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Leah J. Smith
District and Business Support Program
Division of Waste Management
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Evaluation of exposure parameters for deriving an alternative soil cleanup target level for a 55 and older community

Dear Ms. Smith:

At your request, we have evaluated the exposure parameters and scenario-specific considerations for deriving alternative soil cleanup target levels (ASCTLs) for an adult residential community ages 55 and older. Adult residential communities differ from the typical residential scenario. Long-term exposures for children or residential exposures that begin in childhood may not be applicable to these communities. Therefore, several of the assumptions normally utilized in the derivation of cleanup target levels for the protection of residents can be altered to reflect residential exposures limited to older adults.

Equations for the derivation of carcinogenic and non-carcinogenic soil cleanup target levels (SCTLs) promulgated in Chapter 62-777, F.A.C. are shown in Figures 1 and 2 and the abbreviations used in these equations are defined in Table 1. Many of the exposure assumptions applicable to a 55 and older community differ from the default residential assumptions inclusive of children and younger adults. Adult residential community-specific assumptions for the derivation of ASCTLs are discussed below.

Exposure duration: The current default residential exposure duration of 26 years represents the 90th percentile residential occupancy period for all ages obtained from a study by Johnson and Capel (1992). Using this same study, the 90th percentile residential occupancy period for adults ages 55 and older ranges from 34-40 years (US EPA, 2011; Table 16-88). This suggests that older adults tend to stay at a residence longer than the general population. While this study provides data on how long a 55 year-old is likely to reside at their current residence, it does not provide information for adults who move into a new residence at age 55. A 55 year-old who moves into a new residence is not as likely to reside there for 34-40 years due to life expectancy. According to the U.S. Social Security Administration, a male at age 55 is likely to live an average of 25.5 additional years and a female at age 55 is likely to live an average of 28.7 additional years (US SSA, 2014). This is an average of 27.1 years of additional life expectancy for men and

women who have lived to the age of 55. The average life expectancy of 27.1 years is below the 90th percentile residential occupancy range of 34-40 years for adults age 55 and older. Therefore, an exposure duration of 27.1 years is more appropriate for an adult who moves into a new residence at age 55. The exposure duration of 27 years is not substantially different from the current default residence time of 26 years.

Body weight: Body weight data for older adults are summarized in the Exposure Factors Handbook (US EPA, 2011). Recommended body weights were derived from an analysis of National Health and Nutrition Examination Survey (NHANES) data from 1999-2006. Using the combined male and female body weight from NHANES (1999-2006) listed in Table 8-3 of the handbook, we calculated a mean body weight of 79.4 kg for adults ages 55 through 82 (27 years exposure duration). This value is not substantially different from the default adult body weight of 80 kg.

Surface area: Surface area is correlated to body weight with larger body weights corresponding to larger skin surface areas. Chapter 62-777, F.A.C. uses a univariate model by Burmaster (1998) to calculate total body surface area from body weight:

$$Surface\ area = Body\ weight^{0.6821} \times 1025$$

For a body weight of 79.4 kg, this is equivalent to 20,260 cm^2. Assuming the head, hands, forearms, and lower legs are exposed, a total of 31.2% of the body surface area is exposed for adults ages 18-65 (CEHT, 2005). Total exposed surface area is 6,320 cm^2.

Soil ingestion rate: There are a limited number of studies attempting to estimate soil and dust ingestion rates in older adults (ages 60 years and older). The studies that present soil ingestion rates for older adults are based on activity pattern modeling. This methodology estimates a soil ingestion rate by combining data on hand-to-mouth activities and time spent in different locations around the residence (i.e., microenvironments). These estimates are limited by the quality and availability of data on input variables (dust loading, time spent in microenvironment, hand-to-mouth activity, and hand washing frequency).

The Exposure Factors Handbook September 2017 update for soil and dust ingestion (US EPA, 2017) provides a critical review of the soil and dust ingestion studies available. There is no recommendation specific to older adults. The oldest age category listed is age 12 to adult. The age range is large due to the lack of information available on differences in ingestion rates among older children and adults. The soil ingestion rate recommendation for individuals 12 years of age and older is 100 mg/day. This value is equivalent to the updated recommendation for adult soil ingestion rates in OSWER Directive 9200.1-120.

Some older adult communities limit interaction with soil by placing restrictions on landscaping and gardening. This likely reduces soil ingestion rates for adults in these communities. However, soil exposure studies listed in the Exposure Factors Handbook (US EPA, 2017) did not record outdoor activities or time spent outdoors from the participants in the studies used to derive the adult soil ingestion rate. Therefore, it cannot be stated with any certainty that the recommended ingestion rate of 100 mg/d is representative of gardening and lawn maintenance activities while other yard activities result in lower ingestion rates. Instead, the range of ingestion rates likely represent a mixture of different outdoor and indoor activities and variability in exposure factors in the population (such as soil adherence to skin and frequency of hand-to-mouth activities for an individual). The limited data on soil ingestion precludes the derivation of a

value specific to older adults or those limited in outdoor activities. Therefore, we recommend using an adult soil ingestion rate of 100 mg/d.

Inhalation rate: Inhalation rates for the general population are also summarized in the Exposure Factors Handbook. Recommended long-term exposure values for males and females combined are listed in Table 6-1 (US EPA, 2011). The mean inhalation rate for males and females ages 55 through 82 (27 years exposure duration) is 13.8 m^3/day. A promulgated inhalation rate for adults is not provided in Chapter 62-777, F.A.C. Currently, only an aggregate resident (child and adult combined) inhalation rate of 12.2 m^3/day is listed. The inhalation rate for adults greater than 55 years old is slightly larger than the aggregate resident inhalation rate since it does not include the lower inhalation rates during childhood.

