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NMED
Hazardous Waste Bureau

Mr. David Cobrain
NMED - Hazardous Waste Bureau
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Santa Fe, NM 87505

RE: Draft Technical Review Comments on the Resource Conservation and Recovery Act Facility Investigation Report, Vadose Zone, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, New Mexico, Dated March 2014

Dear Mr. Cobrain:

Attached please find draft technical review comments on the subject Kirtland Air Force Base (AFB) report for the Bulk Fuels Facility (BFF) spill site, dated March 2014. This report presents the results of RCRA Facility Investigation (RFI) for the vadose zone portion (SWMU ST-106) of the BFF spill site.

We have several general concerns about the report. We also have other specific comments that NMED should consider.

If you or any of your staff have questions, please contact me at (801) 451-2864 or via email at paigewalton@msn.com.

Thank you,

Paige Walton

Paige Walton
AQS Senior Scientist and Program Manager

Enclosure

cc: Ben Wear, NMED (electronic)
Kent Friesen, Wyoming Environmental Consulting (electronic)
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The contents of this deliverable should not be evaluated as a final work product.

Draft Technical Review Comments on the Resource Conservation and Recovery Act Facility Investigation Report, Vadose Zone, Bulk Fuels Facility Spill Solid Waste Management Units ST-106 and SS-111 Kirtland Air Force Base, Albuquerque, New Mexico Dated March 2014

GENERAL COMMENTS

1. The appendices submitted with the Vadose Zone Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) contain the data, analyses, and other supporting information generated during the performance of the RFI. The RFI references information contained in the appendices as a means of directing the reader to supporting data and analyses or for details that are not furnished in the text. However, the appendices are lengthy and the pages are not numbered; thus, locating the referenced information is difficult. It is recommended that the appendices be subdivided (e.g., subdivide Appendix A by subject of correspondence) and the subdivisions labeled to facilitate the location of the information referenced in text. Revise the appendices submitted with the Vadose Zone RFI to address this issue.

2. Soil contaminants of concern (COCs) – Soil COCs have been developed based on the soil concentration results presented in the RFI, including extensive Geoprobe sampling of soil from 0 to 20 ft bgs along the FFOR and connecting pipelines, and from five borings around the former above-ground storage tanks (ASTs). The identification of soil COCs was based on exceedance of NMED residential risk criteria (or Environmental Protection Agency (EPA) Regional Screening Levels if there are no NMED criteria for a given analyte). These screening levels are based on human exposure risk; however, it is obvious that a primary concern with soil contamination at this site is the continued leaching of volatile hydrocarbons into groundwater. Therefore, the identification of COCs should incorporate both human health risk comparison criteria, as well as protection of groundwater criteria. If additional identification of COCs based on protection of groundwater is not provided in this RFI Report, then it should be evaluated during the upcoming risk assessment.

3. Soil vapor COCs – Respondents states that there are no published COCs for soil vapor; however, given the widespread extent of the soil vapor plume, as well as the fact that soil LNAPL and contaminated soil are the source of soil vapor, there needs to be a more rational effort expended towards identifying additional COCs based on the soil vapor data. A specific example of this shortcoming is benzene, which has not been identified as a soil COC, yet has been extensively evaluated as a soil vapor plume constituent. However, there are tools that are available for assessing soil vapor, through use of soil gas and groundwater data. The Vapor Intrusion Screening Level (VISL) Calculator is a spreadsheet tool that (1) lists chemicals considered to be volatile and known to pose a potential cancer risk or noncancer hazard through the inhalation pathway; (2) provides generally recommended screening-level concentrations for groundwater, soil gas (exterior to buildings and sub-slab) and indoor air for default target risk levels and exposure scenarios; and (3) allows calculation of site-specific screening levels based on user-defined target risk levels and exposure scenarios. Given vapor plume, evaluation of

the soil gas and groundwater data using the VISL should be conducted. Another approach towards developing soil COCs from the soil vapor data could be to back-calculate the equilibrium soil concentration expected from maximum soil vapor concentrations identified for each analyte, and then compare the calculated soil concentrations with protection of groundwater comparison values.

4. Soil vapor extent and risk – We question if the lateral extent of soil vapor has been adequately determined. The contouring algorithm used in preparation of soil vapor concentration maps appears to have assumed a limited "radius of influence." This leads to mapping the soil vapor results in the widely-spaced wells located immediately north of the BFF as discrete "circles" in the contour maps, rather than the alternate interpretation of connecting the contours between offsite wells. This interpretation could also impact assumptions of completed pathways to offsite receptors. Based on the data provided in this report, the future risk assessment must evaluate potential offsite impacts of soil vapor to recreators, workers and residents.

