

APPENDIX D.1

Volatilization to Indoor Air Pathway (VIAP) Screening Levels

Proposed May 12, 2020

Appendix D.1

Volatilization to Indoor Air Pathway (VIAP) Screening Levels

Generic Volatilization to Indoor Air Inhalation Criteria

Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), and the associated Administrative Rules establish the generic cleanup criteria for the hazardous substances in vapors emanating from groundwater (R 299.5714) and soil (R 299.5724) to indoor air.

Appendix C.1 details the assumptions used in the development of the generic groundwater volatilization to indoor air inhalation criteria (GVIIC) and soil volatilization to indoor air inhalation criteria (SVIIC). This appendix also provides a checklist to assist in determining the applicability of the generic volatilization to indoor air inhalation criteria. The generic GVIIC and SVIIC are derived from data that reflect long-term (chronic) exposures. In some instances, the assumptions used to develop the generic GVIIC and SVIIC may be met at a specific property; however, the presence of hazardous substances that represent less than chronic (i.e. short-term or acute) risk is not assessed with the application of generic GVIIC and SVIIC.

A site-specific evaluation should be conducted for compliance and/or due care purposes if the generic GVIIC and SVIIC are not applicable, if there are hazardous substances present that have short-term risk concerns, and/or soil gas data (including sub-slab) have been collected.

Volatilization to Indoor Air Pathway Screening Levels

The volatilization to indoor air pathway (VIAP) screening levels are values that the department has determined reflect best available information regarding the toxicity and exposure risks posed by the hazardous substances in indoor air (Table 1 and Table 2). The VIAP screening levels may be used provided it is documented that the conditions assumed in developing the screening levels are met at the site/facility as detailed in the following sections. Other values may be developed by a person consistent with the statutory provisions for development of site-specific criteria (Section 20120b) and must be provided for department review and approval.

Building Construction

Residential VIAP Screening Levels

Residential VIAP screening levels (Table 1) are calculated based on unrestricted residential use of a property. The building input parameters assume a residential structure that has a basement with poured concrete floor, block or poured concrete walls, and has less than 6 floors (i.e. is not a high-rise apartment). Residential VIAP screening levels are intended to address places where people live and/or children or other sensitive populations are present on a regular basis [greater than intermittent]. Residential VIAP screening levels may be appropriate for unique exposure scenarios (e.g., daycares, churches, schools, doctor's offices, hospitals, recreational areas); however, a site-specific risk assessment is typically warranted to address the unique exposure scenario.

Submittals relying on the residential VIAP screening levels (Table 1) must contain documentation that supports the screening levels are appropriate for conditions at the site. The following building construction characteristics are not consistent with the residential VIAP screening levels and therefore the screening levels do not apply when:

- There is not a poured concrete floor, block or poured concrete wall in a basement
- There is a slab-on-grade foundation

Appendix D.1

Volatilization to Indoor Air Pathway (VIAP) Screening Levels

- 46 • There is a crawl space foundation, with dirt floor or poured concrete slab
- 47 • There are 6 or more floors (including basements)
- 48 • There are other building characteristics not consistent with the basic assumptions

49

50 Site-specific volatilization to indoor air criteria (SSVIAC) must be developed for residential structures
51 that do not meet the assumptions used to develop the VIAP screening levels.

52

53 *Nonresidential VIAP Screening Levels*

54 Nonresidential VIAP screening levels are developed for healthy adult workers and potential intermittent
55 exposure of adults and children who are customers, patrons, or visitors to commercial or industrial
56 establishments during a portion of the workday. The acceptable air concentrations are not adjusted to
57 account for a nonresidential workday exposure. When appropriate, nonresidential SSVIAC adjusted for a
58 workday exposure may be pursued using Option 1 or Option 2 described below. Nonresidential VIAP
59 screening levels are not appropriate for establishments where children and other sensitive populations
60 are present on a regular basis [greater than intermittent] (e.g., schools, day-care, churches, doctor's
61 offices, hospitals, campgrounds, recreational areas).

62

63 Nonresidential VIAP screening levels (Table 2) are calculated based on restricted nonresidential use of a
64 property. Nonresidential VIAP screening levels were developed to account for "All Appropriate
65 Nonresidential Uses" and may be applied at nonresidential structures that meet the assumptions used
66 to develop the VIAP screening levels.

