# Vapor Intrusion Technical Memorandum

# Addendum to the 3rd Five-Year Review Report

# For Fort Riley, Kansas

# June 2013

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List of Acronyms and Abbreviations

| | |
|---|---|
| ASTM | American Society of Testing and Materials |
| bgs | Below Ground Surface |
| CERCLA | Comprehensive Environmental Response, Compensation, & Liability Act |
| CFR | Code of Federal Regulations |
| COPC | Chemical of Potential Concern |
| DCE | Dicholorethylene |
| EPA | Environmental Protection Agency |
| HEAST | Health Effects Assessment Summary Tables |
| HHBLRA | Human Health Baseline Risk Assessment |
| HI | Hazard Index |
| IRIS | Integrated Risk Information System |
| KDHE | Kansas Department of Health & Environment |
| PCE | Tetracholorethylene or Perchloroethylene |
| PID | Photo-Ionization Detector |
| QA | Quality Assurance |
| RAGS | Risk Assessment Guidance for Superfund |
| RI | Remedial Investigation |
| RME | Reasonable Maximum Exposure |
| RSK | KDHE Risk-Based Standard |
| TCE | Trichloroethylene |
| ug/kg | microgram per kilogram |
| ug/L | microgram per liter |
| $ug/m^3$ | microgram per cubic meter |
| VC | Vinyl Chloride |
| VOC | Volatile Organic Compound |

## 1.0 Introduction

This technical memorandum is being developed to address a concern that there may be a potential vapor intrusion issue that is affiliated with building 367 within the 354 Area Solvent Detections Operable Unit 005 (OU 005) (354) at Fort Riley, Kansas. The issue was raised during the installation's 3rd Five-Year Review effort being conducted pursuant to 40 Code of Federal Regulations (CFR) 300.430(f) (4) (ii).

## 2.0 Building History and Condition

Building 367 was constructed in 1903 as a gun shed to house horse-drawn artillery pieces in bays. It is a one-story building constructed of coursed, ashlar limestone on a limestone foundation with an on-grade, concrete slab floor. It is a contributing building to the National Register of Historic Places Main Post Historic District in the Cavalry and Artillery thematic group. Its later history was conversion to a motor pool and finally to general storage which is its present use. The building originally had large swing-out doors but those have been converted to the more modern, roll-up style, garage doors. There are numerous penetrations throughout the building's structure. Some examples are large-area chimney vents for old style, gas, space heaters that are extant but not in use, an attic, door openings without doors that interconnect to other bay areas, and loose fitting, bay doors and older windows that are not tight. These conditions permit extensive air exchange and movement within the structure. The building's current purpose as general storage has it containing motorized equipment and a wide variety of containerized products that have the potential to volatilize. Finally, the building is not occupied on a continuous or long-term basis. It is commonly occupied for a few minutes to a few hours on an irregular, limited basis by a limited number of personnel. Additionally, the building is completely surrounded by asphalt pavement that is nominally 8-inches thick. See images of this building in the Appendix to this document.

## 3.0 Site Condition and History

As noted previously, Building 367 is within the boundary of the 354 site. This operable unit has undergone extensive characterization as a result of the presence of contamination by hazardous substances listed per the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The principal contaminant is tetrachloroethylene (PCE). To properly address site characterization, a complete Remedial Investigation (RI) was completed November 3, 2003. A Human Health Baseline Risk Assessment (HHBLRA) was conducted as a component of the RI and is found in Chapter 7 of that document.

### 3.1 Human Health Baseline Risk Assessment

The HHBLRA addressed both the future indoor worker and the future utility worker scenarios. It specifically noted in Chapter 7 Section 7.1.2 of the RI that it followed the procedures outlined in EPA's *Risk Assessment Guidance for Superfund (RAGS) Volume 1: Human Health Evaluation Manual Part A* (USEPA, 1989) and other EPA guidance documents that were cited throughout the text. The building 367 area was one of three source areas that were addressed.

