

DECISION DOCUMENT

**FORMER FORT CROWDER
CHEMICAL WARFARE MATERIEL SITE
NEWTON COUNTY, MISSOURI**

FUDS PROJECT NO. B07MO013801



Prepared by

US Army Corps of Engineers – Kansas City District
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List of Abbreviations and Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
ASR	archives search report
BLRA	Base Line Risk Assessment
CAIS	chemical agent identification sets
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CG	phosgene
CN	chloroacetophenone
CSS	chemical safety submittal
CWM	chemical warfare materiel
DD	Decision Document
DM	Adamsite
DoD	Department of Defense
DERP	Defense Environmental Restoration Act
FS	Feasibility Study
FUDS	Formerly-Used Defense Site
GIS	geographical information system
H	mustard
HD	distilled mustard
HN-1	nitrogen mustard
HN-3	nitrogen mustard
HS	mustard
INPR	Inventory Project Report
L	Lewisite
LTM	long-term management
LUC	land use control
M-1	Lewisite
MDNR	Missouri Dept. of Natural Resources
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
PA	Preliminary Assessment
PCO	project closeout
PIP	Public Involvement Plan
PS	chloropicrin
RAO	Remedial Action Objective
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act of 1986
SI	Site Inspection
TBC	To Be Considered
TEC	U.S. Army Engineer Research and Development Center, Topographic Engineering Center
TEU	U.S. Army Technical Escort Unit
USACE	United States Army Corps of Engineers
USACE-KCD	United States Army Corps of Engineers - Kansas City District
USAESCH	U.S. Army Engineering and Support Center, Huntsville

USEPA
UU/UE
UXO

United States Environmental Protection Agency
Unlimited use/unrestricted exposure
unexploded ordnance

1 Declaration

1.1 Site Name and Location

Former Fort Crowder Chemical Warfare Materiel (CWM) Site
Newton County, Missouri

Formerly-used Defense Sites (FUDS) Project No. B07MO013801

1.2 Statement of Basis and Purpose

This Decision Document (DD) presents the Selected Remedy for the former Fort Crowder CWM Site, located near the City of Neosho in Newton County, Missouri. In consultation with the Missouri Department of Natural Resources (MDNR), the United States Army Corps of Engineers (USACE) chose this remedy as the best alternative to address CWM, in the form of chemical agent identification sets (CAIS), at the site. The Selected Remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This Decision Document is based on the Administrative Record file for the former Fort Crowder CWM Site maintained at the Neosho/Newton County Library, and available for public review.

1.3 Assessment of the Site

The Selected Remedy for the former Fort Crowder CWM Site presented in this Decision Document is necessary to protect the public health or welfare or the environment from potential or threatened releases of hazardous substances into the environment.

1.4 Description of the Selected Remedy

The Selected Remedy for the former Fort Crowder CWM Site will address the greatest risk to human health and the environment associated with CWM in the form of CAIS, which is the risk of acute exposure to CAIS chemical agents from breakage of intact, loose ampoules and bottles remaining at the site. The Selected Remedy has a minor addition associated with the annual frequency of certain long-term management actions from what was presented in the Proposed Plan. The minor addition involves an allowance for a change in frequency of certain long-term management actions after five years.

Specific elements of the Selected Remedy include the following:

- An online educational awareness program available at URL: <https://www.denix.osd.mil/uxosafety>. This public-access website has information on CAIS, the history of chemical warfare, and the response process.
- Long-term Management (LTM), consisting of interviews with stakeholders, such as the property owners of the former Chemical Exercise Area (now referred to as an Educational Awareness Area), nearby land owners and emergency officials; land use site inspections; updates on property ownership; and newsletters to land owners surrounding the site. Communication with stakeholders is an important means to remain actively informed of any new or different information regarding the site, including changes in current or future land use. As part of the interviews, updated educational awareness materials will be provided to stakeholders, as necessary. Inspection reports generated will be incorporated into the project record and placed in the information repository. Details and implementation of these long-term management activities will be the responsibility of the U.S. Army Corps of Engineers, Kansas City District (USACE-KCD) and will be provided in the Long-term Management Plan. The LTM Plan, which will be submitted to MDNR for review and completed within twelve (12) months of this Decision Document's approval, will present these activities as annual in frequency with an evaluation for potential change in frequency after five years of LTM. The frequency of these activities may be adjusted to not less frequent than once every five years provided that the selected frequency allows for the remedy to remain protective and achieve the Remedial Action Objectives. Changes in frequency will be proposed to and made in consultation with MDNR. Public availability sessions will also be considered as a supplement to the LTM activities listed above.

The remedy selected in this decision document is the final remedy for the former Fort Crowder CWM Site and the final planned remedy for CWM at the site.

1.5 Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, and is cost-effective.

The remedy does not satisfy the statutory preference for treatment as a principal element of the remedy for the following reasons:

- treatment is impracticable due to technical infeasibility, inadequate short-term protection of human health and the environment, and extraordinarily high costs;
- no source materials constituting principal threats will be addressed within the scope of this action.

While no contamination in the form of CAIS is known to be present, the available technology to investigate the site does not provide for a definitive determination that the site is available for unlimited use and unrestricted exposure (UU/UE). Because this remedy will result in the potential for CAIS to remain on-site, a statutory review will be conducted no less frequently than every five years after initiation of the selected remedial action as long as hazardous

substances, pollutants, or contaminants remain at the site above levels that allow for UU/UE. A Five-Year Review Report will be provided to MDNR for review.

1.6 Data Certification Checklist

The following information is included in the Decision Summary section of this Decision Document. Additional information can be found in the Administrative Record file for this site.

- Contaminants of concern (Section 2.5).
- Baseline risk represented by the contaminants of concern (Section 2.7).
- How source materials constituting principal threats are addressed (Section 2.8 & 2.12).
- Current and reasonably anticipated future land use assumptions (Section 2.6).
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.12).
- Key factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (Section 2.9, 2.10, 2.11, 2.12).

1.7 Authorizing Signature

The signature of the District Engineer, U.S. Army Corps of Engineers, Kansas City District (USACE-KCD), acknowledges approval of the selected Remedy for Chemical Warfare Materiel at the Former Fort Crowder Site in Newton County, Missouri.



ANDREW D. SEXTON
COL, EN
Commanding

12 MAR 15

Date

2 Decision Summary

2.1 Site Name, Location, and Brief Description

Site name:	Former Fort Crowder Chemical Warfare Materiel Site
Location:	Newton County, Missouri
Identification number:	FUDS project no. B07MO013801
Lead agency:	U.S. Army Corps of Engineers, Kansas City District
Federal support agency:	U.S. Environmental Protection Agency Region 7
State support agency:	Missouri Department of Natural Resources
Source of cleanup monies:	Defense Environmental Restoration Account (DERA), U.S. Department of Defense (DoD)
Site type	Former fort with CAIS as the sole type of CWM
Site description:	The former Fort Crowder is located in Newton County, Missouri, approximately three miles southeast of the City of Neosho (Fig. 2-1). The Chemical Exercise Area was used for chemical warfare training between 1942 and 1946. Chemical warfare training included field exercises where soldiers were exposed to chemical agents in settings that simulated actual battlefield conditions. The area included the No. 110 Gas Chambers Area (Fig. 2-2). The former Pistol Ranges Area, a separate munitions response site, is east of Mink Road (formerly June Road). Both areas are currently under private ownership and are identified on Figure 2-2 as an Educational Awareness Area. The No. 110 Gas Chambers Area is currently residential property and horse pasture. The former Pistol Ranges Area is currently the site of a privately-owned chicken farm.

2.2 Site History and Enforcement Activities

2.2.1 Site History

2.2.1.1 Military Operations, 1941-1967

Fort Crowder, originally called Camp Crowder, was constructed during 1941 to 1942 on approximately 42,800 acres of land in Newton and McDonald Counties, Missouri. From 1942 until deactivated in 1946, it operated as a Signal Corps Replacement Training Center. The fort was reactivated in 1951 as an Army Reception Center for the Korean conflict. From 1953 to 1958, the fort was used as a U.S. Branch Disciplinary Barracks. From 1958 to 1967, an area in the northern part of the fort was used as U.S. Air Force Plant 65. Starting in 1962, the bulk of the land comprising the former Fort Crowder was declared excess property and sold.

