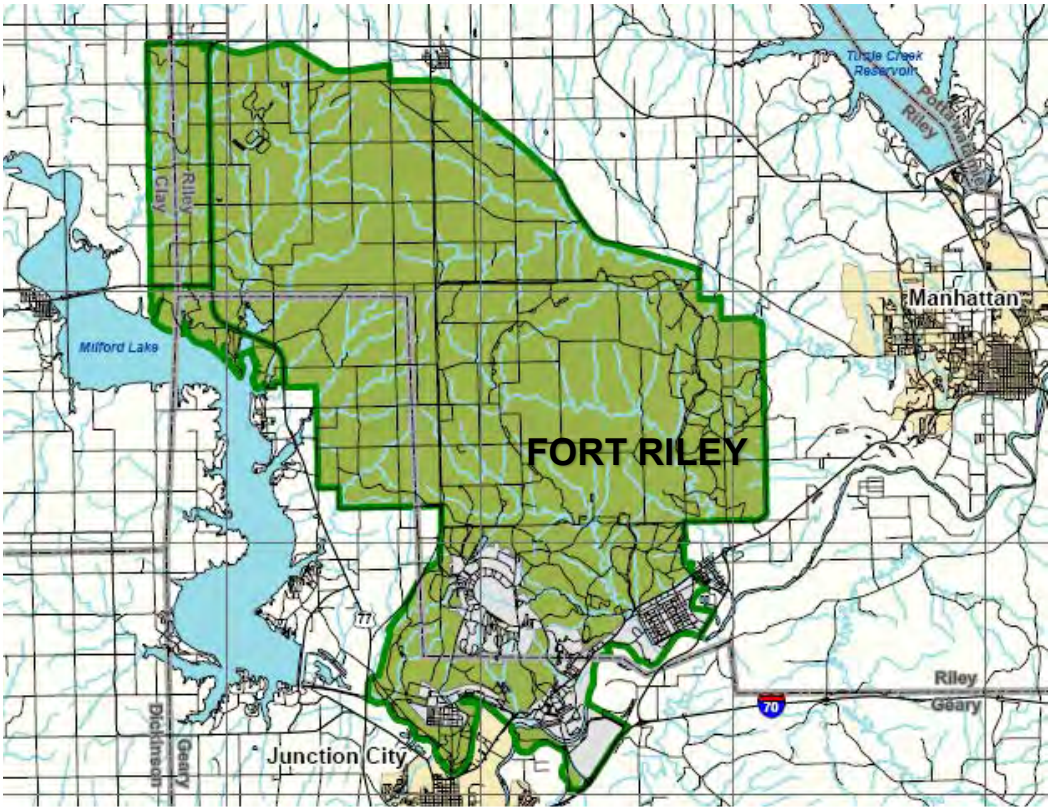
Final
Record of Decision

June 2020

Fort Riley

Military Munitions Response Program
Camp Forsyth Landfill Area 2 Munitions Response Site
Operable Unit 09, FTRI-003-R-01
Geary County, Kansas

U.S. Army Corps of Engineers
Omaha District



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Record of Decision

MILITARY MUNITIONS RESPONSE PROGRAM
FORT RILEY
CAMP FORSYTH LANDFILL AREA 2 MUNITIONS RESPONSE SITE
OPERABLE UNIT 09, FTRI-003-R-01
GEARY COUNTY, KANSAS

Prepared for

and

Prepared by

U.S. ARMY CORPS OF ENGINEERS
Omaha District

June 2020
Revision 01

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Acronyms And Abbreviations

%	percent
§	section
°F	degrees Fahrenheit
µg/L	micrograms per liter
AP	anti-personnel
ARAR	Applicable or Relevant and Appropriate Requirements
Army	U.S. Department of the Army
AT	anti-tank
Bay West	Bay West LLC
BER	Bureau of Environmental Remediation
bgs	below ground surface
cal	caliber
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFLFA2	Camp Forsyth Landfill Area 2
CFR	code of federal regulations
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Program
DGM	digital geophysical mapping
DMM	Discarded Military Munitions
DoD	Department of Defense
e2M	Engineering-Environmental Management, Inc.
Eco-SSL	ecological soil screening level
EOD	Explosive Ordnance Disposal
ESL	ecological screening levels
ESS	explosives safety submission
FFA	Federal Facilities Agreement
FS	feasibility study
FUDS	Formerly Used Defense Sites
GIS	geographic information system
HA	hazard assessment
HE	high-explosive
HEAT	high-explosive anti-tank
HFD	hazardous fragmentation distance
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
HRR	historical records review
ID	identification
INRMP	Integrated Natural Resources Management Plan
JV	Joint Venture
KDHE	Kansas Department of Health and Environment
K.S.A.	Kansas Statutes Annotated
LANL	Los Alamos National Laboratory
LBA	Louis Berger & Associates, Inc.
LOD	limit of detection
LUC	Land Use Control
MC	munitions constituents
MCL	maximum contaminant level
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm	millimeter(s)
MMRP	Military Munitions Response Program
MPPEH	Material Potentially Presenting an Explosive Hazard
MRS	munitions response site
MRSPP	MRS Prioritization Protocol
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operations and maintenance
OB/OD	open burn/open detonation
OD	other debris
OMB	Office of Management and Budget
OU	operable unit
PAOC	potential area of environmental concern
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RBC	risk-based concentrations
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	remedial investigation

ROD .....Record of Decision
RRD .....range-related debris
RSL .....regional screening level
SAAD .....small arms ammunition debris
SAR.....species at risk
SARA .....Superfund Amendments and Reauthorization Act
SI .....site inspection
SINC .....species in need of conservation
SLERA.....screening level ecological risk assessment
SQG .....sediment quality guideline
TBC.....to be considered
TEC.....threshold effect concentration
TMV .....toxicity, mobility, or volume through treatment
TNT.....trinitrotoluene
TWG-HA.....Technical Working Group – Hazard Assessment
U.S.....United States
USACE.....U.S. Army Corps of Engineers
USC .....United States Code
USEPA .....U.S. Environmental Protection Agency
USGS .....U.S. Geological Survey
UU/UE .....unlimited use/unrestricted exposure
UXO.....unexploded ordnance
Wenck .....Wenck Associates, Inc.

1.0 DECLARATION

1.1 Site Name and Location

This Record of Decision (ROD) presents the selected remedy for the Camp Forsyth Landfill Area 2 (CFLFA2), Munitions Response Site (MRS) FTRI-003-R-01 located at Fort Riley, Kansas. Fort Riley is located near Junction City in Geary, Riley, and Clay Counties in northeast Kansas. The CFLFA2 MRS is located in Geary County (**Figure 1-1**). Fort Riley is on the National Priorities List (NPL) with U.S. Environmental Protection Agency (USEPA) Site identification (ID) number KS6214020756. CFLAFA2 MRS also is referred to as Operable Unit (OU) 9.

1.2 Statement of Basis and Purpose

This ROD presents the selected remedy for the CFLFA2 MRS (FTRI-003-R-01) located at Fort Riley, Kansas. The CFLFA2 MRS also is referred to as "the MRS" throughout this document. The selected remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for the MRS.

This document is issued by the United States (U.S.) Department of the Army (Army), the lead agency for MRS activities. The USEPA is the lead regulatory agency, with support from the Kansas Department of Health and Environment (KDHE). The Army has consulted with USEPA and KDHE, and they concur with the selected remedy. Letters of concurrence from the KDHE and USEPA are provided in **Appendix A**.

1.3 Assessment of Site

The selected remedy in this ROD is necessary to protect human health or welfare or the environment from actual or threatened releases of potential munitions and explosives of concern (MEC) hazards at the MRS that may present an imminent and substantial endangerment to public health or welfare.

1.4 Description of Selected Remedy

The selected remedy for the MRS is Alternative 4, MEC Removal for Republican River and Breakneck Creek and Land Use Controls (LUCs). MEC will be removed from Breakneck Creek in the area from the junction of Breakneck Creek and the Republican River upstream to the Breakneck Lake dam. The removal area will be at least 75 feet on both sides of Breakneck Creek. Alternative 4 also includes MEC removal within the Republican River, including shoreline and sandbars, inside the MRS (**Figure 1-2**). MEC identified during remedy implementation will be detonated (treatment) and disposed, reducing the number and volume of explosive hazards. Alternative 4 may not initially allow for unlimited use and unrestricted exposure (UU/UE). Therefore, LUCs also will be implemented within the MRS. LUCs will provide protection to property owners and the public from potential hazards present at the MRS. LUCs will warn of potential MEC hazard and/or limit access to, or use of, the MRS. Additional detail on the selected remedy is presented in **Sections 2.9.2, 2.9.3, 2.9.4,** and **2.12.2**. The selected remedy is intended to be the final remedy for CFLFA2 MRS and does not impact any other areas at Fort Riley.

1.5 Statutory Determinations

This section confirms that the selected remedy satisfies the statutory requirements of CERCLA Section (§) 121 and, to the extent practicable, the NCP.

1.5.1 Part 1: Statutory Requirements

The selected remedy for the MRS is protective of human health and the environment, complies with applicable or relevant and appropriate requirements (ARARs), is cost effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

1.5.2 Part 2: Statutory Preference for Treatment

The selected remedy satisfies the statutory preference for treatment as a principal element of the remedy by reducing volume of potential MEC hazards through treatment (destruction) and munitions debris (MD) will be recycled as appropriate.

1.5.3 Part 3: Five-Year Review Requirement

Alternative 4 will result in MEC hazards potentially remaining at the MRS above levels that allow for UU/UE. Therefore, a statutory review, in accordance with NCP § 300.430(f)(4)(ii), will be conducted every five years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment. Recurring reviews will continue to be conducted every five years until risk management is no longer required.

1.6 ROD Data Certification Checklist

This section provides a data certification checklist (**Table 1-1**), which certifies that this ROD contains key remedy selection information. **Table 1-1** includes references to section numbers where the information can be found in the body of this ROD. Additional information can be found in the Administrative Record file maintained at Fort Riley, at the Dorothy Bramlage Public Library, and the Manhattan Public Library, Manhattan, Kansas (locations provided in **Section 2.3**).

Table 1-1 ROD Data Certification Checklist

Data	ROD Section
Chemicals of concern (COCs) and their respective concentrations (MEC hazards)	**Section 2.7.1**
Baseline risks represented by the COCs (MEC hazards)	**Section 2.7.1**
Cleanup levels and the basis for these levels (MEC hazards)	**Sections 2.7.3** and **2.8**
How source materials constituting principal threats are addressed	**Section 2.11**
Current and reasonably anticipated future land use assumptions	**Section 2.6**
Potential land and groundwater use that will be available at the MRS as a result of the selected remedy	**Section 2.12.4**
Estimated capital, annual operation and maintenance (O&M), total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected	**Section 2.12.3**
Key factor(s) that led to selecting the remedy	**Section 2.12.1**

1.7 Authorizing Signatures

This Record of Decision (ROD) presents the selected remedy, Alternative 4, Munitions and Explosives of Concern (MEC) Removal for Republican River and Breakneck Creek and Land Use Controls (LUCs) for the Camp Forsyth Landfill Area 2 (CFLFA2) Munitions Response Site (MRS) FTRI-003-R-01 located at Fort Riley, Kansas.

The Army is the lead agency under the Defense Environmental Restoration Program (DERP) and has developed this ROD consistent with the Comprehensive, Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This action is conducted by the Army in consultation with the U.S. Environmental Protection Agency (USEPA) and the Kansas Department of Environmental Protection (KDHE). The USEPA is the lead regulatory agency and the KDHE is the support regulatory agency. This signed ROD will be incorporated into the Administrative Record for Fort Riley available for public review at the locations described in **Section 2.3**. This document, presenting the selected remedy with a total present worth cost estimate of $4,682,000 is approved by the undersigned, pursuant to Memorandum, DAIM-ZA, 9 September 2003, subject: Policies for Staffing and Approving Decision Documents.

12 June 2020

ISAAC C. MANIGAULT
COL, CM
Commanding

Date

This Record of Decision (ROD) presents the selected remedy, Alternative 4, Munitions and Explosives of Concern (MEC) Removal for Republican River and Breakneck Creek and Land Use Controls (LUCs) for the Camp Forsyth Landfill Area 2 (CFLFA2) Munitions Response Site (MRS) FTRI-003-R-01 located at Fort Riley, Kansas.

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Scott D. Hayes Digitally signed by Scott D. Hayes Date: 2020.06.22 12:02:45 -05'00' for

Mary Peterson, Director
Superfund and Emergency Management Division
U.S. Environmental Protection Agency, Region 7

Date

This Record of Decision (ROD) presents the selected remedy, Alternative 4, Munitions and Explosives of Concern (MEC) Removal for Republican River and Breakneck Creek and Land Use Controls (LUCs) for the Camp Forsyth Landfill Area 2 (CFLFA2) Munitions Response Site (MRS) FTRI-003-R-01 located at Fort Riley, Kansas.

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Randy Carlson — 6/15/2020

Mr. Randy Carlson, Chief,
Remedial Section, KDHE-BER

Date

2.0 DECISION SUMMARY

This decision summary provides an overview of the MRS characteristics, alternatives evaluated, and the analysis of those alternatives. It also identifies the selected remedy and explains how the remedy fulfills statutory and regulatory requirements. Although some of the information presented here is similar to that in the declaration, this section discusses the topics in greater detail and provides the rationale for the summary declarations presented in **Section 1.5**.

While this document provides a consolidated summary of information about the MRS and the chosen remedy, including the rationale behind the selection, it is only one part of the Administrative Record file. The Administrative Record file contains the full details of MRS characterization, alternatives evaluation, and remedy selection. The Administrative Record file for Fort Riley is available for public review at the locations described in **Section 2.3**.

This ROD has been prepared in accordance with USEPA guidance EPA/540-R-98-031 (USEPA, 1999) and the USEPA *Toolkit for Preparing CERCLA Records of Decision* (USEPA, 2011). The ROD is based on the Remedial Investigation (RI; Bay West LLC [Bay West], 2017) Feasibility Study (FS; Trevet-Bay West Joint Venture [JV], 2018) and Proposed Plan (Army, 2019).

2.1 Site Name, Location, and Brief Description

Fort Riley is a U.S. Army Installation occupying approximately 101,733 acres in portions of Clay, Geary, and Riley Counties in northeast Kansas. Approximately 70,926 acres are used for maneuver training. Fort Riley is located directly north and east of Junction City, Kansas and lies to the west of Manhattan, Kansas. Fort Riley is located at the confluence of the Smoky Hill and Republican Rivers, which combine to form the Kansas River. Portions of Fort Riley are bounded by the cities of Ogden, Riley, and Junction City, Kansas (**Figure 1-1**). Fort Riley is on the NPL with USEPA Site ID number KS6214020756.

The 123.4-acre CFLFA2 MRS lies within the lower southwestern boundary of Fort Riley, in Geary County. The CFLFA2 MRS begins at the Breakneck Lake dam and extends south, including approximately 75 feet on both sides of Breakneck Creek, to the Republican River and the Republican Flats floodplain (**Figure 1-2**). The MRS lies between U.S. Highway 77 and Trooper Drive (formerly known as Alternate Route 77), and crosses two roads over Breakneck Creek, Rifle Range Road and Milford Lake Road. A nature trail is present within the MRS along the north side of the Republican River. There are no structures within the MRS.

2.2 Site History and Enforcement Activities

In 2002, the U.S. Congress established the Military Munitions Response Program (MMRP) to address Department of Defense (DoD) sites suspected of containing MEC or munitions constituents (MC). Under the MMRP, the Army is the lead agency conducting environmental response activities at Fort Riley. The USEPA is the lead regulatory agency with support from the KDHE. Pursuant to the DoD Manual 4715.20, Defense Environmental Restoration Program (DERP) Management (DoD, 2018), the Army is conducting MEC response activities in accordance with the DERP statute (10 United States Code [USC] 2701 et seq.), CERCLA (42 USC § 9620), Executive Orders 12580 and 13016, and the NCP (40 Code of Federal Regulations [CFR] Part 300.430). The DERP statute provides the DoD the authority to respond to releases of MEC and MC, and DoD policy states that such responses shall be conducted in accordance with CERCLA and the NCP.

Historical activities in the vicinity of the CFLFA2 MRS include the Camp Forsyth landfill, historical maneuver and training areas (including a mock Vietnam village), public walking trail, and dredging operations. Camp Forsyth historical maneuver and training areas and the historical Republican

River channels areas are shown on **Figure 2-1**. The historical and enforcement/investigation activities at the MRS are presented in **Table 2-1** and described below.

Table 2-1 Historical Timeline

Date	Activity
1930s–current	Approximate time frame for training and maneuver area activity
1944–1960	Approximate time frame for Camp Forsyth Landfill activities
1990	Fort Riley placed on NPL
1991	Fort Riley entered into Federal Facilities Agreement (FFA) with USEPA and KDHE
1993	Installation-Wide Site Assessment
2001	Removal Action-Republican River Bank Stabilization
2001	United States Geological Survey (USGS) Study
2002-2006	Routine Inspections
2006	Site Inspection (SI) Report
2011	CFLFA2 RI Technical Memo
2012	CFLFA2 Historical Records Review (HRR)
2017	CFLFA2 RI Report
2018	CFLFA2 FS Report
2019	CFLFA2 Proposed Plan

2.2.1 Installation Mission and Operational History

Fort Riley was initially established in 1853 as a temporary camp at the confluence of the Smoky Hill and Republican Rivers. It was named “Camp Center” because it was believed to be near the geographical center of the U.S. Its mission was to protect settlers moving west. Later in 1853 the camp was renamed “Fort Riley.”

Construction of many new facilities occurred during the 1880s and early 1890s. Fort Riley became the home of the Army’s Cavalry and Light Artillery Schools in 1893 (combined into the Mounted Service School in 1907) with the mission to provide instruction in advanced military training.

Fort Riley experienced a tremendous expansion of facilities during World War I. First, Camp Funston was constructed in 1917 and became the largest semi-permanent training camp in the country, with a capacity for 50,000 troops. The mission of the Mounted Service School changed in 1919 to encompass the training of officers and enlisted men in the techniques and tactics of cavalry, to the exclusion of artillery instruction. Subsequently, the name was changed at this time to the Cavalry School. Marshall Army Airfield opened on Fort Riley in 1921.

Activity increased at Fort Riley during World War II. The Cavalry Replacement Training Center was established in 1942 at the present-day location of Camp Forsyth. The center trained approximately 150,000 enlistees until its closing in 1946. An officer training program that provided courses in mechanized warfare was added to the Cavalry School. Also, during this period, Camp Whitside was built and Camp Funston was rebuilt. The Cavalry School was deactivated in 1946 when all horse units in the Army were replaced by mechanized Cavalry and Armor units. The 10th Army Training Division occupied Camp Funston beginning in 1948 and later trained troops for the Korean Conflict.

Significant restructuring of the U.S. Army began in 1996. The 1st Infantry Division’s Headquarters and many of its other elements were forward deployed to Germany. The 1st Brigade of the 1st

Infantry Division remained at Fort Riley and later was joined by the 3rd Brigade of the 1st Armored Division. The 24th Infantry Division Headquarters was moved to Fort Riley in June 1999 to consolidate Active components and Reserve components into one division.

Numerous environmental investigations and sampling events were performed at Fort Riley starting in the 1970s and are ongoing. These investigations identified activities and facilities where hazardous substances had been released or had the potential to have been released to the environment. Potential sources of contamination include a variety of landfills; printing, dry cleaning and furniture shops; and pesticide storage facilities. Fort Riley was placed on the NPL on August 30, 1990. The Army and Fort Riley entered into a Federal Facilities Agreement (FFA) with the KDHE/Bureau of Environmental Remediation (BER) and USEPA Region VII in February 1991. The FFA, which incorporates both the CERCLA and the Resource Conservation and Recovery Act (RCRA) actions, became effective in June 1991.

An Installation-Wide Site Assessment was performed in 1993 to identify potential areas of environmental concern. As a result, five OUs were established:

- OU1 – Southwestern Funston Landfill
- OU2 – Pesticides Storage Facility
- OU3 – Dry Cleaning Facility Area
- OU4 – Marshall Army Airfield - Former Fire Training Area
- OU5 – Building 354 Area Solvent Detections

Three additional OUs have been identified since that time. CFLAF2 was designated as OU9 in 2013. This ROD relates only to the CFLFA2 MRS. Seventy-two other sites were identified at Fort Riley that have been or are being addressed by the Installation Restoration Program.

When the CFLFA2 MRS was originally identified during the Site Inspection (SI; Engineering-Environmental Management, Inc. [e2M], 2006), the boundaries and investigations were focused towards determining if the Camp Forsyth landfill was the source of MEC and MC that have been encountered in the Republican River. At that time the CFLFA2 MRS covered approximately 27 acres and was located between Camp Forsyth on the north and the Republican River on the south. The SI recommended expanding the MRS footprint to 34.9 acres to include off-installation sandbars and the banks of the Republican River. Subsequent investigations determined that the former landfill was not the source of the MEC; rather, military maneuver activities were likely the source of MEC. Additional investigations brought the CFLFA2 MRS to its current size, 123.4 acres (**Figure 1-2**) including expansion to the north up to the Breakneck Lake dam, and approximately 75 feet on both sides of Breakneck Creek. The Camp Forsyth landfill, inactive since the 1960s, was officially closed under the RCRA by KDHE in 2007 (Trevet-Bay West JV, 2018).

2.2.2 History of Historical Maneuver and Training Areas

Training activities appear to have been conducted on and around the former landfill from at least the 1930s through current time. There is evidence of tracks crossing the north portion of the former landfill as early as 1934; and various vehicle tracks, roads, and disturbed areas are observed throughout the former landfill area and adjacent areas in aerial photos until at least 1977. There also appear to be vehicle tracks and roads leading to the Republican River in the area of the former landfill, sometimes leading to disturbed areas along the riverbank, in the aerial photos and base maps from at least 1934 through 1977. Anecdotal evidence indicates that the vehicle tracks, roads, and disturbed areas visible on the aerial photographs may be from both civilian and military uses.

In a 1994 memo (Bay West, 2012) regarding the discovery of MEC on Republican River sandbars in the area of the former landfill (following the 1993 flood), First Lieutenant Leland A. Browning,

Jr., Commanding Officer, Fort Riley Ordnance Division, estimated that ordnance was dumped at or very near this area sometime between 1950 and 1965 (prior to the avulsion of the river). It was suspected that all ordnance encountered on the sandbars was training ammunition (i.e., practice ammunition generally void of high explosives but sometimes containing a spotting charge). The vehicle tracks and disturbed areas observed along the Republican River in the aerial photos from 1940 through 1977 corroborate the possible MEC disposal activities at or near the Republican River as stated in the memo. However, the U.S. Army published technical guidance prohibited disposal of explosives and ammunition in waste places, pits, wells, marshes, shallow streams, and inland waterways since at least the 1920s (Army, 1928; U.S. War Department, 1945). It is probable that material was deposited prior to 1950, before the oxbow avulsed.

Munitions types discovered on the Republican River sandbars in 1994 and during subsequent investigation activities performed at the former landfill since 2000 correspond to the munition types identified in 1930s and 1940s training records reviewed for the HRR (Bay West, 2012), such as rockets, mortars, rifle grenades, hand grenades, and small arms ammunition. This is an indication that munitions-related training activities may have been conducted at or near the former landfill in the 1930s through 1940s and munitions from this era may have been fired or disposed of at the MRS.

Tank training appears to have been conducted in the immediate vicinity of the MRS since at least 1944, as supported by evidence of tank maneuvering activities observed in the aerial photos. A tank crew proficiency course is indicated adjacent to the north edge of the Camp Forsyth landfill in a 1969 base map. A tank trail is indicated adjacent to the northeast edge of the former landfill in the base maps from at least 1977 through 2010. A report of excess real property indicated that maneuver training was conducted on the 68-acre portion of oxbow land formerly within Fort Riley and adjacent to the south edge of the former landfill prior to 1945. The oxbow land was severed from Fort Riley and became inaccessible when the Republican River avulsed in 1945 (**Figure 2-1**).

2.2.3 Investigation Activities

The following sections summarize the findings of site investigation activities that are related to CFLFA2 MRS.

2.2.3.1 Installation-Wide Site Assessment

According to the Installation-Wide Site Assessment (Louis Berger & Associates, Inc. [LBA], 1993) on-site records review performed in 1985, the Camp Forsyth Landfill operated from approximately 1943 to 1957 as both the debris and sanitary landfill for Camp Forsyth. Aerial photographs taken in 1950, 1956, and 1957 indicate trench-type land filling within the originally-designated Camp Forsyth landfill boundary. Evidence of activity on the aerial photos indicates the Camp Forsyth landfill was active from at least 1950 through 1957. The former landfill is labeled “Sanitary Fill Area” in a 1957 topographic map.

Several areas of landfilling were identified in the area south of Camp Forsyth, known as the Republican Flats. Information gained during interviews and visual observations indicated that dumping may have occurred throughout the area. Thus, the entire area between Camp Forsyth and the Republican River was evaluated as a single potential area of concern (PAOC). The assessment identified limited information regarding the types of refuse placed at the former Camp Forsyth landfill; however, the former landfill was expected to consist of predominantly municipal type waste.

Information also indicated that Junction City operated a landfill in this area, just east of Trooper Drive (formerly known as Alternate Route 77) as it crosses the Republican River from Junction City to Fort Riley. The visual inspection identified uneven topography with abrupt changes,

indicative of man-made activities. While there was evidence of landfilling at several locations, no discrete landfills were readily identifiable. The west side of the Camp Forsyth landfill area had experienced erosion of the southern face, exposing landfill debris. The majority of the area was covered with soils and vegetation during the visual inspection.

2.2.3.2 Removal Action Report: Republican River Bank Stabilization

Evidence of erosion and solid waste debris was discovered along the bank of the Republican River following regional flooding in 1993. The Republican River overflowed its banks for approximately 30 days during the 1993 flood. A sandbar in the Republican River, approximately 700 feet downstream from the original Camp Forsyth landfill footprint, was found to contain MEC in the spring of 1994. Approximately 200 3.5- and 2.36-inch rockets, M1 mines, and a variety of small arms ammunition were discovered. The Fort Riley 774th Explosive Ordnance Disposal (EOD) Detachment detonated the rockets and mines in-place during the summer of 1994 and the remaining ordnance was relocated to the Fort Riley EOD Range and properly destroyed.

Aerial photographs and land surveys show that over time, the Republican River eroded an approximate 800-by-100-foot area along the riverbank of the original Camp Forsyth landfill footprint. In 1998, a design was developed to stabilize the erosion. Construction of a revetment and baffles for riverbank stabilization were completed in two phases. The first 500 feet were completed in the summer of 2000 and the remaining 1,000 feet were constructed in the spring of 2001. Unexploded ordnance (UXO) personnel were on-site to identify UXO and the Fort Riley 774th EOD Detachment was responsible for removal and destruction of UXO items.

During construction the following items were encountered: blank small arms cartridges, a .30-caliber (cal) magazine containing live cartridges, 2.36-inch rocket heads, a 2.36-inch anti-tank (AT) rocket, a 2.36-inch rocket motor, a 3.5-inch AT rocket, 4.2-inch mortar primers/igniters, three ounces of dynamite, and miscellaneous AT round components. An apparent open burn/open detonation (OB/OD) site also was identified 100 feet outside of the active construction area on and around a sandbar in the middle of the Republican River. Numerous 2.36-inch and 3.5-inch AT rockets, two rifle smoke grenades, and other blank small arms cartridges were found. The OB/OD site is likely associated with the MEC disposal activities conducted in 1994 in response to the 1993 flood. (Wenck Associates, Inc. (Wenck), 2001).

2.2.3.3 Routine Inspections

Fort Riley personnel conducted annual inspections of the Republican River sandbars and riverbed from approximately 2002 through 2006. While suspect munitions were encountered, the subsequent blow-in-place operations by Fort Riley's EOD did not yield sympathetic detonations. (Fort Riley 774th EOD Detachment, 2003 and e2M, 2006).

2.2.3.4 Site Inspection Report

The SI (e2M, 2006) of other-than-operational ranges and other sites with known or suspected MEC, MD, or MC was completed to collect information necessary to determine whether the MRS qualifies for no further action, requires immediate response, or requires further clarification. In addition, the SI also gathered information used to prepare cost-to-complete estimates and to prepare the MRS Prioritization Protocol (MRSPP).

During the visual/magnetometer survey of the originally-designated MRS, a number of suspected MEC and MD items were observed on a sandbar in the Republican River, including 7.62-millimeter (mm) cartridges, .50-cal cartridges, expended 2.36-inch rocket bodies, 2.36-inch rocket nose cones, smoke grenades, and rifle grenades. Analytical results of surface soil samples did not indicate the presence of explosives at concentrations greater than the limits of detection (LODs), nor metals at concentrations greater than the KDHE/BER Tier 2 Standards. Based on

results of the SI, the MRS was recommended for further characterization. Subsequent to the SI, the MRS footprint was modified to include off-installation sandbars and banks of the Republican River and to exclude the active training area (e2M, 2006).

2.2.3.5 Remedial Investigation Technical Memorandum

The RI field work, identified as Mobilization 1 and reported in a technical memorandum, did not identify a definitive source of the encountered MEC and MD (Bay West, 2011). A large amount of MD was recovered in an area that is not downstream of the former landfill (**Figure 2-2**). No rocket targets were encountered; however, three dud M6 rockets were encountered. MD such as fins, nose cones and expended motors related to M6 and M7 rockets were encountered. Trip flares and landmines were encountered, including practice AT landmines and one live AT landmine at the bank of the river within the central region of the MRS.

The technical memorandum concluded that it is likely that the area in and around former landfill was a maneuver area that pre-dates the landfill and further MEC may exist in areas outside of the MRS boundary. The course of the river had shifted significantly since the installation was established. Therefore, it is possible that portions of this former maneuver area are no longer within the installation boundary.

2.2.3.6 Historical Records Review

The HRR (Bay West, 2012) included a review of on-site and off-site repositories, personal interviews, and historical photograph and map review. The HRR concluded that munitions utilized in training activities were fired, stored, and/or disposed of in the immediate vicinity of the concrete rubble (**Figure 2-1**). The concrete rubble appears to have been present since at least 1940 and was located on the north portion of the former oxbow land. The oxbow land was utilized for maneuver training until it was severed from Fort Riley when the Republican River avulsed in 1945.

The river appears to have encroached upon the concrete rubble circa 1950 and the concrete remained submerged within the river channel until sometime between 1994 and 2000 (**Figure 2-1**). Munitions were first discovered at the MRS in the spring of 1994, following the 1993 regional flooding of the Republican River. More than 200 MD items and at least 10 MEC items were encountered at the MRS during SI and remediation activities.

