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Brian Dougherty
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Tallahassee, FL 32399-2400

Re: Human health risk assessment for on-site soil at the Koppers Inc. site

Dear Mr. Dougherty:

At your request, we have reviewed the *Evaluation of Potential Theoretical On-Site Human Health Risks Associated with Soils and Sediments at the Koppers Inc. Wood-Treating Facility in Gainesville, Florida*. This document was prepared by Arcadis and is dated May 2010. The document assesses risk to current and future trespassers and future commercial/industrial workers, recreational users, construction workers, and utility workers from exposure to on-site soil and sediment. The assessment includes a probabilistic microexposure event (MEE) model that calculates commercial/industrial worker risk from exposure to carcinogenic COCs (arsenic, BAP-TEQs, dioxin, and pentachlorophenol) in on-site soil.

The approach to calculating risks is similar in methodology to two previous human health risk assessments for on-site exposures at the Koppers site, both prepared by AMEC Earth & Environment. We criticized many aspects of the previous assessments in review letters to you dated August 21 and December 11, 2009. Although some aspects have been modified in the current assessment, notably the change in focus from Koppers workers to a more general commercial/industrial exposure scenario, the technical approach is essentially the same and has the same flaws previously noted. These flaws make it unsuitable as a basis for decision-making by the Florida Department of Environmental Protection, and we recommend that it be rejected for this purpose. Specific criticisms are outlined in the following comments.

1. The report states, "Absent information to the contrary, the HHRA assumes that the statutory language refers to the typical, or average, Floridian (as opposed to some theoretical statistically defined upper bound Floridian) having a potential theoretical excess lifetime cancer risk equal to or less than the risk benchmark" (page ES-5). The contention by Arcadis here is that the Florida statutory cancer risk goal (1×10^{-6} or less) only needs to be achieved for half of the exposed population. This was not the intent of the Florida statute, which states, "It is the intent of the Legislature to protect the health of all people under actual circumstances of exposure" (376.30701(2) F.S.). Clear guidance on percentiles from probabilistic assessments to be used for risk management decisions is

available from the US EPA. RAGS Volume 3, Part A (US EPA, 2001) states, "In human health PRA, a recommended starting point for risk management decisions regarding the RME is the 95th percentile of the risk distribution" (Section 7.2.3). With this in mind, in order to meet FDEP's risk threshold, the MEE estimate of risk should be below 1E-06 at the 95th percentile. Additionally, Arcadis states on page 5-13 of the risk assessment that when the upper percentiles of risk are more likely to overestimate potential theoretical risk, the US EPA (2001) recommends utilizing the lower end of the RME percentile range. To clarify, the EPA guidance states, "This guidance adopts the 90th to 99.9th percentiles of the risk distribution as the recommended RME risk range for decision-making purposes, consistent with EPA's *Guidelines for Exposure Assessment* (US EPA, 1992)" (Section 7.4, page 7-11). In cases where multiple conservative inputs are likely to overestimate risk, the guidance states the 90th percentile may be used at the discretion of the risk manager (Section 7.2.3, page 7-5). There is nothing in this source cited by Arcadis that suggests using the 50th percentile, or anything close, for risk management purposes.

2. In previous assessments, the site was divided into a number of exposure units, some of which were not well justified in our opinion. In the current risk assessment, the entire 90-acre site was treated as one exposure unit for future indoor workers, outdoor workers, utility workers, construction workers, and current and future trespassers. Given that plans for the site are uncertain, trespassing and future utility, construction, and commercial/industrial activities could conceivably occur anywhere on site. That does not mean, however, that these activities will necessarily occur across the entire site, with individuals having equal and random contact with soil over the entire 90 acres. It is more realistic to assume that these activities will occur, for a given trespasser or utility, construction, or commercial/industrial worker, over a smaller area within the site. Exposure units should be designated accordingly, preferably no more than 5 acres each.

3. The risk assessment does not address the leachability of contaminants to groundwater. Leachability cleanup target levels (CTLs) should be met throughout the vadose zone. FDEP default leachability criteria can be utilized (Chapter 62-777, F.A.C.) or site-specific criteria may be developed using SPLP.

