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NMED
Hazardous Waste Bureau

February 3, 2014

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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 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

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 January 2014. This report presents the results of soil vapor extraction (SVE) system pilot testing at the BFF spill site source area. A spreadsheet has also been provided showing the calculation of hydrocarbon removal rates used in reviewing the report.

We generally concur with the findings of the report. However, caution should be used when applying the pilot test results to the full scale system design, as discussed herein. Several comments are similar to those made by AQS during our previous review of the June 2013 *Pre-Remedy Monitoring and Site Investigation Report for January – March 2013* for the BFF site at Kirtland AFB. 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

Enclosures

cc: Ben Wear, NMED (electronic)
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Joel Workman, AQS (electronic)

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

Draft Technical Review Comments on the 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

GENERAL COMMENTS

1. A key provision of this assessment is the use of 0.3 inches of water column (inWC) as the "edge" or perimeter of the radius of influence (ROI). This is subjective and results in a rather large ROI of 180 ft (well KAFB-106149) to 340 feet (well KAFB-106160). A more conservative value for the edge of the ROI, such as 0.5 inches, would result in a more spatially conservative ROI of 35 to 225 ft.

2. The radius of vacuum influence should not be used directly as a basis for full scale design. ROI as defined in this report is not the same as the effective radius of treatment, because measurable vacuum does not imply effective air flow. Consequently, the calculated ROIs in the report (180 ft to 340 ft) should not be used for system design; that is, 340 ft is not an acceptable SVE well spacing. Instead, we recommend calculation of the air permeability of soil, and establishing minimum soil gas flow parameters (such as air flow velocities) for full-scale design.

3. The following guidance documents (obtained from http://www.clu-in.org/techfocus/default.focus/sec/Soil_Vapor_Extraction/cat/Guidance) provide additional validation for these recommendations:

   a. U.S. Army Corps of Engineers, 2002, Engineering and Design: Soil Vapor Extraction and Bioventing, Engineering Manual (EM) 1110-1-4001. Pg. 4-21, above eq. 4-2, refers to the "zone of effective air exchange," which indicates that adequate exchange of air (i.e., multiple soil pore volumes) is more important than just pressure influence. Pg. 4-26, (2) indicates that the observed vacuum distribution should not be used as the basis for the well field design. Instead, a specific air permeability value should be estimated, and estimates of pore gas velocity (specific discharge) can be made for a given SVE extraction flow rate. Pg. 4-33 text in bold indicates that the radius of pressure influence is not appropriate as a basis for selecting vent spacing. Pg. 4-34, Paragraph 18, indicates the radius of vacuum/pressure influence does not provide an adequate estimate of the zone of effective air exchange of the vent, which is often much smaller than the radius of pressure influence.

   b. EPA, 1992 Ground Water Issue, Evaluation of Soil Venting Application, EPA/540/S-92/004. Pg. 5, text indicates that the radius of influence is not an effective parameter for locating extraction wells.

   c. EPA, 1998, Innovative Site Remediation Technology, Volume 7: Vacuum Extraction and Air Sparging, 542-B-97-01. Pg. 3.35, last two paragraphs, indicates that vacuum radius of influence is not adequate, but rather air flow predictions should be used to design the well field. "Historically, radius of influence has been determined by plotting

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the log of subsurface pressure with distance from the extraction well, regression, and interpolating the regression line to an arbitrary pressure value, typically ranging from 0.01 to 1 inch water column… The radius of influence evaluated in this way is arbitrary, because the vacuum cutoff level is arbitrary….Many alternative approaches have been developed that focus on air flow."

4. The Report does not provide specific recommendations for wells to be used as extraction wells for the full-scale SVE system. As an aid towards these types of decisions, we have developed a simple "Hydrocarbons Removal Calculator" that uses air flow and hydrocarbon concentration measurements from each well, and the same assumptions as reported in the pilot test report, to calculate the rate of hydrocarbon removal in pounds per hour (see attached spreadsheet). From these calculations, it is clear that existing extraction wells KAFB-106160 and -106161 are removing the greatest mass of hydrocarbons of all wells tested, and therefore obviously should be maintained as extraction wells. Wells KAFB-106148 and -106150 similarly have high hydrocarbon removal rates as demonstrated by long term testing, and therefore should also be brought on line as SVE extraction wells to further the progress of remediation. Wells KAFB-106149 and -106155 have lower yet still substantial removal rates as demonstrated by long term testing, and therefore should also be considered for bringing on line. Further, during the "quick testing" the following wells demonstrated the potential for significant removal of hydrocarbons, and should be considered for SVE extraction wells: KAFB-106113, -106129, and -106156.