2.2.1.2 Chemical Warfare Training

During World War II, chemical warfare training at the former Fort Crowder was conducted at the Chemical Exercise Area, which included the No. 110 Gas Chambers Area and the area

around the Former Pistol Ranges (TCT-St. Louis, 1992) (Fig. 2-2). Two of the three gas chambers built at Fort Crowder for gas mask proficiency training were located at the No. 110 Gas Chambers area. Chemical warfare training also included field exercises where soldiers were exposed to chemical agents in settings that simulated actual battlefield conditions (TCT-St Louis, 1992).

Chemical agent identification sets (CAIS) were expendable training aids used by all branches of the military to train soldiers in the safe identification, handling, and decontamination of chemical agents and industrial chemicals used in chemical warfare. CAIS consist of small glass containers filled with various chemical agents, which were packed in metal shipping containers or wooden boxes. More than 100,000 CAIS were produced from 1928 to 1969.

At Fort Crowder, chemical training materials, munitions, and explosive simulators were stored in quonset huts and igloos located in the vicinity of the Chemical Exercise Area. After World War II, these buildings were declared surplus and sold. Historical records do not include any information on the final disposal of the CAIS.

2.2.2 Previous Investigations and Remedies

2.2.2.1 1981 incident at the former Magazine Area (National Guard Property-Non-FUDS)

In July 1981, three National Guard soldiers were excavating near the location of a former storage igloo in the former Magazine Area of the National Guard facility (Fig 2-1), when they were overcome by vapors apparently coming from the ground (Parsons, 2003). They experienced difficulty breathing, burning eyes, and nausea, and were treated and released from a local hospital with no apparent long-term effects. A follow-up investigation did not reveal the source of the vapors.

The soldiers doing the excavation work in 1981 may have encountered some of the former igloo contents. Their injuries were consistent with exposure to phosgene gas. Descriptions from witnesses and the patient report for one of the injured soldiers suggest that components of a CAIS were disturbed.

2.2.2.2 1986 incident at the former Pistol Ranges-(FUDS)

In June 1986, a bulldozer operator preparing a site on the former Pistol Ranges (privately-owned chicken farm) for new building construction uncovered several vials of unidentified liquid and metallic material of military nature (Fig. 2-2). A white gaseous cloud filled the air behind the bulldozer after it ran over some of the vials. The operator's eyes became watery and he had difficulty breathing. After resting a while, he returned to work. The next day, he reported the incident.

The U.S. Army Technical Escort Unit (TEU) responded and removed military-related debris, including mine fuzes and mine fuze components, surface trip flares, grenade fuzes, an aircraft signal, and 30 glass vials containing chemical agent or chemical agent simulants. Nine vials were confirmed as components of K951 CAIS, and three vials contained mustard (H). The TEU carefully cleared the site of munitions and vials by sifting the loose soil moved by the bulldozer. The area was then decontaminated with calcium hypochlorite.

2.2.2.3 1992 Archives Search Report

In 1992, an Archives Search Report (ASR) for conventional munitions was compiled by TCT-St. Louis on behalf of the USACE. The ASR was prepared by reviewing all available records, photographs, and reports that documented the history of the site, and conducting site visits and interviews.

The 1992 ASR identified the area around the Former Pistol Ranges and the No. 110 Gas Chambers Area as the Chemical Exercise Area. The two areas are adjacent and separated by Mink Drive (formerly June Road). An interviewee identified an area about 350 feet east of the gas chambers as the location where training with chemical agents occurred. The training consisted of exposing soldiers to chemical agents in a setting that simulated actual battlefield conditions. The interviewee stated that the agents used at this site included mustard (H, HS), Lewisite (M-1 or L), chloropicrin (PS), and phosgene (CG).

2.2.2.4 1993 USACE ASR Addendum

In 1993, the USACE – St. Louis District issued an addendum to the TCT-St. Louis ASR in order to specifically search for evidence of CWM. This ASR addendum is a primary source for information about Fort Crowder and incidents that occurred in the years since it was closed (USACE, 1993).

In this ASR addendum, another interviewee stated that munitions, explosive simulators, and chemical training materials were stored in twenty-two 30-foot by 30-foot quonset huts or igloos located in the southeast corner of June Corner, in the general area where the former Pistol Ranges were located (USACE, 1993).

2.2.2.5 2005 Site-specific CWM Scoping and Security Study

In 2005, the U.S. Army Engineering and Support Center, Huntsville (USAESCH) completed a site-specific CWM Scoping and Security study for the former Fort Crowder, which consisted of a two-part phased evaluation and characterization consistent with FUDS Program Policy (Engineer Regulation 200-3-1) and the Preliminary Assessment (PA) and Site Inspection (SI) phases of the CERCLA process.

2.2.2.5.1 Preliminary Assessment Phase

The PA included historical records review, limited aerial photographic analysis, and site data collection.

2.2.2.5.1.1 2003 Aerial Photographic Analysis

In February 2003, the U.S. Army Engineer Research and Development Center, Topographic Engineering Center (TEC) collected and analyzed aerial photographs from July 1938, September 1953, and March of 1996 and 1997 to identify features that could represent disposal areas for CWM, such as ground scars, areas of disturbed ground, berms, and ditches. This information was used to aid in the selection of areas for geophysical survey during the site investigation.

2.2.2.5.2 Site Inspection Phase

The SI included site visits and interviews, geophysical surveys, intrusive investigation, sampling and analysis for munitions constituents, and additional aerial photographic analysis.

2.2.2.5.2.1 2003 Site Visit

On February 20, 2003, USAESCH conducted a site visit to the former Fort Crowder to evaluate current site conditions and to confirm the findings of the ASR. The findings and conclusions of the site visit were as follows:

- The property owner of the former Pistol Ranges identified the location where the vials were found in 1986 by placing a mark on one of the TEC aerial photographs near an E-shaped berm. The identified location was east of both the No. 110 Gas Chambers Area and Mink Drive.
- This area is high ground that is covered with grass and includes a chicken facility. Portions of old berms and several building foundations from the former military installation remain at the site.
- A survey with a magnetic locator indicated a significant magnetic anomaly on top of the berm and small magnetic anomalies in the area of the 1986 incident. Bullet casings and an expended fuze from a practice grenade were found on one of the foundations.
- Further investigations, including geophysical methods, were recommended for the areas of the 1986 exposure incident, the chicken facility, and the remaining berms.

2.2.2.5.2.2 2003 Intrusive Investigation

During August to November, 2003, USAESCH conducted an SI to characterize the No. 110 Gas Chambers Area and the former Pistol Ranges for the potential presence of CWM. The field investigation included a geophysical survey of approximately 30 acres to detect ferrous metal objects, intrusive investigation of selected geophysical anomalies, and analysis of soil samples from excavations for chemical agents or agent breakdown products.

No CWM or chemical agent-contaminated media were found during the intrusive investigation. The only military-related items were a live practice mine fuze and ordnance-related scrap from two rifle grenades. The live practice mine fuze was found in the former Pistol Ranges, approximately 40 feet southeast of the 1986 incident location. The fuze was relocated next to the berm and blown-in-place by a U.S. Army Explosives Ordnance Disposal unit from Fort Leonard Wood. The remainder of the items recovered were common scrap metal items consistent with building materials and farm activities, including barbed wire, banding material, nails, rebar, tool parts, wire, nuts, bolts, and pieces of reinforced concrete.

Although no CWM was discovered during the 2003 SI, buried CAIS may remain at the site.

2.2.2.5.2.3 2004 Aerial Photographic Analysis

In May 2004, TEC completed the Special Assessment GIS-Based Historical Photographic Analysis report for the former Fort Crowder. This report included additional photographic sources from December 1942, August 1945, and November 1950, as well as the photographic sources used in the 2003 report. The 1942 aerial photographs clearly show the No. 110 Gas Chambers, and the Pistol Ranges to the east. However, ground scars to the east of the Pistol Ranges identified in the 1953 aerial photograph are not as evident in the 1942 aerial photograph.

