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ENVIRONMENT DEPARTMENT

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ENTERED

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

SEP 23 2020

Colonel David S. Miller
Base Commander
377 ABW/CC
2000 Wyoming Blvd SE
Kirtland AFB, NM 87117

Lt. Colonel Wayne J. Acosta
Civil Engineer Office
377 Civil Engineer Division
2050 Wyoming Blvd SE, Suite 116
Kirtland AFB, NM 87117

RE: DISAPPROVAL
BIOVENTILATION CONSTRUCTION AND INITIATION REPORT
BULK FUELS FACILITY SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO
EPA ID# NM6213820974
HWB-KAFB-20-001

Dear Colonel Miller and Lt. Colonel Acosta:

The New Mexico Environment Department (NMED) is in receipt of Kirtland Air Force Base's (Permittee) *Bioventilation Construction and Initiation Report* (Report), dated January 2020. NMED has reviewed the Report and deficiencies were identified throughout the Report. NMED hereby issues this Disapproval with comments.

Although NMED is disapproving the Report we recommend continuation of the long-term pilot test. Continuation of data collection will help address many of the attached comments and will assist in ascertaining the long-term effectiveness of the bioventing technology.

The Permittee must submit a revised Report that addresses all comments contained in this letter. Two hard copies and an electronic version of the revised Report must be submitted to the NMED. Please include a redline-strikeout version in electronic format showing where all revisions to the Report have been made. The revised Report must be accompanied with a response letter that details where all revisions have been made, cross-referencing NMED's numbered comments. The Revised Report must be submitted to NMED no later than **April 30, 2021**.

Should you have any questions or wish to meet with us to discuss these comments, please contact me at (505) 476-6035.

Sincerely,

Kevin Pierard

Digitally signed by Kevin Pierard
Date: 2020.09.23 12:40:15 -06'00'

Kevin Pierard
Chief
Hazardous Waste Bureau

cc: D. Cobrain, NMED HWB
B. Wear, NMED HWB
M. Suzuki, NMED HWB
L. King EPA Region 6 (6LCRRC)
S. Kottkamp, KAFB
K. Lynnes, KAFB

File: KAFB 2020 Bulk Fuels Facility Spill and Reading

Attachment

SPECIFIC COMMENTS

1. **Executive Summary, ES-1, Installation of Bioventing Monitoring Wells, page ES-1**

   Permittee Statement: "Each SVMW is comprised of six 0.75-inch outside diameter nested vapor probes with 2 feet (ft) of screen each targeting different depths of the vadose zone. Vapor probes were installed at depths varying between 102 and 262.5 ft below ground surface to facilitate discrete vertical monitoring of the vadose zone."

   NMED Comment: According to the *Bioventing Respiration Pilot Testing Procedure* (Procedure), dated September 2018, lengths of the screened intervals for the nested vapor probes were indicated as 2.5 feet, rather than two feet. Clarify whether the vapor probes have two- or 2.5-feet screened intervals in the revised Report. Revise all applicable sections of the Report, as appropriate. In addition, the depths of both wells KAFB-106V1 and KAFB-106V2 were reported as 102.5 to 272.5 feet below ground surface (bgs) in Table 1-1. Provide an explanation for or resolve the discrepancies in the revised Report.

2. **Section 1.2, Bioventing Pilot Test Objectives and Scope, page 1-1**

   Permittee Statement: "The bioventing pilot test is being performed to evaluate the feasibility of this technology for the Corrective Measures Evaluation Report."

   NMED Comment: According to Table 3-12, *Summary of Hydrocarbon Analytical Results*, the elevated TPH-GRO concentrations in soil vapor samples collected from all pilot test monitoring wells indicate that free phase and adsorbed hydrocarbons may be present in the vicinity of the pilot test area. In order to maximize the effectiveness of remediation, delineation of the extent of hydrocarbon contamination is crucial regardless of the technology that is ultimately proposed through corrective measures evaluation (CME).

   In order to effectively remediate the extent of hydrocarbon contamination where free phase hydrocarbon is present, the Permittee must clarify whether the extent has been fully delineated. Either confirm that the extent of contamination has been fully delineated through previous investigations in the revised Report or submit a work plan to delineate the extent of the vadose zone contamination (e.g., Laser-Induced Fluorescence), if necessary. If the work plan is deemed necessary, submit the work plan no later than **July 30, 2021**.