The majority of MD identified during initial RI field work in 2011 was clustered on the sandbar along the south side of the Republican River (**Figure 2-2**), in the immediate vicinity of the concrete rubble. Additionally, a large geophysical anomaly was identified on a sandbar approximately 100 feet southeast of the concrete rubble (adjacent to the revetment) during the 2011 geophysical survey. This anomaly was suspected to represent a high concentration of MD and MEC buried in the sandbar. However, very few MD items had been encountered upstream of the concrete rubble, and these few items were located immediately upstream of the concrete rubble. Based on this information, the HRR concluded that the primary source of the MEC and MD at the MRS was likely to be in the immediate vicinity of the concrete rubble.

According to the HRR, training munitions may also have been dumped on land and/or in the Republican River in the vicinity of the former landfill in the 1930s through 1970s. Tracks leading through the former landfill and to disturbed areas along the Republican River have been identified in historic aerial photos and installation maps. These training munitions are likely inert or have had their energetic material expended or removed because the U.S. Army has officially prohibited disposal of munitions in waste places, pits, wells, marshes, shallow streams, and inland waterways since at least the 1920s.

The Republican River channel has migrated both laterally and vertically significantly throughout time in the vicinity of the MRS (**Figure 2-1**). The Republican River channel bed lowered

approximately 9 feet between 1967 and 1997. It is suspected that MEC and MD identified at the MRS have migrated with the changes in the Republican River channel location and depth; undiscovered MEC may be located in the vicinity of previous river channels throughout the MRS and adjacent areas. Interviews with the neighboring sand dredging operation located south of MRS stated that MEC or MD have been recovered at those operations. The HRR found no indication of MC sampling at the sand dredging operations. Based on the interviews and a review of the historic river channel configurations and locations of tracks and disturbed areas identified along the river, the HRR concluded that MEC are potentially located outside of the former landfill in the following areas:

- On Fort Riley within the MRS and adjacent to the east edge of the MRS; and
- Off Fort Riley within the MRS and adjacent to the northwest and south edge of the MRS.

The HRR concluded that the source of the munitions is not the former landfill and that the munitions are associated with the military maneuver area.

The HRR also reported on the 2001 U.S. Geological Survey (USGS) Water-Resources Investigations Report 01-4205 that was completed to assess the channel-bed elevation changes downstream from 24 large Federal reservoirs in Kansas using information from USGS streamflow-gaging stations. The reservoirs, most of which were completed in the 1950s or 1960s, were built by either the U.S. Army Corps of Engineers (USACE) or the Bureau of Reclamation initially for the primary purposes of providing flood control and water for irrigation. The Republican River channel bed downstream from Milford Lake was studied during the USGS investigation. The study determined that the Republican River downstream from Milford Lake dam began a pronounced lowering of the river channel bed elevation downstream immediately after completion of the dam in 1967. From 1967 to 1997, the channel bed lowered at an average rate of approximately 0.3 feet per year, which resulted in a lowering of the streambed by approximately 9 feet between 1967 and 1997. The rate of lowering was reported to have stabilized in recent years (Bay West, 2012).

2.2.3.7 Remedial Investigation Report

The RI (Bay West, 2017) characterized the nature and extent of impacts to the MRS and evaluated the risks posed by the MRS to human health and the environment in three mobilization events. Mobilization 1 is summarized in **Section 2.2.3.5**, and the results of all three mobilizations are summarized in this section. The RI addressed MEC hazards, as well as MC in environmental media. The MEC investigation was performed in an expanded area, including underwater locations and a portion of Breakneck Creek. The RI included intrusive investigation of 4,604 subsurface anomalies, 2.3 acres of mag and dig, 2.4 acres of bulk removal (i.e., with earth moving machinery), and collection of 50 analytical samples.

MEC

Fourteen MEC items were recovered. The average MEC density for the area investigated (48.7 acres) was 0.29 MEC items per acre. In general, the MEC encountered were located adjacent to or in the Republican River at depths up to 2 feet below ground surface (bgs). Concentrated areas of MD were encountered in sediments and sandbars within the Republican River. Pits of debris were excavated to depths of up to 9 feet bgs. The location of the MEC and MD items found during investigation activities are shown on **Figure 2-2**. A summary of MEC items and types of MEC and MD items recovered during investigation activities is provided in **Table 2-2** and **Table 2-3**, respectively.

Table 2-2 MEC Recovered During RI

Nomenclature	Type
Bulk TNT	Bulk HE
M18 Smoke Grenade	Grenade
M22 Rifle Grenade, Smoke	Grenade
M22 Rifle Grenade, Smoke	Grenade
M22 Rifle Grenade, Smoke	Grenade
M-49A2/3 60-mm Mortar	Mortar
M6 AT	Mine
M604 Fuze for M12/M20 AT Mine	Fuze
M6A3 2.36-inch Rocket (HEAT)	Rocket
M9A1 Rifle Grenade (HEAT)	Grenade
Signal, Illumination Rifle	Flare
Trip Flare	Flare

Notes:
HE = high-explosive
HEAT = high-explosive anti-tank
TNT = trinitrotoluene

Table 2-3 Identifiable Munitions (MEC or MD) Recovered During RI

Nomenclature	Type
Unknown	40 mm cartridge case
Unknown	57 mm recoilless rifle cartridge case
Unknown	90 mm cartridge case
Unknown	105 mm illumination candle
M1	Landmine, AT, practice
M11	Rifle grenade
M12 (T8E1)	Landmine, AT, practice
M126, M127, or M195	Signal, illumination, ground (slap flare)
M18	Grenade, smoke
M19	Rifle grenade, smoke
M22	Rifle grenade, smoke
M28A2	3.5-inch rocket, HEAT
M29	3.5-inch rocket, practice
M30	Grenade, practice
M48	Trip flare
M49A2 or M49A3/A4	60-mm mortar
M5	Landmine, AP, (mouse trap/booby trap)
M6	Landmine, AT, practice
M6	Landmine, heavy, AT
M6	2.36-inch rocket
M62	Grenade, practice
M604	Fuze for M12/M20 AT land mine
M609	Land mine fuze, practice
M7A4/A5	2.36-inch rocket, practice
M8	Landmine, AP, practice
M8	Grenade, smoke
MkII	Hand grenade, practice
Unknown	37 mm projectile
M18, M20, M22, M52	Signal illumination, ground (rifle grenade)
Unknown	4.2-inch mortar

Notes:
AP = anti-personnel
Unknown = not identifiable due to deterioration or lack of identification features

A summary of the types of items, locations, and potential associations are described below:

- **Rockets**: Rocket debris was clustered along Breakneck Creek and in the northern portions of the Republican River within CFLFA2. This supports historical records which indicate that there was a rocket range near the current location of the Fort Riley Elementary School.
- **Grenades**: Grenade debris was found primarily along Breakneck Creek and near the historical Vietnam village.
- **Mines**: Anti-personnel (AP) and AT landmine debris was found near the historical Vietnam village.
- **Trip Flares**: Most trip flare debris was encountered near the historical Vietnam village. Additional trip flare debris was encountered upstream of the village.
- **Rifle Grenade (smoke and AT)**: Rifle grenade debris was encountered in the banks and the river near the historical Vietnam village.

In addition, range-related debris (RRD), small arms ammunition debris (SAAD), and other debris (OD) was recovered during the follow-on RI as described below:

- **RRD and SAAD**: RRD and SAAD were encountered in the Republican River, Breakneck Creek, and the banks of the Republican River. The highest densities of RRD and SAAD were located in the vicinity of the Vietnam village and where Breakneck Creek meets the Republican River. In general, RRD and SAAD were not recovered downstream of the historical Vietnam village.
- **OD**: OD was the most common material recovered during the RI. It was most dense from the south portion of Breakneck Creek to just downstream of the Vietnam village. Although the density of OD recovered does not assist with the definition of the nature and extent of MEC and MD at the site, it provides context for the level of effort for any future investigation or remedial activities in the area.

Most of the MEC encountered throughout the three mobilizations were located adjacent to or in the Republican River at depths up to 2 feet bgs. Concentrated areas of MD were encountered in sediments and sandbars within the Republican River and were located primarily within the northern portions of the MRS. Pits of debris were excavated to depths up to 9 feet bgs.

The area around the concrete rubble was investigated (i.e., rubble removed, area investigated, rubble replaced) as a potential source area. However, the findings do not support the concrete rubble as a source area. A trash pit was encountered during the RI effort. The pit was characterized using earth moving machinery and was densely packed with household waste and MD. Although the pit was determined to be a potential source of MEC and MD in the Republican River, it was concluded that it did not appear to be the only source. Geophysical surveys completed to the north of the pit indicated additional anomalies are present that may represent MEC. These anomalies were not scoped for investigation under follow-on RI activities. In addition, the MEC and MD encountered in Breakneck Creek indicate that MEC and MD may be more widespread than originally anticipated.

The RI did not include 100 percent (%) investigation of any portions of the investigated areas; the RI included investigation of a subset of the anomalies identified and transect sweeps. Therefore, the actual densities of MEC and MD in these areas may be higher. The findings of the RI field efforts show that MEC have been identified cross-gradient and upgradient from the former landfill, confirming that the landfill area is not the source of the MEC and MD. MEC may be associated with the historical maneuver areas or active training areas. A MEC risk assessment was completed as part of the RI work and is summarized in **Section 2.7.1**.

MC

Detonation, damage on impact, or degradation of MEC may release the chemicals that are associated with the composition of munitions to the environment. These chemicals are called MC and include metals and explosive compounds. Primary sources of potential MC are the residue of munitions and their filler materials remaining in the environment because of munitions firing, detonation, or disposal.

Seven metals and one explosive compound were detected in investigative area samples. In all cases, suspected MC compounds were compared to their most conservative media-specific human health and ecological screening levels (ESLs) and background levels. Analytical results were below respective screening levels and/or background levels. MC sampling results are presented in **Tables 2-4** through **2-7**. Please note that both investigative area soil and demolition area soil sample results are presented in **Table 2-4**. Investigative area results for antimony, selenium, and tetryl are “U” flagged, meaning they were “not detected at the LOD.” The risk posed by the constituents identified in the MC evaluation samples and their LODs are addressed in the human health risk assessment (HHRA) and in the screening level ecological risk assessment (SLERA) summarized in **Section 2.7.2**.

Table 2-4 MC Analytical Data, Investigative Area Soil and Demolition Area Soil

Analyte	Background Levels (mg/kg) [5]	Human Health Screening Criteria* (mg/kg)	Ecological Screening Criteria† (mg/kg)	4/12/2011 CFLFA2-11-04-S-003-PS	4/12/2011 CFLFA2-11-04-S-004-PS	4/12/2011 CFLFA2-11-04-S-005-PS	4/12/2011 CFLFA2-11-04-S-006-PS	4/12/2011 CFLFA2-11-04-S-007-PS	4/12/2011 CFLFA2-11-04-S-008-TS [1]	4/13/2011 CFLFA2-11-04-S-009-PS	4/14/2011 CFLFA2-11-04-S-010-PS	4/14/2011 CFLFA2-11-04-S-011-PS	4/14/2011 CFLFA2-11-04-S-013-PS	4/14/2011 CFLFA2-11-04-S-014-PS	4/14/2011 CFLFA2-11-04-S-015-TS [3]	4/14/2011 CFLFA2-11-04-S-017-PS	4/18/2011 CFLFA2-11-04-S-018-PS	4/18/2011 CFLFA2-11-04-S-019-PS	6/19/2014 CFLA2-14-06-S-002-PS	6/19/2014 CFLA2-14-06-S-003-PS	6/19/2014 CFLA2-14-06-S-004-PS	6/19/2014 CFLA2-14-06-S-005-PS	6/19/2014 CFLA2-14-06-S-006-PS	2/16/2011 CFLFA2-11-02-S-001-PS	4/5/2011 CFLFA2-11-04-S-002-PS	4/14/2011 CFLFA2-11-04-S-012-PS [2]	4/14/2011 CFLFA2-11-04-S-016-PS [4]	10/28/2015 CFLA2-15-10-S-013-PS	11/4/2015 CFLA2-15-11-S-014-PS	11/4/2015 CFLA2-15-11-S-015-FS
Sample Type				**Investigative Area Soil**																					**Demolition Area Soil**					
Inorganics (mg/kg)																													
Antimony	6	31	0.27	0.58 U	0.59 U	0.57 U	0.59 U	0.55 U	0.58 U	0.55 U	0.57 U	0.59 U	0.58 U	0.57 U	0.58 U	0.55 U	0.60 U	0.55 U	0.63 U	0.65 U	0.63 U	0.62 U	0.65 U	0.59 U	0.58 UJ	0.56 U	0.56 U	**0.44 J**	0.48 U	0.49 U
Arsenic	5	0.68	18	**2.1 J**	**1.1 J**	**1.5 J**	**1.5 J**	**1.4 J**	**1.9 J**	**1.2 J**	**1.0 J**	**1.1 J**	**1.1 J**	**1.3 J**	**1.2 J**	**1.3 J**	**1.4 J**	**0.76 J**	**1.4 J**	**3.8**	**2**	**2**	**1.7**	**1.0 J**	**0.88 J**	**1.3 J**	**1.4 J**	**5**	**2.5**	**2.4**
Barium	–	15,000	330	**31**	**22**	**33**	**28**	**36**	**31**	**23**	**22**	**16**	**21**	**22**	**29**	**29**	**38**	**21**	**38 J**	**52**	**40**	**35**	**33**	**25**	**18**	**29**	**38**	**130 J**	**46**	**41**
Cadmium	1	71	0.36	**0.048 J**	0.098 U	**0.041 J**	0.099 U	**0.049 J**	**0.046 J**	0.091 UJ	0.096 U	0.098 U	0.097 U	0.095 U	0.096 U	0.091 U	**0.047 J**	0.092 U	**0.069 J**	**0.10 J**	**0.11 J**	**0.049 J**	**0.15 J**	0.099 U	0.097 U	0.093 U	0.094 U	**0.53**	**0.10 J**	**0.078 J**
Chromium	24.06	0.3	26	**2.1 J**	**0.88 J**	**2.0 J**	**1.6 J**	**2.6 J**	**2.1 J**	**1.1 J**	**0.87 J**	**0.69 J**	**0.97 J**	**1.4 J**	**1.0 J**	**2.4 J**	**2.7 J**	**1.1 J**	**1.0 J**	**3.1**	**1.9 J**	**1.3 J**	**1.5 J**	**0.75 J**	**0.85 J**	**0.83 J**	**0.87 J**	**12 J**	**3.4**	**3.4**
Copper	17.68	3,100	28	**1.8 J**	**0.57 J**	**1.5 J**	**1.6 J**	**2.7 J**	**1.7 J**	**0.71 J**	**0.47 J**	**0.38 J**	**0.68 J**	**0.64 J**	**0.72 J**	**1.3 J**	**1.6 J**	**0.54 J**	**1.2 J**	**3.3**	**3.2**	**2.9**	**3.8**	**0.38 J**	**0.53 J**	**1.3 J**	**1.4 J**	**2700**	**4.9**	**3.7**
Lead	32.31	400	11	**2.9**	**1.3**	**3.9**	**2.6**	**2.2**	**2.7**	**1.7 J**	**1.5**	**1.4**	**6.5 J**	**2**	**1.9 J**	**2.5**	**2.9**	**1.7**	**2.2**	**3.2**	**4.7**	**3**	**1.8**	**1.2**	**1.4**	**2**	**2.3**	**770 J**	**4.1**	**3.8**
Selenium	0.6	390	0.52	1.2 U	1.2 U	1.1 U	1.2 U	1.1 U	1.2 U	1.1 U	1.1 U	1.2 U	1.2 U	1.1 U	1.2 U	1.1 U	1.2 U	1.1 U	1.3 U	1.3 U	1.3 U	1.2 U	1.3 U	1.2 U	1.2 U	1.1 U	1.1 U	**1.4 J**	**0.83 J**	0.97 U
Zinc	72.86	23,000	46	**11**	**4.2**	**6.8**	**8.9**	**8.7**	**7.9**	**4.2 J**	**2.8 J**	**2.4 J**	**5.5**	**4.6**	**4.1**	**8.6**	**8**	**3.2**	**50 J**	**11**	**16**	**10**	**5.9**	**2.5 J**	**2.6 J**	**3.5**	**4.2**	**130 J**	**11**	**11**
Explosives (mg/kg)																													
2,4,6-TNT	–	21	7.6	0.039 U	0.038 U	0.038 U	0.038 U	0.040 U	0.038 U	0.040 U	0.037 U	0.038 U	0.040 U	0.040 U	0.039 U	**0.96**	0.037 U	0.038 U	0.040 U	0.039 U	0.039 U	0.039 U	0.038 U	0.039 U	0.038 U	0.040 U	0.039 U	0.097 U	0.095 U	0.096 U
Tetryl	–	160	1.5	0.078 U	0.075 U	0.076 U	0.077 U	0.080 U	0.077 U	0.079 U	0.074 U	0.076 U	0.080 U	0.079 U	0.077 U	0.076 U	0.075 U	0.077 U	0.079 U	0.079 U	0.078 U	0.078 U	0.076 U	0.077 U	0.075 U	**0.047 J**	0.078 U	**0.11 J**	0.095 U	0.096 U

Notes:
Shaded indicates the result exceeds one or more screening criterion
Bold = Result above LOD
** Screening criteria is the most conservative of KDHE risk-based residential scenario values for soil (soil pathway and soil to groundwater pathway) (RSK Manual, 5th Version, September 2015) and the EPA Regional Screening Level (RSL) for residential soil (USEPA RSL Table, November 2017). RSLs are based on a 1E-06 excess cancer risk and a non-cancaer target hazard quotient of 1.0.*
† Screening criteria is the most conservative of the EPA Eco-SSLs. If an Eco-SSL is not available, the most conservative Los Alamos National Laboratory (LANL) EcoRisk Database Ecological Screening Levels (ESLs) (Release 3.2, October 2014) was used.
– Not established or insufficient data to calculate value
(1) Replicate sample of S-003
(2) Post-explosive demil sample (pre explosive sample = S-001)
(3) Replicate sample of S-013
(4) Post-explosive demil sample (pre explosive sample = S-002)
(5) Burns and McDonnell, 2001
J = estimated quantity
mg/kg = milligrams per kilogram
U = non-detection as <LOD
LOD = limit of detection

Table 2-5 MC Analytical Data, Sediment

Analyte	Human Health Screening Criteria* (mg/kg)	Ecological Screening Criteria† (mg/kg)	04/14/11 CFLFA2-11-04-SD-001-PS	04/14/11 CFLFA2-11-04-SD-002-PS	04/14/11 CFLFA2-11-04-SD-003-PS	04/14/11 CFLFA2-11-04-SD-004-FS (1)	08/27/14 CFLA2-14-08-SD-010-PS	08/27/14 CFLA2-14-08-SD-011-PS	08/27/14 CFLA2-14-08-SD-012-PS
Inorganics (mg/kg)									
Arsenic	0.68	9.79	**2.0**	**1.4 J**	**2.2**	**1.0 J**	**1.5**	**0.78 J**	**1.1 J**
Barium	15,300	48	**34**	**27**	**27**	**19**	**39**	**24**	**25**
Cadmium	71	0.99	0.10 U	0.11 U	**0.078 J**	0.11 U	0.098 U	0.088 U	0.11 U
Chromium	0.3	43.4	**1.1 J**	**0.61 J**	**0.80 J**	**0.61 J**	**1.0 J**	**0.74 J**	**1.1 J**
Copper	3,100	31.6	**0.98 J**	**0.72 J**	**0.83 J**	**0.66 J**	**0.88 J**	**0.53 J**	**0.53 J**
Lead	400	35.8	**2.0**	**1.5**	**2.7**	**1.2**	**2.0**	**1.2**	**1.2**
Zinc	23,000	121	**3.6**	**3.0**	**3.2**	**2.2 J**	**4.9**	**3.3**	**4.0**

Shaded indicates the result exceeds one or more screening criterion

Bold = Result above LOD

** Screening criteria is the most conservative of KDHE risk-based residential scenario values for soil (soil pathway and soil to groundwater pathway) (RSK Manual, 5th Version, September 2015) and the EPA Regional Screening Level (RSL) for residential soil (USEPA RSL Table, November 2017) was used. RSLs are based on a 10^{-6} excess cancer risk and a non-cancer target hazard quotient of 1.0*

† Screening criteria is the consensus-based Threshold Effect Concentration (TEC) (MacDonald et al., 2000). If a TEC is not available, the Los Alamos National Laboratory (LANL) ESL (Release 3.2, October 2015) was used.

(1) Duplicate sample of SD-003

mg/kg = milligrams per kilogram
J = estimated quantity
U = non-detection as <LOD
LOD = limit of detection

Table 2-6 MC Analytical Data, Surface Water

Analyte	Human Health Screening Criteria* (µg/L)	Ecological Screening Criteria† (µg/L)	04/14/11 CFLFA2-11-04-SW-001-PS	04/14/11 CFLFA2-11-04-SW-002-PS	04/14/11 CFLFA2-11-04-SW-003-PS	04/14/11 CFLFA2-11-04-SW-004-FS (1)	08/27/14 CFLA2-14-08-SW-007-PS	08/27/14 CFLA2-14-08-SW-008-PS	08/27/14 CFLA2-14-08-SW-009-PS
Inorganics (µg/L)									
Arsenic	0.052	150	**9.4 J**	**6.5 J**	**6.2 J**	**8.4 J**	**11 J**	**11 J**	**9.1 J**
Barium	2,000	--	**230**	**220**	**220**	**220**	**210**	**190**	**190**
Chromium	0.035	40	1.5 U	1.5 U	1.5 U	1.5 U	**1.3 J**	1.5 U	1.5 U
Copper	800	9.3 a,b	**3.1 J**	**3.7 J**	**3.2 J**	**3.1 J**	**3.6 J**	3.5 U	3.5 U
Selenium	50	5	**9.1 J**	12 U	12 U	12 U	12 U	**4.9 J**	12 U
Zinc	5000	120 a	13 U	13 U	13 U	13 U	**7.5 J**	13 U	13 U

Shaded indicates the result exceeds one or more screening criterion

Bold = Result above LOD

** Screening criteria is the more conservative of public health domestic water supply values from KDHE Kansas Surface Water Quality Standards (March 2015), USEPA maximum contaminant levels (MCLs) and USEPA tap water RSL (USEPA RSL Table, November 2017). RSLs are based on a 10^{-6} excess cancer risk and a non-cancer target hazard quotient of 1.0*

† Screening criteria is aquatic life chronic values from KDHE Kansas Surface Water Quality Standards, March 2015.

-- Not established or insufficient data to calculate value

(1) Duplicate sample of SW-003

[a] Hardness-dependent aquatic life support criteria. Value shown assumes a hardness of 100 mg/L. http://www.kdheks.gov/water/download/swqs_numeric_criteria.pdf

[b] KDHE Bureau of Water. Kansas Surface Water Standards. 1 October 2012. (http://www.kdheks.gov/water/download/swqs_numeric_criteria.pdf)

µg/L = micrograms per liter

J = estimated quantity

LOD = limit of detection

U = non-detection as <LOD

Table 2-7 MC Analytical Data, Groundwater

Analyte	Background Levels[c]	Human Health Screening Criteria* (µg/L)	Ecological Screening Criteria† (µg/L)	04/13/11 CFLFA2-11-04-GW-001-PS	04/13/11 CFLFA2-11-04-GW-002-PS	04/13/11 CFLFA2-11-04-GW-003-PS	04/13/11 CFLFA2-11-04-GW-004-PS	04/13/11 CFLFA2-11-04-GW-005-PS	04/13/11 CFLFA2-11-04-GW-006-PS	04/13/11 CFLFA2-11-04-GW-007-FS [(1)]	04/13/11 CFLFA2-11-04-GW-008-PS	04/13/11 CFLFA2-11-04-GW-009-PS
Inorganics (µg/L)												
Arsenic	20	0.052	150	12 U	**4.6 J**	12 U	**11 J**	**5.2 J**	12 U	12 U	12 U	12 U
Barium	--	2,000	--	**150**	**220**	**260**	**430**	**370**	**240**	**220**	**420**	**360**
Chromium	6.5	0.035	40	1.5 U	1.5 U	1.5 U	**8.4 J**	1.5 U	1.5 U	1.5 U	**1.4 J**	**1.2 J**
Copper	52	800	9.3 a,b	**4.0 J**	**4.2 J**	**3.5 J**	**12 J**	**5.0 J**	**2.4 J**	**4.0 J**	**4.0 J**	**4.2 J**
Lead	12	15	2.5 a	5.0 U	5.0 U	5.0 U	**7.8 J**	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Selenium	5	50	5	**26**	12 U	**7.8 J**	12 U	12 U	12 U	12 U	**7.0 J**	**6.5 J**
Zinc	388	4,670	120 a	13 U	13 U	13 U	**31 J**	**4.8 J**	13 U	13 U	**5.3 J**	**8.4 J**

Shaded indicates the result exceeds one or more screening criterion

Bold = Result above LOD

** Screening criteria is the more conservative of the KDHE risk-based residential scenario values for groundwater pathway from RSK Manual 5th Version, September 2015, USEPA maximum contaminant levels (MCLs) and USEPA tap water RSL (USEPA RSL Table, November 2017). RSLs are based on a 10^{-6} excess cancer risk and a non-cancer target hazard quotient of 1.0*

† Screening criteria is aquatic life chronic values from KDHE Kansas Surface Water Quality Standards, March 2015.

-- Not established or insufficient data to calculate value

(1) Duplicate sample of GW-002

[a] Hardness-dependent aquatic life support criteria. Value shown assumes a hardness of 100 mg/L. http://www.kdheks.gov/water/download/swqs_numeric_criteria.pdf

[b] KDHE Bureau of Water. Kansas Surface Water Standards. 1 October 2012. http://www.kdheks.gov/water/download/swqs_numeric_criteria.pdf

[c.] Burns and McDonnell, 2001

J = estimated quantity

U = non-detection as <LOD

LOD = limit of detection

µg/L = micrograms per liter

Seven demolition area soil samples were collected from four demolition locations associated with the three mobilizations. Explosives were not detected in demolition area soil in concentrations above their respective human health and ecological soil screening levels (Eco-SSLs). Lead, arsenic, and chromium were detected in demolition area soil in concentrations exceeding their respective human health-based screening levels. Antimony, cadmium, copper, lead, selenium, and zinc were detected in demolition area soil in concentrations exceeding their respective Eco-SSLs. Of these metals, copper, lead, selenium, and zinc were detected in concentrations exceeding their respective background concentrations (Burns and McDonnell, 2001). Additional detail on these metals is presented below. The demolition area shot holes were backfilled, limiting the potential for exposure to residual contaminants.

- **Copper, lead, and zinc**: These exceedances were limited to sample location CFLA2-15-10-S-013-PS. This sample location was associated with the Breakneck Creek work and the sample was collected within the historical maneuver areas approximately 1,600 feet north of the nearest RI soil sample location. Given the location of this sample and that explosives were not associated with this sample location, these metals in soil are likely not associated with demolition activities and instead, likely indicate an impact from the historical small arms ranges located to the east of the MRS.
- **Selenium**: Selenium was detected at two locations (CFLA2-15-10-S-013-PS and CFLA2-15-10-S-014-PS); both detections exceeded the most conservative Eco-SSL. A 1998 USGS study of sediments in Milford Lake as well as other lakes in its drainage basin noted an increase in selenium concentrations due to irrigation of areas within the watershed (Juracek and Ziegler, 1998). The sediment concentration associated with Milford Lake during this study (0.8 milligrams per kilogram [mg/kg]) is greater than the soil background concentration for selenium at Fort Riley (0.6 mg/kg). Irrigation water may be contributing to the selenium detected in soil at CFLFA2.

Based on the results of the RI, an FS for MEC was recommended for the portions of the areas investigated that are not part of the active training areas or landfill.

2.2.3.8 Feasibility Study Report and Proposed Plan

An FS (Trevet-Bay West JV, 2018) for MEC hazards was completed using the results of the investigation activities. Five alternatives were initially screened to address MEC hazards at the MRS. Four of the five alternatives were carried forward for further evaluation. During the development of the draft Proposed Plan, due to initial feedback from stakeholders, modifications were made to the alternatives, including a substantial modification to enlarge the MRS area to include all of Breakneck Creek to the north up to the Breakneck Lake dam. This resulted in the revision of the alternatives in the Proposed Plan (Army, 2019). As a result of these changes, cost estimates also were revised to support the Proposed Plan. The Proposed Plan reflects these modifications. The remainder of this ROD summarizes the outcomes of the FS and Proposed Plan.

2.3 Community Participation

NCP Section 300.430(f)(3) establishes a number of public participation activities that the lead agency must conduct during the remedy selection process. Components of these activities and documentation of how each component was satisfied for the MRS are described in **Tables 2-8** and **2-9**.

Table 2-8 Public Notification of Document Availability

Requirement	Satisfied by
Notice of availability of the Proposed Plan, RI/FS must be made in a general circulation major local newspaper.	Notice of availability was published in: (1) *The Daily Union, Junction City,* Kansas (September 29, October 1, October 6, and October 8, 2019); (2) *The Manhattan Mercury*, Manhattan, Kansas (September 29, October 1, October 6, and October 8, 2019); and (3) *The 1st Infantry Division Post. Fort Riley*, Kansas (October 4, and October 11, 2019).
Notice of availability must include a brief abstract of the Proposed Plan, which describes the alternatives evaluated and identifies the preferred alternative (NCP Section 300.430[f][3][i][A]).	The notice of availabilities included the required components and is included for reference in **Appendix B**.

Table 2-9 Public Comment Period Requirements

Requirement	Satisfied by
Lead agency should make document available to public for review on same date as newspaper notification.	The Proposed Plan was made available to the public on October 7, 2019.
Lead agency must ensure that all information that forms the basis for selecting the response action is included as part of the Administrative Record file and made available to the public during the public comment period.	Fort Riley maintains the Administrative Record file for the MRS at the locations identified below. Data collected and CERCLA primary documents produced for the MRS were placed therein and made available to the public at those locations. Directorate of Public Works Environmental Division 1MNW-RLY-PWE 407 Pershing Court Fort Riley, Kansas, 66442 Dorothy Bramlage Public Library 230 West 7th Street Junction City, Kansas 66441 Manhattan Public Library 629 Poyntz Avenue Manhattan, Kansas 66502
CERCLA Section 117(a)(2) requires the lead agency to provide the public with a reasonable opportunity to submit written and oral comments on the Proposed Plan. NCP Section 300.430(f)(3)(i)(C) requires the lead agency to allow the public a minimum of 30 days to comment on the RI/FS, Proposed Plan, and other supporting information located in the Administrative Record.	The Army provided a public comment period for the Proposed Plan and other supporting information from October 7, 2019 to November 7, 2019 (30 days).
The lead agency must extend the public comment period by at least 30 additional days upon timely request.	The Army received no requests to extend the public comment period.
The lead agency must provide the opportunity for a public meeting to be held at or near the MRS during the public comment period.	The Army held a public meeting on October 23, 2019, at Riley's Community Center, Fort Riley, Kansas, to accept oral and written comments. A copy of the transcript is included as **Appendix B**.
The lead agency should solicit community input on reasonably anticipated future land use and potential beneficial groundwater uses at the site.	This information was solicited during the public meeting. No additional information from the public was obtained.

