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Alameda County
Environmental Health

Aaron Costa
Project Manager
Marketing Business Unit

Chevron Environmental Management Company
6111 Bollinger Canyon Road
San Ramon, CA 94583
Tel (925) 543-2961
Fax (925) 543-2324
acosta@chevron.com

Alameda County Health Care Services
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

Re: Former Chevron Service Station No. 9-0020
1633 Harrison Street
Oakland, CA

I have reviewed the attached report dated March 9, 2010.

I agree with the conclusions and recommendations presented in the referenced report. This information in this report is accurate to the best of my knowledge and all local Agency/Regional Board guidelines have been followed. This report was prepared by Conestoga Rovers Associates, upon who assistance and advice I have relied.

This letter is submitted pursuant to the requirements of California Water Code Section 13267(b)(1) and the regulating implementation entitled Appendix A pertaining thereto.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Sincerely,

Aaron Costa
Project Manager

Attachment: Report

CONESTOGA-ROVERS & ASSOCIATES

5900 Hollis Street, Suite A
Emeryville, California 94608
Telephone: (510) 420-0700 Fax: (510) 420-9170
http://www.craworld.com

March 9, 2010 Reference No. 311956

Mr. Mark Detterman
Alameda County Environmental Health Services
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

Re: Revised Risk Assessment
Former Chevron Service Station 9-0020
1633 Harrison Street
Oakland, California
Fuel Leak Case No. RO0000143

Dear Mr. Detterman:

Conestoga-Rovers & Associates (CRA) is submitting this *Revised Risk Assessment* on behalf of Chevron Environmental Management Company (Chevron) for the site referenced above. Alameda County Environmental Health (ACEH) requested an additional evaluation of potential risk associated with elevated TPH concentrations at the site using the June 6, 2009 Department of Toxic Substances Control's (DTSC) *Interim Guidance Evaluating Human Health Risks from Total Petroleum Hydrocarbons (TPH)* in a letter dated February 19, 2010. This additional risk evaluation, intended to be considered in conjunction with the revised risk assessment included as part of the *Additional Onsite Investigation Report* submitted by CRA on December 30, 2009, utilizes DTSC's interim guidance and the most current soil vapor data collected at the site. Below is the revised risk assessment and evaluation of methodology used.

POTENTIAL RISKS POSED TO HUMAN HEALTH

Chevron conducted an onsite Tier II Risk-Based Corrective Action (RBCA) evaluation, dated May 21, 2007, and submitted the results of this evaluation in CRA's *Risk Assessment and Proposed Vapor Survey*, dated May 25, 2007. An updated risk assessment was included as part of CRA's *Remedial Activities Report*, submitted on July 11, 2008 to document the remedial actions at the site and the removal, reinstallation and re-sampling of vapor probes VP-1R, VP-4R, and VP-5R (Figure 1). This RBCA evaluation has been updated to include soil vapor results from VP-1R, VP-4R, VP-5R, and VP-7. Previous data for VP-1, VP-4, and VP-5 presented in the original risk assessments, was replaced with post-remedial maximum vapor concentrations. This evaluation was conducted to determine if potential exposure pathways exist, to estimate potential risk due to the residual concentrations of petroleum hydrocarbons left in the soil, and to identify any data gaps. Exposure pathways were evaluated for ingestion of soil, dermal contact with soil, ingestion of groundwater, dermal contact with groundwater and inhalation of dust and vapors. Original soil vapor data had been collected onsite almost 20 years ago and was considered unusable for modeling. Soil vapor probes were installed in 2007 and 2009 and sampled, and undisturbed soil samples were collected to analyze for physical parameters to provide site specific data for the purpose of modeling current site conditions for potential risk from vapor intrusion. A risk and hazards estimate for the site, including the evaluation tables, is included in Attachment A. Below are the results of the RBCA evaluation and the vapor intrusion evaluation.

The proposed senior housing development plans call for the entire site to be covered by buildings or concrete floors. Landscaping will only be along the street fronts and there is a planned exterior landscaped courtyard that will be located above the garage area on the second floor. Future residents should have no direct contact with soil. The only potential direct contact with impacted soil would be by construction/utility workers during future construction. The maximum detected concentration of TPH as gasoline (TPHg) in shallow soil at the site is 600 milligrams per kilogram (mg/kg), which does not exceed the TPHg environmental screening level (ESL) for construction/trench workers of 4,200 mg/kg.

