BDM International, Inc.
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BDM/MID-DTL-EV07-98

February 10, 1998

Ms. Mudhulla Logan
Case Coordinator
Alameda County Environmental Health Department
1131 Harbor Bay Parkway, 2nd Floor
Alameda, CA 94502
(510) 567-6764 Office / (510) 337-9335 Fax

RE: RESPONSE TO QUESTIONS IN REGARD TO THE RISK ASSESSMENT PERFORMED FOR THE ULTRAMAR, INC., BEACON GAS STATION NO. 604, 1619 WEST FIRST STREET, LIVERMORE, CA.

Dear Ms. Logan:

During a telephone conversation on January 27, 1998, you requested a response to several questions concerning the above mentioned site. The following is the list of questions, as understood by BDM, and the responses provided by Mr. Leon Crain and myself.

1. **What is the zoning classification for the Beacon Gas Station No. 604?**

The zoning for the Beacon Gas Station No. 604 property is classified as "Outer Core Area" (OCA). On the basis on a discussion with personnel from the City of Livermore Planning Department, the OCA designation is a ~~commercial zone~~ classification supportive of the downtown commercial businesses.

2. **How was the groundwater concentrations for the chemicals of concerned calculated for application to the risk evaluation? Use an average value for all of the monitoring wells (in the hydrocarbon plume), the concentrations for each well should be first averaged over the four most recent quarterly sampling events.**

The source area dissolved hydrocarbon concentrations ~~in the~~ groundwater used for the risk assessment were taken from the most recent sampling event for MW-2 (benzene, toluene) and MW-6 (ethylbenzene, xylenes). It is the opinion of BDM that any calculation of hydrocarbon concentration using historic data would not accurately reflect the current conditions due to the success of the groundwater remediation operation.

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At your request I have recalculated the source area dissolved hydrocarbon concentration by averaging the last four sampling events from each monitoring well and then averaging all for the monitoring wells within the hydrocarbon impact plume (defined by EPA MCL of benzene). The results of this calculation are provided on Table 1.

Table 1
CHEMICALS OF CONCERN
Source Area Concentrations

Hydrocarbon Constituents	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Groundwater (mg/L)
Aromatic Volatiles (8020)			
Benzene	NA	20.9	2.16
Toluene	NA	160	1.05
Ethylbenzene	NA	110	0.55
Xylenes	NA	700	2.86

NA No surface soil samples recovered.
Subsurface concentrations based on sample recovered from former gasoline tankhold at 19 feet BGS and remediation system installation.
Groundwater concentrations base on March 1997 samples recovered from MW-2 and MW-6.

3. Why wasn't the "current indoor inhalation of VOC's" exposure route evaluated for the residential dwelling located 2,700 feet down gradient from the site?

Two current residential receptor pathways were used in the risk evaluation. A resident located 2,700 feet down gradient was used to evaluate the "ingestion of groundwater" and "dermal contact" (while showering) pathways because a water well which may be partially completed in the impacted zone is present at that location. The risk assessment does not take into account exposure to vapors from the groundwater due to water use such as residential ingestion and showering. An assumption is made that the chemical intake calculated for ingestion and dermal contact pathway is conservative enough to take into account any additional risk due to inhalation of vapors during these activities.

A resident located 1,800 feet down gradient was used to evaluate the "indoor inhalation of vapors from the groundwater" pathway, because it is the nearest current down gradient resident relative to the source area. For this reason chemical intake from indoor inhalation of vapors are greater (more conservative) than the chemical intake from indoor inhalation of vapors at the resident located 2,700 feet from the source area.

4. Why wasn't the "current indoor inhalation of VOC's" exposure route evaluated for the on-site commercial building (Beacon Gas Station building)?

The "current indoor inhalation of VOC's" exposure route for the Beacon Gas Station building was not evaluated because it is up gradient from the source area (as is the nearest residential dwelling to the south of the source area). Based on the laboratory results from MW-1 it is believed that the groundwater plume does not extend below the building.

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5. What is the average depth to groundwater and the average gradient at the site?

The average depth to groundwater fluctuates seasonally from approximately 33 feet near the end of the summer to approximately 22 in the early spring. The groundwater gradient, however, remains fairly consistent at 0.006 to 0.013 feet per foot to the north-northwest.

6. What default values were used in the risk assessment calculations?

The default values used to calculate the exposure point concentrations from the equations provided in Section 3.0 of the Risk Assessment portion of the report are found on Table 4 (Page 12 and 13). They are also provided with the spreadsheets in Appendix B (see attachments).

The exposure parameter default values used to calculate the exposure risk from the equations provided in Section 4.0 of the Risk Assessment portion of the report are found on Table 6(a) and 6(b) (Page 16 and 17). They are also provided with the spreadsheets in Appendix C (see attachments).

7. Re-evaluate risk using different source area dissolved hydrocarbon concentrations (question No. 2) and the California slope factors for benzene (EPA values × 0.29).

The risk assessment re-calculation utilizes the following critical toxicity values. These values are lower than the critical toxicity values used in the original evaluation:

Critical Toxicity Values used in the Quantitative Risk Evaluation

Chemicals	Benzene	Toluene	Ethylbenzene	Xylenes
Reference Dose				
RfD_o	--	0.20	0.10	2.0
RfD_i	0.0017	0.40	1.0	0.086
RfD_d	--	0.16	0.097	1.84
Slope Factor				
SF_o	0.0084	--	--	--
SF_i	0.0084	--	--	--
SF_d	0.0087	--	--	--

Appendix A includes the RBCA tool kit spreadsheets that were used to calculate only the down gradient change in hydrocarbon concentrations for the off-site exposure pathways that require fate and transport modeling (Domenico). – DAF

Appendix B includes the spreadsheets that calculate the surface vapor concentrations (indoor & outdoor) from the soil and groundwater at the source area and at all potential down gradient exposure points. The results of these calculations are provided on Table 5. – for what risk –

Appendix C includes the spreadsheets that calculate the chemical intake from ingestion and dermal contact using the exposure point concentrations from the source area and down gradient from the source area

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(determined by the Domenico model). It also calculates the chemical intake from vapors determined in Appendix B and applies the critical toxicity values to calculate carcinogenic and non-carcinogenic risk.

The results of the risk assessment re-evaluation have been provided on Table 8(a) and 8(b). These results should be compared to the original evaluation on pages 19 and 20 of risk assessment report. Generally, the carcinogenic risks to current and future receptors is lower and the non-carcinogenic risks are slightly higher. The maximum hazard quotient calculated at the site (22.8) and the maximum carcinogen risk (7.65×10^{-5}) is associated with a potential future commercial receptor (enclosed-space). Site-specific Target Levels (SSTL) for the chemicals responsible for these values have been calculated and provided in Appendix C-4. On the basis of these results, it is believed that the recommendations provided in the original report remain valid.

Please feel free to call me if you have any further questions concerning this assessment or other activities performed at the site.

Sincerely,
BDM International, Inc.
Environmental Services Unit

Dale T. Littlejohn, CAPM
Senior Geologist, Director

Attachments: Table 5, Table 8, Appendix A, Appendix B, and Appendix C

cc: Mr. Leon Crain, Project Manager, BDM (SM-ALC/ERM), 5050 Dudley Blvd., Suite 3, Building 259E, McClellan AFB, CA 95652-1389, (916) 643-0830, ext. 410 - Office, (916) 643-0827 - Fax

Mr. Terry Fox, Senior Project Manager, Ultramar, Inc., 525 West 3rd Street, Hanford, CA 93230, (209) 583-3345 - Office, (209) 583-3282 - Fax

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Table 5

EXPOSURE POINT CONCENTRATIONS
Natural Attenuation with No Biodegradation

Compounds	Subsurface Soil (source area)			
	Maximum Concentration (mg/kg)	Volitalize to Air		
		Ambient (mg/m^3)	Enclosed (R) (mg/m^3)	Enclosed (C) (mg/m^3)
Aromatic Volatiles				
Benzene	2.09E+01	5.98E-04	NA	1.17E-01
Toluene	1.60E+02	2.39E-03	NA	6.21E-01
Ethylbenzene	1.10E+02	8.08E-04	NA	1.08E-01
Total Xylenes	7.00E+02	1.16E-02	NA	3.28E+00

Compounds	Groundwater (source area)			
	Maximum Concentration (mg/L)	Volitalize to Air		
		Ambient (mg/m^3)	Enclosed (R) (mg/m^3)	Enclosed (C) (mg/m^3)
Aromatic Volatiles				
Benzene	2.16E+00	1.65E-05	NA	1.33E-02
Toluene	1.05E+00	7.77E-06	NA	6.43E-03
Ethylbenzene	5.50E-01	3.67E-06	NA	3.04E-03
Total Xylenes	2.86E+00	2.02E-05	NA	1.69E-02

Compounds	Groundwater (120 feet down-gradient)			
	Maximum Concentration (mg/L)	Volitalize to Air		
		Ambient (mg/m^3)	Enclosed (R) (mg/m^3)	Enclosed (C) (mg/m^3)
Aromatic Volatiles				
Benzene	1.20E+00	NA	NA	7.42E-03
Toluene	5.90E-01	NA	NA	3.61E-03
Ethylbenzene	3.10E-01	NA	NA	1.71E-03
Total Xylenes	1.60E+00	NA	NA	9.43E-03

Table 5

EXPOSURE POINT CONCENTRATIONS
Natural Attenuation with No Biodegradation

Compounds	Groundwater (1800 feet down-gradient)			
	Maximum Concentration (mg/L)	Volitalize to Air		
		Ambient (mg/m^3)	Enclosed (R) (mg/m^3)	Enclosed (C) (mg/m^3)
Aromatic Volatiles				
Benzene	9.90E-03	NA	1.51E-04	NA
Toluene	4.80E-03	NA	7.24E-05	NA
Ethylbenzene	2.50E-03	NA	3.40E-05	NA
Total Xylenes	1.30E-02	NA	1.89E-04	NA

Compounds	Groundwater (2500 feet down-gradient)			
	Maximum Concentration (mg/L)	Volitalize to Air		
		Ambient (mg/m^3)	Enclosed (R) (mg/m^3)	Enclosed (C) (mg/m^3)
Aromatic Volatiles				
Benzene	5.10E-03	NA	7.77E-05	NA
Toluene	2.50E-03	NA	3.77E-05	NA
Ethylbenzene	1.30E-03	NA	1.77E-05	NA
Total Xylenes	6.80E-03	NA	9.88E-05	NA

