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CBRN CONSEQUENCE MANAGEMENT ADVISORY DIVISION

DECONTAMINATION ANALYTICAL AND TECHNICAL SERVICE (DATS) II CONTRACT

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Review of the US Air Force Response to US Environmental Protection Agency Comments on the *ST012 Remedial Action Field Variance Memorandum #5 Extraction and Treatment System Construction, September 30, 2016*, Former Williams Air Force Base, Mesa, Arizona

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CSS-Dynamac Technical Points of Contact (POCs):

Daniel F. Pope, Biologist
Anne Busher, DATS Program Manager

CSS-Dynamac
4900 Olympic Boulevard
Erlanger, KY 41018

INTRODUCTION

CSS-Dynamac was tasked with providing technical comments on the US Air Force (AF) response to comments (AF RTC) to US Environmental Protection Agency (EPA) comments (EPA Comments) on the *ST012 Remedial Action Field Variance Memorandum #5 Extraction and Treatment System Construction, September 30, 2016* (FVM #5), Former Williams Air Force Base (FWAFB), Mesa, Arizona.

The site-related documents reviewed or used for additional site information include:

> ST012 Remedial Action Field Variance Memorandum #5 Extraction and Treatment System Construction. (**FVM #5**). September 30, 2016
> *ST012 RTC Containment-EPA 14October 2016 letter-10-26-16.pdf*

The Site is at the former Liquid Fuels Storage Area of FWAFB, where fuel storage and distribution facilities were located until decommissioning in 1991. Contamination of soil and groundwater occurred when jet petroleum grade 4 (JP-4) and aviation gasoline (AVGAS) were released. Benzene, toluene, ethylbenzene, total xylenes, and naphthalene (BTEX+N), are indicated to be the contaminants of primary concern (COPC; COC) that require treatment to achieve remediation goals.

Hydrogeological characteristics of the Site include the Upper Water Bearing Zone (UWBZ), the Cobble Zone (CZ), the Low Permeability Zone (LPZ), and the Lower Saturated Zone (LSZ).

As part of remedial activities, steam enhanced extraction (SEE) was used for the removal of light non-aqueous phase liquid (LNAPL) at specified thermal treatment zones (TTZs). The AF proposes enhanced bioremediation (EBR) to address BTEX+N in groundwater and LNAPL remaining in the TTZs after SEE, and also outside of the TTZs. The proposed EBR effort involves the injection of sulfate as a terminal electron acceptor (TEA) to enhance the anaerobic biodegradation of the COPCs.

The AF expects that EBR can be used to bring COPC groundwater concentrations down to a range where monitored natural attenuation (MNA) will suffice to further reduce COPC concentrations to final required levels, all within a twenty year timeframe. The twenty year timeframe started at the signing of the Site Record of Decision amendment 2 (RODA 2) which occurred in 2013.

Significant quantities of LNAPL remain, both within the TTZs, and outside the TTZs.

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DISCUSSION

Increased Temperatures in TTZs

The AF indicates that if they are not able to take advantage of the "post-steam advantages of increased temperature, increased contaminant solubility/dissolution, and increased anaerobic degradation" (p1 AF RTC) (i.e., by immediately implementing EBR, and postponing any groundwater extraction for plume control), then that will "prevent the AF from achieving the remedial objectives within the estimated remedial timeframe" (p3 AF RTC), and "will fatally impact the efficacy of EBR implementation and achieving the remedial action objectives." (p7 AF RTC).

If it is assumed that the AF is correct in stating that taking advantage of the increased subsurface temperature in the TTZs and nearby zones is necessary for EBR to be able to meet the remedial action objectives in the required timeframe for those zones, then it follows that EBR will not be able to meet the remedial action objectives in the required timeframe for those LNAPL-contaminated areas outside the zones of increased temperatures.

Note that while elevated temperatures (due to the SEE thermal treatment) may increase degradation of COCs (due to supposed increased rates of biodegradation and perhaps some increase in partitioning of some of the COCs from the LNAPL into groundwater), the AF has presented no data and analyses to show that such is the case at the Site, and that such increase would be significant in terms of meeting the Site remedial goals in the required timeframe.

Note also that if the elevated temperatures do in fact lead to significantly greater increased contaminant solubility/dissolution, potential for migration of contaminants is also greater, underscoring EPA's contention for immediate implementation of a hydraulic control system.

