ENTERED

From: Shean, Frederic [fshean@abcwua.org]
Sent: Monday, March 19, 2012 1:08 PM
To: Berardinelli, Thomas F Civ USAF AFMC 377 ABW/DS
Cc: Sanchez, Mark S.; Stomp, John M.; Kieling, John, NMENV; Moats, William, NMENV; Leonard, Mary Lou (CITY); Price, David J.; Gastian, Barbara; Lieuwen, Andrew L.
Subject: ABCWUA Comments Regarding Addendum to SVE Optimization Plan
Attachments: 20120319_SVEOptAddendum-ABCWUA Comments.pdf

Mr. Berardinelli:

Please see our attached technical memo regarding the Addendum to the SVE Optimization Plan submitted by KAFB at the end of December.

Sincerely,

Rick Shean
Water Quality Hydrologist
Albuquerque Bernalillo County Water Utility Authority
P.O. Box 1293
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505-768-3634 (office)
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KAFB3869

Kieling, John, NMENV

From: Berardinelli, Thomas F Civ USAF AFMC 377 ABW/DS [Thomas.Berardinelli@kirtland.af.mil]
Sent: Monday, March 19, 2012 2:09 PM
To: Shean, Frederic
Cc: Sanchez, Mark S.; Stomp, John M.; Kieling, John, NMENV; Moats, William, NMENV; Leonard, Mary Lou (CITY); Price, David J.; Gastian, Barbara; Lieuwen, Andrew L.; 377 ABW/CC Wing Commander; 377 MSG/CC Administrative Mailbox; Donald.Conley@kirtland.af.mil; Wilson, Brent Civ USAF AFMC 377 MSG/CE; Pike, John S Civ USAF AFMC 377 MSG/CEAN; Bitner, Ludie W Jr Civ USAF AFMC 377 MSG/CEANR; Marie.Vanover@kirtland.af.mil; Shupe, James Civ USAF AFMC AFNWC/JA; Indermark, Michele CIV USAF SAF/IEE; Davis, Jim, NMENV
Subject: RE: ABCWUA Comments Regarding Addendum to SVE Optimization Plan
Attachments: 20120319_SVEOptAddendum-ABCWUA Comments.pdf

Rick, thank you for the ABCWUA input. We will review and forward on to the Corps and Shaw for their consideration and they will contact you if they have any questions. However, we will not provide a specific response to inputs. Thank you again for taking the time to provide the detailed input.
V/r, tom

Tom Berardinelli
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-----Original Message-----
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Sent: Monday, March 19, 2012 1:08 PM
To: Berardinelli, Thomas F Civ USAF AFMC 377 ABW/DS
Cc: Sanchez, Mark S.; Stomp, John M.; Kieling, John, NMENV (john.kieling@state.nm.us); Moats, William, NMENV (Williams.Moats@state.nm.us); Leonard, Mary Lou (CITY); Price, David J.; Gastian, Barbara; Lieuwen, Andrew L.
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Description: http://www.abcwua.org/templates/waterauthority/images/blank.gif
<http://www.abcwua.org/>

Albuquerque Bernalillo County
Water Utility Authority

To: Tom Berardinelli, Director of Staff, 377th Air Base Wing KAFB (via email)

From: Rick Shean, Water Quality Hydrologist, ABCWUA

CC: Mark Sanchez, Executive Director, ABCWUA
John Stomp, Chief Operating Officer, ABCWUA
John Kieling, Hazardous Waste Bureau Chief, NMED
Will Moats, Project Manager, NMED-HWB
Mary Lou Leonard, Director, COA-EHD

Date: 3/19/12

Re: ABCWUA comments on the Addendum to the *Soil Vapor Extraction Well Design, Location, and Installation Interim Measures Work Plan, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111* (December, 2011)

Introduction

On behalf of the Albuquerque Bernalillo County Water Utility Authority (Water Authority), INTERA Incorporated (INTERA), reviewed the document entitled *Soil Vapor Extraction Well Design, Location, and Installation Interim Measures Work Plan, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111* (December 5, 2011) written by Shaw Environmental Inc. (Shaw). This document was reviewed concurrently with relevant sections from recent quarterly monitoring reports and correspondence between the New Mexico Environment Department (NMED) and Kirtland Air Force Base (KAFB).