2.4 Scope and Role of the Operable Unit or Response Action

The Fort Riley site includes nine total OUs with chemicals of concern (COCs) primarily including chlorinated solvents, MEC, and metals. The response action described in this ROD only pertains to OU-9, encompassing the CFLFA2 MRS. No COCs have been identified for OU-9. However, explosive hazards may remain at the MRS due to the potential presence of MEC, which is the focus of this response action. Previous response activities at OU-9 include a Republican River

bank stabilization completed in 2001 and several rounds of MEC removal and detonation during site investigations, including during the multi-phase RI (Bay West, 2017) performed from 2011 to 2015. These project phases resulted in decreasing the volume of MEC remaining. However, the areal extent of OU-9 increased to encompass additional areas potentially impacted by MEC. This response action is being conducted independent of any RCRA Corrective Actions undertaken at Fort Riley.

2.5 Site Characteristics

This section presents a brief overview of the MRS and its environments that are used to develop the conceptual site model (CSM) upon which the risk assessments and response actions are based. This CSM was developed in accordance with USACE guidance (USACE, 2012) and describes the sources of MEC and MC hazards at a site, actual or potential pathways, current or proposed use of property, and potential receptors to explosives hazards or MC. The CSM provides a planning tool to integrate site information from a variety of sources, evaluate the information with respect to project objectives and data needs, and respond through an iterative process for further data collection or response action. The CSM development is a process that reflects the progress of activities at a site from initial assessment through site closeout. Information in this CSM includes:

- **Facility Profile**: Describes the history, location, and man-made features at or near the site (**Sections 2.1** and **2.2**);
- **Physical Profile**: Describes the factors that may affect release, fate, and transport (**Sections 2.5.1**);
- **Land Use and Exposure Profile**: Provides the information used to identify and evaluate the applicable exposure scenarios and receptor locations (**Section 2.6**);
- **Ecological and Cultural Resources Profile**: Describes the natural habitats and ecological receptors present on and around the site (**Sections 2.5.2**); and
- **Release Profile**: Presents the extent of contaminants or hazards in the environment (**Section 2.5.3**).

Using the MRS characteristics, nature and extent of contamination, land use, exposure route, and receptors, graphical depictions of the CSM for MEC (**Figure 2-3**) and MC (**Figure 2-4**) were developed for the MRS illustrating current and future risks to human health and the environment.

2.5.1 Physical Profile

2.5.1.1 Climate

Fort Riley has a temperate continental climate characterized by hot summers, cold dry winters, moderate winds, low humidity, and a pronounced peak in rainfall late in the spring and in the first half of summer. Prevailing winds are from the south to southwest during most of the year, except during February and March when the prevailing winds are from the north.

Temperatures in the Fort Riley area vary widely and often fluctuate abruptly throughout the year. July and August are the hottest months, averaging 80 degrees Fahrenheit (°F). January is the coldest month, averaging 26°F. The average date of the last killing frost in spring is April 22 and the average date of the first killing frost of the fall is October 17. The area has an average of 180 frost-free days per year.

Average yearly precipitation is 31.64 inches and 75% of the precipitation falls within the 6-month period from April through September, with the three highest monthly rainfall totals averaging more than 4 inches per month in May, June, and July. Much of this precipitation occurs during severe thunderstorms, when 2 inches or more of rain may fall in one storm. The driest months are

December, January, and February, with each averaging less than 1.56 inches of liquid equivalent precipitation. An average of 22 inches of snowfall occurs annually.

Insufficient precipitation is the major limiting factor to plant growth at Fort Riley. Spring rains are sufficient to recharge soil moisture before the summer months when evapotranspiration rates typically exceed precipitation rates, especially in the latter half of the summer. In years of below average rainfall, soil moisture in the upper soil levels is depleted, which stresses shallow rooted plants (Bay West, 2014).

2.5.1.2 Topography

The ground surface elevation at Breakneck Lake dam is approximately 1,175 feet above mean sea level (msl). The elevation at the southwestern end of the MRS at the Republican River is approximately 1,050 feet above msl.

Three types of physiographic areas are found at Fort Riley: high upland tallgrass prairies, alluvial bottomland floodplains, and broken and hilly transition zones. Alternating layers of Permian-aged limestone and shale dominate the uplands. The softer shale units eroded at a significantly faster rate than the more resistant limestone escarpments, which form the broken and hilly transition areas of the central and east portions of the Installation.

The cutting action of the streams on the thick shale units has sculpted much of the area into a rolling plateau. Fort Riley is composed of two types of alluvial bottomlands: wide meandering floodplains of major rivers with associated terraces, and areas created by smaller creeks and streams that cut the uplands (Bay West, 2014).

2.5.1.3 Hydrology

Surface waters on Fort Riley are within the Lower Republican-Upper Kansas River drainage basin. Intermittent and perennial creeks, ponds, lakes, and rivers are represented at Fort Riley. With 15,600 surface acres of water and 163 miles of shoreline, Milford Lake is a reservoir on the western edge of Fort Riley that impounds the Republican River; it is located approximately 2.25 miles upstream of the MRS. Fort Riley has an additional 174 lakes and ponds ranging in size from 0.1 to 40 acres. With the exception of three oxbow lakes, the lakes and ponds on Fort Riley are man-made. Fort Riley manages 29 lakes and ponds to provide fishing opportunities for civilian and military personnel.

Fort Riley is drained by the Republican River, Kansas River, Threemile Creek, Sevenmile Creek, Honey Creek, Wildcat Creek, and numerous smaller tributaries. The Kansas and Republican Rivers are along the southern boundary of Fort Riley. Fort Riley has 14 named creeks, 10 of which have perennial flow. Breakneck Creek and numerous unnamed intermittent flow creeks also are present at Fort Riley (Bay West, 2014). The MRS is present on both sides of the Republican River and a tributary, Breakneck Creek.

2.5.1.4 Hydrogeology

Alluvial sand and gravel deposits in the Fort Riley area serve as excellent aquifers. Water table maps indicate the general direction of groundwater flow in the alluvial aquifer is down the valley, but flow can be variable near the Kansas and Republican Rivers in the Fort Riley vicinity. Groundwater levels in the alluvial aquifer are affected primarily by the stage of the Kansas River and to a lesser extent by the stage of tributaries, ponds, and lakes and by infiltration from precipitation. The correlation between Kansas River stage and groundwater levels in the alluvial aquifer is strongest near the river and weakens farther from the river.

Fort Riley and the surrounding communities of Junction City, Ogden, and Manhattan rely on groundwater withdrawn from alluvial materials. Fort Riley has eight active water supply wells, located downgradient from the MRS in the Republican River alluvium. In the upland areas, the

limestone formations are identified as groundwater sources. Lateral inflow of groundwater from adjacent bedrock likely contributes a small but important component of groundwater to the alluvial aquifer in the valley. The town of Riley and many of the rural residences surrounding Fort Riley are located in the uplands area and their wells tap bedrock formations. For example, the town of Riley uses seven wells ranging in depths from 90 to 100 feet and the wells draw water from the limestone formations. In general, the limestone formations are sufficiently transmissive to yield reliable groundwater supplies. Groundwater in the uplands area is generally present within 100 feet of the ground surface (Bay West, 2014). During the SI field work, groundwater was encountered at depths of 14 to 24 feet bgs (e2M, 2006).

2.5.1.5 Geology

Fort Riley is underlain by consolidated bedrock of Permian age. The bedrock is composed of the Chase Group formation from the Upper Permian system which is exposed at the ground surface in many areas or covered by a thin mantle of loess (wind-blown silts). Older Permian rocks of the Council Grove Group are limited to the southeastern portion of the Fort Riley.

The Permian bedrock units consist of alternating layers of shale and limestone. The Barneston and Winfield Formations underlie most of Fort Riley; both units contain limestone and shale members. Many of the more prominent bedrock outcrops at Fort Riley are composed of the Fort Riley Limestone Member of the Barneston Limestone, which due to its 30-foot thickness and its massive, chert-free character, is resistant to erosion. The Barneston Limestone Formation is visible in many stream banks as white, wall-like exposures. The Fort Riley Limestone is prominent as a “rim rock” outcrop that has a wall-like appearance near the top of bluff lines.

The Fort Riley Limestone Member is 30 to 45 feet thick and is a massive to thin-bedded limestone with minor shale. The basal part is the massive “rim rock.” Quaternary-aged alluvial sand and gravel deposits are present within the river floodplains. The alluvial deposits of the Republican River consist of clay, silt, and sand near the surface and coarser sands and gravel at depth. The alluvial deposits are underlain by area limestones and shales (Bay West, 2014).

2.5.2 Ecological and Cultural Resources Profile

2.5.2.1 Vegetation Types

The vegetation in the MRS includes four main vegetation communities (Bay West, 2014):

- **Riverine Sand Flats/Bars**: Occurs on alluvial sands in the beds of rivers and streams. Vegetation usually is highly ephemeral due to hydraulic action of the Republican River. Plant types include purslane, curly top knotweed, bearded sprangletop and various sedges.
- **Green Ash-Elm-Hackberry Forest**: Occurs in the upper floodplain terraces of the Republican River. It has an open to closed canopy. Trees are mainly American elm, ash, and hackberry with a lesser occurrence of walnut, maple, and cottonwood. The subcanopy may include slippery elm. The shrub layer is very diverse and includes poison ivy, Missouri gooseberry, coral berry, and common prickly ash. Herbaceous undergrowth includes fescue, Virginia wild rye, and catchweed bed straw.
- **Eastern Cottonwood-Black Willow Forest**: Occurs on the floodplain terraces along the Republican River. It has closed or nearly closed tree canopies and consists chiefly of cottonwood and black willow trees with a smaller amount of maple, willow, and sycamore trees. The undergrowth often lacks shrubs and herbaceous types are lush but patchy consisting of such types such as purslane and rice cutgrass.
- **Oak Ravine Woodland**: Occurs on moderate to steep south and west facing slopes along the Republican River. It is an open-canopy, upland community dominated by chinquapin

oak and bur oak. Elm and eastern redbud are found in moister areas. Common shrubs are dogwood and coral berry. Herbaceous species include little bluestem and switchgrass.

2.5.2.2 Wildlife and Fish

The Integrated Natural Resources Management Plan (INRMP, 2018) did not identify any federally listed critical habitat on Fort Riley. However, the state of Kansas has designated critical habitat on the installation for three species: piping plover (C*haradrius melodus*), least tern (*Sterna antillarum*) and Topeka shiner (*Notropis topeka*). Designated critical habitat for the least tern and piping plover is all waters within the corridor along the main stem of the Kansas River. Designated critical habitat for the Topeka shiner is the mainstem and tributary reaches of Wildcat, Little Arkansas, Wind, Honey, Silver and Sevenmile creeks. The Kansas Department of Wildlife and Parks has rated the Republican River as a high priority fishery resource. The Kansas Biological Survey, completed in 2011/2012, developed a new vegetation classification for the installation, identifying eight primary habitat types; floodplain forest, ravine woodland, Flint Hills tallgrass prairie, sand prairie, limestone butte vegetation, altered grassland vegetation, woodland-brushy, and planted/cultivated vegetation. Sand prairie is restricted to the floodplain of the Republican River, usually immediately adjacent to the river.

Three federally listed species have been documented on Fort Riley: The least tern and Topeka shiner, which are both endangered, and the piping plover, which is threatened. The bald eagle (*Haliaeetus leucocephalus*), delisted in 2007, is a year-round resident. The Kansas-listed species documented on Fort Riley are the least tern, which is endangered, and the plains minnow, piping plover, snowy plover, sturgeon chub and Topeka shiner, which are all threatened.

Kansas lists Fort Riley as being within the historic range of six additional species; the American burying beetle (*Nicrophorus americanus*), silver chub (*Macrhybopsis storeriana*), shoal chub (*Macrhybopsis hyostoma*), eastern spotted skunk (*Spilogale putorius*), Eskimo curlew (*Numenius borealis*), and whooping crane (*Grus americana*). The American burying beetle, Eskimo curlew and whooping crane also are federally listed as endangered. (INRMP, 2018)

The Topeka shiner has been found in Wildcat, Sevenmile, Wind, Honey, Silver and Little Arkansas creeks. It is believed that Topeka shiners potentially may immigrate into Fourmile, Threemile, and Forsyth creeks. The least tern and piping plover are uncommon, primarily transient migrants, but are also potential breeders along the Republican and Kansas rivers' sandbars. The least tern has been observed along the Kansas River and Milford Lake shorelines. The piping plover has been observed along the Republican and Kansas rivers sandbars. The primary migratory path for a fourth species, the endangered whooping crane, occurs within 100 miles of Fort Riley. It remains possible that this species may be encountered within the installation's boundaries or air space.

The bald eagle, while no longer federally listed as threatened, still receives federal protection under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c), enacted in 1940. Five locations with eagle nests occur on and around Fort Riley. Three eagle nests occur near Madison Creek Cove, Milford Lake on Fort Riley. This area has had one pair of nesting eagles annually since 2004. The second area with an eagle nest is on USACE property along Farnum Creek, adjacent to Fort Riley. This nest was first used in 2005 and was occupied annually for 11 years, but was unoccupied in 2016. Meanwhile, a new, active bald eagle nest was located on Fort Riley (TA 54) in 2016, approximately 3.5 miles from the Farnum Creek nest. Fort Riley pursued and obtained an Eagle Nest Take Permit for and subsequently removed the TA 54 nest on November 6, 2017, due to the location of the nest and its proximity to frequent military training. The fourth area is around the confluence of the Kansas River, where four nests exist. Two nests are along the Kansas River on Fort Riley, and two nests are along the Smoky Hill River just upstream from the installation. One pair of nesting eagles have been active in this locale annually since 2009. A fifth eagle nesting location exists approximately 1 mile west of the installation along the old

channel of the Republican River below Milford Dam. Additionally, a sixth eagle nest location has been observed directly across the Kansas River from the Southeast corner of the installation on property owned and managed by the Kansas Department of Wildlife, Parks and Tourism. Bald eagles roost along the Kansas and Smoky Hill rivers, and are frequently observed perched along the Republican River, Kansas River, and Milford Lake shorelines, and flying over Fort Riley. Additionally, Fort Riley has documented sightings of golden eagles (*Aquila chrysaetos*) in maneuver areas. Golden eagles also are protected by the Bald and Golden Eagle Protection Act. (INRMP, 2018).

The Army created a species at risk (SAR) list to identify imperiled species that would have a significant impact on military missions if federally listed as threatened or endangered. The objective of creating the SAR list is to proactively conserve these species now and thereby preclude the need for a future listing. The Army-designated SARs that occur on Fort Riley are the Henslow's sparrow (*Centronyx henslowii)*, regal fritillary (*Speyeria Idalia)*, rusty blackbird (*Euphagus carolinus)*, and Texas horned lizard (*Phrynosoma cornutum*; INRMP, 2018).

Species in need of conservation (SINC) is a Kansas designation given to any nongame species in the state deemed to require conservation measures in an attempt to keep the species from becoming a threatened or endangered species. SINC species do not have the same level of statutory protection as those species listed as threatened or endangered in Kansas. Species on the SINC list that have been documented on Fort Riley are the prairie mole cricket (*Gryllotalpa major)*, blue sucker (*Cycleptus elongatus)*, common shiner (*Luxilus cornutus)*, Johnny darter (*Etheostoma nigrum)*, southern redbelly dace (*Chrosomus erythrogaster)*, western hognose snake (*Heterodon nasicus)*, black rail (*Laterallus jamaicensis)*, black tern (*Chlidonias niger)*, bobolink (*Dolichonyx oryzivorus)*, ferruginous hawk (*Buteo regalis)*, golden eagle, Henslow's sparrow, short-eared owl (*Asio flammeus)*, whip-poor-will (*Antrostomus vociferous)*, and southern bog lemming (*Synaptomys cooperi;* INRMP, 2018).

2.5.3 Release Profile

The release profile for the MRS includes the nature and extent of MEC, the inferred mechanisms for release, and any potential influences from natural features or events that could affect distribution. The profile builds upon the historical, physical, and ecological information presented in the preceding sections.

The term MEC distinguishes specific categories of military munitions that may pose unique explosive safety risks, including the following:

- **UXO**: Military munitions that fulfill the following criteria:
  - Have been primed, fused, armed, or otherwise prepared for action;
  - Have been fired, dropped, launched, projected, or placed in a manner as to constitute a hazard to operations, installations, personnel, or material; and
  - Remain unexploded either by malfunction, design, or any other cause (DoD, 2008).
- **Discarded military munitions (DMM)**: Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include UXO, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations. (DoD, 2008).

The definition of MEC also includes MC, such as TNT and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), present in soil, facilities, equipment, or other materials in high enough concentrations so as to pose an explosive hazard (DoD, 2008).

MC is defined as follows:

- Any materials originating from MEC, DMM, or other military munitions, including explosive and nonexplosive materials, and emission, degradation, or breakdown elements of such munitions (DoD, 2008).

A summary of the nature and extent of MEC is discussed in the following sections.

2.5.3.1 Nature and Extent of MEC and MD

MEC and MD have been identified on land and underwater at the surface and subsurface within soil and sediment during construction, inspection, and investigation activities. The locations of the MEC and MD items found during investigation activities are shown on **Figure 2-2**. A summary of MEC items and types of MEC and MD items recovered during investigation activities is provided in **Table 2-2** and **Table 2-3**, respectively. A total of 14 MEC items were recovered. The average MEC density for the area investigated (48.7 acres) was 0.29 MEC per acre. In general, the MEC encountered were located adjacent to or in the Republican River at depths up to 2 feet bgs. Concentrated areas of MD were encountered in sediments and sandbars within the Republican River and were located primarily within the northern portions of the MRS. Pits of debris containing MD were excavated to depths up to 9 feet bgs.

A specific MEC source area has not been identified. However, as indicated in **Section 2.2.3.7**, MEC that are present in site media are likely associated with the historical maneuver areas or active training areas. In addition, given the changes in the flow patterns of the Republican River since the maneuver areas were first used (**Figure 2-1**), MEC and MD may be present outside the operational boundaries of Fort Riley, particularly in areas downstream of the maneuver areas along the historical alignments of the Republican River. In addition, the MEC and MD encountered in Breakneck Creek indicate that munitions extend beyond the Republican River.

Transport processes have potential, significant impacts on the migration of MEC at the MRS. Future flooding of the river and erosion may have an effect on MEC locations at the MRS. Human activities may result in future transport/erosion. Frost heave may cause vertical migration of MEC.

2.6 Current and Potential Future Land Use and Resource Uses

The MRS consists of government-owned and privately owned property. Land types consists of river shoreline, sandbars, the Republican River, Breakneck Creek, and heavily wooded areas. The Republican River is a very dynamic area affected by storm events and flow conditions within the river, which affects water level, sediment deposition and movement of sediment within and adjacent to the river. Industrial property is present on the southern border of the MRS and consists of privately owned sand and gravel supply; dredging and construction operations also are possible in some locations.

The MRS, which extends into the Republican River and on to southwestern riverbanks and sandbars, is accessible to the public. The Breakneck Creek area of the MRS is accessible to personnel with Fort Riley base access. In 1997, the Army entered into a licensing agreement with Junction City, Kansas, allowing construction of a nature trail and recreational access along the Republican River adjacent to the original Camp Forsyth Landfill footprint. The river shoreline, a relatively flat area, is used for the nature trail maintained by the City of Junction City through a Memorandum of Understanding with Fort Riley. The nature trail is currently open to the public. In May of 2002, Fort Riley posted a series of UXO warning signs between the riverbank stabilization area and the nature trail stating the following: “Caution Potential Unexploded Ordnance May Be Present in the Area, Avoid Entry.” The purpose of the signs is to notify the public of the site conditions. There are currently no known plans to change the land use at the MRS (Bay West, 2014).

Reasonably anticipated future land use of most of the MRS is expected to remain the same as the current land use, which is primarily active military training with compatible recreational use (e.g., fishing, hiking, and boating). Expansion or contraction of activities on the privately owned property on the southern border of the MRS is possible.

Fort Riley is located between two large reservoirs and manages 29 lakes and ponds to provide fishing opportunities for civilian and military personnel. There are currently no drinking water wells at the MRS; though Fort Riley draws all of its water from groundwater aquifers located downgradient of the MRS in the Republican River alluvium. There is limited potential for placement of a drinking water well on the site in the future because the majority of the area is located within a floodplain.

2.7 Summary of Site Risks

2.7.1 Summary of MEC Risks

2.7.1.1 MEC Risk Assessment

The CERCLA process for responding to releases or potential releases of hazardous substances includes the development of site-specific risk assessments. The results of the risk assessments are used to help site managers decide whether a response action is required. Also, to support the risk management decisions that are made through the remedy evaluation, selection, and implementation process. The CERCLA methodology for human health chemical risk assessment was not designed to address explosive safety hazards at MEC sites.

A MEC risk assessment is performed as part of the RI to evaluate explosives hazards to human receptors under existing conditions (baseline hazard assessment). The information obtained during the RI field activities is used as the input to the MEC risk assessment. The potential receptors considered during MEC risk assessment included Fort Riley residents, recreational users including residents walking on the nature trail adjacent to the site, Fort Riley personnel, authorized contractors, and trespassers. The MEC CSM is provided on **Figure 2-3**. The current and future potential land use is described in **Section 2.6**.

By nature, MEC explosive hazards are acute and are therefore evaluated as present or not present. The following three components are used to evaluate the potential for explosive hazard incidents:

- **Severity**: The potential consequences of the effect on human receptors (i.e., initiating and secondary human receptors) should a MEC item detonate.
- **Accessibility**: The likelihood that a human receptor will be able to encounter a MEC item.
- **Sensitivity**: The likelihood that a human receptor will be able to interact with a MEC item such that it will detonate.

Using the findings of all information gathered and RI field data collected, the MRS MEC risks are characterized as follows:

- **Severity**: The potential consequences for primary and secondary human receptors include loss of life, limb, and/or livelihood.
- **Accessibility**: MEC and MD have been encountered within and along the banks of the Republican River and Breakneck Creek and have been reported at the sand dredging operations. A public recreation area is present in the MRS, and schools and housing are nearby. The Republican River area of the MRS, including the nature trail, riverbanks and sandbars, is accessible to the public. The Breakneck Creek area of the MRS is accessible to personnel with Fort Riley base access. Warning signs are present in some areas along

the nature trail. Exposure to MEC at the MRS could potentially occur through walking on the site or conducting intrusive activities.

- **Sensitivity**: Some of the MEC encountered function using a point-detonating fuze. Others, if armed, are pressure- or trip-sensitive. A receptor could kick, step on, or pick up one of these items and cause it to function.

A MEC hazard including sensitive munitions that are accessible to the public, Fort Riley personnel, authorized contractors and trespassers is present at this MRS.

2.7.1.2 MEC Hazard Assessment

A MEC Hazard Assessment (HA) was performed and included in the Draft RI (Bay West, 2016) to assess baseline explosive hazards. A summary of the MEC HA results presented in the Draft RI is provided below. Following implementation of the remedial alternative described in this ROD, post-remedial action receptor risk will be determined using either MEC HA or a similar, approved MEC risk assessment methodology. A trial period for The Risk Management Methodology for Formerly Used Defense Sites (FUDS) MMRP Projects was issued on February 7, 2019 (USACE, 2019). A copy of this methodology is included in **Appendix C**.

The MEC HA methodology (TWG-HA, 2008) was used to assess potential explosive hazards to human receptors at the CFLFA2. Using the MEC HA methodology, an overall Hazard Level is assigned to a site that reflects the interaction between the past munitions-related use of the site and the current, determined, or reasonably anticipated future use activities at the site.

Numeric scores are assigned for each category and are in multiples of five, with a maximum possible score of 1000 and a minimum possible score of 125. The numeric scores reflect the relative contributions of the different input factors to MEC hazard. The TWG-HA (2008) warns that the MEC HA scores should not be interpreted as quantitative measures of explosive hazard. An overall Hazard Level is assigned to a site that reflects the interaction between the past munitions-related use of the site and the current, determined or reasonably anticipated future use activities at the site.

Each of the MEC HA methodology components described in **Section 2.7.1.1** are assessed by adding input factors for the site. The sum of the input factor scores falls within one of four defined ranges, called hazard levels. Each of the four levels reflects site attributes that describe groups of sites and site conditions ranging from the highest to the lowest hazards. The MEC HA hazard levels are as follows:

- Hazard Level 1 – Sites with the highest hazard potential. There might be instances where an imminent threat to human health exists from MEC.
- Hazard Level 2 – Sites with a high hazard potential. A site with surface MEC or one undergoing intrusive activities such that MEC would be encountered in the subsurface. The site would also have moderate or greater accessibility by the public.
- Hazard Level 3 – Sites with a moderate hazard potential. A site that would be considered safe for the current land use without further munitions responses, although not necessarily suitable for reasonable, anticipated future use. Level 3 areas generally would have restricted access, a low number of contact hours, and, typically, MEC only in the subsurface.
- Hazard Level 4 – Sites with a low hazard potential. A site compatible with current and reasonably anticipated future use. Level 4 sites typically have had a MEC cleanup performed.

The CFLFA2 MEC HA indicates a baseline hazard level for the CFLFA2 of Level 1, based on a MEC HA score of 860. The total component scores were 130 out of a maximum of 130 for severity, 510 out of a maximum of 650 for accessibility, and 220 out of a maximum of 220 for sensitivity.

2.7.2 MC Risk Assessment

MC are explosive compounds and metals derived from MEC. MEC were identified during historical investigations. Therefore, there are potential sources of MC. The MC CSM considers the potential receptors and exposure pathways present at the site. The MC CSM is provided on **Figure 2-4**. Approximately 50 analytical samples collected from environmental media (soil, sediment, surface water, and groundwater) were obtained within the MRS to evaluate any adverse risks to human health and ecological receptors. An HHRA and a SLERA were completed and documented in the RI Report (Bay West, 2017) to evaluate risks assuming baseline conditions (i.e., no remedy is implemented for existing chemical contamination). In summary, investigative area soil, sediment, surface water, and groundwater at the MRS do not contain MC in concentrations that would pose an unacceptable risk to Fort Riley residents, recreational users including residents walking on the nature trail adjacent to the site, Fort Riley personnel, authorized contractors, and trespassers. Therefore, no COCs were identified at CLFLA2 MRS.

2.7.3 Basis for Taking Action

A MEC hazard, including sensitive munitions that are accessible to the public, is potentially present at the MRS. Therefore, it is the Army's current judgment that the selected alternative identified in this ROD is necessary to protect the public from MEC hazards. A summary of the alternatives considered and evaluated in the FS and the Proposed Plan, along with more detailed information concerning the selected alternative for implementation, is presented in **Section 2.9** and **Section 2.12**, respectively. The selected remedy supports the current and potential future land uses discussed in **Section 2.6**.

2.8 Remedial Action Objectives

In accordance with the 40 CFR 300.430(e)(2)(i), the FS established remedial action objectives (RAOs) specifying contaminants and media of concern, potential exposure pathways, and remediation goals. The RAOs are defined to assist with remedial alternative design, and to determine the effectiveness of the remedial actions. The HHRA and SLERA demonstrated that MCs in investigative area soil, sediment, surface water, and groundwater at the CFLFA2 MRS do not pose an unacceptable risk to human health or the environment. Therefore, RAOs for MC were not developed.

To address the explosive hazard present due to MEC, the RAO for the CFLFA2 MRS is:

> To minimize Fort Riley residents, recreational users (including residents walking on the nature trail adjacent to the site), Fort Riley personnel, authorized contractors, and trespassers contact with MEC in the top 2 feet of the Republican River and Breakneck Creek and surrounding banks while maintaining the intended future land use which is primarily recreational use.

2.9 Description of Alternatives

Five alternatives were initially screened in the FS Report to address MEC hazards at the MRS. However, during the development of the Proposed Plan, due to initial feedback from stakeholders, modifications were made to the alternatives, including a substantial modification to enlarge the MRS area to include all of Breakneck Creek to the north up to the Breakneck Lake dam. The alternatives as presented in the Proposed Plan are listed in **Table 2-10** and described below.

Table 2-10 Remedial Action Alternatives

Designation	Description
Alternative 1	No Action
Alternative 2	LUCs
Alternative 3	Surface and Subsurface Removal of Military Munitions in Breakneck Creek and LUCs
Alternative 4	MEC Removal for the Republican River and Breakneck Creek and LUCs
Alternative 5	Surface and Subsurface Removal of Military Munitions to Support UU/UE – Initial Screening Assessment Only

2.9.1 Alternative 1: No Action

In accordance with the NCP, 40 CFR § 300.430(e)(6), the No Action Alternative is evaluated as a baseline for comparison with other alternatives that provide a greater level of protection. The No Action Alternative equates with a determination to do nothing further at the MRS, and it can be selected only if investigation activities reveal that there is no remaining unacceptable human health or environmental risks or hazards. There would be no limitations on current or future site use or activities, including transfer of the property. The government may not respond to any future MEC discoveries under the No Action alternative. Further, the No Action alternative does not require identification and screening for MEC during construction activities. There are no activities performed for Alternative 1, so there would be no estimated implementation time frame. There are no costs associated with this alternative.

2.9.2 Alternative 2: LUCs

LUCs are used in cases where it may not be possible or practical to physically remove munitions. LUCs would provide protection to property owners and the public from potential hazards present at the MRS by warning of potential MEC hazards and/or limiting access to, or use of, the MRS. The LUC objectives and a control would be designed to prohibit unacceptable human exposures based on current and future land use and to prohibit intrusive activities, unless USEPA and the Army approve them and trained explosive experts perform the work. LUCs were developed using USACE guidance Engineer Pamphlet 1110-1-24 for *Establishing and Maintaining Institutional Controls for Ordnance and Explosive Projects* (USACE, 2000) and Sample Federal Facility Land Use Control ROD Checklist with Suggested Language (LUC Checklist) (USEPA, 2013). Under Alternative 2, risks related to potential explosives hazards would potentially be managed through:

- Administrative Controls
    - Restrictive Covenants
    - Deed Notices
    - Camp Forsyth Area Development Plan
    - Dig Permit System
    - Contractor Control Policies
    - Construction Support
- Engineering Controls
    - Warning Signs
- Educational Controls

- Community Awareness Meetings
- Letter Notifications, Informational Pamphlets, and Fact Sheets
- Formal Education Sessions

The use of LUCs on Army-owned portions of the MRS would provide a means for Fort Riley to reduce munitions encounters and handling by site users through education and training. There would be approximately 1.5 months (estimated implementation time frame) of short-term hazards until the RAOs is achieved during sign installation. Due to the dynamic nature of the Republican River, and other potential transport processes noted in **Section 2.5.3.2**, surface sweeps (monitoring) would be performed within the MRS to locate and remove any items that have become exposed at the surface. LUCs would not allow for UU/UE. Therefore, LUCs would need to be maintained until it is determined that the MEC hazards no longer present an unacceptable risk. Additionally, a statutory review would be conducted within five years after initiation of the remedial action to ensure that the remedy is protective of human health and the environment.

