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Mr. David Cobrain
NMED - Hazardous Waste Bureau
2905 Rodeo Park Dr. East
Building One
Santa Fe, NM 87505

RE: Draft Technical Review Comments on the Fourth Quarter CY 2013 Aquifer Test Results, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base (KAFB), New Mexico, Dated January 2014

Dear Mr. Cobrain:

Attached please find the revised draft technical review comments on the Fourth Quarter CY 2013 Aquifer Test Results, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111 for KAFB.

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
AQS Senior Scientist and Program Manager

Enclosures

cc: Ben Wear, NMED (electronic)
William Moats, NMED (electronic)
Kent Friesen, Wyoming Environmental Consulting (electronic)
Joel Workman, AQS (electronic)

The contents of this deliverable should not be evaluated as a final work product.

Draft Technical Review Comments on the Fourth Quarter CY 2013 Aquifer Test Results, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, New Mexico Dated January 2014

GENERAL COMMENTS

1. **Summary.** We agree that pumping well KAFB-106157 exhibited significant well losses, likely attributed to "skin affect" or a zone of reduced permeability in the immediate vicinity of the well. This condition may be due to biofouling or other aspects of ineffective well development. The Report makes an effort towards recovering the data by using post-pumping well recovery measurements, rather than drawdown during pumping, to calculate hydraulic parameters. However, given the importance of the extraction well for interim containment of the plume, the resulting data is suspect. Therefore, the following additional activities are required:
   a. Aggressive re-development of extraction well KAFB-106157
   b. Pre-test proofing of the extraction well flow rate (targeting greater than 50 gpm);
   c. Installation of an additional monitor well closer (within 50 ft to 100 ft) to the extraction well; and
   d. Repeat the constant rate pumping test.
2. **Water Authority/INTERA Review.** We have also reviewed the February 18, 2014 Technical Memo from the Albuquerque Bernalillo County Public Water Authority, prepared by INTERA. We agree with INTERA's approach and conclusions that a new aquifer test should be performed on a properly developed well, and that monitor wells should be sufficiently close to demonstrate drawdown associated with pumping with greater certainty.
3. **Variability of Water Levels in Observations Wells.** The actual pump-induced drawdown affects are nearly indiscernible due to variability from changes in barometric pressure and other unquantified factors, as demonstrated in Figures 3-2, 3-3 and 3-4 from Shaw's report, as well as Figures 1 and 2 of the INTERA review. The influence from the test extraction well is not easily differentiated from other influences, such as pumping from other nearby water supply wells. This problem could be better addressed by installing additional monitor well(s) located closer to the extraction well, and repeating the test. Kirtland should also consider an assessment and monitoring of pump operations at other nearby water supply wells, such as the VA hospital supply well.
4. **Variability of Water Levels Before and After Testing.** Water level observations indicate that the unconfined groundwater system is dynamic, and that the water level affects before the aquifer test were not significantly different than during the pump test. Long-term transducer monitoring of water levels in wells, as well as barometric pressure, should be conducted to understand the variability of water levels in the unconfined groundwater, as well as to help determine the causes of the anomalous head variability.
5. **Anomalous Spike Measurements.** As shown in Figure 3-2, there is an anomalous spike in the displacement measurements, which occurred about mid-day on 12/5/2013 at KAFB-10610. A similar response, although less in amplitude, is shown at the same approximate

time at KAFB-106032. This type of anomalous response should be more thoroughly investigated and explained.

6. **Anomalous Indications in Corrected Displacement Curves.** As shown on Figures 3-6 (with similar effects in Figures 3-7 and 3-8), there is slight but apparently observable drawdown in the corrected displacement curves during the initial 90 gpm pumping period, but then some slight rebound or a rise in the corrected water level during the initial duration of the 45 gpm pumping period, followed by a gradual decrease. A more expected response would be a consistently gradual decrease or stabilization of water level while pumping 45 gpm. After pumping was complete, there was an expected rise in the corrected water level as expected, but the water level ended up higher than the initial water level prior to any pumping. Then, the water level initially "plateaus" for a time, and then gradually increases even more. Therefore, there appear to be other outside influences on the water elevations that are reflected in the pump test data, perhaps due to the cycling of other pumping wells in the vicinity. Other stresses to the aquifer are apparent or likely, and need to be somehow explained or quantified. Figure 3-6 also shows that the barometric pressure is clearly more influential than the corrected drawdown, which renders the overall test results as uncertain. Although drawdown of 0.1 to 0.2 ft was seen in three observation wells, since the water level subsequently recovered above the pre-pumping water elevation in all wells, the recovery data is suspect and the actual drawdown due to pump well influence is uncertain.