5. Site Complexity - The text of the RFI Report does not adequately describe the complexity of the vadose zone contamination and lithology. The site is comprised of a relatively complex vadose zone that extends laterally over approximately 20 to 30 acres and is over 400 feet deep. However, Respondents have presented a considerable amount of soil and soil vapor data, and significant effort has been expended in the preparation of lithologic and soil vapor cross sections, and maps of soil vapor results at discrete depths. In addition, the PneuLog assessment for three wells indicates substantial changes vertically in both air permeability and hydrocarbons distribution. But the text description of the site is fairly simple, and does not adequately describe the complexity of lithologic layering, and resulting contaminant migration. In general, the detail presented in the analytical data, cross sections and PneuLog results have not been translated into an adequately detailed conceptual site model, which reduces the likelihood that the future corrective action design will be adequate. Respondent should provide additional evaluation of the existing data by more thoroughly describing the complexity of subsurface conditions of the vadose zone.

6. PneuLog Testing - PneuLog assessment of only three well cluster locations was performed, although PneuLog wells were installed at approximately 9 locations. However, the results from these three wells indicate considerable vertical variation of both air permeability and contaminant distribution with depth. We believe that the PneuLog assessment provides a useful tool to describe the variation in vertical distribution of these factors that could be successful used to implement full-scale SVE to remove vadose zone hydrocarbons from the site.

7. Radius of Influence (ROI) Testing - The evaluation approach for determining the ROI of the existing CATOX SVE system is similar to previous evaluations (*Soil-Vapor Extraction System Pilot Test Report, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, New Mexico*, dated January 2014), and therefore we have similar objections to the ROI evaluation process as has been previously raised. Also, we are puzzled why this RFI Report refers to ROI field testing conducted in March 2013, when the report we previously reviewed used SVE ROI field testing results from November 2013. An explanation of this duplicity, as well as the

reporting of these later results, should be provided. Objections previously raised regarding the ROI assessment are summarized as follows:

a. The use of 0.2 inches of water column (inWC) as the "edge" or perimeter of the ROI is subjective and results in over-estimation of the ROI. We previously recommended using 0.5 inWC as the edge of vacuum ROI.

b. The ROI defined as the radius of vacuum influence should not be used directly as a basis for full scale design; instead, the effective radius of treatment should be determined; measurable vacuum does not imply effective air flow for treatment.

SPECIFIC COMMENTS

1. **Pg. 2-8, Section 2.3.6, fourth bulleted item.** Remediation Service International Units 335, 344, and 345 were moved to increase system performance. While it is clear that these units were moved to KAFB-106149-484, KAFB-106161, and KAFB-106160, respectively, and likely were previously located at KAFB-1065, KAFB-1066, and KAFB-1068, it is not clear which unit was located at which groundwater monitoring well. Revise the first and second bulleted items on page 2-8 to include this same information.

2. **Pg. 2-8, Section 2.4 Data Gaps, bullets at bottom of page.** Data gaps that were the subject of this investigation are listed as bullets in this section. Not all of these findings have been clearly reported, although we recognize that some may be inferred or the answers may be buried in an appendix. For example, where is the amount of fuel in the vadose zone (fuel volumes were provided in Appendix K, but were not clearly reported in the text)? What is the source of the NAPL plume (Figure 7-1 suggests it is the FFOR area, which is apparent from the soil and soil gas data, but Section 7 Conclusions does not clearly discuss this)? What is the relationship of the vadose zone hydrogeology with the underlying groundwater (Section 3.4 and 3.5 discusses regional aspects of this, but the site-specific relationship of the vadose zone with underlying groundwater is not clearly discussed)? Also, in the 4th bullet, the portion of text in parentheses does not make sense; please clarify.

3. **Section 3.2.** This section discuss meteorological conditions such as seasonal daily high and low temperatures, rainfall, snowfall, prevailing wind direction, and wind speed. In addition, Section 3.4 includes a discussion of precipitation rate, evapotranspiration rate, and recharge to ground surface. However, a table listing the monthly and annual average values for these parameters is not included. Revise the Vadose Zone RFI to include a table in both reports that presents the monthly values, as well as the annual average, and if desired seasonal averages, for the meteorological parameters discussed in Sections 3.2 and 3.4.

