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September 6, 2018

Bill Gierke
Manager, Site Remediation and Due Diligence
Pfizer Global Engineering - Pfizer Inc.
100 Route 206 North M/S 611
Peapack, NJ 07977

Subject: Barceloneta, PR Facility
Benzene Cleanup Level for Soil Vapor

Dear Bill:

Per your request, TRC has revised the technical memorandum summarizing our work to develop a soil-gas cleanup value for benzene at the above referenced facility in response to EPA's comment letter of August 20, 2018.

Should you have any questions, I can be reached at 860-298-6351. Thank you for the opportunity to work with you on this effort.

Very Truly Yours,

TRC

A handwritten signature in black ink, appearing to read "Karen M. Vetrano", with a large, stylized loop at the end.

Karen M. Vetrano, Ph.D.
Manager, Risk Assessment and Toxicology

TECHNICAL MEMORANDUM

INTRODUCTION

TRC previously prepared a RCRA Facility Investigation Report for the Pfizer Facility in Barceloneta, Puerto Rico in 2007. As part of the investigation, TRC prepared a human health risk assessment evaluating future construction workers and current/future commercial/industrial workers. The results of the risk assessment showed that construction worker and commercial/industrial worker exposures to soils and groundwater were below the target levels of $1\text{E-}04$ and $1\text{E+}00$ for cancer risks and non-cancer hazards, respectively. Using USEPA's Johnson and Ettinger (J&E) Model (SG-SCREEN, version 3.1; 02/04) and RFI data (TRC 2007), the model evaluation showed a potential exposure risk from soil vapor intrusion of benzene to indoor air. The benzene in soil gas has undergone remediation by soil vapor extraction (SVE).

This memo provides calculated soil vapor clean-up levels for benzene under two commercial/industrial worker scenarios so that Pfizer, in cooperation with EPA, can determine when the remediation is complete.

METHODOLOGY

USEPA's J&E Model (v. 6.0) was recently updated in September 2017. The revised model provides incremental risk estimates and risk-based target screening levels, including target soil gas concentrations. All site specific input parameters used for the J&E Model during the RFI risk assessment (TRC 2007) were used for the calculation of the clean-up values, including the assumption of the presence of a concrete slab for each indoor air scenario. Although the J&E model uses a default $Q_{\text{soil}}/Q_{\text{building}}$ ratio of 0.003, per EPA's comments, the ratio has been changed to 0.03 to reflect the default attenuation factor used in EPA's VISL calculator.

TRC calculated soil gas clean-up values under two different commercial/industrial worker scenarios (See Attachment A for J&E spreadsheets):

Current/Future Pfizer Worker – TRC calculated a soil gas clean-up value based upon a current/future Pfizer worker exposure as originally evaluated in the risk assessment (TRC 2007). The clean-up value was calculated based upon the OSHA PEL of 1 ppm (3.19 mg/m^3) as the benchmark value with USEPA default commercial/industrial worker input parameters. The workers are assumed to work 8 hours per day, 250 days per year for 25 years. This assumes that Pfizer employees have gone through OSHA Hazard Communication (HAZCOM) training for chemicals used/stored on site (i.e. benzene). This value is for reference only considering current operations.

Future Commercial/Industrial Worker – TRC calculated a risk-based soil gas clean-up value based upon a future commercial/industrial worker scenario. This assumes that the property is eventually sold and another commercial/industrial business is conducted in existing buildings or newly constructed on the site. There is no assumption that the employees would be trained under OSHA HAZCOM, therefore, the clean-up value is based upon USEPA's cancer slope factor and non-cancer reference concentration for benzene with USEPA default commercial/industrial worker input parameters. The workers are assumed to work 8 hours per day, 250 days per year for 25 years. The target cancer risk (TCR) was set at $1\text{E-}06$, $1\text{E-}05$ and $1\text{E-}04$ and the Hazard Quotient was set at 1.

RESULTS

Table 1 presents the soil gas clean-up value calculated under the OSHA PEL scenario for reference only, while Table 2 presents the USEPA risk-based soil gas clean-up values using TCRs of 1E-06, 1E-05 and 1E-04. Remedial decisions will be made using the USEPA risk-based soil gas clean-up values. Attachment A provides the J&E spreadsheets for each scenario.

TABLE 1. Target benzene clean-up value under OSHA PEL Scenario.

Scenario	Benzene Soil Gas Value (mg/m ³)
Current/Future Pfizer Worker – OSHA*	57,800

*For reference only

TABLE 2. Target benzene USEPA risk-based clean-up value.