Compounds	Groundwater (2700 feet down-gradient)			
	Maximum Concentration (mg/L)	Volitalize to Air		
		Ambient (mg/m^3)	Enclosed (R) (mg/m^3)	Enclosed (C) (mg/m^3)
Aromatic Volatiles				
Benzene	4.40E-03	NA	6.70E-05	NA
Toluene	2.10E-03	NA	3.17E-05	NA
Ethylbenzene	1.10E-03	NA	1.50E-05	NA
Total Xylenes	5.80E-03	NA	8.43E-05	NA

has a well

ONSITE

Table 8(a)

Current Cumulative Pathway Risk (No Biodegradation)
Acceptable Limits = 1.0 Hazard Quotient / 1x(10)-6 "Class A" Carcinogen Risk

Human Receptors	Commercial Receptor On-site		Construction Worker Receptor On-site		Residential Receptor On-site	
Exposure Pathways	**Hazard Quotient**	**Carcinogen Risk**	**Hazard Quotient**	**Carcinogen Risk**	**Hazard Quotient**	**Carcinogen Risk**
Ingestion from Groundwater, Subsurface Soil, and/or Surface Water	NA	NA	NA	NA	NA	NA
Inhalation of Vapors (Ambient) from Groundwater and/or Subsurface Soil	9.85E-02	3.61E-07	NA	NA	NA	NA
Dermal Contact with Groundwater Subsurface Soil, and/or Surface Water	NA	NA	NA	NA	NA	NA
Total Receptor Risk	9.85E-02	3.61E-07	NA	NA	NA	NA

OFFSITE

Human Receptors	Commercial Receptor Off-site (120')		Construction Worker Receptor Off-site		Residential Receptor Off-site (1800-2700')	
Exposure Pathways	**Hazard Quotient**	**Carcinogen Risk**	**Hazard Quotient**	**Carcinogen Risk**	**Hazard Quotient**	**Carcinogen Risk**
Ingestion from Groundwater, Subsurface Soil, and/or Surface Water	NA	NA	NA	NA	6.68E-04	4.34E-07
Inhalation of Vapors (Enclosed-space) from Groundwater and/or Subsurface Soil	8.78E-01	**4.36E-06**	NA	NA	1.87E-02	1.12E-07
Dermal Contact with Groundwater Subsurface Soil, and/or Surface Water	NA	NA	NA	NA	5.91E-04	9.43E-08
Total Receptor Risk	8.78E-01	**4.36E-06**	NA	NA	2.00E-02	6.40E-07

Table 8(b)

Future Cumulative Pathway Risk (No Biodegradation)
Acceptable Limits = 1.0 Hazard Quotient / 1x(10)-4 "Class A" Carcinogen Risk

Human Receptors	Commercial Receptor On-site		Construction Worker Receptor On-site		Residential Receptor On-site	
Exposure Pathways	**Hazard Quotient**	**Carcinogen Risk**	**Hazard Quotient**	**Carcinogen Risk**	**Hazard Quotient**	**Carcinogen Risk**
Ingestion from Groundwater, Subsurface Soil, and/or Surface Water	1.19E-01	6.34E-05	NA	NA	NA	NA
Inhalation of Vapors (Enclosed-space) from Groundwater and/or Subsurface Soil	**2.28E+01**	7.65E-05	NA	NA	NA	NA
Dermal Contact with Groundwater Subsurface Soil, and/or Surface Water	NA	NA	NA	NA	NA	NA
Total Receptor Risk	**2.29E+01**	**1.40E-04**	NA	NA	NA	NA

this is based on worst (one from MW-2 4 quarters)

Human Receptors	Commercial Receptor Off-site		Construction Worker Receptor Off-site		Residential Receptor Off-site (2500')	
Exposure Pathways	**Hazard Quotient**	**Carcinogen Risk**	**Hazard Quotient**	**Carcinogen Risk**	**Hazard Quotient**	**Carcinogen Risk**
Ingestion from Groundwater, Subsurface Soil, and/or Surface Water	NA	NA	NA	NA	3.72E-04	7.09E-08
Inhalation of Vapors (Enclosed-space) from Groundwater and/or Subsurface Soil	NA	NA	NA	NA	NA	NA
Dermal Contact with Groundwater Subsurface Soil, and/or Surface Water	NA	NA	NA	NA	3.78E-04	5.64E-08
Total Receptor Risk	NA	NA	NA	NA	7.50E-04	1.27E-07

Bold - Cumulative Values Exceed Acceptable Levels

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Where is Tier 2 worksheet 9.2?

APPENDIX A
RBCA Tool Kit Output Tables
(used for fate & transport values only)

Run #1 - 120 feet from source area

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Beacon Station No. 604 | Job Identification: BS604-120 | Software: GSI RBCA Spreadsheet
Site Location: Livermoore, CA | Date Completed: 1/29/98 | Version: v 1.0
Completed By: Dale Littlejohn

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined.

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
ATc	Averaging time for carcinogens (yr)	70				
ATn	Averaging time for non-carcinogens (yr)	30	6	16	25	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	25	1
EF	Exposure Frequency (days/yr)	350			250	180
EF.Derm	Exposure Frequency for dermal exposure	350			250	
IRgw	Ingestion Rate of Water (l/day)	2			1	
IRs	Ingestion Rate of Soil (mg/day)	100	200		50	100
IRadj	Adjusted soil ing. rate (mg-yr/kg-d)	1.1E+02			9.4E+01	
IRa.in	Inhalation rate indoor (m^3/day)	15			20	
IRa.out	Inhalation rate outdoor (m^3/day)	20			20	10
SA	Skin surface area (dermal) (cm^2)	***3.2E+03***		***2.0E+03***	3.2E+03	3.2E+03
SAadj	Adjusted dermal area (cm^2-yr/kg)	1.6E+03			1.3E+03	
M	Soil to Skin adherence factor	***0.5***				
AAFs	Age adjustment on soil ingestion	FALSE			FALSE	
AAFd	Age adjustment on skin surface area	FALSE			FALSE	
tox	Use EPA tox data for air (or PEL based)	TRUE				
gwMCL?	Use MCL as exposure limit in groundwater?	FALSE				

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
Groundwater Pathways:				
GW.i	Groundwater Ingestion	FALSE	TRUE	
GW.v	Volatilization to Outdoor Air	FALSE	FALSE	
GW.b	Vapor Intrusion to Buildings	FALSE	TRUE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	FALSE	FALSE	
SS.v	Volatiles and Particulate Inhalation	FALSE	FALSE	FALSE
SS.d	Direct Ingestion and Dermal Contact	FALSE	FALSE	FALSE
S.l	Leaching to Groundwater from all Soils	FALSE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	FALSE	TRUE	

Matrix of Receptor Distance and Location on- or off-site		Residential Distance	Residential On-Site	Commercial/Industrial Distance	Commercial/Industrial On-Site
GW	Groundwater receptor (cm)	3.7E+03	FALSE	3.7E+03	FALSE
S	Inhalation receptor (cm)		FALSE		FALSE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	1.0E-06	
TRc	Target Risk (class C carcinogens)	1.0E-05	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	2	
Tier	RBCA Tier	2	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)	***1.0E+06***		***1.0E+06***
W	Length of affected soil parallel to wind (cm)	***1.0E+03***		1.0E+03
W.gw	Length of affected soil parallel to groundwater (c	***1.0E+03***		
Uair	Ambient air velocity in mixing zone (cm/s)	2.3E+02		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)	***6.1E+01***		
Pe	Particulate areal emission rate (g/cm^2/s)	2.2E-10		

Groundwater	Definition (Units)	Value
delta.gw	Groundwater mixing zone depth (cm)	2.0E+02
I	Groundwater infiltration rate (cm/yr)	3.0E+01
Ugw	Groundwater Darcy velocity (cm/yr)	***3.1E+02***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***6.1E+02***
Ks	Saturated Hydraulic Conductivity(cm/s)	7.5E-04
grad	Groundwater Gradient (cm/cm)	1.3E-02
Sw	Width of groundwater source zone (cm)	3.7E+03
Sd	Depth of groundwater source zone (cm)	6.1E+02
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	FALSE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	***1.0E-02***

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	5.0E+00		
hv	Vadose zone thickness (cm)	***7.6E+02***		
rho	Soil density (g/cm^3)	1.7		
foc	Fraction of organic carbon in vadose zone	0.01		
phi	Soil porosity in vadose zone	0.38		
Lgw	Depth to groundwater (cm)	***7.6E+02***		
Ls	Depth to top of affected soil (cm)	***5.8E+02***		
Lsubs	Thickness of affected subsurface soils (cm)	***1.8E+02***		
pH	Soil/groundwater pH	6.5		
		capillary	vadose	foundation
phi.w	Volumetric water content	0.342	0.12	0.12
phi.a	Volumetric air content	0.038	0.26	0.26

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (a^-1)	1.4E-04	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	0.01	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		3.7E+02
ay	Transverse dispersion coefficient (cm)		1.2E+02
az	Vertical dispersion coefficient (cm)		1.8E+01
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

RBCA CHEMICAL DATABASE

Physical Property Data

CAS Number	Constituent	type	Molecular Weight (g/mole) MW	ref	Diffusion Coefficients in air (cm2/s) Dair	re	in water (cm2/s) Dwat	re	log (Koc) or log(Kd) (@ 20 - 25 C) (l/kg) Koc	ref	Henry's Law Constant (@ 20 - 25 C) (atm-m3/mol)	(unitless)	re	Vapor Pressure (@ 20 - 25 C) (mm Hg) Pure Component	ref	Solubility (@ 20 - 25 C) (mg/l) Pure Component	ref	acid pKa	base pKb	ref
71-43-2	Benzene	A	78.1	5	9.30E-02	A	1.10E-05	A	1.58	A	5.29E-03	2.20E-01	A	9.52E+01	4	1.75E+03	A			
100-41-4	Ethylbenzene	A	106.2	5	7.60E-02	A	8.50E-06	A	1.98	A	7.69E-03	3.20E-01	A	1.00E+01	4	1.52E+02	5			
108-88-3	Toluene	A	92.4	5	8.50E-02	A	9.40E-06	A	2.13	A	6.25E-03	2.60E-01	A	3.00E+01	4	5.15E+02	29			
1330-20-7	Xylene (mixed isomers)	A	106.2	5	7.20E-02	A	8.50E-06	A	2.38	A	6.97E-03	2.90E-01	A	7.00E+00	4	1.98E+02	5			