2.2.2.6 2007 Programmatic RI/FS Report for Possible CAIS Sites

In 2007, USAESCH completed a *Programmatic RI/FS* for sites where CAIS is the CWM of concern and no further information is available concerning any known or suspected burial locations. Although historical records indicate that CAIS were used and stored at the former Fort Crowder, the records do not include any information on the final disposition of the CAIS. Thus, buried CAIS may remain on site. Further investigation is considered technically unfeasible because: 1) no other burial locations were identified during records review or visual site inspection; 2) glass vials from CAIS cannot be detected in soil with currently available technology; and 3) soil sampling and analysis for chemical agents and associated breakdown products is impractical due to the lack of identifiable locations and the small quantities likely involved. The *Programmatic RI/FS* evaluates the former Fort Crowder collectively with other CAIS sites where field investigation is unfeasible, and discusses potential remedial alternatives.

2.3 Community Participation

USACE-KCD has developed a relationship with the communities around the former Fort Crowder through various public involvement activities.

In October, 2003, USACE-KCD issued a media release to notify the public about environmental investigations to be conducted at the former Fort Crowder as part of the *CWM Scoping and Security Study*. A site-specific Fact Sheet about Fort Crowder was also issued.

Prior to the intrusive investigations, a meeting with stakeholders was held on October 21, 2003 to coordinate with local officials and emergency responders in the event that an exposure or other incident occurred.

During 2005-2006, a Public Involvement Plan (PIP) was prepared. As part of the PIP process, a community survey was conducted in September 2005 to identify public concerns and issues. On April 6, 2006, an Educational Awareness and Training session was conducted to address public concerns and provide information about the site and potential hazards associated with CWM that may be present.

On June 3, 2008, a Fact Sheet about the *CWM Scoping and Security Study* and long-term management was issued.

The Proposed Plan was made available for public review on June 6, 2012. A copy of the Administrative Record file, which contains the Proposed Plan and supporting documentation is located at the Neosho/Newton County Library in Neosho, Missouri.

The notice of availability of the Proposed Plan and date for the public meeting was published June 6, 2012 in the *Neosho Daily News*. The public comment period was June 6, 2012 to July 6, 2012. The public meeting was held on June 13, 2012 at the Neosho Fish Hatchery Visitors Center, and the Selected Remedy was presented. Site information was available at the public meeting for public review and representatives from the Army, U. S. Army Corps of Engineers, and MDNR were present to answer questions from the public. A transcript of the meeting is available to the public in the Administrative Record located at the Neosho/Newton County Library in Neosho, Missouri.

2.4 Scope and Role of Operable Unit or Remedy

The selected Remedy presented in this DD will be the final remedy for remediation of CWM at the private properties located on the former Fort Crowder. This remedy builds upon the previous restoration activities at the private properties, which include a site educational awareness and training session conducted in 2006 as part of the PIP, and an online educational awareness and training program available at URL: <https://www.denix.osd.mil/uxosafety>, which has information on CAIS, the history of chemical warfare, and the response process. The goal of the former Fort Crowder remedy associated with the private properties is to reduce the risk of exposure to CWM in the form of CAIS, and reduce the impact in the event an exposure occurs.

2.5 Site Characteristics

2.5.1 Site Geology and Soils

The former Fort Crowder lies on the west-central edge of the Ozark Plateau physiographic province, which is characterized by heavily eroded features and relatively deep valleys (Fenneman, 1946). The site is located on the southern flank of the Springfield Plateau, which is a localized expression of the Ozark Dome. Stream flow is controlled by regional bedrock dip and localized fracture systems. The area is notable for features typical of karst topography, such as sinkholes and lost streams (M DN R, 1986).

The geology of Newton County is characterized by outcrops of primarily Mississippian limestones and dolomites that dip gently to the west. The uppermost formation commonly encountered in the Fort Crowder area is the Warsaw Formation, which consists of crystalline, fossiliferous limestone with bedded chert (MDNR, 1986).

Overburden materials found on ridges and uplands in the Fort Crowder area consist of reworked loess and cherty limestone residuum. Formation of soils from cherty limestone or dolomite produces soils of moderate to high permeability due to the insolubility of the chert (US Dept. of Agriculture, 1979). Lowland and stream valley soils characteristically contain fragipan, or hard calcite deposits, which are laterally discontinuous, but extensive enough to restrict permeability in some areas.

2.5.2 Nature and Extent of Contamination

The suspected CWM contamination at the former Fort Crowder is CAIS. Historical records indicate that CAIS were used and stored at the former Fort Crowder but do not include any information on the final disposal of the CAIS. Although no CWM or chemical agent-contaminated media were discovered during an intrusive investigation conducted in 2003, the results of the 2005 *CWM Scoping and Security Study* (Parsons, 2005) indicated that CWM in the form of CAIS could potentially remain at the former Fort Crowder.

The available data indicates that the two main types of CAIS used at Fort Crowder were “sniff sets” (K955 Navy or Navy X sets) and ampoule sets (K951/K952 sets). The chemical agents associated with these types of CAIS are listed in Table 2-1. All types of CAIS contained only small amounts of chemicals.

“Sniff sets” were intended for indoor use to instruct military personnel in recognizing chemical odors. This type included the K955 and Navy X sets, which were used from the late 1930s through World War II. Sniff sets contained glass bottles filled with chemical-impregnated charcoal, chemical-impregnated plastic pellets, or agent simulants. The sniff set bottles were stored in metal cans with paint can-type lids, which were packaged in hinged wooden boxes.

Ampoule sets were designed for outdoor use, and consisted of chemicals (pure or in solution) in sealed ampoules made of shock-resistant borosilicate glass. These CAIS were exploded with detonators during field exercises to simulate actual battlefield conditions. This type included the K951 and K952, which were used in the early 1950s during the Korean War. The ampoules were approximately one inch in diameter and approximately 7.5 inches long. Individual ampoules were packed in cardboard screw-cap containers with the chemical type indicated on the cap. Twelve cardboard containers were placed into a metal can with a press-fit lid. Four cans were stored in a steel shipping container (called a “pig”).

Potential sources of CAIS contamination include: 1) intact CAIS ampoules or bottles (full, partly full, or empty); 2) CAIS chemicals released to the environment during chemical warfare training and/or CAIS disposal. Data from CAIS sites indicates that the intact CAIS ampoules or bottles are the main potential source of CAIS contamination. These items, if present, are likely to be buried beneath the ground surface. However, due to the nature of the chemical warfare training activities, some items could be present on the ground surface. Release of CAIS chemicals to the environment would have occurred at outdoor demonstration and training areas where detonation sets and decontamination training were conducted and also potentially at disposal sites where the contents of CAIS were dumped and incompletely destroyed. However, release of CAIS chemicals to the environment has not been shown to be a source of contamination to soil, groundwater, or surface water (Parsons, 2007).

2.6 Current and Potential Future Site and Resource Uses

The City of Neosho (population 10,505) is the county seat of Newton County. Land use in the vicinity of the former Fort Crowder is primarily agricultural and woodland. Approximately 4,358 acres of the former Fort Crowder now comprises the Missouri Army National Guard Fort Crowder facility (Fig. 2-1), which trains several thousand troops each year. As an

active National Guard facility, this property is not included in the FUDS program and was not evaluated as part of the Proposed Plan or Decision Document. Commercial, educational, and industrial facilities occupy other portions of the former Fort Crowder.

The No. 110 Gas Chambers Area is currently residential property and horse pasture. The former Pistol Ranges is currently the site of a privately-owned chicken farm. Future land use is anticipated to remain similar with respect to agriculture. However, the potential exists that development will extend farther south from Neosho.

2.7 Summary of Site Risks

As required by CERCLA, a baseline risk assessment (BLRA) was prepared in support of the *Programmatic RI/FS Report*. The greatest risk to human health and the environment associated with CWM in the form of CAIS is the safety risk due to acute exposure from breakage of loose ampoules and bottles remaining at the site. Due to the small amounts of chemicals in CAIS, release of the chemicals to the environment is a lesser hazard.