I. USACE Guidance for Well Design

The Letter Addendum describes the well design but does not describe the design of the remediation systems to be placed within the wells. Several possibilities for remediation systems in the wells are listed: soil vapor extraction (SVE), water extraction and/or containment, air sparging, and LNAPL skimming. Shaw states that it designed the wells so that "...they are viable for any of these technologies." However, our review of the proposed design and the U.S. Army Corps of Engineers' (USACE) guidance documents for SVE (USACE, 2002) dual phase extraction (USACE, 1999), and air sparging (USACE, 2008) revealed that the proposed well design may be "viable" but not necessarily optimal or even well suited for at least two of the cited remediation systems.

The proposed wells will be constructed within locations containing high concentrations of vapor-phase, dissolved-phase, and NAPL-phase contaminants in both the vadose and saturated zones. Based on the vapor-phase plume plots that reveal very high volatile organic compound (VOC) concentrations in the vadose zone immediately above the water and the long screen to be installed above the water table, Shaw appears to have selected SVE as one of the primary remediation methods for the two wells. If designed and constructed properly, the SVE wells will remove contaminant mass of VOCs from the vapor phase and, to a lesser degree, from the NAPL-phase, assuming the NAPL is distributed in relatively thin stringers (USACE, 2002). SVE alone is not considered an effective treatment for dissolved-phase VOCs by the USACE.

Advancing with well design and construction prior to designing the SVE system contravenes USACE guidance (see section 5.0 including Figures 5.1 and 5.7 in USACE, 2002). The proposed well diameter of six inches is within the USACE's recommended range (USACE, 2002), but the work plan provides no justification for the proposed 90-foot screen length above the water table. Nor does the work plan provide any justification that the two proposed wells will provide sufficient volume of air exchange to treat the roughly 400 ft x 300 ft contour area with the very highest vapor concentrations (see the plot for the 450-ft depth in Figure 1 of the Letter Addendum). Well number and well design are determined by the key SVE design variables of contaminated volume, desired time frame, number of pore volumes to be exchanged per unit time, and desired air velocity distribution.

The accompanying plot of total VOC concentration with depth in the vadose zone only provides justification for screening the fifty feet of vadose zone above the water table. Screening intervals with the highest vapor concentrations, such as the bottommost 50 feet of the vadose zone, and installing more wells over the large area with this high contamination will yield a more cost effective remediation effort than installing fewer wells with longer screens that span intervals of high and low concentrations.

II. Borehole Data

The proposed work plan states that no sediment samples or geophysical logs will be collected during drilling of the two wells. Given the paramount importance of measuring the air permeability to proper design of any SVE system (see pages 5-2 and 5-13 of USACE, 2002), the work plan must be amended to collect core samples of vadose zone materials within the proposed screen depths at intervals of 1 to 1.5 meters and analyze them for air permeability, water content, porosity, particle size distribution, bulk density, and LNAPL content. The sediment samples should also be geologically described to determine mineral composition, bedding, patterns of grain size variations, and indications of anisotropy in permeability. Collecting measurements of air permeability will greatly reduce the uncertainty in the overall system performance and thereby reduce total cost and time to achieve remediation goals.

III. Effective Soil Vapor Extraction (SVE) Treatment Considerations

SVE is considered to be an effective treatment method for the more volatile components of petroleum hydrocarbons. Suitability of SVE to effectively remove contaminants depends on the contaminant's Henry's Law constant and vapor pressure. Typical criteria for effective SVE require a Henry's Law constant greater than 0.001 atm-m^3/mole and a vapor pressure greater than 1 mm of Hg at 20° C (Suthersan, 1997). SVE is therefore very effective for the volatile BTEX compounds, but less effective for the less volatile or semi-volatile components of jet fuel. SVE is considered less effective for ethylene dibromide (EDB) by some authorities because its

Henry's Law constant of 0.00082 atm-m^3/mole is lower than the cut-off (its vapor pressure of 11 mm Hg does exceed the second criterion), but the USACE (2002) states that SVE can effectively remove EDB. The work plan does not make clear whether EDB is present in vadose zone vapor or NAPL phases, which can be effectively remediated by SVE, or whether it is predominantly found in the dissolved phase, which is not effectively remediated by SVE.

