RESPONSE TO COMMENTS/FINAL DECISION DOCUMENT
EPA REGION 6

under

Final Administrative Order (Order), Docket No. RCRA-VI-002(h)-95-H, pursuant to Section 3008(h) of the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §6928(h)

for

Altus Air Force Base
Altus, Oklahoma
OK9571824045

INTRODUCTION

EPA proposed a final remedy for addressing soil and groundwater contamination at the Altus Air Force Base (Altus AFB) site in Jackson County, Altus, Oklahoma on September 6, 2007 as part of the RCRA corrective action requirements outlined in the above-mentioned Order. The EPA Order was issued on November 6, 1996 and a complete record of soil and groundwater investigations is available for review in the Administrative Record. A public meeting was held in Altus, Oklahoma on September 6th to open the 45-day public comment period which ended on October 22, 2007. EPA has received comments and is now prepared to make the final decision regarding this remedy. The final conceptual site model is documented in the Final Corrective Measure Study (August 2007). EPA's remedy proposal is documented in the Statement of Basis for Altus Air Force Base (September 2007).

CORRECTIVE ACTION OBJECTIVES

The EPA-proposed remedy relies on the attainment of specific cleanup goals. This approach is sometimes referred to as "performance-based" and is focused on progress towards meeting the cleanup goals. The cleanup goals are outlined in the corrective action objectives (CAO's) for groundwater, surface soils, subsurface soil and surface water. EPA met with representatives from Oklahoma Department of Environmental Quality (ODEQ) on June 26 – 28, 2007 to finalize the Corrective Action Objectives (CAO's) outlined below.

Groundwater

Corrective Action Objective 1:

The final groundwater CAO is to contain the contaminant plume, rather than return the groundwater in the uppermost aquifer to its maximum beneficial use. This decision is based on EPA's review of the use, value and vulnerability of the affected uppermost aquifer. Because of high chloride and sulfide content in the upper aquifer, the Oklahoma Water Resources Board (OWRB) has classified this aquifer as a Class III aquifer having a beneficial use as agricultural and municipal/industrial cooling water. Altus AFB is

underlain by about 20 feet of terrace deposits of Quaternary age, consisting of unconsolidated sands, silts and clays. Below the terrace deposits there are transitions to a weathered zone of the Hennessey shale. The weathered zone of shale transitions to a more consolidated shale below depths of 40 feet. The consolidated shale extends to depths greater than 150 feet. The high chloride content of the upper aquifer is, in fact, contributing to the weathering of the Hennesey shale, but the extensive layer of consolidated shale serves as a confining unit to the deeper usable aquifer.

The value of an aquifer is based on its potential impact on the underlying aquifer, potential discharge to surface water, and potential exposures to indoor air. Regional groundwater studies reveal that the upper aquifer (from about 8 feet below ground surface to about 45 feet below ground surface) is not hydraulically connected to the lower aquifer. The upper aquifer in this area discharges to local creeks, producing surface water that is brackish in nature with high chloride and sulfide content. Potential for contaminated indoor air from the affected groundwater at Altus AFB is high due to the volatile nature of the contaminants and the shallow depth to groundwater. Altus AFB will mitigate potential indoor air exposures in administrative buildings located directly over existing plumes using engineered controls. Altus AFB will use institutional controls to protect offsite exposures, as described in the *Land Use Control Plan* currently being developed under the corrective measures implementation (CMI) phase of corrective action.