A Land Use Control Implementation Plan (LUCIP) would be prepared as the land use component of the Remedial Design and included in the Remedial Action Work Plan. In accordance with contract deliverable requirements, Fort Riley would prepare and submit to USEPA for review and approval a LUC remedial design that contains implementation and maintenance actions, including periodic inspections. If Fort Riley transfers LUC procedural responsibilities to another party by contract, property transfer agreement, or through other means, Fort Riley would retain ultimate responsibility for remedy integrity. UXO support for intrusive activities conducted on private property within the MRS also would be evaluated during the development of LUCIP. Additional details on the LUC components are provided below.

2.9.2.1 Administrative Controls

Restrictive Covenants and Deed Notices

A restrictive covenant, which is also known as a deed restriction, is commonly used by the federal government to prohibit certain types of development, use, or construction on a piece of land where residual contamination does not allow unrestricted use of the property. Under a restrictive covenant, the government can usually take legal action to enforce the restriction if the new property owner does not abide with the development restrictions imposed.

Camp Forsyth Area Development Plan and Dig Permit System

The Camp Forsyth Area Development Plan and the Geographic Information System (GIS) database would be annotated to show where LUCs are required. The plan would be used to review proposed actions within the MRS. In conjunction with this, the Fort Riley Directorate of Public Works would review the Plan and GIS database to determine whether future projects are consistent with the LUCs implemented at the MRS.

Contractor Control Policies

Contractors performing intrusive activities on the MRS that have the potential to contact MEC would be required to receive training. The DoD educational message for explosive safety is referred to as “the 3Rs:” recognize, retreat, and report any future munitions that are encountered while performing maintenance, improvement, or construction activities on their property.

Construction Support

When activities are required that may affect the LUCs established for the MRS, UXO construction support activities would be necessary. Discussions with Fort Riley staff indicated that they have provided UXO construction support activities at the site in the past and will continue to do so as needed. This is an ongoing cost that would need to be funded by the entity performing the activity.

UXO construction support would be used to ensure the safety of workers or the public in the event that MEC items are discovered at the MRS. In accordance with the Defense Explosives Safety Regulation DESR 6055.09 (DoD Directive, 2019), the responsible authority (e.g., installation commander or designated representative) would determine the level of construction support required on a case-by-case basis. Construction support is determined by the probability of encountering UXO or DMM. Each activity occurrence also would be reviewed with Fort Riley Safety Office through the dig permit process to ensure the appropriate support is provided based upon the type of activity planned. The DESR 6055.09 requirements consist of the following.

- For intrusive activities in areas where the likelihood of encountering MEC is low, EOD personnel or UXO-qualified personnel must be contacted to ensure their availability, advised about the project, and placed "on call" to assist if suspected UXO are encountered during construction.
- For intrusive activities in areas where the likelihood of encountering MEC is moderate to high, EOD personnel or UXO-qualified personnel must attempt to identify and remove any explosive hazards in the construction footprint prior to any intrusive construction activities. Alternatively, anomaly avoidance may be used to avoid surface explosive and subsurface anomalies when working in the area (e.g., to install pilings).

2.9.2.2 Engineering Controls

Warning Signs

Warning signs would be installed and maintained by Fort Riley around the MRS, notifying the public of the area in which MEC are likely to be present, and of the hazards associated with MEC. Some of this signage is already in-place as the Army installed signs between the nature trail and the Republican River previously. A total of 155 signs (one every 200 feet) were estimated for cost estimating purposes in the FS. The signs would be placed around the perimeter of the MRS, shown conceptually on **Figure 2-5A** and **Figure 2-5B**. The LUCIP would describe the recommended sign placement. The final sign placement would be assessed at the completion of the remedial actions. The Army awarded a contract in the spring of 2020 to install warning signs along specific segments of the nature trail in July 2020. The specific sign locations will be documented in the LUCIP.

2.9.2.3 Educational Controls

Community Awareness Meetings

Community meetings would be held to share potential, significant changes to the selected remedy (i.e., ROD amendment). Fort Riley does not have an active Restoration Advisory Board (RAB). If the RAB is reestablished, it would work with Fort Riley on matters related to its environmental cleanup program. Its responsibilities would include reviewing Army documents and plans, working with the Army to develop cleanup priorities, and sharing information with and soliciting feedback from members of the community. RAB meetings are open to the public.

Letter Notifications, Informational Pamphlets, and Fact Sheets

Development and distribution of informational materials would be performed to periodically provide awareness to property owners and Junction City and Geary County authorities of the potential presence of MEC. It is anticipated the materials would be distributed annually at the onset of LUC implementation but reduced to once every five years if determined to be acceptable during the five-year review. In addition, informational materials would be made available to recreational users of the Republican River and Breakneck Creek.

Formal Education Sessions

An educational program also is considered under Alternative 2, including providing periodic training for the local community to promote awareness of the MEC characterized at the MRS. Attendance would be open to the public. In addition, formal education sessions would be held to train base residents and contractors in the 3Rs for explosives safety.

2.9.2.4 Monitoring and Five-Year Reviews

Due to the dynamic nature of the Republican River and other potential transport processes (i.e., intrusive activities, frost heave), surface sweeps would be performed within the MRS to locate and remove any items that have become exposed at the surface. These surveys would initially be conducted annually after initiation of the remedial action. Surveys would be evaluated annually thereafter based on data obtained from the previous survey(s) to determine the need for inspection interval and/or areal extent increases or decreases. Additional survey(s) could be performed during drought years should it be determined that the river height has been lowered or after heavy rain events (i.e. related to flooding) that potentially expose items. The low flow and high river flow rates that trigger out-of-cycle surveys would be calculated from historical data and determined in the remedial design phase. The Remedial Action Work Plan would describe the proposed frequency of inspections for periodic monitoring (i.e., signs, land disturbance, etc.). Any change in inspection frequency would be coordinated with and approved by EPA and KDHE.

LUCs would not allow for UU/UE. Therefore, a statutory review would be conducted within five years after initiation of the remedial action to ensure that the remedy is protective of human health and the environment. Five-year reviews would include inspections/surface sweeps to assess conditions of LUCs, erosion, and potential migration of MEC from the subsurface due to frost heave. Detailed specifications for implementation and monitoring would be determined during the remedial design phase. Recurring reviews would be completed by the Army and would include the following general steps:

- Prepare recurring review plan;
- Establish project delivery team and begin community involvement activities;
- Review existing documentation;
- Identify/review new information and current site conditions;
- Prepare preliminary site analysis and work plan;
- Conduct site visit; and
- Prepare recurring review report.

2.9.3 Alternative 3: Surface and Subsurface Removal of Military Munitions in Breakneck Creek and LUCs

Breakneck Creek was confirmed to contain MEC and is located near a school and residential areas. Therefore, this area has the highest potential for contact with MEC and also is the easiest to clear as the work can be done using primarily traditional (i.e., terrestrial) MEC removal techniques. Breakneck Creek is a shallow intermittent stream. Therefore, removal activities would be performed during the dry season. Any area with remaining standing water would be cleared by a UXO technician. No MEC removal would occur from the Republican River. Alternative 3 would not allow for UU/UE. Therefore, LUCs also would be implemented as described under Alternative 2. There would be approximately three months (estimated implementation time frame) of short-term hazards until the RAO is achieved during MEC removal and sign installation. Components of this Alternative are described below.

2.9.3.1 MEC Clearance

MEC clearance includes three steps: detection and positioning, removal, and disposal. A description of the types of technologies used in each step is presented in the FS and briefly summarized below. The Remedial Action Work Plan would describe the site-specific detection, removal, and disposal technologies/procedures to be used to achieve the RAO at the MRS. A Department of Defense Explosives Safety Board (DDESB)-Explosive Safety Submission (ESS) also would be prepared to conduct MEC clearance and removal activities. MEC clearance would be performed using primarily land-based methods from Breakneck Creek in the area from the junction of Breakneck Creek and the Republican River upstream to the Breakneck Lake dam. The removal area would extend at least 75 feet on both sides of Breakneck Creek and all anomalies would be investigated.

MEC Detection

MEC detection involves using experienced UXO-qualified personnel to locate items (i.e., MEC and MD) in the environment through use of analog (mag & flag and/or mag & dig) or DGM instruments to mark, identify, and record the locations of all MEC and MD found within the area investigated for removal or subsequent disposal. Significant developments of geophysical technology during the past ten years indicate that analog tools currently do not represent the best available science for most applications because they do not provide a permanent, audible record of the data, and do not generate data capable of being substantially reproduced. For these reasons analog geophysical tools would not be used for munitions response activities, except in cases where site conditions preclude the use of DGM tools. The UXO-qualified team would divide the investigation area into convenient work grids that would allow for work to be optimized on the land and within the water environment. When working in the water, the UXO technician would wade into the water wearing waders. However, as the majority of Breakneck Creek is shallow (less than 1 foot) and intermittent in nature, the removal could be scheduled during dry times such that location and removal of MEC could be performed using standard land-based practices.

MEC Removal

MEC removal involves the movement of hazardous items (i.e., MEC) from the source area to another location either on-site or off-site. MEC removal would be performed manually. All MD also would be removed. Manual excavation consists of hand digging methods performed by qualitied UXO technicians. When excavating an anomaly manually, non-essential personnel would be evacuated to the HFD.

MEC Disposal

MEC disposal would be performed on all material potentially presenting an explosive hazard (MPPEH). If the item is unsafe to move, the item would be blown-in-place. If safe to move, any underwater MPPEH would be relocated and/or removed from the water for on land disposal using a DDESB-approved Explosive ESS). This would be evaluated on a case-by-case basis. Underwater blow-in-place is generally not acceptable due to potential damage to the environment. Underwater blasting creates rapid and significant positive and negative pressure changes that can cause injury to aquatic fauna. Engineering controls such as bubble curtains and other physical barriers may be considered to attenuate the blast wave. For areas with no standing water, standard land-based MEC detonation practices would be followed.

All MD and/or material documented as safe (MDAS) also would be disposed of/recycled so that it does not remain in the environment and interfere with future surface sweeps or cause future munitions response action.

2.9.3.2 LUCs, Monitoring, and Five-Year Reviews

LUCs, monitoring, and five-year reviews are included in this alternative in addition to surface and subsurface removal of MEC. The LUCs, as described in **Section 2.9.2**, would continue to be needed as MEC could remain in Breakneck Creek and the Republican River. Additionally, monitoring and five-year reviews as described in **Section 2.9.2.4**, would continue to be needed as MEC could remain in Breakneck Creek and the Republican River.

2.9.4 Alternative 4: MEC Removal for the Republican River and Breakneck Creek and LUCs

MEC would be removed from Breakneck Creek in the area from the junction of Breakneck Creek and the Republican River upstream to the Breakneck Lake dam. The removal area would extend at least 75 feet on both sides of Breakneck Creek and all anomalies would be removed as described under Alternative 3. Alternative 4 also includes MEC removal within the Republican River, including shoreline and sandbars, inside the MRS as shown in **Figure 2-5A** and **Figure 2-5B**. Alternative 4 may not allow for UU/UE initially. Therefore, LUCs also would be implemented within the MRS as described under Alternative 2. There would be approximately five months (estimated implementation time frame) of short-term hazards until the RAO is achieved during MEC removal and sign installation. Components of this Alternative are described below.

2.9.4.1 MEC Clearance

As described under Alternative 3, MEC clearance includes three steps: detection and positioning, removal, and disposal. The Remedial Action Work Plan would describe the site-specific detection, removal, and disposal technologies/procedures to be used to achieve the RAO at the MRS. A DDESB-ESS also would be prepared to conduct MEC clearance and removal activities. to be used to achieve the RAO at the MRS. Additional detail on performance of underwater MEC clearance in the Republican River is described below.

MEC Detection

MEC detection performed in shallow water (i.e., less than 2–3 feet) would be completed similar to Alternative 3. However, the Republican River water depth can exceed 3 feet. In areas deeper than 3 feet of water, MEC detection would be accomplished with a combination of analog and DGM instruments. DGM instruments adapted to an underwater platform would be used to collect data of sufficient resolution to generate a map of all metallic items in the MRS. The data would be collected, processed, evaluated, and analyzed to select target anomalies likely to represent munitions of interest within the upper 2 feet of the substrate.

Where a target anomaly is present, the coordinates would be located with a stake placed in the water or other buoy for subsequent anomaly investigation and MEC/MD removal. In severely cluttered areas, it would be difficult and time consuming to attempt to reacquire individual anomalies. These areas would be divided into convenient work grids defined by ropes and weights. UXO-qualified divers would use marine metal detectors and follow a line of rope (a jackstay) placed on the bottom to define grid lanes. When an anomaly is detected, the diver would identify the item using visual observation when possible. If visibility is poor, the diver would use touch and feel techniques taught as part of underwater UXO diver training. Objects that are not exposed on the bottom would be investigated within 2 feet into the sediment. If needed, suction devices would be used to remove sediment.

MEC Removal

MEC removal involves the movement of hazardous items (i.e., MEC) from the source area to another location either on-site or off-site. MEC removal would be performed manually. All MD also would be removed. Manual excavation consists of hand digging methods performed by qualitied UXO technicians. Manual excavations in the wetlands and shores are limited to 2 to 3 feet or less

due to muddy conditions and the shallow water table. Manual excavations under water would require divers and are restricted to less than 2 feet into the substrate because of flowing sand. When excavating an anomaly manually, non-essential personnel would be evacuated to the HFD. For water removal, in severely cluttered areas, it would be difficult and time consuming to attempt to reacquire individual anomalies. These areas would be divided into convenient work grids defined by ropes and weights. Objects that are not visible on the bottom would be investigated within arm's reach by UXO-qualified divers into the sediment. If needed, suction devices would be used to remove sediment.

MEC removal in deeper water would be performed by UXO-qualified divers using standard salvage techniques. Divers would first make a positive identification of the item and ensure that it is safe to move. The diver would then place the item in a basket to be raised by a winch mounted on a boat. If the item is too large for the diver to move, the diver would fasten straps to the item so that it can be raised directly by a winch or float lift bag. Assuming there are 40 MEC and/or MD items per acre or less, it is plausible that a 4-person dive team could search and clear 0.25 acres each day.

MEC Disposal

MEC disposal would be performed on all MPPEH. If the item is unsafe to move, underwater detonation may be necessary. If safe to move, any underwater MPPEH would be removed from the water for on-land disposal using DDESB-approved ESS. This would be evaluated on a case-by-case basis. Underwater blow-in-place is generally not acceptable due to potential damage to the environment. Underwater blasting creates rapid and significant positive and negative pressure changes that can cause injury to marine animals. Engineering controls such as bubble curtains and other physical barriers may be considered to attenuate the blast wave.

All MD and MDAS also would be disposal of so that it does not remain in the environment and interfere with future sweeps or cause future munitions response action.

2.9.4.2 LUCs, Monitoring, and Five-Year Reviews

LUCs, monitoring, and five-year reviews are included in this alternative in addition to MEC removal. The LUCs, as described in **Section 2.9.2**, would continue to be needed as MEC could remain in Breakneck Creek and the Republican River. Additionally, monitoring and five-year reviews, as described in **Section 2.9.2.4**, would continue to be needed as MEC could remain in Breakneck Creek and the Republican River.

2.9.5 Alternative 5: Surface and Subsurface Removal of Military Munitions to Support Unlimited Use/Unrestricted Exposure (UU/UE) – Initial Screening Assessment Only

The Republican River would be diverted, and the sediments dried such that MEC could be located and removed using terrestrial methods. This would enable the location and removal of MEC to a deeper depth than water-based techniques. Although this alternative would be effective at reducing the risks by removing MEC at the MRS, achieving UU/UE, the alternative was not retained after the initial screening due to implementability and cost barriers. The remedy was determined to not be implementable as the properties located southwest of the MRS, through which the river would need to be diverted, are privately owned and commercially used. In addition, the capital cost of this alternative was considered very high in comparison with the other alternatives evaluated. Therefore, Alternative 5 was not retained for detailed analysis in the FS following the initial screening assessment.

2.10 Comparative Analysis of Alternatives

In accordance with the NCP, the alternatives for the MRS were evaluated using the nine criteria described in Section 121(a) and (b) of CERCLA and 40 CFR § 300.430 (e)(9)(iii) as cited in NCP

§ 300.430(f)(1)(i). These criteria are classified as threshold criteria, balancing criteria, and modifying criteria.

Threshold criteria are standards that an alternative must meet to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—the alternative must meet them, or it is unacceptable. The following are classified as threshold criteria:

- Overall protection of human health and the environment; and
- Compliance with ARARs.

Balancing criteria weigh the tradeoffs between alternatives. These criteria represent the standards upon which the detailed evaluation and comparative analysis of alternatives are based. In general, a high rating on one criterion can offset a low rating on another balancing criterion. Five of the nine criteria are considered balancing criteria:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume (TMV) through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

Modifying criteria that may be considered to the extent that information is available during the RI/FS, but can be only fully considered after public and regulator comments have been received:

- State acceptance; and
- Community acceptance.

This section summarizes how well each alternative satisfies each evaluation criterion and indicates how it compares to the other alternatives under consideration. A relative ranking of alternatives against the nine criteria is shown in **Table 2-11**.

A comparison of the results of the detailed analysis of Alternatives 1 through 4 with regard to the required NCP criteria is summarized in **Table 2-11** and described below. A detailed description of this evaluation is provided in the final FS (Trevet-Bay West JV, 2018).

Table 2-11 Summary of Comparative Analysis of Alternatives

MRS	Type	Screening Criterion	Alternative 1: No Action	Alternative 2: LUCs	Alternative 3: Surface and Subsurface Removal of Military Munitions in Breakneck Creek and LUCs	Alternative 4: MEC Removal for Republican River and Breakneck Creek and LUCs
CFLFA2	Threshold	Overall Protection of Human Health and the Environment	No	No	Yes	Yes
		Compliance with ARARs	Yes	Yes	Yes	Yes
	Balancing	Long-Term Effectiveness	○	◊ (Effective, Not Permanent)	◊ (Effective, Not Permanent)	● (Effective, Not Permanent)
		Reduction of Toxicity, Mobility, or Volume through Treatment	○	◊	◊	●
		Short-Term Effectiveness	●	●	●	●
		Implementability	●	●	●	●
		-Technical Feasibility	●	●	●	●
		-Administrative Feasibility	●	●	●	●
		-Availability of Materials and Services	●	●	●	●
		Cost[1]				
		Estimated Capital Cost	$0	$400,000	$1,417,000	$4,325,000
		Total 30-Year O&M Cost	$0	$357,000	$357,000	$357,000
		Total Present Worth Cost	$0	$757,000	$1,774,000	$4,682,000
	Modifying	State Agency Acceptance	No	No	No	Yes
		Community Acceptance	No	No	No	Yes

● *In comparison with other alternatives, complies well with criteria.*
◊ *In comparison with other alternatives, partially complies with criteria.*
○ *In comparison with other alternatives, does not comply well with criteria.*
[1] *30-Year present worth costs assuming a 0.7% escalation factor (Office of Management and Budget [OMB], 2019). Costs are detailed in the Proposed Plan.*

2.10.1 Overall Protection of Human Health and the Environment

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

Alternative 1 and Alternative 2, consists of leaving the site in its current state. Due to the potential hazard posed by MEC, Alternative 1 is not considered to be protective of human health because there are no mechanisms included for mitigating potential exposure to MEC. Alternative 2 would use LUCs to reduce exposure to hazards but does not remove MEC. LUCs can be effective at protecting human health when properly administered and maintained; however, the LUCs without MEC removal as proposed under Alternative 2 may not meet the RAO of minimizing exposure to MEC while maintaining current land use. Alternative 3 provides the next highest level of protection as MEC would be removed from Breakneck Creek, which is close to a school and use LUCs to prevent contact with MEC in the Republican River. Alternative 4 would offer the highest level of protection of human health, as MEC hazards would be removed from all areas within the MRS where MEC were identified.

2.10.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations, which are collectively referred to as “ARARs,” unless such ARARs are waived under CERCLA § 121(d)(4). Compliance with ARARs evaluates whether the alternative meets Federal and State environmental statutes, regulations, and other requirements that pertain to the MRS, or whether a waiver is justified.

No chemical-specific ARARs or to be considered (TBC) were identified for the MRS; however, location-specific and action-specific ARARs were identified (**Table 2-12**). The applicable federal location-specific ARARs includes the Federal Endangered Species Act (16 USC 1531), the Migratory Bird Treaty Act (16 USC 703 et seq.), and the Bald and Golden Eagle Protection Act (16 USC 668 et seq.). Also, one federal action-specific ARAR was identified as appropriate and relevant: Subpart X of RCRA for miscellaneous units (substantive provisions of 40 CFR 264.601). No action would be taken under Alternative 1; therefore, Alternative 1 would comply with ARARs. Alternatives 2, 3, and 4 would be implemented in a manner that would comply with these ARARs.
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Table 2-12 ARARs and TBC Criteria

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Chemical-Specific ARARs			
None identified	Not applicable	Not applicable	Chemical-specific ARARs do not relate to the type of MEC found (i.e., no elevated explosives considered to be MEC). Further, the HHRA and SLERA demonstrated that COPCs present in investigative area soil, sediment, groundwater, and/or surface water at the MRS do not pose threaten unacceptable risk to human health or the environment. Therefore, there are no chemical-specific ARARs.
Location-Specific ARARs			
Endangered species	Federal – Endangered Species Act, 16 USC 1531 Migratory Bird Treaty Act: 16 USC 703 et seq Bald and Golden Eagle Protection Act: 16 USC 668 et seq.	Requires action to conserve threatened or endangered species and their habitat.	*Applicable* Applicable if endangered or threatened species are identified in or surrounding the water at the CFLFA2 MRS.
Action-Specific ARARs			
Environmental Performance Standards	Subpart X – Miscellaneous Units: substantive provisions of 40 CFR 264.601	Miscellaneous Units will be required to be located, designed, constructed, operated, maintained, and closed in a manner that will prevent any release that may have adverse effects on human health and the environment.	*Relevant and Appropriate* Relevant and Appropriate if actions require treatment of explosives by open detonation.

2.10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once the RAO has been met. This criterion includes the consideration of residual risk that would remain on-site following remediation and the adequacy and reliability of controls.

Alternative 1 is neither effective nor permanent as MEC are anticipated to remain and there are no controls to prevent access to MEC. Alternative 2 does not provide permanence for the MRS but could provide long-term effectiveness as long as the LUCs are maintained. Alternative 3 would permanently remove MEC from Breakneck Creek and at least 75 feet on both sides of the creek; however, MEC would remain in the remainder of the MRS. Alternative 4 would remove the greatest quantity of MEC from the MRS providing increased long-term effectiveness. However, as MEC may still remain, it also would minimize the potential for movement of MEC into areas previously cleared. LUCs would be required to provide long-term effectiveness.

2.10.4 Reduction in Toxicity, Mobility, or Volume through Treatment

Reduction of TMV refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. There would be no reduction in TMV through treatment provided by Alternative 1. For Alternative 2, no reduction in TMV through treatment would be provided unless MEC are identified during the surface sweeps or during construction support activities. MEC removal under Alternatives 3 and 4, would include detonation and disposal of recovered MEC and MD, reducing the number or volume of explosives hazards. Alternative 4 provides an increased level of reduction in TMV through treatment because MEC would be also be removed from the Republican River. Destruction of MEC would be irreversible and would satisfy the statutory preference for treatment. No detectable explosives concentrations would be anticipated to remain following the detonations. MDAS would be recycled.

2.10.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until the RAO is achieved.

There are no activities performed for Alternative 1, so it entails no risks during implementation. For Alternative 2 there would be approximately 1.5 months of short-term hazards until the RAO is achieved during sign installation. For Alternative 3 there would be approximately three months of short-term hazards until the RAO is achieved during MEC removal and sign installation. For Alternative 4 there would be approximately five months of short-term hazards until the RAO is achieved during MEC removal and sign installation. For Alternatives 2, 3, and 4 additional periodic short-term hazards would occur during surface sweeps and construction support activities in the event future activities are planned.

These hazards would be controlled by implementing safety measures detailed in approved work planning documents, including site safety and health plans, ESSs, and/or dive plans. Exclusion zones and health and safety requirements to protect local residents and site workers would be detailed in an ESS and work planning documents. Implementing the requirements of the ESS would protect the local public and site workers during remedy completion.

2.10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

No actions would be taken under Alternative 1, so it is the most implementable. Alternatives 2, 3, and 4 would all be feasible with respect to their technology. The LUCs under Alternative 2 are standard technologies that have been applied with success at various other DoD installations. LUCs would be easy to implement on installation property. Ease of implementation off installation property would be dependent on private landowners' willingness to coordinate with the Army and to maintain LUCs.

MEC removal is a standard technology that has been applied with success at various other DoD installations. However, due to the dynamic nature of the Republican River, Alternative 4 would be the most difficult to implement. Removal of MEC by UXO-qualified personnel under Alternative 4 would require additional safety considerations for underwater MEC removal technologies compared to land-based MEC removal technologies, but all of these safety considerations would be considered during the work planning process.

2.10.7 Cost

The estimated capital costs, 30-year O&M costs, and total present worth costs assuming a 0.7% escalation factor (OMB, 2019) are detailed in the Proposed Plan. Total costs are summarized in **Table 2-11**.

Alternative 1 has no capital or O&M cost because no remedial activity is performed. Alternative 3 (MEC removal in Breakneck Creek with LUCs) is more expensive than Alternative 2 (LUCs) but would provide an additional level of protection as MEC would be removed from Breakneck Creek. Relative to each other, Alternative 1 has no costs, and Alternative 2 has low overall costs. Alternatives 3 and 4 are significantly more expensive than Alternative 2; Alternative 4 is the costliest but provides the highest level of protection as MEC are removed from Breakneck Creek and the Republican River.

2.10.8 State Acceptance

KDHE is in support of Alternative 4 as documented in the KDHE letter included in **Appendix A.**

2.10.9 Community Acceptance

During the public comment period and public meeting, no comments were received from the community. No other concerns related to the selected remedy were voiced. Therefore, the community accepts the selected remedy as specified in the Proposed Plan.

2.11 Principal Threat Wastes

The NCP states a preference for using (to the extent practicable) treatment that reduces the TMV of the principal threat wastes. The principal threat concept refers to the source materials at a CERCLA site considered to be highly toxic or highly mobile that generally cannot be reliably controlled in place or present a significant risk to human health or the environment should exposure occur. MEC, specifically DMM and UXO, may be considered a principal threat due to the acute nature of hazard associated with these types of munitions. If MEC is found, the FFA parties will consult to make a determination as to whether the material should be classified as principal threat waste as defined by CERCLA, the NCP, and USEPA guidance. If the material is determined to be a principal threat waste, the Army will take all necessary actions to ensure protectiveness of human health and the environment to address the risks posed by the material designated as a principal threat waste.

2.12 Selected Remedy

Alternative 4, MEC Removal for the Republican River and Breakneck Creek and LUCs was selected because it provides a long-term, cost-effective, implementable solution to address the MEC at the MRS. This section describes the rationale for choosing the selected remedy

(**Section 2.12.1**), provides specific details (**Section 2.12.2**) and costs for the selected remedy (**Section 2.12.3**), and describes the expected outcomes after the selected remedy is implemented (**Section 2.12.4**).

The Army is responsible for implementing, maintaining, reporting on monitoring, and enforcing the selected remedy presented in this ROD. The Army will exercise their responsibility in accordance with CERCLA and the NCP.

2.12.1 Summary of the Rationale for the Selected Remedy

The Army believes the preferred alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The Army expects the preferred alternative to satisfy the following statutory requirements of CERCLA § 121(b): (1) be protective of human health and the environment; (2) comply with ARARs; (3) be cost effective; and, (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element.

Alternative 4 can be implemented to achieve the RAO in a cost-effective manner while providing the highest level of overall protectiveness relative to current and reasonably anticipated future land use at the MRS. Alternative 4 will comply with ARARs. The total cost estimated for Alternative 4 over a 30-year period is $4,682,000 (rounded to nearest thousand dollars). The USEPA and KDHE support the Army's selection of Alternative 4.

2.12.2 Description of the Selected Remedy

MEC will be removed from Breakneck Creek in the area from the junction of Breakneck Creek and the Republican River upstream to the Breakneck Lake dam as described in **Section 2.9.3**. The removal area will extend at least 75 feet on both sides of Breakneck Creek. MEC removal also will be conducted within the Republican River, including shoreline and sandbars, inside the MRS as described in **Section 2.9.4**. The MRS potentially will be subdivided during the future Remedial Action Design Phase in order to account for differing management practices, landowners, completion times, and technologies needed in order to achieve the overall RAOs for the MRS. LUCs also will be implemented within the MRS as described in **Section 2.9.2**. LUCs will provide protection to property owners and the public from potential hazards present at the MRS by warning of potential MEC hazards and/or limiting access to, or use of, the MRS. Additionally, monitoring and five-year reviews, as described in **Section 2.9.2.4**, will continue to be needed as MEC could remain in Breakneck Creek and the Republican River.

The MEC removal area and LUC boundary area are within the MRS boundary. The MRS boundary is depicted on **Figure 2-5A** and **Figure 2-5B**. The property lines and remediation areas drawn on **Figure 2-5A** and **Figure 2-5B** are approximate and will be further refined during the remedial design. In addition, the Army's MRS boundary depiction is approximate with respect to hazards. As such, during the remedial design and with stakeholder approval, the Army may further delineate the potentially affected area to increase or decrease the size of the MRS area as it applies to implementation of Alternative 4. The Army will work with affected private property landowners regarding implementation of Alternative 4. Successful implementation of Alternative 4 is subject to private property landowner approvals where applicable.

2.12.3 Summary of Estimated Remedy Costs

A detailed, activity-based breakdown of the estimated costs associated with implementing and maintaining the selected remedy are provided in the Proposed Plan and summarized in **Table 2-13**. The cost estimate is based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements may occur as a result of new

information and data collected during the implementation of the selected remedy. Significant changes will be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Differences, or a ROD Amendment, as appropriate. This is an order-of-magnitude engineering cost estimate that is expected to be within +50% to -30% of the actual project cost.