The work plan does not include logging the two wells with the PneuLog® method used at many other recently-installed vapor monitoring wells installed. The work plan should be revised to include this potentially important determination of the depth intervals that contribute the most vapor flow into the wells.

The work plan does indicate the possibility of configuring the two wells for dual phase extraction, in which the wells will have an applied vacuum to remove vapors and a groundwater pump that can extract dissolved-phase and possibly NAPL-phase contamination. If properly designed, constructed, and operated, dual phase extraction systems can effectively contain dissolved-phase plumes while removing source contamination from the vadose zone. Dual phase extraction pumps can help address the impacts on SVE system performance from the rising water table so that the SVE system can continue to remove jet fuel by locally minimizing drowning of the LNAPL as the water table continues to rise.

IV. USACE Guidance for Dual Phase Systems

USACE guidance (1999) recommends a six inch diameter well as a minimum for dual phase systems. Given the high horizontal saturated hydraulic conductivity expected for these ancestral Rio Grande River sediments, achieving sufficient drawdown in the dual phase well may require a high pumping rate, which in turn can require a relatively large diameter drop or riser pipe. The groundwater riser pipe running within the six-inch diameter SVE well will significantly reduce the cross-sectional area available in the well for vapor flow to the vacuum system and may cause additional vapor pressure losses by inducing turbulent flow. Without completing the design of the dual phase system works first, it is possible that the proposed well design will not have a sufficiently large diameter to allow effective groundwater and vapor extraction, resulting in an expensive, inefficient remediation system. Similarly, if a LNAPL skimmer is installed in the well rather than a groundwater pump, it may also occlude enough of the well's cross-sectional area to render the SVE system inefficient.

USACE (1999) guidance for dual phase extraction wells with LNAPL contamination flatly rejects well development using jetting or surging in the depth intervals that contain LNAPL. The work plan must therefore be revised to develop the wells without any surging. Otherwise, surging will force water into the pores that contain LNAPL and thereby significantly slow or occlude the flow of LNAPL into the proposed wells. The USACE (1999) guidance for well development of dual phase extraction wells follows:

> *(i) Well development. Well development is critical to the ultimate performance of the well. A careful specification of the acceptable development methods and development criteria is strongly recommended. Require the water bearing interval of the well be developed by surging and bailing using a suitably sized surge block or jetting at appropriate water velocities. The development of the water-bearing zone*

> *should continue until the well is producing clear water with less than 2 to 5 ppm by weight sand and/or other suspended solids. A turbidity criterion defined as less than 5 Nephelometric Turbidity Units (NTUs) determined by a nephelometric turbidity measurement method can be used. Such criteria may not be appropriate or feasible in fine-grained formations. Establishing some required level of effort (e.g., development time) may be an acceptable option in those cases. Sometimes, the use of dispersing agents such as phosphates can help develop wells by breaking down clay smears on the borehole walls. The regulatory authorities may need to approve dispersing agents or other additives such as acids. Note that jetting or other development techniques that use water can dramatically affect product recovery by disrupting floating hydrocarbon flow pathways. Do not use jetting (or surging) in the product-bearing zone. The use of surfactants in development of the product-bearing zone may also improve product recovery by reducing pore-scale NAPL/water interfacial tension barriers to product flow. In rare cases, and only with regulatory agency approval, introduction of previously recovered product into the well may improve product recovery by increasing product saturation in the filter pack and surrounding formation.*
> *Development is conducted after placement of the filter pack and before or after grouting the well. Development before the grouting of the well will ensure that the filter pack is fully settled before grout placement, thus assuring no voids would be created; however, the potential exists for cross-contamination while the well annulus is open above the pack. Normally, conduct development after grouting.*

