbenzene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
Carbon disulfide	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	7.10E+01	3.39E+04
Chlorobenzene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+03	3.39E+04
Chloroform	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	3.10E+02	3.39E+04
Methyl chloride (chlorometh	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	5.00E+01	3.39E+04
Chlorodibromomethane	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
Dichlorodifluoromethane	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.90E+00	3.39E+04
cis-1,2-Dichloroethylene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	3.30E+00	3.39E+04
Ethylbenzene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.00E+03	3.39E+04
Cumene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	4.90E+03	3.39E+04
Methylisobutylketone (4-me	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+02	3.39E+04
MTBE	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.50E+02	3.39E+04
Naphthalene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.60E+01	3.39E+04
n-Propylbenzene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
1,1,2,2-Tetrachloroethane	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	5.00E+01	3.39E+04
Tetrachloroethylene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.50E+02	3.39E+04
Toluene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	5.30E+02	3.39E+04
1,1,1-Trichloroethane	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	1.70E+02	3.39E+04
1,1,2-Trichloroethane	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
Trichlorofluoromethane	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	6.90E+01	3.39E+04
1,2,4-Trimethylbenzene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	4.20E+01	3.39E+04
1,3,5-Trimethylbenzene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.50E+01	3.39E+04
Vinyl chloride (chloroethene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.90E+00	3.39E+04
p-Xylene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	5.00E+01	3.39E+04
o-Xylene	9.46E+08	290	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	4,000	2.40E+02	3.39E+04

	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
Acetone	1.00E+06	5.00E-03	15	7,447	2.99E-05	1.25E-03	1.78E-04	7.31E-03	0.00E+00	0.00E+00	7.31E-03	290
Benzene	1.00E+06	5.00E-03	15	8,030	4.19E-03	1.75E-01	1.78E-04	5.08E-03	0.00E+00	0.00E+00	5.08E-03	290
Bromodichloromethane	1.00E+06	5.00E-03	15	8,576	1.19E-03	4.95E-02	1.78E-04	1.72E-03	0.00E+00	0.00E+00	1.72E-03	290
Methylethylketone (2-butar	1.00E+06	5.00E-03	15	8,307	4.18E-05	1.74E-03	1.78E-04	4.76E-03	0.00E+00	0.00E+00	4.76E-03	290
tert-Butyl alcohol	1.00E+06	5.00E-03	15	10,734	6.24E-06	2.60E-04	1.78E-04	6.44E-03	0.00E+00	0.00E+00	6.44E-03	290
n-Butylbenzene	1.00E+06	5.00E-03	15	11,734	8.74E-03	3.65E-01	1.78E-04	3.29E-03	0.00E+00	0.00E+00	3.29E-03	290