Historical depth to groundwater across the site ranges from 11.6 feet below grade (fbg) to 22.1 fbg, so there is no expected direct contact to groundwater for either future residents or construction/utility workers.

Soil vapor data were collected on October 29, 2009 from VP-1R, VP-2, VP-3, VP-4R, VP-5R, VP-6 and the newly installed VP-7. Previous sampling events occurred on June 13, 2007 and April 10, 2008 and results from those events are also used in the risk evaluation. Only concentrations of TPHg, benzene, toluene, ethylbenzene and xylenes (BTEX), naphthalene, and chloroform have been detected above the reporting limit in various vapor wells. An evaluation of potential vapor intrusion into buildings was conducted based on California Environmental Protection Agency (Cal-EPA) and United Stated Environmental Protection Agency (USEPA) guidelines. This risk assessment was updated to include:

- The newly collected soil vapor data
- Maximum concentrations detected (as compared to the 95 Upper Confidence Level)
- Ethylbenzene inhalation unit risk
- Inhalation reference concentration (RfC) for chloroform

- The most recent version of the Johnson & Ettinger model using the newer Cal-EPA and USEPA approaches to estimating risks and hazards following recommendations in DTSC's *Interim Guidance Evaluating Human Health Risks from Total Petroleum Hydrocarbons (TPH)*

These data, along with the risk evaluation tables are included in Attachment A.

The Johnson and Ettinger-based vapor intrusion model default soil vapor depth from which vapor concentrations are modeled is 5 fbg. At this site, maximum detected volatile constituent concentrations were collected at both the 5 and 10 fbg soil depth. Therefore, to assist with risk-based decision making for the site, this evaluation includes estimated excess lifetime cancer risks and hazards for expected future occupants of an onsite housing complex, assuming the source of vapors is either from the shallow soil depth of 5 fbg or the deep soil depth of 10 fbg.

For this evaluation, TPHg concentrations were evaluated using the recommended DTSC guidance that conservatively assumes a 50/50 split of TPHg vapor into aliphatic and aromatic components and were further divided into the DTSC recommended hydrocarbon fractions; aliphatic C_5-C_8, C_9-C_{18} and C_{19}-C_{32}, and aromatic C_6-C_8, C_9-C_{16} and C_{17}-C_{32}. Therefore, the total TPHg vapor concentrations for shallow and deep soil were equally divided by six into the recommended hydrocarbon fractions. The SG-SCREEN model does not include TPH fractions among the list of allowable chemicals, therefore the following "surrogate" constituents were selected to represent the corresponding carbon fractions and to predict the infinite source building concentrations: hexane for the C_5-C_8 aliphatics, toluene for C_9-C_{18} aliphatics and 2-methylnaphthalene for C_9-C_{16} aromatics. The spreadsheet was used to calculate the indoor air concentrations and then risk was calculated using Cal-EPA inhalation reference concentrations for the TPH fractions. Since Cal-EPA does not have established inhalation RfCs for the aliphatic range C_{19}-C_{32} and the aromatic range C_{17}-$C_{32,}$ these carbon ranges were not included in the evaluation. Estimated risks and hazards were calculated separately for benzene. Therefore the aromatic range C_6-$C_{8,}$ which is represented by benzene, was not evaluated with the TPH fractions to prevent duplication of risk/hazard estimates.

The potential excess lifetime cancer risks for the shallow soil zone (5 fbg) was estimated to be 3×10^{-8} and 6×10^{-9} for onsite adult and child residents, respectively, and the noncancer hazard index for onsite child residents was estimated to be 0.005. The potential excess lifetime cancer risks for the deep soil zone (10 fbg) was estimated to be 1×10^{-7} and 2×10^{-8} for onsite adult and child residents, respectively, and the noncancer hazard index for onsite child residents was estimated to be 0.1. An acceptable level range for excess lifetime cancer risks are from 1×10^{-6} to 1×10^{-4} and an acceptable hazard index is less than 1, as established by Cal-EPA, the USEPA and other regulatory agencies. This indicates that, given this particular exposure scenario, potential vapor intrusion does not present an adverse health affect to individuals residing in future onsite buildings.