Table 2-13 Cost Estimate Summary for the Selected Remedy

Capital Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**
Public meeting, Admin Record Update	1	LS	$22,850	$22,850
Master Plan Input	1	LS	$2,500	$2,500
Signs	155	EA	$110	$17,050
Field Work (MEC Removal and Sign Installation)	1	LS	$3,029,397	$3,029,397
Training/Education Materials	1	LS	$7,500	$7,500
Deed Notification and Recording	1	LS	$10,000	$10,000
Project Contingency	25%			$772,324.14
Program Management	15%			$463,394.49
		Total Capital Cost		**$4,325,000**
Annual O&M Costs				
Annual Sign Maintenance	30	EA	$10,191	$305,726
		Total Annual Cost		**$305,726**
Periodic Costs				
Five Year Review	6	EA	$12,000	$72,000
		Total Periodic Cost		**72,000**
			Total 30-Year O&M Cost (1.5% DISCOUNT)	**$357,000**
			Total Present Worth Cost (1.5% DISCOUNT)	**$4,682,000**

2.12.4 Expected Outcomes of Selected Remedy

The expected outcomes of the selected remedy are:

- The current and reasonably anticipated future land uses will be supported and will not represent unacceptable risks to receptors. Timeframe to achieve the RAO is approximately five months when both MEC removal and sign installation is complete.
- MEC hazards may potentially remain at the MRS above levels that allow for UU/UE. Therefore, LUCs will be maintained until it is determined that the MEC hazards no longer remain. LUCs will provide protection to property owners and the public from potential hazards present at the MRS by warning of potential MEC hazards and/or limiting access to, or use of, the MRS. The LUCs will be administered in accordance with the requirements

of the LUC Plan. Additionally, monitoring and five-year reviews will be needed as MEC could remain in Breakneck Creek and the Republican River.

- Implementation of the remedy is expected to achieve a relative risk reduction from Level 1 to a Level 3 and possibly Level 4 depending on the outcome of the response actions. As described in **Section 2.7.1.2** Level 3 and Level 4 are:
    - Hazard Level 3 – Sites with a moderate hazard potential. A site that would be considered safe for the current land use without further munitions responses, although not necessarily suitable for reasonable, anticipated future use. Level 3 areas generally would have restricted access, a low number of contact hours, and, typically, MEC only in the subsurface.
    - Hazard Level 4 – Sites with a low hazard potential. A site compatible with current and reasonably anticipated future use. Level 4 sites typically have had a MEC cleanup performed.

2.13 Statutory Determinations

Under CERCLA § 121 and NCP § 300.430(f)(5)(ii), the lead agency must select a remedy that protects human health and the environment, complies with ARARs (unless a waiver is justified), is cost-effective, and uses permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA also includes: 1) a preference for remedies that employ treatment which permanently and significantly reduces the TMV of hazardous substances, pollutants, and contaminants; and 2) a bias against off-site disposal of untreated wastes. Periodic five-year reviews are required if the remedy will result in hazardous substances remaining in place above levels allowing for UU/UE. The following sections discuss how the selected remedy meets these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedy in this ROD is necessary to protect human health or welfare or the environment from potential MEC hazards at the MRS that may present an imminent and substantial endangerment to public health or welfare. LUCs, annual inspections, construction support, and CERCLA five-year reviews will be necessary as MEC may potentially remain. There will be an increased risk to workers during excavation, screening, and disposal activities (estimated at 5 months). The risk to workers and the community during implementation of the remedy will be mitigated using engineering controls, evacuations, and/or road closures to maintain a safe distance.

2.13.2 Compliance with ARARs

The selected remedy will comply with the action and location-specific ARARs (**Table 2-12**). The Remedial Action Work Plan will provide measures to comply with all ARARs.

2.13.3 Cost Effectiveness

In the Army's judgment, the selected remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness" (40 CFR 300.430[f][1][ii][D]). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination: long-term effectiveness and permanence; reduction in TMV through treatment; and short-term effectiveness. Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of the selected remedy was determined to be proportional to its costs. Therefore, the selected remedy represents a reasonable value for the money to be spent. The estimated present worth cost of the selected remedy is $4,682,000 (in 2019 dollars).

2.13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The Army has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the MRS. The Army has determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment and considering regulatory and community acceptance. The NCP recognizes that some contamination problems will not be suitable for treatment and permanent remedies. For this MRS, MEC destruction provides permanent treatment of the MEC hazards. Alternative treatment technologies are not applicable to the MRS.

2.13.5 Preference for Treatment as a Principal Element

The NCP establishes the expectation that treatment will be used wherever practicable (40 CFR 300.430[a][1][iii](A]). The selected remedy for the MRS satisfies the statutory preference for treatment as a principal element of the remedy by reducing volume of potential MEC hazards through treatment (destruction) and MD/MDAS will be recycled as appropriate.

2.13.6 Five-Year Review Requirements

The NCP at 40 CFR 300.430(f)(4)(ii) requires reviews no less than every five (5) years in cases where a remedial action results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for UU/UE. Alternative 4 will result in MEC hazards potentially remaining at the MRS above levels that allow for UU/UE. Therefore, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy is protective of human health and the environment. After the first statutory review, the risk will be evaluated, along with historical data, in order to determine the need to continue with statutory reviews.

2.14 Documentation of Significant Changes

The Proposed Plan for the MRS was released for public comment on October 7, 2019. The Proposed Plan identified Alternative 4, MEC Removal for Republican River and Breakneck Creek and LUCs as the preferred alternative. The public did not provide comments on the Proposed Plan that led to a change in the selected remedy. Thus, it was determined that no significant changes to the preferred alternative, as originally identified in the Proposed Plan, were necessary or appropriate.

3.0 RESPONSIVENESS SUMMARY

This section provides a summary of the public comments regarding the Proposed Plan for the remedial action at the MRS and the Army response to comments. At the time of the public review period, the Army had selected Alternative 4 – MEC Removal for the Republican River and Breakneck Creek and LUCs as the preferred alternative for the MRS.

3.1 Stakeholder Comments and Lead Agency Responses

As noted previously, this document is issued by the Army, the lead agency for the MRS. The Army has consulted with the USEPA and KDHE, and they concur with the selected remedy. The USEPA and KDHE provided comments on a Draft Final ROD and Proposed Plan that were incorporated into the Final ROD and Proposed Plan. The USEPA and KDHE accepted all changes and indicated that they had no further comments on the ROD.

3.2 Community Participation

The RI/FS and Proposed Plan for the MRS were made available to the public on October 7, 2019. The availability of these documents was published (**Appendix B**) in *The Junction City Union*, Junction City, Kansas, and *The Manhattan Mercury*, Manhattan, Kansas, and *The Fort Riley Post* on the dates noted in **Table 2-8** with a 30-day public comment period from October 7, 2019 through November 7, 2019. In addition, the Army held a public meeting on the Proposed Plan on October 23, 2019 at Fort Riley's Conference Center, Fort Riley, Kansas, to accept oral and written comments. The meeting was transcribed. A copy of the transcript is included as **Appendix B**.

3.3 Summary of Comments Received during the Public Comment Period and Agency Responses

3.3.1 Comments Received During the Public Meeting

A public meeting was held on October 23, 2019. There were no written comments received during the public meeting. One verbal comment was made by the USEPA. The USEPA requested the Army review the USEPA LUC Checklist (USEPA, 2013) to confirm the items are addressed in the ROD. The checklist numbers 1 through 9 listed as "would usually appear in the ROD" have been addressed within the body of this ROD.

3.3.2 Written Comments Received During the Comment Period

The public comment period for the Proposed Plan was held between October 7, 2019 to November 7, 2019 (30 days). There were no written comments received during the public comment period.

3.4 Technical and Legal Issues

No technical or legal issues regarding the Proposed Plan were identified during the public comment period.

This ROD will be added to the Administrative Record file after it is signed. In addition, a notice of the availability of the ROD will be published in *The Junction City Union*, Junction City, Kansas, and *The Manhattan Mercury*, Manhattan, Kansas, and *The Fort Riley Post* in accordance with NCP Section 300.430(f)(6).

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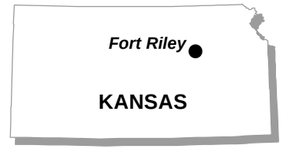
Figures

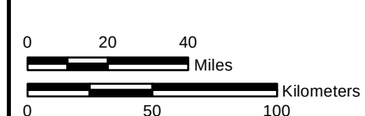
Figure 1-1

Site Location Map

Camp Forsyth Landfill Area 2
Operable Unit 9
Record of Decision
Fort Riley, Kansas



Fort Riley
Camp Forsyth Landfill Area 2
Munitions Response Site



Map Projection: NAD 83 Zone 14N Meters

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: NJ | Date Drawn/Revised: 10/29/2019 | Project No. J170664

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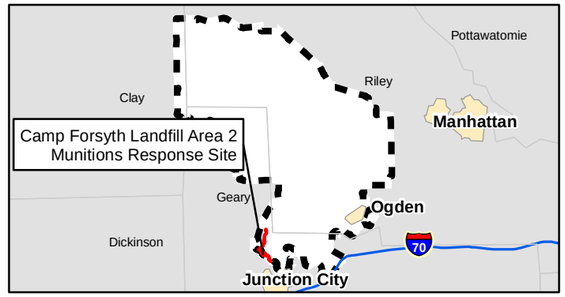
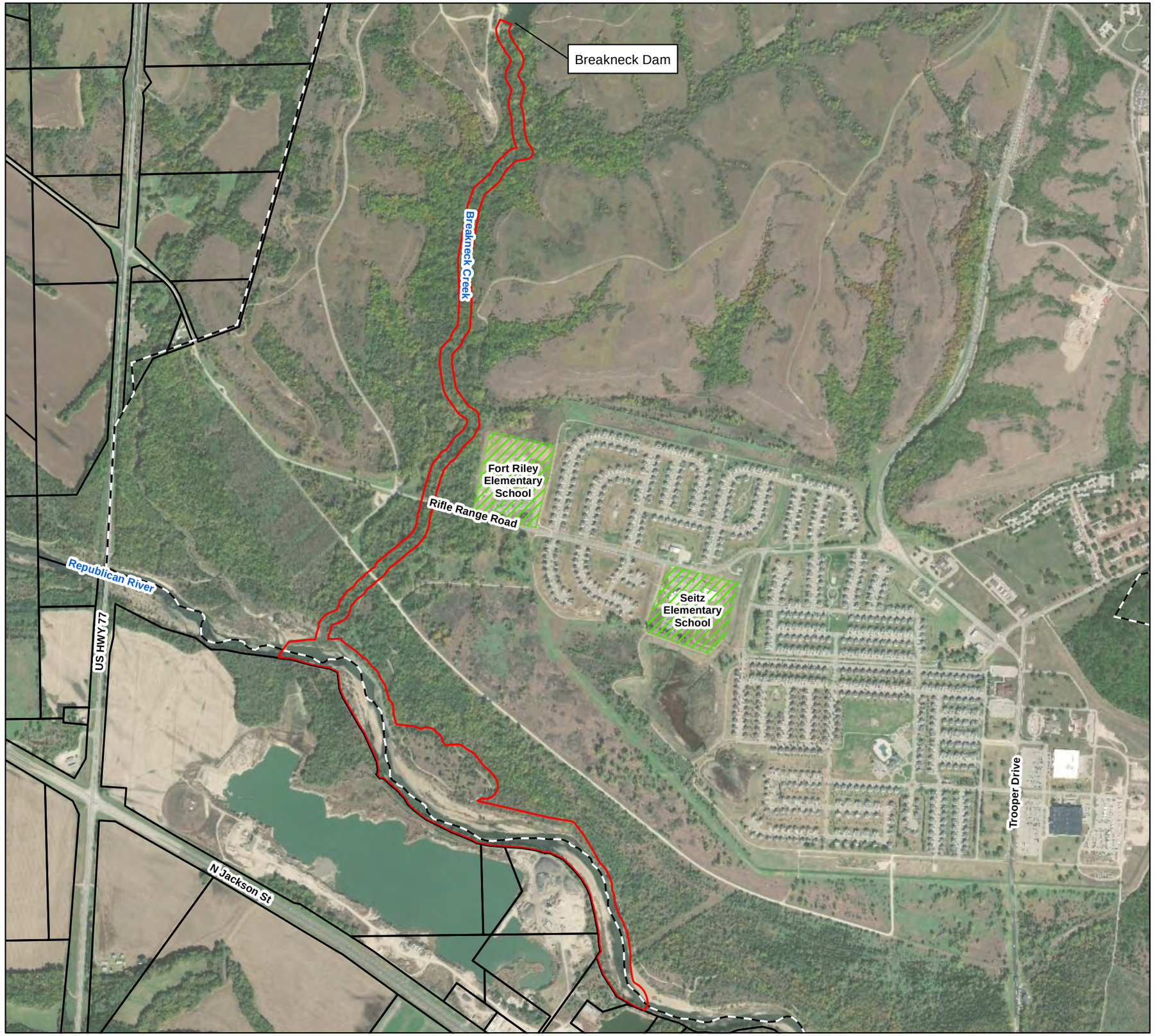
Figure 1-2

Camp Forsyth Landfill Area 2 Munitions Response Site

Camp Forsyth Landfill Area 2
Operable Unit 9
Record of Decision
Fort Riley, Kansas





Camp Forsyth Landfill Area 2 Munitions Response Site
Fort Riley Boundary
School Site
Parcel Boundary

Depictions in the figure are accurate but represent approximations and should not be construed as definitive locations.

0 50100 200 300
Meters
0 700 1,400 2,100
Feet

N
W E
S

Map Projection: NAD 83 Zone 14N Meters

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: NJ | Date Drawn/Revised: 1/31/2020 | Project No. J170664

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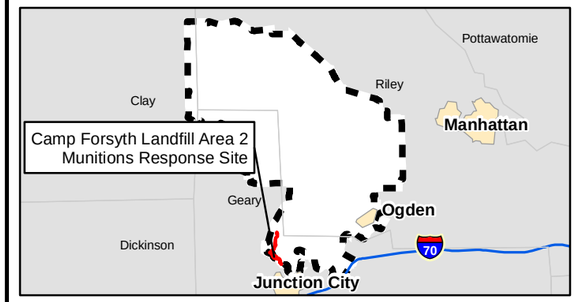
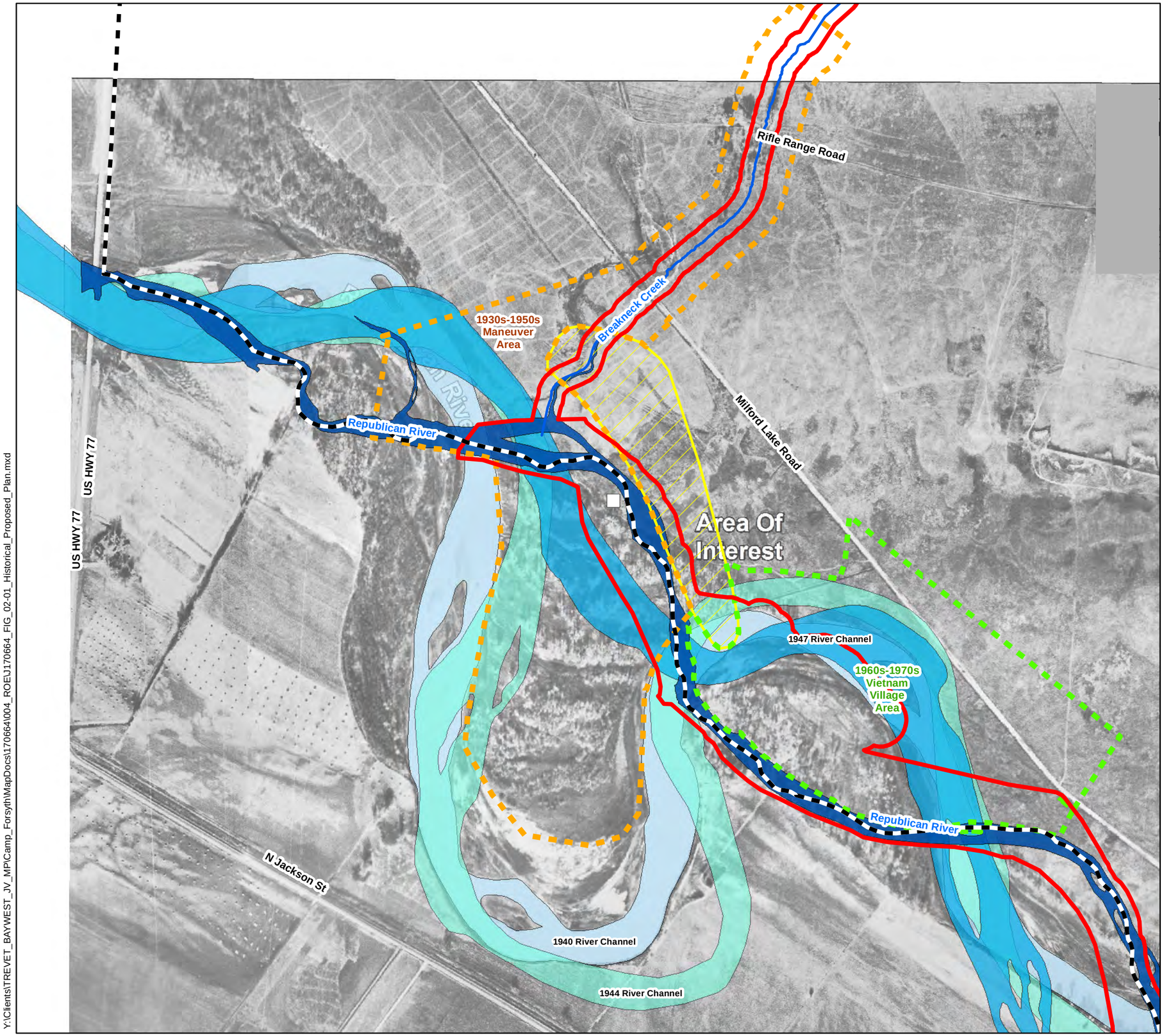
Figure 2-1

Summary of Historical Activities and Republican River Channel

Camp Forsyth Landfill Area 2
Operable Unit 9
Record of Decision
Fort Riley, Kansas





- Fort Riley Boundary
- Camp Forsyth Landfill Area 2 Munitions Response Site
- 1930s-1950s Maneuver Area
- 1960s-1970s Vietnam Village Area
- Concrete Rubble
- Creek
- Historical Camp Forsyth Landfill Area 2 (Fill Area)
- Current River Channel
- 1947 River Channel
- 1944 River Channel
- 1940 River Channel
- Photo Background from 1940 (Bay West, 2012b)

Depictions in the figure are accurate but represent approximations and should not be construed as definitive locations.

0 50 100 200 300 Meters

0 700 Feet

Map Projection: NAD 83 Zone 14N Meters

N W E S

Bay West
Customer-Focused Environmental & Industrial Solutions

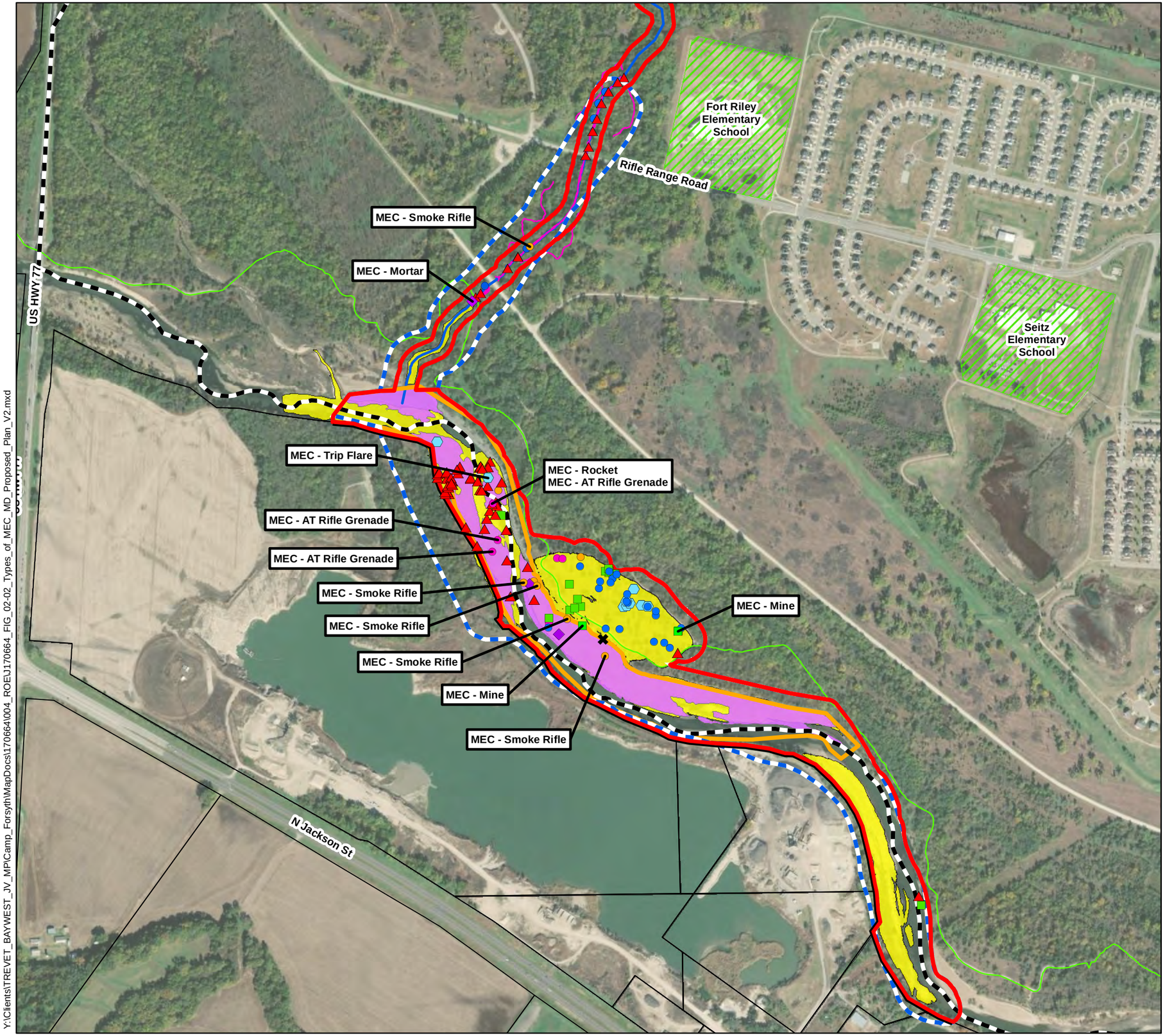
Drawn By: NJ | Date Drawn/Revised: 10/21/2019 | Project No. J170664

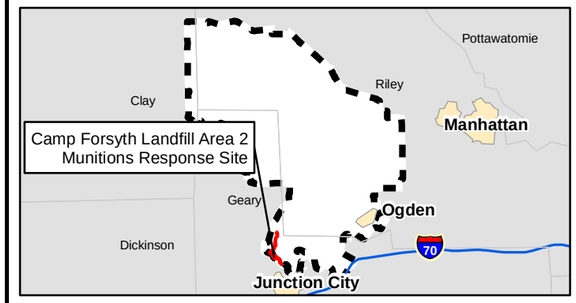
Y:\Clients\TREVET_BAYWEST_JV_MP\Camp_Forsyth\MapDocs\170664\004_ROE\J170664_FIG_02-01_Historical_Proposed_Plan.mxd

Figure 2-2

Remedial Investigation Results Munitions Debris and Munitions and Explosives of Concern Finds

Camp Forsyth Landfill Area 2
Operable Unit 9
Record of Decision
Fort Riley, Kansas





MEC/MD Items (MEC Items Have Callouts)

- Bulk Explosives
- Rocket
- Grenade
- Mines
- Mortars
- Trip Flare
- Smoke Rifle
- AT Rifle Grenade
- Camp Forsyth Landfill Area 2 Munitions Response Site
- Fort Riley Boundary
- Site Inspection CFLFA2 Boundary, 34.9 acres
- Nature Trail
- Creek
- Overall Investigative Area, ESS (Bay West, 2008), Amendment 1 ESP (Bay West, 2013), and Amendment 2 ESP (Bay West, 2015)
- Area investigated during Mob 1, 18.7 Acres
- Area investigated during Mob 2, 44.0 acres
- Analog Area investigated during Mob 3, 0.8 acres
- School Site
- Parcel Boundary

Depictions in the figure are accurate but represent approximations and should not be construed as definitive locations.

0 50 100 200 300 Meters

0 700 1,400 Feet

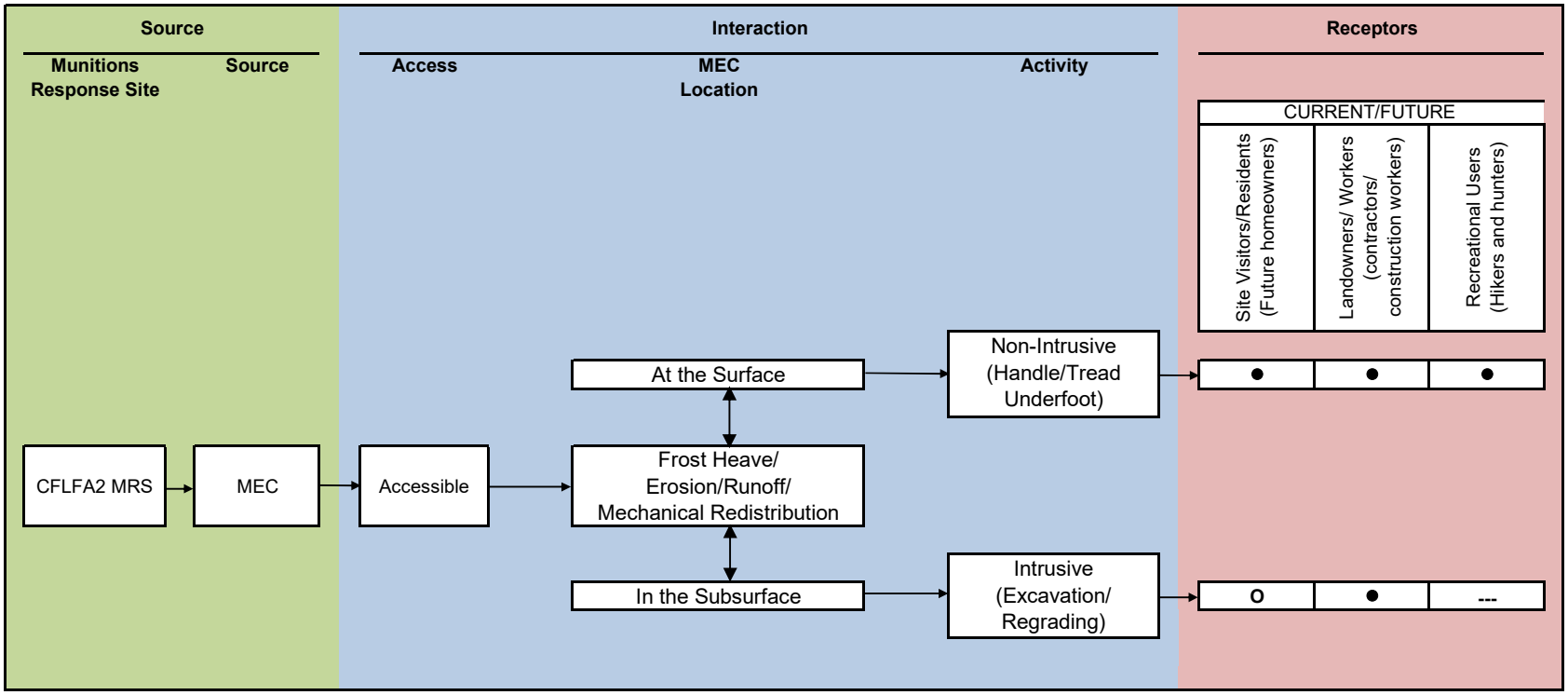
N
W E
S

Map Projection: NAD 83 Zone 14N Meters

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: NJ | Date Drawn/Revised: 1/31/2020 | Project No. J170664

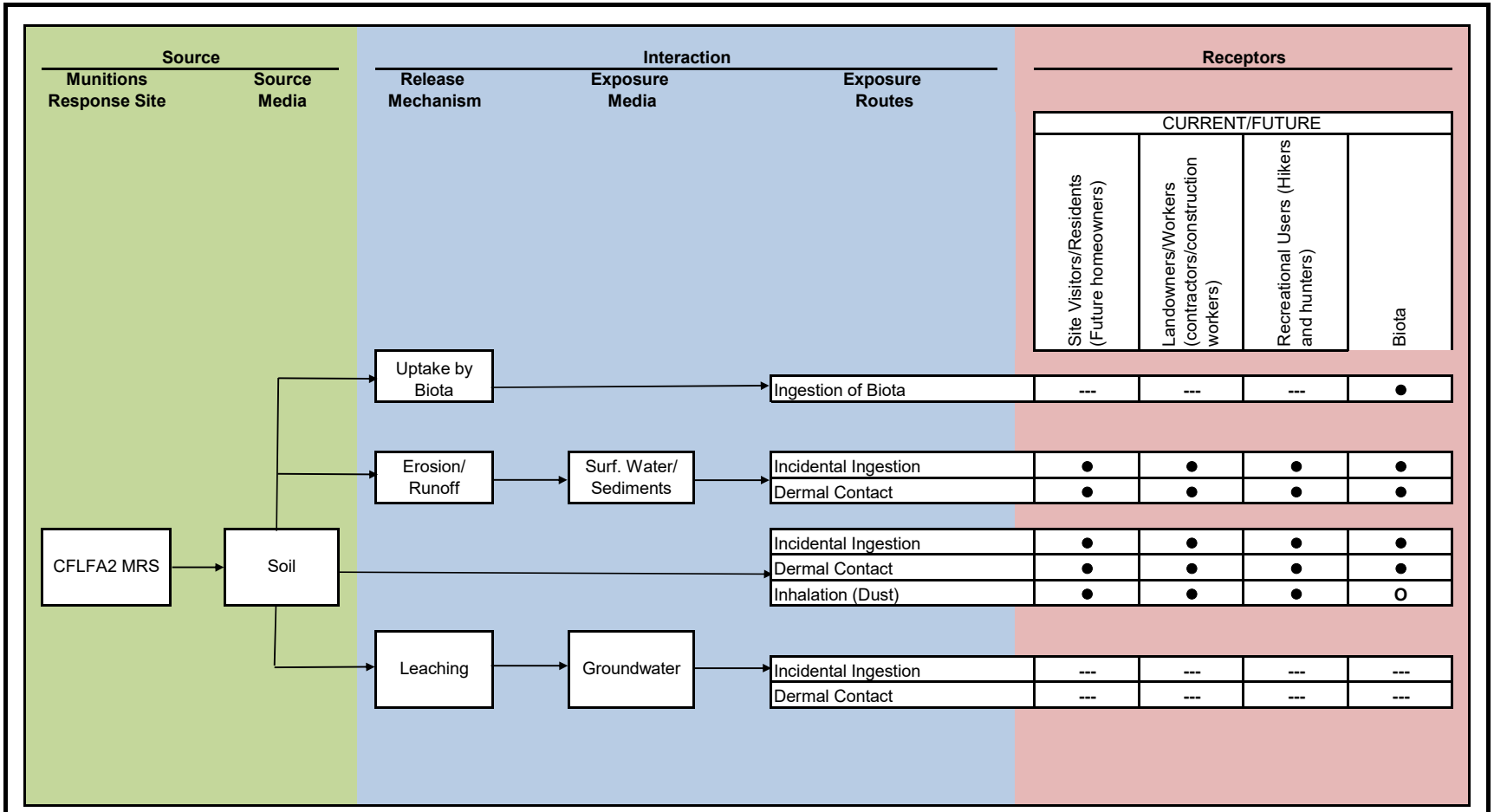
Y:\Clients\TREVET_BAYWEST_JV_MP\Camp_Forsyth\MapDocs\1170664\004_ROE\J170664_FIG_02-02_Types_of_MEC_MD_Proposed_Plan_V2.mxd