Scenario	Benzene Soil Gas Value (mg/m ³) TCR = 1E-06	Benzene Soil Gas Value (mg/m ³) TCR = 1E-05	Benzene Soil Gas Value (mg/m ³) TCR = 1E-04
Future Commercial/Industrial Worker – USEPA Risk Based	6.5	65	543

TCR = target cancer risk

CONCLUSIONS

Pfizer has indicated that the site area with industrial operations will be deed-restricted to commercial/industrial use; in addition, since benzene is the only constituent of concern, the risk-based clean up value of 65 mg/m³ at a TCR of 1E-05 would be the most applicable for a remediation cleanup goal.

REFERENCES

TRC 2007. Draft RCRA Facility Investigation Supplemental Report. Pfizer Pharmaceuticals, LLC, Barceloneta, Puerto Rico. EPA I.D. No. PRD-090346909. June.

ATTACHMENT A

JOHNSON & ETTINGER WORKSHEETS

**COMMERCIAL/INDUSTRIAL WORKER –
OSHA PEL BASED CLEAN-UP VALUE
For Reference Only**

Preview	Unit	Value	Range	Default	Default Range	
Soil gas to indoor air attenuation coefficient	(-)	2.4E-04	#REF!	0.0002	#REF!	
Predicted indoor air concentration due to vapor intrusion	(ug/m3)	3.4E+04	#REF!	3.4E+04	#REF!	
Please check WARNING or ERROR flags	(ppbv)	1.1E+04	#REF!	1.1E+04	#REF!	Warning: Some versions of excel do not

Model Input

Site Name/Run Number:

Note:
 -Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
 -Dotted outline cells indicate default values that may be changed with justification.
 -Toxicity values are taken from the Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Exterior Soil Gas					
Soil gas concentration	(ug/m3)	Cmedium	149032314.6		NA			
Depth below grade to soil gas sample	(m)	Ls	5.05		Vary - 50	NA		
Average vadose zone temperature	(°C)	Ts	25	25	3-30			
Calc: Source vapor concentration	(ug/m3)	Cs	149032315					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	37.412%					

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Benzene					
CAS No.		CAS	71-43-2					
Toxicity Factors								
Unit risk factor	(ug/m ³) ⁻¹	IUR	Not Available	Not Available	NA	NA		No IUR available for this compound.
Mutagenic compound		Mut	No	NA	NA	NA		
Reference concentration	(mg/m ³)	PEL	3.19E+00	3.19E+00	NA	NA		

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	1.79E+03	1.79E+03	NA	NA		
Henry's Law Constant @ 25°C	(atm-m ³ /mol)	Hc	5.55E-03	5.55E-03	NA	NA		
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	2.27E-01	2.27E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	2.27E-01	2.27E-01				
Diffusivity in air	(cm2/s)	Dair	8.95E-02	8.95E-02	NA	NA		
Diffusivity in water	(cm2/s)	Dwater	1.03E-05	1.03E-05	NA	NA		

Building Characteristics:

Select Building Assumptions:

☒ Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)

