**Vapor Intrusion Fact Sheet**

**Tier 2 Evaluation**

**Can I calculate Tier 2 Indoor Inhalation Remediation Objectives (ROs)?**

Yes, as with the other routes of concern, Tier 2 indoor inhalation exposure route soil gas and groundwater ROs can be developed using site-specific information. TACO (35 Ill. Adm. Code 742) Section 742.600 provides a general overview of the Tier 2 options.

**What parameters can be made site specific in a Tier 2 indoor inhalation route assessment using the modified Johnson & Ettinger (J&E) model?**

The only parameters that can be changed in a Tier 2 indoor inhalation route analysis are those identified below:

- $D_{\text{source}}$: distance from the ground surface to top of contamination
- $L_i$: thickness of soil layer $i$ (except for capillary fringe- must use default of 37.5 cm)
- $L_T$: distance from bottom of slab to top of contamination
- $n$: total number of layers of different types of soils
- $W$: moisture content
- $\rho_b$: dry soil bulk density
- $\rho_{s,i}$: dry soil particle density

**Why can’t the building parameters be adjusted when developing a Tier 2 indoor inhalation route RO?**

The Tiers 1 and 2 default building parameters are based on a conservative representation of the type of buildings that are or may be present at the site in the future. Without these conservative values, institutional controls would be required on the minimum size of building that could exist or be constructed on the contaminated area. Site-specific building parameters can be proposed as a Tier 3 proposal; however, the property would be required to have an institutional control restricting future and existing development to the building size proposed in the Tier 3 proposal or larger.

**When is it not acceptable to develop Tier 2 indoor inhalation route objectives based on the Modified J&E Model?**

The Modified J&E Model assumes existing and potential buildings are constructed with full concrete slab-on-grade or a full concrete basement floor and walls. The model also assumes the contaminant vapors will enter the building through a 0.1 cm crack along the perimeter of the concrete slab-on-grade foundation and in the case of a full concrete basement, along the perimeter of the basement floor. If other protrusions to the floor or foundation exist, the assumptions of the Modified J&E model are violated. As a result, ROs based on the Modified J&E Model would not be applicable at sites with existing or proposed buildings with earthen crawl spaces, earthen floor, a stone foundation walls, a partial concrete floor, or a basement floor with a sump.

**When sampling for the physical soil parameters for the indoor inhalation route, how many samples are necessary and where should the samples be collected?**

The number of samples required and the location(s) of the sample(s) are dependent upon the program under which remediation is performed. Contact should be made with program staff for these program-specific determinations. If there is an existing building, the sample(s) can be collected from boring(s) completed adjacent to the building at the appropriate depth. It is not necessary to collect the sample(s) from the soil located directly below the building. In general however, samples collected for the analysis of physical soil parameters should be collected from the soil that represents those soils located between the floor of the building and the top of the soil or groundwater contamination, whichever is closer to the building.

**What parameters are sensitive to a Tier 2 indoor inhalation route assessment?**
Soil moisture content has a significant impact on the Tier 2 indoor inhalation route remediation objectives, as the higher the moisture content the lower the air-filled porosity. If the air-filled porosity (soil void space taken up by air) of the soil is low, the volatile chemicals are hindered or restricted from migrating through the soils resulting in higher, less conservative ROs. Depth to soil or groundwater contamination (LT) can also have a significant impact on ROs, particularly in the case where the soil moisture content is high and the air-filled porosity is low.

**Soil or groundwater contamination exceeding the most stringent Tier 1 ROs is within 5 feet of building. Do I have an option under Tier 2 to consider diffusion only in this situation?**

No, as with Tier 1 in this circumstance, advection and diffusion must be considered in calculating the Tier 2 indoor inhalation route ROs.

**Under Tier 2 can indoor inhalation ROs based on advection and diffusion be developed in a situation where the soil and/or groundwater contamination is located at a distance greater than five feet from an existing building or associated man-made pathway?**

Yes, just as it is acceptable under Tier 1 to use ROs from Table I (Diffusion Only) or Table H (Advection and Diffusion) when soil and groundwater contamination is located greater than five feet from a building or associated man-made pathway, it is also acceptable under Tier 2 to develop ROs based on advection and diffusion. Developing indoor inhalation route objectives based on advection and diffusion may be desirable, as some property owners will want to avoid the institutional control restricting the location of existing and future buildings and associated man-made pathways closer than 5 feet vertically and horizontally from soil or groundwater contamination (5-ft Institutional Control).