MEC Munitions and Explosives of Concern
MRS Munitions Response Site

● Complete Pathway
O Potentially Complete Pathway
--- Incomplete Pathway

FIGURE 2-3
MEC Conceptual Site Model – Exposure Pathway Analysis
CFLFA2 MRS



MC Munitions Constituents
MRS Munitions Response Site

● Complete Pathway
O Potentially Complete Pathway
--- Incomplete Pathway

FIGURE 2-4
MC Conceptual Site Model – Exposure Pathway Analysis
CFLFA2 MRS

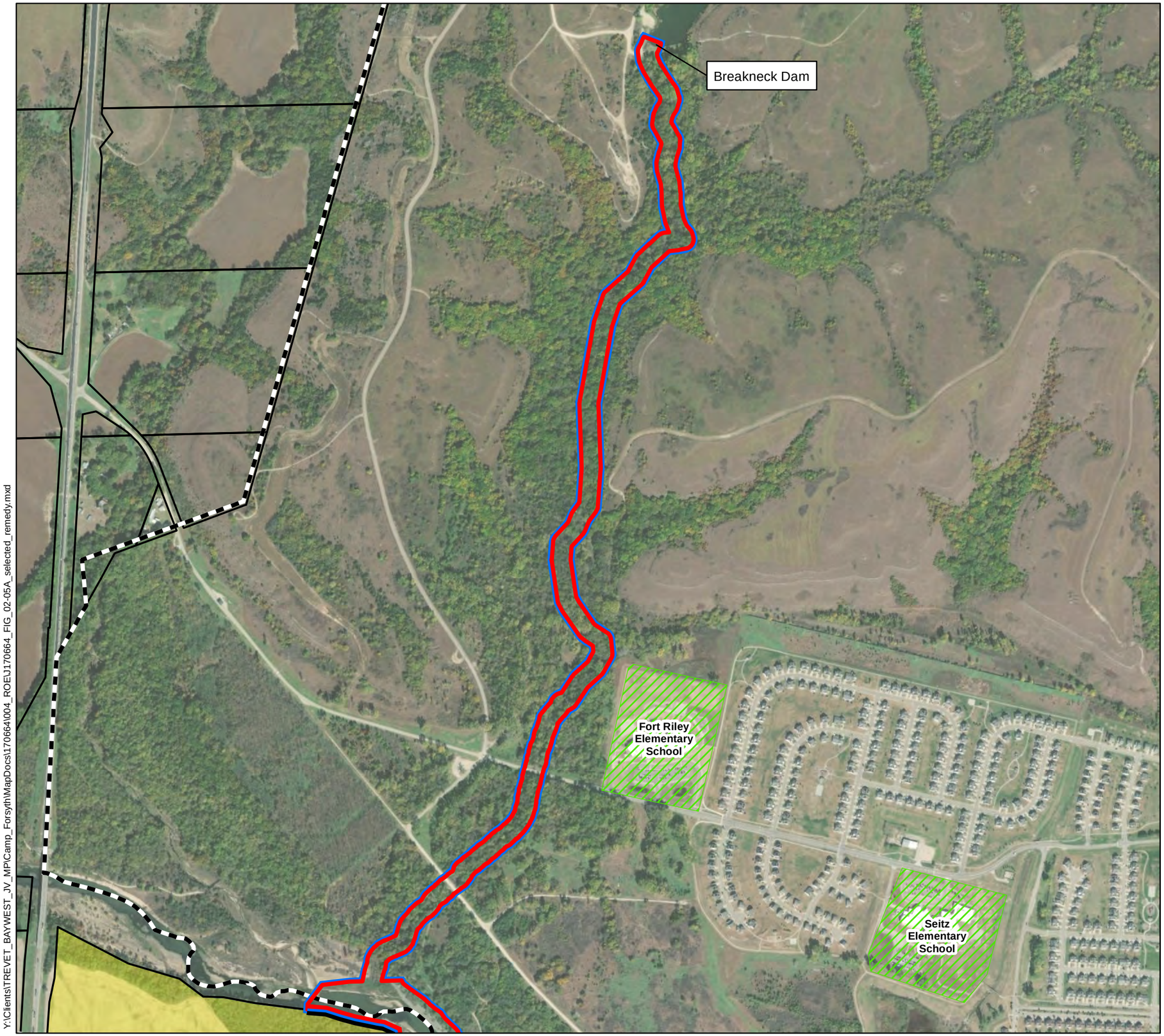
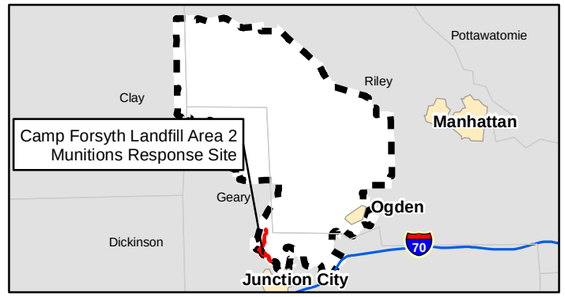


Figure 2-5A

Selected Remedy Munitions and Explosives of Concern Removal for the Republican River and Breakneck Creek and Land Use Controls

Camp Forsyth Landfill Area 2
Operable Unit 9
Record of Decision
Fort Riley, Kansas



- Sign Perimeter (signs placed approximately on 200 ft centers)
- Camp Forsyth Landfill Area 2 Munitions Response Site
- School Site
- Fort Riley Boundary
- Parcel Boundary
- Parcels Immediately Adjacent to the MRS that may Potentially be Affected by Remedial Actions

Depictions in the figure are accurate but represent approximations and should not be construed as definitive locations.

0 50 100 200 300 Meters

0 700 1,400 Feet

Map Projection: NAD 83 Zone 14N Meters

N W E S

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: NJ | Date Drawn/Revised: 5/29/2020 | Project No. J170664

Y:\Clients\TREVET_BAYWEST_JV_MP\Camp_Forsyth\MapDocs\170664\004_ROE\J170664_FIG_02-05A_selected_remedy.mxd

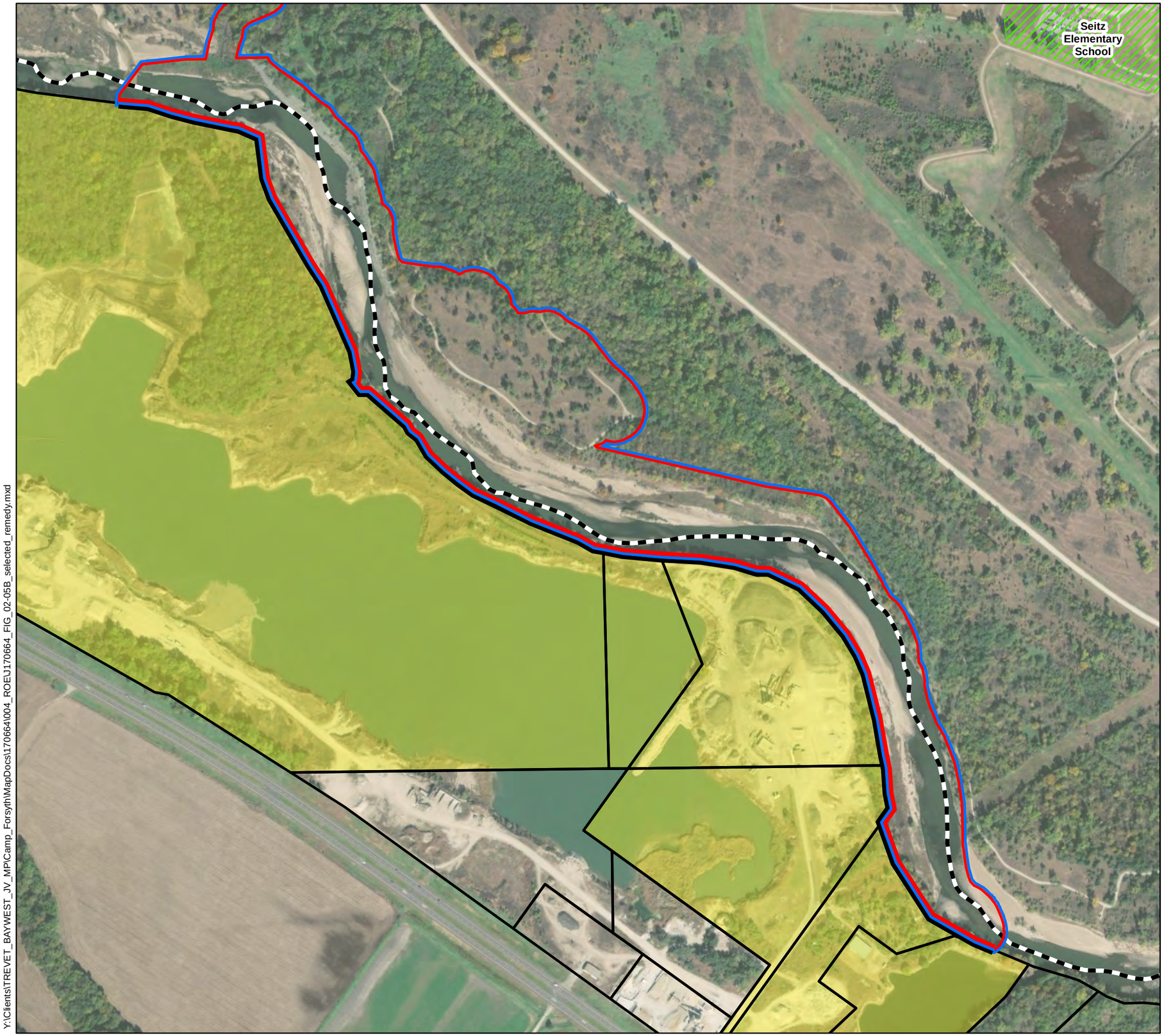
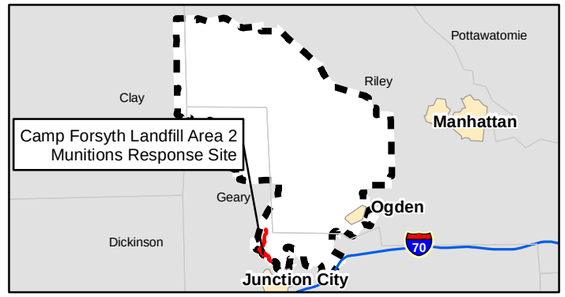


Figure 2-5B

Selected Remedy Munitions and Explosives of Concern Removal for the Republican River and Breakneck Creek and Land Use Controls

Camp Forsyth Landfill Area 2
Operable Unit 9
Record of Decision
Fort Riley, Kansas



- Sign Perimeter (signs placed approximately on 200 ft centers)
- Camp Forsyth Landfill Area 2 Munitions Response Site
- School Site
- Fort Riley Boundary
- Parcel Boundary
- Parcels Immediately Adjacent to the MRS that may Potentially be Affected by Remedial Actions

Depictions in the figure are accurate but represent approximations and should not be construed as definitive locations.

0 50 100 200 300 Meters

0 700 Feet

Map Projection: NAD 83 Zone 14N Meters

N W E S

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: NJ | Date Drawn/Revised: 5/29/2020 | Project No. J170664

Y:\Clients\TREVET_BAYWEST_JV_MP\Camp_Forsyth\MapDocs\170664\004_ROE\J170664_FIG_02-05B_selected_remedy.mxd

Appendix A

USEPA and KDHE Letters of Concurrence

Division of Environment
Curtis State Office Building
1000 SW Jackson St., Suite 410
Topeka, KS 66612-1367

Kansas
Department of Health
and Environment

Phone: 785-296-1660
Fax: 785-559-4261
www.kdheks.gov

Lee A. Norman, M.D., Secretary

Laura Kelly, Governor

May 5, 2020

Mr. Alan Hynek
Chief Conservation Branch
Directorate of Public Works
Environmental Division
407 Pershing Court
Ft. Riley, Kansas 66442

RE: **Draft Final Camp Forsyth Landfill Area 2, Response to Comments**
Fort Riley, Kansas

Dear Mr. Hynek,

The Kansas Department of Health and Environment/Bureau of Environmental Remediation (KDHE/BER) has received the above-referenced draft final document on April 28, 2020. KDHE reviewed and accepts the response to comments for the document.

KDHE/BER furnishes no further comment. Please provide an electronic copy, a final hard copy and CD at your earliest convenience.

If you have any questions, please call me at (785) 260-4207 (cell) or email at margaret.townsend@ks.gov.

Sincerely,

Margaret Townsend

Margaret Townsend, PG
Federal Facilities Unit Chief
Remedial Section/BER

C: Randy Carlson → Margaret Townsend → Cathryn Mallonee → C5-031-71147–1
Daniel O'Connor, EPA, Region 7, electronic
Amanda Chirpich, USACE, KC District, electronic
David Jones, Fort Riley, electronic

Appendix B

Community Participation

Public Notice Proofs

Transcripts from Public Meeting

Response to Comments

Seaton Media, Inc

The Manhattan Mercury, Junction City Union
Wamego Smoke Signal, The Times
1st Infantry Divisional Post, Flint Hills Shoppers
P.O. Box 787, Manhattan, KS 66505

In The Matter of IN THE DISTRICT COURT OF GEARY COUNTY, KANSAS

STATE OF KANSAS
GEARY COUNTY SS

[LEGAL.TEXT]

I, Tabitha Hilyn-Lee being first duly sworn, depose an say: That I am Inside Sales of The Junction City Union, a daily newspaper printed in the State of Kansas, and published in and of general circulation in Geary County, Kansas, with a general paid circulation on a dail basis in Geary County, Kansas and that said newspaper i not a trade, religious or fraternal publication. Said newsp per has been so published continuously and uninterrupt edly in said county and state for a period of more than fi years prior to the first publication of said notice; and has been admitted at the post office of Junction City in said county as second class matter. That the attached notice is true copy thereof and was published in the regular and e tire issue of said newspaper for 4 consecutive insertion the first publication thereof being made as aforesaid on t 29 day of September, 2019 with subsequent publica tions being made on the following dates:

On the 1 day of October 2019

On the 1e day of October 2019

On the 8 day of October, 2019

On the ____ day of _____, 2019

Tabitha Hilyn-Lee

Subscribed and sworn to before me this 8

day of October ,2019

Robin T. Phelan Notary Public

ROBIN T. PHELAN
Notary Public, State of Kansas
My Appointment Expires
12-16-19

Notary Seal

Public Notice

Army Seeks Public Input on Proposed Plan for Munitions Response Site FRTI-003-R-01

PURPOSE:

The Army, in consultation with the U.S. Environmental Protection Agency (USEPA) and Kansas Department of Health and Environment (KDHE), announces the public comment period for the Proposed Plan for Camp Forsyth Landfill Area 2 (CFLFA2) Munitions Response Site (MRS) (FRTI-003-R-01), at Fort Riley, Kansas. The Proposed Plan and historical documentation can be reviewed here:

Dorothy Bramlage Public Library 230 West Seventh Street Junction City, Kansas	Manhattan Public Library 629 Poyntz Avenue Manhattan, Kansas

BACKGROUND:

The CFLFA2 MRS lies along the lower southwestern boundary of Fort Riley and extends into the Republican River, the Republican Flats floodplain, and Breakneck Creek, and between US 77 and Trooper Dr, along the Junction City River Trail. The Army conducted historical training maneuvers on and around the CFLFA2 MRS from the 1930s through the 1970s. Munitions and explosives of concern (MEC) were encountered adjacent to or in the Republican River at depths up to 2 feet. Concentrated areas of munitions debris were encountered in sediments and sandbars within the Republican River. The Army is proposing to remove MEC from the affected area and implement a public education and awareness program along with land use restrictions, where applicable.

SUMMARY:

Fort Riley, the USEPA, and the KDHE provide information regarding the ongoing activities at the MRS to the public through the information repositories, announcements published in the local newspapers, and public meetings. Before finalizing the Proposed Plan, Fort Riley, the USEPA, and the KDHE encourage the public to gain a more complete understanding of the MRS, the activities that have been conducted to date, and an evaluation of the proposed cleanup activities as we move forward.

THE 30-DAY PUBLIC COMMENT PERIOD IS FROM OCT. 7 TO NOV. 7, 2019

Fort Riley invites public comment on the Proposed Plan for the MRS. Before finalizing the Proposed Plan, Fort Riley will consider all oral and written comments received during the 30-day public comment period. Comment letters must be postmarked by Nov. 7, 2019, and should be submitted to:

David Jones
Environmental Division
Public Works
Building 407 Pershing Court
Fort Riley, KS 66442
david.p.jones124.civ@mail.mil

PUBLIC MEETING OCT. 23, 2019, AT 7:00 P.M.

In addition, the Army will hold a public meeting on this Proposed Plan on Oct. 23, 2019, at 7:00 p.m. at Fort Riley's Community Center, Fort Riley, Kansas. A brief description of the proposed cleanup activities will be explained to the public at this time. Additionally, this meeting will provide an opportunity for the public to comment on the preferred cleanup activities. Comments made at the meeting will be documented and a copy of the meeting minutes will be added to the Fort Riley Administrative Record and information repositories.

A4720 Sept. 29, Oct. 1, 6 and 8, 2019

Jewls Tschida

From: Jordan Mitchell <jcdailyunion.info@gmail.com>
Sent: Thursday, October 24, 2019 11:32 AM
To: Jewls Tschida
Subject: RE: RE: RE: Affidavit for Proposed Plan for Munitions Response Site FRTI-003-R-01
Attachments: Post Affidavit A4720 (2).pdf; Post Affidavit A4720 .pdf

Attached is the affidavit for the Post.
Thank you and sorry about that!

Tabitha Hiltgen-Lee
Inside Sales Executive, Classifieds, Legal Notices
785-762-5000 ext 104
info@jcdailyunion.com

From: Jewls Tschida
Sent: Thursday, October 24, 2019 11:19 AM
To: Jordan Mitchell
Subject: RE: RE: Affidavit for Proposed Plan for Munitions Response Site FRTI-003-R-01

Thanks!

Jewls Tschida
Corporate Coordinator
direct: 651-291-3400 fax: 651-291-0099
jewlst@baywest.com

Bay West LLC
Customer-Focused Environmental & Industrial Solutions
5 Empire Drive, St. Paul, MN 55103
24-hrs: 1-800-279-0456
www.baywest.com

Check it out. . . Bay West Way of Being

From: Jordan Mitchell <jcdailyunion.info@gmail.com>
Sent: Thursday, October 24, 2019 11:06 AM
To: Jewls Tschida <jewlst@baywest.com>
Subject: RE: RE: Affidavit for Proposed Plan for Munitions Response Site FRTI-003-R-01

I can get that for you as well,
That is my bad.

Tabitha Hiltgen-Lee
Inside Sales Executive, Classifieds, Legal Notices

785-762-5000 ext 104
info@jcdailyunion.com

From: Jewls Tschida
Sent: Thursday, October 24, 2019 10:58 AM
To: Jordan Mitchell
Subject: RE: Affidavit for Proposed Plan for Munitions Response Site FRTI-003-R-01

Good morning Tabitha.

I received the affidavits from you for the JC Daily Union ad runs.

When should I see the affidavits for the Ft Riley Post ad runs? Or from whom should I request them from?

Please let me know as soon as possible.

Thank you,
Jewls

Jewls Tschida
Corporate Coordinator
direct: 651-291-3400 fax: 651-291-0099
jewlst@baywest.com

Bay West LLC
Customer-Focused Environmental & Industrial Solutions
5 Empire Drive, St. Paul, MN 55103
24-hrs: 1-800-279-0456
www.baywest.com

Check it out. . . Bay West Way of Being

From: Jordan Mitchell <jcdailyunion.info@gmail.com>
Sent: Tuesday, October 8, 2019 3:14 PM
To: Jewls Tschida <jewlst@baywest.com>
Subject: Affidavit for Proposed Plan for Munitions Response Site FRTI-003-R-01

Attached is the affidavit for the legal notice.
Please let me know if there are any further questions.
Thank you!

Tabitha Hiltgen-Lee
Inside Sales Executive, Classifieds, Legal Notices
785-762-5000 ext 104
info@jcdailyunion.com

Seaton Media, Inc
The Manhattan Mercury, Junction City Union
Wamego Smoke Signal, The Times
1st Infantry Divisional Post, Flint Hills Shoppers
P.O. Box 787, Manhattan, KS 66505

In The Matter of IN THE DISTRICT COURT OF GEARY COUNTY, KANSAS

STATE OF KANSAS
GEARY COUNTY SS

[LEGAL.TEXT]

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On the 11 day of October, 2019

On the _____ day of _____, 2019

On the _____ day of _____, 2019

On the _____ day of _____, 2019

Tabitha Hittgen-Lee

Subscribed and sworn to before me this 24 day of October, 2019

Robin T. Phelan
_____ Notary Public

ROBIN T. PHELAN
Notary Public, State of Kansas
My Appointment Expires
12-16-19

Notary Seal

Public Notice

Army Seeks Public Input on Proposed Plan for Munitions Response Site FRTI-003-R-01

PURPOSE:

The Army, in consultation with the U.S. Environmental Protection Agency (USEPA) and Kansas Department of Health and Environment (KDHE), announces the public comment period for the Proposed Plan for Camp Forsyth Landfill Area 2 (CFLFA2) Munitions Response Site (MRS) (FRTI-003-R-01), at Fort Riley, Kansas. The Proposed Plan and historical documentation can be reviewed here:

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SUMMARY:

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David Jones
Environmental Division
Public Works
Building 407 Pershing Court
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david.p.jones124.civ@mail.mil

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A4720 Oct. 4 and 11, 2019

THE 1ST INFANTRY DIVISION POST

CLASSIFIED MARKETPLACE

1st Infantry Division Post *Fort Riley* | The Daily Union *Junction City*

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THE BEST RESULTS

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su|do|ku

8				9	6			
5							6	
4						3	1	
			1	5	2			
			6				8	
		1	7		4			2
		9				2	5	
3					8			
	6						3	1

Level: Advanced

What Is su|do|ku?

The objective of the game is to fill all the blank squares in a game with the correct numbers. There are three very simple constraints to follow. In a 9 by 9 square sudoku game:

- Every row of 9 numbers must include all digits 1 through 9 in any order
- Every column of 9 numbers must include all digits 1 through 9 in any order
- Every 3 by 3 subsection of the 9 by 9 square must include all digits 1 through 9

Last Sudoku's Answers

8	7	5	6	1	4	2	3	9
4	9	3	5	7	2	1	8	6
6	1	2	8	9	3	4	5	7
3	6	4	7	2	5	9	1	8
2	8	1	9	4	6	3	7	5
7	5	9	1	3	8	6	2	4
9	4	7	3	5	1	8	6	2
1	2	8	4	6	7	5	9	3
5	3	6	2	8	9	7	4	1

EMPLOYMENT

Help Wanted

Security, Dancers & DJ
No experience necessary. Good pay. Flexible hours. Apply in person after 7:30pm. at 1330 Grant Avenue, Junction City.

The Junction City Union is currently looking for a District Manager in the Circulation Department. Duties include working with carriers of all ages, delivering routes as needed, increasing circulation through sales and promotions, and assisting customers. Must be able to work independently and have strong people and communication skills. Reliable transportation required. Afternoon, Evening and Sunday hours.
This is a full-time salaried position with a competitive benefits package.
Applications accepted at:
222 W 6th St
Junction City

Help Wanted

The Junction City Union is looking for an independent contractor for newspaper delivery in the Chapman area. Reliable transportation, valid driver's license and insurance, and a phone number are required. Contact Bonnie at (785) 776-8808, ext 260 for more information.

Wakefield Care and Rehabilitation Center
Come join our warm and friendly team.
We are now hiring!
Wakefield Care and Rehabilitation is looking for **self-motivated Registered Nurses (RN) or LPN** that have the ability to supervise and lead a team. **Pay based on credentialing and experience ranges from $20.00 to $28.00 / hour. Plus, RN sign on bonus of $4000 and LPNs $3000.**
Stop by 509 Grove, Wakefield, KS and visit us or call us at 785-461-5417.

MERCHANDISE

Miscellaneous

A PLACE FOR MOM has helped over a million families find senior living. Our trusted local advisors help solutions to your unique needs at NO COST TO YOU! CALL 855-973-9062

ARE YOU BEHIND $10k OR MORE ON YOUR TAXES? Stop wage & bank levies, liens & audits, unfiled tax returns, payroll issues, & resolve tax debt FAST. Call 855-462-2769

Miscellaneous

ATTENTION SMALL BUSINESS OWNERS! Are you protected in case of property damage or if you have an interruption in service due to a property event? Business Owner Property insurance IS AFFORDABLE and WILL PROTECT YOU when the unexpected happens! For free quote, call 913-914-7784 (M-F 7:30am-9:30pm ET)

BEST SATELLITE TV with 2 Year Price Guarantee! $59.99/mo with 190 channels and 3 months free premium movie channels! Free next day installation! Call 316-223-4415

CASH paid for your unwanted Inogen or Respironics portable oxygen concentrators! Call NOW for top-dollar offer. Agents available 24/7. No CPAP/TANKS. 844-909-0094

Denied Social Security Disability? Appeal! If you're 50+, filed for SSD and denied, our attorneys can help get you approved! No money out of pocket! Call 785-329-4931.

DISH TV – BEST DEAL EVER! Free Voice Remote & DVR Included! www.dish.com Referral Code VCD0019117934

DONATE YOUR CAR TO CHARITY. Receive maximum value of write off for your taxes. Running or not! All conditions accepted. Free pickup. Call for details. 844-268-9386

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Miscellaneous

PIANO DEALS! Baldwin spinet, $888; Yamaha console, $1888; Kimball baby grand, $2988; Steinway grand, $9988! Free delivery within 150 miles of Manhattan, first tuning complimentary, easy financing. Mid-America Piano, 1-800-950-3774, www.piano4u.com

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Steel Cargo/Storage Containers available In Kansas City & Solomon Ks. 20s' 40s' 45s' 48s' & 53s' Call 785 655 9430 or go online to chuckhenry.com for pricing, availability & Freight. Bridge Decks. 40'x8' 48'x8'6" 90' x 8'6" 785 655 9430 chuckhenry.com

VIAGRA and CIALIS USERS! There's a cheaper alternative than high drugstore prices! 50 Pills SPECIAL $99.00 FREE Shipping! 100% guaranteed. CALL NOW! 855-850-3904

Were you an INDUSTRIAL or CONSTRUCTION TRADESMAN and recently diagnosed with LUNG CANCER? You and your family may be entitled to a SIGNIFICANT CASH AWARD. Call 866-409-2142 for your risk free consultation

Winter is just around the corner, seasonal firewood for sale. (785)761-5500

RENTALS

Houses

Prime Location 3 Br, 1.5 Bath, CH CA, Garage, $725 monthly, 785-761-7741 or 785-238-7718

Public Notice
Army Seeks Public Input on Proposed Plan for Munitions Response Site FRTI-003-R-01

PURPOSE:
The Army, in consultation with the U.S. Environmental Protection Agency (USEPA) and Kansas Department of Health and Environment (KDHE), announces the public comment period for the Proposed Plan for Camp Forsyth Landfill Area 2 (CFLFA2) Munitions Response Site (MRS) (FRTI-003-R-01), at Fort Riley, Kansas. The Proposed Plan and historical documentation can be reviewed here:

Dorothy Bramlage Public Library 230 West Seventh Street Junction City, Kansas	Manhattan Public Library 629 Poyntz Avenue Manhattan, Kansas

BACKGROUND:
The CFLFA2 MRS lies along the lower southwestern boundary of Fort Riley and extends into the Republican River, the Republican Flats floodplain, and Breakneck Creek, and between US 77 and Trooper Dr, along the Junction City River Trail. The Army conducted historical training maneuvers on and around the CFLFA2 MRS from the 1930s through the 1970s. Munitions and explosives of concern (MEC) were encountered adjacent to or in the Republican River at depths up to 2 feet. Concentrated areas of munitions debris were encountered in sediments and sandbars within the Republican River. The Army is proposing to remove MEC from the affected area and implement a public education and awareness program along with land use restrictions, where applicable.

SUMMARY:
Fort Riley, the USEPA, and the KDHE provide information regarding the ongoing activities at the MRS to the public through the information repositories, announcements published in the local newspapers, and public meetings. Before finalizing the Proposed Plan, Fort Riley, the USEPA, and the KDHE encourage the public to gain a more complete understanding of the MRS, the activities that have been conducted to date, and an evaluation of the proposed cleanup activities as we move forward.

THE 30-DAY PUBLIC COMMENT PERIOD IS FROM OCT. 7 TO NOV. 7, 2019

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David Jones
Environmental Division
Public Works
Building 407 Pershing Court
Fort Riley, KS 66442
david.p.jones124.civ@mail.mil

PUBLIC MEETING OCT. 23, 2019, AT 7:00 P.M.

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A4720 Oct. 4 and 11, 2019

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su|do|ku

6				5			1	2
8						5	7	
3					6			
5				4			6	
		9			2			8
				7	3	1	8	
	4		8					
	1						9	

Level: Advanced

What Is su|do|ku?