☐ Specify Qsoil and Qbuilding separately; calculate ratio

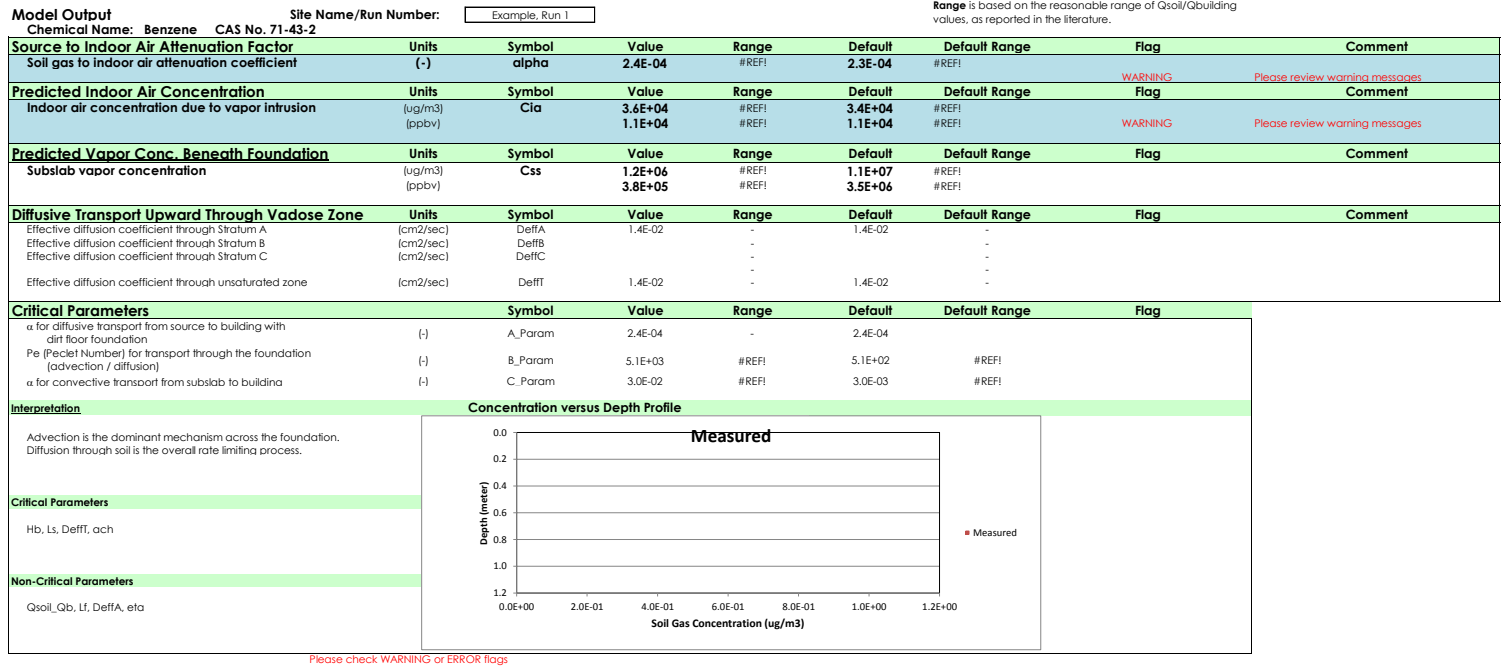
	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Commercial	Commercial				
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade				
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00		
Enclosed space floor area	(m2)	Abf	1500.00	1500.00	80-1000	NA		
Enclosed space mixing height	(m)	Hb	3.00	3.00	2.13 - 3.05	NA		
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	.3-4.1	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0300	0.0030	0.0001 - 0.05	1.24	WARNING	
Calc: Building ventilation rate	(m3/hr)	Qb	6750.00	6750.00	NA	0.30		
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	202.50	20.25	NA	NA		

Model Input Site Name/Run Number: Example, Run 1

Chemical Name: Benzene CAS No. 71-43-2

Depth below grade to soil gas sample: 5.05 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sand					
Stratum A thickness (from surface)	(m)	hSA	5.05					
Stratum A total porosity	(-)	nSA	0.375	0.375	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.054	0.054	0.053 - 0.055	0.25		
Stratum A bulk density	(g/cm³)	rhoSA	1.660	1.660	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm³)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm³)	rhoSC			NA	NA		
Stratum containing soil gas sample								
Stratum A, B, or C		src_soil	Stratum A					
					NA	NA		
					NA			
					NA			
Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-04	1.00E-06	NA	NA	WARNING	Value is different from default value; please justify.
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Commercial	Commercial				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA		
Exposure duration	(yrs)	ED	25	25	NA	NA		
Exposure frequency	(days/yr)	EF	250	250	NA	NA		
Exposure time	(hrs/24 hrs)	ET	8	8	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE	MMOAF not relevant for non-mutagenic compounds



Model Output		Site Name/Run Number:		Example, Run 1				
Chemical Name: Benzene		CAS No. 71-43-2						
Risk Calculations	Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels Scenario: Commercial								
Target risk for carcinogens	(-)	Target_CR	1E-04	-	1E-04	-		
Target hazard quotient for noncarcinogens	(-)	Target_HQ	1	-	1	-		
Target indoor air concentration	(ug/m3)	Target_IA	1.40E+04	-	1.40E+04	-	Target indoor air concentration based upon PEL	
	(ppbv)		4.38E+03	-	4.38E+03	-		
Target soil gas concentration	(ug/m3)	Target_SV	5.78E+07	#REF!	6.20E+07	#REF!		
Incremental Risk Estimates								
Incremental cancer risk from vapor intrusion	(-)	Cancer_Risk	No IUR	-	No IUR	No IUR - No IUR		
Hazard quotient from vapor intrusion	(-)	HQ	2.58E+00	#REF!	2.41E+00	#REF!		