The following chemicals were selected as Chemicals of Potential Concern (COPCs) for subsoil:

PAHs

| | | |
|---|---|---|
| Acenaphthylene | Benzo(k)fluoranthene | Naphthalene |
| Benzo(a)anthracene | Chrysene | Phenanthrene |
| Benzo(a)pyrene | Dibenz(a,h)anthracene | Pyrene |
| Benzo(b)fluoranthene | Fluoranthene | Benzo(g,h,i)perylene |
| Indeno(1,2,3-cd)pyrene | | |

Volatiles

| | | |
|---|---|---|
| Acetone | PCE | m & p Xylenes |
| Carbon disulfide | trans-1,2-Dichloroethylene(DCE) | cis-1,2-Dichloroethylene |
| Trichloroethylene (TCE) | | |

The following chemicals were selected as COPCs for ground water:

Volatiles

| | | |
|---|---|---|
| 1,1,2-Trichloroethane(TCA) | cis-1,2-DCE | TCE |
| Carbon tetrachloride ($CCL_4$) | PCE | Vinyl chloride (VC) |
| Chloroform | trans-1,2-DCE | |

For the risk assessment work, the toxicity of the COPCs is evaluated for carcinogenic and non-carcinogenic potential to produce adverse health effects. The data regarding health effects are used to determine numerical toxicity values. The primary source for the toxicological information utilized for the RI was the EPA sponsored *Integrated Risk Information System* [IRIS] or the EPA's *Health Effects Assessment Summary Tables* [HEAST] .

The entire set of protocols for deriving non-carcinogenic and carcinogenic effects was laid out in Section 7.3.1 and Section 7.3.2 of the RI. Tables 7-11, 7-12, and 7-13 from the RI are presented in the Appendix for this document to provide the pertinent data regarding the values utilized. Appendix 7C from the RI contains the Vapor Modeling that was conducted for the modeling the migration of chemical vapors from soil, soil gas, and ground water and is found in the Appendix of this document. It was used to estimate vapor concentrations in indoor and outdoor air.

The next step in the RI was to develop exposure assessments and those are found in Section 7.4. The potentially exposed populations and potential exposure pathways are

identified. The site physical features, land use, and zoning are considered in order to ascertain pathways and population for which exposure may exist. The only exposure pathways considered are those that are completed. Current and future land use and current and future water use were two of the criteria evaluated based against potentially exposed populations. The building 367 area population exposures were current and future indoor worker employed within the building and future utility excavation worker. As the area is under pavement, as noted earlier, a groundskeeper was unlikely to be exposed so it was not evaluated. The worst-case scenario using the current site conditions were the basis for the determinations.

The current or future indoor worker was unlikely to have incidental ingestion of impacted soil based on the fact that the entire area is paved. Chemical vapors from the volatile organic compounds (VOCs) could potentially migrate into the building and into the worker's breathing zone which would lead to potential exposure by inhalation.

The future utility excavation worker could have direct contact with soils. The direct contact with the contaminated soils could lead to incidental ingestion from the disturbed soils or chemical adsorption through dermal contact. There is the potential of VOCs being present in the breathing zone of the worker that would lead to the inhalation of vapor phase of the chemicals. Table 7-14 from the RI presented the pathways considered in the human health risk assessment and is included in the Appendix.

Exposure variables are used to established values to yield a reasonable maximum exposure (RME). The RME is representative of a high-end exposure situation but still in the range of potential exposure levels. The Section 7.4.4 Estimation of Intake, Sections 7.4.4.1 Exposure Variables, and 7.4.4.2 Chemical Variables were presented in the RI.

The next step in the process is to do the risk characterization. That involves quantification of the potential risks by exposure to chemicals through the identified pathways. The intake of each chemical is combined mathematically with the appropriate toxicity value to estimate the likelihood of health risks. The risk characterization is provided in two segments. There are non-carcinogenic and carcinogenic aspects for each exposure pathway and scenario. These are covered in detail in Section 7.5 of the RI.