4. **Sections 3.3 and 3.4.** These sections describe the regional geology and regional hydrogeology, respectively. However, figures supporting the text descriptions are not included in the Vadose Zone RFI. Revise the Vadose Zone RFI to include figures illustrating the regional geology and regional hydrology to support the descriptions provided in the report texts.

5. **Section 4.2, Deep Soil Investigation, page 4-4,** does not identify the work plan on which the deep soil investigation was based (e.g., Vadose Zone Investigation Work Plan). Revise Section 4.2 to identify the work plan(s) and other project documents that provided the basis for the deep soil investigation conducted as part of the Vadose Zone RFI.

6. **Section 4.2.4, Split-Spoon Sampling, page 4-8, first full paragraph**, the text indicates that the Vadose Zone Investigation Work Plan requires that soil samples from at least two deep borings be analyzed for volatile petroleum hydrocarbons (VPH) and extractable petroleum hydrocarbons (EPH). Furthermore, Section 4.2.4 states that the required sample analyses were not performed; instead, the samples were analyzed for TPH-GRO and TPH-DRO. Justification for this deviation from the work plan is based on a statement that VOC and SVOC analyses will provide the necessary data on any chemicals that exceed regulatory limits. However, the Vadose Zone RFI fails to demonstrate that the approach taken during the vadose zone investigation generates information that constitutes an adequate replacement for VPH and EPH analytical results. Revise the discussion in the last paragraph of Section 4.2.4 to demonstrate that the results of VOC and SVOC analyses obviate the need for VPH and EPH results in deep soil. The demonstration should show that use of VOC and SVOC results to estimate risks associated with the spills at the BFF is equivalent to characterize those risks using VOC, SVOC, VPH, and EPH results.

7. **Pg. 4-11, Section 4.4, first sentence.** What is meant by "inform SVE requirements"? Please clarify.

8. **Pg. 4-12, Section 4.4.2.** This describes various phases of Radius of Influence (ROI) testing of the soil vapor extraction (SVE) system, including the current CATOX system. Field work was performed from January through May 2013. However, we have previously reviewed a pilot test report with the results of ROI testing that was performed more recently in October 2013. Why have Respondents not reported the most recent ROI testing? Re: *Soil-Vapor Extraction System Pilot Test Report, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, New Mexico*, dated January 2014?

9. **Section 4.5, Quality Assurance and Quality Control, page 4-16,** indicates that four field work variances are located in Appendix A-1. Examination of Appendix A indicated that the appendix was not subdivided and the field work variance forms as well as all correspondence were presented in Appendix A. Revise the Vadose Zone RFI to include a more specific reference to the location of the field work variance forms within Appendix A. For example, the appendix could be subdivided and each subdivision could be identified by a title page.

10. **Pg. 5-1, Section 5.1.1**. A clay layer was observed within the shallow soil zone in the vicinity of Bldg, 1033, generally between 10 and 15 feet bgs. Given the predominately sandy lithology of most of the vadose zone, residual fuel hydrocarbons would tend to adsorb to silty and clay layers preferentially to sand and gravel layers. This hypothesis seems to be supported by an "anvil" of higher soil vapor concentrations in the shallower silty zones (see Figure 5-52 cross section G-G', and Figure 5-54 cross section I-I'..). Also see Pg. 10 of the PneuLog report in Appendix D, which indicates that a low permeability layer in test well KAFB-106148 contained elevated soil vapor

concentrations, suggesting preferential adsorption of fuel hydrocarbons onto clay layers. See also Figure 5-13, 5-14, and 5-15 Pneulog results; higher TVH readings are often associated with sudden decrease in vapor permeability with depth. Preferential adsorption onto clay or silt layers can have significant implications for long-term optimization of the SVE system, since these layers may continue to "bleed" hydrocarbons long after treatment is substantially competed in more sandy zones. These aspects should be incorporated into full-scale SVE design.

11. **Pg. 5-2, Section 5.1.2, 3rd paragraph on page**. Although 1,1,2-trichloroethane and 1,2,3-trichloropropane may not be fuel related, these compounds must not be ignored in the risk assessment.

12. **Section 5.1.2, Shallow Soil Sample Results, page 5-1**, refers to Appendix C-1 as the location of the analytical results for shallow soil samples. Examination of Appendix C indicated that the appendix was not subdivided; however, the analytical results are included within Appendix C. Revise the Vadose Zone RFI to include a more specific reference to the location of the analytical results for shallow soil samples within Appendix C. For example, the appendix could be subdivided and each subdivision could be identified by a title page.