**How do I avoid the “5-ft Institutional Control” associated with using Table I?**

To avoid the 5-ft Institutional Control associated with the ROs based on diffusion only, Tier 2 indoor inhalation route objectives based on advection and diffusion may be developed using site-specific physical soil parameters (moisture content, porosity etc.). Although the “source to building separation” (LT) can be changed under Tier 2, to avoid an institutional control defining the LT distance to be maintained between the soil and groundwater contamination and existing and future buildings and associated man-made pathways, LT must be set at the default value of 142.4 cm when developing Tier 2 soil gas ROs and 294.8 cm when developing Tier 2 indoor inhalation route groundwater ROs.

**Under Tier 2 when developing indoor inhalation route objectives using equation J&E7 (advection and diffusion), must a \( Q_{soil} \) value of 83.33 cm\(^3\)/sec be used?**

Yes, when developing Tier 2 indoor inhalation route objectives based on equation J&E7, \( Q_{soil} \) must be set at 83.33 cm\(^3\)/sec.

**If the Tier 2 indoor inhalation route ROs are based on the assumption a basement is present, will an institutional control be required?**

Yes, if the Tier 2 indoor inhalation route objectives are based on the assumption a basement is present, then an institutional control will be necessary that states the Indoor Inhalation route ROs were based on a basement scenario resulting in all existing and future buildings be constructed with a basement having a full concrete floor and walls and no sumps.

**Do all Tier 2 indoor inhalation route ROs based on the modified J&E Model require an institutional control?**

An assumption of the modified J&E Model is all existing or potential buildings are constructed with full concrete slab-on-grade or a full concrete basement floor and walls. As a result, sites with indoor inhalation route ROs based on equations J&E7 or J&E8 will be subject to an institutional control.
restricting all existing and future buildings to have full concrete slab-on-grade or a full concrete basement floor and walls.

Equations J&E1 and J&E2 are strictly risk based equations for developing contaminant levels that are safe for indoor air. Although identified as J&E equations in Appendix C, Table L, J&E1 and J&E2 are not based on the assumption a full concrete slab-on-grade or full concrete basement floor and walls exist. It is acceptable under Tier 2 to develop indoor inhalation soil gas ROs based on the J&E1 and J&E2. The indoor inhalation soil gas ROs are based on J&E1 and J&E2. It should be noted that these soil gas ROs are very low and coordination with the lab will be important to ensure the detection limits are at or below the ROs. In some cases the method detection limit will be higher than the soil gas ROs based on J&E1 and J&E2. In this case a Tier 3 proposal would be necessary to request a higher soil gas RO. Soil gas sampling must conform to all the sampling requirements discussed in Section 742.227(b, c, and d). Since the proposal develops soil gas ROs versus indoor air remediation objectives the proposal would be part of a Tier 2 evaluation and the “similar acting chemicals provisions” would not apply.

**Default Values for \( \theta_{a,\text{crack}} \), \( \theta_{a,i} \) and \( \theta_{w,i} \) (for capillary fringe) provided in Appendix C, Table M are incorrect.**

The air filled soil porosity value provided for soils located in the crack of the foundation (\( \theta_{a,\text{crack}} \)) and the default air filled soil porosity (\( \theta_{a,i} \)) are both incorrectly noted as 0.13 cm\(^3\)/cm\(^3\). The correct value for both of these parameters is 0.28 cm\(^3\)/cm\(^3\). Water-filled porosity \( \theta_{w,i} \) (for capillary fringe) is also incorrectly stated as 0.375 cm\(^3\)/cm\(^3\) and should be 0.387 cm\(^3\)/cm\(^3\). These errors will be corrected with the next revision of TACO. In the interim, the values for the subject soil parameters presented in Table M shall be used when developing Tier 2 ROs. If the corrected values are to be used to develop ROs, this could be done so as a Tier 3 evaluation. With respect to \( \theta_{w,i} \) (for capillary fringe) as noted in Table M, it is also acceptable under Tier 2 to propose a \( \theta_{w,i} \) equal to 90 percent of the total porosity (\( \theta_{T} \)) of the soil type located immediately above the capillary fringe.

**Where can I get more information?**

You may contact the project manager on-call for your remediation program at 217-524-3300 for further information regarding vapor intrusion.

This fact sheet is for general information only and is not intended to replace, interpret, or modify laws, rules, or regulations.

June 2013