Site Name: Beacon Station No. Site Location: Livermoore, CA Completed By: Dale Littlejohn Date Completed: 1/29/1998

Software version: v 1.0

Site Name: Beacon Station No. 604 | Site Location: Livermoore, CA | Completed By: Dale Littlejohn | Date Completed: 1/29/1998 | 6 OF 6

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: INGESTION

Constituents of Concern	Exposure Concentration: 1) Source Medium — Groundwater Concentration (mg/L)	2) NAF Value (dim) — Receptor: Off-Site Commercial	3) Exposure Medium — Groundwater: POE Conc. (mg/L) (1)/(2): Off-Site Commercial	4) Exposure Multiplier (IRxEFxED)/(BWxAT) (L/kg-day): Off-Site Commercial	5) Average Daily Intake Rate (mg/kg-day): Off-Site Commercial	MAX. PATHWAY INTAKE (mg/kg-day) (Maximum intake of active pathways soil leaching & groundwater routes.): Off-Site Commercial
Benzene	2.2E+0	1.8E+0	1.2E+0	3.5E-3	4.3E-3	4.3E-3
Ethylbenzene	5.5E-1	1.8E+0	3.1E-1	9.8E-3	3.0E-3	3.0E-3
Toluene	1.1E+0	1.8E+0	5.9E-1	9.8E-3	5.8E-3	5.8E-3
Xylene (mixed isomers)	2.9E+0	1.8E+0	1.6E+0	9.8E-3	1.6E-2	1.6E-2

NOTE: AT = Averaging time (days) | BW = Body Weight (kg) | CF = Units conversion factor | ED = Exp. duration (yrs) | EF = Exposure frequencey (days/yr) | IR = Intake rate (L/day or mg/day) | POE = Point of exposure

Serial: G-483-YPX-784 | Software: GSI RBCA Spreadsheet Version: v 1.0

Groundwater Concentration 120 feet Down Gradient from Source

Run #2 - 1800 feet from source area

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Beacon No. 604 (1800 feet) Job Identification: BS604-1800
Site Location: Livermoore, CA Date Completed: 1/29/98
Completed By: Dale Littlejohn

Software: GSI RBCA Spreadsheet
Version: v 1.0

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined.

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
ATc	Averaging time for carcinogens (yr)	70				
ATn	Averaging time for non-carcinogens (yr)	30	6	16	25	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	25	1
EF	Exposure Frequency (days/yr)	350			250	180
EF.Derm	Exposure Frequency for dermal exposure	350			250	
IRgw	Ingestion Rate of Water (l/day)	2			1	
IRs	Ingestion Rate of Soil (mg/day)	100	200		50	100
IRadj	Adjusted soil ing. rate (mg-yr/kg-d)	1.1E+02			9.4E+01	
IRa.in	Inhalation rate indoor (m^3/day)	15			20	
IRa.out	Inhalation rate outdoor (m^3/day)	20			20	10
SA	Skin surface area (dermal) (cm^2)	***3.2E+03***		***2.0E+03***	3.2E+03	3.2E+03
SAadj	Adjusted dermal area (cm^2-yr/kg)	1.6E+03			1.3E+03	
M	Soil to Skin adherence factor	***0.5***				
AAFs	Age adjustment on soil ingestion	FALSE			FALSE	
AAFd	Age adjustment on skin surface area	FALSE			FALSE	
tox	Use EPA tox data for air (or PEL based)	TRUE				
gwMCL?	Use MCL as exposure limit in groundwater?	FALSE				

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GW.v	Volatilization to Outdoor Air	FALSE	FALSE	
GW.b	Vapor Intrusion to Buildings	FALSE	FALSE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	FALSE	FALSE	
SS.v	Volatiles and Particulate Inhalation	FALSE	FALSE	FALSE
SS.d	Direct Ingestion and Dermal Contact	FALSE	FALSE	FALSE
S.l	Leaching to Groundwater from all Soils	FALSE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	FALSE	FALSE	

Matrix of Receptor Distance and Location on- or off-site		Residential Distance	Residential On-Site	Commercial/Industrial Distance	Commercial/Industrial On-Site
GW	Groundwater receptor (cm)	5.5E+04	FALSE	5.5E+04	FALSE
S	Inhalation receptor (cm)		FALSE		FALSE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	1.0E-06	
TRc	Target Risk (class C carcinogens)	1.0E-05	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	2	
Tier	RBCA Tier	2	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)	***1.0E+06***		***1.0E+06***
W	Length of affected soil parallel to wind (cm)	***1.0E+03***		1.0E+03
W.gw	Length of affected soil parallel to groundwater (c	***1.0E+03***		
Uair	Ambient air velocity in mixing zone (cm/s)	2.3E+02		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)	***6.1E+01***		
Pe	Particulate areal emission rate (g/cm^2/s)	2.2E-10		

Groundwater	Definition (Units)	Value
delta.gw	Groundwater mixing zone depth (cm)	2.0E+02
I	Groundwater infiltration rate (cm/yr)	3.0E+01
Ugw	Groundwater Darcy velocity (cm/yr)	***3.1E+02***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***8.1E+02***
Ks	Saturated Hydraulic Conductivity(cm/s)	7.5E-04
grad	Groundwater Gradient (cm/cm)	1.3E-02
Sw	Width of groundwater source zone (cm)	3.7E+03
Sd	Depth of groundwater source zone (cm)	6.1E+02
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	FALSE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	***1.0E-02***

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	5.0E+00		
hv	Vadose zone thickness (cm)	***7.6E+02***		
rho	Soil density (g/cm^3)	1.7		
foc	Fraction of organic carbon in vadose zone	0.01		
phi	Soil porosity in vadose zone	0.38		
Lgw	Depth to groundwater (cm)	***7.6E+02***		
Ls	Depth to top of affected soil (cm)	***5.8E+02***		
Lsubs	Thickness of affected subsurface soils (cm)	***1.8E+02***		
pH	Soil/groundwater pH	6.5		
		capillary	vadose	foundation
phi.w	Volumetric water content	0.342	0.12	0.12
phi.a	Volumetric air content	0.038	0.26	0.26

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s^-1)	1.4E-04	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	0.01	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		5.5E+03
ay	Transverse dispersion coefficient (cm)		1.8E+03
az	Vertical dispersion coefficient (cm)		2.7E+02
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

Site Name: Beacon No. 604 (1800 feet) | Site Location: Livermoore, CA | Completed By: Dale Littlejohn | Date Completed: 1/29/1998 | 6 OF 6

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

GROUNDWATER EXPOSURE PATHWAYS — ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: INGESTION

Constituents of Concern	Exposure Concentration: 1) Source Medium — Groundwater Concentration (mg/L)	2) NAF Value (dim) — Receptor: Off-Site Commercial	3) Exposure Medium — Groundwater: POE Conc. (mg/L) (1)/(2): Off-Site Commercial	4) Exposure Multiplier (IRxEFxED)/(BWxAT) (L/kg-day): Off-Site Commercial	5) Average Daily Intake Rate (mg/kg-day): Off-Site Commercial	MAX. PATHWAY INTAKE (mg/kg-day) (Maximum intake of active pathways soil leaching & groundwater routes.): Off-Site Commercial
Benzene	2.2E+0	2.2E+2	9.9E-3	3.5E-3	3.5E-5	3.5E-5
Ethylbenzene	5.5E-1	2.2E+2	2.5E-3	9.8E-3	2.5E-5	2.5E-5
Toluene	1.1E+0	2.2E+2	4.8E-3	9.8E-3	4.7E-5	4.7E-5
Xylene (mixed isomers)	2.9E+0	2.2E+2	1.3E-2	9.8E-3	1.3E-4	1.3E-4

NOTE: AT = Averaging time (days); BW = Body Weight (kg); CF = Units conversion factor; ED = Exp. duration (yrs); EF = Exposure frequencey (days/yr); IR = Intake rate (L/day or mg/day); POE = Point of exposure

Serial: G-483-YPX-784 Software: GSI RBCA Spreadsheet Version: v 1.0

Groundwater Concentration 1800 feet down gradient from the Source area

Run #3 - 2500 feet from source area

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Beacon No. 604 (2500 feet) Job Identification: BS604-2500
Site Location: Livermoore, CA Date Completed: 1/29/98
Completed By: Dale Littlejohn

Software: GSI RBCA Spreadsheet
Version: v 1.0

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined.

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
ATc	Averaging time for carcinogens (yr)	70				
ATn	Averaging time for non-carcinogens (yr)	30	6	16	25	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	25	1
EF	Exposure Frequency (days/yr)	350			250	180
EF.Derm	Exposure Frequency for dermal exposure	350			250	
IRgw	Ingestion Rate of Water (l/day)	2			1	
IRs	Ingestion Rate of Soil (mg/day)	100	200		50	100
IRadj	Adjusted soil ing. rate (mg-yr/kg-d)	1.1E+02			9.4E+01	
IRa.in	Inhalation rate indoor (m^3/day)	15			20	
IRa.out	Inhalation rate outdoor (m^3/day)	20			20	10
SA	Skin surface area (dermal) (cm^2)	***3.2E+03***		***2.0E+03***	3.2E+03	3.2E+03
SAadj	Adjusted dermal area (cm^2-yr/kg)	1.6E+03			1.3E+03	
M	Soil to Skin adherence factor	***0.5***				
AAFs	Age adjustment on soil ingestion	FALSE			FALSE	
AAFd	Age adjustment on skin surface area	FALSE			FALSE	
tox	Use EPA tox data for air (or PEL based)	TRUE				
gwMCL?	Use MCL as exposure limit in groundwater?	FALSE				

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
Groundwater Pathways:				
GW.i	Groundwater Ingestion	FALSE	TRUE	
GW.v	Volatilization to Outdoor Air	FALSE	FALSE	
GW.b	Vapor Intrusion to Buildings	FALSE	FALSE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	FALSE	FALSE	
SS.v	Volatiles and Particulate Inhalation	FALSE	FALSE	FALSE
SS.d	Direct Ingestion and Dermal Contact	FALSE	FALSE	FALSE
S.l	Leaching to Groundwater from all Soils	FALSE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	FALSE	FALSE	