Soil adherence factor: We could not locate any soil adherence to skin data based on the age of the subject. Soil adherence factors are usually determined based on the activity being performed and the type of soil. Without age-specific data, the most appropriate adherence factor is the default adult residential soil adherence factor of 0.07 (OSWER Directive 9200.1-120).

Exposure factors appropriate for calculating a site-specific ASCTL will depend on the type of use envisioned at the site. Older adult communities with a neighborhood garden or park could incorporate several ASCTLs based on the proposed future use of different areas of the site. For example, a recreational area would need to consider child exposures since they would have access to the park during visits to the community. A community garden area might necessitate unrestricted use criteria so that produce grown in the area can be safely consumed. These areas would be assessed with exposure factors different from the older adult residential areas.

The exposure parameters proposed for deriving ASCTLs for an adult residential community ages 55 and older are not substantially different from those used to derive soil cleanup target levels for other adult residential scenarios and will likely result in similar values. Although older adult communities are intended to house persons ages 55 and older, not every resident needs to meet this requirement. The most common exception is an allowance for spouses and adult children under the age of 55 to live in the residence with the older adult. Additionally, not every house is required to have a resident over the age of 55. According to the Housing for Older Persons Act of 1995, at least 80% of the occupied units in the community must be occupied by at least one person 55 years or older. The remaining 20% of the units may be occupied by people under age 55 and the community will still qualify as an older adult community. The actual percentage of units occupied by people under 55 and the age of those residents varies over time and is community-specific based on the homeowner's association (HOA) rules. Children who reside in an older adult community would not be protected by ASCTLs developed for adults. Therefore, communities that allow children to reside on-site will need to address their exposures using exposure factors that include childhood exposure.

Please let us know if you have any questions regarding this evaluation.

Sincerely,

Leah D. Stuchal, Ph.D.

Stephen M. Roberts, Ph.D.

References:

CEHT (2005) *Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C*. Center for Environmental & Human Toxicology, University of Florida, Gainesville, FL.

US EPA (2011) *Exposure Factors Handbook: 2011 Edition.* United States Environmental Protection Agency, National Center for Environmental Assessment, Office of Research and Development, Washington, DC.

US EPA (2017) *Update for Chapter 5 of the Exposure Factors Handbook, Soil and Dust Ingestion.* United States Environmental Protection Agency, National Center for Environmental Assessment, Office of Research and Development, Washington, DC.

US SSA (2014) *Period Life Tables.* United States Social Security Administration, Washington, DC. https://www.ssa.gov/oact/HistEst/PerLifeTables/2017/PerLifeTables2017.html

Figure 1 - Equation for Developing Acceptable Soil Cleanup Target Levels for Carcinogens:

$$\text{SCTL} = \frac{TR \times BW \times AT_c}{EF \times ED \times FC \times \left[(CSF_o \times IR_o \times 10^{-6} kg/mg \times RBA) + (CSF_d \times SA \times AF \times DA \times 10^{-6} kg/mg) + \left(CSF_i \times IR_i \times \left(\frac{1}{VF} + \frac{1}{PEF}\right)\right)\right]}$$

Figure 2 - Equation for Developing Acceptable Soil Cleanup Target Levels for Non-Carcinogens:

$$\text{SCTL} = \frac{THI \times BW \times AT_{nc}}{EF \times ED \times FC \times \left[\left(\frac{1}{RfD_o} \times IR_o \times 10^{-6} kg/mg \times RBA\right) + \left(\frac{1}{RfD_d} \times SA \times AF \times DA \times 10^{-6} kg/mg\right) + \left(\frac{1}{RfD_i} \times IR_i \times \left(\frac{1}{VF} + \frac{1}{PEF}\right)\right)\right]}$$

Table 1 – Recommended exposure parameters for 55 and older communities.

Symbol	Definition (units)	Default
AF	Soil adherence factor (mg/cm^2)	0.07
AT_{nc}	Averaging time (days) (non-carcinogens)	ED × 365
AT_c	Averaging time (days) (carcinogens)	25,550
BW	Body weight (kg)	79.4
CSF_d	Inhalation cancer slope factor $(mg/kg\text{-}d)^{-1}$	Chemical-specific
CSF_i	Dermal cancer slope factor $(mg/kg\text{-}d)^{-1}$	Chemical-specific
CSF_o	Oral cancer slope factor $(mg/kg\text{-}d)^{-1}$	Chemical-specific
DA	Dermal absorption (unitless)	Chemical-specific
ED	Exposure duration (years)	27
EF	Exposure frequency (days/yr)	350
IR_i	Inhalation rate (m^3/day)	13.8
IR_o	Ingestion rate, oral (mg/day)	100
PEF	Particulate emission factor (m^3/kg)	1.24×10^9
RfD_d	Inhalation reference dose (mg/kg-d)	Chemical-specific
RfD_i	Dermal reference dose (mg/kg-d)	Chemical-specific
RfD_o	Oral reference dose (mg/kg-d)	Chemical-specific
SA	Surface area exposed (cm^2/day)	6,320
THI	Target hazard index (unitless)	1
TR	Target risk (unitless)	1×10^{-6}