Certified Mail - Return Receipt Requested

January 30, 2023

Colonel Jason F. Vattioni
Base Commander
377 ABW/CC
2000 Wyoming Blvd SE
Kirtland AFB, NM 87117

Ms. Melissa Clark
Civil Engineer Office
377 MSG/CEIE
2050 Wyoming Blvd SE
Kirtland AFB, NM 87117

RE: SECOND DISAPPROVAL
FINAL ETHYLENE DIBROMIDE IN SITU BIODEGRADATION PILOT TEST REPORT, REVISION 1
BULK FUELS FACILITY SOLID WASTE MANAGEMENT UNITS ST-106 AND SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO
EPA ID# NM6213820974
HWB-KAFB-19-011

Dear Colonel Vattioni and Ms Clark:

The New Mexico Environment Department (NMED) is in receipt of the Kirtland Air Force Base (Permittee) *Final Ethylene Dibromide In Situ Biodegradation Pilot Test Report, Revision 1* (Report), dated March 2021. NMED has reviewed the Report and hereby issues this Second Disapproval with the following comments.

NMED concurs that the efforts to delineate and remediate the vertical and lateral extent of light non-aqueous phase liquid (LNAPL) for the Corrective Measures Evaluation (CME) should be addressed separately, as stated. However, the pilot test, although not stated explicitly, is to support the CME and further develop a full-scale remediation system. As such, the Report is disapproved because the in-situ enhanced bioremediation (ISEB) of ethylene dibromide (EDB) is insufficient to support use of this technology as a remedial alternative in the CME nor is it appropriate for use as part of a full-scale remediation system; therefore, ISEB must not be proposed as a viable remedial alternative for the CME. Note that the basis for this disapproval is not based on editorial or technical deficiencies; rather, the pilot test does not align with an appropriate scope for the CME which must achieve the remediation of contamination at the site. NMED provides the following comments that intend to clarify the scope of the CME and to help establish an appropriate path for future ISEB implementation as a potential groundwater polishing technology, if ISEB is deemed applicable after removal of LNAPL and the significant petroleum-related contamination in soil and groundwater. No revision is required.

COMMENTS

1. **Permittee's Response to NMED's Disapproval Comment 4, dated March 4, 2020**

   Permittee Statement: "This corrective action addresses historical release[s] from the BFF. Construction of the updated fuels facility was completed on March 18, 2011. At this time, fuel receipt became fully automated and required balance of fuel delivery and receipt to the gallon. The current operation of the fueling facility is not relevant to corrective action under the Resource Conservation and Recovery Act (RCRA) permit."

   NMED Comment: NMED's Disapproval Comment 4 states, "[c]larify whether or not the fuels currently used at the site contain other potentially toxic fuel additives in the revised Report." The Permittee's response does not address the comment. The information regarding the current fuel use is related to the BFFS corrective action activities. If the fuels currently used at the site contain additives other than EDB, such compounds must be monitored.

2. **Permittee's Response to NMED's Disapproval Comment 6, dated March 4, 2020, and Appendix A, Attachment 2, Scope of EDB ISB Pilot Test, page 1**

   Permittee Statements: "Regarding the treatability tests, it is possible that the native bacteria at the site did not survive sample collection and/or under microcosm conditions, thus leading to the negative data in the laboratory." and, "Microbial community analyses and bench-scale treatability studies were performed using Kirtland AFB soils and groundwater, and the results indicated that in situ bioremediation (ISB) showed promise for enhancing EDB biodegradation at Kirtland AFB, either through biostimulation of native debrominating organisms or through bioaugmentation with an exogenous debrominating culture (e.g., SDC-9)."

   NMED Comment: The former statement indicates that biostimulation was not successful while the latter statement indicates that biostimulation was successful in the bench-scale study. The Permittee's statements are contradictory. Regardless, no response is necessary.

3. **Permittee's Response to NMED's Disapproval Comment 6, dated March 4, 2020, and Appendix A, Attachment 2, Scope of EDB ISB Pilot Test, page 2**

   Permittee Statements: "If applicable, bioaugmentation may be considered in the CME if ISB is evaluated for larger scale application." and,"Light non-aqueous phase liquid (LNAPL) was discovered during pump installation at groundwater monitoring well KAFB-106MW1-S in September 2017."

NMED Comment: Note that abatement of LNAPL must be a primary focus of the CME. LNAPL is present at the BFFS where the pilot test was conducted. LNAPL acts as source of dissolved phase contamination. Therefore, any in-situ technologies including in-situ biostimulation and bioaugmentation, that aim to reduce the concentrations of dissolved phase contaminants may be proposed for implementation after the LNAPL is removed. Such technologies are desirable for groundwater polishing and may be useful after the LNAPL and significant concentrations of petroleum-related contamination are removed. Address this comment in the CME.