3. **Section 1.2, Bioventing Pilot Test Objectives and Scope, page 1-1**

   Permittee Statement: "The rate of oxygen utilization is directly proportional to the aerobic biodegradation rate of fuel hydrocarbons in the subsurface and can be used as an indication of the effectiveness of bioventing to achieve site cleanup."

NMED Comment: The reduction of oxygen levels in monitoring and injection wells does not necessarily mean that all of the oxygen is utilized for biodegradation of hydrocarbons. Although oxygen utilization may be an indicator, it is not clear that this is directly proportional due to a variety of factors including diffusion of oxygen-depleted soil gas from soil pore space and dissipation of injected air toward the low-pressure gradient outside of the test cell boundary. Other monitoring parameters (e.g., isotope analysis) may be necessary to confirm evidence of biodegradation. Because the Permittee continues to evaluate the effectiveness of the bioventing technology through the long-term pilot testing, additional monitoring parameters may be useful to confirm the occurrence of biodegradation. Evaluate the necessity of additional monitoring parameters to confirm evidence of biodegradation and provide a discussion in the revised Report (see Comment 34). Evidence of biodegradation does not necessarily indicate its effectiveness as a remedial alternative. In order for this technology to be considered as viable remedial alternative, the pilot test must demonstrate reduction of hydrocarbon concentrations.

4. **Section 1.2, Bioventing Pilot Test Objectives and Scope, page 1-2, and Section 5.4, Bioventing Pilot Test Performance Assessment, page 5-2**

Permittee Statements: "Status reports will be provided quarterly as an appendix to the appropriate Groundwater Monitoring Report."
and,
"Respiration and analytical data collected from each quarter will be reported in the appropriate quarterly groundwater monitoring report."

NMED Comment: The pilot test is not associated with groundwater remediation and groundwater is not monitored as part of this test. Inclusion of the status report in an appendix of a separate report is not appropriate. Status reports must be submitted separately from the quarterly groundwater monitoring reports. Please revise the Report accordingly.

5. **Section 2, Background Information, page 2-1**

NMED Comment: A discussion regarding fuel release (e.g., release date range, contaminants of concern, area where fuel was released, range of estimated volumes released) is not included in this section of the Report. Please include the discussion in the revised Report.

6. **Section 2.2, Site History, page 2-1**

   Permittee Statement: "Impacted soil was excavated in the release area to a depth of approximately 20 feet (ft) below ground surface in the area shown on Figure 1-2. Soil vapor extraction activities were performed at the site between 2003 and 2015 to reduce the mass of contaminants in the vadose zone."

   NMED Comment: Figure 1-2, *Bioventing Pilot Test Area,* does not depict the area where contaminated soil was excavated. Please revise the figure or include a new figure to present the area where the soil was excavated. Additionally, explain whether the soil vapor extraction (SVE) system is still present at the Bulk Fuels Facility Site. Even if the SVE system alone did not achieve effective mass removal, the combination of SVE and bioventing technologies may increase the effectiveness of each technology. Please evaluate the feasibility and benefits of operating both systems concurrently and provide a discussion in the revised Report.

7. **Section 2.3, Ongoing Soil Vapor Monitoring, page 2-1**

   Permittee Statement: "A total of 284 soil vapor monitoring points at 56 soil vapor monitoring locations are being sampled semiannually. The results from the vapor monitoring data indicate that the majority of the petroleum hydrocarbon concentrations found in the vadose zone are located in the vicinity of the release area."

   NMED Comment: Please include a separate figure presenting locations of all soil vapor monitoring wells with designations in the revised Report.

8. **Section 3.2, Bioventing Equipment Installation, page 3-1**

   Permittee Statements: "The [1.5-horsepower regenerative] blower unit provides injection air to the SVEWs through a 2-inch polyethylene conveyance line that manifolds to the individual SVEWs."
   and,
   "Due to high head losses associated with high volume injection flow rates through the 0.5-inch diameter SVMWs, the regenerative blower could not be used for air injection due to pressure limitations. As a result, injection air is provided to the SVMWs via two 1-horsepower Gast rotary vane pumps."

   NMED Comment: It is not clear whether or not the 1.5-horsepower regenerative blower was concurrently used with rotary vane pumps during the pilot test. Please provide a clarification in the revised Report. In addition, it is not clear whether the two 1-horsepower rotary pumps provided sufficient power to deliver air to SVMWs or all wells. Please provide head loss calculations to demonstrate that the pumps were adequate in the revised Report.