POTENTIAL RISKS POSED TO THE ENVIRONMENT

Hydrocarbon impact in the soil in the vicinity of former groundwater monitoring well MW-7 was well defined from previous investigations. The majority of impacted soil that may have been contributing to offsite elevated hydrocarbon concentrations in groundwater was removed by bucket auger drilling techniques and it was agreed by Chevron and ACEH that this would sufficiently remove the need for any potential future onsite remediation.

CONCLUSIONS

The risk assessment, updated to include the current soil vapor results, indicate that the subsurface conditions do not pose any potential risk to future onsite residents.

All other necessary work onsite, including destruction of the soil vapor wells, excavation and bottom sampling of the second generation UST pit, and additional over-excavation of the used oil UST pit will be completed at the time of redevelopment construction.

Please contact Charlotte Evans at (510) 420-3351 if you have any questions or require additional information.

Sincerely,

CONESTOGA-ROVERS & ASSOCIATES

PROFESSIONAL GEOLOGIST
BRANDON S. WILKEN
No. 7564
STATE OF CALIFORNIA

Charlotte Evans

Brandon S. Wilken, P.G. #7564

CE/doh/9

Enc.

Figure 1 Site Plan with Proposed Building

Attachment A Risk and Hazard Estimates

cc: Mr. Aaron Costa, Chevron Environmental Management Company
Mr. Shad Small, Oakland Housing Authority
Mr. Karl Lauff, Christian Church Homes
Ms. Jeriann Alexander, FugroWest