Matrix of Receptor Distance and Location on- or off-site		Residential Distance	Residential On-Site	Commercial/Industrial Distance	Commercial/Industrial On-Site
GW	Groundwater receptor (cm)	7.6E+04	FALSE	7.6E+04	FALSE
S	Inhalation receptor (cm)		FALSE		FALSE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	1.0E-06	
TRc	Target Risk (class C carcinogens)	1.0E-05	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	2	
Tier	RBCA Tier	2	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)	***1.0E+06***		***1.0E+06***
W	Length of affected soil parallel to wind (cm)	***1.0E+03***		1.0E+03
W.gw	Length of affected soil parallel to groundwater (c	***1.0E+03***		
Uair	Ambient air velocity in mixing zone (cm/s)	2.3E+02		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)	***6.1E+01***		
Pe	Particulate areal emission rate (g/cm^2/s)	2.2E-10		

Groundwater	Definition (Units)	Value
delta.gw	Groundwater mixing zone depth (cm)	2.0E+02
I	Groundwater infiltration rate (cm/yr)	3.0E+01
Ugw	Groundwater Darcy velocity (cm/yr)	***3.1E+02***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***8.1E+02***
Ks	Saturated Hydraulic Conductivity(cm/s)	7.5E-04
grad	Groundwater Gradient (cm/cm)	1.3E-02
Sw	Width of groundwater source zone (cm)	3.7E+03
Sd	Depth of groundwater source zone (cm)	6.1E+02
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	FALSE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	***1.0E-02***

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	5.0E+00		
hv	Vadose zone thickness (cm)	***7.6E+02***		
rho	Soil density (g/cm^3)	1.7		
foc	Fraction of organic carbon in vadose zone	0.01		
phi	Soil porosity in vadose zone	0.38		
Lgw	Depth to groundwater (cm)	***7.6E+02***		
Ls	Depth to top of affected soil (cm)	***5.8E+02***		
Lsubs	Thickness of affected subsurface soils (cm)	***1.8E+02***		
pH	Soil/groundwater pH	6.5		
		capillary	vadose	foundation
phi.w	Volumetric water content	0.342	0.12	0.12
phi.a	Volumetric air content	0.038	0.26	0.26

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s^-1)	1.4E-04	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	0.01	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		7.6E+03
ay	Transverse dispersion coefficient (cm)		2.5E+03
az	Vertical dispersion coefficient (cm)		3.8E+02
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

Site Name: Beacon No. 604 (2500 feet) | Site Location: Livermoore, CA | Completed By: Dale Littlejohn | Date Completed: 1/29/1998 | 6 OF 6

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: INGESTION

Constituents of Concern	Exposure Concentration 1) Source Medium: Groundwater Concentration (mg/L)	2) NAF Value (dim) Receptor: Off-Site Commercial	3) Exposure Medium Groundwater: POE Conc. (mg/L) (1)(2): Off-Site Commercial	4) Exposure Multiplier (IRxEFxED)/(BWxAT) (L/kg-day): Off-Site Commercial	5) Average Daily Intake Rate (mg/kg-day): Off-Site Commercial	MAX. PATHWAY INTAKE (mg/kg-day) (Maximum intake of active pathways soil leaching & groundwater routes.): Off-Site Commercial
Benzene	2.2E+0	4.2E+2	5.1E-3	3.5E-3	1.8E-5	1.8E-5
Ethylbenzene	5.5E-1	4.2E+2	1.3E-3	9.8E-3	1.3E-5	1.3E-5
Toluene	1.1E+0	4.2E+2	2.5E-3	9.8E-3	2.4E-5	2.4E-5
Xylene (mixed isomers)	2.9E+0	4.2E+2	6.8E-3	9.8E-3	6.6E-5	6.6E-5

NOTE: AT = Averaging time (days) | BW = Body Weight (kg) | CF = Units conversion factor | ED = Exp. duration (yrs) | EF = Exposure frequencey (days/yr) | IR = Intake rate (L/day or mg/day) | POE = Point of exposure

Serial: G-483-YPX-784 | Software: GSI RBCA Spreadsheet Version: v 1.0

Groundwater Concentration
2,500 feet down-gradient
from the source area

Run #4 - 2700 feet from source area

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Beacon No. 604 (2700 feet) Job Identification: BS604-2700
Site Location: Livermoore, CA Date Completed: 1/29/98
Completed By: Dale Littlejohn

Software: GSI RBCA Spreadsheet
Version: v1.0

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined.

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
ATc	Averaging time for carcinogens (yr)	70				
ATn	Averaging time for non-carcinogens (yr)	30	6	16	25	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	25	1
EF	Exposure Frequency (days/yr)	350			250	180
EF.Derm	Exposure Frequency for dermal exposure	350			250	
IRgw	Ingestion Rate of Water (l/day)	2			1	
IRs	Ingestion Rate of Soil (mg/day)	100	200		50	100
IRadj	Adjusted soil ing. rate (mg-yr/kg-d)	1.1E+02			9.4E+01	
IRa.in	Inhalation rate indoor (m^3/day)	15			20	
IRa.out	Inhalation rate outdoor (m^3/day)	20			20	10
SA	Skin surface area (dermal) (cm^2)	***3.2E+03***		***2.0E+03***	3.2E+03	3.2E+03
SAadj	Adjusted dermal area (cm^2-yr/kg)	1.6E+03			1.3E+03	
M	Soil to Skin adherence factor	***0.5***				
AAFs	Age adjustment on soil ingestion	FALSE			FALSE	
AAFd	Age adjustment on skin surface area	FALSE			FALSE	
tox	Use EPA tox data for air (or PEL based)	TRUE				
gwMCL?	Use MCL as exposure limit in groundwater?	FALSE				

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
Groundwater Pathways:				
GW.i	Groundwater Ingestion	FALSE	TRUE	
GW.v	Volatilization to Outdoor Air	FALSE	FALSE	
GW.b	Vapor Intrusion to Buildings	FALSE	FALSE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	FALSE	FALSE	
SS.v	Volatiles and Particulate Inhalation	FALSE	FALSE	FALSE
SS.d	Direct Ingestion and Dermal Contact	FALSE	FALSE	FALSE
S.l	Leaching to Groundwater from all Soils	FALSE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	FALSE	FALSE	

Matrix of Receptor Distance and Location on- or off-site		Residential Distance	Residential On-Site	Commercial/Industrial Distance	Commercial/Industrial On-Site
GW	Groundwater receptor (cm)	8.2E+04	FALSE	8.2E+04	FALSE
S	Inhalation receptor (cm)		FALSE		FALSE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	1.0E-06	
TRc	Target Risk (class C carcinogens)	1.0E-05	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	2	
Tier	RBCA Tier	2	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)	***1.0E+06***		***1.0E+06***
W	Length of affected soil parallel to wind (cm)	***1.0E+03***		1.0E+03
W.gw	Length of affected soil parallel to groundwater (c	***1.0E+03***		
Uair	Ambient air velocity in mixing zone (cm/s)	2.3E+02		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)	***8.1E+01***		
Pe	Particulate areal emission rate (g/cm^2/s)	2.2E-10		

Groundwater	Definition (Units)	Value
delta.gw	Groundwater mixing zone depth (cm)	2.0E+02
I	Groundwater infiltration rate (cm/yr)	3.0E+01
Ugw	Groundwater Darcy velocity (cm/yr)	***3.1E+02***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***8.1E+02***
Ks	Saturated Hydraulic Conductivity(cm/s)	7.5E-04
grad	Groundwater Gradient (cm/cm)	1.3E-02
Sw	Width of groundwater source zone (cm)	3.7E+03
Sd	Depth of groundwater source zone (cm)	6.1E+02
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	FALSE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	***1.0E-02***

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	5.0E+00		
hv	Vadose zone thickness (cm)	***7.6E+02***		
rho	Soil density (g/cm^3)	1.7		
foc	Fraction of organic carbon in vadose zone	0.01		
phi	Soil porosity in vadose zone	0.38		
Lgw	Depth to groundwater (cm)	***7.6E+02***		
Ls	Depth to top of affected soil (cm)	***5.8E+02***		
Lsubs	Thickness of affected subsurface soils (cm)	***1.8E+02***		
pH	Soil/groundwater pH	6.5		
		capillary	vadose	foundation
phi.w	Volumetric water content	0.342	0.12	0.12
phi.a	Volumetric air content	0.038	0.26	0.26

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s^-1)	1.4E-04	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	0.01	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		8.2E+03
ay	Transverse dispersion coefficient (cm)		2.7E+03
az	Vertical dispersion coefficient (cm)		4.1E+02
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

Site Name: Beacon No. 604 (2700 feet) | Site Location: Livermoore, CA | Completed By: Dale Littlejohn | Date Completed: 1/29/1998 | 6 OF 6

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: INGESTION

Constituents of Concern	Exposure Concentration 1) Source Medium: Groundwater Concentration (mg/L)	2) NAF Value (dim) Receptor: Off-Site Commercial	3) Exposure Medium Groundwater: POE Conc. (mg/L) (1)(2): Off-Site Commercial	4) Exposure Multiplier (IRxEFxED)/(BWxAT) (L/kg-day): Off-Site Commercial	5) Average Daily Intake Rate (mg/kg-day): Off-Site Commercial	MAX. PATHWAY INTAKE (mg/kg-day) (Maximum intake of active pathways soil leaching & groundwater routes.): Off-Site Commercial
Benzene	2.2E+0	4.9E+2	4.4E-3	3.5E-3	1.5E-5	1.5E-5
Ethylbenzene	5.5E-1	4.9E+2	1.1E-3	9.8E-3	1.1E-5	1.1E-5
Toluene	1.1E+0	4.9E+2	2.1E-3	9.8E-3	2.1E-5	2.1E-5
Xylene (mixed isomers)	2.9E+0	4.9E+2	5.8E-3	9.8E-3	5.7E-5	5.7E-5

NOTE: AT = Averaging time (days) | BW = Body Weight (kg) | CF = Units conversion factor | ED = Exp. duration (yrs) | EF = Exposure frequencey (days/yr) | IR = Intake rate (L/day or mg/day) | POE = Point of exposure

Serial: G-483-YPX-784 | Software: GSI RBCA Spreadsheet Version: v 1.0

Groundwater Concentration 2,700 feet down gradient from the source area.