5. The report indicates in Section 1.1, Pg. 1-2, first paragraph that the CATOX treatment system capacity is up to 1600 standard cubic feet per minute (scfm) of soil vapor with concentrations of up to 3,450 parts per million, volume basis (ppmv), resulting in potentially 2,100 pounds per day (lbs/day) hydrocarbon removal. The report also indicates that up to 900 scfm of dilution air was added during operation, resulting in a total flow capacity of 2500 scfm. In comparison, the average SVE system flow rate was 1,851 scfm from January to March 2013, and average influent concentration was 1,918 ppmv, resulting in approximately 45 pounds/hour of hydrocarbon removal during actual operations (Ref: Table 2-4 of Jan-March 2013 Quarterly Report). Therefore, it is evident that additional treatment capacity is available in the existing CATOX system, although it is also apparent that the existing CATOX system may be undersized for full-scale treatment. Since some additional treatment capacity is already available, it is recommended that Kirtland bring additional wells online as soon as possible, such as KAFB-106148 and 106150.

6. On Pg. 2-1, Section 2, first paragraph, second sentence, Kirtland reports that additional SVE treatment equipment will be installed in late 2014. We agree that additional SVE treatment capacity is required given the pilot test results, which indicate substantially more SVE extraction opportunities than the current system may be able to accommodate.

7. The data reduction techniques performed for this pilot test are very similar to the techniques used for the ROI testing described in the Jan-March 2013 quarterly report, which was previously reviewed by AQS on August 30, 2013. The data analysis approach was generally adequate and so additional critique is not provided herein.

8. In addition to this pilot test report information, future design of the full-scale SVE system must also consider the site characterization results for the proposed SVE system expansion. In general, there was no consideration of site characterization vapor monitoring results in this pilot test report. As an example, virtually no SVE data has been provided near tanks 2420 and 2422 (south and southeast of KAFB-106113), and yet there was a significant lobe of >1000 ppmv total VOC vapor plume at 450 ft bgs in this area (see Figure 4-3 of Jan-March quarterly report). However, we also note that the site characterization results provide some additional rationale for the pilot testing performed that was not otherwise clearly presented in this pilot test report. For example, the soil vapor maps previously reported in the Jan-March 2013 quarterly report indicate that well KAFB-106148 would address shallower soil contamination; in that context, Section 4.2.6 of the pilot test report makes more sense when reporting that the ROI for KAFB-106148 was better defined for shallower intervals than for deeper ones.

SPECIFIC COMMENTS

1. **Pg. 2-3, Section 2.2, 1st paragraph at top of page.** In the 5th sentence, it is stated that wells KAFB-106149 and KAFB-106154 were added to the wells planned for long duration tests to address benzene and ethylene dibromide (EDB) concentrations "above the current SVE system zone of influence." However, we note from Table 4-11 that the highest concentrations of EDB were instead encountered in wells KAFB-106160, -106161, -106148, and -106150. Therefore, adding well KAFB-106148 and -106150 in the interim to the existing SVE system (as recommended above) would also help to address a significant source of EDB.

2. **Pg. 3-2 to 3-3, Section 3.1.2, 1st paragraph in Section:** Well KAFB-106148 is incorrectly listed in the text for both the mobile SVE system and the CATOX SVE system. KAFB-106154 is not listed at all in the text, although it also underwent a long-duration pilot test.

3. **Pg. 4-5, Section 4.2.3, and Figure 4-25.** For the long-duration test for KAFB-106160, why was there not a western monitoring point provided for this test? We predict that monitoring from well KAFB-106156 could have brought closure to the vacuum influence contours (Figure 4-25).

4. **Pg. 4-8, Section 4.2.5, and Figure 4-33.** For the long-duration test for KAFB-106154, why was there not a northern monitoring point provided for this test? We predict that monitoring from well KAFB-106152 could have brought closure to the vacuum influence contours (Figure 4-33).

5. **Pg. 4-10, Section 4.2.6, and Figure 4-35.** For the long-duration test for KAFB-106148, why was there not a northwestern monitoring point provided for this test? We predict that monitoring from the SVMW or SVEW wells to the north and west of KAFB-106148 could have brought closure to the vacuum influence contours (Figure 4-35).

6. **Pg. 4-11, Section 4.2.7, and Figure 4-40.** For the long-duration test for KAFB-106155, why was there not more northern and western monitoring points provided for this test? We

predict that monitoring from wells KAFB-106150 and KAFB-106153 could have brought closure to the vacuum influence contours (Figure 4-40).

7. **Pg. 4-15, Section 4.2.8, last paragraph in Section.** Rather than simply concluding "inconsistent results" for this well KAFB-106150, it appears that significant anisotropy was exhibited by the long-duration test results. Also, it appears that soil vapor was extracted from the 484 ft bgs interval at KAFB-106150; why then were higher vacuum influence results observed in the 50 ft bgs level observation wells than lower levels? Does this indicate some sort of vertical short-circuiting of air flow in this well?

8. **Pg. 4-15, Section 4.3, and Table 4-11.** It is not clear what the analytical data were used for in the pilot test report. The data were not utilized to describe the SVE performance results in any way. We recommend use of the analytical data to specify additional extraction wells for full-scale SVE.

9. **Pg. 5-1, Section 5, and Table 5-1.** In the last paragraph, it appears that Table 5-1 is simply offered as an example table to be used later in design, as opposed to proposing these parameters for the basis of design. This approach is acceptable (and a good idea at this stage), but should be more clearly represented in the table.

