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July 2, 2015

Ms. Alisa Westenskow
Contract Administrative Officer
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Reference: UDSHW Contract No.126015, Work Assignment No. 09, Chevron Pipeline Diesel Spill, Willard Bay State Park, TechLaw Review of the Arcadis Memorandum, Willard Bay PAH Sediment and Porewater Data Summary, dated April 2, 2015, Task 4 Deliverable

Dear Ms. Westenskow:

TechLaw reviewed the Arcadis Memorandum, Willard Bay PAH Sediment and Porewater Data Summary, dated April 2, 2015 (Arcadis Memo) as part of preparation of the Addendum to a Screening-Level Ecological Risk Assessment (SLERA) for the Chevron Pipeline Diesel Spill at Willard Bay State Park, Utah. The deliverable herein includes technical comments on the Arcadis Memo. The Addendum to the SLERA was provided to Utah Division of Solid and Hazardous Waste as a separate deliverable.

If you or Chris Bittner have any questions, please feel free to call me at (312) 345-8960.

Sincerely,

Bradley K. Martin

Bradley Martin
Program Manager

Enclosure

cc: C. Bittner, DWQ (electronically)
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CHEVRON PIPELINE DIESEL SPILL

TECHNICAL REVIEW OF THE ARCADIS MEMORANDUM WILLARD BAY PAH SEDIMENT AND POREWATER DATA SUMMARY DATED APRIL 2, 2015

BOX ELDER COUNTY, UTAH

Submitted to:

Ms. Alisa Westenskow
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Submitted by:

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July 2, 2015

CHEVRON PIPELINE DIESEL SPILL

TECHNICAL REVIEW OF THE
ARCADIS MEMORANDUM
WILLARD BAY PAH SEDIMENT AND POREWATER DATA SUMMARY
DATED APRIL 2, 2015

BOX ELDER COUNTY, UTAH

Presented below are the evaluations of the Arcadis Memorandum, Willard Bay PAH Sediment and Porewater Data Summary, dated April 2, 2015 (Arcadis Memo).

GENERAL COMMENTS

1. An unstated but underlying premise of the entire body of work summarized in the Arcadis Memo is that the toxicity of weathered diesel fuel in sediment is governed entirely by ∑TU PAH-34. While that fraction is an acknowledged factor in causing toxicity to benthic invertebrates, it does not account for the total toxicity that may be present in diesel-contaminated sediment due to the presence of alkanes and other diesel-related hydrocarbons. Please amend the Arcadis Memo, where needed, to acknowledge and recognize this fact in order to provide a more balanced interpretation of the data.

2. The Arcadis Memo does not include maps showing where (a) the sediment samples were collected in August 2013, November 2013, May 2014, and October 2014 in the wetlands and channel segments for use in the bulk sediment and pore water ΣTU PAH_{34} analysis, (b) the sediment from sample location WP2-SS-BS-02 (0-0.5) were excavated as part of the 2013 remedial effort, and (c) the sediment were amended using Activated Carbon (AC). For the sake of completeness, please include one or more maps showing the requested information.

3. The Arcadis Memo provides data from sediment samples collected from the wetlands and channel segments which were analyzed for ΣTU PAH_{34} in both the solid phase and the pore water phase. However, the text of the Arcadis Memo is not clear as to which of these two matrices is driving the risk characterization presented on pages 7 through 13. The emphasis appears to be on pore water ΣTU PAH_{34}, particularly since Attachment 2 and 3 in the Arcadis Memo focus exclusively on pore water. Please clarify this issue both in the executive summary and in the risk characterization section of the memo. Also, clearly state how the bulk sediment ΣTU PAH_{34} data are used in the risk conclusions of the Arcadis Memo.

4. Attachment 3 in the Arcadis Memo describes the relationship of diesel-associated alkanes on freely-dissolved PAH-34 concentrations in sediment pore water samples. However, the discussion does not include a clear explanation of how the presence of alkane microdroplets causes the analytical technique to generate a positive bias (i.e., overestimate the PAH-34 concentration). An explanation is presented in the first sentence of the first full paragraph on page 9 (i.e., the partitioning of dissolved PAHs from the pore water to the alkane microdroplets). The same information is presented in the last sentence of the second

paragraph of the Background section in Attachment 3 of the 2015 Arcadis Memo (i.e., the presence of PAHs associated with micro-droplets of weathered diesel in the pore water samples). Please expand on this explanation and ensure that it is included in an uncertainty analysis, since it has an important impact on the data interpretation and the decision-making process.