APPENDIX B
Exposure Point Volatilization Spreadsheets

APPENDIX B-1

Exposure Point Parameters and Calculation Spreadsheet (source area)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Field Measurements				
C_{soil} (mg/kg)	20.9	160	110	700
C_{gw} - leach from soil (mg/L)	0.223	0.514	0.099	2.783
C_{gw} - measured (mg/L)	2.16	1.05	0.55	2.86
C_{gw} - max (mg/L)	2.16E+00	1.05E+00	5.50E-01	2.86E+00
A (m^2)	100	100	100	100
L_s (cm)	580	580	580	580
L_{gw} (gw)	760	760	760	760
W (m)	20.0	20.0	20.0	20.0
h_{cap} (cm)	5.0	5.0	5.0	5.0
h_v (cm)	755.0	755	755	755
d_s (cm)	180.0	180	180	180
S_w (cm)	4000	4000	4000	4000
S_d (cm)	610	610	610	610
rho (gm/cm^3)	1.7	1.7	1.7	1.7
f_{oc} (g-carbon/g-soil)	0.01	0.01	0.01	0.01
phi wtr-vadose	0.12	0.12	0.12	0.12
phi air-vadose	0.26	0.26	0.26	0.26
phi total	0.38	0.38	0.38	0.38
phi wtr-cap	0.342	0.342	0.342	0.342
phi air-cap	0.038	0.038	0.038	0.038
phi wtr-crack	0.12	0.12	0.12	0.12
phi air-crack	0.26	0.26	0.26	0.26
Qr (cm^3/yr)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V_{gw} (cm/yr)	310	310	310	310
U_{air} (m/s)	2.25	2.25	2.25	2.25
delta air (m)	2.0	2.0	2.0	2.0
eta (cm^2-cracks/cm^2-total area)	0.01	0.01	0.01	0.01
L_{crack} (cm)	15.0	15.0	15.0	15.0
LDF (unitless)	100.0	100.0	100.0	100.0
Chemical-Specific Parameters				
H (at 20-C atm/mol	5.59E-03	6.37E-03	6.43E-03	7.04E-03
H' (unitless)	2.32E-01	2.65E-01	2.67E-01	2.93E-01
k_{oc} (mg/kg-carb/mg/L-wtr)	83	300	1100	240
k_s (cm^3-wtr/g-soil)	0.83	3	11	2.4
D^{air} (cm^2/s)	9.33E-02	8.38E-02	7.48E-02	7.40E-02
D^{water} (cm^2/s)	1.10E-05	9.40E-06	8.50E-06	8.50E-06
tau (sec)	936	1152	1404	1404
Residential-Specific Parameters				
ER (s^{-1} L/s)	0.00014	0.00014	0.00014	0.00014
L_b (cm)	200	200	200	200
t (sec)	9.50E+08	9.50E+08	9.50E+08	9.50E+08
Commercial-Specific Parameters				
ER (s^{-1} L/s)	0.00023	0.00023	0.00023	0.00023
L_b (cm)	300	300	300	300
t (sec)	7.90E+08	7.90E+08	7.90E+08	7.90E+08

APPENDIX B-1

Exposure Point Parameters and Calculation Spreadsheet (source area)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Ambient Inhalation of Volatiles				
From Subsurface Soil				
D_{ei}	2.58E-02	2.31E-02	2.07E-02	2.04E-02
K_{as}	2.80E-01	8.83E-02	2.43E-02	1.22E-01
Dispersivity	1.52E-03	4.48E-04	1.12E-04	5.42E-04
VF_{samb}	2.86E-05	1.49E-05	7.35E-06	1.65E-05
NAF	3.49E+04	6.70E+04	1.36E+05	6.04E+04
Exp. Pt. Concentration (mg/m^3)	**5.98E-04**	**2.39E-03**	**8.08E-04**	**1.16E-02**
Ambient Inhalation of Volatiles				
From Groundwater				
D_{cap}^{eff}	2.13E-05	1.77E-05	1.58E-05	1.52E-05
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{wamb}	7.62E-06	7.40E-06	6.68E-06	7.08E-06
NAF	1.31E+05	1.35E+05	1.50E+05	1.41E+05
Exp. Pt. Concentration (mg/m^3)	**1.65E-05**	**7.77E-06**	**3.67E-06**	**2.02E-05**
Residential Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
K_{sw}	1.07E+00	3.21E-01	9.00E-02	3.98E-01
VF_{seap} (1)	3.10E-02	9.56E-03	2.41E-03	1.15E-02
VF_{seap} (2)	1.15E-02	1.15E-02	1.15E-02	1.15E-02
VF_{seap} (min)	1.15E-02	9.56E-03	2.41E-03	1.15E-02
NAF	8.69E+01	1.05E+02	4.15E+02	8.69E+01
Exp. Pt. Concentration (mg/m^3)	**2.40E-01**	**1.53E+00**	**2.65E-01**	**8.05E+00**
Commercial Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
VF_{seap} (1)	1.26E-02	3.88E-03	9.78E-04	4.68E-03
VF_{seap} (2)	5.61E-03	5.61E-03	5.61E-03	5.61E-03
VF_{seap} (min)	5.61E-03	3.88E-03	9.78E-04	4.68E-03
NAF	1.78E+02	2.58E+02	1.02E+03	2.14E+02
Exp. Pt. Concentration (mg/m^3)	**1.17E-01**	**6.21E-01**	**1.08E-01**	**3.28E+00**
Residential Enclosed-Space Inhalation				
of Volatiles From Groundwater				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{wsap}	1.52E-02	1.51E-02	1.36E-02	1.45E-02
NAF	6.57E+01	6.63E+01	7.35E+01	6.88E+01
Exp. Pt. Concentration (mg/m^3)	**3.29E-02**	**1.58E-02**	**7.48E-03**	**4.16E-02**

Exposure Point Parameters and Calculation Spreadsheet (source area)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Commercial Enclosed-Space Inhalation				
of Volatiles From Groundwater				
VF_{weap}	6.18E-03	6.12E-03	5.52E-03	5.90E-03
NAF	1.62E+02	1.63E+02	1.81E+02	1.70E+02
Exp. Pt. Concentration (mg/m^3)	**1.33E-02**	**6.43E-03**	**3.04E-03**	**1.69E-02**
Subsurface Soil Leaching to				
Groundwater				
LF_{sw}	1.07E-02	3.21E-03	9.00E-04	3.98E-03
NAF	9.36E+01	3.11E+02	1.11E+03	2.52E+02
Exp. Pt. Concentration (mg/L)	**2.23E-01**	**5.14E-01**	**9.90E-02**	**2.78E+00**

Run #2 - 120 feet from source area

APPENDIX B-2

Exposure Point Parameters and Calculation Spreadsheet (120 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Field Measurements				
C_{soil} (mg/kg)	0	0	0	0
C_{gw} - leach from soil (mg/L)	0.000	0.000	0.000	0.000
C_{gw} - measured (mg/L)	1.2	0.59	0.31	1.6000
C_{gw} - max (mg/L)	1.20E+00	5.90E-01	3.10E-01	1.60E+00
A (m^2)	100	100	100	100
L_s (cm)	580	580	580	580
L_{gw} (gw)	760	760	760	760
W (m)	20.0	20.0	20.0	20.0
h_{cap} (cm)	5.0	5.0	5.0	5.0
h_v (cm)	755.0	755	755	755
d_s (cm)	180.0	180	180	180
S_w (cm)	4000	4000	4000	4000
S_d (cm)	610	610	610	610
rho (gm/cm^3)	1.7	1.7	1.7	1.7
f_{oc} (g-carbon/g-soil)	0.01	0.01	0.01	0.01
phi wtr-vadose	0.12	0.12	0.12	0.12
phi air-vadose	0.26	0.26	0.26	0.26
phi total	0.38	0.38	0.38	0.38
phi wtr-cap	0.342	0.342	0.342	0.342
phi air-cap	0.038	0.038	0.038	0.038
phi wtr-crack	0.12	0.12	0.12	0.12
phi air-crack	0.26	0.26	0.26	0.26
Qr (cm^3/yr)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V_{gw} (cm/yr)	310	310	310	310
U_{air} (m/s)	2.25	2.25	2.25	2.25
delta air (m)	2.0	2.0	2.0	2.0
eta (cm^2-cracks/cm^2-total area)	0.01	0.01	0.01	0.01
L_{crack} (cm)	15.0	15.0	15.0	15.0
LDF (unitless)	100.0	100.0	100.0	100.0
Chemical-Specific Parameters				
H (at 20-C atm/mol	5.59E-03	6.37E-03	6.43E-03	7.04E-03
H' (unitless)	2.32E-01	2.65E-01	2.67E-01	2.93E-01
k_{oc} (mg/kg-carb/mg/L-wtr)	83	300	1100	240
k_s (cm^3-wtr/g-soil)	0.83	3	11	2.4
D^{air} (cm^2/s)	9.33E-02	8.38E-02	7.48E-02	7.40E-02
D^{water} (cm^2/s)	1.10E-05	9.40E-06	8.50E-06	8.50E-06
tau (sec)	936	1152	1404	1404
Residential-Specific Parameters				
ER (s^{-1} L/s)	0.00014	0.00014	0.00014	0.00014
L_b (cm)	200	200	200	200
t (sec)	9.50E+08	9.50E+08	9.50E+08	9.50E+08
Commercial-Specific Parameters				
ER (s^{-1} L/s)	0.00023	0.00023	0.00023	0.00023
L_b (cm)	300	300	300	300
t (sec)	7.90E+08	7.90E+08	7.90E+08	7.90E+08