13. **Section 5.1.2, Shallow Soil Sample Results, page 5-2**, indicates the analytical results for shallow soil samples were compared to NMED residential SSLs. If a residential SSL was not available for a constituent, the EPA Region 9 Regional Screening Level was used for screening. In addition to the analytical results for shallow soil samples, Table 5-1 provides a summary of the screening analysis. As such, it should be referenced in the discussion at the top of page 5-2. A review of Table 5-1 indicates that the maximum detected concentration for a constituent was compared to the screening criterion. Also, EPA revises the RSLs in May and November each year. Thus, a reference is needed for the EPA RSLs to demonstrate that the most recent version (at the time the screening analysis was performed) of the RSLs was used in screening shallow soil sample results. Revise the discussion on the screening of shallow soil sampling results at the top of page 5-2 to include a reference to Table 5-1. Indicate that the maximum detected concentration for a constituent was compared to the applicable screening criterion. In addition, add a reference citation for the EPA RSLs used in the screening analysis. Ensure a citation for the EPA RSLs is included among the References listed at the end of the Vadose Zone RFI.

14. **Pg. 5-5, Section 5.2.2 Pneulog testing results.** In general, this section provides an overly abbreviated description of the results presented in Appendix D. Please expand the discussion with emphasis on test results that would influence future CMI design.

15. **Pg. 5-7 and 5-8, Section 5.2.3, first paragraph of Section.** This section reports that the deep soil samples generally do not exceed NMED residential SSLs. Therefore, there is little human health risk associated with deep soils, as well as no pathway due to the depth > 20 ft bgs. However, this risk screening evaluation does not adequately address the potential risk of deep soils to continue to contaminate groundwater with petroleum hydrocarbons. Indeed, the primary concern of the vadose zone soil is likely to be groundwater contamination, rather than ingestion/contact risk, given the presence of the groundwater plume. Respondents must assess the shallow and deep soil results for the

potential to contaminate groundwater, such as a comparison with Protection of Groundwater SSLs.

16. **Pg. 5-7, Section 5.2.3, first paragraph of Section.** This discussion of the deep soil sample analyses states that 466 soil samples were collected for the deep soil investigation, but it is not possible to assess where these samples were collected, and therefore to understand the general distribution of sampling, in order to assess the adequacy of sample coverage. The analytical data for these samples is buried within Appendix C, and it is not possible to determine the sample locations on a map. Some sort of visual comparison with the soil vapor results is warranted to show if the more highly contaminated deep soil areas were sampled, or not. This uncertainty undermines the conclusions regarding the resulting soil COCs.

17. **Section 5.2.3, Split-Spoon Samples Results, pages 5-8 and 5-9**, indicate that split-spoon sample results and those historical soil sample results (2006 through 2010) reported to the Environmental Resources Program Information Management System Database were screened against NMED SSLs or EPA RSLs. EPA revises the RSLs in May and November each year. Thus, a reference is needed for the EPA RSLs to demonstrate that the most recent version (at the time the screening analyses were performed) was used in screening the split-spoon and historical soil sample results. Revise the discussion on the screening of spilt-spoon and historical soil sample results on pages 5-8 and 5-9 to include a reference citation for the EPA RSLs used in the screening analyses. Ensure a citation for the EPA RSLs is included among the References listed at the end of the Vadose Zone RFI.

18. **Pg. 5-13, Section 5.2.5.7, Summary of Quarterly Soil Vapor Sample Results.** Within the BFF on-site area, there are many soil vapor data points, and potentially Kirtland could optimize monitoring sites; for example, there seems to be no reason to have four locations around each of the former ASTs (KAFB-106120 through -106127).

19. **Pg. 5-13, Section 5.2.5.7, Summary of Quarterly Soil Vapor Sample Results.** One of the general observations from soil vapor data is that there are detected hydrocarbon constituents everywhere that soil vapor is monitored. As an example, sample location KAFB-106138 is located adjacent to the VA medical center complex, and has vapors in both the shallow and deep intervals. Therefore, vapor intrusion is a potentially significant concern for the offsite areas, including the neighborhoods north of the BFF.

20. **Pg. 5-13, Section 5.2.5.7, Summary of Quarterly Soil Vapor Sample Results.** Soil vapor results for SVMW04, SVMW08, and SVMW09 are rather high in comparison to surrounding sample results, which would argue towards additional source area soils treatment near the FFOR.