sec-Butylbenzene	1.00E+06	5.00E-03	15	107,157	3.38E-04	1.41E-02	1.78E-04	3.30E-03	0.00E+00	0.00E+00	3.30E-03	290
tert-Butylbenzene	1.00E+06	5.00E-03	15	9,468	8.55E-03	3.57E-01	1.78E-04	3.26E-03	0.00E+00	0.00E+00	3.26E-03	290
Carbon disulfide	1.00E+06	5.00E-03	15	6,612	2.40E-02	1.00E+00	1.78E-04	6.00E-03	0.00E+00	0.00E+00	6.00E-03	290
Chlorobenzene	1.00E+06	5.00E-03	15	9,712	2.64E-03	1.10E-01	1.78E-04	4.22E-03	0.00E+00	0.00E+00	4.22E-03	290
Chloroform	1.00E+06	5.00E-03	15	7,461	2.83E-03	1.18E-01	1.78E-04	6.00E-03	0.00E+00	0.00E+00	6.00E-03	290
Methyl chloride (chlorometh	1.00E+06	5.00E-03	15	4,640	7.49E-03	3.12E-01	1.78E-04	7.27E-03	0.00E+00	0.00E+00	7.27E-03	290
Chlorodibromomethane	1.00E+06	5.00E-03	15	6,726	6.19E-04	2.58E-02	1.78E-04	1.14E-03	0.00E+00	0.00E+00	1.14E-03	290
Dichlorodifluoromethane	1.00E+06	5.00E-03	15	8,118	2.58E-01	1.08E+01	1.78E-04	3.84E-03	0.00E+00	0.00E+00	3.84E-03	290
cis-1,2-Dichloroethylene	1.00E+06	5.00E-03	15	7,643	3.12E-03	1.30E-01	1.78E-04	4.25E-03	0.00E+00	0.00E+00	4.25E-03	290
Ethylbenzene	1.00E+06	5.00E-03	15	10,052	5.55E-03	2.31E-01	1.78E-04	4.33E-03	0.00E+00	0.00E+00	4.33E-03	290
Cumene	1.00E+06	5.00E-03	15	12,518	7.50E-01	3.13E+01	1.78E-04	3.75E-03	0.00E+00	0.00E+00	3.75E-03	290
Methylisobutylketone (4-me	1.00E+06	5.00E-03	15	9,741	9.82E-05	4.10E-03	1.78E-04	4.36E-03	0.00E+00	0.00E+00	4.36E-03	290
MTBE	1.00E+06	5.00E-03	15	7,179	4.86E-04	2.03E-02	1.78E-04	5.92E-03	0.00E+00	0.00E+00	5.92E-03	290
Naphthalene	1.00E+06	5.00E-03	15	12,820	3.09E-04	1.29E-02	1.78E-04	3.42E-03	0.00E+00	0.00E+00	3.42E-03	290
n-Propylbenzene	1.00E+06	5.00E-03	15	11,251	7.21E-03	3.01E-01	1.78E-04	3.47E-03	0.00E+00	0.00E+00	3.47E-03	290
1,1,2,2-Tetrachloroethane	1.00E+06	5.00E-03	15	10,450	2.40E-04	9.99E-03	1.78E-04	4.11E-03	0.00E+00	0.00E+00	4.11E-03	290
Tetrachloroethylene	1.00E+06	5.00E-03	15	9,462	1.32E-02	5.52E-01	1.78E-04	4.16E-03	0.00E+00	0.00E+00	4.16E-03	290
Toluene	1.00E+06	5.00E-03	15	9,056	4.84E-03	2.02E-01	1.78E-04	5.02E-03	0.00E+00	0.00E+00	5.02E-03	290
1,1,1-Trichloroethane	1.00E+06	5.00E-03	15	7,787	1.31E-02	5.46E-01	1.78E-04	4.50E-03	0.00E+00	0.00E+00	4.50E-03	290
1,1,2-Trichloroethane	1.00E+06	5.00E-03	15	9,474	6.56E-04	2.74E-02	1.78E-04	4.51E-03	0.00E+00	0.00E+00	4.51E-03	290
Trichlorofluoromethane	1.00E+06	5.00E-03	15	6,053	7.84E-02	3.27E+00	1.78E-04	5.02E-03	0.00E+00	0.00E+00	5.02E-03	290
1,2,4-Trimethylbenzene	1.00E+06	5.00E-03	15	11,579	4.11E-03	1.72E-01	1.78E-04	3.50E-03	0.00E+00	0.00E+00	3.50E-03	290
1,3,5-Trimethylbenzene	1.00E+06	5.00E-03	15	11,561	3.93E-03	1.64E-01	1.78E-04	3.48E-03	0.00E+00	0.00E+00	3.48E-03	290
Vinyl chloride (chloroethene	1.00E+06	5.00E-03	15	4,898	2.27E-02	9.48E-01	1.78E-04	6.12E-03	0.00E+00	0.00E+00	6.12E-03	290
p-Xylene	1.00E+06	5.00E-03	15	10,143	5.38E-03	2.24E-01	1.78E-04	4.44E-03	0.00E+00	0.00E+00	4.44E-03	290
o-Xylene	1.00E+06	5.00E-03	15	10,302	3.62E-03	1.51E-01	1.78E-04	5.02E-03	0.00E+00	0.00E+00	5.02E-03	290