The risk estimates for the Future Indoor Worker Scenario for the building 367 area are as follows:

- The non-carcinogenic value for inhalation of chemical vapors in this pathway resulted in a total hazard index of 3E-04 which is significantly below the EPA risk value of a hazard index greater than one
- The carcinogenic value for excess cancer risk was 2E-07 which is below the 1E-04 to 1E-06 acceptable risk range.

The risk estimates for the Future Utility Excavation Worker Scenario are as follows:

- The non-carcinogenic value for incidental ingestion was a hazard index of 8E-05. The value for dermal contact was a hazard index of1E-07. The value for inhalation of fugitive dust was a hazard index of 5E-10. The value for inhalation for chemical vapors was a hazard index of 2E-05. The total hazard index was 1E-04. All of those values are significantly below the hazard index of one.
- The carcinogenic value for soil through incidental ingestion was 2E-08. The value for dermal contact was 2E-09. The value for inhalation of fugitive dust was 2E-13. The value for inhalation of vapor phase was 2E-08. The total excess lifetime cancer risk was 4E-08. This is well below the 1E-04 to 1E-06 established by the EPA.

The HHBLRA results indicate that the excess cancer risks for all populations were below the EPA's allowable levels. The hazard indices for all the populations were also below the EPA's level of concern. The RI Table 7-44 presents that data & is included in the Appendix.

## 3.2 Indoor Air Sampling

Two indoor air sampling events were conducted in February and April of 2003.

During the first event, samples were taken from seven buildings at Fort Riley. A total of 14 samples were taken of ambient air in evacuated one-liter summa canisters continuously over an eight-hour period. One duplicate and one QA sample were taken in the same location and at the same time as one of the samples. The samples were shipped to Precision Analytical in Phoenix, Arizona. They were analyzed by Method TO-15 for a Target Analyte List of vinyl chloride, 1,1-DCE, trans-1,2-DCE, cis-1,2-DCE, carbon tetrachloride, TCE, and PCE. The Quality Control Summary Report (QCSR) dated March 2003 stated that carbon tetrachloride was detected at concentrations ranging from 0.53 ug/$m^3$ to 0.63 ug/$m^3$ in all the samples. The samples for this investigation were taken from sites where carbon tetrachloride was found and from where it was not found. Consistent detections at the same concentration tend to indicate laboratory contamination. A photo-ionization detector (PID) was used as part of the safety plan to screen ambient air during sample collector setup and disassembly. This detector would register PCE, TCE, and cis-1,2-DCE at the concentrations detected in the air samples. The concentrations were as high as 150 ug/$m^3$. See Tables 7A through 7D in the Appendix. Based on the ubiquitous detection of carbon tetrachloride at constant concentrations in the Summa canisters and the failure of the PID to detect concentrations of compounds found in the laboratory analysis, all the data are questionable. As a result, the data are rejected based on the following: "Sample 022603-366-01 was a QA sample sent to a different laboratory for analysis. Table 6 illustrates that the QA laboratory produced significantly different results compared to the primary laboratory…Based on the QA results not being comparable to the primary

sample and its duplicate, it was determined that no useful data could be drawn from this investigation." Table 6 from this report is included in the Appendix of this document.

During the second event, samples were taken from seven buildings at Fort Riley. A total of 14 samples were taken of ambient air in evacuated one-liter summa canisters continuously over an eight-hour period. One duplicate and one QA sample were taken in the same location and at the same time as one of the samples. The QA sample was sent to a different laboratory for analysis. The QCSR dated June 2003 stated that the QA laboratory produced significantly different results compared to the primary laboratory. Based on the QA results not being comparable to the primary sample and its duplicate, it was determined that no useful data were obtained from the investigation. See Tables 6A through 6D in the Appendix.

## 3.3 2004 Pilot Study for Soil Remediation

A pilot study effort was conducted from March 2004 to March 2005 adjacent to building 367. Figure 1-3 (included in the Appendix) from the *Pilot Study Report Pilot Study for Soil Remediation 354 Area Solvent Detections (Operable Unit 005) at Main Post Fort Riley, Kansas* dated June 28, 2005 depicts the site and treatment area.