10. **Table 4.4 through 4.10.** These tables calculate potential hydrocarbon removal rates for the wells that underwent long-duration tests. However, the report does not make any assessment of removal rates from the quick tests performed on additional wells, as reported in Table 4-1. AQS has developed a Hydrocarbon Removal Rate calculator that uses the same equations presented in Tables 4.4 through 4.10 to calculate hydrocarbon removal (in pounds per hour). Using the air flow rates and TVH concentrations for the quick test wells (Table 4.1), hydrocarbon removal rates were also calculated for the quick test wells. Wells KAFB 106113 and -106129 exhibited approximately 7.3 and 8.9 lbs/hour removal, respectively, which were the highest removal rates following wells KAFB-106160 (46 lbs/hour), -106161 (76 lbs/hour), -106148 (35 lbs/hr), and -106150 (28.6 lbs/hour). Extraction wells in the full scale design should not be limited to those wells that underwent long-duration tests.

Hydrocarbon mass recovery calculations for long term pilot tests

Assumptions:

20000 Btu/lb
6.2 lb/gallon of gasoline
86.18 Mole Weight of Extracted VOC
2520 Btu/Cubic Foot of Propane
1000 Btu/Cubic Foot of Natural Gas

Parts/Million by Volume (PPMV) Conversion to Micrograms/Liter (µg/L)
(PPMV/24.055)*AVG. Mole Weight=µg/L

Mass Transfer Equation to Convert to Pounds/Hour:
(µg/L)*(Flow SCFM)*28.3 L/SCF*60 Minutes/Hour*2.2 lbs/Kg*(1/10^9)

Well Location	Data Source	Notes	Flow (scfm)	PPMV of TPH	µg/L	Removed Lbs/Hour	Recommendations
CATOX system	Sect. 1.1	Potential	2500	3450	12360	**115.43**	= 1773 lbs/day
SVE system	Qrtly Rpt	Actual/avg.	1851	1918	6871	**47.51**	
106161			753	7650	27407	**77.09**	Keep on line
106160			474	7242	25945	**45.92**	Keep on line
106148 (349')	Table 4-1		276	10000	35826	**36.95**	Place online
106149 (484')	Table 4-1		264	1660	5947	**5.86**	Consider
106150 (484')	Table 4-1		248	10000	35826	**33.20**	Place online
106152 (450')	Table 4-1		184	23	82	0.06	
106153 (484')	Table 4-1		247	245	878	0.81	
106154 (484')	Table 4-1		489	350	1254	2.29	
106155 (484')	Table 4-1		238	1239	4439	**3.94**	Consider
106156 (341')	Table 4-1		266	937	3357	**3.34**	Consider
SVEW-11 (450'+)	Table 4-1		42	11	39	0.01	
10628 (250, 450, 350)	Table 4-1		73	348	1247	0.34	
106113 (450')	Table 4-1		232	2570	9207	**7.99**	Consider
106129 (450')	Table 4-1		236	2710	9709	**8.54**	Consider
106130 (450')	Table 4-1		262	191	684	0.67	
106142 (450')	Table 4-1		243	0	0	0.00	
106149 (484')	Table 4-3	Quick Test	173	1257	4503	**2.92**	Consider
106152 (494')	Table 4-3	Quick Test	245	525	1881	1.72	
106153 (484')	Table 4-3	Quick Test	250	272	974	0.91	
106154 (484')	Table 4-3	Quick Test	268	402	1440	1.44	
106155 (484')	Table 4-3	Quick Test	245	1154	4134	**3.79**	Consider
106156 (341')	Table 4-3	Quick Test	256	931	3335	**3.19**	Consider
SVEW-11	Table 4-3	Quick Test	109	70	251	0.10	
106113 (450')	Table 4-3	Quick Test	221	2452	8785	**7.26**	Consider
106119 (450')	Table 4-3	Quick Test	135	27	97	0.05	
106131 (450')	Table 4-3	Quick Test	258	407	1458	1.40	
106129 (450')	Table 4-3	Quick Test	225	2947	10558	**8.86**	Consider
106130 (450')	Table 4-3	Quick Test	249	208	745	0.69	
106142 (450')	Table 4-3	Quick Test	229	5	18	0.02	
10628	Table 4-3	Quick Test	102	239	856	0.32	
106148 (349')	Table 4-3	Long term test	273	9693	34726	**35.35**	Place online
106149 (349')	Table 4-3	Long term test	517	411	1472	**2.85**	Consider
106150 (484')	Table 4-3	Long term test	214	10000	35826	**28.57**	Place online
106154 (350')	Table 4-3	Long term test	437	99	355	0.58	
106155 (484')	Table 4-3	Long term test	275	1156	4142	**4.26**	Consider
106160	Table 4-3	Long term test	474	7242	25945	**45.92**	Keep on line
106161	Table 4-3	Long term test	744	7669	27475	**76.31**	Keep on line
					0	0.00	