FIGURES

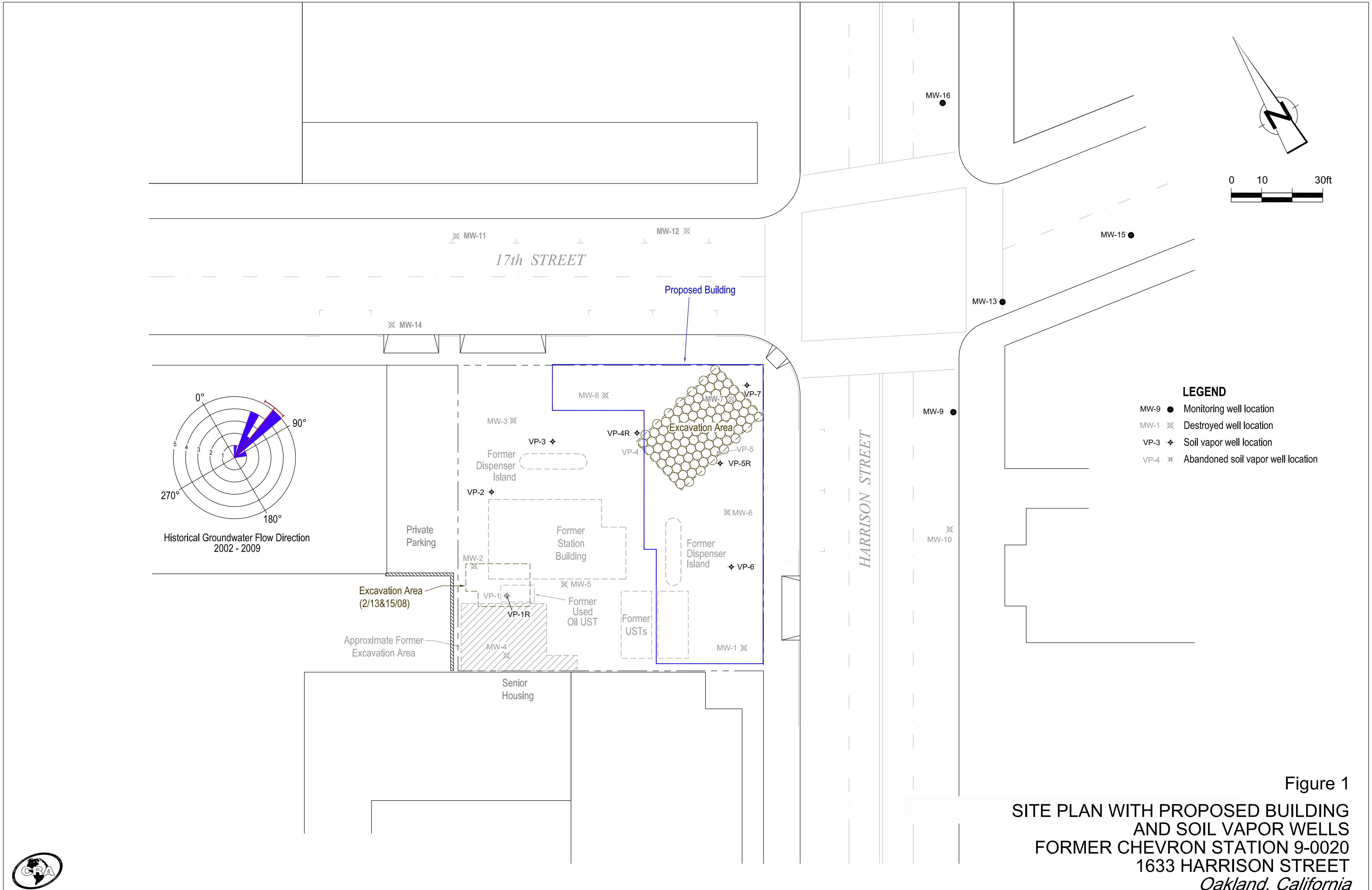

Figure 1

SITE PLAN WITH PROPOSED BUILDING
AND SOIL VAPOR WELLS
FORMER CHEVRON STATION 9-0020
1633 HARRISON STREET
Oakland, California

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ATTACHMENTA

RISK AND HAZARD ESTIMATES

Table 1. Chemicals of Potential Concern in Soil Vapor and Their Detected Concentrations
Former Chevron Station No. 9-0020, Oakland, California

Chemical	VP1R				VP2						VP3						VP4R				VP5R				VP6						VP7		Maximum Concentration			
Sample Date	4/10/08	10/26/09	4/10/08	10/26/09	6/18/07	4/10/08	10/26/09	6/18/07	4/10/08	10/26/09	6/18/07	4/10/08	10/26/09	6/18/07	4/10/08	10/26/09	4/10/08	10/26/09	4/10/08	10/26/09	4/10/08	10/26/09	4/10/08	10/26/09	6/18/07	4/10/08	10/26/09	6/18/07	4/10/08	10/26/09	10/26/09	10/26/09				
Probe Depth (fbg)	5	5	10	10	5	5	5	10	10	10	5	5	5	10	10	10	5	5	10	10	5	5	10	10	5	5	5	10	10	10	5	10	Site- Wide	5 ft	10 ft	Within Proposed Building Footprint
Benzene	<3.7	<3.8	<3.6	<3.9	7.9	<3.9	<3.9	12	<3.9	<4.1	29	<3.4	<4.1	56	<3.9	<4	<3.6	<3.6	6.3	<3.6	<3.6	<4	14	<8.6	28	4.4	<3.9	20	<3.6	<3.9	37	280	280	37	280	280
Chloroform	<3.4	NS	<3.4	NS	<3.6	<3.5	NS	<3.5	<3.5	NS	4.3	<3.2	NS	4.3	<3.5	NS	10	NS	4	NS	5.3	NS	<3.4	NS	<3.4	<3.6	NS	<3.4	<3.4	NS	NS	NS	10	10	4.3	10
Ethylbenzene	<5	<5.1	<5	<5.2	170	<5.2	<5.3	<3.5	<3.6	<5.6	120	7.8	<5.5	170	<5.2	<5.5	<4.9	<4.9	<5.6	<4.9	<5	<5.4	<5	<12	130	<5.4	<5.3	95	<5	<5.2	<11	<190	170	170	<190	130
Naphthalene	<24	<25UJ	<24	<25UJ	<26	<25	<26UJ	<25	<26	<27UJ	<25	<23	<27UJ	<25	<25	<26UJ	<23	<24UJ	<27	<24UJ	<24	<26UJ	<24	<56UJ	110	<26	<26UJ	29	<24	<25UJ	<52UJ	<900	110	110	<900	110
Toluene	<4.4	<4.4	<4.3	<5.1	420	<4.6	9.4	280	<4.6	<4.9	600	6.5	<4.8	1,000	<4.6	<4.8	<4.2	<4.2	10	<4.3	7.7	<4.7	<4.4	<10	320	17	11	450	<4.3	<4.6	28	<160	1,000	600	1,000	450
Xylenes	<5	<5.1	<5	<5.2	530	8.2	17	260	<5.4	<5.6	490	32	<5.5	630	<5.2	<5.5	<4.9	<4.9	15	14	5.3	8.3	9.4	<12	320	28	11	330	<5	<5	15	<190	630	530	630	330
TPHg	<240	<97	<230	<99	9,300	1,600	260J	4,500	<250	3900J	9,100	330	310J	11,000	<250	<100	380	340J	1,100	690J	590	260	680	460J	41,000	860	<100	17,000	4,600	<99	77,000J	5,400,000	5,400,000	77,000	5,400,000	5,400,000
Oxygen	NS	13	2.3	10	16	15	15	16	14	14	16	13	13	15	16	13	8.1	9.8	7.7	7.7	15	4.6	11	4.8	14	11	9.6	12	9.4	7.4	7	1.5	16	16	16	15
Carbon Dioxide	NS	4.3	10	5.5	1.2	2.8	3.7	2.3	3.6	4.7	0.8	2.1	3.1	0.93	1.7	4.6	0.56	3.8	2.7	2.7	0.056	1.4	0.6	2.6	1.8	6	8.3	1.4	8.1	11	<0.025	<0.026	11	8	11	11