APPENDIX B-2

Exposure Point Parameters and Calculation Spreadsheet (120 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Ambient Inhalation of Volatiles				
From Subsurface Soil				
D_{el}	2.58E-02	2.31E-02	2.07E-02	2.04E-02
K_{as}	2.80E-01	8.83E-02	2.43E-02	1.22E-01
Dispersivity	1.52E-03	4.48E-04	1.12E-04	5.42E-04
VF_{samb}	2.86E-05	1.49E-05	7.35E-06	1.65E-05
NAF	3.49E+04	6.70E+04	1.36E+05	6.04E+04
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Ambient Inhalation of Volatiles				
From Groundwater				
D_{cap}^{eff}	2.13E-05	1.77E-05	1.58E-05	1.52E-05
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{wamb}	7.62E-06	7.40E-06	6.68E-06	7.08E-06
NAF	1.31E+05	1.35E+05	1.50E+05	1.41E+05
Exp. Pt. Concentration (mg/m^3)	**9.14E-06**	**4.37E-06**	**2.07E-06**	**1.13E-05**
Residential Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
K_{sw}	1.07E+00	3.21E-01	9.00E-02	3.98E-01
VF_{seap} (1)	3.10E-02	9.56E-03	2.41E-03	1.15E-02
VF_{seap} (2)	1.15E-02	1.15E-02	1.15E-02	1.15E-02
VF_{seap} (min)	1.15E-02	9.56E-03	2.41E-03	1.15E-02
NAF	8.69E+01	1.05E+02	4.15E+02	8.69E+01
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Commercial Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
VF_{seap} (1)	1.26E-02	3.88E-03	9.78E-04	4.68E-03
VF_{seap} (2)	5.61E-03	5.61E-03	5.61E-03	5.61E-03
VF_{seap} (min)	5.61E-03	3.88E-03	9.78E-04	4.68E-03
NAF	1.78E+02	2.58E+02	1.02E+03	2.14E+02
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Residential Enclosed-Space Inhalation				
of Volatiles From Groundwater				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{weap}	1.52E-02	1.51E-02	1.36E-02	1.45E-02
NAF	6.57E+01	6.63E+01	7.35E+01	6.88E+01
Exp. Pt. Concentration (mg/m^3)	**1.83E-02**	**8.90E-03**	**4.22E-03**	**2.32E-02**

APPENDIX B-2

Exposure Point Parameters and Calculation Spreadsheet (120 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Commercial Enclosed-Space Inhalation				
of Volatiles From Groundwater				
VF_{weap}	6.18E-03	6.12E-03	5.52E-03	5.90E-03
NAF	1.62E+02	1.63E+02	1.81E+02	1.70E+02
Exp. Pt. Concentration (mg/m^3)	**7.42E-03**	**3.61E-03**	**1.71E-03**	**9.43E-03**
Subsurface Soil Leaching to				
Groundwater				
LF_{sw}	1.07E-02	3.21E-03	9.00E-04	3.98E-03
NAF	9.36E+01	3.11E+02	1.11E+03	2.52E+02
Exp. Pt. Concentration (mg/L)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**

Run #3 - 1800 feet from source area

APPENDIX B-3

Exposure Point Parameters and Calculation Spreadsheet (1800 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Field Measurements				
C_{soil} (mg/kg)	0	0	0	0
C_{gw} - leach from soil (mg/L)	0.000	0.000	0.000	0.000
C_{gw} - measured (mg/L)	0.0099	0.0048	0.0025	0.0130
C_{gw} - max (mg/L)	9.90E-03	4.80E-03	2.50E-03	1.30E-02
A (m^2)	100	100	100	100
L_s (cm)	580	580	580	580
L_{gw} (gw)	760	760	760	760
W (m)	20.0	20.0	20.0	20.0
h_{cap} (cm)	5.0	5.0	5.0	5.0
h_v (cm)	755.0	755	755	755
d_s (cm)	180.0	180	180	180
S_w (cm)	4000	4000	4000	4000
S_d (cm)	610	610	610	610
rho (gm/cm^3)	1.7	1.7	1.7	1.7
f_{oc} (g-carbon/g-soil)	0.01	0.01	0.01	0.01
phi wtr-vadose	0.12	0.12	0.12	0.12
phi air-vadose	0.26	0.26	0.26	0.26
phi total	0.38	0.38	0.38	0.38
phi wtr-cap	0.342	0.342	0.342	0.342
phi air-cap	0.038	0.038	0.038	0.038
phi wtr-crack	0.12	0.12	0.12	0.12
phi air-crack	0.26	0.26	0.26	0.26
Qr (cm^3/yr)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V_{gw} (cm/yr)	310	310	310	310
U_{air} (m/s)	2.25	2.25	2.25	2.25
delta air (m)	2.0	2.0	2.0	2.0
eta (cm^2-cracks/cm^2-total area)	0.01	0.01	0.01	0.01
L_{crack} (cm)	15.0	15.0	15.0	15.0
LDF (unitless)	100.0	100.0	100.0	100.0
Chemical-Specific Parameters				
H (at 20-C atm/mol	5.59E-03	6.37E-03	6.43E-03	7.04E-03
H' (unitless)	2.32E-01	2.65E-01	2.67E-01	2.93E-01
k_{oc} (mg/kg-carb/mg/L-wtr)	83	300	1100	240
k_s (cm^3-wtr/g-soil)	0.83	3	11	2.4
D^{air} (cm^2/s)	9.33E-02	8.38E-02	7.48E-02	7.40E-02
D^{water} (cm^2/s)	1.10E-05	9.40E-06	8.50E-06	8.50E-06
tau (sec)	936	1152	1404	1404
Residential-Specific Parameters				
ER (s^{-1} L/s)	0.00014	0.00014	0.00014	0.00014
L_b (cm)	200	200	200	200
t (sec)	9.50E+08	9.50E+08	9.50E+08	9.50E+08
Commercial-Specific Parameters				
ER (s^{-1} L/s)	0.00023	0.00023	0.00023	0.00023
L_b (cm)	300	300	300	300
t (sec)	7.90E+08	7.90E+08	7.90E+08	7.90E+08

Exposure Point Parameters and Calculation Spreadsheet (1800 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Ambient Inhalation of Volatiles				
From Subsurface Soil				
D_{ei}	2.58E-02	2.31E-02	2.07E-02	2.04E-02
K_{as}	2.80E-01	8.83E-02	2.43E-02	1.22E-01
Dispersivity	1.52E-03	4.48E-04	1.12E-04	5.42E-04
VF_{samb}	2.86E-05	1.49E-05	7.35E-06	1.65E-05
NAF	3.49E+04	6.70E+04	1.36E+05	6.04E+04
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Ambient Inhalation of Volatiles				
From Groundwater				
D_{cap}^{eff}	2.13E-05	1.77E-05	1.58E-05	1.52E-05
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{wamb}	7.62E-06	7.40E-06	6.68E-06	7.08E-06
NAF	1.31E+05	1.35E+05	1.50E+05	1.41E+05
Exp. Pt. Concentration (mg/m^3)	**7.54E-08**	**3.56E-08**	**1.67E-08**	**9.20E-08**
Residential Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
K_{sw}	1.07E+00	3.21E-01	9.00E-02	3.98E-01
VF_{seap} (1)	3.10E-02	9.56E-03	2.41E-03	1.15E-02
VF_{seap} (2)	1.15E-02	1.15E-02	1.15E-02	1.15E-02
VF_{seap} (min)	1.15E-02	9.56E-03	2.41E-03	1.15E-02
NAF	8.69E+01	1.05E+02	4.15E+02	8.69E+01
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Commercial Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
VF_{seap} (1)	1.26E-02	3.88E-03	9.78E-04	4.68E-03
VF_{seap} (2)	5.61E-03	5.61E-03	5.61E-03	5.61E-03
VF_{seap} (min)	5.61E-03	3.88E-03	9.78E-04	4.68E-03
NAF	1.78E+02	2.58E+02	1.02E+03	2.14E+02
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Residential Enclosed-Space Inhalation				
of Volatiles From Groundwater				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{weap}	1.52E-02	1.51E-02	1.36E-02	1.45E-02
NAF	6.57E+01	6.63E+01	7.35E+01	6.88E+01
Exp. Pt. Concentration (mg/m^3)	**1.51E-04**	**7.24E-05**	**3.40E-05**	**1.89E-04**

APPENDIX B-3

Exposure Point Parameters and Calculation Spreadsheet (1800 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Commercial Enclosed-Space Inhalation				
of Volatiles From Groundwater				
VF_{weap}	6.18E-03	6.12E-03	5.52E-03	5.90E-03
NAF	1.62E+02	1.63E+02	1.81E+02	1.70E+02
Exp. Pt. Concentration (mg/m^3)	**6.12E-05**	**2.94E-05**	**1.38E-05**	**7.66E-05**
Subsurface Soil Leaching to				
Groundwater				
LF_{sw}	1.07E-02	3.21E-03	9.00E-04	3.98E-03
NAF	9.36E+01	3.11E+02	1.11E+03	2.52E+02
Exp. Pt. Concentration (mg/L)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**

Run #4 - 2500 feet from source area

APPENDIX B-4

Exposure Point Parameters and Calculation Spreadsheet (2500 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Field Measurements				
C_{soil} (mg/kg)	0	0	0	0
C_{gw} - leach from soil (mg/L)	0.000	0.000	0.000	0.000
C_{gw} - measured (mg/L)	0.0051	0.0025	0.0013	0.0068
C_{gw} - max (mg/L)	5.10E-03	2.50E-03	1.30E-03	6.80E-03
A (m^2)	100	100	100	100
L_s (cm)	580	580	580	580
L_{gw} (gw)	760	760	760	760
W (m)	20.0	20.0	20.0	20.0
h_{cap} (cm)	5.0	5.0	5.0	5.0
h_v (cm)	755.0	755	755	755
d_s (cm)	180.0	180	180	180
S_w (cm)	4000	4000	4000	4000
S_d (cm)	610	610	610	610
rho (gm/cm^3)	1.7	1.7	1.7	1.7
f_{oc} (g-carbon/g-soil)	0.01	0.01	0.01	0.01
phi wtr-vadose	0.12	0.12	0.12	0.12
phi air-vadose	0.26	0.26	0.26	0.26
phi total	0.38	0.38	0.38	0.38
phi wtr-cap	0.342	0.342	0.342	0.342
phi air-cap	0.038	0.038	0.038	0.038
phi wtr-crack	0.12	0.12	0.12	0.12
phi air-crack	0.26	0.26	0.26	0.26
Qr (cm^3/yr)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V_{gw} (cm/yr)	310	310	310	310
U_{air} (m/s)	2.25	2.25	2.25	2.25
delta air (m)	2.0	2.0	2.0	2.0
eta (cm^2-cracks/cm^2-total area)	0.01	0.01	0.01	0.01
L_{crack} (cm)	15.0	15.0	15.0	15.0
LDF (unitless)	100.0	100.0	100.0	100.0
Chemical-Specific Parameters				
H (at 20-C atm/mol	5.59E-03	6.37E-03	6.43E-03	7.04E-03
H' (unitless)	2.32E-01	2.65E-01	2.67E-01	2.93E-01
k_{oc} (mg/kg-carb/mg/L-wtr)	83	300	1100	240
k_s (cm^3-wtr/g-soil)	0.83	3	11	2.4
D^{air} (cm^2/s)	9.33E-02	8.38E-02	7.48E-02	7.40E-02
D^{water} (cm^2/s)	1.10E-05	9.40E-06	8.50E-06	8.50E-06
tau (sec)	936	1152	1404	1404
Residential-Specific Parameters				
ER (s^{-1} L/s)	0.00014	0.00014	0.00014	0.00014
L_b (cm)	200	200	200	200
t (sec)	9.50E+08	9.50E+08	9.50E+08	9.50E+08
Commercial-Specific Parameters				
ER (s^{-1} L/s)	0.00023	0.00023	0.00023	0.00023
L_b (cm)	300	300	300	300
t (sec)	7.90E+08	7.90E+08	7.90E+08	7.90E+08