The objectives of the pilot study included:

- The evaluation of potassium permanganate oxidation and in-situ mixing as a viable technical option for treatment of shallow, chlorinated solvent contaminated areas
- The reduction of soil contamination within the treatment area to concentration below the KDHE Risk-Based Standards (RSKs). The target was 180 micrograms per kilogram (ug/kg) of PCE for the soil-to-ground-water pathway (residential scenario). The cleanup goal for TCE was 200 ug/kg and the goal for cis-1,2-DCE was 800 ug/kg.

The treatment area was located on the east side of building 367 within 5-feet of the building in Figure 1-3 from the Pilot Study Report and shown in the Appendix to this document. The surface area was approximately 40-feet x 70-feet and the subsurface area was from immediately below the pavement (ground surface) to about 10-feet below ground surface (bgs). PCE was the main constituent of the contamination on site. A large number of GeoProbe borings had established levels ranging from as high as 29,000 ug/kg to as low as 6.9 ug/kg for PCE. TCE values ranged from 756J ug/kg to 6.7 ug/kg. cis-1,2-DCE ranged from 8,120J ug/kg to 6.3 ug/kg.

Permanganate is commercially available as a salt of potassium or sodium. The primary difference is based on solubility. Potassium permanganate is less soluble than sodium permanganate. It was decided to utilize potassium permanganate. After evaluating site conditions, in-situ soil mixing was selected as the treatment option based on the relatively shallow depth of the contamination. It was decided to use the Lang Tool LTC-

290 blender. (See the color image of the tool in operation mixing the permanganate in the soil at the site in this Appendix.) It is capable of mixing dry soil as well as saturated and sludge material to a treatment depth of approximately 18-feet below grade. The deep digger blender attachment can develop 20,000 pounds-foot of torque. The results were an effective mixing of contaminated soil and potassium permanganate.

Post-treatment confirmation soil sampling was conducted to determine the effectiveness of the in-situ soil treatment. The samples were collected using direct-push equipment to advance boring through treated and untreated soils. The original plan was to sample nine specified locations, but as a result of the treated soils not dewatering sufficiently only eight locations were occupied. Seven soil samples were obtained at each direct-push location to a maximum depth of 44-feet. The samples taken at 20'-24', 30'-34', and 40'-44' were untreated soil. Sampling was done in 8 girds. Grids 5, 6, 12, and 16 had PCE detections above the KDHE RSK standard of 180 mg/kg in the 40'-44' interval. Grids 10, 12, and 16 had PCE detections above the KDHE RSK in the 30'-34' interval. The rest of the girds were below the standard. The TCE and cis-1,2-DCE results were all below their respective standards. Tables 3-2 and Figure 2-1 are included in the Appendix of this document for clarification.

Following an evaluation of the confirmation soil sampling results, it was determined that post-treatment PCE concentrations were elevated above the RSK of 180 ug/kg. Another factor was the treated soil remained highly saturated from the water used to inject the potassium permanganate. It was decided that additional treatment was required. Upon consideration of the circumstances, it was felt that additional treatment with more water would only exacerbate the situation, therefore, more treatment with permanganate was ruled out. The decision was made to establish a temporary land-farm area, excavate the saturated soil, transport it to the land farm, and disk the material to improve volatilization of the chlorinated solvents. The disking transpired at intervals of approximately every two weeks. Twelve confirmation samples were taken from the land farm 17 days after the 3rd disking event. Soil samples were submitted to an off-site, analytical laboratory. The PCE results were from 9.7J to non-detect, TCE was not detected, and cis-1,2-DCE results were from 12.9J ug/kg to non-detect. The soil was removed from the land farm and utilized as cover material at the Campbell Hill Construction/Demolition Landfill on the installation.