Resident using 10 ft. soil vapor data south, southwest, and west of the Western Parcel

	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
Acetone	15	1.80E+03	1.25	8.33E+01	7.31E-03	5.00E+03	6.96E+14	5.71E-04	1.03E+00	NA	3.1E+01
Benzene	15	5.30E+01	1.25	8.33E+01	5.08E-03	5.00E+03	2.34E+21	4.27E-04	2.26E-02	2.9E-05	3.0E-02
Bromodichloromethane	15	2.50E+01	1.25	8.33E+01	1.72E-03	5.00E+03	9.61E+62	1.64E-04	4.09E-03	3.7E-05	7.0E-02
Methylethylketone (2-butar	15	4.00E+01	1.25	8.33E+01	4.76E-03	5.00E+03	6.40E+22	4.05E-04	1.62E-02	NA	5.0E+00
tert-Butyl alcohol	15	1.50E+03	1.25	8.33E+01	6.44E-03	5.00E+03	7.29E+16	5.17E-04	7.76E-01	NA	3.0E+01
n-Butylbenzene	15	2.50E+01	1.25	8.33E+01	3.29E-03	5.00E+03	9.87E+32	2.95E-04	7.37E-03	NA	1.4E-01
sec-Butylbenzene	15	1.50E+03	1.25	8.33E+01	3.30E-03	5.00E+03	7.93E+32	2.95E-04	4.43E-01	NA	1.4E-01
tert-Butylbenzene	15	2.50E+01	1.25	8.33E+01	3.26E-03	5.00E+03	1.93E+33	2.92E-04	7.31E-03	NA	1.4E-01
Carbon disulfide	15	7.10E+01	1.25	8.33E+01	6.00E-03	5.00E+03	1.22E+18	4.89E-04	3.47E-02	NA	7.0E-01
Chlorobenzene	15	2.50E+03	1.25	8.33E+01	4.22E-03	5.00E+03	5.72E+25	3.65E-04	9.13E-01	NA	1.0E+00
Chloroform	15	3.10E+02	1.25	8.33E+01	6.00E-03	5.00E+03	1.21E+18	4.89E-04	1.52E-01	5.3E-06	3.0E-01
Methyl chloride (chlorometh	15	5.00E+01	1.25	8.33E+01	7.27E-03	5.00E+03	8.45E+14	5.69E-04	2.84E-02	1.8E-06	9.0E-02
Chlorodibromomethane	15	2.50E+01	1.25	8.33E+01	1.14E-03	5.00E+03	2.37E+95	1.11E-04	2.77E-03	2.7E-05	7.0E-02
Dichlorodifluoromethane	15	2.90E+00	1.25	8.33E+01	3.84E-03	5.00E+03	1.92E+28	3.37E-04	9.77E-04	NA	2.0E-01
cis-1,2-Dichloroethylene	15	3.30E+00	1.25	8.33E+01	4.25E-03	5.00E+03	3.52E+25	3.68E-04	1.21E-03	NA	3.5E-02
Ethylbenzene	15	1.00E+03	1.25	8.33E+01	4.33E-03	5.00E+03	1.19E+25	3.74E-04	3.74E-01	2.5E-06	1.0E+00
Cumene	15	4.90E+03	1.25	8.33E+01	3.75E-03	5.00E+03	8.65E+28	3.30E-04	1.62E+00	NA	4.0E-01
Methylisobutylketone (4-me	15	2.50E+02	1.25	8.33E+01	4.36E-03	5.00E+03	7.77E+24	3.76E-04	9.40E-02	NA	3.0E+00
MTBE	15	1.50E+02	1.25	8.33E+01	5.92E-03	5.00E+03	2.19E+18	4.84E-04	7.26E-02	2.6E-07	3.0E+00
Naphthalene	15	1.60E+01	1.25	8.33E+01	3.42E-03	5.00E+03	6.11E+31	3.05E-04	4.87E-03	3.4E-05	3.0E-03
n-Propylbenzene	15	2.50E+01	1.25	8.33E+01	3.47E-03	5.00E+03	1.96E+31	3.09E-04	7.72E-03	NA	1.4E-01
1,1,2,2-Tetrachloroethane	15	5.00E+01	1.25	8.33E+01	4.11E-03	5.00E+03	2.54E+26	3.58E-04	1.79E-02	5.8E-05	1.4E-02
Tetrachloroethylene	15	1.50E+02	1.25	8.33E+01	4.16E-03	5.00E+03	1.32E+26	3.61E-04	5.41E-02	5.9E-06	3.5E-02
Toluene	15	5.30E+02	1.25	8.33E+01	5.02E-03	5.00E+03	4.13E+21	4.23E-04	2.24E-01	NA	3.0E-01
1,1,1-Trichloroethane	15	1.70E+02	1.25	8.33E+01	4.50E-03	5.00E+03	1.30E+24	3.86E-04	6.57E-02	NA	5.0E+00
1,1,2-Trichloroethane	15	2.50E+01	1.25	8.33E+01	4.51E-03	5.00E+03	1.21E+24	3.87E-04	9.66E-03	1.6E-05	1.4E-02
Trichlorofluoromethane	15	6.90E+01	1.25	8.33E+01	5.02E-03	5.00E+03	4.16E+21	4.23E-04	2.92E-02	NA	7.0E-01
1,2,4-Trimethylbenzene	15	4.20E+01	1.25	8.33E+01	3.50E-03	5.00E+03	1.07E+31	3.11E-04	1.31E-02	NA	7.0E-03
1,3,5-Trimethylbenzene	15	2.50E+01	1.25	8.33E+01	3.48E-03	5.00E+03	1.72E+31	3.09E-04	7.73E-03	NA	6.0E-03
Vinyl chloride (chloroethene	15	2.90E+00	1.25	8.33E+01	6.12E-03	5.00E+03	5.54E+17	4.97E-04	1.44E-03	7.8E-05	1.0E-01
p-Xylene	15	5.00E+01	1.25	8.33E+01	4.44E-03	5.00E+03	2.85E+24	3.82E-04	1.91E-02	NA	1.0E-01
o-Xylene	15	2.40E+02	1.25	8.33E+01	5.02E-03	5.00E+03	4.12E+21	4.23E-04	1.02E-01	NA	1.0E-01

END

RESULTS SHEET

Resident using 10 ft. soil vapor data south, southwest, and west of the Western Parcel

INCREMENTAL RISK CALCULATIONS:

	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
Acetone	NA	3.2E-05
Benzene	2.7E-07	7.2E-04
Bromodichloromethane	6.2E-08	3.1E-06
Methylethylketone (2-butanone)	NA	3.1E-06
tert-Butyl alcohol	NA	2.5E-05
n-Butylbenzene	NA	5.0E-05
sec-Butylbenzene	NA	3.0E-03
tert-Butylbenzene	NA	5.0E-05
Carbon disulfide	NA	4.8E-05
Chlorobenzene	NA	8.8E-04
Chloroform	3.3E-07	4.8E-04
Methyl chloride (chloromethane)	2.1E-08	3.0E-04
Chlorodibromomethane	3.1E-08	3.8E-05
Dichlorodifluoromethane	NA	4.7E-06
cis-1,2-Dichloroethylene	NA	3.3E-05
Ethylbenzene	3.8E-07	3.6E-04
Cumene	NA	3.9E-03
Methylisobutylketone (4-methyl-2-pentanone)	NA	3.0E-05
MTBE	7.8E-09	2.3E-05
Naphthalene	6.8E-08	1.6E-03
n-Propylbenzene	NA	5.3E-05
1,1,2,2-Tetrachloroethane	4.3E-07	1.2E-03
Tetrachloroethylene	1.3E-07	1.5E-03
Toluene	NA	7.2E-04
1,1,1-Trichloroethane	NA	1.3E-05
1,1,2-Trichloroethane	6.4E-08	6.6E-04
Trichlorofluoromethane	NA	4.0E-05
1,2,4-Trimethylbenzene	NA	1.8E-03
1,3,5-Trimethylbenzene	NA	1.2E-03
Vinyl chloride (chloroethene)	4.6E-08	1.4E-05
p-Xylene	NA	1.8E-04
o-Xylene	NA	9.7E-04
	2E-06	2E-02

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

Resident using groundwater data along and south, southwest, and west of the Western Parcel

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

Program modified to accommodate multiple chemicals

#REF!

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
71432	1.70E+01	Benzene
75650	2.50E+02	tert-Butyl alcohol
104518	1.40E+00	n-Butylbenzene
135988	3.00E+01	sec-Butylbenzene
98066	3.30E+00	tert-Butylbenzene
75150	3.10E+00	Carbon disulfide
108907	2.00E+00	Chlorobenzene
67663	1.00E+00	Chloroform
100414	3.60E+00	Ethylbenzene
98828	1.10E+02	Cumene
91576	1.10E+02	2-Methylnaphthalene
1634044	1.80E+02	MTBE
91203	3.30E+02	Naphthalene
103651	7.60E+01	n-Propylbenzene
79345	2.20E+00	1,1,2,2-Tetrachloroethane
79005	5.40E+00	1,1,2-Trichloroethane
95636	2.80E+00	1,2,4-Trimethylbenzene
95476	5.50E-01	o-Xylene

Note: same as isopropylbenzene (Cumene)

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
19	15	360	360	0	0	A	SIL	SIL		

Thickness columns: Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
15	40	1000	1000	244	0.1	0.5	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

TR and THQ: Used to calculate risk-based groundwater concentration.

END

Resident using groundwater data along and south, southwest, and west of the Western Parcel

	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	ɪnthalpy of ɔorization ːhe normа ɔiling poir $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
Benzene	8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	5.89E+01	1.79E+03	2.9E-05	3.0E-02
tert-Butyl alcohol	9.85E-02	1.14E-05	9.05E-06	25	9,338	355.41	508.00	2.20E+00	1.00E+06	0.0E+00	3.0E+01
n-Butylbenzene	5.70E-02	8.12E-06	1.31E-02	25	9,290	456.46	660.50	1.11E+03	2.00E+00	0.0E+00	1.4E-01
sec-Butylbenzene	5.70E-02	8.12E-06	1.39E-02	25	88,730	446.50	679.00	9.66E+02	3.94E+00	0.0E+00	1.4E-01
tert-Butylbenzene	5.65E-02	8.02E-06	1.19E-02	25	8,980	442.10	1220.00	7.71E+02	2.95E+01	0.0E+00	1.4E-01
Carbon disulfide	1.04E-01	1.00E-05	3.02E-02	25	6,391	319.00	552.00	4.57E+01	1.19E+03	0.0E+00	7.0E-01
Chlorobenzene	7.30E-02	8.70E-06	3.69E-03	25	8,410	404.87	632.40	2.19E+02	4.72E+02	0.0E+00	1.0E+00
Chloroform	1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	5.3E-06	3.0E-01
Ethylbenzene	7.50E-02	7.80E-06	7.86E-03	25	8,501	409.34	617.20	3.63E+02	1.69E+02	2.5E-06	1.0E+00
Cumene	6.50E-02	7.10E-06	1.16E+00	25	10,335	425.56	631.10	4.89E+02	6.13E+01	0.0E+00	4.0E-01
2-Methylnaphthalene	5.22E-02	7.75E-06	5.17E-04	25	12,600	514.26	761.00	2.81E+03	2.46E+01	0.0E+00	1.4E-02
MTBE	1.02E-01	1.05E-05	6.23E-04	25	6,678	328.30	497.10	7.26E+00	5.10E+04	2.6E-07	3.0E+00
Naphthalene	5.90E-02	7.50E-06	4.82E-04	25	10,373	491.14	748.40	2.00E+03	3.10E+01	3.4E-05	3.0E-03
n-Propylbenzene	6.01E-02	7.83E-06	1.07E-02	25	9,123	432.20	630.00	5.62E+02	6.00E+01	0.0E+00	1.4E-01
1,1,2,2-Tetrachloroethane	7.10E-02	7.90E-06	3.44E-04	25	8,996	419.60	661.15	9.33E+01	2.96E+03	5.8E-05	1.4E-02
1,1,2-Trichloroethane	7.80E-02	8.80E-06	9.11E-04	25	8,322	386.15	602.00	5.01E+01	4.42E+03	1.6E-05	1.4E-02
1,2,4-Trimethylbenzene	6.06E-02	7.92E-06	6.14E-03	25	9,369	442.30	649.17	1.35E+03	5.70E+01	0.0E+00	7.0E-03
o-Xylene	8.70E-02	1.00E-05	5.18E-03	25	8,661	417.60	630.30	3.63E+02	1.78E+02	0.0E+00	1.0E-01