The objective of the game is to fill all the blank squares in a game with the correct numbers. There are three very simple constraints to follow. In a 9 by 9 square sudoku game:
- Every row of 9 numbers must include all digits 1 through 9 in any order
- Every column of 9 numbers must include all digits 1 through 9 in any order
- Every 3 by 3 subsection of the 9 by 9 square must include all digits 1 through 9

Last Sudoku's Answers

8	1	7	3	9	6	4	2	5
5	2	3	8	4	1	7	6	9
4	9	6	5	2	7	3	1	8
9	4	8	1	5	2	6	7	3
7	5	2	6	3	9	1	8	4
6	3	1	7	8	4	5	9	2
1	8	9	4	6	3	2	5	7
3	7	5	2	1	8	9	4	6
2	6	4	9	7	5	8	3	1

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Public Notice
Army Seeks Public Input on Proposed Plan for Munitions Response Site FRTI-003-R-01

PURPOSE:
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A4720 Oct. 4 and 11, 2019

In The Matter of Public Notice

STATE OF KANSAS, RILEY COUNTY, ss

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I, Robin Phelan being first duly sworn, depose and say: That I am Advertising Director of *The Manhattan Mercury*, a daily newspaper printed in the State of Kansas, and published in and of general circulation in Riley County, Kansas, with a general paid circulation on a daily basis in Riley County, Kansas and that said newspaper is not a trade, religious or fraternal publication. Said newspaper is a daily published at least weekly 50 times a year; has been so published continuously and uninterruptedly in said county and state for a period of more than five years prior to the first publication of said notice; and has been admitted at the post office of Manhattan in said County as second class matter. That the attached notice is a true copy thereof and was published in the regular and entire issue of said newspaper for FOUR consecutive insertion the first publication thereof being made as aforesaid on the 29th day of September, 2019 with subsequent publications being made on the following dates:

On the 1st day of October, 2019

On the 6th day of October, 2019

On the 8th day of October, 2019

Robin T

Subscribed and sworn to before me this 11th day of October, 2019.

Notary Public

Notary Seal

SAMANTHA FOSHA
Notary Public - State of Kansas
My Appt. Expires 6/8/2021

Public Notice

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Attendees List

Public Meeting Camp Forsyth Landfill Area 2

23 October 2019

Name	Organization	Email	Telephone
Herbert J. Abel	Environmental Div, DPW	herbert.j.abel.civ@mail.mil	785-239-2284
Alan E. Hynek	Environmental Div, DPW	alan.e.hynek.civ@mail.mil	785-239-8574
Steve Elstrom	Public Affairs Director	steve.j.elstrom.civ@mail.mil	785-240-1795
Harry Hardy	Staff Judge Advocate	harry.f.hardy2.civ@mail.mil	785-239-2717
SFC Janet Schnell	Staff Judge Advocate	janet.l.schnell.mil@mail.mil	Not Available
Danny O'Connor	USEPA, Region VI	oconnor.daniel@epa.gov	913-551-7868
Marc Radloff	KDHE, Federal Facilities Unit	Marc.Radloff@ks.gov	785-296-1936
Margaret Townsend	KDHE, Federal Facilities Unit Chief		785-296-8801
Brenda Winkler	Bay West LLC	BrendaW@BAYWEST.com	651-291-3416

Public meeting for Military Munitions Restoration Program

23 October 2019

Speaker: Alan Hynek

Transcribed by: SFC Janet Schnell

Start time: 1900

End time: 1923

Alan: All right. This is a public meeting at Camp Forsyth Landfill Area two cleanup project. As you all are aware it's a legally required public meeting for the certain process and we will get start just by introducing everybody. Harry Hardy, Fort Riley SJA. Mike Bowlby, Army Environmental Center. Brenda, and I can't think of your last name.

Brenda: Winkler.

Alan: From Bay West. Margaret Townsend, the Unit Chief of the Federal Facilities. Herb Abel, Fort Riley DPW. I missed a few people.

Regulatory agencies involved of course are the Environmental Protection Agency, Kansas Department of Health, and then there's other stake holders involved in this process, some residence in the area, military trainers, land owners, and interested parties that may be interested in this process.

CERCLA's evidence. It's a pretty step wise project process and this is where we are at in that right now. Just getting into the

proposed plan portion of that. This is probably the part of that and part of the process.

The dual of public meeting is to allow the residence and any stake holders really to come and ask questions, express their concerns, just to get more details on this. Just kind of a continuation of what the process involved is here. We've got series of alternatives that we went through and looked at. We've come up with what we think is the best alternative to mitigate the issue. We will get into that a little bit later a little more. Part of the process is to lessen other [indiscernible], we've done that through newspapers, other media, and of course there's this meeting.

Fort Riley itself is in the--I talked about this earlier, it's in the Flint Hills Eco Region. It's kind of a transition to the Smoky Hills Region. It's bounded on the south by the Kansas River and then the Republican River, which is where majority of the MRS is, down in the South West part of the installation. The landfill itself was down, we will look at it later if we need to. A little closer look but it was in the area just right in this area of the Republican River, right next to the river bank. And we will see a little bit later how the installation boundary changed a few times. It's a little more complex than just the river being right there. A lot of things have changed around here.

This is the MRS site, Break Neck Creek it runs all the way up to Break Neck Dam and the Republican River and the boundaries of the South West part of Fort Riley. This is all private property right here. This is a commercial operation, most of this is commercial operations.

This is the map that shows how the river has changed over the years. This used to be Fort Riley Proper, this little loop right here, and then 1946 I believe it changed course and then that changed the pattern of Fort Riley's boundary. The river right now flows right through everything in red. Right now, this is the boundary [between red lines]. That is where the MRS is located.

History of the site started in 1993 with our installation wide assessment identified as a potential area of concern, primarily because of the landfill. There was a site investigation done in 2006, and part of the reason that that got moved up is because there were a couple of instances where munitions and munition related items were found in the Republican River when the flooding happened. It was designated [indiscernible] review in 2013. We've done three remedial investigations, most recently in 2015 where we identified certain possible areas of sewers, we never did--we have not really found that. I think that was mainly from the landfill. That was cleaned up. We still found a little more after we got, thought we had it all [indiscernible]. Hopefully this [indiscernible] will

finish that out [indiscernible] in the future. A feasibility study was done in 2018 and finished in 2018. We further identified the boundary in the MRS was, it has changed quite a bit over the last 20 years since we've been studying it. It went from 43 acres I think to [indiscernible]. So, it has changed a bit.

The studies over the years have identified. The constituents have been found in the river. It's kind of hard to see. [The lights were dimmed in the room to make the slide more visible.]

This map shows where the constituents have been found. There have been several studies and remedial actions to allow us to further identify where the current MRS is, [indiscernible] might be there. The last instances we went up to Break Neck Creek a little ways and found somethings. So, in this portion we're going to go all the way up to Break Neck Dam, a little bit further, and try to find anything that could be up in there that could have been a source at one time. The bulk of it is was it around that landfill. There was other items that we found upstream from there, which is what prompts these studies and further investigations.

Just a definitions of what the hazards are, first, we're going to encounter munitions out there. There's recreationist using the trails down there, hunting, fishing, and there's military training. All those things prove there's a risk of public access to that area, been exposed to [indiscernible].

And the goal of this whole project is to minimize those individuals contact with munitions up to two feet in the Republican River without keeping future land uses unrestricted. We'll always some restrictions on it because it being a military training base [indiscernible].

There were four alternatives that were considered. Alternative one is no action of course. Alternative two is land use controls consist of signage of public notice. Alternative three consists of that plus further investigation of Break Neck Creek all the way up to the dam. Alternative four it's [indiscernible]----

MIKE BOWLBY: It's just missing land use controls.

ALAN: Yeah, the only difference between this and three is the investigation. So, that is the most extensive as taking much time.

MIKE: Realize we're going to be getting a clearance of action not [indiscernible] of investigations.

ALAN: This is alternative four, just a little more detail and it's just a part of that and a part of that, [indiscernible]. But, what's outlined here is red where the additional surveys will take place within 75 feet of Break Neck Creek to the other side of the stream. The blue line on the outside is where signage will be placed. I am not sure of the intervals yet, but the signage throughout that will be maintained through there. And this is the

Republic River. It is the same key that red is the study area. This may change just slightly, what I understand [indiscernible] depending on further property the evaluation [indiscernible] particularly on this side.

The blue line is of course where the signage will be, this, for reference is the tank trail, the walking trail. This is that commercial property that does the sand dredging on the south side, it is private property [pointing to the left side of the screen]. The bulk of it is on Fort Riley, but there is of course some that is on owned private property.

The process involves clearance in land use controls. The clearance in more detail is mobilization after just getting out here and getting set up, surveying the area just to make sure that we are trespassing somewhere we shouldn't be or where we haven't already had permission to make sure our points are correct. We will need to do some rush clearing in some areas, particularly along the Republican River and Break Neck Creek. And the actual meat of that part of the project is the detection and then removal of anything we can find, of course, it will then be disposed of properly.

Land use controls just in further details, the generic controls along the force of the river, particularly where it goes adjacent to private property. Its public awareness and signage, periodic investigations, re-inspections in the area [indiscernible],

something else [indiscernible], hopefully [indiscernible]. It's hard to say 100%.

Some of the administrative mechanisms are already in place is that it is identified, there are planning documents for our military. You have to have a dig permit if you want to dig anywhere. So, if a dig permit came up to us and it was down there in that area for instance, we're not going to approve it. Any contractor work that's going on in that area, we would know. We would find some training and [indiscernible].

In addition to that we would have circular five year reviews just to make sure the process is doing it and is going as well as we think it's going to, make sure that the alternatives are working, make sure that there's no areas we can improve on, and if there are, we will address those in [indiscernible].

Just the three R's from the military response. [Indiscernible.] There's still comments, there's still period is still open for comment through October 28th [indiscernible] decision would be selected and at some point we would come up and finalize the ROD, hopefully get this moving and do some cleaning up.

Are there any questions?

There are plenty of SME's here and know quite a bit about this. They've done it before.

MIKE: I will just add the process between signage [indiscernible] it’s similar to and send some photos. We’re hoping alleviate [indiscernible] [The individual is too far from the mic to pick up.]

[There’s I back and forth conversation between Mike, Danny, and Brenda concerning that the land owners can’t be forced to use signage, but offered the opportunity. Further, it is stated that there needs to be a specific check list to what the Army needs to use and that there still needs to be an institutional control agency and a secondary option. It was discussed that there was an ROE, Right of Entry, in place with the land owners.]

[END of PAGE]

Appendix C

Trial Period for Risk Management Methodology at Formerly Used Defense Sites (FUDS) MMRP Projects (USACE, 2019)

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS 441 G STREET NW
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF

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CEMP-CED

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Trial Period Extension for Risk Management Methodology (RMM) at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects

REFERENCES:

a. Memorandum dated 3 January 2017, signed by Karen Baker, Subject: Trial Period for Risk Management Methodology at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects

1. PURPOSE: This memorandum establishes a one year extension of the process described in Study Paper: Decision Logic to Assess Risks Associated with Explosive Hazards, and to Develop Remedial Action Objectives (RAOs) for Munitions Response Sites (MRS), (Enclosure 1). The original two-year trial began by Memorandum signed 3 January 2017 (Reference A).

2. TRIAL RESULTS: Input provided from multiple project teams in all Military Munitions Design Centers to date has resulted in the following findings:

a. The tool promotes communication within the PDT and supports more robust development of data quality objectives during preparation of the Uniform Federal Policy Quality Assurance Project Plan (UFP QAPP).

b. The process relies on real data, using anomaly distributions and other findings that were useful for defining the "Amount of MEC" input factor.

c. The process provides a simple standard procedure that is useful for a variety of site conditions and assists the project team in differentiating and justifying acceptable vs. unacceptable conditions. This decision logic supports the definition of RAOs for the project.

d. There was minimal to no cost difference in implementation. The minimal increase was related to learning the tool use.

e. The tool allows the potential for a No Further Action (NFA) end point to remain as a reasonable result of the remedial process, where decision logic can support this

determination.

f. Although the tool was generally successful, there are some areas where development of terminology and additional guidance will be useful. An extension of the RMM trial will allow continued use, while allowing time to develop FUDS guidance to improve the tool and assist in providing additional structure for continued use. Specifically, during this one year extension, the RMM will be updated to include:

(1) Discussion of standard terminology and examples, such as "MD Indicative of MEC" and "Evidence of MEC," and "Likelihood to Impart Energy."

(2) Standardization for munitions static characteristics as they relate to the Sensitivity and Severity, and other conditions of the munition with examples for table selection.

(3) Establishment of a process to consider factors and conditions that result in frequency of access selection.

(4) Establishment of factors in consideration of institutional controls that result in reduction of access or activities that may impart energy, and provide examples.

3. APPLICABILITY: This guidance is applicable to all USACE elements engaged in FUDS MMRP projects.

4. REQUIREMENTS: In accordance with 40 CFR Part 300.175(d)(4), *"...the Lead Agency shall conduct a site specific baseline risk assessment to characterize the current and potential threats to human health and the environment..."* For unacceptable risks, and in accordance with 40 CFR Part 300.430(e)(i), the Lead Agency shall *"Establish Remedial Action Objectives (RAOs) specifying contaminants and media of concern, potential exposure pathways, and remediation goals."* The methodology in Enclosure 1 is intended to satisfy the requirement for a risk assessment for FUDS MMRP projects. RAOs are established to define the acceptable end state for a MRS.

5. IMPLEMENTATION: Although application of this risk method is first intended for use at the end of Remedial Investigations, it is also intended to support remedy selection and the post Remedial Action data assessment.

a. The method will continue to be used to:

(1) Provide information to support risk management decisions upon completion of characterization:

(2) Develop remedial action objectives: and

(3) Provide basis for assessing achievement of remedial actions relative to acceptable end states.

b. Implementation will avoid disruption of service contracts, where possible. For circumstances where ongoing work is not able to transition to the new methodology and be conducted in compliance with this Memorandum, efforts will be made to include consideration of the risk criteria discussed in Enclosure 1 and provide feedback to address how other approaches compare to the process described in the Study Paper. This information will be submitted to the EM CX in lieu of Enclosure 2 information.

6. DATA MANAGEMENT: Information regarding use for this methodology during the one year trial will be collected by the EM CX. Project teams will submit the attached Feedback Form (Enclosure 2), at the time draft reports are submitted for EM CX review. The methodology will be assessed at the end of one year from the date of this memorandum. HQUSACE, at the end of the extension, will provide FUDS guidance for continued use and implementation. Project teams are encouraged to contact the EM CX if questions arise during the use.

7. TRAINING: Project teams are encouraged to enroll in the FUDS training course #428 to learn how to use the methodology, or engage the EM CX to assist in project-specific application.

8. EFFECTIVE DATES: The requirements and procedures set forth in this interim guidance are effective immediately. They will remain in effect for one year, unless superseded by other policy or regulation.

9. POINT OF CONTACT: For additional information, please contact Ms. Nancy Flaherty, FUDS MMRP Program Manager, at 202-761-1503.

KAREN J. BAKER
Chief, Environmental Division
Directorate of Military Programs

ENCLOSURES:
1. Final Study Paper: Decision Logic to Assess Risks Associated with Explosive Hazards, and to Develop Remedial Action Objectives (RAOs) for Munitions Response Sites, 29 September 2016
2. New Risk Management Methodology Feedback Form

CEMP-CED
SUBJECT: Trial Period Extension for Risk Management Methodology at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects

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Commander, Southwestern Division
Chief Counsel
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Final
Study Paper:
Decision Logic to Assess Risks Associated with Explosive Hazards, and to Develop Remedial Action Objectives (RAOs) for Munitions Response Sites

Abstract

A framework of logic is presented to evaluate hazards at Munitions Response Sites (MRS) such that a systematic assessment of the associated site specific human health risks can be determined, and remedial action objectives (RAOs) can be established. This paper is presented as a consistent methodology for these determinations which depend on site-specific characterization data and specific land use conditions at each MRS. These data are processed similar to the Department of Army Pamphlet for Risk Management (DA Pam 385-30), but the framework utilizes MRS characteristics of Accessibility, Sensitivity and Severity to illustrate site specific conditions, and assign acceptable versus unacceptable scenarios at an MRS. Acceptable end states as presented in Figure A3-1 achieve negligible risk scenarios for an MRS and can be A) Acceptable, where unlimited use unrestricted exposure (UU/UE) is supported, B) Acceptable without additional land use controls (LUCs), where UU/UE may not be supported, or C) Acceptable with LUCs, where UU/UE is not supported.

1 Purpose

The purpose of this paper is to provide U.S. Army Corps of Engineers (USACE) Formerly Used Defense Sites (FUDS) Project Delivery Teams (PDT) with decision logic to differentiate acceptable versus unacceptable site conditions at Munitions Response Sites (MRSs), to establish a systematic approach for developing remedial action objectives (RAOs), and to assist in developing acceptable response alternatives to meet the RAOs. This paper establishes a parallel to the Department of the Army Pamphlet defining the process of Risk Management (DA Pam 385-30), by defining factors more appropriate for Military Munitions Response Program (MMRP), to include specific site conditions and munitions sensitivities. The strength in the Army risk assessment approach is that it is intended to address potentially acute hazard scenarios by factoring real site conditions to establish risk.

- Section 2 provides the applicability of this paper.
- Section 3 introduces CERCLA regulatory requirements for risk assessment and defining remedial action objectives, and limitations to available tools.
- Section 4 addresses the requirement for risk assessment at Munitions Response Sites (MRSs) by providing considerations for site characterization and a framework that allows PDTs to define the current state of an MRS as acceptable or unacceptable based on specific site conditions and information gathered through characterization.
- Section 5 addresses the requirements for developing the RAO by utilizing the framework for MRS risk assessment in Section 4 to identify one or more site scenarios that are

considered acceptable and therefore would constitute a protective end state. These scenarios provide the basis for determining the RAO(s) for the MRS.

- Section 6 presents an exit strategy using post remedy data assessments to evaluate confidence in the remedial action and support achievement of the RAOs for an acceptable end state.

2 Applicability

This study paper methodology may be applied by all USACE organizations conducting FUDS MMRP CERCLA response actions.

3 Background

3.1 NCP Requirement for a Risk Assessment

In accordance with 40 CFR Part 300.175(d)(4), *"...the Lead Agency shall conduct a site specific baseline risk assessment to characterize the current and potential threats to human health and the environment..."* The methodology described in this paper is intended to meet the NCP requirement for a risk assessment, and be consistent with the risk management decision process described in DA Pam 385–30, which establishes a framework for risk management in accordance with Department of Defense Instruction (DODI) 6055.1 and Army Regulation (AR) 385–10.

3.2 NCP Requirement for Remedial Action Objectives

For unacceptable risks, and in accordance with 40 CFR Part 300.430(e)(i), the Lead Agency shall *"Establish Remedial Action Objectives (RAOs) specifying contaminants and media of concern, potential exposure pathways, and remediation goals."*

Similar to a chemical contaminant, defining a measureable and achievable RAO for munitions response sites will be dependent upon a defensible characterization[1] to result in clear identification of the munitions and explosives of concern (MEC), as well as the exposure pathways to receptors. Identification of MEC for a munitions project must first be supported by the nature of the specific munitions known or suspected to exist at a MRS. The specific nature of the munitions present is a significant consideration in defining the presence of a hazard.[2]

[1] Although there are different goals for cleanup of munitions than for HTRW, CERCLA is generally the regulatory framework that DoD has determined will be used for the MMRP. The term "characterization" is used broadly to foster the iterative development of a robust, high quality Conceptual Site Model (CSM) through investigative response actions, such as the CERCLA Preliminary Assessment (PA), Site Inspection (SI) and Remedial Investigation (RI) phases collectively, but generally irrespective of the regulatory framework under which a project is being conducted. At the end of the RI under CERCLA, the site is "characterized" and data is used for assessment of risk.

[2] Variability in explosive nature (sensitivity) of specific munitions, and variance in the anticipated result of an incident (severity) is acknowledged in determining an acceptable versus unacceptable risk on an MRS (e.g., small spotting charge vs. high explosive, fuzed munitions).

With these considerations applied to the 40 CFR Part 300 requirement for developing a measureable RAO, development of measureable and achievable RAO for a MRS requires:

A

a. Identification of specific munitions and explosives of concern (MEC) and media of concern.
b. Identification of exposure pathways to receptors, and
c. Identification of acceptable remediation goal.

3.3 Current Tools for Assessment of Explosive Hazards

Currently, there are tools available to assist in prioritization, and qualitative assessment of hazard reduction for MRSs. These tools have specific programmatic functions, but have limitations at the project level regarding initial determination of acceptable versus unacceptable risk at an MRS. Without this initial assessment of risk supported by the conceptual site model (CSM), it is difficult to establish RAOs for a MRS. A summary of these tools and how they were assessed in support of the approach described in this paper is provided at Attachment 1.

4 Assessing Risk at Munitions Response Sites

The following section is intended to assist project teams to initially define and defend determinations of acceptable versus unacceptable risk at munitions response sites. Section 5 builds on this logic to identify acceptable site scenarios as RAOs that will achieve one of the acceptable end states.

4.1 Defining Risk after MRS Characterization

Characterization is critical to define the presence of MEC hazards and exposure pathways to receptors that are used to create the baseline risk determination.[3] At the completion of successful characterization, the project team must be able to determine whether the conditions at the site are "acceptable" or "unacceptable," such that only unacceptable risks require remedial action. *For determination of an unacceptable risk and to develop the RAO, the likely presence of MEC with a reasonably anticipated current or future exposure scenario must be clearly supported by MRS specific information.*

B

Presence of Site Munitions with a Specific Explosive Nature and
Site Specific Receptor and Exposure Pathway →
Determination of Risk

[3] See Attachment 4.

The general expression for risk, shown in block B, is derived from items a and b in block A, and is directly related to the CSM[4] resulting from characterization. The determination of an explosive risk must include a) likely presence of *specific munitions* having an explosive nature at the MRS; it cannot be solely dependent on historical suspicion or general observance of uncharacterized munitions debris (MD). The known explosive component characteristics of the specific munitions present are a critical consideration in assessing and defining the sensitivity and severity of site risks.[5] Additionally, the determination of unacceptable risk in block B must also be supported by accessibility, specifically b) site-specific current or reasonably anticipated future land use scenarios, defining receptors and a pathway that would result in a likelihood of exposure.

C	"Unacceptable Explosive Risk" is determined if the CSM indicates presence of munitions having a specific explosive nature, as well as the accessibility supported by the specific land use, such that the likelihood of encounter, sensitivity of the munitions items, and severity of a potential incident are collectively unacceptable.

Multiple lines of evidence are required to define the presence and nature of specific munitions, receptors and pathways that will support a qualitative risk assessment and development of the RAO. As these data typically rely heavily on observation, geophysical data, and qualified experts to determine likely presence and nature of explosive munitions, additional lines of evidence that need to be considered whenever available are historical records identifying type of ordnance used and operational context (nature of operations, when, where, how much, etc.). Additionally, details such as the horizontal and vertical spatial distribution information resulting from characterization, as well as topography and terrain, vegetation, and geology are the types of information collectively used to support a determination of the potential of an explosive risk based on current and future land use.

In section 4.3, information from the CSM is used to assess the accessibility, severity and sensitivity of the site scenario. The section provides decision logic that supports a determination of whether there is an ***unacceptable explosive risk***.[6]

4.2 MRSs with Undefined Risk

Similar to response for chemical contamination, a remedial action that results in "zero risk" remaining on the site is ***not*** possible or required. A Feasibility Study (FS) is only conducted to

[4] See Engineer Manual 200-1-12 for CSM development. Additional assistance with development of the CSM (lateral and vertical) is available through the EM CX.

[5] For HTRW, without definition of the specific chemical, concentration, toxicity, and an assessment of exposure, it is impossible to define (even relatively) the severity of risk or to assess an appropriate response. Similarly in MMRP, without defining the specific munition, the scale to the explosive nature of specific munitions, and assessment of site specific exposure pathways, it is impossible to assess and define risk at a MRS (See footnote 12).

[6] This is consistent with HTRW response process, conducting the risk assessment subsequent to defining hazards resulting from RI site characterization. It is also consistent with the Department of the Army Pamphlet 385-30, Safety: Risk Management, such that the CSM conditions define the presence of a hazard.

address an unacceptable risk. It is critical to note that a RAO cannot be developed for an unknown or unlikely risk.

- If there is an "unknown" risk, then characterization is not complete.

- If there is a determination that a site risk is so small (often seen in reports described as "unlikely" or "negligible") that response would result in a residual risk equal to the initial risk, then there is no further reduction possible such that a more acceptable level of protectiveness can be defined.[3]

Therefore, it is not appropriate to conduct a FS, nor can a remedial action be conducted to reduce an "unknown," "negligible," or "unlikely" risk.

4.3 Approach to Assessing Acceptable versus Unacceptable Risk at MRSs

For each MRS, the project team is encouraged to develop data and structure for differentiating an acceptable versus unacceptable risk. By defining unacceptable versus acceptable using site specific characteristics of severity, accessibility, and sensitivity, a project team can more effectively communicate the risks and associated requirements for remedial action, develop a RAO, and facilitate the achievement of response complete (RC) for the Site.

A simple approach for this logic is to employ matrices using site-specific CSM data to relate accessibility, munitions sensitivity, and severity of an explosive event if it were to occur, to determine baseline risks.[7] The purpose of each matrix is introduced here, and then presented in detail in section 4.4 to support unacceptable risk determinations for a site.

- ***Matrix 1,*** *the Likelihood of Encounter,* relates the site characterization data for amount of MEC potentially present to site use, including *accessibility,* in order to determine the likelihood of encountering MEC at a specific site.

- ***Matrix 2,*** *the Severity of an Incident,* assesses the likelihood of encounter from Matrix 1 as related to the *severity* of an unintentional detonation.

- ***Matrix 3,*** *the Likelihood of Detonation,* relates *sensitivity* of the MEC items to the likelihood for energy to be imparted on an item during an encounter by specific land users.

- ***Matrix 4*** combines the results of the above categories to differentiate *Acceptable and Unacceptable Site Conditions.* A site which results in an unacceptable initial condition will

[7] Accessibility, Sensitivity and Severity are the same factors used in the MEC HA. This methodology requires that data elements for these hazard components result from the site specific characterization data. It is anticipated that individual site circumstances will require different levels of the severity, accessibility, or sensitivity determinations. Decision logic used to select particular levels in the matrices must be justified and well-supported by facts presented in the CSM.

proceed to the next phase of the CERCLA response process. This matrix identifies acceptable conditions, which become possible remedial action goals that are ultimately achievable (via remedial response actions) for all portions of the MRS. Section 5 discusses these acceptable conditions as RAOs.

4.4 The Risk Matrices

4.4.1 *Matrix 1.* In Matrix 1, below, the "Likelihood of Encounter" is dependent on two factors, the amount of MEC items known or suspected to exist, and access conditions (e.g., accessibility and frequency of use). Either or both of these factors can be modified as a result of the selected remedial action to reduce or eliminate the likelihood of encounter.

"Amount of MEC" is determined using site specific characterization data or anticipated or completed results of a remedial action.[8] Although the scale emphasizes the results of distribution, the selection may also include consideration of available historical information, such as development history.[9] "Access Conditions" are selected based on considerations of the access and frequency of use for the MRS.

The selection considers "Accessibility" as similarly defined by the MEC Hazard Assessment (MEC HA); but also considers other relevant conditions, such as topography, terrain, specific land use, and specific potential receptors via defined pathways to establish access conditions as a frequency of use.[10] As such, site specific circumstances may result in different access conditions, which should be supported and documented by the CSM.

[8] The "Amount of MEC" selection in Matrix 1 differs from the MEC HA's input factor for "Amount of MEC" which is based solely on the MRS "type" historically identified. Instead, the "Amount of MEC" in Matrix 1 is initially dependent on the results of characterization data regarding MEC and MD distribution. The Matrix is then used to assess anticipated or completed results of a remedial action (physical removal of MEC) to a "reduced" amount.

[9] For example, historical information indicating an area has been extensively developed and used for years with no MEC encounters, in many cases, will be evidence to support a low determination for "Amount of MEC" in the table, and therefore support a lower "Likelihood of Encounter."

[10] A site may be accessible but may have relatively low frequency of use due to the difficult terrain, which results in lower possible contact hours or "access" for the MRS. This scale of "access conditions" may include several factors, including number of visitors or receptor hours per year, nearby population, or residential versus industrial use. Each of these factors may have different justifications depending on the facts at the site. The concept of calculation of "receptor hours per year" is provided in the MEC HA document.

Matrix 1. Likelihood of Encounter

Likelihood of Encounter, Matrix 1: Amount of MEC vs. Access Conditions		Access Conditions (frequency of use)[10]			
		Regular (e.g., daily use, open access)	Often (e.g., less regular or periodic use, some access)	Intermittent (e.g., some irregular use, or access limited)	Rare (e.g., very limited use, access prevented)
Amount of MEC[8,9]	• MEC is visible on the surface and detected in the subsurface.	Frequent	Frequent	Likely	Occasional
	• The area is identified as a Concentrated Munitions Use Area (CMUA) where MEC is known or suspected (e.g., MD indicative of MEC is identified) to be present in surface and subsurface.	Frequent	Likely	Occasional	Seldom
	• MEC presence based on physical evidence (e.g., MD indicative of MEC), although the area is not a CMUA, or • The MEC concentration is below a project-specific threshold to support this selection (e.g., less than 1.0/acre at 95% confidence).	Likely	Occasional	Seldom	Unlikely
	• MEC presence is based on isolated historical discoveries (e.g., EOD report) prior to investigation, or • A DERP response action has been conducted to physically remove MEC and known or suspected hazard remains to support this selection, (e.g., surface removal where subsurface not addressed) or • The MEC concentration is below a project-specific threshold to support this selection (e.g., less than 0.5/acre at 95% confidence).	Occasional	Seldom	Unlikely	Unlikely
	• MEC presence is suspected based on historical evidence of munitions use only, or • A DERP response action has been conducted to physically remove surface and subsurface MEC (evidence that some residual hazard remains to support this selection), or • The MEC concentration is below a project-specific threshold to support this selection (e.g., less than 0.25/acre at 95% confidence).	Seldom	Seldom	Unlikely	Unlikely
	• Investigation of the MRS did not identify evidence of MEC presence, or • A DERP response action has been conducted that will achieve UU/UE.	Unlikely	Unlikely	Unlikely	Unlikely

Matrix 2. Severity of Incident

Severity of Explosive Incident, Matrix 2: Severity vs. Likelihood of Encounter		Likelihood of Encounter[11]				
		Frequent: Regular, or inevitable occurrences	Likely: Several or numerous occurrences	Occasional: Sporadic or intermittent occurrences	Seldom: Infrequent, rare occurrences	Unlikely: Not probable
Severity Associated with Specific Munitions items[12]	**Catastrophic/Critical:** May result in 1 or more deaths, permanent total or partial disability, or hospitalization	A	A	B	B	D
	Modest: May result in 1 (or more) injury resulting in emergency medical treatment, without hospitalization	B	B	B	C	D
	Minor: May result in 1 or more injuries requiring first aid or medical treatment	B	C	C	C	D
	Improbable: No injury is anticipated	D	D	D	D	D

"A" indicates conditions most likely to result in determination of an unacceptable risk.
"D" indicates conditions most likely to result in determination of an acceptable risk.