The open excavation that remained after the removal of the saturated soil adjacent to building 367 was backfilled with clean soil from an on-post borrow site. Two discrete samples were obtained from the borrow source for geotechnical analysis prior to beginning soil compaction activities. The backfill was placed in the excavated area in lifts of maximum loose thickness of 8-inches and compacted to 95 percent of ASTM D698 maximum dry density. After completing the backfilling operations, the surface area, with an additional 2-feet of pavement removal to improve the seal, was repaved.

## 3.4 Soil-Gas Investigation

A soil-gas investigation was conducted in 2004 around eight buildings in the Main Post Historic District. The objective of this soil-gas investigation was to determine if elevated levels of soil gas were present in the subsurface soils immediately adjacent to those buildings. The analytes of interest were those chlorinated solvents that had been detected in the ground-water plume. Those chemicals are PCE, TCE, cis-1,2-DCE, and carbon tetrachloride. The data are to assist in determining if the indoor air quality could be degraded and, therefore, be a risk to building occupants.

The original intent was to collect samples at three locations around each structure. These were to be located 'side gradient' and 'up gradient' with respect to the general direction of flow of ground water in the terrace aquifer which is approximately north to south. The direct-push borings would be northwest, northeast, and southwest of each structure within three to six-feet of exterior walls. There were some adjustments imposed by sites conditions such as utilities, decorative vegetation, or other factors.

At each direct-push boring location, the planned effort was to collect seven soil-gas samples at depths of 5, 10, 15, 20, 30, 40, and 50-feet below ground surface (bgs). There was one refusal at the depth of 50-feet at building 367. The direct-push equipment was composed of probe rods with a threaded point holder and disposable point that were pushed hydraulically to the desired sampling depths. Polyethylene tubing was then lowered down the probe rods and threaded into the point holder. The rods were then retracted to create a void in the soil and the drive point disengaged. A vacuum was applied to purge the tubing and draw a soil-gas sample. The soil gas was then withdrawn using a disposable syringe and immediately injected into a Shimadzu GC-14A gas chromatograph for analysis. The soil-gas samples were analyzed only for the previously enumerated chlorinated solvents.

A total 23 samples were taken or attempted at the building 367 location. One was a duplicate sample, one was a re-analysis, and there was one refusal at 50-feet. cis-1,2-DCE was detected in three samples with a range of 1.5J to 2.6 ug/L. TCE was not detected in reportable quantities. PCE was detected in 12 samples ranging from 1.9J to 236 ug/L. The two elevated values were 236 ug/L at 10-feet and 145 ug/L at 15-feet. These higher hits were located on the southwest, down-gradient side of building 367 next to the triangle A . See Figure 1-1 and Table 2-1 (continued) from the report in this Appendix.

The study concluded that there could be, not that it did, pose an issue with indoor air quality based on those two hits out of 23 samples. The action taken was to instruct occupants to open garage doors on the west side of the building and ventilate the workspace during use.

## 4.0 Risk Discussion

Fort Riley has completed the third five-year review of the remedial action implemented by the Record of Decision and the Remedial Action Plan. While vapor intrusion releases and exposure were not anticipated or addressed in the initial selection of the remedial action, Fort Riley has been requested to address such issues as a result of the five-year review.

The remedy was selected before the US Environmental Protection Agency (EPA) released new risk assessment guidance which now addresses some of the related issues, such as its Supplemental Guidance for Inhalation Risk Assessment (Part F of Risk Assessment Guidance for Superfund: http://www.epa.gov/oswer/riskassessment/ragsf/index.htm), its Regional Screening Levels for Chemical Contaminants at Superfund Sites (RSLs: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm), and 2012 Vapor Intrusion (VI) Frequently Asked Questions (FAQs: http://www.epa.gov/superfund/sites/npl/Vapor_Intrusion_FAQs_Feb2012.pdf).

