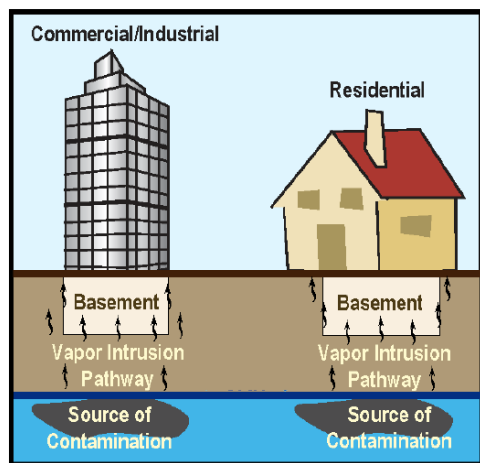


The Fundamentals of Vapor Intrusion – Part 4. EPA’s VISL Calculator

In the June and July 2014 issue of *Focus on the Environment* we discussed the decline in chemical concentration (attenuation) as vapor migrates from subsurface to indoor air. The ratio of indoor air to subsurface concentration is the attenuation factor. EPA combines default attenuation factors with Regional Screening Levels (RSLs) for indoor air to generate SLs for soil gas and groundwater. EPA’s Vapor Intrusion Screening Level (VISL) Calculator is an essential tool for vapor intrusion (VI) work.....



The earliest version of the [VISL Calculator](#) was based on November 2011 RLSs and was generally a great improvement over SL tables in EPA’s Draft [2002 Vapor Intrusion Guidance](#). Toxicity levels used to generate SLs in the 2002 guidance were long outdated, whereas the VISL Calculator is updated semiannually, following updates to EPA’s RSLs. Additionally, SLs in the 2002 guidance were tied to residential settings, and overestimated VI risk in commercial industrial (CI) settings where exposure times are shorter. What’s more, the 2002 groundwater SLs were based on a temperature of 25 degrees centigrade, which works in Miami, Florida, but exaggerates VI risk in Ohio.

The VISL Calculator is in the form of an Excel spreadsheet. One can use the calculator online, or download the spreadsheet to a computer and save it with project-specific conditions. The spreadsheet’s first sheet, Navigation Guide, describes the calculations used to generate SLs, and the sources of chemical properties and toxicity data used in the VISL. Additional documentation and explanation for the VISL Calculator can be found in [EPA’s VISL User’s Guide](#).

The heart of the VISL Calculator is on the spreadsheet’s second sheet, VISL, but first, click the Enable Editing button on the top of the page. The four inputs at the top of the VISL page, highlighted in yellow, are:

- Exposure Scenario [default = Residential],
- Target Risk for Carcinogens [default = 1.00E-6],
- Target Hazard Quotient for Non-Carcinogens [default = 1], and
- Average Groundwater Temperature [default = 25 Centigrade].

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Residential	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens
Average Groundwater Temperature (°C)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target

CAS	Chemical Name	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source?	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source?	Target Indoor Air Conc. @ TCR = 1E-06 or THQ = 1	Toxicity Basis	Target Sub-Slab and Exterior Soil Gas Conc. @ TCR = 1E-06 or THQ = 1	Target Ground Water Conc. @ TCR = 1E-06 or THQ = 1	Is Target Ground Water Conc. < MCL?	Temperature for Groundwater Vapor Conc.	Lower Explosive Limit**	LEL Source
		Cvp > Cia target?	Chc > Cia target?	MIN(Cia.c,Cia.nc)		Csq	Cgw	Cgw<MCL?	Tgw or 25	LEL	
		Yes/No	Yes/No	(ug/m ³)	C/NC	(ug/m ³)	(ug/L)	Yes/No	C	(% by wt)	
71-43-2	Benzene	Yes	Yes	3.6E-01	C	3.6E+00	1.6E+00	Yes (5)	25	1.2	N
100-41-4	Ethylbenzene	Yes	Yes	1.1E+00	C	1.1E+01	3.5E+00	Yes (700)	25	0.8	N
108-88-3	Toluene	Yes	Yes	5.2E+03	NC	5.2E+04	1.9E+04	No (1000)	25	1.1	N
1330-20-7	Xylenes	Yes	Yes	1.0E+02	NC	1.0E+03	4.9E+02	Yes (10000)	25		

The target risk and hazard quotient vary by region and program, and the appropriate settings are specified in the VI guidance for some states, including [Ohio EPA's VI Guidance](#). The Groundwater Temperature setting affects only groundwater SLs, but the effect can be significant. Changing the temperature from 25 degrees C to 11, as per Ohio guidance, increases the groundwater SL for benzene from 16 to 31 micrograms/liter (µg/l). Groundwater temperature is more or less constant seasonally, and normally equals the average annual outdoor air temperature.

These are the only user inputs on the VISL sheet, but many of the outputs can be filtered by touching the small gray box at the top of each column. For example, someone working at a petroleum hydrocarbon site might wish to display only benzene, toluene, ethylbenzene, and xylenes (BTEX). Some outputs can be filtered mathematically, such as presenting only compounds with Target Indoor Air concentrations below 5 micrograms/cubic meter (µg/m³).