END

Resident using groundwater data along and south, southwest, and west of the Western Parcel

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	345	0.259	ERROR	ERROR	0.307	2.86E-09	0.798	2.28E-09	68.18	0.439	0.090	0.349	4,000

	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
Benzene	3.39E+04	1.00E+06	5.00E-03	15	8,030	4.19E-03	1.75E-01	1.78E-04	5.08E-03	0.00E+00	0.00E+00	1.61E-04	7.21E-04	345
tert-Butyl alcohol	3.39E+04	1.00E+06	5.00E-03	15	10,734	6.24E-06	2.60E-04	1.78E-04	6.44E-03	0.00E+00	0.00E+00	6.98E-03	6.54E-03	345
n-Butylbenzene	3.39E+04	1.00E+06	5.00E-03	15	11,734	8.74E-03	3.65E-01	1.78E-04	3.29E-03	0.00E+00	0.00E+00	1.02E-04	4.58E-04	345
sec-Butylbenzene	3.39E+04	1.00E+06	5.00E-03	15	107,157	3.38E-04	1.41E-02	1.78E-04	3.30E-03	0.00E+00	0.00E+00	1.88E-04	7.73E-04	345
tert-Butylbenzene	3.39E+04	1.00E+06	5.00E-03	15	9,468	8.55E-03	3.57E-01	1.78E-04	3.26E-03	0.00E+00	0.00E+00	1.01E-04	4.55E-04	345
Carbon disulfide	3.39E+04	1.00E+06	5.00E-03	15	6,612	2.40E-02	1.00E+00	1.78E-04	6.00E-03	0.00E+00	0.00E+00	1.81E-04	8.17E-04	345
Chlorobenzene	3.39E+04	1.00E+06	5.00E-03	15	9,712	2.64E-03	1.10E-01	1.78E-04	4.22E-03	0.00E+00	0.00E+00	1.38E-04	6.18E-04	345
Chloroform	3.39E+04	1.00E+06	5.00E-03	15	7,461	2.83E-03	1.18E-01	1.78E-04	6.00E-03	0.00E+00	0.00E+00	1.93E-04	8.64E-04	345
Ethylbenzene	3.39E+04	1.00E+06	5.00E-03	15	10,052	5.55E-03	2.31E-01	1.78E-04	4.33E-03	0.00E+00	0.00E+00	1.35E-04	6.06E-04	345
Cumene	3.39E+04	1.00E+06	5.00E-03	15	12,518	7.50E-01	3.13E+01	1.78E-04	3.75E-03	0.00E+00	0.00E+00	1.12E-04	5.07E-04	345
2-Methylnaphthalene	3.39E+04	1.00E+06	5.00E-03	15	16,123	2.95E-04	1.23E-02	1.78E-04	3.02E-03	0.00E+00	0.00E+00	1.88E-04	7.59E-04	345
MTBE	3.39E+04	1.00E+06	5.00E-03	15	7,179	4.86E-04	2.03E-02	1.78E-04	5.92E-03	0.00E+00	0.00E+00	2.57E-04	1.11E-03	345
Naphthalene	3.39E+04	1.00E+06	5.00E-03	15	12,820	3.09E-04	1.29E-02	1.78E-04	3.42E-03	0.00E+00	0.00E+00	1.92E-04	7.92E-04	345
n-Propylbenzene	3.39E+04	1.00E+06	5.00E-03	15	11,251	7.21E-03	3.01E-01	1.78E-04	3.47E-03	0.00E+00	0.00E+00	1.08E-04	4.85E-04	345
1,1,2,2-Tetrachloroethane	3.39E+04	1.00E+06	5.00E-03	15	10,450	2.40E-04	9.99E-03	1.78E-04	4.11E-03	0.00E+00	0.00E+00	2.46E-04	1.00E-03	345
1,1,2-Trichloroethane	3.39E+04	1.00E+06	5.00E-03	15	9,474	6.56E-04	2.74E-02	1.78E-04	4.51E-03	0.00E+00	0.00E+00	1.85E-04	8.02E-04	345
1,2,4-Trimethylbenzene	3.39E+04	1.00E+06	5.00E-03	15	11,579	4.11E-03	1.72E-01	1.78E-04	3.50E-03	0.00E+00	0.00E+00	1.12E-04	5.01E-04	345
o-Xylene	3.39E+04	1.00E+06	5.00E-03	15	10,302	3.62E-03	1.51E-01	1.78E-04	5.02E-03	0.00E+00	0.00E+00	1.61E-04	7.19E-04	345