To support the groundwater cleanup objective, the distinct volatile organic compound (VOC) groundwater plumes in the upper aquifer will be managed as plume management zones. There are four groundwater plumes associated with Altus AFB. Each plume management zone will be called a "groundwater management unit" (GWMU) adequately delineated by groundwater monitoring wells (denoted as sentinel wells). EPA and ODEQ will agree on statistically significant protective concentration levels to be maintained at the sentinel well monitoring locations to show that each of the plumes are either stable or shrinking in size. EPA and ODEQ will approve the calculation of the protective concentration levels for each contaminant at the sentinel wells. The final point of compliance (POC) will be at the Base boundary, where concentrations of chemicals of concern must be at maximum concentration levels (MCLs) for drinking water. If Altus AFB is successful in eliminating the human health exposure pathway (including vapor intrusion) for offsite properties through controls on groundwater use, as agreed by property owners, the POC will move to the boundary of the area under control. Controls on groundwater use will be memorialized in the form of institutional controls, as described in the *Land Use Control Plan.* Details of the management of the plumes will be outlined in the *Performance Monitoring Plan* to be developed during the corrective measures implementation (CMI) phase of corrective action.

Groundwater vulnerability is the relative ease at which a contaminant introduced into the environment can migrate to an aquifer. At Altus, the upper aquifer is vulnerable to the past releases of contaminants because of the shallow depth to groundwater and the unconsolidated nature of the soils.

Corrective Action Objective 2:
To support the final groundwater cleanup objective, Altus must remove or treat source material in subsurface soils and/or groundwater to the extent practicable. Some chlorinated VOC's have higher specific gravities than water, and as a result, have the potential to sink in groundwater and form "pooled areas" on top of resistance bedrock. These pooled areas, also known as "DNAPL (dense non-aqueous phase liquid) pools" are source areas that will continue to leach contaminants to groundwater if not treated or removed. Removal or treatment of source material that could subsequently migrate into groundwater will enhance the attainment of the performance metrics. Source removal activities must target the removal of chlorinated VOC's in soils at concentrations that exceed their corresponding solubility constants in water.

Surface Soils

Corrective Action Objective 3:
ODEQ defines surface soils as the top two feet of soil. For the protection of human health from exposures of residual contaminants in surface soils, EPA is proposing a media-specific cleanup level at any identified release area. Contaminants of concern in surface soils must be remediated to levels that do not exceed **human health-based risk levels** that correspond to excess lifetime cancer risks of one in 100,000 (denoted as 1E-5) for an industrial outdoor worker exposure scenario. Non-carcinogenic contaminants must be remediated to levels that do not exceed a hazard index (HI) of 1 for an industrial outdoor worker. Confirmation sampling data from corrective actions at sites will confirm attainment of appropriate cleanup levels.

Subsurface Soils

Corrective Action Objective 4:
As stated in the CAO's for groundwater, Altus AFB must remove or treat source material in subsurface soils (greater than 2 feet below ground surface) that could subsequently migrate to groundwater, and attain a subsurface soil media-specific cleanup goal protective of groundwater. This determination of cleanup goals for subsurface soils is widely used and is based on the water/soil partitioning theory. This theory is conservative and assumes that contaminated soil and groundwater are in direct contact. The approach predicts the maximum amount of contamination that may remain in soil so that leachate from the contaminated soil will not violate groundwater cleanup standards.

A Base-wide *Site Management Plan* will provide on-site institutional controls to protect construction workers from exposure to residual contaminants in subsurface soils.

Surface Water

Corrective Action Objective 5:
Sampling of surface water features on and near Altus AFB reported elevated levels of COCs released from the contaminated aquifer. (Groundwater is connected to surface water in this area). However, because of the volatile nature of contaminants, the risk associated with exposure to contaminants in surface water is low. Therefore, the CAO for surface water is to monitor contaminant levels in surface water features associated with groundwater management units to assure protection of human and ecological

receptors. If sampling results indicate levels of contaminants are elevated, then the appropriate response will be made, as outlined in the *Contingency Plan* to be developed during Corrective Measures Implementation (CMI) phase of corrective action.