67

68 The building input parameters assume a nonresidential structure that has a poured concrete slab-on-
69 grade and has less than 50,000 ft² of continuously open space. The nonresidential building size of less
70 than or greater than (</>) 50,000 ft² is based on continuously open space and refers to the structure or
71 portion of the structure that may be subdivided (e.g. offices, breakrooms, etc.). If a single structure
72 contains areas with both </> 50,000 ft² of continuously open space, the nonresidential VIAP screening
73 levels apply because they represent the most appropriate values to evaluate risk associated with the
74 VIAP for that structure.

75 Submittals relying on the nonresidential VIAP screening levels (Table 2) must contain documentation
76 that supports the screening levels are appropriate for conditions at the site. The following building
77 construction characteristics are not consistent with the nonresidential VIAP screening levels and
78 therefore the screening levels do not apply when:

- 79 • The structure has > 50,000 ft² of continuously open space with no areas < 50,000 ft²
- 80 • There is a basement
- 81 • There is a below grade pit, crawlspace (with dirt floor or poured concrete slab), or elevator
82 shafts that extend below grade such that conditions do not meet the assumptions of a slab-on-
83 grade
- 84 • There is a combination of foundation types
- 85 • The structure is a former residential structure that is now a nonresidential use
- 86 • There are other building characteristics not consistent with the basic assumptions

87

88 Site-specific VIAC must be developed for nonresidential structures that do not meet the assumptions
89 used to develop the VIAP screening levels.

90

Appendix D.1

Volatilization to Indoor Air Pathway (VIAP) Screening Levels

91 The exposure scenario for a nonresidential structure with a slab-on-grade and less than 50,000 ft² of
92 continuously open space represents the majority of exposure scenarios at sites that requested the
93 department's assistance to develop applicable SSVIAC since May of 2017. The scenario does not
94 represent the most conservative nonresidential VIAP screening levels that could be developed.
95

Mixed Residential and Nonresidential Use

96 Properties that have structures where the use of the building consists of mixed residential and
97 nonresidential use are required to evaluate the VIAP using the residential exposure scenario. The use of
98 the residential VIAP screening levels (Table 1), provided the assumptions listed above are met, would be
99 acceptable to the department. However, a site-specific assessment beyond the scope of this document
100 may be performed that assesses the structure and shows that the residential and nonresidential use
101 areas are separate and distinct and that there is no potential for air exchange or transfer between the
102 two.
103
104

Groundwater VIAP Screening Levels

Groundwater Separation Distance

105
106 Depth to groundwater is a sensitive parameter that determines the groundwater separation distance
107 from a structure. It is not appropriate to use an average depth to groundwater. Instead, the depth to
108 groundwater below grade should represent the depth of the first encountered groundwater that
109 includes observed seasonal variations, transient presence of perched groundwater, the capillary zone,
110 and heterogenous lithology. The threshold for shallow groundwater determination is different between
111 residential and nonresidential VIAP screening levels due to the presence of basement and slab-on-grade
112 foundations; respectively.
113
114

Shallow groundwater VIAP screening levels

115 The United States Environmental Protection Agency (US EPA) guidance for the Johnson and Ettinger
116 Model (JEM) states that the presence of shallow groundwater within five feet of the building foundation
117 may result in unattenuated or enhanced transport of vapors into buildings (US EPA 2015). The
118 department modified standard equations to develop applicable VIAP screening levels for shallow
119 groundwater scenarios (formerly referred to as "groundwater in contact") that frequently occur
120 throughout Michigan.
121
122

123 The residential shallow groundwater VIAP screening levels (Table 1) must be used for a residential
124 structure with a basement when the depth to first encountered groundwater is 10 feet below ground
125 surface or less.
126

127 The nonresidential shallow groundwater VIAP screening levels (Table 2) must be used for a
128 nonresidential structure that has less than 50,000 ft² of continuously open space with a slab-on-grade
129 when the depth to first encountered groundwater is 5 feet below ground surface or less.
130

Groundwater Not In Contact VIAP Screening Levels

131 The groundwater not in contact VIAP screening levels do not use the JEM to calculate a chemical-specific
132 attenuation factor based on groundwater separation distance. Groundwater not in contact VIAP
133 screening levels are instead developed using the recommended vapor attenuation factor of 0.001 (US
134 EPA 2015) when groundwater is not shallow.
135
136

Appendix D.1

Volatilization to Indoor Air Pathway (VIAP) Screening Levels

137 The residential groundwater not in contact VIAP screening levels (Table 1) apply for a residential
138 structure with a basement when the depth to first encountered groundwater is greater than 10 feet
139 below ground surface.