5. The laboratory-scale sediment AC treatment study included as Attachment 2 in the Arcadis Memo represents an important "proof of concept" to show that adding AC to diesel-contaminated sediments decreases both the toxicity related to PAHs and the freely-dissolved PAH-34 levels in pore water. However, an important caveat associated with these results is that they show the dynamics associated with fresh diesel fuel. It is therefore unknown how well these results can be extrapolated to represent the more degraded diesel fuel components that may still be present in the sediments from the wetlands and the channel segments. This issue is briefly mentioned in the Arcadis Memo (see bottom bullet, page 6 of 13) but should be discussed more formally in a uncertainty analysis section of the risk characterization.

6. The Risk Characterization section starting on page 7 of 13 of the Arcadis Memo lacks a formal uncertainty analysis. Two major uncertainties (i.e., how the pore water concentrations of PAHs do not represent the full toxicity associated with diesel-related contamination in sediment, and the short [24-hour] equilibration time when water was added to sediment samples before they were extracted to generate pore water for use in the ΣTU PAH_{34} analyses), and other uncertainties (e.g., the lack of laboratory sediment toxicity testing using benthic invertebrates to "ground truth" the interpretation of the pore water PAH analytical data) should also be included and fully discussed. It is noted that the discussion on the potential for "false positives" due to the presence of alkane microdroplets represents a major uncertainty with the ΣTU PAH_{34} analysis approach which receives a lot of attention in the Arcadis Memo. Please add a detailed uncertainty analysis to the Risk Characterization section in order to provide context to the conclusions and help support the risk management decision-making process.

SPECIFIC COMMENTS

1. **Executive summary, 2nd ¶, page 1 of 13.** The text states "Porewater analytical data […] exceeded the Utah Department of Environmental Quality (UDEQ) "effect" threshold etc." This statement suggests that UDEQ has officially endorsed the effect threshold for the *ΣTU PAH_{34}* analyses, which is not accurate.

   The January 2014 Willard Bay SLERA (page 19) stated the following on this topic:

   > *The PAH analytical results obtained from each pore water sample were converted to Toxic Units (TU = measured concentration/Final Chronic Value [FCV]). The FCVs were obtained from Table 3-4 in EPA (2003a). The PAH-specific TUs in each sample were then summed across the 34 PAHs (detected values only) to calculate a sample-specific ΣTU PAH_{34}. The EPA narcosis model (EPA, 2003a) predicts that a sediment sample will be toxic to benthic invertebrates if the ΣTU PAH_{34} measured in its pore water*

equals or exceeds 1.0. More recent research published by McDonough et al. (2010) suggested that a ΣTU PAH_{34} of 5.0 may be a less restrictive predictor of PAH toxicity. To help in the data evaluation, it was decided to use a ΣTU PAH_{34} of 1.0 as a "no effect" threshold and a ΣTU PAH_{34} of 5.0 as an "effect" threshold. The ΣTU PAH_{34} values between 1.0 and 5.0 provided uncertain risk conclusions which may require further evaluation as part of future risk management discussions.

The statement in the Arcadis Memo is different from the way the TUs were presented and interpreted in the SLERA. In addition, the statement occludes the fact that a ΣTU PAH_{34} value between 1.0 and 5.0 is still open to regulatory scrutiny. Please amend the text of the Executive Summary to reflect the interpretation presented in the SLERA. Note that the correct interpretation is provided under "Risk Characterization" at the bottom of page 7 of 13 in the Arcadis Memo.

2. **Executive summary, 2nd ¶, last sentence, page 2 of 13.** The sentence states "This indicates that activated carbon content in channel segments II and III is likely sufficient to reduce freely-dissolved PAH-34 concentrations over time resulting in a reduction of potential risk to benthic organisms." This sentence, though factually correct, is potentially misleading because it suggests that risk to benthic invertebrates exposed to diesel-related hydrocarbons in sediment is associated solely with the PAH-34 fraction of diesel fuel. Please amend this sentence as follows: "[…] resulting in a reduction of potential risk to benthic organisms exposed to this group of diesel-related compounds." In addition, this issue also needs to be addressed in the uncertainty analysis.