In this exercise, the RSL calculator is used with some building specific exposure assumptions and the inhalation reference concentration (RfC) for non-cancer toxicity and the inhalation unit risk (IUR) for cancer from EPA's Integrated Risk Information System (IRIS) to calculate building specific air screening levels. The RSL calculator's default cancer risk of 1E-01 (1/1,000,000) and a hazard quotient of 1 have not been changed for this calculation.

The building specific exposure assumptions provided by Fort Riley personnel and used in these calculations are:

- Exposure frequency: 30 days/year,
- Exposure duration: 1 year, and
- Exposure time: 1 hour/day.

Using these assumptions and inputs, a non-cancer screening level of 1.17 E+04 $\mu g/m^3$ and a cancer risk screening level of 7.86 E+04 $\mu g/m^3$ are calculated as shown in the attached output using these inputs with the RSL calculator. The lower of these two values 1.17 E+04 (11,700) $\mu g/m^3$ based upon non-cancer toxicity is then used.

Fort Riley personnel have collected soil-gas samples from sub-surface soil 10' beneath the building used for storage and only occasionally visited by its personnel. The most significant (highest risk) level of contamination found in the soil gas was a maximum concentration of 236 µg/l tetrachloroethylene (PCE). EPA air-screening levels and air-toxicity values are presented in $\mu g/m^3$. 236 µg/l is 236,000 µg/m3. Using the default attenuation factor of 0.1 provided in the 2012 FAQ for soil gas to indoor air

would be expected to attenuate (e.g. reduce) the measured concentration of 236,000 µg/$m^3$ to 23,600 (2.36E+04) µg/$m^3$ .

The attenuated measured concentration of 23,600 µg/$m^3$ is thus approximately twice as large as the calculated building specific screening level of 11,700 µg/$m^3$ which is based upon non-cancer toxicity, and represents a hazard quotient (a measure of non-cancer toxicity) of about 2 [*since the non-cancer screening level was lower than the cancer screening level, the non-cancer screening level was used. The attenuated measured concentration of 23,000 µg/$m^3$ represents an excess lifetime cancer risk of about 3.0E-07 well below the CERCLA protective cancer risk range of E-04 to E-06*.]. The default hazard quotient used by EPA is 1, above which non-cancer effects can sometimes occur. However, the default attenuation (soil gas to indoor air) factor of 0.1 is considered highly conservative for the environmental setting of this building in view of the silt soils surrounding the building and because no PCE was detected closer to the building's slab than at a depth of the 5'. It should also be noted that this building is not "tightly sealed" and is highly ventilated, which would tend to quickly exhaust any contamination entering the building. In view of these factors, an exceedance by the attenuated measured air concentration by a factor of about two above the building specific screening level is not believed to represent a potentially significant risk to persons occasionally visiting or entering this building.

The following bullets address the pertinent facts with regard to the site, its condition, and the issues:

- The RI and its HHBLRA that investigated the impact to an indoor worker stated that the non-carcinogenic risk was 3E-04 with the HI of 1 or greater posing a risk and the carcinogenic risk was 2E-07 with a range of 1E-04 to 1E-06 being the regulatory level for risk concern. See Table 7-44 in this Appendix
- The RI and its HHBLRA that investigated the impact to a utility worker in a trench with direct exposure to the site contaminants stated the non-carcinogenic risk was 1E-04 with the HI of 1 or greater posing a risk and the carcinogenic risk was 4E-08 with a range of 1E-04 to 1E-06 being the regulatory level for risk concern. See Table 7-44 in this Appendix
- The potential source for continuous input to soil gas was removed by the pilot study remedial action in 2004.
- The ground-water concentrations of PCE have steadily decreased in the two monitoring wells nearest the building 367 site since the treatment and removal of the contaminated soil adjacent to the building. See the Technical Memorandum Concentrations Table in this Appendix.
- The soil-gas study had only two hits of concern below 8-inches of asphalt in fine-grained soils 10-feet and 15-feet bgs out a sample populations of 23. This a statistically small percentage upon which to base a concern.
- The screening levels applied to the site are generic, are utilized without site-specific data, are based on exposure over a lifetime, and are ultraconservative.