140
141 The nonresidential groundwater not in contact VIAP screening levels (Table 2) apply for a nonresidential
142 structure that has less than 50,000 ft² of continuously open space with a slab-on-grade when the depth
143 to first encountered groundwater is greater than 5 feet below ground.

144
145 Site-specific VIAC may be developed using chemical-specific attenuation factors from the JEM; however,
146 this approach was not utilized for the development of VIAP screening levels due to the infinite amount
147 of possible groundwater separation distances.

148
149 **Soil VIAP screening levels**
150 Soil VIAP screening levels were developed using inputs for the United States Department of Agriculture
151 (USDA) soil type of sand and are considered applicable for all other USDA soil types. The USDA soil
152 classification of sand is appropriate to develop VIAP screening levels because it is representative of most
153 areas within Michigan and is the most conservative soil type.

154
155 *United States Department of Agriculture (USDA) Soil Characterization*
156 Historical soil boring logs were typically recorded using Unified Soil Classification System (USCS);
157 however, the JEM relies on soil parameter inputs based on USDA soil characterization. There is not a
158 direct relationship between the two soil classification systems (ERDC/CRREL 2015). Provided that
159 appropriate field methodology was used and documented to representatively characterized for USDA
160 soil types in all horizons in order to determine the most conservative soil layer, USDA classifications of
161 sand, loamy sand, sandy loam, or loam may be used to develop soil SSVIAC. Site-specific VIAC may be
162 developed using the remaining USDA soil classifications but require additional laboratory grain size
163 analysis that includes sieve and hydrometer testing of the coarsest material within representative
164 borings across the site. Documentation of appropriate site characterization including characterization of
165 heterogenous soils must be provided for department review and approval to justify use of USDA soil
166 types other than sand.

167
168 **Soil gas VIAP screening levels**
169 The soil vapor VIAP screening levels may be used to evaluate representative sub-slab soil vapor and
170 exterior soil gas data. However, the VIAP screening levels are not applicable when the vapor source is
171 shallower than the depth of sample collection and do not account for preferential vapor migration
172 pathways through the vadose zone.

173
174 Soil vapor VIAP screening levels were developed using the attenuation factor of 0.03 identified as the
175 95th percentile value from US EPA's vapor intrusion data base (US EPA 2012) as recommended by US EPA
176 (2015). This vapor attenuation factor allows the resulting soil vapor VIAP screening levels to be applied
177 to all depths because diffusion from the vapor source through the vadose zone is not considered.
178 Consequently, the soil vapor value is not affected by soil type. Therefore, consideration should be given
179 to decide whether the extra time and cost associated with representatively sampling and characterizing
180 soil type across a site/facility using USDA methodology is necessary when soil vapor data is being
181 collected to evaluate the VIAP.

182

Appendix D.1

Volatilization to Indoor Air Pathway (VIAP) Screening Levels

183 **Site-Specific Volatilization to Indoor Air Criteria**

184 The VIAP screening levels may be applied to structures that meet the assumptions used during
185 development; however, these VIAP screening levels do not limit the ability for a person to pursue
186 SSVIAC or site-specific target levels (SSTLs) that are more representative of site-specific conditions. If a
187 structure does not meet the assumptions identified above for the development of the VIAP screening
188 levels (and the generic GVIIC and SVIIC or RBSLs are not applicable), a site-specific assessment is
189 required.

190

191 *Option 1: Facility-Specific SSVIAC or SSTLs Using the Department's VIAP Calculator*

192 The department has assisted the regulated community in developing applicable SSVIAC or SSTLs since
193 the previous screening levels were rescinded using an internal VIAP calculator tool. The input
194 parameters of the VIAP calculator represent the department's determination of best available
195 information. The department will continue to provide this customer service on a site-specific basis until
196 such time as an online VIAP calculator module is released. A person may request the department's
197 assistance by contacting the appropriate district project manager to complete a questionnaire [\[link\]](#).
198 This site-specific evaluation can account for site-specific geology, groundwater depth, and chemical-
199 specific attenuation factors from the points of compliance using the JEM. Additionally, other building
200 uses, sizes, and foundation types can be evaluated.