3. **Executive summary, top ¶, page 3 of 13.** The text states that all of the August 2013 sediment samples, 11 of the 13 November 2013 sediment samples, and 8 of the 11 May 2014 sediment samples did not contain enough water to obtain pore water samples. Hence, the analytical laboratory added water to these sediments, and let the mixtures equilibrate for 24 hours before extracting the pore water for PAH analysis. It appears uncertain that complete equilibration can be achieved in such a short amount of time given that some of the PAHs included in the ΣTU PAH_{34} analysis are highly insoluble and would therefore take substantially longer than 24 hours to solubilize and reach equilibrium with the surrounding pore water. Those insoluble PAHs are also the most toxic to aquatic receptors (see third paragraph, page 2 of Attachment 2 to the Arcadis Memo). Please amend the text to address this important issue and discuss how the short equilibration time could have affected the conclusions presented in the Arcadis Memo.

4. **Results, Summary Statistics, 4th ¶, page 5 of 13.** The text states "Bulk PAH-34 sediment concentrations in nine of the resampled locations were similar (i.e., concentration within order of magnitude of the original data point)." However, it is inaccurate to refer to data that may differ by up to a factor of 10 as being "similar." The same issue was found in the next two paragraphs and may occur elsewhere in the text. Please remove the term "similar" and simply state factually that the concentrations fell within an order of magnitude of the original data point.

5. **Results, Risk Characterization, bottom hollow bullet, page 7 of 13.** The sentence states "23 out of 33 sample locations had porewater ΣTU PAH-34 less than or equal to 1.0, indicating no effect to BMI [Benthic Macro-Invertebrates]." This sentence, though factually correct, is potentially misleading because it suggests that risk to benthic invertebrates exposed to diesel-related hydrocarbons in sediment is associated solely with the PAH-34 fraction of diesel fuel. Please amend the target sentence as follows: "[…] no effect to BMI from exposure to this group of diesel-related compounds." In addition, the fact that ΣTU PAH_{34} covers only one part of the total toxicity associated with diesel-related hydrocarbons needs to be addressed in the uncertainty analysis. The clarification also needs to be made at numerous other places on page 8 of 13.

6. **Risk Characterization, hollow bullets on page 8 of 13.** The risk ranges for the pore water ΣTU PAH_{34} data (i.e., <1.0, between 1.0 and 5.0, and > 5.0) pertain only to pore water. Yet, the risk characterization also applies these same risk ranges to the bulk sediment ΣTU PAH_{34} analytical data. This approach is erroneous. Please re-assess the risk interpretation of the bulk sediment ΣTU PAH_{34} results and amend the 2015 Arcadis Memo accordingly.

7. **Attachment 2, Figure 1 and 2.** The interpretation and usefulness of these two figures would be greatly enhanced if the data were analyzed using an Analysis of Variance (ANOVA), with the outcome added to the graphs using letters to denote significant differences. Please perform the statistical analysis and amend the figures accordingly.

8. **Attachment 2, Results, *Effect of Activated Carbon Treatment,* 1st ¶, last sentence.** This sentence implies that the addition of AC was responsible for the lack of a sheen observed in any of the test jars. This observation is potentially significant since AC was also mixed into sediments from channel segments II and III in March 2014 to help control sheen formation in the field. It is unclear, however, if sheens were observed in the test sediments after each jar was spiked with 0.25 mL of fresh diesel fuel and mixed overnight (see Attachment 2, Approach, first paragraph), but before the AC was added to the jars. Please amend the text to address this issue.

9. **Attachment 2, Results, *Effect of Activated Carbon Treatment,* 2nd ¶, 2nd sentence.** The sentence states that "some biological degradation occurs […]." However, the term "some" is qualitative. This statement would be greatly strengthened by performing the statistical analyses requested in a previous comment. Please reassess the results based on the outcome of the ANOVA.

10. **Attachment 2, Results, *Effect of Activated Carbon Treatment,* 2nd ¶, 3rd sentence.** This sentence uses the term "significant reduction" to describe the downward trend shown in Figure 1. Significance can only be determined based on statistical testing. Please perform the requested ANOVA and re-interpret the data based on the outcome of that analysis.

11. **Attachment 3, Approach.** The text explains how the n-alkane peak areas were integrated, summed for each GC/MS analysis, and ratioed to the d8-naphthalene internal standard to estimate the alkane concentrations. However, the bottom graph in Figure 1 of Attachment 3 shows an example of a d10-naphthalene internal standard for a representative pore water

sample. It is therefore unclear which internal naphthalene standard was used to calculate the alkane concentrations. Please amend the text to clarify.