EPA'S FINAL SELECTED REMEDY

EPA's proposed remedy involves a combined approach of removal actions and implementation of a treatment technology. The preferred treatment technology is an in-situ bioremediation application known as enhanced reductive dechlorination (ERD). (See Table 1) To attain the CAO's outlined for Altus AFB, EPA is confident that a combination of activities using the ERD technology will address contaminants to levels that are protective of human health and the environment. Altus AFB will perform reviews of the effectiveness of the final remedy to meet CAO's every three years. During the course of performance reviews, as outlined in the *Performance Review Plan*, if there is a failure to meet the CAO's, then Altus AFB will implement the *Contingency Plan*, also being developed as part of the CMI phase of corrective action. The following is a summation of the selected final remedy;

Soil/groundwater excavation at source areas for **source removal**

Enhanced reductive dechlorination (ERD) for source zone treatment using **bioreactors**

Enhanced reductive dechlorination (ERD) for source containment using **bio-mulch walls** at the facility boundary and additional upgradient bio-mulch walls or enhancements of the bio-mulch walls, if necessary to meet the CAO's

Enhanced reductive dechlorination (ERD) using a **well injection circulation system** enhancing mass transfer from the nonaqueous phase to the aqueous phase (to address dissolved phase and residual DNAPL in the groundwater unit known as the "transmissive zone" that flows beneath the existing bio-mulch walls)

Optimization of selected ground water wells to monitor the GWMU's for compliance with the CAO's, as proposed in the *Performance Monitoring Plan* to be developed during Corrective Measures Implementation (CMI) phase of corrective action. Optimizing the locations, screened depth intervals and sampling parameters will be reviewed, approved and implemented to increase the efficiency of determining from monitoring data that CAO's are met.

Use of **institutional controls** to control offsite exposure to contaminated groundwater. Altus AFB must meet MCLs for contaminants in groundwater at the Air Force Base property boundary. Institutional controls on offsite properties must be in place in order to move the point of compliance to the new boundary of control. The effectiveness and placement of controls will be reviewed every three years as part of the *Performance Review Plan* during the corrective measures implementation phase of corrective action.

Source Removal
Removal of contaminated soils at source areas where concentrations of contaminants are elevated will advance the attainment of groundwater cleanup goals. Source removal through excavation of contaminated soil will also enable long-term cleanup goals to be reached in a shorter amount of time. Where applicable, Altus AFB should also remove contaminated groundwater as part of the de-watering process necessary for excavation.

Source Treatment and Containment using Enhanced Reductive Dechlorination (ERD) Technology
Pilot studies conducted at Altus AFB have shown the effectiveness of the use of bioreactors for the treatment of contaminant source zones. The introduction of carbon from the bioreactor enhances the reductive dechlorination process that breaks down contaminants to final daughter products that have less toxicity (Figure 1).

The use of bio-mulch walls along the boundaries have proven effective for treatment and containment of shallow groundwater contaminants (Figure 2). The bio-mulch walls are designed such that as groundwater passes through the wall, the contaminants are subjected to a treatment process before exiting the wall. The long-term effectiveness of bioreactors and bio-mulch walls has not been proven; therefore additional measures, such as additional bio-mulch walls installed upgradient and/or the addition of carbon substrates may be needed to ensure continued effectiveness. Also, there is a concern that the deeper groundwater "transmissive zone" is not affected by the bio-mulch wall treatment, since the walls were constructed to a depth of 35 feet, and the deeper transmissive zone extends to depths of greater than 45 feet in some areas. To address the deeper contamination, EPA's remedy includes the installation of a well injection circulation system or a well injection system to enhance treatment and containment of contaminants in the deeper transmissive zone.