BTEX, chloroform, and naphthalene concentration units are in micrograms per cubic meter ($\mu g/m^3$).
O_2 and CO_2 concentration units are in percent volume.

< = not detected above specified reporting limit.

95UCL = 95 upper confidence limit of the mean concentration calculated using the USEPA's Version 4.00.4 ProUCL software.

NS = Not sampled

NC = Not calcuated. For chloroform, ethylbenzene and naphthalene the amount of detects was too low for statistically valid 95UCL to be calculated.

Table 2. Input Parameters Used to Estimate Indoor Air Risks and Hazards
Former Chevron Station No. 9-0020, Oakland, California

Parameter	Value	Units	Source
Source vapor concentration, C_{source}	Chemical-specific	$\mu g/m^3$	Measured (Table 1)
Depth below grade to bottom of enclosed space floor[1]	15	cm	Model default
Shallowest soil vapor sampling depth below grade	152.4 (5)	cm (ft)	Assumed
Average soil temperature	24 (75)	^oC (^oF)	DTSC indoor air guidance default
Vadose zone SCS soil type	Sand (S)	-	Assumed
Average vadose zone soil dry bulk density[2]	1.83	g/cm^3	Measured
Average vadose zone total porosity[2]	32.4%	percent	Measured
Average air-filled porosity[2]	4.5%	percent	Measured
Average vadose zone soil water-filled porosity[2]	27.9%	percent	Measured

[1] Assumes slab-on-grade building foundation.
[2] Average based on samples collected 4/27/07 (SB-1) and 6/13/07 (VP-1) at 10 and 9.5 fbg, respectively.

Table 3. Exposure Parameters Used to Estimate Indoor Air Risks
Former Chevron Station No. 9-0020, Oakland, California

Parameter	Symbol	Units	Value	Source
Infinite source building concentration	$C_{building}$	$\mu g/m^3$	Chemical-specific	Modeled
Exposure frequency-resident	EF_r	days/year	350	USEPA, 1991; DTSC, 1992
Exposure duration-adult resident	ED_{adult}	years	30	USEPA, 1991; DTSC, 1992
Exposure duration-child resident	ED_{child}	years	6	USEPA, 1991; DTSC, 1992
Averaging time-adult and child (carcinogens)	AT_c	days	25,550	USEPA, 1989
Averaging time-child (noncarcinogens)	AT_{nc-c}	days	2,190	ED x 365