APPENDIX B-4

Exposure Point Parameters and Calculation Spreadsheet (2500 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Ambient Inhalation of Volatiles				
From Subsurface Soil				
D_{ei}	2.58E-02	2.31E-02	2.07E-02	2.04E-02
K_{as}	2.80E-01	8.83E-02	2.43E-02	1.22E-01
Dispersivity	1.52E-03	4.48E-04	1.12E-04	5.42E-04
VF_{samb}	2.86E-05	1.49E-05	7.35E-06	1.65E-05
NAF	3.49E+04	6.70E+04	1.36E+05	6.04E+04
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Ambient Inhalation of Volatiles				
From Groundwater				
D_{cap}^{eff}	2.13E-05	1.77E-05	1.58E-05	1.52E-05
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{wamb}	7.62E-06	7.40E-06	6.68E-06	7.08E-06
NAF	1.31E+05	1.35E+05	1.50E+05	1.41E+05
Exp. Pt. Concentration (mg/m^3)	**3.88E-08**	**1.85E-08**	**8.68E-09**	**4.81E-08**
Residential Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
K_{sw}	1.07E+00	3.21E-01	9.00E-02	3.98E-01
VF_{seap} (1)	3.10E-02	9.56E-03	2.41E-03	1.15E-02
VF_{seap} (2)	1.15E-02	1.15E-02	1.15E-02	1.15E-02
VF_{seap} (min)	1.15E-02	9.56E-03	2.41E-03	1.15E-02
NAF	8.69E+01	1.05E+02	4.15E+02	8.69E+01
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Commercial Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
VF_{seap} (1)	1.26E-02	3.88E-03	9.78E-04	4.68E-03
VF_{seap} (2)	5.61E-03	5.61E-03	5.61E-03	5.61E-03
VF_{seap} (min)	5.61E-03	3.88E-03	9.78E-04	4.68E-03
NAF	1.78E+02	2.58E+02	1.02E+03	2.14E+02
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Residential Enclosed-Space Inhalation				
of Volatiles From Groundwater				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{weap}	1.52E-02	1.51E-02	1.36E-02	1.45E-02
NAF	6.57E+01	6.63E+01	7.35E+01	6.88E+01
Exp. Pt. Concentration (mg/m^3)	**7.77E-05**	**3.77E-05**	**1.77E-05**	**9.88E-05**

APPENDIX B-4

Exposure Point Parameters and Calculation Spreadsheet (2500 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Commercial Enclosed-Space Inhalation				
of Volatiles From Groundwater				
VF_{weap}	6.18E-03	6.12E-03	5.52E-03	5.90E-03
NAF	1.62E+02	1.63E+02	1.81E+02	1.70E+02
Exp. Pt. Concentration (mg/m^3)	**3.15E-05**	**1.53E-05**	**7.17E-06**	**4.01E-05**
Subsurface Soil Leaching to				
Groundwater				
LF_{sw}	1.07E-02	3.21E-03	9.00E-04	3.98E-03
NAF	9.36E+01	3.11E+02	1.11E+03	2.52E+02
Exp. Pt. Concentration (mg/L)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**

Run #5 - 2700 feet from source area

APPENDIX B-5

Exposure Point Parameters and Calculation Spreadsheet (2700 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Field Measurements				
C_{soil} (mg/kg)	0	0	0	0
C_{gw} - leach from soil (mg/L)	0.000	0.000	0.000	0.000
C_{gw} - measured (mg/L)	0.0044	0.0021	0.0011	0.0058
C_{gw} - max (mg/L)	4.40E-03	2.10E-03	1.10E-03	5.80E-03
A (m^2)	100	100	100	100
L_s (cm)	580	580	580	580
L_{gw} (gw)	760	760	760	760
W (m)	20.0	20.0	20.0	20.0
h_{cap} (cm)	5.0	5.0	5.0	5.0
h_v (cm)	755.0	755	755	755
d_s (cm)	180.0	180	180	180
S_w (cm)	4000	4000	4000	4000
S_d (cm)	610	610	610	610
rho (gm/cm^3)	1.7	1.7	1.7	1.7
f_{oc} (g-carbon/g-soil)	0.01	0.01	0.01	0.01
phi wtr-vadose	0.12	0.12	0.12	0.12
phi air-vadose	0.26	0.26	0.26	0.26
phi total	0.38	0.38	0.38	0.38
phi wtr-cap	0.342	0.342	0.342	0.342
phi air-cap	0.038	0.038	0.038	0.038
phi wtr-crack	0.12	0.12	0.12	0.12
phi air-crack	0.26	0.26	0.26	0.26
Qr (cm^3/yr)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V_{gw} (cm/yr)	310	310	310	310
U_{air} (m/s)	2.25	2.25	2.25	2.25
delta air (m)	2.0	2.0	2.0	2.0
eta (cm^2-cracks/cm^2-total area)	0.01	0.01	0.01	0.01
L_{crack} (cm)	15.0	15.0	15.0	15.0
LDF (unitless)	100.0	100.0	100.0	100.0
Chemical-Specific Parameters				
H (at 20-C atm/mol	5.59E-03	6.37E-03	6.43E-03	7.04E-03
H' (unitless)	2.32E-01	2.65E-01	2.67E-01	2.93E-01
k_{oc} (mg/kg-carb/mg/L-wtr)	83	300	1100	240
k_s (cm^3-wtr/g-soil)	0.83	3	11	2.4
D^{air} (cm^2/s)	9.33E-02	8.38E-02	7.48E-02	7.40E-02
D^{water} (cm^2/s)	1.10E-05	9.40E-06	8.50E-06	8.50E-06
tau (sec)	936	1152	1404	1404
Residential-Specific Parameters				
ER (s^{-1} L/s)	0.00014	0.00014	0.00014	0.00014
L_b (cm)	200	200	200	200
t (sec)	9.50E+08	9.50E+08	9.50E+08	9.50E+08
Commercial-Specific Parameters				
ER (s^{-1} L/s)	0.00023	0.00023	0.00023	0.00023
L_b (cm)	300	300	300	300
t (sec)	7.90E+08	7.90E+08	7.90E+08	7.90E+08

APPENDIX B-5

Exposure Point Parameters and Calculation Spreadsheet (2700 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Ambient Inhalation of Volatiles				
From Subsurface Soil				
D_{ei}	2.58E-02	2.31E-02	2.07E-02	2.04E-02
K_{as}	2.80E-01	8.83E-02	2.43E-02	1.22E-01
Dispersivity	1.52E-03	4.48E-04	1.12E-04	5.42E-04
VF_{samb}	2.86E-05	1.49E-05	7.35E-06	1.65E-05
NAF	3.49E+04	6.70E+04	1.36E+05	6.04E+04
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Ambient Inhalation of Volatiles				
From Groundwater				
D_{cap}^{eff}	2.13E-05	1.77E-05	1.58E-05	1.52E-05
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{wamb}	7.62E-06	7.40E-06	6.68E-06	7.08E-06
NAF	1.31E+05	1.35E+05	1.50E+05	1.41E+05
Exp. Pt. Concentration (mg/m^3)	**3.35E-08**	**1.55E-08**	**7.34E-09**	**4.10E-08**
Residential Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_s^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
K_{sw}	1.07E+00	3.21E-01	9.00E-02	3.98E-01
VF_{seap} (1)	3.10E-02	9.56E-03	2.41E-03	1.15E-02
VF_{seap} (2)	1.15E-02	1.15E-02	1.15E-02	1.15E-02
VF_{seap} (min)	1.15E-02	9.56E-03	2.41E-03	1.15E-02
NAF	8.69E+01	1.05E+02	4.15E+02	8.69E+01
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Commercial Enclosed-Space Inhalation				
of Volatiles From Subsurface Soil				
VF_{seap} (1)	1.26E-02	3.88E-03	9.78E-04	4.68E-03
VF_{seap} (2)	5.61E-03	5.61E-03	5.61E-03	5.61E-03
VF_{seap} (min)	5.61E-03	3.88E-03	9.78E-04	4.68E-03
NAF	1.78E+02	2.58E+02	1.02E+03	2.14E+02
Exp. Pt. Concentration (mg/m^3)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Residential Enclosed-Space Inhalation				
of Volatiles From Groundwater				
D_{crack}^{eff}	7.28E-03	6.54E-03	5.84E-03	5.77E-03
D_{ws}^{eff}	2.24E-03	1.91E-03	1.71E-03	1.65E-03
VF_{weap}	1.52E-02	1.51E-02	1.36E-02	1.45E-02
NAF	6.57E+01	6.63E+01	7.35E+01	6.88E+01
Exp. Pt. Concentration (mg/m^3)	**6.70E-05**	**3.17E-05**	**1.50E-05**	**8.43E-05**

APPENDIX B-5

Exposure Point Parameters and Calculation Spreadsheet (2700 feet off-site)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes
Commercial Enclosed-Space Inhalation				
of Volatiles From Groundwater				
VF_{weap}	6.18E-03	6.12E-03	5.52E-03	5.90E-03
NAF	1.62E+02	1.63E+02	1.81E+02	1.70E+02
Exp. Pt. Concentration (mg/m^3)	**2.72E-05**	**1.29E-05**	**6.07E-06**	**3.42E-05**
Subsurface Soil Leaching to				
Groundwater				
LF_{sw}	1.07E-02	3.21E-03	9.00E-04	3.98E-03
NAF	9.36E+01	3.11E+02	1.11E+03	2.52E+02
Exp. Pt. Concentration (mg/L)	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**