If in-well air-sparging (IAS) is to be included in the proposed wells, then the well design should be revisited to ensure that it complies with USACE guidance (2008). For example, the screen must be placed just below the interval containing LNAPL in the saturated zone:

> *(d) Where LNAPL exists, consider applying IAS at shallower depths below the water table surface. This depth should ideally be selected based on knowledge of the location of NAPL filled pores beneath the water table. As described in Chapter 2, LNAPL may be distributed well below the water table, depending on a variety of factors, including historical (since the LNAPL release) water table fluctuations and the pressure-head pushing the LNAPL downward during the release. Field observations of LNAPL saturation beneath the water table should be used to determine the bottom of the LNAPL zone. IAS well screens should be set based on this depth.*
> *Without this knowledge, typical top of screen depths for pilot tests are 1.5 to 6 m (5 to 20 ft) below the seasonal low water table. Note the reference made to the seasonal low water table; otherwise, the IAS well may be only seasonally useful. One strategy for setting well depths is to "customize" the screen location for each well based on field observations of LNAPL saturations in core samples when the IAS well is installed. By using knowledge from each IAS well, the IAS well network can be made appropriately specific to the site. Note that air contact with residual LNAPL is sometimes difficult to achieve, in which case the LNAPL may represent a long term source of low concentrations of dissolved contaminants.*

In summary, the Water Authority strongly urges NMED, KAFB, and Shaw to expedite a preliminary engineering design of the remediation systems to be placed into the two wells and ensure that the proposed well design will lead to effective remediation, not just "viable" remediation. The Water Authority strongly recommends that the proposed work plan be amended to include collection of vadose zone sediment samples for air permeability and other parameters to ensure that the SVE design is matched to site-specific conditions. The Water Authority also requests that surging, jetting, or other well development methods that force water into the formation be excluded from the work plan.

V. Recommendations for SVE Design

The following points were presented in our previous memorandum on the SVE Optimization Plan and are repeated here for incorporation into the SVE design for the two proposed wells. "Optimization Plan" should be replaced by "SVE design" throughout.

A. More detail on optimization criteria is warranted. The Optimization Plan states that 3D SVE modeling will be used to optimize the SVE units to access the current high-concentration contaminant areas in the vadose zone. This approach suggests that optimization is defined only by the focusing of SVE efforts on discreet zones where contamination persists. Although this criterion is important, "optimization" should include means of reaching closure or remediation objectives quicker. The optimization should include an analysis of well spacing, infrastructure improvements, and pore volume exchange rates that could increase treatment efficiency and reduce long term operational costs.

B. Section 5 of the Optimization Plan indicates that the basis for optimization will be the results of the radius of influence (ROI) testing. The U.S. Army Corps of Engineers (USACE) indicates that a design based on pore-gas velocity or travel time is preferred over a design based on ROI (USACE, 2002). A pore-gas velocity approach puts an emphasis on the rate of air exchange (pore volume per time), with a minimum pore-gas velocity of 3 to 30 feet per day recommended.

C. The operational data of applied vacuums and extraction rates suggest that there is a strong possibility that the current system is operating more as a bioventing system than an SVE system. Section 4.6.1 of the Optimization Plan states "...the overall vapor concentration declines potentially can be attributed to natural degradation of organic compounds..." and that additional data to confirm the effects of degradation is required. If future operations of the SVE system are constrained to the use of the existing infrastructure and equipment, then it seems like more emphasis should be placed on at least understanding the in situ degradation dynamics. The Optimization Plan does not include microbial studies (for example, heterotrophic plate counts) or a discussion regarding available macronutrients (i.e. nitrogen and phosphorus). It's possible that given the low extraction rates, the observed asymptotic contaminant recovery rate may have to do in part with degradation and not exclusively diffusion limitations. Additionally, there is no discussion given to the benefits of oxygen introduction through passive inlet wells or air injection wells. Air injection, particularly near the capillary fringe, could provide dramatic improvements in degradation rates as well as SVE efficiency, because pore volume exchange rates could be accelerated.