To the right of the column of Target Indoor Air Concentrations is a column labeled "Toxicity Basis". The calculator automatically selects the lower target level - Cancer versus Non Cancer - to determine SLs, and the Toxicity Basis column indicates which was lower. Other output columns include Target Soil Gas Concentrations, Target Groundwater Concentrations, and Lower Explosive Limits (LELs). As discussed in July's [Focus on the Environment](#) newsletter, the VISL's default attenuation factor for soil gas and groundwater are 0.1 and 0.001, respectively. Accordingly, the subslab and deep soil gas target levels are ten times higher than indoor-air target levels, and groundwater target levels are 1,000 times higher than indoor targets (after allowing for Henry's Law partitioning from water to air). Arguably, EPA has good reasons to use a highly conservative attenuation factor of 0.1 for soil gas, but it's inconsistent with the 0.03 factor recommended in [EPA's 2013 VI Guidance](#), and vastly more conservative than the ratio of indoor/subslab soil gas concentrations observed by Cox-Colvin and many others in field samples.

The next three sheets in the VISL Calculator are SG_IA_calc, GW_IA_calc, and IA_risk calc. These are designed for entering soil-gas, groundwater, or indoor air concentrations, respectively, for various chemicals to determine risk to building occupants. After specifying the Exposure Scenario (residential or commercial), Target Risk for Carcinogens, and Target Hazard Quotient for Non-Carcinogens, enter the concentration for each compound. Using the default attenuation factors of 0.1 for soil gas and 0.001 (with the Henry's Law multiplier) for groundwater, the Calculator estimates the indoor air concentration and subsequent risks for each chemical. If the calculated Carcinogenic Risk or VI Hazard (Non-Carcinogenic) in indoor air exceeds specified risk levels, the value is highlighted pink.

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario
Target Risk for Carcinogens	TCR	1.00E-05	Enter target risk for carcinogens
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens
Average Groundwater Temperature (°C)	Tgw	11	Enter average of the stabilized groundwater temperature

CAS	Chemical Name	Site Groundwater Concentration	Calculated Indoor Air Concentration	VI Carcinogenic Risk	VI Hazard
		Cgw (ug/L)	Cia (ug/m ³)	CR	HQ
71-43-2	Benzene	5.0E+02	5.77E+01	3.7E-05	4.4E-01
100-41-4	Ethylbenzene	2.0E+02	2.77E+01	5.6E-06	6.3E-03
108-88-3	Toluene	5.0E+06	6.34E+05	No IUR	2.9E+01
1330-20-7	Xylenes	6.6E+02	5.96E+01	No IUR	1.4E-01

The four remaining sheets in the VISL Calculator are Chem Props, Tox Summary, Parameters Summary, and Version Notes. These pages are not interactive, but are an invaluable source of information for molecular weights, solubility, and other chemical properties, as well as cancer Reference Concentrations (RfCs), and other toxicity data.

Despite issues with the highly conservative subslab and deep soil-gas SLs, the availability of indoor air target levels based on regularly-updated toxicity data, and having a single source for chemical properties in an easy-to-use document are most helpful. The VISL Calculator will no doubt continue to be an essential tool for VI assessments. Next month, in the Focus on the Environment newsletter, we'll discuss how VI differs between chlorinated and non-chlorinated compounds.

LINKS

VISL Calculator

<http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.epa.gov%2Foswer%2Fvaporintrusion%2Fdocuments%2FVISL-Calculator.xlsm&ei=O-PHU9ncBs6nyATixIHYCA&usg=AFQjCNGltVuMZN2vQA-205luNVklSgdeEw&bvm=bv.71198958,d.aWw>

EPA's Draft 2002 Vapor Intrusion Guidance

<http://www.epa.gov/epawaste/hazard/correctiveaction/eis/vapor.htm>

VISL User's Guide

<http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0CDAQFjAC&url=http%3A%2F%2Fwww.epa.gov%2Foswer%2Fvaporintrusion%2Fdocuments%2FVISL-UsersGuide.pdf&ei=O-PHU9ncBs6nyATixIHYCA&usg=AFQjCNFOTglU0U3GtitARaz9lZujg3m59Q&bvm=bv.71198958,d.aWw>

Ohio Vapor Intrusion Guidance

http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.epa.ohio.gov%2Fportals%2F30%2Frules%2Fvapor%2520intrusion%2520to%2520indoor%2520air.pdf&ei=iRPIU4j5KMOiyATT_4K4Cg&usg=AFQjCNGgglo1c4y75QzM2841AzjVgvEyEw&bvm=bv.71198958,d.aWw&cad=rja

EPA's 2013 VI Guidance

http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB0QFjAA&url=http%3A%2F%2Fwww.epa.gov%2Foswer%2Fvaporintrusion%2Fdocuments%2FvaporIntrusion-final-guidance-20130411-reviewdraft.pdf&ei=P-LfU6P2Bc6nyASG_oLYBA&usg=AFQjCNFWtPxGTnflRT4oqauP9CWgTaN8TQ&bvm=bv.72197243,d.aWw

KEY WORDS: vapor intrusion, screening levels, VISL, soil gas, subslab, sub-slab, RSLs

PICTURES:

Little Picture.png

VISL.png

GW_IA_calc.png