9. Section 3.3, Baseline Respirometry and Vapor Sampling, page 3-2

Permittee Statement: "Well purging was performed by removing one well volume (casing volume plus the filter pack pore space volume of the screened interval) from the monitoring well utilizing a Gast rotary vane pump."

NMED Comment: The rotary vane pumps were used to inject air into SVMWs. Explain whether the same pump was used for the purpose of purging in the revised Report.

10. Section 3.3, Baseline Respirometry and Vapor Sampling, page 3-2

Permittee Statement: "Analytical samples were collected using 6-liter Summa cannisters and..."

NMED Comment: The September 2018 Procedure indicates that the size of Summa cannisters proposed to be used was one liter. Explain the basis for the deviation. All deviations from the work plan must be described in the revised Report. Please revise the Report to include a section that discusses deviations from the work plan.

11. Section 3.4, Respirometry Field Testing, page 3-2, and Section 4.1, Respiration Data Analysis, page 4-1

Permittee Statements: "The water injection was performed on May 23 and 24, 2019. After the water was injected, the test cells were allowed approximately 4 weeks to acclimate prior to the start of the wet respiration testing."
and,
"The results suggest little or no change to soil vapor humidity as the result of moisture addition."

NMED Comment: The September 2018 Procedure states, "[t]he water is radially forced into the formation." The pressurized water injection method was unlikely to distribute moisture radially throughout the pore space. Rather, injected water likely followed the least resistant (preferential) flow paths. The water may have infiltrated into deeper soils by gravity rather than providing moisture to soils in the target pore space during the acclimation period. As a result, changes to soil vapor humidity were not observed after water injection. The Executive Summary, *ES-4 Respiration Testing,* page ES-2, states, "[o]xygen utilization rates were marginally higher during the dry respiration testing compared to the wet respiration testing indicating that the moisture addition did not increase the rate of biodegradation." Because the water was likely not evenly distributed within the test cell, the results obtained from wet respiration test are not reliable and must not be used for decision-making purposes. The Permittee must not draw any conclusions related to the wet respiration test. In addition, the Executive Summary, *ES-4 Respiration Testing,* page ES-2, states, "[t]he need to add moisture will be further assessed during the long-term bioventing pilot test." NMED agrees that further assessment through the long-term pilot test is appropriate and supports the injection of cool mist rather than pressurized water. Mist injected with air may provide more uniform distribution of moisture in the formation. Propose this approach in the revised Report.

12. Section 3.4, Respirometry Field Testing, page 3-2

Permittee Statement: "No measurable degradation was observed due to the high concentration of hydrocarbons and the limited amount of ambient air supplied to the subsurface."

NMED Comment: Tables 4-2 through 4-13 provide volatile organic compound (VOC) concentrations measured in the monitoring wells. Air was continuously injected for more than 30 days between October 7 and November 5, 2019. However, the VOC concentrations appear to be persistent and relatively unchanged from the baseline levels in most monitoring locations. Considering the immediate effect of dilution with air, it is not clear why hydrocarbon concentrations are not declining after 30 days of air injection. It is possible that a major fraction of the injected air may have followed the preferential flow paths (e.g., fractures) and did not directly flow into the monitoring locations. Please evaluate the causes of persistent VOC concentrations and provide a discussion in the revised Report.

13. Section 3.4.1.1, [Dry Respirometry Testing] Air Injection and Pressure Monitoring, page 3-3, Section 3.4.3.1, [Wet Respirometry Testing] Air Injection and Pressure Monitoring, page 3-4, and Section 5.2, Long-Term Pilot Test Operational Parameters, page 5-1

Permittee Statement: "A 15-ft radius from the injection well was assumed for the calculation of each test cell control volume. The thickness of each test cell control volume was the filter pack length, plus 5 ft above and below to account for vertical air flow. The injection rate was calculated based on the addition of four pore volumes of the test cell in each well."
and,
"The remediation area for the long-term bioventing test is defined as a control radius of 70 ft (the farthest distance between injection wells and observation wells) along with the filter pack thickness of the injection well to obtain a volume of impacted soil."