	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
Benzene	15	2.97E+03	1.25	8.33E+01	5.08E-03	5.00E+03	2.34E+21	6.02E-05	1.79E-01	2.9E-05	3.0E-02
tert-Butyl alcohol	15	6.51E+01	1.25	8.33E+01	6.44E-03	5.00E+03	7.29E+16	4.56E-04	2.96E-02	NA	3.0E+01
n-Butylbenzene	15	5.10E+02	1.25	8.33E+01	3.29E-03	5.00E+03	9.87E+32	3.86E-05	1.97E-02	NA	1.4E-01
sec-Butylbenzene	15	4.22E+02	1.25	8.33E+01	3.30E-03	5.00E+03	7.93E+32	6.44E-05	2.72E-02	NA	1.4E-01
tert-Butylbenzene	15	1.18E+03	1.25	8.33E+01	3.26E-03	5.00E+03	1.93E+33	3.83E-05	4.51E-02	NA	1.4E-01
Carbon disulfide	15	3.11E+03	1.25	8.33E+01	6.00E-03	5.00E+03	1.22E+18	6.80E-05	2.11E-01	NA	7.0E-01
Chlorobenzene	15	2.20E+02	1.25	8.33E+01	4.22E-03	5.00E+03	5.72E+25	5.18E-05	1.14E-02	NA	1.0E+00
Chloroform	15	1.18E+02	1.25	8.33E+01	6.00E-03	5.00E+03	1.21E+18	7.17E-05	8.45E-03	5.3E-06	3.0E-01
Ethylbenzene	15	8.33E+02	1.25	8.33E+01	4.33E-03	5.00E+03	1.19E+25	5.07E-05	4.23E-02	2.5E-06	1.0E+00
Cumene	15	3.44E+06	1.25	8.33E+01	3.75E-03	5.00E+03	8.65E+28	4.26E-05	1.47E+02	NA	4.0E-01
2-Methylnaphthalene	15	1.36E+03	1.25	8.33E+01	3.02E-03	5.00E+03	8.01E+35	6.33E-05	8.58E-02	NA	1.4E-02
MTBE	15	3.65E+03	1.25	8.33E+01	5.92E-03	5.00E+03	2.19E+18	9.12E-05	3.33E-01	2.6E-07	3.0E+00
Naphthalene	15	4.25E+03	1.25	8.33E+01	3.42E-03	5.00E+03	6.11E+31	6.60E-05	2.80E-01	3.4E-05	3.0E-03
n-Propylbenzene	15	2.29E+04	1.25	8.33E+01	3.47E-03	5.00E+03	1.96E+31	4.08E-05	9.33E-01	NA	1.4E-01
1,1,2,2-Tetrachloroethane	15	2.20E+01	1.25	8.33E+01	4.11E-03	5.00E+03	2.54E+26	8.27E-05	1.82E-03	5.8E-05	1.4E-02
1,1,2-Trichloroethane	15	1.48E+02	1.25	8.33E+01	4.51E-03	5.00E+03	1.21E+24	6.67E-05	9.85E-03	1.6E-05	1.4E-02
1,2,4-Trimethylbenzene	15	4.80E+02	1.25	8.33E+01	3.50E-03	5.00E+03	1.07E+31	4.21E-05	2.02E-02	NA	7.0E-03
o-Xylene	15	8.31E+01	1.25	8.33E+01	5.02E-03	5.00E+03	4.12E+21	6.00E-05	4.99E-03	NA	1.0E-01

END

RESULTS SHEET

Resident using groundwater data along and south, southwest, and west of the Western Parcel

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS: INCREMENTAL RISK CALCULATIONS:

	Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)		Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
Benzene	NA	NA	NA	1.79E+06	NA		2.1E-06	5.7E-03
tert-Butyl alcohol	NA	NA	NA	1.00E+09	NA		NA	9.5E-07
n-Butylbenzene	NA	NA	NA	2.00E+03	NA		NA	1.3E-04
sec-Butylbenzene	NA	NA	NA	3.94E+03	NA		NA	1.9E-04
tert-Butylbenzene	NA	NA	NA	2.95E+04	NA		NA	3.1E-04
Carbon disulfide	NA	NA	NA	1.19E+06	NA		NA	2.9E-04
Chlorobenzene	NA	NA	NA	4.72E+05	NA		NA	1.1E-05
Chloroform	NA	NA	NA	7.92E+06	NA		1.8E-08	2.7E-05
Ethylbenzene	NA	NA	NA	1.69E+05	NA		4.3E-08	4.1E-05
Cumene	NA	NA	NA	6.13E+04	NA		NA	3.5E-01
2-Methylnaphthalene	NA	NA	NA	2.46E+04	NA		NA	5.9E-03
MTBE	NA	NA	NA	5.10E+07	NA		3.6E-08	1.1E-04
Naphthalene	NA	NA	NA	3.10E+04	NA		3.9E-06	9.0E-02
n-Propylbenzene	NA	NA	NA	6.00E+04	NA		NA	6.4E-03
1,1,2,2-Tetrachloroethane	NA	NA	NA	2.96E+06	NA		4.3E-08	1.2E-04
1,1,2-Trichloroethane	NA	NA	NA	4.42E+06	NA		6.5E-08	6.7E-04
1,2,4-Trimethylbenzene	NA	NA	NA	5.70E+04	NA		NA	2.8E-03
o-Xylene	NA	NA	NA	1.78E+05	NA		NA	4.8E-05
						TOTALS	6E-06	5E-01