Pump and Treat (P&T)

The AF indicates that "Pump and treat [P&T] has already been established as an ineffective technology for ST012 and was the reason SEE/EBR was selected as the new groundwater remedy" (p3 AF RTC), and so the AF claims that P&T should not be implemented now. It appears likely to this reviewer that P&T was discontinued and SEE implemented because P&T was not considered to be an effective remedy for removal of the large volumes of LNAPL at the Site (i.e., by dissolution of the LNAPL-contained COCs into groundwater and subsequent removal of the contaminated groundwater by pumping). However, EPA's proposed use for P&T is not for LNAPL treatment, but rather for hydraulic control of the groundwater-dissolved COC plume, for which P&T has proved useful at many sites.

It might be noted also that while the AF contends that P&T is an ineffective technology for dealing with the highly-LNAPL-contaminated Site, the AF proposes to use EBR at the Site – and EBR also depends on dissolution of the NAPL-contained COCs into groundwater (and subsequent removal of the groundwater contaminants by biodegradation). In both cases (P&T and EBR) the transfer of COCs from the LNAPL to groundwater is likely to be the major limiting step, and therefore both P&T and EBR suffer from the same weakness. So if P&T was found to be ineffective, it is likely that EBR will also.

LNAPL

The AF contends that "It was also well established and known that significant quantities of LNAPL, commensurate with current estimates of residual LNAPL, would be remaining after SEE, primarily at or outside the thermal treatment zone perimeter." (p2 AF RTC) That is, the AF contends that it should be no surprise that millions of pounds of LNAPL remain at the Site, and therefore the AF indicates that current and future remedial plans should not be affected by the fact that large quantities of LNAPL do in fact remain at the Site.

While there are significant differences of opinion between the AF and EPA about how much LNAPL remains (and at what locations) in the Site subsurface, both parties agree that large quantities do remain. Much of this LNAPL appears to be in large somewhat continuous masses (i.e., rather than in small, dispersed globules, small amounts scattered in pore spaces, thin films on the water table, etc.). Also, LNAPL still is moving into many wells around the Site, both in the TTZs and outside the TTZs, so at least some of the LNAPL is not "residual" LNAPL, in the technical sense of the term as referring to immobile LNAPL.

The AF argues that EBR (and, eventually, MNA) will suffice to treat COCs transferring from the LNAPL to the groundwater, so that eventually the remaining LNAPL will be remediated by EBR/MNA. If there were only a small amount of LNAPL remaining at the Site, in small globules, small amounts in pores, etc., so that the LNAPL was in close contact with moving groundwater (i.e., so reagents can effectively and efficiently be moved into close contact with the LNAPL), had a high surface area (i.e., high contact surface area between the LNAPL and groundwater, so that transfer of COC mass from LNAPL to groundwater would be rapid, and microorganisms living in this contact area could effectively attack the LNAPL), then the AF argument might have some force, though remedial timeframes would still be problematic to predict.

However, since the LNAPL is in fact in large quantities, and much of the LNAPL appears to be in configurations with relatively low LNAPL/groundwater contact area, there is little reason to think that EBR/MNA could be so effective as to treat the LNAPL and meet the Site remedial goals in a timely manner. Indeed, as the military's own environmental remediation research programs have indicated for enhanced in situ anaerobic bioremediation of fuel-contaminated

ground water (i.e., the same technology the AF is proposing) "However, we note that the technology will be effective at NAPL-contaminated sites only if the trapped NAPL can be remediated, i.e., if the amount of residual NAPL is small…" (ESTCP 1999). While the AF has presented their experience at other sites, and other material related to EBR which encourages them to think that active biodegradation can take place in close contact with LNAPL (i.e., usefully active biodegradation at the LNAPL/groundwater interface, which is not disputed by this reviewer), the fundamental physical limitation of COC transfer from LNAPL to groundwater under low LNAPL/groundwater contact area conditions still remains. So, since there are large amounts of both residual and mobile LNAPL remaining at the Site, this reviewer does not expect that the proposed EBR/MNA approach will be suitable for meeting remedial goals at the Site.

Performance Monitoring and Contingency Remedies

The AF states that "Evaluation and implementation of contingency actions will be based on performance in regard to remedial objectives and performance metrics." (p3 AF RTC) However, the AF has neither provided details of proposed contingency actions, nor remedy performance metrics, contingency triggers, etc. (e.g., based on specific monitoring locations, frequencies, statistical evaluations, specific timeframes/specific goals, specific/measurable milestones, etc.). Such details should be developed immediately, because it is not appropriate to implement a remedy without having developed concrete, actionable details of what will be done in case of remedy failure.

REFERENCES

Enhanced In Situ Anaerobic Bioremediation of Fuel-Contaminated Ground Water. December 1999. Cost and Performance Report (CU-9522). Environmental Security Technology Certification Program (ESTCP). U.S. Department of Defense.

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