Figure 1: A 2-Dimensional Schematic of the Bioreactor

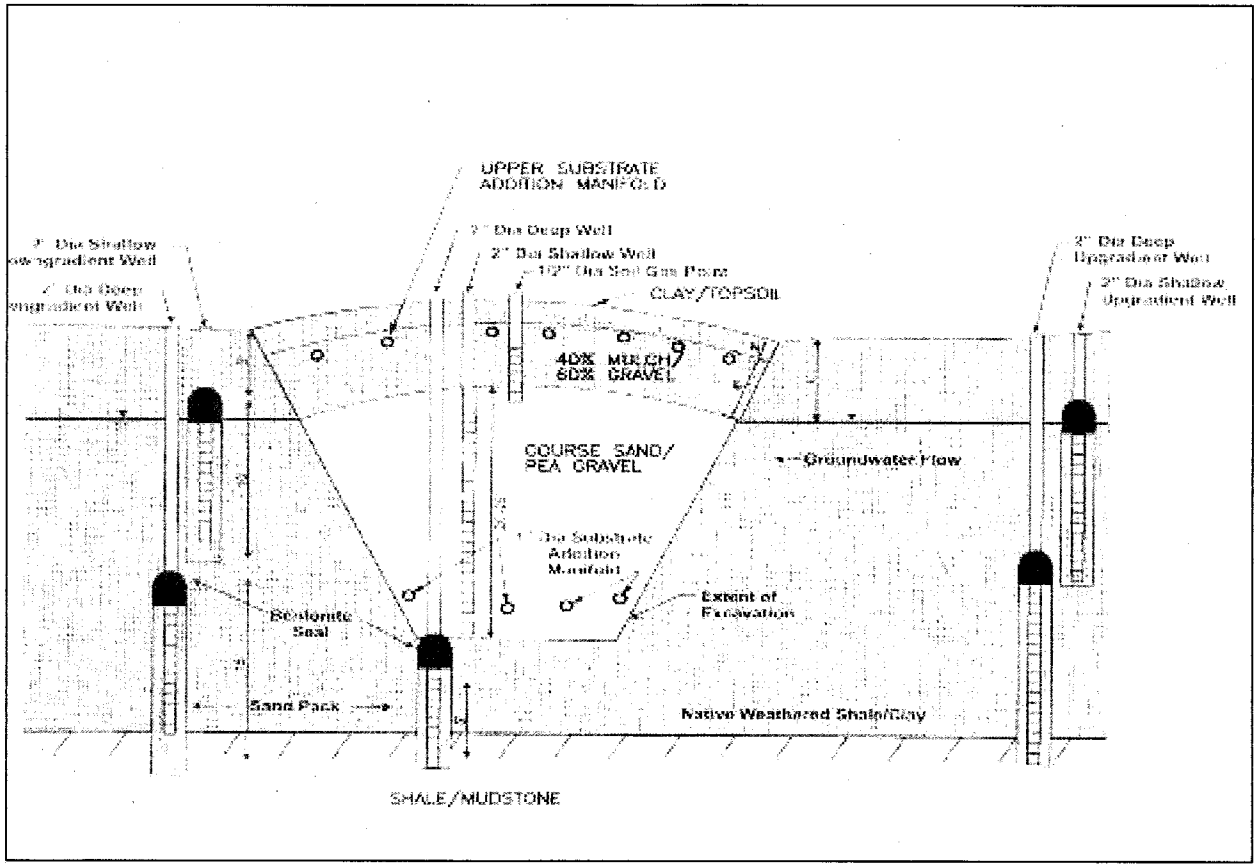

Figure 2: A 3-Dimensional Schematic of a Bio-Mulch Wall

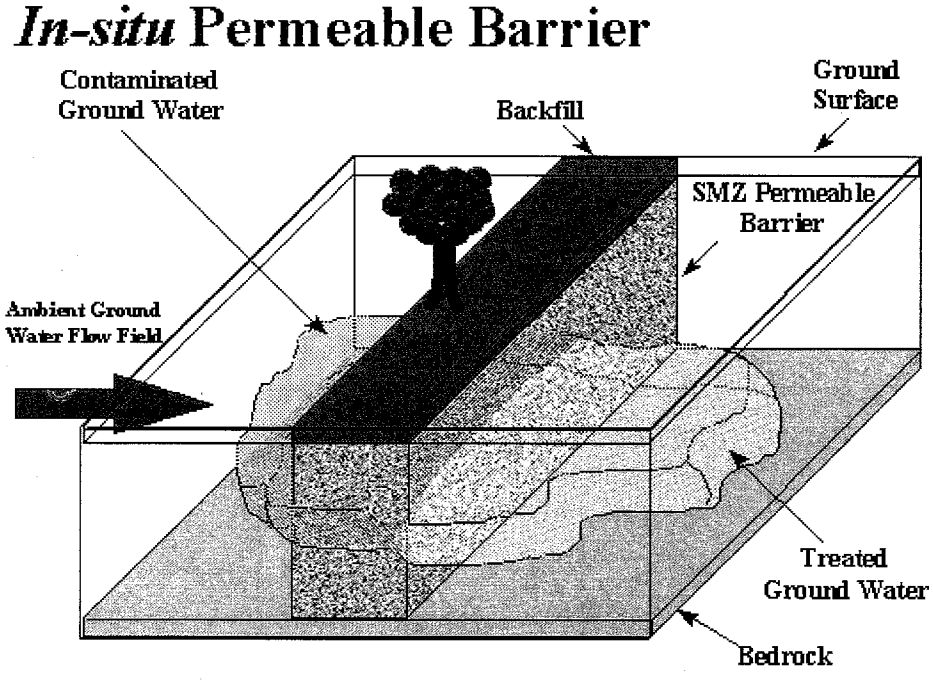

Table 1 Advantages of ERD Technology	
ERD is a "green" remediation	The insitu bioremediation of contaminants does not use nonrenewable energy sources.
Destruction of contaminants in-situ:	Chlorinated VOC's that are treated have the potential of being completely mineralized or destroyed. The benefits of in-situ treatment include; no secondary waste stream to treat, potential risks related to exposure during remediation are limited, and there is minimal impact to infrastructure.
Interphase mass transfer:	Data has shown that the enhancement of the anaerobic process may increase the rate of DNAPL source zone dissolution, thus speeding up the removal of sources that are contributing to groundwater contamination.
Potential application to a variety of COCs:	Other COCs affected are carbon tetrachloride and all daughter products of chlorinated ethenes.
Other degradation processes that take place simultaneously:	Other chemical reactions, both biological and abiological can be induced and/or enhanced to facilitate the destruction of chlorinated VOCs, which means there are many ways to enhance the system to produce results

PUBLIC PARTICIPATION ACTIVITIES

With assistance from Altus AFB, EPA hosted a public meeting on September 6, 2007 at the South West Technology Center in Altus, Oklahoma from 7 pm to 9:30 pm. Announcements for the public meeting appeared in the *Altus Times* on Sunday, August 5, and Sunday, August 12, 2007. The Administrative Record for the EPA Order was available for review during the public comment period at the Altus public library. Altus AFB is also required to have a *Community Relations Plan* to document how they will keep the public informed of the overall effectiveness of the remedy during the corrective measures implementation (CMI) phase of corrective action.