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

Attachment C

Soil Vapor Summary Table from Exponent (2009)

Table 1. Analytical data for chemicals detected in soil vapor ($\mu g/m^3$) using EPA Method 8260B (unless otherwise noted)

Chemcial	Sgp-1-5-1V	Sgp-1-5-3V	Sgp-1-5-7V	Sgp-1-15	Sgp-2-5	Sgp-2-15	Sgp-3-5	Sgp-3-15	Sgp-4-5	Sgp-4-15
Benzene	220	430	460	36	<36	<36	53	<36	82	<36
t-Butanol (TBA)	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
n-Butylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
sec-Butylbenzene	<50	<50	<50	110	<50	<50	<50	1600	260	3100
Tert-Butylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cyclohexane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
1,2-Dichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
cis-1,2-Dichloroethene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Ethylbenzene	180	780	960	190	<50	1500	<50	580	990	<50
Heptane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isopropylbenzene	<50	150	160	90	<50	580	<50	6900	1300	10000
4-isopropyltoluene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
MTBE	<50	<50	<50	<50	60	410	140	3400	<50	<50
Naphthalene	<32	<32	<32	<32	<32	<32	<32	<32	<32	<32
n-Propylbenzene	<50	80	80	60	<50	<50	<50	5900	640	5800
Propylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	120	290	330	100	<50	950	<50	<50	1000	<50
1,1,1-Trichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
1,2,4-Trimethylbenzene	<50	220	190	220	<50	130	<50	<50	<50	<50
1,3,5-Trimethylbenzene	<50	50	<50	<50	<50	60	<50	<50	<50	<50
m,p-Xylenes	180	800	960	240	<100	4200	<100	<100	2600	<100
o-Xylenes	50	240	280	60	<50	1000	<50	<50	630	<50

Note: NA - Not Analyzed

* Analyzed Using EPA Method TO-15

Table 1. (cont.)

Chemcial	Sgp-4-15 DUP	Sgp-5-5	Sgp-5-15	Sgp-6-5	Sgp-6-15	Sgp-7-5	Sgp-7-15	Sgp7-15 DUP	Sgp-7-15*
Benzene	<36	77	<36	2100	<36	76	<36	<36	<479
t-Butanol (TBA)	<500	<500	<500	<500	<500	<500	<500	<500	NA
n-Butylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	NA
sec-Butylbenzene	3000	140	2700	240	3400	170	3000	2800	NA
Tert-Butylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	NA
Cyclohexane	NA	NA	NA	NA	NA	NA	NA	NA	895
1,1-Dichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<607
1,2-Dichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<607
cis-1,2-Dichloroethene	<50	<50	<50	<50	<50	<50	<50	<50	<595
Ethylbenzene	<50	220	<50	110	<50	<50	<50	<50	<651
Heptane	NA	NA	NA	NA	NA	NA	NA	NA	<615
Isopropylbenzene	9800	450	6500	910	17000	950	17000	16000	NA
4-isopropyltoluene	<50	<50	<50	<50	<50	<50	<50	<50	NA
MTBE	<50	<50	<50	<50	<50	<50	<50	<50	<541
Naphthalene	<32	<32	<32	<32	<32	<32	<32	<32	NA
n-Propylbenzene	<50	280	4200	740	12000	630	6200	5900	NA
Propylene	NA	NA	NA	NA	NA	NA	NA	NA	<516
Toluene	500	<50	<50	<50	<50	<50	<50	820	<565
1,1,1-Trichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<818
1,2,4-Trimethylbenzene	<50	150	<50	<50	<50	<50	<50	<50	<737
1,3,5-Trimethylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<737
m,p-Xylenes	<100	150	<100	130	<100	<100	<100	<100	<1303
o-Xylenes	<50	<50	<50	60	<50	60	<50	<50	<651

Note: NA - Not Analyzed

* Analyzed Using EPA Method TO-15

Table 1. (cont.)