D. The Optimization Plan assumes that there are adequate data for solid matrix properties and does not specifically discuss the results of sieve analyses, porosity testing, moisture content analyses, or estimated air permeability for each extraction zone. These will be important parameters needed for the model. The reason for addressing this issue is that there were references to "assumed" effective porosity in one of the calculations. If geotechnical properties of the soil have not been quantified using lab and/or bench scale tests, then it is recommended that samples be collected during the next drilling event from each elevation associated with a typical screen interval in an SVE well.

E. There was limited discussion in the text regarding the impacts of groundwater mounding in the vicinity of the SVE wells and testing procedures provided in Sections 5.1 and 5.2 do not include the logging of water levels in the test area. If SVE wells span the water table, then consideration should be given to installing transducers in the well during tests to log water table levels. Significant and prolonged mounding can impact treatment efficiencies by:
   a. Reducing the screen interval in the well,
   b. Flooding NAPL in the capillary zone and making it more difficult to reach with SVE treatment, and/or
   c. Moving LNAPL away from the well and toward areas of lower head.

F. Related to the groundwater level issue, it was observed that there was a lack of discussion regarding the rebound in regional water table elevations as a result of reduced municipal demand on the aquifer. A rapid increase in the water table can have a detrimental effect on the efficiency of the SVE system as NAPL becomes trapped below the water table. Construction of a 3D model and development of an optimization plan should address observed changes in the water table as well as predictive trends to the extent possible. Continued rises in the water table elevation could eventually affect SVE infrastructure by occluding deep screen intervals.

G. Field measurements of vapor temperatures and barometric pressure logging were not observed in the testing section (Section 5). These are parameters that will be useful in development of the model, optimization of the SVE system, and analysis of the data.

H. Figure 5.1 shows several PneuLog® installations across the site. The SVE design should be based on analysis of the data already collected from other vapor monitoring wells and, ideally, PneuLog® logging of all new extraction vapor wells.

I. In 2001, the Air Force Center for Environmental Excellence (AFCEE) developed a guidance document for SVE optimization (AFCEE, 2001). This document stressed the importance of two tools for evaluating an SVE system, both of which are missing from the Optimization Plan. The first tool is monitoring vapor chemistry responses at monitoring points as well as vacuum. The document states:

> *The Air Force recommends a combination of vacuum and soil gas chemistry monitoring at multiple discrete [vapor monitoring points] [VMPs] as the most practical indication that a volume of soil is being treated by an SVE system. Changes in vacuum and soil gas chemistry can be easily measured in discrete VMPs located at varying distances and in varying soil types. This method has been widely applied at bioventing sites and has been found to be more reliable than vacuum methods alone in confirming the area of treatment influence. To use this method, multiple VMPs should be in place before the SVE system is turned on. Soil gas concentrations of oxygen, carbon dioxide and total volatile hydrocarbons should be measured in each VMP before starting the extraction system. Once the system is started, these measurements should be taken at 2, 4, 8, and 16 hours and then daily intervals until soil gas chemistry stabilizes. At most waste sites, initial soil gas oxygen will be depleted and carbon dioxide is elevated above levels found in clean background soil gas (Background oxygen in soil gas is generally 18 – 20 percent. Background carbon dioxide in soil gas is generally < 1 percent.)*

In general, a change in soil gas chemistry is a more convincing indicator of SVE system influence than just vacuum.

The second tool that should be considered is a performance indicator to incorporate into the operation and maintenance of the system. AFCEE recommends periodic equilibrium/rebound testing. The asymptotic reduction in contaminant concentrations in the soil gas may not be a good indicator of treatment effectiveness. It may just be indicating a transition from contaminant recovery by advective flow conveyance to desorption and diffusion dominant conditions. AFCEE recommends turning the system off on routine intervals and allowing the contaminants in the soil gas to equilibrate. Comparison of the contaminant levels each time the system is restarted is a better indicator of treatment effectiveness than looking only at the mass removed over time.

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