The potential for a CWM safety risk depends on the presence of three critical elements:

- a source (presence of CWM);
- a receptor; and
- an interaction between source and receptor.

There is no risk if any one of these three elements is missing.

2.7.1 Hazard Identification

The potential for CAIS to remain at the former Fort Crowder is based on site history and documentation (Parsons, 2005). The chemicals of potential concern contained in the CAIS used at Fort Crowder are listed in Table 2-1. The greatest hazard is from intact, loose bottles or ampoules. All reported injuries from accidental exposures to CAIS were from ampoules or bottles (Parsons, 2007). Chemicals in these containers may persist indefinitely until opened or accidentally broken. The ampoules and bottles from the CAIS normally detonated in outdoor demonstrations were most likely to have been buried as a means of disposal or buried following attempted destruction via burning (Parsons, 2007). Chemicals from “sniff sets” were most likely expended prior to disposal of the bottles.

Old releases, chemicals and breakdown products remaining from the use of CAIS during chemical warfare training, may also be a potential hazard. However, there have been no reports of injuries related to exposure to old releases (Parsons, 2007). Persistent CAIS chemicals dissolved in a solvent (e.g., mustard, Lewisite, nitrogen mustard) most likely have volatilized or degraded into breakdown products. Chloroform in the soil may persist while gradually volatilizing over time. Some compounds (e.g., Adamsite, chloroacetophenone) only present a hazard if made airborne as a dust or if direct skin contact to high concentrations is made. All nonpersistent chemicals (e.g., phosgene, triphosgene, chloropicrin) will have long since volatilized and dispersed.

2.7.2 Exposure Assessment

The exposure assessment estimates the extent of human contact with potential chemicals of concern by characterizing potentially exposed receptors, identifying actual or potential routes of exposure, and estimating the extent of human exposure. Undisturbed CAIS do not present significant hazard to humans or the environment. An exposure can only occur if CAIS are encountered and the glass containers are broken. The most common scenario for encountering CAIS occurs during excavation for utilities or building foundations (Parsons, 2007). If bottle or ampoule breakage occurs during excavation, workers in the immediate vicinity will be subject to the harmful effects of the chemical release. Exposure would occur via inhalation and dermal contact.

The current and future receptors are:

- a construction worker, who is assumed to be conducting some form of intrusive activities in the soil;
- a maintenance worker, who would only be servicing existing facilities and, therefore, would be less likely to encounter CAIS chemicals;
- an emergency responder to an incident involving exposure to CAIS chemicals;
- passersby and pedestrians, including casual visitors, who might be exposed due to intrusive activities.

The most likely exposure pathways for construction workers are:

- inhalation of vapors released from broken CAIS ampoules or bottles;
- direct dermal contact with CAIS chemicals;
- direct dermal contact with contaminated soil.

The most likely exposure pathways for emergency responders are:

- direct dermal contact with CAIS chemicals;
- direct dermal contact with contaminated soil;
- direct dermal contact with contaminated personnel.

Other receptors are less likely to be exposed.

2.7.3 Toxicity Assessment

The limited history of unintentional exposures to CAIS chemicals shows that acute symptoms predominate, including choking, watery eyes, trouble breathing, blisters, and redness of skin.

2.7.4 Uncertainty Analysis

Uncertainty in evaluating the hazards due to CAIS is due to inability to determine the presence of CAIS at the site or to quantify the amounts of chemicals in the CAIS, and lack of information on the locations of outdoor chemical warfare training or demonstration areas and the locations of CAIS burials. The conservative assumption is that CAIS are present, although in many cases the quantities of chemicals used were likely very small.

2.7.5 Summary and Conclusions

The greatest risk from CAIS is the potential presence of intact, loose bottles or ampoules, which could produce a dangerous release of chemicals if opened or broken. A less significant risk may also remain from small amounts of chemical agents and breakdown products that persist from historical chemical warfare training exercises.

2.7.6 Basis for Action

The Selected Remedy for the former Fort Crowder CWM Site presented in this DD is necessary to protect the public health or welfare or the environment from potential or threatened releases of hazardous substances in the environment.

2.8 Remedial Action Objectives

Remedial action objectives (RAOs) provide a general description of what the remediation at the former Fort Crowder CWM Site will accomplish. These goals provide a basis for understanding how the risks identified in Section 2.7 will be addressed by the Selected Remedy.

The overall RAO for CWM at Fort Crowder is to reduce the risk of human exposure via dermal contact, inhalation, and/or ingestion of CAIS chemical agent or chemical agent-impacted media. Specific RAOs to reduce the hazards from an acute exposure include the following:

- To educate site workers and managers in the possible hazards of releases from CAIS to include an emphasis of the 3Rs (Recognize-when you may have encountered a CAIS, Retreat-do not touch, move or disturb it, but carefully leave the area, Report!- call 911!), and to reduce risk by understanding that CAIS may remain at the site, avoiding items that may potentially be CAIS, and promptly reporting a possible CAIS exposure incident.;
- To promote early recognition to site workers and managers of potential CAIS exposures, so that exposed persons can receive prompt, proper treatment, and so the incident location can be closed until the authorities can respond, avoiding follow-on exposure incidents.

2.9 Description of Alternatives

Five remedial alternatives considered for the former Fort Crowder CWM Site are presented in this section based on the results of the *Programmatic RI/FS for Possible CAIS Sites* (Parsons, 2007), which evaluated remedial alternatives for remedies at sites where CAIS is the CWM of concern.

The range of alternatives developed to address CAIS under the *Programmatic RI/FS* is unique because identifiable CAIS disposal or burial locations are not known, and technologies for investigation or detection of CAIS are limited or not available.

The five alternatives developed in the *Programmatic RI/FS* are:

- Alternative 1: No Action
- Alternative 2: Access Controls
- Alternative 3: Educational Awareness and Long-term Management
- Alternative 4: Geophysics and Intrusive Investigation
- Alternative 5: Excavation and Restoration

2.9.1 Description of Remedy Components

2.9.1.1 Alternative 1: No Action

The “No Action” alternative is required to be considered in the CERCLA process, and is used to establish a baseline for comparison with the other remedial alternatives. No Action means that no remedial action will be implemented to reduce the potential safety risk posed by suspect CAIS. This alternative would involve the continued use of the site in its current condition.

2.9.1.2 Alternative 2: Access Controls

Alternative 2 utilizes signage and fencing as physical land use controls (LUCs) to limit access to the site, thus reducing the potential for future receptor interaction and exposure pathway completion. Because specific CAIS disposal or burial locations are not known, access controls would be applied to the entire former Chemical Exercise Area, which is now referred to as an Educational Awareness Area.

Signage and fencing reinforce the link between appropriate access and safety. Signage consists of a comprehensive warning sign posting system indicating that entry to a site is prohibited, activities within the property are restricted, and the area has a history of past CAIS-related activity. Fencing provides a physical barrier to inadvertent future receptor entry. Enforcement of trespass restrictions will be more effective if fencing is present, however, restrictions may be bypassed.

Access controls require periodic repair and maintenance, depend on cooperation of stakeholders for implementation, and may not coincide with current and planned land use.

2.9.1.3 Alternative 3: Educational Awareness and Long-term Management (Selected Remedy)

Alternative 3 involves educational awareness measures to be implemented by USACE-KCD that consist of online educational tools and materials that contain information on CAIS, the history of chemical warfare, and the response process, and includes videos, presentations, and fact sheets. These materials are available through a public-access website (<https://www.denix.osd.mil/uxosafety>). These measures have the goal of modifying behavior to reduce the risk of exposure and reduce the impact in the event exposure occurs. USACE-KCD will also issue a fact sheet to notify stakeholders (about the history and location of the site, contaminants of concern, USACE points of contact, public comment information and location of the educational awareness materials).