NMED Comment: The estimated test cell volume was significantly increased for the long-term pilot test. In the revised Report, provide a table presenting (1) soil types at the screened intervals of injection and monitoring wells, (2) all input values (e.g., thickness, control radius, porosity) for the short- and long-term pilot tests, (3) calculated pore volumes based on the input values, (4) target volumes of air to be injected, and (5) actual volumes of air injected.

14. Section 3.4.1.1, [Dry Respirometry Testing] Air Injection and Pressure Monitoring, page 3-3

Permittee Statement: "Air injection flow rates and well head pressures were recorded daily and are presented in Tables 3-13 through 3-15. During air injection, well head pressures were monitored in wells KAFB-106V1 and KAFB-106V2 and are presented in Tables 3-16 and 3-17."

NMED Comment: Tables 3-13 through 3-17 provide data collected during air injection for the dry (April 22 – 28) and wet (June 20 – 26) respiration tests. Although respiration monitoring was conducted for the dry (April 28 – May 9) and wet (June 26 – July 5) respiration tests without air injection, these tables do not indicate that subsequent monitoring was conducted. Section 3.4, *Respirometry Field Testing,* states that the dry and wet respiration pilot tests were conducted between April 22 and May 9, 2019 and between June 20 and July 5, 2019, respectively. However, since the timeline of the events was not clearly described in the Report, the tables may be perceived as incomplete and cause confusion among readers. In the revised Report, provide a table presenting timeline for the short- and long-term pilot tests including dates for (1) baseline data collection, (2) air injection periods, and (3) post-injection respiration monitoring periods.

15. Section 3.4.1.2, Dry Respirometry, page 3-3

Permittee Statement: "Oxygen concentration within the subsurface was plotted against time for each well location and a linear regression was applied to determine the oxygen utilization rate."

NMED Comment: The plots were included in Appendix D, *Oxygen Utilization Plots*. However, it is more appropriate to include these plots in the Report, rather than the appendix because the slope of linear regression is interpreted as an oxygen utilization rate, which is the key parameter to estimate the biodegradation rate and long-term bioventing flow rate. Please include the plots in the figures section of the revised Report.

16. Section 3.4.2, Water Injection, page 3-3

Permittee Statement: "Prior to injection, the water was field tested for residual chlorine in order to reduce the possibility that chlorinated water could inhibit microbial growth in the subsurface."

NMED Comment: Explain what kind of field test was conducted to determine residual chlorine level in the water. If field notes that record testing procedures and results are available, include them in the revised Report.

17. Section 4.1, Respiration Data Analysis, page 4-1

Permittee Statement: "If the oxygen and carbon dioxide readings were at atmospheric conditions of 20.9 and 0.0%, respectively, then the field readings were accepted as correct."

NMED Comment: The statement indicates that the instrument is unable to detect changes in oxygen and carbon dioxide levels less than one thousand parts per million. The instrument may be adequate to monitor overall changes in oxygen and carbon dioxide concentrations in subsurface after air injection, but it is not clear whether such instrument is suitable for quantification of microbial activity. Please explain why the instrument is appropriate for the pilot tests in the revised Report.

18. Section 4.1, Respiration Data Analysis, page 4-1

Permittee Statement: "While variability of oxygen/carbon dioxide was observed in many of the wells during the respiration testing, the changes were more prevalent within the SVEWs, possibly due to the longer screen intervals that would be more greatly affected by barometric pressure changes."

NMED Comment: Discuss the correlation between barometric pressure, subsurface oxygen/carbon dioxide levels and screen length in the revised Report. Additionally, provide example data to support the discussion.

19. Section 4.1, Respiration Data Analysis, page 4-1

Permittee Statement: "However, oxygen concentrations overall consistently declined during the respiration testing providing clear evidence of oxygen demand and hydrocarbon biodegradation."

NMED Comment: The decrease in oxygen levels and increase in carbon dioxide levels in injection wells may also be attributed to diffusion of soil gas, dilution of injected air, and desorption/volatilization of organic compounds. Influx of soil gas and efflux of air may be the primary causes of an increase in carbon dioxide and a decrease in oxygen concentrations. Revise the statement for accuracy in the revised Report.

20. Section 4.1, Respiration Data Analysis, page 4-1

Permittee Statement: "A safety factor of 4 times the calculated oxygen utilization rate is being supplied to ensure oxygen is being delivered at a rate much greater than it is being utilized."