PUBLIC COMMENTS AND EPA RESPONSE

Dr. John Wilson, from the EPA National Risk Management Laboratory in Ada, Oklahoma made the comment that the mulch biowalls should not be referred to as "bark mulch biowalls" as used in the Statement of Basis document. The terminology is now changed to "bio-mulch walls".

EPA solicited comments from the U.S. Department of the Interior Bureau of Reclamation field office in Oklahoma City, Oklahoma and was notified that they had no official comments to submit.

EPA also solicited comments from Mr. Tom Buchanan of the Lugert-Altus Irrigation District in Altus, Oklahoma. [The Lugert-Altus Irrigation District uses a 270-mile system

of canals downstream of the Lake Altus dam to irrigate about 46,000 acres (Comparison of Irrigation Water Use Estimates Calculated from Remotely Sensed Irrigated Acres and State Reported Irrigated Acres in the Lake Altus Drainage Basin, Oklahoma and Texas, 2000 Growing Season)] Mr. Buchanan explained in a phone conversation with the EPA project manager that he had read the Statement of Basis document and that he was very interested if EPA could request that Altus Air Force Base line some of the irrigation canals on the Air Force property. He explained that this would conserve water for downgradient irrigation. The local region is interested in all water conservation efforts because the volume of water supply in Lake Altus is decreasing due to sediment loading in Lake Altus (see U.S. Department of the Interior Bureau of Reclamation Appraisal Report of the W. C. Austin Project, Oklahoma March 2005). This decrease in water volume, along with recent drought situations has affected irrigation efforts and farming. The EPA project manager explained to Mr. Buchanan that this could be included in the final remedy. Lining canals that are a water source to the groundwater plumes will also enhance our groundwater CAO of keeping the groundwater management plumes stable or shrinking in size, therefore EPA is including this project as part of the final remedy.