21. **Pg. 5-14, Section 5.3, first paragraph on page.** Regarding the ROI evaluation, the report states that 0.2 inches WC was used as the edge of the ROI "based on field observations." However, the previous January 2014 pilot test report used 0.3 inches as the edge of the ROI, and we commented then that 0.5 inches would be more appropriate. Why are Respondents moving back towards a less certain criteria of 0.2 inches WC in this report? We have also previously commented that the radius of vacuum influence, as currently evaluated in this report, is not the same as radius of effective treatment

influence for SVE. Based on these concerns, there is considerable uncertainty in the ROI results presented herein.

22. **Pg. 5-17, Section 5.3, bottom paragraph on page; and Table 5-12.** Please provide details on this calculated maximum and minimum vapor pressure; also, please clarify what this information is useful for.

23. **Section 5.3.3.1, Barometric Influence on Vacuum Pressure in the Vadose Zone**, page 5-16, first sentence, refers to Section 4.3.4 for a description of the methods used to quantify the vacuum response of the vadose to barometric fluctuations. However, there is no Section 4.3.4 in the Vadose Zone RFI. It is likely that the reference should be to Section 4.4.3, Barometric Fluctuations. Revise the section reference in the first sentence of Section 5.3.3.1 to refer to the location of the methods for quantifying the vacuum response of the vadose zone to barometric fluctuations within the Vadose Zone RFI.

24. **Pgs 5-18 and 5-19, Section 5.4.1.** The text indicates that screening analyses were performed to identify constituents of concern (COCs) in soil and soil vapor. Page 5-18 list the criteria that COCs must meet. The COCs identified in soil and soil vapor are listed on page 5-19 of the Vadose Zone RFI. No other information on these screening analyses was found in the report texts or the accompanying appendices. The discussion of the screening analysis in the RFI report should be expanded to include additional information on the application of the criteria used to identify COCs. Each discussion should define the data set used in the COC screening analysis and the constituents eliminated under criterion 1 and criterion 2 should be identified. A table summarizing the COC Screening Analysis for groundwater should be included for the screening of soil and soil vapor. The table should present the data set used as well as the number of available samples, the number of detections, and the applicable screening values for each constituent. In addition, the table should include a column that indicates if the constituent is identified as a COC. The reasons for selection or elimination as a COC should also be provided. If the size of this table is a concern, it can be submitted as a self-contained appendix to the Vadose Zone RFI and referenced in the report text. Revise the Vadose Zone RFI to address this issue.

25. **Section 5.4.1, Detected Compounds and Contaminants of Concern, page 5-18**, third bulleted item, a reference citation is included for EPA residential RSLs. According to the list of References at the end of the Vadose Zone RFI, the citation is for EPA's National Primary Drinking Water Standards, EPA 816-F-09-0004, dated May 2009. This document is not a preferred source for EPA RSLs. Note that EPA revises the RSLs in May and November each year. Thus, a reference is needed for the EPA RSLs to demonstrate that the most recent version (at the time the screening analysis was performed) was used in screening soil and soil vapor sample results. Revise the third bulleted item in Section 5.4.1 to include a reference citation for the EPA RSLs used in the screening analysis. Ensure the referenced information source is included among the References listed at the end of the Vadose Zone RFI.

26. **Pg. 5-20, Section 5.4.2.** It is ironic that this section is entitled "Spatial Analysis of COCs" since a considerable portion of the section is used to describe soil vapor results, and Respondents have claimed elsewhere that there are no soil vapor COCs.

27. **Pg. 5-23, Section 5.4.2.3, first full paragraph on page.** The third sentence is not correct, since the Figure 5-50 results do not show any EDB detections.

28. **Pg. 5-24, Section 5.4.2.3**. In the top paragraph, regarding the 50 ft bgs results, we disagree with the statement "The area of lower concentrations became larger while the area of higher concentrations became smaller, illustrating that concentrations decreased overall…" This is not conclusively true. If overall average concentrations stayed the same, then one would expect lower concentration areas to spread and higher concentration areas to get smaller, simply due to dispersion of a finite source of hydrocarbons vapor. Therefore, Respondents need to develop a calculated average or spatially weighted average to determine if overall concentrations are decreasing for soil vapor. This comment also applies for the 150 ft bgs interval (bottom of page 5-24), 250 ft bgs interval (top of pg. 5-25), and 450 ft bgs interval (2nd paragraph pg. 5-26).