Long-term Management (LTM) consists of interviews with stakeholders, such as the property owners of the former Chemical Exercise Area (now referred to as an Educational

Awareness Area), nearby land owners and emergency officials; land use site inspections; updates on property ownership; and newsletters to land owners surrounding the site. Communication with stakeholders is an important means to remain actively informed of any new or different information regarding the site, including changes in current or future land use. As part of the interviews, updated educational awareness materials will be provided to stakeholders, as necessary. Inspection reports generated by USACE-KCD will be submitted to MDNR for review and incorporated into the project record and placed in the information repository.

The LTM Plan, which will be submitted to MDNR for review and completed within twelve (12) months of this Decision Document's approval, will present these activities as annual in frequency with an evaluation for potential change in frequency after five years of LTM. The frequency of these activities may be adjusted to not less frequent than once every five years provided that the selected frequency allows for the remedy to remain protective and achieve the Remedial Action Objectives. Changes in frequency will be proposed to and made in consultation with MDNR. Public availability sessions will also be considered as a supplement to the LTM activities listed above.

2.9.1.4 Alternative 4: Geophysics and Intrusive Investigation

Alternative 4 includes geophysical surveys to identify subsurface metallic anomalies which may be associated with CAIS, and intrusive investigation of metallic anomalies until either the cause of the anomaly is identified or until the site-specific risk-based depth is reached. Metallic objects discovered during intrusive investigation will be identified as CAIS-related or as scrap metal. If CAIS are found, soil sampling and analysis would be conducted for chemical agents and breakdown products.

Because specific CAIS disposal or burial locations are not known, geophysical surveys would be conducted over the entire former Chemical Exercise Area (now referred to as an Educational Awareness Area). A land survey to establish control points, vegetation removal, and surface clearing by unexploded ordnance (UXO)-qualified personnel would be required prior to geophysical surveying. The geophysical data must be reviewed and evaluated by a qualified geophysicist to select the anomalies that will be investigated.

This alternative requires development and approval of site-specific work plans, including UXO safety and Chemical Safety Submittals (CSS) that detail monitoring and remedies for UXO and chemical agents. Planning and implementation require specialized equipment and technical specialists. During intrusive investigations, special provisions for safety of workers and the public would be required, including air monitoring for chemical releases, establishment of an exclusion zone, use of a decontamination station, and onsite standby medical support.

After the remedial action, CAIS could potentially remain on site in areas not selected for excavation.

2.9.1.5 Alternative 5: Excavation and Restoration

Alternative 5 includes excavation to remove CAIS from all potential disposal or burial areas within a target excavation depth at the site, followed by restoration. Based on CAIS disposal

depths observed at other sites, excavation depth would be a minimum of six feet below ground surface, but could be deeper if there are indications that additional CAIS or potential CAIS items may be present at greater depths.

Because specific CAIS disposal or burial locations are not known, the entire former Chemical Exercise Area (now referred to as an Educational Awareness Area) would be excavated. All existing vegetation, including tree cover, will be cleared to facilitate excavation. Surface clearing by unexploded ordnance (UXO)-qualified personnel would be required prior to excavation.

Excavated soils will be sifted to identify and remove CAIS-related items for proper disposal. If CAIS are found, soil sampling and analysis would be conducted for chemical agents and breakdown products. Soils free of chemical agents will be reused at the site for backfill. Extensive site restoration activities would be required following the removal action.

This alternative also requires development and approval of site-specific work plans, including UXO safety and CSS that detail monitoring and Remedies for UXO and chemical agents. Planning and implementation require specialized equipment, technical specialists, and other resources that may not be readily available. During intrusive investigations, special provisions for safety of workers and the public would be required, including air monitoring for chemical releases, establishment of an exclusion zone, use of a decontamination station, and onsite standby medical support.

After the remedial action, CAIS could potentially remain on site at depths greater than those excavated.

2.10 Comparative Analysis of Alternatives

The U.S. Environmental Protection Agency (USEPA) has established nine criteria that balance health, technical, and cost considerations to determine the most appropriate remedial alternative (NCP Section 300.430(e)(9)(iii)). These criteria are used to select a remedial alternative that is protective of human health and the environment, attains ARARs, is cost effective, and utilizes permanent solutions and treatment technologies to the maximum extent practicable. The five remedial alternatives described in Section 2.9 have been evaluated and compared using the following nine criteria:

1. Overall Protection of Human Health and the Environment
2. Compliance with Applicable or Relevant and Appropriate Requirements
3. Long-Term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment
5. Short-Term Effectiveness
6. Implementability
7. Cost
8. State Acceptance
9. Community Acceptance

2.10.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether a remedial alternative provides protection of human health and the environment and describes how risks which are posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

This criterion was evaluated based on the impact each remedial action alternative has on the factors of possible CAIS exposure hazard. CAIS exposure hazard is comprised of two components, the CAIS source characteristics and receptor interaction. Both components (i.e., source and receptor) are required in order to pose a safety threat to the public.

The “protectiveness” criterion was evaluated in terms of possible future human interaction with CAIS chemicals, whether in containers or released to the environment. An environmental protectiveness factor was based on the protection employing an alternative will have on the existing environment and ecology. Each alternative was evaluated in terms of whether it would decrease the amount of CAIS chemicals currently in the environment.

Alternative 1 is not protective of human health and the environment. Alternatives 1, 2, and 3 do not remove any CAIS chemicals and provide no source reduction. However, Alternatives 2 and 3 provide protection by decreasing the potential for exposure pathway completion, either by restricting access (Alternative 2) or improving hazard recognition (Alternative 3).

Although Alternatives 4 and 5 provide source reduction by removing CAIS, there is no way to ensure that all CAIS are removed. Also, Alternatives 4 and 5 both have a potential to cause an accidental release as part of the investigative or removal process. Alternative 4 may not provide an adequate level of protection, since only CAIS associated with detected subsurface metallic anomalies will be removed, and only if those anomalies are selected for intrusive investigation. Alternative 5 will remove CAIS within the target excavation depth, but CAIS may remain at other depths. Also, Alternative 5 causes significant associated ecological damage by excavating the entire site.

2.10.2 Compliance with ARARs

Compliance with ARARs addresses whether a remedial alternative will meet all applicable or relevant and appropriate requirements of federal and state laws and regulations related to addressing hazardous substances at the site.

The criteria, Compliance with ARARs, is not applicable as there are no ARARs pertaining to the evaluated alternatives for this site.

2.10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence addresses the ability of a remedial alternative to permanently reduce or eliminate the potential for CAIS exposure hazard.

Alternative 1 does not meet the criterion. Alternative 2 can be effective at decreasing possible receptor interaction, but access controls require maintenance, may not be compatible with current or future land use, and must be reviewed and updated over time. Alternative 3 can be effective at behavior modification, but requires implementation by stakeholders, may not be effective for all persons, and also must be reviewed and updated over time. Alternative 4 is not effective at decreasing CAIS risk in areas without detectable

metallic anomalies. Alternative 5 provides the most long-term effectiveness and permanence based on the ability to remove the risk due to possible CAIS.

2.10.4 Reduction of Toxicity, Mobility, and Volume through Treatment

This criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies which permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when treatment is used to decrease the principal threats at a site by destruction of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media.

Alternatives 1, 2, and 3 provide no reduction in toxicity, mobility, or volume of contaminants. Alternative 4 may not provide an adequate level of reduction in toxicity, mobility, or volume of contaminants, since only CAIS associated with detectable subsurface metallic anomalies will be removed. Alternative 5 provides the greatest reduction in toxicity, mobility, or volume of potential contaminants by removing CAIS items and associated contaminated soils (if present) to a predetermined target depth.

2.10.5 Short-term Effectiveness

Short-term effectiveness addresses short-term risks and the potential consequences and effects of an alternative during the implementation phase. Short-term risks are potential adverse impacts to workers, the community, and the environment during the construction and implementation phases of the remedial action.

Alternatives 1 and 3 both had no associated short-term risks or adverse impacts to workers, the community, and the environment. Alternative 2 has possible short-term impacts to workers associated with heavy equipment use during fence installation. Alternatives 4 and 5 both have short-term impacts associated with vegetation removal, heavy equipment use, intrusive activities and/or excavation, and possible interaction with CAIS. However, the risks associated with Alternative 5 were determined to be greater because the activities are more extensive. Also, Alternative 5 would cause significant environmental and ecological impacts by excavating the entire site to a predetermined depth.