4. **Permittee's Responses to NMED's Disapproval Comments 7, 8, and 9 dated March 4, 2020**

Permittee Statements: "This pilot test is not the appropriate vehicle for directing the Air Force to develop a work plan to define the nature and extent of NAPL. NMED acknowledged this in its 02 April 2020 letter ...that the scope of the pilot was not to determine the extent of LNAPL." and, "Collecting and interpreting undisturbed soils cores for the presence or absence of fractures or carefully identifying hydrocarbon stains was beyond the scope of the pilot test." and, "As detailed in the 09 July 2020 letter from the Air Force to Mr. Pierard, the Air Force has respectfully requested that NMED cease including global comments for future unrelated work in individual notices of disapproval."

NMED Comment: The Permittee misinterprets the intent of the NMED's April 2, 2020, letter. The April 2, 2020, letter states, "[the pilot test] provide insights for future work, and identify additional questions that must be answered before a decision is made on the acceptability of the approach." NMED intends to provide comments that help establish an appropriate path to the CME. The comments are provided to assist the Air Force in its submittal of a clear, concise, and approvable CME and other corrective action documents. If the comments are not addressed in the CME and other submittals, the Permittee can expect to receive a disapproval of the submittal with the requirement to address the comments. NMED provides direction for future work in comments related to document reviews and will continue to do so.

Further, NMED issued the *Reporting Requirements for All Document Submittals,* dated September 2, 2020, that addresses the Permittee's concern stated in the referenced July 9, 2020, letter.

5. **Permittee's Response to NMED's Disapproval Comment 8, dated March 4, 2020**

Permittee Statement: "The air rotary casing hammer (ARCH) drilling method was determined to be the best approach for the installation of the tightly spaced wells required for the pilot test."

NMED Comment: The success of most in-situ technologies depends on an adequate understanding of subsurface environment (e.g., presence or absence of fractures, identifying hydrocarbon stains). In every opportunity when soil borings are advanced in the vicinity of the source zone, the Permittee must make every effort to collect data that allow for a better understanding of the subsurface environment (e.g., collection of continuous core and/or geophysics).

6. **Permittee's Response to NMED's Disapproval Comment 9, dated March 4, 2020**

Permittee Statement: "Further characterization of soil samples from the borings was beyond the scope of the pilot test (Attachment 2 of the RTC Table [Appendix A of the revised Report])."

NMED Comment: The *Disapproval* Comment 9 states, "[p]ropose to collect soil samples from every boring at the site in all future work plans." To clarify, this comment was to provide insight for future work.

7. **Permittee's Response to NMED's Disapproval Comment 10, dated March 4, 2020**

Permittee Statement: "It is important to note that well installation was performed in accordance with the NMED-approved Work Plan (KAFB, 2016). NMED reviewed and approved via email the draft well completion diagrams generated by the field geologist prior to initiating well installation."

NMED Comment: NMED's comments are provided based on the information presented in this Report not the 2016 Work Plan. Approval of a work plan does not guarantee that additional work will not be required based on data acquired during investigation and monitoring conducted at a site.

8. **Permittee's Responses to NMED's Disapproval Comments 10 and 19, dated March 4, 2020**

Permittee Statements: "These tracer results demonstrated that injected water arrived at deeper sampling locations in addition to shallower locations." and, "There is little evidence that data collected during the pilot test are biased. Conservative tracers injected during the study demonstrated that water was distributed to wells with differing screen intervals. Based on tracer data, it is not clear how preferential flow might account for the orders of magnitude decreases in EDB observed during the pilot test."

NMED Comment: Figure 2 depicts that intermediate well KAFB-106063 is located approximately halfway between injection well KAFB-106IN and extraction well KAFB-106EX1. Well KAFB-106063 is an intermediate well while KAFB-106EX1 is a shallow well. According to Table 7, *Groundwater Analytical Results for KAFB-106063,* a breakthrough of

fluorescein was not observed in well KAFB-106063 during the entire observation period. However, the breakthrough was observed in well KAFB-106EX1 during the initial Phase I recirculation period according to Table 9, *Groundwater Analytical Results for KAFB-106EX1*. Therefore, the fluid injected from KAFB-106IN apparently was not uniformly distributed within the aquifer matrix; rather, the fluid might have traveled on top of the water table or in close proximity to the interface. Accordingly, the data obtained from the pilot test may be positively biased. The screen and filter pack intervals of the injection well should have been positioned below the water table for more uniform distribution.