29. **Pg. 5-29, Section 5.4.2.3, Summary of Soil Vapor Spatial Analysis.** We agree that both the VOC and benzene results seem to support identification of the FFOR area as the initial release source area, with vertical migration to approximately 250 ft bgs, and then a southeast migration deeper into the vadose zone and vertically to the water table. We also note that cross section G-G' exhibits higher VOC concentrations that are spatially associated with the upper silt/silty sand layer, which is also shown in cross section I-I' to some degree. At other locations, high concentrations of vapor are associated with the water table occurrence, as shown on cross section K-K'. The benzene results in cross section G-G' seem to be associated with a clay layer near SVMW-06. These observations are important considerations for full-scale SVE design.

30. **Pg. 5-29, Section 5.4.2.3, Summary of Soil Vapor Spatial Analysis.** This section primarily discusses the spatial occurrence of higher concentration portions of the soil vapor plume, which is informative. However, Respondents should also consider the extent of the "soil vapor plume" and whether off-Base receptors are potentially affected. It is apparent that the soil vapor plume maps (Figures 5-41 through 5-49) are affected by some arbitrary determination that soil vapor concentrations have a limited geographic affect of approximately 600 ft diameter, or 300 ft radius. This results in isolated "circles" of mapped soil vapors, when in fact the "circles" could be connected into a larger plume mass, based on lack of data between these data points. For example, Figure 5-41 shows discrete "circles" of vapor plume around the individual offsite SVMs (at 50 ft bgs) (examples: KAFB-106138, -106141, -106142, and -106136), when in fact they could be contoured as a continuous mass extending from the on-Base source area. Consequently, Respondents cannot discount the offsite migration of soil vapor to residential receptors via the vapor intrusion pathway. This concept is also illustrated in cross section on Figure 5-56, Section K-K'; note that on the K side there are no data points shown, although clearly KAFB-106142 is nearby and appears to influence the presence of the "blue" vapor areas, which could easily be considered as contiguous with the soil vapor plume from the on-Base area. In this regards, we question if the downgradient extent of the soil vapor plume is fully characterized.

31. **Pg. 6-1, Section 6.** Given the large quantity of hydrocarbon vapors in the subsurface, this section should also clearly present the physical parameters that will be required for future vapor intrusion risk analysis, such as soil type, porosity, etc. The risk assessor should be able to refer to the RFI Report for these types of parameters.

32. **Pg. 6-2, Section 6.1.** When considering contaminant fate and transport, it is inappropriate to only identify the soil COCs as COCs for the vadose zone. Respondents did not make any effort at identifying COCs for soil gas. We understand that there are no directly comparable criteria for soil gas; however, given the relatively high levels of benzene in soil gas, and the contouring of benzene in soil gas in maps and cross sections, it is unacceptable to not consider benzene as a COC for soil. Similar arguments apply for all BTEX and fuel-related compounds.

33. **Pg. 6-5, Section 6.1.1.** A discussion is included on the fate and transport characteristics of 1,2,4-trimethylbenzene (1,2,4-TMB). The discussion presents a value of 6.16×10^{-3} atmosphere-cubic meters per mole (atm-m^3/mol) for the Henry's Law Constant which differs from the value reported in the Groundwater RFI (5.18×10^{-3} atm-m3/mol). Note that both values are referenced to EPA's *Health Effects Assessment for Trimethylbenzenes* dated 1987. It is believed the different values are based on different temperatures; however, neither RFI report references the temperature for the value reported in the text. Information on the Henry's Law Constant for 1,2,4-TMB should be reviewed for accuracy and consistency. It is preferred that a single value of the Henry's Law Constant be reported and the reported value reflect the value used in fate and transport calculations. In addition, the reference temperature for any reported value of the Henry's Law Constant should be provided. Revise the 1,2,4-TMB discussion in Section 6.1.1 of the Vadose Zone RFI to include the reference temperature for the reported value of the Henry's Law Constant. Ensure the information source for the reported value is accurately and appropriately referenced and included among the list of References at the end of the RFI Report.

34. **Page 6-6, Section 6.1.2, PAHs bullet.** This statement in the 8th sentence exhibits poor logic: "Based on the range in values and the apparent lack of a significant competing fate process, biodegradation may be an important process in soil." It is not reasonable to assume biodegradation is present simply because no other fate or migration processes are identified; in fact, the logical conclusion would be that the compounds would persist in the absence of migration processes.