APPENDIX C
Chemical Intake and Risk Calculations Spreadsheets

APPENDIX C-1

Chemical Intake and Risk Calculations
Groundwater Ingestion

Future On-site Commercial Receptor

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes	Total Risk
Exposure Point Concentration	**2.16E+00**	1.05E+00	5.50E-01	2.86E+00	
Units	mg/L	mg/L	mg/L	mg/L	
Intake Rate Parameters					
IRw (L/day)	1.0	1.0	1.0	1.0	
Exposure Parameters					
EF (days/yr)	250	250	250	250	
ED (years)	25	25	25	25	
BW (kg)	70	70	70	70	
AT (years)	70	25	25	25	
Chemical Intake (mg/kg-day)	**7.55E-03**	**1.03E-02**	**5.38E-03**	**2.80E-02**	
SFo	8.40E-03				
RfDo		2.00E-01	1.00E-01	2.00E+00	
Carcinogenic Risk	**6.34E-06**				**6.34E-06**
Hazard Quotient		**5.14E-02**	**5.38E-02**	**1.40E-02**	**1.19E-01**

Current Off-site Residential Receptor (2700 feet down-gradient)

Exposure Point Concentration	4.40E-03	2.10E-03	1.10E-03	5.80E-03	
Units	mg/L	mg/L	mg/L	mg/L	
Intake Rate Parameters					
IRw (L/day)	2.0	2.0	2.0	2.0	
Exposure Parameters					
EF (days/yr)	350	350	350	350	
ED (years)	30	30	30	30	
BW (kg)	70	70	70	70	
AT (years)	70	30	30	30	
Chemical Intake (mg/kg-day)	**5.17E-05**	**5.75E-05**	**3.01E-05**	**1.59E-04**	
SFo	8.40E-03				
RfDo		2.00E-01	1.00E-01	2.00E+00	
Carcinogenic Risk	**4.34E-07**				**4.34E-07**
Hazard Quotient		**2.88E-04**	**3.01E-04**	**7.95E-05**	**6.68E-04**

APPENDIX C-1

Chemical Intake and Risk Calculations
Groundwater Ingestion

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes	Total Risk
Future Off-site Residential Receptor (2500 feet down-gradient)					
Exposure Point Concentration	5.10E-03	2.50E-03	1.30E-03	6.80E-03	
Units	mg/L	mg/L	mg/L	mg/L	
Intake Rate Parameters					
IRw (L/day)	1.4	1.4	1.4	1.4	
Exposure Parameters					
EF (days/yr)	235	235	235	235	
ED (years)	9	9	9	9	
BW (kg)	70	70	70	70	
AT (years)	70	9	9	9	
Chemical Intake (mg/kg-day)	**8.44E-06**	**3.22E-05**	**1.67E-05**	**8.76E-05**	
SFo	8.40E-03				
RfDo		2.00E-01	1.00E-01	2.00E+00	
Carcinogenic Risk	**7.09E-08**				**7.09E-08**
Hazard Quotient		**1.61E-04**	**1.67E-04**	**4.38E-05**	**3.72E-04**

APPENDIX C-2

Chemical Intake and Risk Calculations
Inhalation of Vapors from Subsurface Soil and/or Groundwater

Current On-site Commercial Receptor (ambient)

Parameters	Benzene (C)	Toluene	Ethylbenzene	Xylenes	Benxene (N)	Total Risk
Exposure Point Concentration	6.15E-04	2.40E-03	8.12E-04	1.16E-02	6.15E-04	
Units (soil + water)	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	
Intake Rate Parameters						
IRa (m^3/day)	20.0	20.0	20.0	20.0	20.0	
Exposure Parameters						
EF (days/yr)	250	250	250	250	250	
ED (years)	25	25	25	25	25	
BW (kg)	70	70	70	70	70	
AT (years)	70	25	25	25	25	
Chemical Intake (mg/kg-day)	**4.29E-05**	**4.69E-04**	**1.59E-04**	**2.27E-03**	**1.20E-04**	
SFi	8.40E-03					
RfDi		4.00E-01	1.00E+00	8.60E-02	1.70E-03	
Carcinogenic Risk	**3.61E-07**					**3.61E-07**
Hazard Quotient		**1.17E-03**	**1.59E-04**	**2.64E-02**	**7.07E-02**	**9.85E-02**

Current Off-site Commercial Receptor (enclosed-space/120 feet down-gradient)

Exposure Point Concentration	7.42E-03	3.61E-03	1.71E-03	9.43E-03	7.42E-03	
Units (water)	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	
Intake Rate Parameters						
IRa (m^3/day)	20.0	20.0	20.0	20.0	20.0	
Exposure Parameters						
EF (days/yr)	250	250	250	250	250	
ED (years)	25	25	25	25	25	
BW (kg)	70	70	70	70	70	
AT (years)	70	25	25	25	25	
Chemical Intake (mg/kg-day)	**5.19E-04**	**7.06E-04**	**3.35E-04**	**1.85E-03**	**1.45E-03**	
SFi	8.40E-03					
RfDi		4.00E-01	1.00E+00	8.60E-02	1.70E-03	
Carcinogenic Risk	**4.36E-06**					**4.36E-06**
Hazard Quotient		**1.77E-03**	**3.35E-04**	**2.15E-02**	**8.54E-01**	**8.78E-01**

APPENDIX C-2

Chemical Intake and Risk Calculations
Inhalation of Vapors from Subsurface Soil and/or Groundwater

Current Off-site Residential Receptor (enclosed-space/1800 feet down-gradient)

Parameters	Benzene (C)	Toluene	Ethylbenzene	Xylenes	Benxene (N)	Total Risk
Exposure Point Concentration	1.51E-04	7.24E-05	3.40E-05	1.89E-04	1.51E-04	
Units (water)	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	
Intake Rate Parameters						
IRa (m^3/day)	15.0	15.0	15.0	15.0	15.0	
Exposure Parameters						
EF (days/yr)	350	350	350	350	350	
ED (years)	30	30	30	30	30	
BW (kg)	70	70	70	70	70	
AT (years)	70	30	30	30	30	
Chemical Intake (mg/kg-day)	**1.33E-05**	**1.49E-05**	**6.99E-06**	**3.88E-05**	**3.10E-05**	
SFi	8.40E-03					
RfDi		4.00E-01	1.00E+00	8.60E-02	1.70E-03	
Carcinogenic Risk	**1.12E-07**					**1.12E-07**
Hazard Quotient		**3.72E-05**	**6.99E-06**	**4.52E-04**	**1.83E-02**	**1.87E-02**

Future On-site Commercial Worker Receptor (enclosed-space)

Exposure Point Concentration	1.30E-01	6.27E-01	1.11E-01	3.30E+00	1.30E-01	
Units (soil + water)	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	
Intake Rate Parameters						
IRa (m^3/day)	20.0	20.0	20.0	20.0	20.0	
Exposure Parameters						
EF (days/yr)	250	250	250	250	250	
ED (years)	25	25	25	25	25	
BW (kg)	70	70	70	70	70	
AT (years)	70	25	25	25	25	
Chemical Intake (mg/kg-day)	**9.11E-03**	**1.23E-01**	**2.17E-02**	**6.45E-01**	**2.55E-02**	
SFi	8.40E-03					
RfDi		4.00E-01	1.00E+00	8.60E-02	1.70E-03	
Carcinogenic Risk	**7.65E-05**					**7.65E-05**
Hazard Quotient		**3.07E-01**	**2.17E-02**	**7.50E+00**	**1.50E+01**	**2.28E+01**

APPENDIX C-3

Chemical Intake and Risk Calculations
Dermal Contact with Groundwater

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes	Total Risk
Current Off-site Residential Receptor (showering/2700 feet down-gradient)					
Exposure Point Concentration	4.40E-03	2.10E-03	1.10E-03	5.80E-03	
Units (water)	mg/L	mg/L	mg/L	mg/L	
Intake Rate Parameters					
EV (events/day)	1.0	1.0	1.0	1.0	
B (unitless)	1.30E-02	5.40E-02	1.40E-01	1.60E-01	
Kp (cm/hr)	2.10E-02	4.50E-02	7.40E-02	8.00E-02	
tau (hr)	2.60E-01	3.20E-01	3.90E-01	3.90E-01	
Z (cm/event)	1.66E-02	4.29E-02	8.88E-02	9.75E-02	
Exposure Parameters					
EF (days/yr)	350	350	350	350	
ED (years)	33	33	33	33	
BW (kg)	70	70	70	70	
AT (years)	70	33	33	33	
t-event (hr/day)	0.26	0.26	0.26	0.26	
SA (cm^2)	23000	23000	23000	23000	
Chemical Intake (mg/kg-day)	**1.08E-05**	**2.84E-05**	**3.08E-05**	**1.78E-04**	
SFd	8.70E-03				
RfDd		1.60E-01	9.70E-02	1.84E+00	
Carcinogenic Risk	**9.43E-08**				**9.43E-08**
Hazard Quotient		**1.77E-04**	**3.17E-04**	**9.69E-05**	**5.91E-04**

APPENDIX C-3

Chemical Intake and Risk Calculations
Dermal Contact with Groundwater

Future Off-site Residential Receptor (showering/2500 feet down-gradient)

Parameters	Benzene	Toluene	Ethylbenzene	Xylenes	Total Risk
Exposure Point Concentration	5.10E-03	2.50E-03	1.30E-03	6.80E-03	
Units (water)	mg/L	mg/L	mg/L	mg/L	
Intake Rate Parameters					
EV (events/day)	1.0	1.0	1.0	1.0	
B (unitless)	1.30E-02	5.40E-02	1.40E-01	1.60E-01	
Kp (cm/hr)	2.10E-02	4.50E-02	7.40E-02	8.00E-02	
tau (hr)	2.60E-01	3.20E-01	3.90E-01	3.90E-01	
Z (cm/event)	1.47E-02	3.89E-02	8.27E-02	9.11E-02	
Exposure Parameters					
EF (days/yr)	235	235	235	235	
ED (years)	33	33	33	33	
BW (kg)	70	70	70	70	
AT (years)	70	33	33	33	
t-event (hr/day)	0.167	0.167	0.167	0.167	
SA (cm^2)	20000	20000	20000	20000	
Chemical Intake (mg/kg-day)	**6.48E-06**	**1.79E-05**	**1.98E-05**	**1.14E-04**	
SFd	8.70E-03				
RfDd		1.60E-01	9.70E-02	1.84E+00	
Carcinogenic Risk	**5.64E-08**				**5.64E-08**
Hazard Quotient		**1.12E-04**	**2.04E-04**	**6.20E-05**	**3.78E-04**