9. Permittee's Response to NMED's Disapproval Comment 14, dated March 4, 2020

Permittee Statement: "The suggested calculations were not included in the scope of the approved Work Plan (KAFB, 2016) and the measured evidence of distribution at field scale provided by tracers is arguably stronger. Calculation and discussion of the estimated pore volumes exchanged within the treatment zone will not be included in the revised Report. If applicable, modeling of amendment distribution in the subsurface may be considered in the CME if ISB is evaluated for larger scale application."

NMED Comment: In order to extrapolate the data collected from a pilot test to a full-scale remediation system consideration, the number of pore volumes exchanged must be comparable. The evidence of distribution is not credible because of the faulty design of the injection well (see the March 4, 2020, Disapproval Comment 10). This comment and the March 4, 2020, Disapproval Comment 10 may be incorporated with an in-situ remedy for LNAPL removal (e.g., surfactant flushing) in the CME, where applicable.

10. Permittee's Response to NMED's Disapproval Comment 16, dated March 4, 2020

Permittee Statement: "NAPL was not detected at KAFB-106MW1-S after November 2017. NAPL was observed in both extraction wells during a video survey of the wells in January 2020."

NMED Comment: According to Table 3, *Field Water Quality Measurements,* the depth to groundwater was 476.13 feet below TOC in well KAFB-106MW1-S when the last detection of LNAPL was reported on October 24, 2017. Since then, the groundwater level in well KAFB-106MW1-S continued to rise. As such, it is likely that LNAPL was not detected at well KAFB-106MW1-S after November 2017 because LNAPL was submerged below the water table as the groundwater level increased.

In addition, LNAPL was observed in extraction wells KAFB-106EX1 and KAFB-106EX2 in January 2020 during a video survey. A camera survey prompted the gauging of LNAPL in extraction wells KAFB-106EX1 and KAFB-106EX2, initiating on March 12, 2020, and August 12, 2020, respectively. According to the text of Report, LNAPL was detected in wells KAFB-

106EX1 and KAFB-106EX2 at thicknesses of 0.65 feet and 11.2 feet, respectively. According to Table 3, the LNAPL thicknesses reported for these wells were the LNAPL thickness remaining *after* LNAPL was removed from the wells.. The data indicates that significant LNAPL is present in the pilot testing area. The extent of the LNAPL plume must be delineated before submittal of the CME; otherwise, the lack of accurate LNAPL delineation will likely result in the requirement for a more conservative corrective action remedy.

11. Permittee's Response to NMED's Disapproval Comment 20, dated March 4, 2020

Permittee Statement: "The treatability test (see Figure 3) using Kirtland AFB soils and groundwater utilized 100 milligrams per liter (mg/L) of lactate and 50 mg/L of DAP, which helped provide a basis for loading."

NMED Comment: The Permittee's response to Comment 6 of the NMED's March 4, 2020 Disapproval states that the treatments without SDC-9 did not provide evidence of EDB biodegradation in the bench-scale test. However, the amendment concentrations were derived from the bench-scale test. It is not clear why data collected from the bench-scale test that was considered unsuccessful were used to design the amendment concentrations for the subsequent pilot test. Regardless, no response is required.

12. Permittee's Response to NMED's Disapproval Comment 21, dated March 4, 2020

Permittee Statement: "A pilot test is a focused, limited-scale test of a technology that is used to determine potential effectiveness under field conditions and the feasibility of including the technology in the final remedy."

NMED Comment: ISEB is not an appropriate technology to abate LNAPL; abatement of LNAPL and significant concentrations of petroleum-related compounds must be a primary focus for the CME. Some technologies used to abate LNAPL may alter the post-remedial subsurface environment. Accordingly, the data obtained from this pilot test may or may not be applicable. For example, if smoldering technology is used to eliminate LNAPL, the microbial population responsible for biodegradation of contaminants will be reduced and the data collected from this pilot test will not apply. If ISEB is proposed as a groundwater polishing technology, NMED may require additional evaluation, depending on the nature of the primary LNAPL and groundwater remedy selected for the site.

13. Permittee's Response to NMED's Disapproval Comment 28, dated March 4, 2020

Permittee Statement: "When NAPL was discovered in September 2017 at KAFB-106MW1-S, samples were collected and sent to Pace Analytical and Clark Testing for certified analysis. An additional NAPL sample was collected and sent to APTIM's Biotechnology Development

and Applications Group (BDAG) Laboratory in Lawrenceville, New Jersey to facilitate EDB compound-specific isotope analysis (CSIA) funded through a separate research grant investigating EDB attenuation and remediation (ESTCP project ER-201331)."