35. **Page 6-6, Section 6.2.** We agree that NAPL migration is a significant contaminant migration process for the vadose zone, and Respondents should recognize that soil COCs and vapor analytes are associated with NAPL as the primary source. However, this discussion would be more informative if it presented what was actually observed or inferred at the BFF based on soil and vapor results, rather than discussing conjecturally what could happen for a NAPL release. For example, it is evident that the Kirtland NAPL release has, in fact, migrated to the water saturated zone (rather than "NAPL may spread laterally as a continuous, free-phase layer along the upper boundary of the water-saturated zone"). It is not as evident that utility trenches have significantly impacted NAPL migration at Kirtland (rather than, "areas backfilled with coarse-grained material (such as utility trenches) can provide a horizontal pathway for NAPL migration").

36. **Pg. 6-8 to 6-9, Section 6.2.2.** The equations presented in this section describe the partitioning of VOC soil vapor from a NAPL source. While interesting, they do not appear to be further used in the evaluation. We suggest back-calculating equilibrium soil (or NAPL) concentrations from the available soil vapor concentrations, and use the calculated values (based on maximum soil vapor concentrations) to identify additional

soil COCs. Comparison of calculated soil values with protection of groundwater SSLs would be warranted.

37. **Pg. 6-11, Section 6.2.5.** This discussion on barometric pressure appears to be generally mis-informed and overall not useful. It is counter-intuitive that barometric pressure would have a profound effect on the ROI of SVE wells (as discussed in Section 5.3.3), but would have no effect on soil vapor contaminant distribution. It is recommended that this discussion be deleted. Note also that Appendix K, Figure 2 notes correlation of barometric pressure with changes in groundwater elevation, so the argument that deeper media is not affected by barometric pressure is invalid.

38. **Pg. 7-1, Section 7 Conclusions, 5th bullet**. This bullet again states that "no screening levels exist for soil vapor, and therefore, no soil vapor COCs have been identified for ST-106 as part of the Vadose Zone RFI." However, Respondent should come up with a better plan to identify COCs related to soil vapor occurrences, which are significant and likely contribute to groundwater contamination.

39. **Pg. 7-1, Section 7 Conclusions, 6th bullet**. It is obvious that VOCs and benzene are "COCs" for soil vapor. However, Respondents need to employ better quantitative tools to support any conclusion that the soil gas plume is decreasing in size.

40. **Pg. 7-1, Section 7 Conclusions, 8th bullet**. We agree with this assessment; this shows the value of the soil vapor data for site characterization, and the need for identifying additional COCs based on the soil vapor data.

41. **Pg. 7-1, Section 7 Conclusions, 9th bullet**. This refers to COCs that are, by inference, soil vapor COCs (i.e., associated with NAPL) which Respondents have failed to define. Therefore, COCs cannot be limited to just the soil COCs defined before.

42. **Figure 5-16 through 5-21.** The horizontal axes are not labeled coherently, as a measure of time.

43. **Figure 5-31 through 5-34.** The horizontal axes are not labeled coherently, as a measure of time. Also, what are these graphs attempting to portray?

44. **Figure 5-50 EDB Results**. The Figure has no useful purpose because apparently there are no EDB detections shown. It would be better to show detected EDB results combined across various sample events to show some sort of useful spatial information. This figure shows 2nd quarter 2013 results, but these results are not included in Table 5-10, perhaps because there was no EDB detected in this quarter.

45. **Figure 5-51 through 5-62, Lithology and Soil Vapor Cross Sections.** Color selection of red for clay, and orange for gravel, was a poor choice given the similarity in these colors but drastically different lithologies. Also, it appears that there are contour lines on the soil vapor cross sections; please label these or describe in the legend.