4. Site-specific adjustments in the default relative bioavailability assumption are acceptable provided that site-specific data are available. Site-specificity is important because soil characteristics that might influence the relative bioavailability of a contaminant from soil can vary from site to site. In this risk assessment, exposure and risk were adjusted downward based upon literature bioavailability values for dioxins, PAHs, and arsenic, i.e., bioavailability data from other sites. There is no scientific basis to conclude that these literature relative absorption factors (RAFs) values are necessarily applicable to the Koppers site. It's simply a guess. The only means to obtain reliable site-specific bioavailability estimates is to measure bioavailability from soil from the site. In the absence of site-specific information, the default RAF of 1.0 should be used. Even if use of literature values was acceptable, we have several criticisms of the approaches that were taken to derive the RAF assumptions. These have been articulated in reviews of the previous human health risk assessments for this site, and include: bootstrapping of data sets that are too small, deriving a distribution of RAF

values from a single number from the literature, and selecting a distribution of RAF values with a bias toward low numbers,

5. Section 4.2 *Theoretical Toxicity Values for the Probabilistic Risk Assessment* proposes a toxicity distribution for TCDD obtained from Maruyama and Aoki (2006). This distribution has a most likely estimate of 1,600 $(mg/kg\text{-}d)^{-1}$ and an upper bound estimate of 3,000 $(mg/kg\text{-}d)^{-1}$. We have the following concerns with the use of this distribution:

    a. Use of toxicity distributions in the MEE analysis is inconsistent with RAGS Volume 3, Part A (US EPA, 2001) which states "This guidance does not develop or evaluate probabilistic approaches for dose-response in human health assessment and, further, *discourages undertaking such activities on a site-by-site basis.* Such activities require contaminant-specific national consensus development and national policy development". [emphasis added]

    b. These values do not reflect the current state of science on the carcinogenic potency of TCDD. In May 2009 the State of California, Office of Environmental Health Hazard Assessment (OEHHA) finalized and adopted a technical support document for the development of cancer potency factors for several chemicals including TCDD (OEHHA, 2009). This document derived an oral cancer slope factor (CSF) of 130,000 $(mg/kg\text{-}d)^{-1}$. This CSF was reviewed by California's Scientific Review Panel on Toxic Air Contaminants and was presented for public comment before adoption. In December 2009 the US EPA, Office of Superfund Remediation and Technology Innovation released a public review draft of the *Draft Recommended Interim Preliminary Remediation Goals for Dioxin in Soil at CERCLA and RCRA Sites* (US EPA, 2009a). This document proposes an oral CSF for dioxin of 156,000 $(mg/kg\text{-}d)^{-1}$. Both of these more recently derived values are two orders of magnitude greater than the upper bound estimate proposed for the Koppers risk assessment, suggesting that the distribution utilized in the MEE analysis may significantly underestimate risk to future workers.

6. The toxicity values utilized in the initial runs of the MEE probabilistic assessment are unclear. Section 4.2 *Toxicity Values for the Probabilistic Risk Assessment* (page 4-6) states the CSFs utilized in the initial runs of the MEE are the same as the ones utilized in the deterministic risk assessment (Table 4-3). Section 5.2.3 *Summary of PTELCRs Estimated by the MEE Analysis* states that a 95^{th} percentile on the distribution of possible CSFs was chosen for each COC in the MEE analysis (page 5-13). However, the deterministic values were not based on a toxicity distribution (page 4-1). The text in Sections 4.2 and 5.2.3 is conflicting and needs to be clarified.

7. The surface soil interval 0.5-2 ft below ground surface (bgs) was not evaluated in the risk assessment due to lack of data from historical sampling. The inability to effectively evaluate risks from contaminants in this surficial soil horizon is a significant weakness in the risk assessment.

8. Section 3.3.1 *EPCs for Soils* (page 3-7) states that soil samples from 2006 were arithmetically averaged over four depth intervals (0-3 in, 3-6 in, 6 in-2 ft, and 2-6 ft bgs) to estimate subsurface soil concentrations. This contradicts the *Proposed Approach to Estimating Potential On-Site Human Health Risks Associated with Soils and Sediments* (AMEC, 2008b), which states a depth-weighted average would be used to estimate soil concentration in the human health risk assessment. Arithmetic averages do not take into account the different depths represented by the soil intervals and overrepresent the smaller soil intervals in the average subsurface soil concentration. This may be of concern if the contamination is higher in the larger soil intervals (e.g. 6 in-2 ft and 2-6 ft bgs).

9. Bootstrapping was used to generate a 95% UCL for the exposure point concentration for sediment samples in the drainage ditch. The ProUCL Version 4.0 Technical Guide (US EPA, 2007) states that the bootstrap method should not be used with data sets of less than 10-15 samples (pg. 25). Only nine samples are available for concentrations in the drainage ditch. We recommend using ProUCL Version 4 to calculate a 95% UCL for these data.