2.10.6 Implementability

This criterion addresses the technical and administrative feasibility of implementing a specific remedial action alternative. Implementability includes consideration of whether the alternative is technically possible; the availability of necessary materials, equipment, and specialists; administrative and regulatory requirements; and monitoring requirements.

Alternatives 1, 2, and 3 are all technically and administratively feasible and readily implemented. No services or materials are necessary for implementation of Alternative 1. Alternative 2 requires landowner permission and the materials and services to install fencing and signs are readily and commercially available. The online educational and training materials for Alternative 3 are readily available through the DENIX public-access website, and the materials, equipment, and specialists for long-term management are available.

Alternative 4 is not technically feasible due to the need to conduct geophysical surveys over the entire site and the limitations of available exploratory geophysical technology, which cannot locate glass CAIS bottles and ampoules unless co-located with detectable metal. Limitations on detection of metal include survey spacing, depth, amount and condition of the metal, and background noise level. Alternative 4 requires materials, services, and technical specialists which may not be readily available.

Alternative 5 is technically feasible, but not cost effective. Removing all vegetation including tree cover, excavating to a predetermined depth, and processing and carefully examining all excavated soils to locate and remove small glass CAIS bottles and ampoules is impractical. Administrative difficulties may be encountered due to the nature and extent of the earth-moving activities, and this alternative may not be acceptable to stakeholders. Alternative 5 requires specialized equipment, materials, services, and technical specialists which may not be readily available.

Both Alternatives 4 and 5 require development of detailed work plans with a CSS and Department of Defense Explosives Safety Board (DDESB) approval. Field activities require special provisions for safety of workers and the public, including qualified UXO technicians with specialized equipment, and specialized air monitoring equipment and personnel with limited availability.

2.10.7 Cost

This criterion evaluates the cost to implement the remedial action alternative, and includes estimated initial capital cost, annual operation and maintenance or monitoring costs, and present worth costs. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. These costs were adapted from cost estimates prepared for the *CWM Scoping and Security Study Report* (Parsons, 2005) and the *Programmatic RI/FS for Possible CAIS Sites* (Parsons, 2007).

The actual costs will depend upon true labor rates, actual site conditions, final project scope and other variable factors. Alternative 1 requires no action, therefore, no costs are incurred. Alternative 2 (\$335,269) has costs associated with installing signs and fencing around the entire perimeter of the site and subsequent long-term maintenance. Alternative 3 (\$262,419) has costs associated with conducting long-term management activities. Alternatives 2 and 3 are similar in present value cost and moderate in cost relative to Alternatives 4 (\$2,400,263) and 5 (\$126,648,306).

Alternatives 4 and 5 both have high initial costs associated with work plan and CSS development, and high to extremely high costs associated with implementation of field activities and site safety precautions during field activities. Alternative 4 has very high costs associated with geophysical surveys and intrusive investigations, and the number of intrusive investigations is based on how the anomalies are selected. Alternative 5 has prohibitive costs associated with implementation, which could exceed \$2,000,000 per acre.

2.10.8 State/Support Agency Acceptance

The MDNR supports the Preferred Alternative (Alternative 3). The MDNR does not believe that Alternative 1 provides adequate protection of human health and environment.

2.10.9 Community Acceptance

As noted in Section 2.3, the Proposed Plan for the former Fort Crowder Chemical Warfare Materiel site was made available for public review and comment on June 6, 2012. A public meeting was held on June 13, 2012, and the public comment period was established from June 6, 2012 through July 6, 2012. The community did not submit written comments during the public comment period, and no comments regarding Alternative 3 were presented during the public meeting. The USACE-KCD worked through various outlets (for example, fact sheets, letters, a public meeting, one-on-one visits with stakeholders and a public comment period) to inform the community of the Proposed Plan and the remedial alternatives.

2.11 Principal Threat

The concept of “principal threat” under CERCLA applies to the characterization of “source material.” A source material generally includes or contains hazardous substances, pollutants or contaminants that either acts as a reservoir for migration of contamination to groundwater, surface water or air, or acts as a source for direct exposure. Principal threat wastes are defined by USEPA as “source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur”. Intact CAIS ampoules and bottles meet the definition of principal threat wastes because they act as a source for direct exposure and present a significant risk to human health if exposure occurs.

2.12 Selected Remedy

The Selected Remedy is Alternative 3 – Educational Awareness and Long-term Management. This is the recommended alternative for all sites such as Ft. Crowder, which are suspect CWM sites that have CAIS as the sole remaining potential CWM hazard.

Table 2-2 presents a summary of the evaluation of the five remedial alternatives with respect to the seven criteria, and identifies the most practicable solution for reducing the CAIS exposure hazard at the Site. Alternatives 1 and 2 must be ruled out since it is ineffective in reducing the risk. Alternatives 4 and 5 all have high to prohibitively high cost, short-term impacts, and are not implementable for any sites as large as the Ft. Crowder site. Alternative 3 will reduce the risk by providing educational awareness information to stakeholders and local responders. Therefore, Alternate 3 is the best alternative based on cost, effectiveness, and implementability.

2.12.1 Description of the Selected Remedy

The Selected Remedy has a minor addition in the annual frequency associated with certain long-term management actions from what was presented in the Proposed Plan. The minor addition involves an allowance for a change in frequency of certain long-term management actions after five years.

The major components of the selected remedy include:

- An online educational awareness program available at URL: <https://www.denix.osd.mil/uxosafety>. This public-access website has information on CAIS, the history of chemical warfare, and the response process.
- Long-term Management (LTM) to be implemented by USACE-KCD, consisting of interviews with stakeholders, such as the property owners of the former Chemical Exercise Area (now referred to as an Educational Awareness Area), nearby land owners and emergency officials; land use site inspections; updates on property ownership; and newsletters to land owners surrounding the site. Communication with stakeholders is an important means to remain actively informed of any new or different information regarding the site, including changes in current or future land use. As part of the interviews, updated educational awareness materials will be provided to stakeholders, as necessary. Inspection reports generated will be incorporated into the project record and placed in the information repository. Details and implementation of these long-term management activities will be provided in the LTM Plan, which will be prepared by USACE-KCD and completed within twelve (12) months of this Decision Document's approval. The LTM Plan, which will be submitted to MDNR for review, will present these activities as annual in frequency with an evaluation for potential change in frequency after five years of LTM. The frequency of these activities may be adjusted to not less frequent than once every five years provided that the selected frequency allows for the remedy to remain protective and achieve the RAOs. Changes in frequency will be proposed to and made in consultation with MDNR. Public availability sessions will also be considered as a supplement to the LTM activities listed above.

2.12.2 Summary of Estimated Remedy Costs

The estimated costs for the Selected Remedy are summarized in Table 2-3, and are an order-of-magnitude estimate that are expected to be within +50 to -30 percent of the actual project cost. The information in this cost estimate summary was based on the best available information regarding the anticipated scope of the Selected Remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the selected remedy. Changes may be documented in a memorandum to the Administrative Record file, an Explanation of Significant Differences, or a Decision Document amendment.

2.13 Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, and is cost-effective.

The remedy does not satisfy the statutory preference for treatment as a principal element of the remedy for the following reasons:

- treatment is impracticable due to technical infeasibility, inadequate short-term protection of human health and the environment, and extraordinarily high costs;
- no source materials constituting principal threats will be addressed within the scope of this action.

While no contamination in the form of CAIS is known to be present, the available technology to investigate the site does not provide for a definitive determination that the site is available for UU/UE. Because this remedy will result in the potential for CAIS to remain on-site, a statutory review will be conducted no less frequently than every five years after initiation of the selected remedial action as long as hazardous substances, pollutants, or contaminants remain at the site above levels that allow for UU/UE. A Five-Year Review Report will be provided to MDNR for review.