NMED Comment: The Permittee appears to have used the data collected from the pilot test for a separate research project. Due to the potential conflict of interest, the result may not be used for the BFF project.

14. Permittee's Response to NMED's Disapproval Comment 28, dated March 4, 2020

Permittee Statement: "Given the concern expressed in the comment provided by NMED and that APTIM's BDAG Laboratory is not specifically certified for VOC analyses, the relevant passage has been removed from the revised Report."

NMED Comment: To clarify, NMED is not questioning the laboratory's certification status. Instead, NMED is concerned about authenticity of the analytical results due to the potential conflict of interest related to the analyses being conducted by the laboratory affiliated with the consultant. The Permittee must not use any laboratory affiliated with their consultant/s in the future.

15. Permittee's Response to NMED's Disapproval Comment 29, dated March 4, 2020

Permittee Statement: "[t]he $\delta^{13}C$ values of EDB in the NAPL sample and at well KAFB-106EX2 were consistently the most negative with values of -16‰ or lower, which indicates they were the least degraded," and "[t]he baseline evaluation performed with samples collected prior to the pilot test included EDB $\delta^{13}C$ values as high as -5‰, significantly higher than the EDB of the NAPL and located at KAFB-106EX2, indicating significant isotope fractionation and providing further evidence of EDB degradation under ambient conditions at the site prior to the pilot test."

NMED Comment: LNAPL acts as a source for dissolved phase contamination in groundwater. Unless LNAPL is characterized and removed from the subsurface, any effort to reduce the concentrations of the dissolved phase constituents will not be useful.

16. Permittee's Response to NMED's Disapproval Comment 34, dated March 4, 2020

Permittee Statement: "As demonstrated in Table 16 of the Report, 106MW2-S is located 28 feet (at the surface) from the injection well. Conservatively, assuming an average thickness of water flow of 50 feet and a reasonably conservative effective porosity of 0.33, then the pore volume between the injection well and KAFB-106MW2-S is: $(28\ ft)^2 * \pi * 50 ft * 0.33$ = 40,640 ft^3 ~ 304,000 $gallons$. Similar math for KAFB-106064 results in a conservative pore volume estimate of ~ 373,000 gallons. Given that approximately 960,000 gallons of water

containing the tracer were recirculated during Phase 2 of the pilot test, it seems extremely likely that the iodide concentrations observed at KAFB-106MW2-S and KAFB-106064 (within ~30% of the expected injected concentrations) support the conclusion that most of the groundwater observe[d] at these wells was previously amended and reinjected."

NMED Comment: It is not clear how the recirculated water volume containing the iodide tracer was given as 960,000 gallons. In addition, the timing of breakthrough and observed tracer concentrations are not consistent in the shallow and intermediate wells although the distance from the top of the screen in intermediate well KAFB-106MW2-I to the bottom of the screen in shallow well KAFB-106MW2-S is only 15 feet. It appears that the assumed thickness of the flow zone (50 feet) may be excessive.

Table 6 indicates that the injection solution volume (V_1) and the mass of potassium iodide (KI) used during the Phase 2 are 1,225 gallons and 71 kg, respectively. Based on the information, the initial concentration of the tracer (iodide) solution (C_1) is calculated to be approximately 14,000 mg/L. The pore volume between the injection well (KAFB-106IN) and well KAFB-106MW2-S (V_2) was calculated to be 304,000 gallons by the Permittee. Accordingly, the highest theoretical iodide concentration at well KAFB-106MW2-S (C_2) is estimated as:

$C_2 = C_1 \times V_1 / V_2 = 56$ mg/L

Section 4.2.2, page 4-5, states, "evident in the iodide data is that final concentrations observed at the nearest monitoring wells of 17 mg/L (KAFB-106MW2-S) and 18 mg/L (KAFB-106064) are equivalent with injected iodide concentrations (KAFB-106IN), which indicates that most of the groundwater observed at these wells was previously amended and reinjected." The injected iodide concentration is approximately 14,000 mg/L and if the tracer is uniformly distributed in the pore space, the iodide concentration in well KAFB-106MW2-S should be approximately 56 mg/L rather than 17 mg/L.

Although NMED does not agree with the Permittee's response above, further explanation is not necessary because ISEB will not be part of the primary scope of the CME.