**FUTURE COMMERCIAL/INDUSTRIAL WORKER –
USEPA RISK-BASED CLEAN-UP VALUE
 $Q_{soil_Qb} = 0.03$; $TCR = 1E-06$**

Preview	Unit	Value	Range	Default	Default Range	
Soil gas to indoor air attenuation coefficient	(-)	2.4E-04	#REF!	0.0002	#REF!	
Predicted indoor air concentration due to vapor intrusion	(ug/m3)	3.4E+04	#REF!	3.4E+04	#REF!	
Please check WARNING or ERROR flags	(ppbv)	1.1E+04	#REF!	1.1E+04	#REF!	Warning: Some versions of excel do not support the CONCATENATE function, so the range values will appear broken. To fix, either upgrade your version of Excel (preferred) or replace all occurrences of 'CONCATENATE' with 'CONCAT.'

Model Input

Site Name/Run Number:

Example, Run 1

Note:

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-Dotted outline cells indicate default values that may be changed with justification.

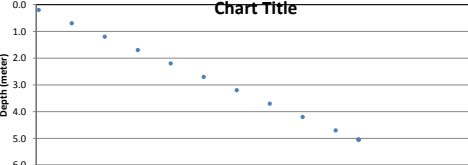
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Exterior Soil Gas					
Soil gas concentration	(ug/m3)	Cmedium	149032314.6		NA			95% UCL from 2007 RA
Depth below grade to soil gas sample	(m)	Ls	5.05		Vary - 50	NA		
Average vadose zone temperature	(°C)	Ts	25	25	3-30			
Calc: Source vapor concentration	(ug/m3)	Cs	149032315					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	37.412%					
Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Benzene					
CAS No.		CAS	71-43-2					
Toxicity Factors								
Unit risk factor	(ug/m ³) ⁻¹	IUR	7.80E-06	7.80E-06	NA	NA		
Mutagenic compound		Mut	No	NA	NA	NA		
Reference concentration	(mg/m ³)	RTC	3.00E-02	3.00E-02	NA	NA		
Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	1.79E+03	1.79E+03	NA	NA		
Henry's Law Constant @ 25°C	(atm-m ³ /mol)	Hc	5.55E-03	5.55E-03	NA	NA		
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	2.27E-01	2.27E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	2.27E-01	2.27E-01				
Diffusivity in air	(cm2/s)	Dair	8.95E-02	8.95E-02	NA	NA		
Diffusivity in water	(cm2/s)	Dwater	1.03E-05	1.03E-05	NA	NA		
Building Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Select Building Assumptions								
● Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)								
○ Specify Qsoil and Qbuilding separately; calculate ratio								
Building setting		Bldg_Setting	Commercial	Commercial				
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade				
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00		
Enclosed space floor area	(m2)	Abf	1500.00	1500.00	80-1000	NA		
Enclosed space mixing height	(m)	Hb	3.00	3.00	2.13 - 3.05	NA		
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	~3-4.1	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0300	0.0030	0.0001 - 0.05	1.24	WARNING	
Calc: Building ventilation rate	(m3/hr)	Qb	6750.00	6750.00	NA	0.30		
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	202.50	20.25	NA	NA		

Model Input Site Name/Run Number: Example, Run 1
 Chemical Name: Benzene CAS No. 71-43-2
 Depth below grade to soil gas sample: 5.05 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sand					
Stratum A thickness (from surface)	(m)	hSA	5.05					
Stratum A total porosity	(-)	nSA	0.375	0.375	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.054	0.054	0.053 - 0.055	0.25		
Stratum A bulk density	(g/cm³)	rhoSA	1.660	1.660	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm³)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm³)	rhoSC			NA	NA		
Stratum containing soil gas sample								
Stratum A, B, or C		src_soil	Stratum A		NA	NA		
					NA			
					NA			
Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA		
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Commercial	Commercial				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA		
Exposure duration	(yrs)	ED	25	25	NA	NA		
Exposure frequency	(days/yr)	EF	250	250	NA	NA		
Exposure time	(hrs/24 hrs)	ET	8	8	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE	MMOAF not relevant for non-mutagenic compounds