NMED Comment: If multiple pore volumes of air were applied to the test cell, air flow would have extended beyond the test cell boundary likely through the same flow paths originally created by initial application of air (e.g., fractures). Injection of multiple pore volumes of air may dilute soil gas within the test cell and push soil gas beyond the test cell boundary. However, excess air may not necessarily increase the microbial oxygen utilization rate. A large volume of the injected air may move contamination round in the subsurface. Revise the statement to acknowledge this possibility.

21. Section 4.1, Respiration Data Analysis, page 4-1

Permittee Statement: "As can be seen in the data, substantially lower relative humidity was measured during the wet respiration testing than the dry. It appears this is an artifact of timing; ambient air temperatures were warmer during the wet test. Measurement instability occurs when a soil vapor sample is extracted above ground and run though the instrument. On warm days, the sample temperature increases to near ambient, which decreases relative humidity. As the ambient temperature fluctuates, so does the relative humidity."

NMED Comment: The method used to measure relative humidity is not appropriate. The relative humidity data must not be affected by fluctuations of the ambient temperature. Subsurface temperature is likely more stable than that of the ambient air; the measurements should have been conducted to minimize the influence of changes in ambient temperatures. Please evaluate alternative methods for relative humidity measurement and provide a discussion in the revised Report.

Since the relative humidity was higher during the dry respiration test compared to the wet respiration test, the relatively humidity data does not make sense. The relative humidity data must be converted to absolute humidity values and its acceptability for use evaluated. If the converted data makes sense, revise all applicable tables to present absolute humidity, rather than relative humidity. Otherwise, remove all data and discussions regarding relative humidity from the revised Report.

22. Section 4.1, Respiration Data Analysis, pages 4-1 and 4-2

Permittee Statement: "In some of the locations, the absolute humidity appears marginally higher in the wet test; however, the reasons for this are unclear. The water injected into the wells for the wet test was likely warmer than the soils resulting in warmer soil immediately surrounding the sampling point screens. This could account for the absolute humidity differences."

NMED Comment: Since water was injected prior to the wet respiration test, the higher absolute humidity readings during the wet respiration pilot test make sense; however, the readings were only marginally higher than those observed during the dry respiration test. This observation suggests that the method used to distribute moisture (pressurized water injection) was not effective. The moisture addition method must be evaluated during the long-term pilot test. During the evaluation, other moisture distribution methods (e.g., cool mist injection) must be evaluated.

Additionally, soil vapor temperatures were generally higher than ambient air temperatures according to Tables 3-2 through 3-10. The water temperature is lower than, or equivalent to, the ambient air temperature. It may be more reasonable to assume that soil temperature was higher than that of the water which would make the Permittee's statement incorrect. Revise the statement accordingly.

23. Section 4.2.1, Oxygen Utilization Rate, page 4-2

Permittee Statement: "Oxygen utilization rates for the dry respiration testing varied between 0.163 and 0.475% per day for the SVMWs and between 0.497 and 0.639% per day for the SVEWs (Appendix D-1 and Table 4-1). The oxygen utilization rate averaged 0.340% per day for the SVMWs while averaging 0.563% per day for the SVEWs. The overall average oxygen utilization rate for the dry respiration test was 0.414% per day."

NMED Comment: According to Appendix D-1, *Oxygen Utilization,* the daily oxygen concentrations are plotted for each injection well. Each slope of the curve is reported as "oxygen utilization rate". However, the reduction in oxygen levels may be attributed to dilution of injected air and is not necessarily limited to oxygen utilized for hydrocarbon biodegradation (see Comment 19).

Additionally, elevated hydrocarbon concentrations (e.g., 250 parts per million benzene) reportedly inhibit aerobic biodegradation. The level of hydrocarbons at the site is high enough to affect the results. In order for aerobic biodegradation to be induced at the site, the concentrations may initially need to be diluted with air. The observed reduction in oxygen levels must not be assumed to be the result of microbial activity. The referenced oxygen utilization rate is more appropriately referred to as "oxygen reduction rate". Please revise the Report for accuracy.

24. Section 4.2.2, Biodegradation Rate, page 4-2

Permittee Statement: "Biodegradation rates during the dry respiration testing ranged between 0.096 and 0.281 milligrams per kilogram per day (mg/kg/day) for the SVMWs and between 0.294 and 0.378 mg/kg/day for the SVEWs (Table 4-1). Biodegradation rates during the wet respiration testing ranged between 0.081 and 0.308 mg/kg/day for the SVMWs and between 0.012 and 0.371 mg/kg/day for the SVEWs."