- The inhalation exposure carcinogenic RfC value for PCE has been altered to a less toxic value. The value was 5.90E-06 per ug/$m^3$ and is now 2.6E-07 per ug/$m^3$.
- The building is in a designated industrial use area and a residential or office setting is not viable as a reasonably anticipated land use scenario for this type of building. The alteration of this historic structure would require securing agreement with the State Historic Preservation Office and such extensive modification would potentially be viewed as an adverse impact and not permitted.
- The KDHE has an indoor air value for a residential setting. The calculations are predicated on an exposure frequency of 350 days per year and an exposure duration of 30 years to arrive at an adult cancer risk. The averaging time is 70-years. The inhalation unit risk factor is chemical specific. The exposure frequency and duration are outside what would be a reasonable maximum exposure scenario for the building.

## 5.0 Summary and Recommendations

The concern was raised that the site and its circumstances might necessitate a vapor intrusion study based on two values obtained in a 2004 soil-gas study. The data presented in the preceding discussion section are indicative of a lack of a reasonable potential for a vapor intrusion issue to exist for the building.

The potential source was removed in a remedial action and the area backfilled with clean soil and re-paved, the ground-water concentrations in nearby monitoring wells are continuing to decrease, and the building's lack of a long-term or continuous human presence supports the contention that no evidence supports the existence of a pathway that would dictate the need to conduct any further studies.

The decrease in the level of toxicity of PCE, the building's many penetrations that do not permit accumulation of vapors, and the lack of potential that the building will be used to house office spaces or other enclosed sensitive functions are further substantiation that there is no supportable reason to be concerned about vapor intrusion or build up.

Based on the data that are presented in the technical memorandum, the physical criteria at the site with regard to the building, its structure and conditions, the 8-inch thick pavement, soil characteristics, and the removal of the contaminated soils, a vapor intrusion pathway cannot be demonstrated to be a viable consideration. The installation does not find it an acceptable approach to expend funds for a study that will fail to demonstrate any potential for vapor accumulation or intrusion from the site contaminants.

Based upon the available information discussed in this memorandum, vapor intrusion exposures in this building do not present a potentially significant threat to human health.

The building has signs posted to advise that there is a potential for vapor intrusion and provides the directions by which the potential exposure can be avoided. The Real Property Master Plan will be updated to include a statement that there is a limited potential for vapor intrusion and should be re-assessed if the building use, conditions, and/or tenants are changed.
Therefore, the protectiveness as defined in the Record of Decision for the 354 Area Solvent Detections (Operable Unit 005) is still effective and should not be considered deferred based on the potential for vapor intrusion.

## 6.0 References


Burns & McDonnell 2003 *Draft Final Remedial Investigation Report 354 Area Solvent Detections (Operable Unit 005) at Main Post Fort Riley, Kansas* Volumes 1 & 2

Burns & McDonnell 2005 *Soil-Gas Investigation 354 Area Solvent Detections (Operable Unit 005) at Main Post Fort Riley, Kansas*

EPA 1989 *Risk Assessment Guidance for Superfund Volume 1 Human Health Manual Part A (RAGS*) EPA/540/1-89/002

EPA 1997 *Health Effects Assessment Summary Tables Annual FY-1997 Office of Emergency and Remedial Response* OERR9200.6-303(91-1)

EPA *Integrated Risk Information System* PCE Evaluation dated February 10, 2012

Malcolm-Pirnie/Burns & McDonnell 2005 *Pilot Study Report Pilot Study for Soil Remediation 354 Area Solvent Detections (Operable Unit 005) at Main Post Fort Riley, Kansas*

U.S. Army Corps of Engineers 2003a *Quality Control Summary Report Indoor Air Sampling Area 354 Fort Riley, Kansas*

U.S. Army Corps of Engineers 2003b *Quality Control Summary Report Indoor Air Sampling 354 Area Solvent Detections Fort Riley, Kansas*

## 7.0 Appendix