46. **Figure 7-1.** Based on the information presented in the Vadose Zone RFI, Figure 7-1 does not present a robust conceptual site model (CSM) suitable for use as an initial CSM for a baseline risk assessment. While the description of Figure 7-1 in Section 7 indicates that exposure pathways and exposure routes are linked to the current understanding of groundwater and vadose zone contamination, CSM does not identify potential exposure pathways and exposure routes for all receptors that will be addressed in the forthcoming

baseline risk assessment for the BFF spills. Potential exposure points, but no exposure pathways or exposure routes are identified for current receptors within the BFF boundary. However, the baseline risk assessment must also consider the potential for exposure of sensitive subpopulations (e.g., on-base day care, on-base hospital) and impacts to future receptor populations such as a hypothetical future residential receptor. Vapor emissions can potentially impact recreational users at Bullhead Park and on-base residents. Also, the future risk assessment must evaluate the potential for contamination of groundwater from vadose zone soils as such an evaluation was not performed as part of the Vadose Zone RFI. Figure 7-1 should be revised to list the exposure pathways and exposure routes associated with the potential exposure points shown on the CSM. For example, it is not clear that direct exposure of workers to contaminated shallow subsurface soils in the FFOR area is accounted for in the CSM. In addition, the title of Figure 7-1 should be changed to "Conceptual Site Model for Current On-Site Receptors." The description of Figure 7-1 in the text should be modified to indicate that the linkage between contamination and receptors is depicted for current on-site receptors only. In addition, the description should note that the CSM will be expanded to include off-site receptor populations (e.g., recreational users of Bullhead Park), future receptor populations, and additional exposure pathways, if necessary as part of the forthcoming risk assessment. Revise Figure 7-1 and Section 7 to address these issues.

47. **<u>Tables 5.4 through 5.9.</u>** In contrast to the deep soil results, considerable effort has been expended in presenting the soil vapor results , including these summary tables for discreet depth intervals, total VOC and benzene plume maps for up to 5 quarters (Figures 5-41 through 5-49), and cross sections (Figures 5-51 through 5-62, and Appendix L). This level of effort provides confidence that the higher concentration source areas in the vadose zone have been adequately identified, although it is not clear if soil samples were collected from the high soil vapor plume areas.

48. **<u>Table 5.10.</u>** This table presents ethylene dibromide (EDB) results for soil vapor samples, although across several quarters. We recognize that Respondents have identified EDB results in vadose zone soils as a data gap. An additional figure showing the spatial distribution of all of the detected EDB results would be helpful, even though this data would need to span across several sampling events. As it is, it is difficult to determine if there is a concentrated source of EDB in vadose zone soil, or if these data represent random detections within a larger EDB soil vapor plume.

49. **<u>App. D PneuLog report, pg. 10.</u>** The Pneulog test on well KAFB-106148 indicates that, "From 267 to 283 feet bgs, a relatively low permeability interval was encountered that appears to harbor significant contamination, as evidenced by its elevated soil vapor concentration of almost 20,000 ppm." Therefore, these results also suggest that low-permeability layers tend to adsorb more petroleum hydrocarbons. Similarly, on pg. 14 of the Praxis report, for well KAFB-106150, it is stated "Low permeability soils were encountered from 245 down to 284 feet bgs (except for one very thin permeable stratum). This low permeability interval produced little flow; however, the TVPH concentration was estimated to be around 30,000 ppm suggesting a residual NAPL may reside near the top of this low permeability interval and could require a long duration of SVE to remediate." This type of detail should be incorporated into the full-scale corrective measure design.

50. **App. D PneuLog report, pg. 18.** In the last two bullets, Praxis identified COCs based on soil vapor results, and also calculated volumes of contaminated soil.

51. **Appendix E Field Sampling Data and Records**. There is a wide variety of different kinds of forms and information in here, including groundwater sampling records and survey data. There is no apparent organization of the material, and therefore it is very difficult to find a particular piece of documentation. Respondents should compile the information into an organized manner and provide a summary Table of Contents at the beginning of this appendix.

52. **Appendix H Data Quality Evaluation Reports and Data Packages.** This appendix also has no apparent organization, and therefore it is very difficult to find a particular piece of documentation. Respondents should compile the information into an organized manner and provide a summary Table of Contents at the beginning of this appendix.

53. **Appendix I, soil vapor data time series graphs.** The first graph is for Well ID KAFB 106028-150, but there is no such location on the map (Figure 4-2). Should this be KAFB-106128, or KAFB-10628?

54. **Appendix I, soil vapor data time series graphs.** General observations of the trends in this Appendix are not provided in the text. We observe the following: 1) analyte trends tend to mimic each other, with C5 to C8 aliphatic hydrocarbons always highest. 2) Vapor concentrations tend to be higher in deeper intervals (like 450 ft), near groundwater. 3) Most wells show no discernible long-term trends, with vapor concentrations alternately increasing and decreasing over time; however some wells show overall decreasing concentration trend over time in deeper intervals (KAFB-106114. -106116 near SVE well, and -106117), which could be an effect of previous SVE operations.