Model Output		Site Name/Run Number:		Example, Run 1					
Chemical Name: Benzene		CAS No. 71-43-2							
Source to Indoor Air Attenuation Factor		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Soil gas to indoor air attenuation coefficient		(-)	alpha	2.4E-04	#REF!	2.3E-04	#REF!		
Predicted Indoor Air Concentration		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion		(ug/m3)	Cia	3.6E+04	#REF!	3.4E+04	#REF!		
		(ppbv)		1.1E+04	#REF!	1.1E+04	#REF!	WARNING	Please review warning messages
Predicted Vapor Conc. Beneath Foundation		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration		(ug/m3)	Css	1.2E+06	#REF!	1.1E+07	#REF!		
		(ppbv)		3.8E+05	#REF!	3.5E+06	#REF!	WARNING	Please review warning messages
Diffusive Transport Upward Through Vadose Zone		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A		(cm2/sec)	DeffA	1.4E-02	-	1.4E-02	-		
Effective diffusion coefficient through Stratum B		(cm2/sec)	DeffB	-	-	-	-		
Effective diffusion coefficient through Stratum C		(cm2/sec)	DeffC	-	-	-	-		
Effective diffusion coefficient through unsaturated zone		(cm2/sec)	DeffT	1.4E-02	-	1.4E-02	-		
Critical Parameters			Symbol	Value	Range	Default	Default Range	Flag	
alpha for diffusive transport from source to building with dirt floor foundation		(-)	A_Param	2.4E-04	-	2.4E-04			
Pe (Peclet Number) for transport through the foundation (advection / diffusion)		(-)	B_Param	5.1E+03	#REF!	5.1E+02	#REF!		
alpha for convective transport from subslab to building		(-)	C_Param	3.0E-02	#REF!	3.0E-03	#REF!		
Interpretation		Concentration versus Depth Profile							
Advection is the dominant mechanism across the foundation. Diffusion through soil is the overall rate limiting process.		Chart Title  • Calculated • Measured							
Critical Parameters		Hb, Ls, DeffT, ach							
Non-Critical Parameters		Qsoil, Qb, Lt, DeffA, eta							

Please check WARNING or ERROR flags.

Model Output		Site Name/Run Number:		Example, Run 1					
Chemical Name: Benzene		CAS No. 71-43-2							
Risk Calculations		Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels		Scenario: Commercial							
Target risk for carcinogens		(-)	Target_CR	1E-06	-	1E-06	-		
Target hazard quotient for noncarcinogens		(-)	Target_HQ	1	-	1	-		
Target indoor air concentration		(ug/m3)	Target_IA	1.57E+00	-	1.57E+00	-		Target indoor air concentration based on cancer risk (unit risk factor)
		(ppbv)		4.92E-01	-	4.92E-01	-		
Target soil gas concentration		(ua/m3)	Target_SV	6.50E+03	#REF!	6.97E+03	#REF!		
Incremental Risk Estimates									
Incremental cancer risk from vapor intrusion		(-)	Cancer_Risk	2.29E-02	#REF!	2.14E-02	#REF!		
Hazard quotient from vapor intrusion		(-)	HQ	2.74E+02	#REF!	2.56E+02	#REF!		

FUTURE COMMERCIAL/INDUSTRIAL WORKER –
USEPA RISK-BASED CLEAN-UP VALUE
 $Q_{\text{soil_Qb}} = 0.03$; $TCR = 1E-05$

Preview	Unit	Value	Range	Default	Default Range	
Soil gas to indoor air attenuation coefficient	(-)	2.4E-04	#REF!	0.0002	#REF!	
Predicted indoor air concentration due to vapor intrusion	(ug/m3)	3.4E+04	#REF!	3.4E+04	#REF!	
Please check WARNING or ERROR flags	(ppbv)	1.1E+04	#REF!	1.1E+04	#REF!	

Warning: Some versions of excel do not support the CONCATENATE function, so the range values will appear broken. To fix, either upgrade your version of Excel (preferred) or replace all occurrences of 'CONCATENATE' with 'CONCAT.'

Model Input

Site Name/Run Number:

Example, Run 1

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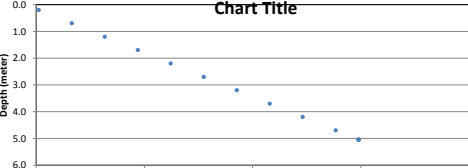
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Soil gas concentration	(ug/m3)	Cmedium	149032314.6		NA			95% UCL from 2007 RA
Depth below grade to soil gas sample	(m)	Ls	5.05		Vary - 50	NA		
Average vadose zone temperature	(°C)	Ts	25	25	3-30			
Calc: Source vapor concentration	(ug/m3)	Cs	149032315					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	37.412%					
Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Benzene					
CAS No.		CAS	71-43-2					
Toxicity Factors								
Unit risk factor	(ug/m ³) ⁻¹	IUR	7.80E-06	7.80E-06	NA	NA		
Mutagenic compound		Mut	No	NA	NA	NA		
Reference concentration	(mg/m ³)	RTC	3.00E-02	3.00E-02	NA	NA		
Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	1.79E+03	1.79E+03	NA	NA		
Henry's Law Constant @ 25°C	(atm-m ³ /mol)	Hc	5.55E-03	5.55E-03	NA	NA		
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	2.27E-01	2.27E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	2.27E-01	2.27E-01				
Diffusivity in air	(cm ² /s)	Dair	8.95E-02	8.95E-02	NA	NA		
Diffusivity in water	(cm ² /s)	Dwater	1.03E-05	1.03E-05	NA	NA		
Building Characteristics:								
Select Building Assumptions								
☒ Use ratio for Qsoil/Qbuilding (recommended if no site specific data available) ☐ Specify Qsoil and Qbuilding separately; calculate ratio								
	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Commercial	Commercial				
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade				
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00		
Enclosed space floor area	(m ²)	Abf	1500.00	1500.00	80-1000	NA		
Enclosed space mixing height	(m)	Hb	3.00	3.00	2.13 - 3.05	NA		
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	.3-4.1	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0300	0.0030	0.0001 - 0.05	1.24	WARNING	
Calc: Building ventilation rate	(m ³ /hr)	Qb	6750.00	6750.00	NA	0.30		
Calc: Average vapor flow rate into building	(m ³ /hr)	Qsoil	202.50	20.25	NA	NA		

Model Input Site Name/Run Number: Example, Run 1
 Chemical Name: Benzene CAS No. 71-43-2
 Depth below grade to soil gas sample: 5.05 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sand					
Stratum A thickness (from surface)	(m)	hSA	5.05					
Stratum A total porosity	(-)	nSA	0.375	0.375	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.054	0.054	0.053 - 0.055	0.25		
Stratum A bulk density	(g/cm³)	rhoSA	1.660	1.660	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm³)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm³)	rhoSC			NA	NA		
Stratum containing soil gas sample								
Stratum A, B, or C		src_soil	Stratum A		NA	NA		
					NA			
					NA			
Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-05	1.00E-06	NA	NA	WARNING	Value is different from default value; please justify.
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Commercial	Commercial				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA		
Exposure duration	(yrs)	ED	25	25	NA	NA		
Exposure frequency	(days/yr)	EF	250	250	NA	NA		
Exposure time	(hrs/24 hrs)	ET	8	8	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE	MMOAF not relevant for non-mutagenic compounds

Model Output		Site Name/Run Number:		Example, Run 1					
Chemical Name: Benzene CAS No. 71-43-2									
Source to Indoor Air Attenuation Factor		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Soil gas to indoor air attenuation coefficient		(-)	alpha	2.4E-04	#REF!	2.3E-04	#REF!		
Predicted Indoor Air Concentration		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion		(ug/m3)	Cia	3.6E+04	#REF!	3.4E+04	#REF!		
		(ppbv)		1.1E+04	#REF!	1.1E+04	#REF!	WARNING	Please review warning messages
Predicted Vapor Conc. Beneath Foundation		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration		(ug/m3)	Css	1.2E+06	#REF!	1.1E+07	#REF!		
		(ppbv)		3.8E+05	#REF!	3.5E+06	#REF!	WARNING	Please review warning messages
Diffusive Transport Upward Through Vadose Zone		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A		(cm2/sec)	DeffA	1.4E-02	-	1.4E-02	-		
Effective diffusion coefficient through Stratum B		(cm2/sec)	DeffB	-	-	-	-		
Effective diffusion coefficient through Stratum C		(cm2/sec)	DeffC	-	-	-	-		
		(cm2/sec)	DeffT	1.4E-02	-	1.4E-02	-		
Critical Parameters			Symbol	Value	Range	Default	Default Range	Flag	
alpha for diffusive transport from source to building with dirt floor foundation		(-)	A_Param	2.4E-04	-	2.4E-04			
Pe (Peclet Number) for transport through the foundation (advection / diffusion)		(-)	B_Param	5.1E+03	#REF!	5.1E+02	#REF!		
alpha for convective transport from subslab to building		(-)	C_Param	3.0E-02	#REF!	3.0E-03	#REF!		
Interpretation		Concentration versus Depth Profile							
Advection is the dominant mechanism across the foundation. Diffusion through soil is the overall rate limiting process.		Chart Title  • Calculated • Measured							
Critical Parameters		Hb, Ls, DeffT, ach							
Non-Critical Parameters		Qsoil, Qb, Lt, DeffA, eta							