2.14 Documentation of Significant Changes

The Proposed Plan was released for a public comment from June 6, 2012 to July 6, 2012 with a public meeting held on June 13, 2012. The Proposed Plan identified Alternative 3, as the Preferred Alternative for remediation. No comments were received from the public during the comment period or at the public meeting. No significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

Tables

Table 2-1. Hazardous Chemicals contained in CAIS

Compound	Type of CAIS		
	K951/K952	K955 Navy	Navy X
Adamsite (DM)		P	P
Chloroacetophenone (CN)		P	P
Chloroform	S		
Chloropicrin (PS)	D	C	C
Lewisite (L, M-1)	D	C	C
Mustard (sulfur) (H, HD, HS)	D	C	C
Nitrogen mustard HN-1			C
Nitrogen mustard HN-3			C
Phosgene (CG)	P		
Triphosgene		P	P

Notes:

C = absorbed in charcoal;

D = diluted;

P = in pure or undiluted form;

S = used as a solvent for other chemicals.

Table 2-2. Evaluation of response alternatives

Criteria	Alternative 1: No Action	Rating	Alternative 2: Access Controls	Rating	Alternative 3: Educational Awareness and Training/ Long-term Management	Rating	Alternative 4: Geophysics and Intrusive Investigation	Rating	Alternative 5: Excavation and Restoration	Rating
Overall protection of human health & the environment	No CAIS source reduction. No risk reduction.	1	No CAIS source reduction. Risk reduction due to restricted access, which reduces interaction with CAIS. Restrictions may be bypassed.	3	No CAIS source reduction. Risk reduction due to improved hazard recognition, which reduces chances of exposure. Training and education may not be effective for all persons.	3	Source and risk reduction only for CAIS associated with detected metallic anomalies, and only if those anomalies are selected for intrusive investigation. Residual CAIS possible.	3	Source and risk reduction only for CAIS within target excavation depth. Residual CAIS possible. Excavating entire site causes significant environmental/ecological damage.	4
Compliance with ARARs	Does not comply.	1	Complies.	5	Complies.	5	Complies.	5	Complies.	5
Long-term effectiveness & permanence	No reduction of possible CAIS. Existing risk will remain.	1	No reduction of possible CAIS. Can be effective at reducing possible receptor interaction. Maintenance required for signs & fencing. Five-year reviews allow for future evaluation of site conditions.	3	No reduction of possible CAIS. Can be effective at behavior modification and appropriate response. Requires implementation by stakeholders. Five-year reviews allow for future evaluation of site conditions.	3	Source and risk reduction only for CAIS associated with detected metallic anomalies, and only if those anomalies are selected for intrusive investigation. Residual CAIS possible. Five-year reviews allow for future evaluation of site conditions.	3	Source and risk reduction only for CAIS within target excavation depth. Residual CAIS possible. Five-year reviews allow for future evaluation of site conditions.	4
Reduction of toxicity, mobility, or volume	No reduction of possible toxicity, mobility, or volume.	1	No reduction of possible toxicity, mobility, or volume.	1	No reduction of possible toxicity, mobility, or volume.	1	Reduction of toxicity, mobility, or volume only for CAIS associated with selected metallic anomalies. Residual CAIS possible.	2	Reduction of toxicity, mobility, or volume only for CAIS within target excavation depth. Residual CAIS possible.	4
Short-term effectiveness	No short term impacts to workers or community.	5	Possible short-term impacts to workers associated with fence installation.	4	No short-term impacts associated with training and education	5	Moderate short-term impacts to workers and community. Risk associated with vegetation removal, heavy equipment, intrusive activities, and possible interaction with CAIS. Possible environmental impacts related to site clearing and intrusive activities.	2	Greatest short-term impacts to workers, community, & environment. Risk associated with tree & vegetation removal, specialized heavy equipment, excavation, and possible interaction with CAIS. Significant environmental impact related to excavating entire site.	1
Implementability	Readily implemented. No action required.	5	Readily implemented. Landowner permission	4	Readily implemented. Stakeholder coordination	5	Moderate implementability.	3	Impractical. Requires entire site be excavated	1

Criteria	Alternative 1: No Action	Rating	Alternative 2: Access Controls	Rating	Alternative 3: Educational Awareness and Training/ Long-term Management	Rating	Alternative 4: Geophysics and Intrusive Investigation	Rating	Alternative 5: Excavation and Restoration	Rating
			required.		required.		Requires geophysical surveying of entire site. Requires vegetation & tree removal. Cannot locate glass CAIS bottles unless co-located with detectable metal. Requires qualified UXO technicians and geophysicists with specialized equipment. Requires specialized air monitoring equipment and personnel with limited availability. Requires work plans and CSS with DDESB approval.		to a predetermined depth, and the excavated material be sifted to remove breakable glass CAIS bottles and ampoules. Requires removal of all trees & vegetation. Administrative difficulties due to nature and extent of earth-moving activities. May not be acceptable to landowners. Requires specialized equipment, services, personnel with limited availability. Requires qualified UXO technicians with specialized equipment. Requires specialized air monitoring equipment and personnel with limited availability. Requires work plans and CSS with DDESB approval.	
Cost	No cost.	5	Some cost.	3	Some cost.	3	High cost.	2	Prohibitively high cost.	1
Remedial Action Costs	\$0.		\$144,520.		\$0.		\$2,269,069.		\$126,517,112.	
Monitoring/ O&M Costs	\$0.		\$88,500.		\$195,000.		\$0.		\$0.	
5-Year Review Costs	\$0.		\$200,000.		\$200,000.		\$200,000.		\$200,000.	
Total Costs	\$0.		\$433,020.		\$395,000.		\$2,469,069.		\$126,717,112.	
Total Present Value Cost	\$0.		\$335,269.		\$262,419.		\$2,400,263.		\$126,648,306.	
total rating		19		23		25		20		20

1 = poor
2 = fair
3 = satisfactory
4 = good
5 = excellent

**Table 2-3. Cost Estimate Summary for the Selected Remedy
Ft. Crowder CWM Site**

A. Costs for Remedy Components

	<u>Unit</u>	<u>No.</u>	<u>cost each</u>	<u>total</u>
Educational Awareness/Long-term Management	each	1	\$ 6,500.00	\$6,500.00
Five-Year Review	each	1	\$ 40,000.00	\$40,000.00

B. Summary of Present Value Analysis

Year	Fiscal Year	Remedial Action Costs(\$)	Monitoring/O&M Costs(\$)	Five-Year Review Costs (\$)	Total Costs (\$)	Discount with R at 3.0%	Total Present Value Cost (\$)
0	FY15	\$0	\$6,500	\$0	\$6,500	1.000	\$6,500
1	FY16	\$0	\$6,500	\$0	\$6,500	0.971	\$6,311
2	FY17	\$0	\$6,500	\$0	\$6,500	0.943	\$6,127
3	FY18	\$0	\$6,500	\$0	\$6,500	0.915	\$5,948
4	FY19	\$0	\$6,500	\$0	\$6,500	0.888	\$5,775
5	FY20	\$0	\$6,500	\$40,000	\$46,500	0.863	\$40,111
6	FY21	\$0	\$6,500	\$0	\$6,500	0.837	\$5,444
7	FY22	\$0	\$6,500	\$0	\$6,500	0.813	\$5,285
8	FY23	\$0	\$6,500	\$0	\$6,500	0.789	\$5,131
9	FY24	\$0	\$6,500	\$0	\$6,500	0.766	\$4,982
10	FY25	\$0	\$6,500	\$40,000	\$46,500	0.744	\$34,600
11	FY26	\$0	\$6,500	\$0	\$6,500	0.722	\$4,696
12	FY27	\$0	\$6,500	\$0	\$6,500	0.701	\$4,559
13	FY28	\$0	\$6,500	\$0	\$6,500	0.681	\$4,426
14	FY29	\$0	\$6,500	\$0	\$6,500	0.661	\$4,297
15	FY30	\$0	\$6,500	\$40,000	\$46,500	0.642	\$29,847
16	FY31	\$0	\$6,500	\$0	\$6,500	0.623	\$4,051
17	FY32	\$0	\$6,500	\$0	\$6,500	0.605	\$3,933
18	FY33	\$0	\$6,500	\$0	\$6,500	0.587	\$3,818
19	FY34	\$0	\$6,500	\$0	\$6,500	0.570	\$3,707
20	FY35	\$0	\$6,500	\$40,000	\$46,500	0.554	\$25,746
21	FY36	\$0	\$6,500	\$0	\$6,500	0.538	\$3,494
22	FY37	\$0	\$6,500	\$0	\$6,500	0.522	\$3,392
23	FY38	\$0	\$6,500	\$0	\$6,500	0.507	\$3,293
24	FY39	\$0	\$6,500	\$0	\$6,500	0.492	\$3,198
25	FY40	\$0	\$6,500	\$40,000	\$46,500	0.478	\$22,209
26	FY41	\$0	\$6,500	\$0	\$6,500	0.464	\$3,014
27	FY42	\$0	\$6,500	\$0	\$6,500	0.450	\$2,926
28	FY43	\$0	\$6,500	\$0	\$6,500	0.437	\$2,841
29	FY44	\$0	\$6,500	\$0	\$6,500	0.424	\$2,758
Total		\$0	\$195,000	\$200,000	\$395,000		\$262,419