Chemcial	Gdy-1-5	Gdy-1-15	Gdy-2-5	Gdy-2-15	Gdy-2-15 DUP	Gdy-3-5	Gdy-3-15	Gdy-4-5	Gdy-4-15	Gdy-5-5	Gdy-5-15
Benzene	89	<36	<36	<36	<36	<36	<36	51	<36	<36	<36
t-Butanol (TBA)	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
n-Butylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
sec-Butylbenzene	<50	2300	<50	1800	1700	580	3000	<50	3900	<50	2100
Tert-Butylbenzene	<50	510	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cyclohexane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
1,2-Dichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
cis-1,2-Dichloroethene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Ethylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Heptane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isopropylbenzene	100	9200	<50	630	520	<50	1100	<50	1900	<50	<50
4-isopropyltoluene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
MTBE	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Naphthalene	<32	<32	<32	<32	<32	<32	<32	<32	<32	<32	<32
n-Propylbenzene	<50	570	<50	<50	<50	<50	670	<50	1200	<50	<50
Propylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	250	<50	<50	<50	<50	<50	<50	280	510	93	<50
1,1,1-Trichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
1,2,4-Trimethylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
1,3,5-Trimethylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
m,p-Xylenes	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
o-Xylenes	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50

Note: NA - Not Analyzed

* Analyzed Using EPA Method TO-15

Table 1. (cont.)

Chemcial	Wnt-1-5	Wnt-1-15	Wnt-1-15*	Wnt-2-5	Wnt-2-15	Wnt-3-5	Wnt-3-15	Wnt-4-5	Wnt-4-15
Benzene	43	<36	17.9	<36	<36	51	<36	<36	<36
t-Butanol (TBA)	<500	<500	NA	<500	<500	<500	<500	<500	<500
n-Butylbenzene	<50	<50	NA	<50	<50	<50	<50	<50	<50
sec-Butylbenzene	<50	<50	NA	1300	1800	<50	8900	<50	<50
Tert-Butylbenzene	<50	<50	NA	<50	<50	<50	630	<50	<50
Cyclohexane	NA	NA	234.1	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	<50	<50	13.4	<50	<50	<50	<50	<50	<50
1,2-Dichloroethane	<50	<50	17.8	<50	<50	<50	<50	<50	<50
cis-1,2-Dichloroethene	<50	<50	154.6	<50	<50	<50	<50	<50	<50
Ethylbenzene	61	<50	91.2	<50	1600	<50	620	260	<50
Heptane	NA	NA	139.4	NA	NA	NA	NA	NA	NA
Isopropylbenzene	<50	75	NA	23000	47000	280	81000	<50	<50
4-isopropyltoluene	<50	<50	NA	<50	<50	<50	<50	<50	<50
MTBE	<50	<50	<11	<50	<50	<50	<50	<50	<50
Naphthalene	<32	<32	NA	<32	<32	<32	<32	<32	<32
n-Propylbenzene	<50	<50	NA	2200	8700	<50	17000	<50	<50
Propylene	NA	NA	327.0	NA	NA	NA	NA	NA	NA
Toluene	150	88	1092.9	840	600	130	740	170	<50
1,1,1-Trichloroethane	<50	<50	180.0	<50	<50	<50	<50	<50	<50
1,2,4-Trimethylbenzene	<50	<50	<15	<50	<50	<50	<50	<50	<50
1,3,5-Trimethylbenzene	<50	<50	<15	<50	<50	<50	<50	<50	<50
m,p-Xylenes	190	130	477.6	<100	<100	<100	<100	780	<100
o-Xylenes	65	<50	112.9	<50	<50	<50	<50	180	<50

Note: NA - Not Analyzed

* Analyzed Using EPA Method TO-15

Table 1. (cont.)

Chemcial	Hill-1-5	Hill-1-15	Hill-2-5	Hill-2-15	Hill-2-15 DUP	Hill-3-5	Hill-3-15	Hill-4-5	Hill-4-15
Benzene	50	<36	<36	<36	<36	86	<36	<36	<36
t-Butanol (TBA)	<500	<500	<500	<500	<500	<500	<500	<500	<500
n-Butylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50
sec-Butylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tert-Butylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cyclohexane	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<50
1,2-Dichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<50
cis-1,2-Dichloroethene	<50	<50	<50	<50	<50	<50	<50	<50	<50
Ethylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50
Heptane	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isopropylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50
4-isopropyltoluene	<50	<50	<50	<50	<50	<50	<50	<50	<50
MTBE	<50	<50	<50	<50	<50	<50	<50	<50	<50
Naphthalene	<32	<32	<32	<32	<32	<32	<32	<32	<32
n-Propylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50
Propylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	180	<50	<50	68	69	250	130	<50	<50
1,1,1-Trichloroethane	<50	<50	<50	<50	<50	<50	<50	<50	<50
1,2,4-Trimethylbenzene	<50	<50	<50	110	99	<50	<50	<50	<50
1,3,5-Trimethylbenzene	<50	<50	<50	<50	<50	<50	<50	<50	<50
m,p-Xylenes	<100	<100	<100	<100	<100	120	<100	<100	<100
o-Xylenes	<50	<50	<50	<50	<50	<50	<50	<50	<50

Note: NA - Not Analyzed

* Analyzed Using EPA Method TO-15