Table 4. Inhalation Toxicity Criteria
Former Chevron Station No. 9-0020, Oakland, California

Chemical	Inhalation RfC $\mu g/m^3$	Inhalation Unit Risk $(\mu g/m^3)^{-1}$
Benzene	3.00E+01	2.9E-05
Chloroform	9.77E+01	2.6E-05
Ethylbenzene	1.00E+03	2.5E-06
Naphthalene	3.00E+00	3.4E-05
Toluene	5.00E+03	NC
Xylenes	1.00E+02	NC
C_5-C_8 Aliphatics	7.00E+02	NC
C_9-C_{18} Aliphatics	3.00E+02	NC
C_{19}-C_{32} Aliphatics	NE	NE
C_6-C_8 Aromatics	Use Benzene Results	Use Benzene Results
C_9-C_{16} Aromatics	5.00E+01	NC
C_{17}-C_{32} Aromatics	NE	NE

RfC = Reference concentration
NC = Noncarcinogen
NE = Not established by Cal/EPA
Source of RfDs = USEPA (2009) Integrated Risk Information System
Source of IURs = Cal/EPA OEHHA (2009) Toxicity Criteria Database

Table 5. Estimated Noncancer Hazards and Excess Lifetime Cancer Risks
Maximum Shallow Soil Vapor Concentrations
Former Chevron Station No. 9-0020, Oakland, California

Equations:

$Risk_{adult} = (C_{building} * EF_r * ED_{adult} * IUR)/AT_c$

$Risk_{child} = (C_{building} * EF_r * ED_{child} * IUR)/Atc$

$\text{Hazard Quotient} = (C_{building} * EF_r * ED_{child})/(AT_{nc\text{-}c} * RfC)$

Chemical	Maximum Soil Vapor Concentration[1] (µg/m³)	Predicted Indoor Air Concentration[2] $C_{building}$ (µg/m³)	Child Estimated Noncancer Hazard	Adult Estimated Cancer Risk	Child Estimated Cancer Risk
Benzene	37	2.66E-04	8.5E-06	3.2E-09	6.4E-10
Chloroform	10	8.96E-05	8.8E-07	9.6E-10	1.9E-10
Ethylbenzene	170	9.79E-04	9.4E-07	1.0E-09	2.0E-10
Naphthalene	110	1.73E-03	5.5E-04	2.4E-08	4.9E-09
Toluene	600	4.07E-03	7.8E-07	NC	NC
Xylenes	530	3.16E-03	3.0E-05	NC	NC
C5-C8 Aliphatics[3]	12,833	1.71E-01	2.3E-04	NC	NC
C9-C18 Aliphatics[4]	12,833	8.70E-02	2.8E-04	NC	NC
C9-C16 Aromatics[5]	12,833	1.94E-01	3.7E-03	NC	NC
Total			**5.E-03**	**3.E-08**	**6.E-09**

[1] Indoor air chemical concentrations were predicted from maximum shallow soil vapor concentrations collected across the site. See Table 1.

[2] Source: USEPA's (2003) SG-SCREEN model Version 2.0 modified by Cal/EPA's HERD on 2/4/09.

NC = Noncarcinogen

[3] Hexane used as a surrogate in the SG-SCREEN model.

[4] Toluene used as a surrogate in the SG-SCREEN model.

[5] 2-methylnaphthalene used as a surrogate in the SG-SCREEN model.

Table 6. Estimated Noncancer Hazards and Excess Lifetime Cancer Risks
Maximum Deep Soil Vapor Concentrations
Former Chevron Station No. 9-0020, Oakland, California

Equations:

$Risk_{adult} = (C_{building} * EF_r * ED_{adult} * IUR)/AT_c$

$Risk_{child} = (C_{building} * EF_r * ED_{child} * IUR)/ATc$

$Hazard\ Quotient = (C_{building} * EF_r * ED_{child})/(AT_{nc-c} * RfC)$

Chemical	Maximum Soil Vapor Concentration[1] ($\mu g/m^3$)	Predicted Indoor Air Concentration[2] $C_{building}$ ($\mu g/m^3$)	Child Estimated Noncancer Hazard	Adult Estimated Cancer Risk	Child Estimated Cancer Risk
Benzene	280	9.56E-04	3.1E-05	1.1E-08	2.3E-09
Chloroform	4.3	1.83E-05	1.8E-07	2.0E-10	3.9E-11
Ethylbenzene	<190	5.19E-04	5.0E-07	5.3E-10	1.1E-10
Naphthalene	<900	6.74E-03	2.2E-03	9.5E-08	1.9E-08
Toluene	1,000	3.22E-03	6.2E-07	NC	NC
Xylenes	630	1.79E-03	1.7E-05	NC	NC
C5-C8 Aliphatics[3]	900,000	5.70E+00	7.8E-03	NC	NC
C9-C18 Aliphatics[4]	900,000	2.90E+00	9.3E-03	NC	NC
C9-C16 Aromatics[5]	900,000	6.46E+00	1.2E-01	NC	NC
Total			**1.E-01**	**1.E-07**	**2.E-08**

[1] Indoor air chemical concentrations were predicted from maximum deep soil vapor concentrations collected across the site. See Table 1.
[2] Source: USEPA's (2003) SG-SCREEN model Version 2.0 modified by Cal/EPA's HERD on 2/4/09.
NC = Noncarcinogen
[3] Hexane used as a surrogate in the SG-SCREEN model.
[4] Toluene used as a surrogate in the SG-SCREEN model.
[5] 2-methylnaphthalene used as a surrogate in the SG-SCREEN model.

Table A-1. Maximum Benzene Soil Vapor Concentration

SG-SCREEN
PA Version 2.0; 04/

Reset to Defaults

DTSC
Vapor Intrusion Guidance
Interim Final 12/04
(last modified 2/4/09)

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
71432	3.70E+01			Benzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152.4	24	S		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
S	1.83	0.324	0.279	5

Lookup Soil Parameters

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)
70	25	25	250

END

Table A-2. Maximum Benzene Soil Vapor Concentration

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Soil gas conc. (μg/m^3)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
137.4	0.045	0.834	1.02E-07	0.055	5.62E-09	4,000	3.70E+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-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)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Diffusion path length, L_d (cm)
1.00E+06	5.00E-03	15	7,977	5.29E-03	2.17E-01	1.80E-04	3.36E-05	137.4

Convection path length, L_p (cm)	Source vapor conc., C_{source} (μg/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., $C_{building}$ (μg/m^3)
15	3.70E+01	1.25	8.33E+01	3.36E-05	5.00E+03	#NUM!	7.19E-06	2.66E-04

Unit risk factor, URF (μg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
2.9E-05	3.0E-02

END

DATA ENTRY SHEET

Table A-3. Maximum Chloroform Soil Vapor Concentration

SG-SCREEN
PA Version 2.0; 04/

Reset to Defaults

DTSC
Vapor Intrusion Guidance
Interim Final 12/04
(last modified 2/4/09)

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
67663	1.00E+01			Chloroform

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (^oC)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152.4	24	S		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
S	1.83	0.324	0.279	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)
70	25	25	250

END

Table A-4. Maximum Chloroform Soil Vapor Concentration

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone 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)
137.4	0.045	0.834	1.02E-07	0.055	5.62E-09	4,000	1.00E+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-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)	Vadose zone effective diffusion coefficient, $D^{eff}{}_V$ (cm^2/s)	Diffusion path length, L_d (cm)
1.00E+06	5.00E-03	15	7,407	3.51E-03	1.44E-01	1.80E-04	4.19E-05	137.4

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., $C_{building}$ ($\mu g/m^3$)
15	1.00E+01	1.25	8.33E+01	4.19E-05	5.00E+03	#NUM!	8.96E-06	8.96E-05

Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
5.3E-06	3.0E-01

END

DATA ENTRY SHEET

Table A-5. Maximum Ethylbenzene Soil Vapor Concentration

SG-SCREEN
PA Version 2.0; 04/

Reset to Defaults

DTSC
Vapor Intrusion Guidance
Interim Final 12/04
(last modified 2/4/09)

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
100414	1.70E+02			Ethylbenzene

MORE

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (^oC)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152.4	24	S		

MORE

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
S	1.83	0.324	0.279	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)
70	25	25	250