NMED Comment: According to Appendix E-1, *Calculation of Biodegradation Rate, Oxygen Demand Flowrate, and Oxygen Radius of Influence*, the biodegradation rates were calculated as a function of oxygen utilization rates. However, the observed oxygen reduction is not entirely accounted for by microbial oxygen utilization (see Comments 19 and 23). Therefore, the biodegradation rates must not be calculated from the observed oxygen reduction rates. Remove the discussion from the revised Report.

25. Section 4.2.3, Oxygen Demand Air Flow Rate, page 4-3

Permittee Statement: "The oxygen demand flow rate represents the minimum ambient air injection flow rate required to maintain the biodegradation rates obtained in the respirometry calculations. The oxygen demand air flow rate was calculated based on the oxygen utilization rate and corresponding biodegradation rates for each well under both the dry and wet respiration conditions (Appendix E-1)."

NMED Comment: The oxygen demand flow rates were calculated as a function of oxygen utilization rates. The calculated flow rates do not represent the minimum air flow rates required to maintain biodegradation rates. However, the minimum air injection flow rates required to compensate the loss of oxygen can be calculated from the observed oxygen reduction rates. Modify the formula provided in Section 3.1.6 of the *Work Plan for Bioventing and Air-Lift Enhanced Bioremediation Pilot Tests* (Work Plan), dated November 2017, and calculate the required air injection flow rates. Revise the Report accordingly.

26. Section 4.2.4, Intrinsic Permeability, page 4-3

Permittee Statement: "Intrinsic permeability was calculated for the SVEWs under both the dry and wet respiration conditions (Table 4-1). The calculations are provided in Appendix E-2."

NMED Comment: According to Appendix E-2, *Intrinsic Permeability Calculations,* intrinsic permeability was calculated based on well vacuum. A positive pressure was applied to the wells as air was injected from the wells; however, the formula used to calculate intrinsic permeability required vacuum (negative) pressure. Please provide an explanation for the discrepancy in the revised Report.

In addition, the radii of influence (ROIs) used to calculate intrinsic permeability were different from the ROIs reported in Table 4-1. For example, the ROI used to calculate intrinsic permeability was 113 feet for well SVEW-01-260 during the dry respiration test according to Appendix E-2-1. However, the ROI reported in Table 4-1 was 143 feet for the same well. Correct, or provide an explanation for, the discrepancy in the revised Report.

27. Section 4.2.4, Intrinsic Permeability, page 4-3

Permittee Statement: "Intrinsic permeability was not calculated for the SVMWs as the large amount of head loss that occurred in the 0.5-inch diameter wells did not allow for accurate pressure monitoring at the injection point."

NMED Comment: Section 3.2 indicates that the issue associated with head loss was resolved by replacing the 1.5-horsepower regenerative blower with two 1-horsepower rotary vane pumps. Please provide further clarification of the issue and resolution in the revised Report. In addition, the well head pressure readings during and after air injection for SVMWs are reported in Tables 3-13, 3-14 and 3-2 through 3-7, respectively. This data should not be included in the Report or it must be qualified to account for the inaccurate pressure readings for SVMWs in the revised Report.

28. Section 4.2.5, Radius of Influence, page 4-3

Permittee Statement: "[T]he oxygen ROI was calculated using the oxygen utilization rates and long-term bioventing operation flow rates as described in the Work Plan (Kirtland AFB, 2017a)… The oxygen ROI varied between 138 and 143 ft for the dry respiration test and between 138 and 152 ft for the wet respiration test."

NMED Comment: The ROI was calculated based on oxygen utilization rates. However, the observed oxygen reduction is not entirely accounted for by microbial oxygen utilization. Therefore, the method used to estimate the ROI is not appropriate. Use pressure response data to estimate the ROIs, where applicable, or if appropriate, modify the formula provided in Section 3.1.8 of the November 2017 Work Plan, and calculate the ROIs. Revise the Report accordingly.

29. Section 4.2.6, Soil Vapor Analytical Results, page 4-3

Permittee Statement: "Soil vapor analytical data and the analytical laboratory reports are provided in Appendix B-2. TPH-GRO, BTEX, and EDB concentrations were collected and are provided in Table 3-12."