Please check WARNING or ERROR flags

Model Output		Site Name/Run Number:		Example, Run 1					
Chemical Name: Benzene		CAS No. 71-43-2							
Risk Calculations		Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels		Scenario: Commercial							
Target risk for carcinogens		(-)	Target_CR	1E-05	-	1E-06	-		
Target hazard quotient for noncarcinogens		(-)	Target_HQ	1	-	1	-		
Target indoor air concentration		(ug/m3)	Target_IA	1.57E+01	-	1.57E+00	-		Target indoor air concentration based on cancer risk (unit risk factor)
		(ppbv)		4.92E+00	-	4.92E-01	-		
Target soil gas concentration		(ua/m3)	Target_SV	6.50E+04	#REF!	6.97E+03	#REF!		
Incremental Risk Estimates									
Incremental cancer risk from vapor intrusion		(-)	Cancer_Risk	2.29E-02	#REF!	2.14E-02	#REF!		
Hazard quotient from vapor intrusion		(-)	HQ	2.74E+02	#REF!	2.56E+02	#REF!		

FUTURE COMMERCIAL/INDUSTRIAL WORKER –
USEPA RISK-BASED CLEAN-UP VALUE
 $Q_{\text{soil_Qb}} = 0.03$; $TCR = 1E-04$

Preview	Unit	Value	Range	Default	Default Range	
Soil gas to indoor air attenuation coefficient	(-)	2.4E-04	#REF!	0.0002	#REF!	
Predicted indoor air concentration due to vapor intrusion	(ug/m3)	3.4E+04	#REF!	3.4E+04	#REF!	
Please check WARNING or ERROR flags	(apbv)	1.1E+04	#REF!	1.1E+04	#REF!	

Warning: Some versions of excel do not support the CONCATENATE function, so the range values will appear broken. To fix, either upgrade your version of Excel (preferred) or replace all occurrences of 'CONCATENATE' with 'CONCAT.'

Model Input

Site Name/Run Number:

Example, Run 1

Note:

-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.

-Dotted outline cells indicate default values that may be changed with justification.

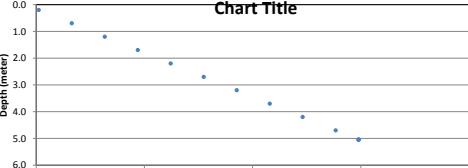
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Exterior Soil Gas					
Soil gas concentration	(ug/m3)	Cmedium	149032314.6		NA			95% UCL from 2007 RA
Depth below grade to soil gas sample	(m)	Ls	5.05		Vary - 50	NA		
Average vadose zone temperature	(°C)	Ts	25	25	3-30			
Calc: Source vapor concentration	(ug/m3)	Cs	149032315					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	37.412%					
Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Benzene					
CAS No.		CAS	71-43-2					
Toxicity Factors								
Unit risk factor	(ug/m ³) ⁻¹	IUR	7.80E-06	7.80E-06	NA	NA		
Mutagenic compound		Mut	No	NA	NA	NA		
Reference concentration	(mg/m ³)	RTC	3.00E-02	3.00E-02	NA	NA		
Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	1.79E+03	1.79E+03	NA	NA		
Henry's Law Constant @ 25°C	(atm-m ³ /mol)	Hc	5.55E-03	5.55E-03	NA	NA		
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	2.27E-01	2.27E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	2.27E-01	2.27E-01				
Diffusivity in air	(cm ² /s)	Dair	8.95E-02	8.95E-02	NA	NA		
Diffusivity in water	(cm ² /s)	Dwater	1.03E-05	1.03E-05	NA	NA		
Building Characteristics:								
Select Building Assumptions								
☒ Use ratio for Qsoil/Qbuilding (recommended if no site specific data available) ☐ Specify Qsoil and Qbuilding separately; calculate ratio								
	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Commercial	Commercial				
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade				
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00		
Enclosed space floor area	(m ²)	Abf	1500.00	1500.00	80-1000	NA		
Enclosed space mixing height	(m)	Hb	3.00	3.00	2.13 - 3.05	NA		
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	.3-4.1	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0300	0.0030	0.0001 - 0.05	1.24	WARNING	
Calc: Building ventilation rate	(m ³ /hr)	Qb	6750.00	6750.00	NA	0.30		
Calc: Average vapor flow rate into building	(m ³ /hr)	Qsoil	202.50	20.25	NA	NA		