10. The Koppers MEE analysis for soil ingestion used a beta pert distribution with a most likely soil ingestion rate of 10 mg/day (letter from Dr. Calabrese, 2003) and a mean soil ingestion rate of 33 mg/day. The US EPA currently recommends using 50 mg/day as the most likely value (US EPA, 2009c, Table 5-1). The Koppers MEE distribution for soil appears to underestimate potential soil ingestion for future workers at the site.

11. Exposure frequencies utilized in the deterministic risk assessment for trespassers and recreational users appear low and may underestimate risk for these receptors.

    a. Trespassers are assumed to contact the property one time a month (12 days/year). This value may be appropriate at an active industrial site, but seems low for a currently inactive industrial property. We recommend utilizing a value of 45 days/year. This value represents an exposure frequency of approximately once a week and appears more reasonable for an inactive site.

    b. Recreational users are assumed to contact the site 150 days/year. This value seems low for Florida where parks are accessible year-round. We recommend utilizing a value of at least 200 days/year.

12. The median tenure for future commercial/industrial workers utilized in the MEE analysis is 4.0 years (Figure 3-21). This distribution is based on the 1987 Bureau of Labor Statistics. However, the US EPA Exposure Factors Handbook (2009) displays a median occupational tenure of employed individuals as 6.6 years (Table 16-82). This value lies between the 65th to 70th percentiles on the MEE distribution utilized in the document. We recommend utilizing the more conservative median tenure value listed in the Exposure Factors Handbook to avoid skewing the distribution to lower values and underestimating the potential future exposure duration at this site.

13. The skin surface areas utilized in the deterministic and MEE model appear incorrect.

   a. Based upon the body weights used in the deterministic risk assessment and the percentage surface area for the body parts listed, the average skin surface area for indoor and outdoor workers is 2,530 cm^2 (2,373 cm^2 is used in the assessment).

   b. In the deterministic assessment, it is unclear why future indoor and outdoor workers (surface area = 2,373 cm^2) and future utility and construction workers (surface area = 2,478 cm^2) have different exposed surface areas. The body weight and exposed body parts are identical; therefore the surface areas should also be equal.

   c. Page 3-16 relates total exposed body surface area to body weight through the equation:

   $$\text{Surface Area} = \text{Body Weight}^{0.6821} * 1025 * 13.65\%$$

   However, the values in Figure 3-22 cannot be reproduced by this method. It is unclear how the MEE surface area distribution was obtained.

14. The dermal adherence factor distributions used in the MEE analysis for future workers underestimates potential soil adherence to skin. Point estimates of dermal adherence factors for future workers were calculated using a geometric mean soil adherence by activity and body region (US EPA, 1997, Table 6-12). The mean soil adherence of 0.206 mg/cm^2 for future workers was used as an upper percentile (90-95th percentile) estimate of the dermal adherence factor distribution. This suggests that greater than 90% of proposed future workers have a soil adherence factor less than the mean.

15. The deterministic dermal adherence factors (AF) chosen for trespassers (0.145 mg/cm^2) and construction workers (0.14 mg/cm^2) likely underestimate dermal adherence for these activities. RAGS Part E (US EPA, 2004) recommends that a default adherence factor represent the 95th percentile of a central tendency activity or the 50th percentile of a high-end soil contact activity. For the trespasser scenario, we recommend utilizing the 50th percentile AF for children (ages 8-12) playing in wet soil of 0.2 mg/cm^2. US EPA (2002) *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* recommends a 95th percentile AF for construction workers of 0.3 mg/cm^2.

16. The assessment uses a 0.25 fraction of exposure for recreational users based on the short time duration (2 hrs) expected on-site. It is unclear how a short exposure time affects the fraction of exposure from the site. The US EPA considers dermal exposure and incidental ingestion of soil to be on an event basis per day. Therefore, the entire daily ingestion and dermal dose could originate from the site regardless of the time exposed. We recommend using the conservative fraction of 1 to prevent underestimating exposure from the site.

17. The distribution for dermal arsenic RAFs was generated using three dose levels that were prorated to a typical workday (page 3-23). Dermal exposure to soil is

assumed to occur over a 24-hour period and should not be prorated to an eight-hour workday. Although conservative, assuming 24-hour exposure is reasonable because exposure to soil does not end when an individual leaves the site. Instead, it is retained on the skin until it is removed by washing or bathing.