NMED Comment: According to Appendix B-2, *Soil Vapor Analytical Results,* EDB was only analyzed with EPA Method TO-15. The Permittee's April 3, 2017 letter states, "[Method]

CARB 422 may be used for individual tasks where it is important to evaluate EDB in soil vapor in the presence of high concentrations of HC in relation to EDB concentrations, such as monitoring the effectiveness of bioventing or air-lifting interim measures in the source area. In these instances, CARB 422 will be included where appropriate in the individual work plan for that task." Since hydrocarbon molecules do not interfere with the measurement of EDB by Method CARB 422, lower limits of quantitation (LOQ) are achievable with the method, allowing for more accurate detection of EDB in soil vapor than with Method TO-15. Elevated hydrocarbon concentrations were observed in soil vapor samples at the site; therefore, it is appropriate to analyze EDB samples using both Methods CARB 422 and TO-15. Include this provision during the long-term pilot test.

30. Section 4.2.6.1, [Soil Vapor Analytical Results] Baseline Respiration Sampling, page 4-4

Permittee Statement: "The sum of BTEX ranged from 2,400,000 to 9,130,000 μg/m^3."

NMED Comment: Although Table 3-12, *Summary of Hydrocarbon Analytical Results,* records concentrations of benzene (B), toluene (T), ethylbenzene (E), and total xylenes (X) separately, the sum of these constituents is not recorded in the table. Revise the table to include the sum of BTEX.

31. Section 4.2.6.2, [Soil Vapor Analytical Results] Post-Dry Respiration Sampling, page 4-4

Permittee Statement: "TPH-GRO ranged from 52,000,000 to 210,000,000 μg/m^3."

NMED Comment: Out of 12 monitoring points, the TPH-GRO concentrations after the air injection were recorded as higher in six locations, the same in three locations, and lower in two locations compared to the baseline concentrations. Longer-term monitoring is necessary to evaluate the effectiveness of the pilot test because the results of the short-term pilot test indicate that the bioventing technology is not effective. Please provide a submission schedule for the required status reports in the revised Report (see Comment 4).

32. Section 4.2.6.3, [Soil Vapor Analytical Results] Post-Wet Respiration Sampling, page 4-4

Permittee Statement: "Data collected during the respiration tests will be used as baseline data to assess the biodegradation throughout the full-scale bioventing test."

NMED Comment: Currently, full-scale bioventing as a means to remediate vadose zone hydrocarbons is not recommended based on the analytical results of the short-term pilot tests. However, longer-term monitoring will be necessary to fully evaluate the effectiveness of the bioventing system for hydrocarbon removal from the vadose zone (see Comment 31).

33. Table 3-18, Bioventing Respiration Pilot Test Water Injection Summary

NMED Comment: The September 2018 Procedure states that the water volume for the wet respiration test was designed to be 1% of the pore volume. However, it is not clear whether the design protocol was followed during water injection. For example, the length of screened intervals for wells SVMW-11-250 and SVMW-11-260 was identical at 2.5 feet; however, water injection volumes for these wells were 325 and 625 gallons, respectively, according to Table 3-18. In Table 3-14, *Bioventing Respiration Pilot Test Air Injection Summary – SVMW-11,* the pore volumes were estimated as 4,278 and 8,036 cubic feet, respectively. It is not clear how the volumes were so different even though the length of screened intervals was identical. Provide an explanation for the difference in the estimated pore volumes among the test cells in the revised Report.

34. Tables 4-2 through 4-13, Respiration Monitoring

NMED Comment: According to the tables, after the long-term bioventing pilot test was initiated, the oxygen levels in all monitoring locations increased and reached a plateau in less than one month. Since hydrocarbons are still abundant in all monitoring locations, microbes could have utilized oxygen to degrade hydrocarbons and produce carbon dioxide and water. However, the carbon dioxide concentrations decreased as oxygen concentrations increased. Similarly, relative humidity readings were lower than those of the baseline in most locations. The carbon dioxide and water production were not obvious at any location. It appears that air is diluting soil gas at the monitoring locations but is not utilized for biodegradation. It is possible that the high level of hydrocarbons may hinder microbial activity. Discuss the kinetics of aerobic biodegradation in comparison to the rate of dilution in the revised Report. Additionally, please propose additional analytical methods to verify biodegradation (e.g., isotope analysis) and evaluate the applicability of such methods during the long-term pilot test (see Comment 3).