No other comments were formally received during the 45-day public comment period.

TECHNICAL ADDITIONS/CLARIFICATIONS TO THE EPA-PROPOSED REMEDY

1) To enhance the cleanup objective for surface soil (top 0 to 2 feet), EPA is including the following table of chemicals and their appropriate cleanup level:

Table 2 Surface Soil Cleanup levels		
Chemical of concern	Cleanup level (mg/kg) based on 1E-5 risk level	Cleanup level based on HI 1 or soil saturation (mg/kg)
Benzene	16	
Carbon tetrachloride	5.8	
Cis-1,2-dichloroethylene		160
1,2-Dichloroethane	8.4	
Trichloroethene (TCE)	53*	
Toluene		520
Vinyl Chloride	8.6	
Xylene		210

* TCE – using 0.013/mg/kg for oral slope factor and 0.007/mg/kg for inhalation slope factor, indoor worker.

2) To clarify the remediation application for addressing the deeper transmissive zone via a "well circulation system", as stated in the Statement of Basis, EPA would like to state that the application may be a well circulation system or a well injection system, whichever is proven most effective in the field to meet the CAO for groundwater.

3) To clarify how EPA has addressed indoor air issues at Altus AFB, the Final Corrective Measures Study (CMS) report (August 2007) reports in Section 2.3.2.3 that as part of the RFI, an evaluation of potential indoor air risks based on soil gas, subsurface soil gas, and indoor air sampling was conducted for three "worst case" facilities at the Base. This evaluation is provided in Appendix R of the Draft RFI/IA/CMS Report (November 2002). Collection of soil-gas samples included 20 locations along the southern Base boundary and 86 soil-gas samples in the off-site area. The Johnson-Ettinger model was applied following this sampling effort and Altus proposed that there was no indoor air risk. Because of recent debates on the use of the Johnson-Ettinger model, and the fact that the unsaturated zone for this facility is limited in depth, the EPA proposed to address indoor air issues by including the remediation of administration buildings at risk onsite (above the plume) with positive-pressure engineering controls as part of the final remedy. Also, to address indoor air issues for the offsite property, EPA first visited the affected offsite landowner and noted that living structures currently on the property had crawl space (thus providing venting of air before entering the living space). At the current time, the off-site groundwater plume is not directly below these structures. Secondly, EPA instructed Altus AFB to have institutional controls in place for the off-site property for the protection of future use of the property. The institutional controls are described in the *Land Use Control Plan* as part of the corrective measures implementation (CMI) phase of corrective action.

FUTURE ACTIONS

Following the final declaration of this Response to Comments/Final Decision document, EPA will review a Hazardous and Solid Waste Act (HSWA) permit jointly prepared by EPA and the ODEQ. The HSWA permit will specifically state all necessary conditions for the implementation of the remedy (known as the corrective measures implementation (CMI) phase of corrective action. Upon issuance of the ODEQ permit, which is equivalent in scope to the EPA Order, EPA will terminate the Final Administrative Order (Order), Docket No. RCRA-VI-002(h)-95-H, pursuant to Section 3008(h) of the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §6928(h). Implementation of the final remedy will then fall under the jurisdiction of the ODEQ Land Protection Division under the HSWA permit.

DECLARATION

Based on the administrative record compiled for this corrective action, I have determined that the selected remedy to be ordered at this site is appropriate and will be protective of human health and the environment.

John Blevins, Director
Compliance Assurance and Enforcement Division

12/19/07

Effective Date