18. The deterministic and MEE models utilize a fixed value of 55% for the TCDD-TEQ inhalation RAF based on Nessel et al. (1990). After careful review of the Nessel et al. document, no support could be found for the 55% RAF value. In fact, the paper concludes, "Although these results illustrate the pulmonary bioavailability of TCDD from contaminated particles, it cannot be quantified based on enzyme induction or histopathologic examination alone". The origin of the TCDD-TEQ inhalation RAF utilized for the Koppers risk assessment should be more clearly described in the risk assessment.

19. In Section 4 *Toxicity Assessment* (page 4-1), the sources utilized for toxicity values include, in order of priority, US EPA's Integrated Risk Information System (IRIS), US EPA's Region 6 Human Health Medium-Specific Screening Levels, and HEAST values listed in the US EPA's Region 6 Human Health Medium-Specific Screening Levels. These sources differ from those acceptable to the FDEP for the development of CTLs. FDEP sources, in descending priority, include US EPA's IRIS, National Center for Environmental Assessment provisional toxicity values, HEAST values, and other sources listed in the *Technical Report* (FDEP, 2005, page 10). Due to differences in sources, we have the following comments regarding chronic toxicity values:

    a. Mercury has an oral RfD in HEAST of 3.0E-04 mg/kg-d. This value should be added to Table 4-2 and utilized in the risk assessment.

    b. Several of the chemicals in Table 4-2 have a gastrointestinal (GI) absorption of approximately 0.5 (ATSDR toxicity profiles). The GI absorption should be included in route-to-route extrapolation to prevent underestimation of toxicity from non-oral routes of exposure. Chemicals in Table 4-2 that have a GI absorption of 0.5 and their extrapolated inhalation RfDs include:

        - Acenaphthene has an inhalation RfD of 3E-02 mg/kg-d
        - Anthracene has an inhalation RfD of 1.5E-01 mg/kg-d
        - Fluoranthene and fluorene have inhalation RfDs of 2E-02 mg/kg-d
        - Phenanthrene and pyrene have inhalation RfDs of 1.5E-02 mg/kg-d

    c. In Table 4-3 chromium is listed as chromium III. To our knowledge, no speciation was performed on the chromium detected in soil at the Koppers site. In the absence of speciation data, the more conservative assumption that all chromium on-site is chromium VI should be used. Chromium VI has an inhalation slope factor of 4.1E+01 $(mg/kg\text{-}d)^{-1}$.

20. The risk assessment does not include risk-based cleanup goals for the site, presenting instead risk results. To be a more flexible management tool for evaluating remedial approaches, soil cleanup goals for each of the chemicals of

concern should be calculated according to Chapter 62-777, F.A.C. and Chapter 62-780, F.A.C.

21. Section 6.3 *Exposure Assessment* cites Dr. David Garabrant's work at the University of Michigan as evidence of decreased bioavailability of dioxin from soil. Insight into the bioavailability of dioxin from soil provided by this study of subjects in Midland, MI and vicinity is limited because the subjects had other sources of dioxin exposure, for the most part substantially larger than what they likely received from soil. This confounds any quantitative assessment of the relative bioavailability of dioxin from study area soil. We are aware that the California DTSC has cited this study in deciding to increase their residential cleanup level for dioxin 10-fold, but point out that there is no technical basis for this number in the University of Michigan study.

As an editorial comment, the repetitious use of "potential theoretical risk" and "theoretical potential risk" throughout the document is distracting. The risk assessment would be much more readable if the authors made their point, *once*, most appropriately in the uncertainty section.

Despite the many problems with this risk assessment, it is clear that soil contamination over most of the site exceeds the FDEP target cancer risk of 1×10^{-6}. Having reviewed now three versions of the human health risk assessment, we are not optimistic that the responsible party and their consultants will ever produce a version that is satisfactory to FDEP. From a practical standpoint, FDEP may want to indicate non-acceptance of the risk assessment and move on to finding a remedial solution for soil that satisfies its risk goals through the use of default criteria, remediation, and/or engineering and institutional controls. This approach should also address leachability issues at the site.

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

Sincerely,

Leah D. Stuchal, Ph.D.

Stephen M. Roberts, Ph.D.

References:

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US EPA (1997) *Exposure Factors Handbook.* National Center for Environmental Assessment. Office of Research and Development.

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US EPA (2009c) *Exposure Factors Handbook: 2009 Update.* External Review Draft. National Center for Environmental Assessment. Office of Research and Development.