201

202 *Option 2: Proposed SSVIAC or SSTLs Pursuant to Section 20120b*

203 A person may pursue development of SSVIAC or SSTL using other models, input parameters, and site-
204 specific data using any of the options available in Section 20120b. An alternative approach, including all
205 of the necessary documentation and justification, may be submitted for department review and
206 approval.

207

208 **References**

209

210 U.S. Army Engineer Research and Development Center (ERDC)/ Cold Regions Research and Engineering
211 Laboratory (CRREL). 2015. USCS and the USDA Soil Classification System: Development of a Mapping
212 Scheme. Technical report released April 2015.

213 <https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/3757/>

214 US EPA. 2012. EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors
215 for Chlorinated Volatile Organic Compounds and Residential Buildings.

216 [https://www.epa.gov/sites/production/files/2015-](https://www.epa.gov/sites/production/files/2015-09/documents/oswer_2010_database_report_03-16-2012_final_witherratum_508.pdf)

217 [09/documents/oswer_2010_database_report_03-16-2012_final_witherratum_508.pdf](https://www.epa.gov/sites/production/files/2015-09/documents/oswer_2010_database_report_03-16-2012_final_witherratum_508.pdf)

218 US EPA. 2015. OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from
219 Subsurface Vapor Sources to Indoor Air. [https://www.epa.gov/sites/production/files/2015-](https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf)

220 [09/documents/oswer-vapor-intrusion-technical-guide-final.pdf](https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf)

221

**Appendix D.1
Volatilization to Indoor Air Pathway (VIAP) Screening Levels**

**Volatilization to Indoor Air Pathway (VIAP)
Screening Levels and Site-Specific Criteria
Overview**

UNRESTRICTED RESIDENTIAL SCREENING LEVELS	Residential structure w/ basement	
	<ul style="list-style-type: none"> Groundwater: Shallow/In Contact <ul style="list-style-type: none"> Depth below grade ≤ 10 ft EGL shallow groundwater α Soil: Infinite source Vapor: EPA Default $\alpha = 0.03$ 	<ul style="list-style-type: none"> Groundwater: Not In Contact <ul style="list-style-type: none"> Depth below grade > 10 ft EPA Default $\alpha = 0.001$ Soil: Infinite source Vapor: EPA Default $\alpha = 0.03$
RESTRICTED NONRESIDENTIAL SCREENING LEVELS	Nonresidential structure $< 50,000$ ft² of continuous open space w/ slab-on-grade <i>NOTE: Not applicable for former residential now nonresidential use structures</i>	
	<ul style="list-style-type: none"> Groundwater: Shallow/In Contact <ul style="list-style-type: none"> Depth below grade ≤ 5 ft EGL shallow groundwater α Soil: Infinite source Vapor: EPA Default $\alpha = 0.03$ 	<ul style="list-style-type: none"> Groundwater: Not In Contact <ul style="list-style-type: none"> Depth below grade > 5 ft EPA Default $\alpha = 0.001$ Soil: Infinite source Vapor: EPA Default $\alpha = 0.03$

Note: Groundwater Not In Contact scenario aligns with EPA's approach for groundwater vapor intrusion screening levels

Site-Specific Volatilization to Indoor Air Criteria (SSVIAC)

Option 1	FACILITY SPECIFIC USING VIAP CALCULATOR	UNRESTRICTED RESIDENTIAL SSVIAC	MAY BE COMBINED	RESTRICTED SSVIAC
		<ul style="list-style-type: none"> Building: House w/ basement Incorporates: <ul style="list-style-type: none"> Site geology Actual groundwater depth J&E model 		<ul style="list-style-type: none"> Residential and Nonresidential Building: <ul style="list-style-type: none"> Other use(s)/ sizes Other foundation types Incorporates: <ul style="list-style-type: none"> Site geology Actual groundwater depth J&E model

Proposed SSVIAC Pursuant to Sec. 20120b

• Alternate approaches proposed to the Department for review and approval

Option 2	SSVIAC PURSUANT TO Sec. 20120b	Model Selection	MAY BE COMBINED	Parameter Selection
		<ul style="list-style-type: none"> Bio vapor/PVIScreen Multi-layer J&E Model Big Building Other 		<ul style="list-style-type: none"> Toxicological Chemical physical Building characteristics Other