7. **Well Re-Development.** We generally agree with Report statements that "It is likely that the filter pack became clogged due to the activity of iron- and manganese-reducing bacteria in the area, because the well remained undeveloped for nearly two years after drilling due to delays in work plan approvals." We also concur that, "The poor fit and low conductivity values are most likely the result of well losses in the filter pack." Both of these statements indicate that re-testing is required. Note however that the first activity described on page 2-1 in the aquifer testing Work Plan (dated October 2013) indicated that extraction well KAFB-106157 would be adequately developed, presumably after publication of the final Work Plan last fall. However, the January 2014 pump test Report does not describe any well development activities, suggesting that the well development was not completed or, at least, not immediately prior to the pump test activities. In this regard, the aquifer test field work is not compliant with the Work Plan. The Work Plan also references a well development work plan, dated September 2013 (*Groundwater Extraction Well KAFB-106157 Well Development Work Plan)*; however, we found no evidence that this submittal was followed.

8. **No Corrective Action during Testing**. Poor well performance was indicated in the initial step drawdown test, as shown by excessive drawdown and low flow yields in the extraction well. These initial results should have been interpreted as requiring corrective action prior to the constant pumping test. Therefore, extraction well re-development should have been implemented as a corrective action following the initial step drawdown test. Well KAFB-106157 should be aggressively re-developed, and the constant pump rate aquifer test repeated.

9. **Skin Effect.** A positive skin effect indicates extra flow resistance near the wellbore. True skin effect is the result of a permeability reduction in the vicinity of the wellbore, which causes additional resistance to fluid flow. INTERA's analysis of the recovery curve data for the pumping well KAFB-106157 showed a high positive skin factor, indicating significant reduction in the permeability of the pore space around the well screen. The skin effect could

be caused by inadequate well development, the drilling itself, or Shaw's claim of biofouling. Therefore, additional assessment (including re-development and additional field pump testing) is required.

10. **Observed Drawdown in Observation Wells.** On Pg. 9, "Drawdown of approximately 0.1 feet was observed in observation wells KAFB-10617 and KAFB-10618 (314 and 324 feet from KAFB-106157, respectively), and drawdown of approximately 0.2 feet was observed in observation well KAFB-106083 (185 feet from KAFB-106157)." Referring to Figures 3-6, 3-7, and 3-8, we note that 0.1 to 0.2 ft is relatively small drawdown for observation wells during a pump test; regardless, we agree that it appears that 0.1 to 0.2 ft drawdown was demonstrated in these observation wells. Since drawdown results for KAFB-106083 were greatest (0.2 ft), this observation well also provided better "straight line" representation of data on semi log plots (Figures 3-13 and 3-14).

11. **Hydraulic Parameter Results.** The expected range of hydraulic conductivity (k) was 40 to 120 ft/day (avg. 100 ft/day) prior to the pump test, based on earlier slug test data. There were no usable results from the step-drawdown test, other than the observation that the well as tested could not sustain 95 gpm. Table 3-1 of the Report presents the results of the multiple tests and analyses. Results should be more clearly presented in the text for the recommended parameters for future use in modeling (including presumptive modeling prior to the next pump test). In our opinion, the more credible results include k = 110 ft/day (using the distance vs. drawdown approach), and k= 130 ft/day for observation well KAFB-106083 based on drawdown recovery after pumping ceased. INTERA reported k = 92 to 140 ft/day from their analysis. Since higher actual k results correspond to a narrower zone of capture, the refinement of this parameter for the extraction well is critical for future project success.

12. **New Observation Well.** Maximum drawdown was approximately 0.2 feet as observed in observation well KAFB-106083 (185 feet from the extraction well); this is minimal and points to the need for additional monitoring points located closer to the pump well. AQS previously provided a similar comment in our 1/5/2011 letter to NMED (regarding review of the *LNAPL Containment Interim Measure Work Plan*, dated Nov. 2010). At that time, we expressed concern that the existing well network would not be adequate for drawdown observations. Based on recent pump test results, we recommend at least one additional, closer observation well, which we suggest should be located approximately 50 to 100 ft from the pump well. This additional observation well would also serve as a performance monitor well during operational pumping.

13. **Produced Water Analysis and Disposal.** There were no reported quantities or concentrations of the produced water in this report, although the Work Plan indicated an expectation to generate 70,000 gallons for the step drawdown test alone. Therefore, evaluation of compliance with discharge limits was not evaluated, although the text stated that all discharged water was below MCLs after treatment.

14. **Additional Extraction Well.** AQS previously commented in our 1/5/2011 letter to NMED (regarding review of the *LNAPL Containment Interim Measure Work Plan*, dated Nov. 2010) that an additional extraction well was warranted. Kirtland should consider installing an additional, redundant extraction well that could also be used as an observation well for the additional pump testing.