END

Table A-6. Maximum Ethylbenzene Soil Vapor Concentration

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Soil gas conc. (μg/m^3)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
137.4	0.045	0.834	1.02E-07	0.055	5.62E-09	4,000	1.70E+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-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)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Diffusion path length, L_d (cm)
1.00E+06	5.00E-03	15	9,994	7.43E-03	3.05E-01	1.80E-04	2.69E-05	137.4

Convection path length, L_p (cm)	Source vapor conc., C_{source} (μg/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., $C_{building}$ (μg/m^3)
15	1.70E+02	1.25	8.33E+01	2.69E-05	5.00E+03	#NUM!	5.76E-06	9.79E-04

Unit risk factor, URF (μg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
2.5E-06	1.0E+00

END

DATA ENTRY SHEET

SG-SCREEN
PA Version 2.0; 04/

Reset to Defaults

Table A-7. Maximum Naphthalene Soil Vapor Concentration

DTSC
Vapor Intrusion Guidance
Interim Final 12/04
(last modified 2/4/09)

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
91203	1.10E+02			Naphthalene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (^oC)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152.4	24	S		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
S	1.83	0.324	0.279	5

Lookup Soil Parameters

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)
70	25	25	250

END

INTERMEDIATE CALCULATIONS SHEET

Table A-8. Maximum Naphthalene Soil Vapor Concentration

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone 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)
137.4	0.045	0.834	1.02E-07	0.055	5.62E-09	4,000	1.10E+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-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)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Diffusion path length, L_d (cm)
1.00E+06	5.00E-03	15	12,768	4.48E-04	1.84E-02	1.80E-04	7.38E-05	137.4

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., $C_{building}$ ($\mu g/m^3$)
15	1.10E+02	1.25	8.33E+01	7.38E-05	5.00E+03	#NUM!	1.58E-05	1.73E-03

Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
3.4E-05	3.0E-03

END

DATA ENTRY SHEET

Table A-9. Maximum Toluene Soil Vapor Concentration

SG-SCREEN
PA Version 2.0; 04/

Reset to Defaults

DTSC
Vapor Intrusion Guidance
Interim Final 12/04
(last modified 2/4/09)

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
108883	6.00E+02			Toluene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152.4	24	S		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
S	1.83	0.324	0.279	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)
70	25	25	250

END

INTERMEDIATE CALCULATIONS SHEET

Table A-10. Maximum Toluene Soil Vapor Concentration

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Soil gas conc. (μg/m^3)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
137.4	0.045	0.834	1.02E-07	0.055	5.62E-09	4,000	6.00E+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-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)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Diffusion path length, L_d (cm)
1.00E+06	5.00E-03	15	9,001	6.29E-03	2.58E-01	1.80E-04	3.17E-05	137.4

Convection path length, L_p (cm)	Source vapor conc., C_{source} (μg/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., $C_{building}$ (μg/m^3)
15	6.00E+02	1.25	8.33E+01	3.17E-05	5.00E+03	#NUM!	6.78E-06	4.07E-03

Unit risk factor, URF (μg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
NA	3.0E-01

END

DATA ENTRY SHEET

Table A-11. Maximum Xylenes Soil Vapor Concentration

SG-SCREEN
PA Version 2.0; 04/

Reset to Defaults

DTSC
Vapor Intrusion Guidance
Interim Final 12/04
(last modified 2/4/09)

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
106423	5.30E+02			p-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152.4	24	S		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
S	1.83	0.324	0.279	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)
70	25	25	250

END

INTERMEDIATE CALCULATIONS SHEET

Table A-12. Maximum Xylenes Soil Vapor Concentration

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone 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)
137.4	0.045	0.834	1.02E-07	0.055	5.62E-09	4,000	5.30E+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-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)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Diffusion path length, L_d (cm)
1.00E+06	5.00E-03	15	10,083	7.22E-03	2.96E-01	1.80E-04	2.79E-05	137.4

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., $C_{building}$ ($\mu g/m^3$)
15	5.30E+02	1.25	8.33E+01	2.79E-05	5.00E+03	#NUM!	5.97E-06	3.16E-03

Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	1.0E-01

END