Model Input Site Name/Run Number: Example, Run 1
 Chemical Name: Benzene CAS No. 71-43-2
 Depth below grade to soil gas sample: 5.05 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sand					
Stratum A thickness (from surface)	(m)	hSA	5.05					
Stratum A total porosity	(-)	nSA	0.375	0.375	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.054	0.054	0.053 - 0.055	0.25		
Stratum A bulk density	(g/cm³)	rhoSA	1.660	1.660	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm³)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm³)	rhoSC			NA	NA		
Stratum containing soil gas sample								
Stratum A, B, or C		src_soil	Stratum A		NA	NA		
					NA			
					NA			
Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-04	1.00E-06	NA	NA	WARNING	Value is different from default value; please justify.
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Commercial	Commercial				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA		
Exposure duration	(yrs)	ED	25	25	NA	NA		
Exposure frequency	(days/yr)	EF	250	250	NA	NA		
Exposure time	(hrs/24 hrs)	ET	8	8	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE	MMOAF not relevant for non-mutagenic compounds

Model Output		Site Name/Run Number:		Example, Run 1					
Chemical Name: Benzene CAS No. 71-43-2									
Source to Indoor Air Attenuation Factor		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Soil gas to indoor air attenuation coefficient		(-)	alpha	2.4E-04	#REF!	2.3E-04	#REF!		
Predicted Indoor Air Concentration		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion		(ug/m3)	Cia	3.6E+04	#REF!	3.4E+04	#REF!		
		(ppbv)		1.1E+04	#REF!	1.1E+04	#REF!	WARNING	Please review warning messages
Predicted Vapor Conc. Beneath Foundation		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration		(ug/m3)	Css	1.2E+06	#REF!	1.1E+07	#REF!		
		(ppbv)		3.8E+05	#REF!	3.5E+06	#REF!	WARNING	Please review warning messages
Diffusive Transport Upward Through Vadose Zone		Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A		(cm2/sec)	DeffA	1.4E-02	-	1.4E-02	-		
Effective diffusion coefficient through Stratum B		(cm2/sec)	DeffB	-	-	-	-		
Effective diffusion coefficient through Stratum C		(cm2/sec)	DeffC	-	-	-	-		
		(cm2/sec)	DeffT	1.4E-02	-	1.4E-02	-		
Effective diffusion coefficient through unsaturated zone		(cm2/sec)	DeffT	1.4E-02	-	1.4E-02	-		
Critical Parameters			Symbol	Value	Range	Default	Default Range	Flag	
alpha for diffusive transport from source to building with dirt floor foundation		(-)	A_Param	2.4E-04	-	2.4E-04			
Pe (Peclet Number) for transport through the foundation (advection / diffusion)		(-)	B_Param	5.1E+03	#REF!	5.1E+02	#REF!		
alpha for convective transport from subslab to building		(-)	C_Param	3.0E-02	#REF!	3.0E-03	#REF!		
Interpretation		Concentration versus Depth Profile							
Advection is the dominant mechanism across the foundation. Diffusion through soil is the overall rate limiting process.		Chart Title  • Calculated • Measured							
Critical Parameters		Hb, Ls, DeffT, ach							
Non-Critical Parameters		Qsoil, Qb, Lt, DeffA, eta							

Please check WARNING or ERROR flags.

Model Output		Site Name/Run Number:		Example, Run 1				
Chemical Name: Benzene		CAS No. 71-43-2						
Risk Calculations	Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels Scenario: Commercial								
Target risk for carcinogens	(-)	Target_CR	1E-04	-	1E-06	-		
Target hazard quotient for noncarcinogens	(-)	Target_HQ	1	-	1	-		
Target indoor air concentration	(ug/m3)	Target_IA	1.31E+02	-	1.57E+00	-		Target indoor air concentration based on non-cancer toxicity (reference concentration)
	(ppbv)		4.11E+01	-	4.92E-01	-		
Target soil gas concentration	(ua/m3)	Target_SV	5.43E+05	#REF!	6.97E+03	#REF!		
Incremental Risk Estimates								
Incremental cancer risk from vapor intrusion	(-)	Cancer_Risk	2.29E-02	#REF!	2.14E-02	#REF!		
Hazard quotient from vapor intrusion	(-)	HQ	2.74E+02	#REF!	2.56E+02	#REF!		