17. Permittee's Response to NMED's Disapproval Comment 36, dated March 4, 2020

Permittee Statement: "The volume of fermentable substrate introduced during each recirculation phase (Phases 2 and 3) were provided in Table 6, which is referenced in Sections 3.5 and 3.6."

NMED Comment: It is not clear from Table 6 how one can determine the mass of lactate initially injected. Regardless, further explanation is not required because ISEB will not be part of the primary scope of the CME.

18. Permittee's Response to NMED's Disapproval Comment 38, dated March 4, 2020

Permittee Statements: "We acknowledge that extra mixing/redistribution in the subsurface likely increased the nutrients and bioavailability of hydrocarbons that can be fermented to support reductive debromination of EDB, which has likely been occurring at the site without significant intervention for some time." and, "Introduction of supplemental electron acceptors (such as sulfate) to enhance hydrocarbon degradation and impacts of elevated concentrations of such competing electron acceptors upon EDB degradation was outside the scope of the pilot test."

NMED Comment: Since hydrocarbon constituents are ubiquitous at the BFFS, it would be appropriate to design ISEB to demonstrate degradation of both EDB and hydrocarbon constituents concurrently, if the technology is deemed appropriate for groundwater polishing in the future.

19. Permittee's Response to NMED's Disapproval Comment 40, dated March 4, 2020

Permittee Statement: "We acknowledge, however, that EDB is very likely attenuating in the source area without intervention, facilitated by the fermentation of hydrocarbons in the subsurface as suggested in the NMED comment. Evaluating tradeoffs between degradation of EDB and hydrocarbons as suggested by the comment was beyond the scope of the pilot test (Attachment 2 of the RTC Table [Appendix A of the revised Report])."

NMED Comment: If EDB degradation was occurring at the BFFS with only hydrocarbon substrates, such tradeoffs should have been investigated because hydrocarbon constituents are ubiquitous at the BFFS. Regardless, once LNAPL is removed from the BFFS, the subsurface environment will likely be altered and the data collected from this pilot test may or may not apply; therefore, NMED may require additional evaluation.

20. Permittee's Response to NMED's Disapproval Comment 44, dated March 4, 2020

Permittee Statements: "No revisions have been made to the text." and, "We agree that increased methane production is expected and not an indicator of effective EDB remediation."

NMED Comment: Section 4.4, pages 4-14 and 4-15, is misleading because the section states that the elevated methane concentrations are indicative of reducing conditions favorable

for EDB debromination. Since the submission of the revised Report is not necessary, no revision is required.

21. Permittee's Response to NMED's Disapproval Comment 49, dated March 4, 2020

Permittee Statements: "The text has been revised to indicate that relative differences in ^{12}C and ^{13}C degradation rates are less than 4%, and that both biological and abiotic degradation result in isotope fractionation." and, "[W]hile isotope information itself only provides evidence of degradation and not the mechanism, the shift in isotope composition was likely a biologically facilitated process due to the relative speed and other lines of evidence noted during the pilot test."

NMED Comment: The statements indicate that the results obtained from carbon isotope analyses do not differentiate biological from abiotic degradation mechanisms; rather, other lines of evidence are provided to support the evidence of biological degradation. When a degradation mechanism can be evaluated quantitatively (e.g., ^{1}H and ^{2}H isotope analysis), other lines of evidence are not acceptable and must not be used.

22. Permittee's Response to NMED's Disapproval Comment 50, dated March 4, 2020

Permittee Statement: "It is not clear which data appear to indicate that benzene or toluene degradation is hindered by lactate addition."

NMED Comment: To clarify, benzene and toluene are not degraded in most shallow wells where reduction of EDB concentrations is prominent during the passive periods according to Figure 29 and Figure 30. Lactate is more bioavailable compared to hydrocarbon constituents. Therefore, when lactate is amended, bacteria likely utilize lactate before benzene or other hydrocarbon constituents. As a result, degradation of the hydrocarbon constituents may be hindered or slowed down. A synergistic degradation of EDB and all hydrocarbon constituents must be evaluated for any future ISEB studies.

No response or revision to the Report necessary or requested. Should you have any questions, please contact me at (505) 629-6494.

Sincerely,

Rick Shean Digitally signed by Rick Shean Date: 2023.01.30 14:12:58 -07'00'

Rick Shean,
Chief
Hazardous Waste Bureau

cc: D. Cobrain, NMED HWB
B. Wear, NMED HWB
L. Andress, NMED HWB
L. King EPA Region 6 (6LCRRC)
S. Kottkamp, KAFB
R. Wortman, KAFB

File: KAFB 2023 Bulk Fuels Facility Spill and Reading