Notes:

discount equation =1/(1+R)^n

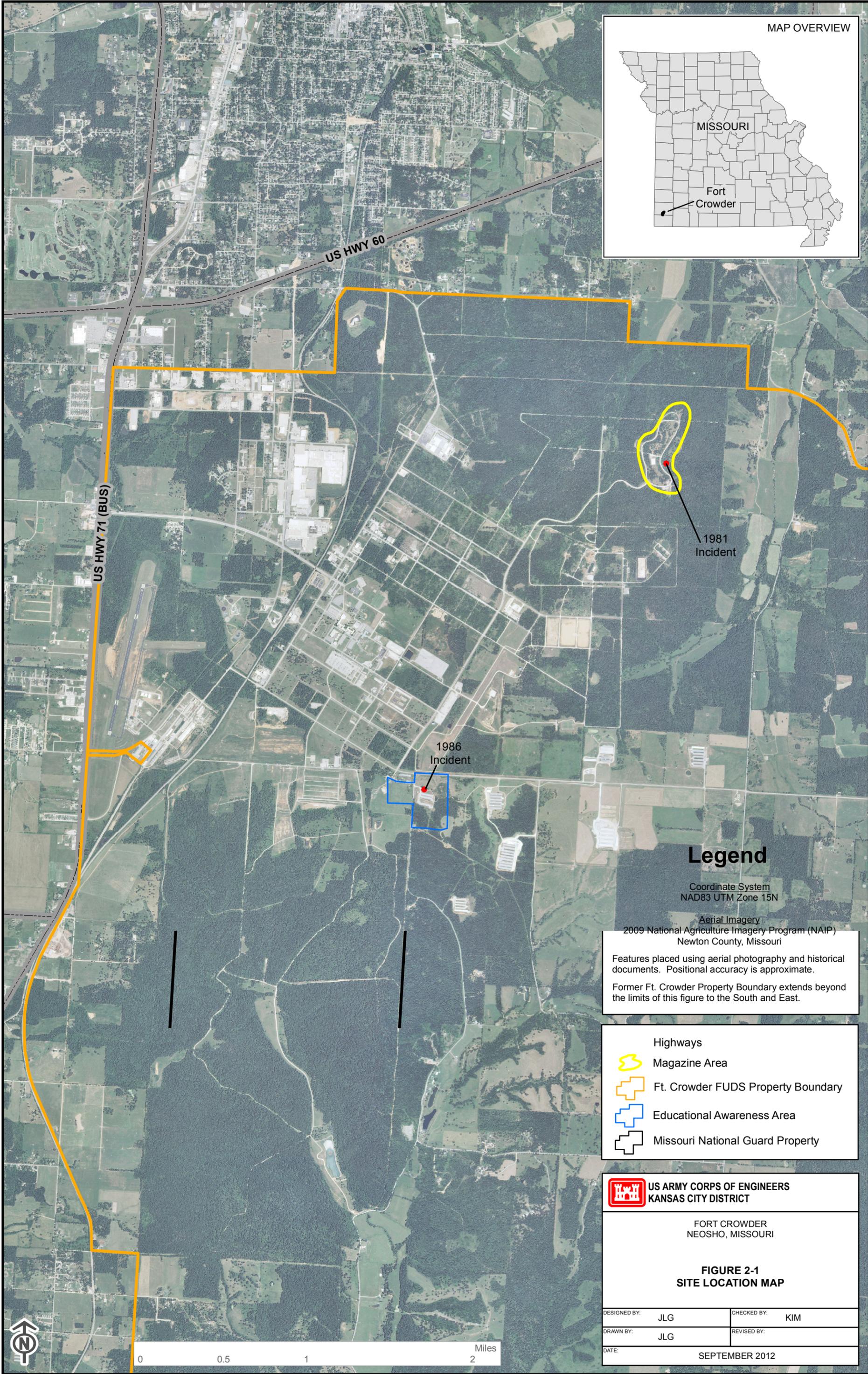
R= discount rate, currently at 3.0%

n = Year

-discount rate is taken from the 30-year real discount rates for the 2007 Appendix C of OMB Circular No. A-94.

-monitoring/O&M costs are estimated on an annual basis and may be subject to a change of frequency after five years of LTM

Figures



MAP OVERVIEW



MISSOURI

Fort Crowder

Legend

Coordinate System
NAD83 UTM Zone 15N

Aerial Imagery
2009 National Agriculture Imagery Program (NAIP)
Newton County, Missouri

Features placed using aerial photography and historical documents. Positional accuracy is approximate.

Former Ft. Crowder Property Boundary extends beyond the limits of this figure to the South and East.

-  Highways
-  Magazine Area
-  Ft. Crowder FUDS Property Boundary
-  Educational Awareness Area
-  Missouri National Guard Property

 **US ARMY CORPS OF ENGINEERS**
KANSAS CITY DISTRICT

FORT CROWDER
NEOSHO, MISSOURI

FIGURE 2-1
SITE LOCATION MAP

DESIGNED BY:	JLG	CHECKED BY:	KIM
DRAWN BY:	JLG	REVISED BY:	
DATE:	SEPTEMBER 2012		





Coordinate System
NAD83 UTM Zone 15N

Aerial Imagery
2009 National Agriculture Imagery Program (NAIP)
Newton County, Missouri

Features placed using aerial photography and historical documents. Positional accuracy is approximate.

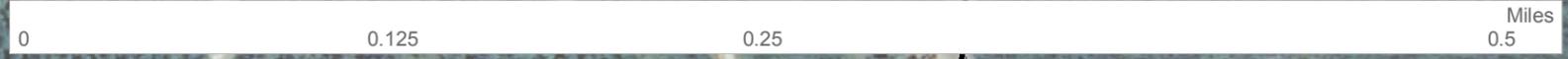
-  Ground Scar (TEC 2003)
-  Roads
-  Educational Awareness Area
-  Missouri National Guard/Fort Crowder
-  Magnetometer Survey Area
-  2003 Geophysical Survey Area
-  Former Structures

 **US ARMY CORPS OF ENGINEERS**
KANSAS CITY DISTRICT

FORT CROWDER
NEOSHO, MISSOURI

FIGURE 2-2
EDUCATIONAL AWARENESS AREA

DESIGNED BY:	JLG	CHECKED BY:	KIM
DRAWN BY:	JLG	REVISED BY:	
DATE:	SEPTEMBER 2012		



K:\MissionProjects\hr\w\l\Ft_Crowder_CWM\GIS\arcgis\maps\Fig2-2_EducationalAwarenessArea_20SEP12.mxd

3 Responsiveness Summary

This Responsiveness Summary provides responses from the USACE to comments received during the public comment period for the Proposed Plan. The notice of availability of the proposed plan and date for the public meeting was published June 6, 2012 in the *Neosho Daily News*. The public comment period was June 6, 2012 to July 6, 2012. The public meeting was held on June 13, 2012 at the Neosho Fish Hatchery Visitors Center.

3.1 Summary of Comments and Responses

No comments or questions were received from the public during the public comment period or at the public meeting.

3.2 Technical and Legal Issues

None.

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