4.4.2 *Matrix 2.* Matrix 2, "The Severity of Incident," relates "Likelihood of Encounter" from Matrix 1 to the severity of an unintentional detonation. Unlike the two factors affecting the likelihood of encounter in Matrix 1, the "Severity" factor in Matrix 2 is a static characteristic of each of the munitions known or suspected to exist at the property. This is consistent with the MEC HA application for munitions identified for the property. Therefore, in order to improve the Category in Matrix 2, either the items are physically treated and/or removed (reducing the amount of MEC), land use or conditions are altered, or both of these factors are improved in Matrix 1.[11]

[11] Note that with data collected from physical remediation, it is possible to support an unlikely determination for Matrix 1 and 2, (Attachment 3).
[12] This paper recognizes there is currently no scale for ranking the explosive nature of munitions, and it therefore requires coordination with qualified UXO professionals, per TP-18 requirements (reference 15), on the project team. Initiatives are underway to evaluate these considerations of scale. There must be a defined munitions item having an explosive nature and a defined exposure scenario. Additionally, the degrees of hazards differentiate between intact UXO and munitions components such as rocket motors, fuzes, discarded military munitions (DMM), and explosive soils. Decision logic to support the selection on this scale must be supported by the CSM, and documented in the project reports. Additional research in this subject area in the future may allow for additional refinement within these categories so site specific conditions will be the primary factor for project team determination once MEC types on site have been determined.

Matrix 3. Likelihood of Detonation

Likelihood of Detonation, Matrix 3: Munitions Sensitivity vs. Likelihood of Energy to be Imparted		Likelihood to Impart Energy on an Item[14]		
		High e.g., areas planned for development, or seasonally tilled	*Modest* e.g., undeveloped, wildlife refuge, parks	*Inconsequential* e.g., not anticipated, prevented, mitigated
Sensitivity[13] Susceptibility to Detonation	***High*** (e.g., classified as sensitive)	1	1	3
	Moderate (e.g., high explosive (HE) or pyrotechnics)	1	2	3
	Low (e.g., propellant or bulk secondary explosives)	1	3	3
	Not Sensitive	2	3	3

4.4.3 *Matrix 3.* Matrix 3, "The Likelihood of Detonation," relates the sensitivity of site specific munitions items to the likelihood for energy to be imparted on an item, such that the interaction results in detonation (incident). MEC sensitivity and the likelihood for energy imparted during an encounter are both specific to the site CSM. The "sensitivity" of a munitions item is alone a static component, inherent to the known or suspected munitions present at the site. The selection for sensitivity is similar to the sensitivity scale in Table 1 of the Military Munitions Response Site Prioritization Protocol (MRSPP).[13] The "Likelihood to Impart Energy" is selected from the known activities at the site that may cause an interaction that results in energy being imparted on a munitions item by human activity.[14] The "Likelihood to Impart Energy" can be affected by behavioral modifications or by altering land use, specifically to prevent accessibility or particular activities to reduce the likelihood or ability of imparting energy on a munitions item.

[13] The Sensitivity categories are scaled highest to lowest, similar to the MRSPP Table 1: Munitions Type Data Elements Table. While the scale of sensitivity in Matrix 3 is similar to MRSPP Table 1, the matrix must have the flexibility to consider the inclusion of unlisted or undefined items, such as fuzes having small amounts of primary charge and not attached to a booster charge, which may be less sensitive than fuzes with large amounts of primary charge or any fuze connected to a booster charge. Therefore, the PDT should build from this baseline structure in Matrix 3 to include additional considerations, and provide justification for the sensitivity selection for the specific item. Selections must be supported by identifying the specific munitions on the MRS (listed with correct nomenclature).

[14] The likelihood to impart energy on an item can be high for farmed land that is regularly tilled, or areas where development is planned. Moderate areas may include parks or areas where digging is manual or limited. Areas that are inconsequential will include areas where digging is not anticipated, or otherwise mitigated to prevent imparting energy on an item. The project team will consider land use, specifically types and amount of energy imparted at the site that will result in an interaction with a munitions item. The project team will document the justification for selection on the scale.

Matrix 4: Acceptable and Unacceptable Site Conditions

Acceptable and Unacceptable Site Conditions		Result From Matrix 2			
		A	B	C	D
Result from Matrix 3	1	Unacceptable	Unacceptable	Unacceptable	Acceptable
	2	Unacceptable	Unacceptable	Acceptable	Acceptable
	3	Unacceptable	Acceptable	Acceptable	Acceptable

Note: Multiple conditions may exist within an MRS, such that unique baselines risks can be established for the multiple explosive hazards that are present within the same property. Acceptable conditions indicate input factors are collectively determined to support a negligible risk. Project teams shall consider the nature of the specific item within the MRS and the probability to encounter in order to support the selection on the scale.

4.4.4 *Matrix 4.* Matrix 4 represents the overall risk for the site, and differentiates "acceptable" from "unacceptable" conditions. This is determined based on the likelihood of an encounter (Matrix 1), with consideration given to the severity of the incident (Matrix 2), combined with the likelihood of an interaction that results in detonation (Matrix 3). For example: The result of A-3 in Matrix 4 indicates "unacceptable" as depicted above. The overall risk for the selection is driven by the "frequent" or "likely" encounter (Matrix 1) with a potentially catastrophic munitions item (Matrix 2), even though the likelihood of a detonation (Matrix 3) is low (3) based on sensitivity and likelihood to impart energy on the item.

At the end of characterization, the result of Matrix 4 is used to differentiate unacceptable from acceptable conditions. Where an unacceptable scenario is identified, this matrix is then used during the feasibility study to identify acceptable conditions that are ultimately achievable via remedial response actions for all portions of the MRS. Finally, the matrices are used in a post remedy data assessment to evaluate the achievement of risk reduction for a given remedy (Attachment 3).

4.5 Addressing Multiple Risk Scenarios

The risk management matrices will be applied to all portions of an MRS. Multiple conditions may exist within an MRS, such that unique baseline risks can be established for the multiple explosive hazard scenarios that are present within the same MRS. If separate remedial actions for different locations of an MRS are anticipated, the matrices may be applied separately to support the risk management decisions in each location. Multiple entries (or multiple matrices) should be used when:

1) accessibility or land use conditions vary across the MRS (e.g. industrial vs. camping or hiking vs. residential),

2) when munitions types and and/or MEC characteristics vary within an MRS, and /or

3) when the distribution of MEC differs across the MRS (e.g., target center, identified as a concentrated munitions use area (CMUA) vs. buffer or safety zones, identified as non-concentrated munitions use areas (NCMUAs)).

Therefore, multiple RAOs may be required where multiple site conditions exist. These multiple conditions may be illustrated in a tabular form. An example of multiple risk scenarios is provided in Attachment 2.

5 Defining the RAO

A RAO must establish the acceptable condition(s) for the MRS which no longer poses an unacceptable risk.[15] Project teams must carefully consider available data and logic to support assessment of any remedial action against the RAO, such that remedial actions can be developed to feasibly take a site which currently poses an unacceptable risk to one which no longer poses an unacceptable risk.

5.1 Planning Risk Reduction to the RAO

After an unacceptable risk has been defined for an MRS, teams can identify conditions that are acceptable in Matrix 4 as RAOs, where remedial actions can be identified that will result in reduction of an unacceptable risk to one of these acceptable conditions.

Once Matrix 4 establishes the unacceptable baseline risk condition, the RAO can then be developed to achieve one of the acceptable conditions of Matrix 4. ***The Remedial Action Objective(s)*** can be written *"to reduce the unacceptable risk due to presence of [name specific munitions of explosive nature or components using appropriate nomenclature] within [specified horizontal MRS boundary] to a depth of [defined depth related to current and future land use, or depth of MEC determined during characterization if less than land use] below surface to address likelihood of exposure to [receptors] via [pathway] such that an acceptable condition (as defined by Matrix 4) is achieved."*

> "The **Remedial Action Objective(s)** can be written *"to reduce the unacceptable risk due to presence of [name specific munitions of explosive nature or components using appropriate nomenclature] within [specified horizontal MRS boundary] to a depth of [defined depth related to current and future land use, or depth of MEC determined during characterization if less than land use] below surface to address likelihood of exposure to [receptors] via [pathway] such that an acceptable condition of negligible risk (as defined by Matrix 4) is achieved."*

Multiple RAOs may be required where multiple site conditions exist, for example, for different MEC characteristics or components within an MRS, for different land uses within the MRS, and/or for areas having different distribution characteristics, (e.g. target area and buffer area).

[15] For many traditional chemical analyte targets, there is either an established acceptable level on which the RAOs are based, or where there are no levels, there are standard processes used to establish project acceptable limits. For explosive hazard, however, there is no promulgated standard, nor are there standard processes to establish acceptable limits. This paper provides general guidelines as a process for defining an acceptable state for a MRS.

These multiple conditions may be illustrated in a tabular form. An example is provided in Attachment 2.

5.2 Achieving the RAO

The RAO is met by changing the unacceptable baseline risk conditions to one of the possible acceptable conditions in Matrix 4. This is achieved by moving to the right within Matrix 2, Matrix 3, or both.

- ***Moving to the right in Matrix 2.*** Risk is reduced by establishing remedial alternatives that reduce the "Likelihood of Encounter" which results in moving to the right on Matrix 2. This is accomplished either by reducing the amount of MEC, altering the frequency of access, or both in Matrix 1.

- ***Moving to the right in Matrix 3.*** Risk is reduced by establishing remedial alternatives to address likelihood of energy imparted to a munitions item as a result of specific activities at the MRS, which will result in moving to the right on Matrix 3. This can be accomplished by implementation of land use controls.

For example, if an MRS baseline is unacceptable, resulting from a "B" category of Matrix 2 and a "2" category from Matrix 3, the remedial alternatives can be established to reduce "B" in Matrix 2 to a "C" or "D", reduce "2" in Matrix 3 to a "3", or affect both matrices to reach any of the "Acceptable" risk levels.

Where multiple site conditions are present on a MRS, e.g., multiple accessibility parameters based on differing land use, or when locations of multiple explosive types and sensitivities can be differentiated from one another, different hazard matrices for these areas may be required. An example presenting multiple acceptable conditions where differing site scenarios are present is included at Attachment 3.

6 Exit Strategy Using Post Remediation Data Assessments

6.1 Defining an Acceptable End State for a MRS

The achievement of one of the "Acceptable" scenarios in Matrix 4 can result in one of the following "end states" to support a Response Complete (RC) determination, as illustrated in Attachment 3 (Figure A3-1):

a. Acceptable, where UU/UE is supported[16], or

[16] DODM 4715.20, Enclosure 3, 4.b.(5)(b)1. The assessment of remedial alternatives to meet the remediation goal must include an action to remediate the site to a condition that provides for a UU/UE alternative, and an alternative that achieves protectiveness with LUCs. Upon achievement of the RAO, information should be developed which supports achievement of the acceptable hazard level and an assessment of a UU/UE determination. Project teams must keep in mind that after any site remedy is complete, if the contamination left behind does not allow for UU/UE, 5- year reviews will be required.

b. Acceptable without LUCs, where UU/UE is not supported[17], or

c. Acceptable with LUCs, where UU/UE is not supported.

6.2 Supporting the Acceptable End State Using Post Remedy Data Assessment

Where a physical removal is a component of the selected alternative, the data collected during the physical removal supplements the CSM such that one of the three exit conditions for RC above can be confidently supported. The project team is encouraged to develop "If-then" statements within the proposed plan and decision document that provide the decision logic for these conditions.

Data assessment at the completion of any physical remediation can be used to support the achievement of the RAO, to support the RC determination, and to provide additional confidence in decisions at the site. This includes determination of whether additional actions, such as LUCs, are necessary. It separately includes the determination of whether UU/UE is supported. Teams must plan for data acquisition during the response action to support this decision logic. An example of a post remedy data assessment is included at Attachment 3.

7 Summary and Considerations of Exit Strategy at MRSs

This paper provides decision logic to define and defend decisions on acceptable versus unacceptable conditions at an MRS such that remedial action objectives can be established. These RAOs must be established so the remedial action will mitigate an unacceptable risk to an acceptable one. Furthermore, a RAO cannot be established to reduce an unknown or unlikely risk.

The following recommendations are made to differentiate acceptable and unacceptable risk conditions for each site based on magnitude of evidence collected through site characterization and/or during collection of data during implementation of physical response actions to support achievement of an acceptable end state, shown in Figure A3-1.

1) The project team is encouraged to utilize the matrices presented in this paper as a site-specific risk assessment structure to differentiate acceptable and unacceptable conditions at an MRS.

    a. The likelihood of encounter must account for the characterized distribution, and specific land use scenario. Together, these data reflect the likelihood of encounter, shown in Matrix 1. The matrix may be used pre and post remedy to assess changes to the likelihood of encounter.

[17] LUCs are additional components of a remedy that further reduce risk where the RAO is not achieved by physical remedy alone. Although UU/UE is not supported, this does not specifically necessitate LUCs. It does, however, necessitate 5-year reviews. Pre-existing site conditions may impose restrictions that are not part of the remedy and will be considered in making the remedial decision, but a site might not achieve UU/UE after RC.

b. Through the assessment of Severity and Sensitivity Matrices 2 and 3, acceptable conditions may be differentiated from unacceptable ones, thereby supporting the development of a site specific RAO.

2) At completion of characterization (or post remedy) where likelihood of exposure is not reasonably anticipated and has been described, based on combined magnitude of evidence, as "negligible" or "unlikely," then an acceptable condition already exists for which no additional remedial response is required.

3) Project teams performing physical response actions to reduce risk levels, must plan to acquire data needed to describe the residual risk post response to evaluate achievement of the RAO. These data are used to determine if an additional remedial action (such as implementation of LUCs or additional treatment or removal) is necessary to achieve the RAO.

4) Furthermore, data acquired during a remedial action in which a physical removal is conducted may be of quality to support a UU/UE determination, if data gathering is planned and the necessary data is acquired during implementation of the remedy. Project teams are encouraged to include "if-then" statements when assessing remedial alternatives that consider potentially different results of remedial data as applicable to the determination of UU/UE.

5) Where multiple site scenarios are present on a site, (for example, multiple accessibility parameters based on differing land use, or when locations of multiple explosive types and sensitivities can be differentiated from one another), different hazard matrices for these areas may be required.

8 References

1) National Oil and Hazardous Substances Pollution Contingency Plan, (NCP). 40 CFR Part 300, Sections 1-7 and 400-525 March, 1990.

2) DoD Ammunition and Explosives Safety Standards: Criteria for Unexploded Ordnance, Munitions Response, Waste Military Munitions, and Material Potentially Presenting an Explosive Hazard (Department of Defense MANUAL NUMBER 6055.09-M, Volume 7, February 29, 2008. Administratively Reissued August 4, 2010).

3) Defense Environmental Response Program (DERP), Department of Defense Instruction Number 4715.07

4) USEPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final. EPA/540/G-89/004. OSWER Directive 9355.3-01. October.

5) Technical Guidance for Military Munitions Response Actions, Environmental and Munitions Center of Expertise Interim Guidance Document (IGD) 14-01, 20 December 2013. EM 200-1-15.

6) ESTCP studies. https://www.serdp-estcp.org/Featured-Initiatives/Munitions-Response-Initiatives/Classification-Applied-to-Munitions-Response

7) USEPA, 2001. Comprehensive Five Year Review Guidance, EPA-540-R-01-007, OSWER Number 9355.7-03B-P, June.

8) USEPA, 2007. Interim guidance for Munitions of Explosive Concern Hazard Assessment (MEC HA).

9) Office of the Secretary of Defense (OSD) Munitions Response Site Prioritization Protocol (MRSPP) Primer, 32 CFR Part 179, April 2007.

10) Office of the Secretary of Defense (OSD). DoD Evaluation of MEC HA. November 2014.

11) USACE Munitions Safety, Engineer Manual (EM) 385-1-97. Chapter III Probability Assessments

12) Department of the Army, Safety: Risk Management, DA PAM 385-30, 2 December 2014.

13) USACE Engineer Manual (EM) 200-1-12.

14) USACE Memorandum dated January 2007, RE: UFP QAPP Implementation

15) DDESB Technical Paper 18: Minimum qualification standards for personnel who support MEC related activities, 16 July 2015.

Attachment 1: Current Tools for Assessment of Hazard

A1.1 Consideration of the MEC Hazard Assessment (MEC HA)

The MEC HA is intended to provide a qualitative assessment of alternatives given a baseline MRS condition. The output for the MEC HA (baseline and alternatives) is hazard levels 1 through 4, with 1 having the highest hazard, and 4 being the lowest. Each remedial alternative receives a reduced score relative to the baseline score. The score is calculated by additive characteristics of the CSM, specifically the "accessibility" to the explosive items at the MRS, "sensitivity" of the items to function, and the "severity" of an incident, should it occur.

In consideration of MEC HA tool, the "munitions classification", "type", and "energetic material" components of the score are, understandably, static characteristics. These components (accounting for ~32% of the baseline) are never reduced, no matter what remedy is selected. However, because the MEC HA score is an additive calculation, where these factors are not changed, the score cannot efficiently account for a reduced "probability of encounter", which should be a multiplicative determination founded on the "amount of MEC" and "accessibility" conditions.

Other limitations identified by the DoD memorandum, dated November 2014, are related to the rigid selection factors of the tool which do not lend flexibility for the multitude of scenarios of site specific CSMs in the MMRP. For instance, the "Amount of MEC" selection for the MEC HA tool relies on the area category, similar to the type of range that is known or suspected, rather than the period and frequency of use, or actual anomaly distribution resulting from characterization.[18] Understanding or estimating the "Amount of MEC" should be more representative of the findings of the CSM and have direct relation to the calculation of the likelihood of encounter. By selecting a "type" of use as currently provided in the MEC HA tool, the resulting score is in no way reflective of the actual distribution data resulting from the completed characterization, and therefore cannot adequately represent differences between a highly used target areas of several years versus sites with limited use having very little findings to support presence as a result of characterization.

Based on the multiple findings of the DoD (reference 10 in Section 8 above), the probability of encounter cannot be appropriately represented by the current MEC HA tool. In this way, there are limitations to the qualitative value presented by the MEC HA score, and thus is not helpful in establishing the acceptable level of risk or in communicating a likelihood of encounter with a munitions item. It is therefore not an appropriate tool to help a project team in differentiating acceptable from unacceptable risk, or in developing a RAO. A project team is left to make these

[18] Note the use of "anomaly" here is a general representation of information resulting from characterization. The "hazard" is the result of the explosive nature of specific munitions that may remain partially or fully intact, not the clutter or debris that may be included in this anomaly distribution. The potential for some of those anomalies to present an explosive concern for specific site receptors is the basis of the unacceptable risk determination. It is those specific items presenting an explosive concern that are the "targets of interest" at the MRS, and for which the RAO is focused to reduce risk by implementing a remedial action.

assumptions and considerations outside of the tool in order to support development of a site specific RAO.

Therefore, while utilizing MEC HA to assess different remedial alternatives could be useful for sites where an unacceptable risk is clearly evident, it is not recommended for use to establish an acceptable site scenario or to define an acceptable amount of reduction for an MRS.

A1.2 Consideration of the Munitions Response Site Prioritization Protocol (MRSPP)

The Munitions Response Site Prioritization Protocol (MRSPP) is specifically used as a funding prioritization, not a hazard or risk assessment. However, data acquired during the project life cycle is used to develop sensitivity, accessibility and severity components of the MRSPP score. Therefore, it may be useful to look at the structure of MRSPP when identifying the MRS hazards, specifically the structured scale for the munitions explosive nature, Tables 1-3 of the MRSPP. The information in the MRSPP tables may be pertinent, and should ultimately be comparable to the methods established in this paper, such that the accessibility, sensitivity, and severity components are reflected similarly. Although the MRSPP is completed annually for each MRS, or as new information is available, it is important to recognize that once a remedial process has been completed, the MRSPP score becomes "no longer required" indicating funding is no longer planned. As a result, the MRSPP is not used to determine the reduction of risk once a remedy has been implemented.

A1.3 MEC Probability Assessment

The Engineer Manual (EM) 385-1-97, Safety and Health Requirements Manual, provides planning requirements for military construction projects having a current scale of "no," "low," and "moderate to high" probability determinations of an explosive hazard defined in a Probability Assessment. Though most of EM 385-1-97 does not apply to FUDS, this Probability Assessment is instructive as to how other programs assess explosives safety. Both "low" and "moderate to high" determinations require planning for MEC construction support (MEC standby or onsite support, respectively) on military installation construction projects.

Prior to Errata sheet No 1, dated 12 April 13 for this EM, "negligible probability" was included as the lowest probability, rather than the current word "no". In consideration of defining a similar scale for an MRS, rather than a construction site, though, the change in this terminology is significant. The word "no" constitutes a zero probability, which ***cannot*** be supported by any characterization effort; however the term "negligible" can be supported, with a specified degree of confidence. Conceptually, by this scale historically in EM 385-1-97, either "no" or "negligible" would support an "acceptable" condition, as no construction support would be required for sites where "negligible" (now "no") probability of encounter is determined.

Further, there is ambiguity in the relative definition of "low" probability, and there is no definition to the former term "negligible". While these general terms can provide a qualitative scale to establish the baseline probability of a hazard that may be found at a site, based on

historic use and observation, there is no established logic in these terms that supports the determination of acceptable versus unacceptable risk at a site for purposes of CERCLA response.

In considering these terms for MMRP, this team recommends the term "negligible" probability because it can be defined using this RAO methodology such that an acceptable risk for an MRS can be established. In the absence of generally accepted definitions for acceptable risk levels for munitions response sites, project teams are currently encouraged to define "negligible" or "low" as acceptable risk levels, depending on specific physical and land use conditions at a MRS. This paper provides a framework of logic to support these determinations of probability, or "likelihood of encounter", relative to acceptability.

A1.4 Army Risk Management

Department of Army Pamphlet for Risk Management (DA Pam 385-30) is used to identify mission-related hazards and conduct a risk assessment for these conditions. It is generally tailored for active military missions. It does not clearly relate to environmental hazards related to MMRP; however, it focuses generally on probability and severity as key input factors for the evaluation of risk. This paper establishes a parallel to this Army process of Risk Management, using more appropriate matrix categories and factors pertinent to MMRP, to include specific site conditions and munitions sensitivities, while incorporating appropriate elements of the MEC HA, MRSPP, and the Probability Assessment. The strength in the Army risk assessment approach is that it is intended to address potentially acute hazard scenarios by assessing real site conditions to establish risk.

Attachment 2. Example RAO Acceptable Conditions

The table below gives examples of unacceptable baseline conditions and resultant acceptable conditions the remedial alternatives can seek to achieve.

MRS Scenario	Horizontal Boundary	Receptors	Pathways	Required remedial response depth[19]	UXO and DMM	Baseline Risk Condition (from Matrix 4)	Acceptable Condition(s) (from Matrix 4)	Baseline Acceptable or Unacceptable? U→FS required A→no action
Target Area	Trails plus 15m buffer that are within Target Area	Recreational users	Interaction during hiking, camping, hunting	0.5 meter	M7 155mm intact UXO	A-1	D-1 or D-3	U
				0.5 meter	M7 155mm low-order UXO	B-2	C-2, D-2, C-3 or D-3	U
				0.2 meter	M48 Fuze	B-2	C-2, D-2, C-3, D-3	U
	All other portions of Target Area	Recreational users	Interaction during hiking, camping, hunting	0.5 meter	M7 155mm intact UXO	B-1	D-1 or D-3	U
				0.5 meter	M7 155mm low-order UXO	B-2	C-2, D-2, C-3, or D-3	U
				0.2 meter	M48 Fuze	C-2	C-2, D-2, C-3, or D-3	A
Buffer Zone	Remaining Buffer Zone Area	Recreational users	Interaction during hiking, camping, hunting	0.5 meter	M7 155mm intact UXO	B-1	D-1 or D-3	U
				0.5 meter	M7 155mm low-order UXO	B-2	C-2, C-3, D-2 or D-3	U
				0.2 meter	M48 Fuze	C-2	C-2, C-3, D-2 or D-3	A

[19] Characterization must provide data to suggest a horizontal as well as depth distribution of the TOI (with indication of confidence). The response depth is built from that distribution, with relative consideration of land use and instrument detection capabilities. See Attachment 3 to illustrate the significance of this data and how the post removal assessment is used to determine need for additional response (LUCs) or whether UU/UE can be supported.

Attachment 3: Example Post Remedy Data Assessment

This attachment illustrates the decision logic that may be performed post-remedy, using data collected during the remedial action to support the decision. Decision logic for this type of assessment is provided in the decision tree at Figure A3-1. The example is based on the tabulated RAO for acceptable conditions, which was developed using the matrices presented in this document:

EXAMPLE: Acceptable Conditions that Achieve the RAO

MRS Scenario	Horizontal Boundary	Receptors	Pathways	Required remedial response depth	UXO and DMM	Baseline Risk Condition	Acceptable Condition(s)= RAOs
Target Area	MRS01 boundary	Recreational users	Interaction during hiking, camping, hunting	0. 65 meter	81mm Mortar	A-1	B-3, D-1 D-2, or D-3
				0.3 meter	37mm projectile	A-1	B-3, D-1 D-2, or D-3

37mm and 81mm mortars are the targets of interest (TOI) based on historic use and confirmed presence of explosives use during characterization. Assumptions resulting from characterization are that:

- *37mm exist from the surface to 30cm*
- *81mm exist from the surface to 65cm*
- *These items are easy to detect and classify in any orientation within those depth intervals.*
- *Items can be detected and recovered at deeper depths when a signal-to-noise ratio is predicted for a given depth and orientation that is equal or greater than the project-specific detection threshold required to detect a horizontal 37mm at 30cm or a horizontal 81mm at 65cm.*

Details of the remedial action will be specified and executed in accordance with the site specific Uniform Federal Policy for Quality Assurance Project Plan (UFP QAPP).[20] Once the remedial action is complete, post remedy data is used at the Post Remedy Decision Points, indicated at Figure A3-1.

In this example, data were collected during remedy implementation to support post remedy evaluation of the residual risk, confirm the CSM and achievement of the RAO, to determine

[20] The Office of the Under Secretary of Defense Memorandum of April 11, 2006, first recommended use of UFP QAPP for DoD. USACE echoed recommendation in Memo dated January 2007. UFP QAPP, has since been implemented into the EM 200-1-15, 30 October 2015. *The DoD Environment, Safety, and Occupational Health Network and Information Exchange* provides the UFP QAPP worksheets at: http://www.denix.osd.mil/edqw/Documents.cfm

whether UU/UE can be supported, and/or to determine whether additional response, such as LUCs, may be required. If the RAO is satisfied, then RC is achieved.

POST-REMEDY DECISION POINTS: Confidence in the CSM and achievement of the RAO is supported when:

- All quality control criteria as specified in the site specific UFP QAPP for the remedial action are met,
- The CSM resulting from the characterization is still true, to include:
    - Identities of the items recovered were anticipated as a result of the characterization CSM.
    - The vertical distribution resulting from characterization reflects the actual vertical distribution of UXO recovered during the remedial response; and
    - All areas within the MRS Scenario (lateral and vertical boundary specifications of the RAO) have been searched for TOI.
        - Partial search (e.g., due to areas of difficult terrain, lack of ROE or other access issues) may result in considerations for additional response at the MRS (such as LUCs), or delineation of the unsearched area for further response while the searched area remedy is considered complete.

Post Remedy Decision Point 1: The Remedial Action work plan (UFP QAPP) defines the data quality objectives (to support achievement of the RAO). The Post Remedy Decision Point 1 assesses whether the conditions of response action met the requirements of the RAO as planned.

NO: For Remedial Responses that do not meet the criteria as specified in the remedial action UFP QAPP, there is reason to suspect the RAO has not been met. The project team must determine whether the deficiencies impact the achievement of the RAO, whether for the whole MRS Scenario, partial MRS Scenario, or if achievement of the RAO can still be supported. Justification for the decision must be provided. For instance, difficult terrain encountered during remedy prevented search of 100% of the MRS. MEC was encountered throughout the remedy of the areas immediately surrounding and within difficult terrain areas of the MRS. The PDT must determine if the reduction of the amount of MEC, with consideration of the confidence in the data can support achievement the RAO. A selection of "No" in the decision tree indicates the physical remedy did not achieve the RAO, where the likelihood of encounter, severity and sensitivity is still unacceptable, and therefore further remedial action is required. (See Post Remedy Decision Point 2b below.)

YES: For physical responses that meet the RAO, additional remedial actions (e.g., LUCs) will not be required to support an acceptable end state. In Figure A3-2, the data supports that the remedial response above the detection depth of the instrument and within the boundaries for the MRS was successful to meet the RAO. All assumptions and quality control data were met,

supporting high confidence in remedy implementation. After the remedy is implemented at 100% of the MRS Scenario, the amount of MEC is confidently reduced to support selection of "unlikely" in Matrix 1, resulting in a D determination in Matrix 2. The reduction of items within the depth interval for current and reasonably anticipated future land users also supports selection of "Inconsequential" in Matrix 3.

For MRS scenarios where the physical response achieves the RAO, the project team must then assess whether UU/UE can be supported. Examples at Figures A3-2 and A3-3 are used to illustrate this subsequent post remedy data assessment for UU/UE considerations. (See ***Post Remedy Decision Point 2a*** below.)

Post Remedy Decision Point 2a: If the result of Decision Point 1 is "YES", the team must consider the achievement of UU/UE. Figures A3-2 and A3-3 are used as an example to illustrate how a post remedy data assessment can be used to support the consideration of UU/UE.

- *Outcome A: UU/UE Supported.* In further evaluation of the data, a significant gap exists below the lowest item found during implementation of the physical response and the known detection depth of the instruments used. The gap provides confidence that residual MEC at the MRS is "unlikely" to be present. In this case, a UU/UE determination is supported by the post remedy data assessment.

  Additional considerations: Another consideration for UU/UE is the limits of physical remedy imposed by site-specific limitations, such as bedrock. Removal to shallow bedrock over 100 % of the MRS Scenario, with appropriate quality data in the UFP QAPP may also be used to support a UU/UE determination.

- *Outcome B: UU/UE Not Supported.* In this example, two TOI were found near or just below the detection depth of the instrument, categorized as "catastrophic" in the severity Matrix 2. Both were identified as an explosive hazard. Based on the distribution of TOI in the subsurface, primarily in the 0-20 cm interval, the single detection of the 37mm at 30 cm, and the single detection of the 81mm at 70 cm are atypical of the remaining data set. However, because the items detected were "live", there is less confidence that residual presence of MEC below the RAO boundaries is "unlikely." If UU/UE is not supported, Five-Year Reviews will be required to assess long term protectiveness of the remedy to ensure the remedy remains protective.

  Consider, though, if the items at these depths were identified as inert fragments, the determination of UU/ UE may further be supported, as the dataset may suggest that MEC was limited to within 20cm of the surface.

Post Remedy Decision Point 2b: When the result of Decision Point 1 is "NO", the Decision Tree provides consideration of the existing data to re-assess the MRS Scenario and determine whether further remedial actions (e.g., LUCs) may be implemented to further support an Acceptable end state, according to Matrix 4.

- *Outcome C: UU/UE Not Supported.* If LUCs can be implemented to support achievement of the RAO, Outcome C is achieved, and response is complete.[21] Five Year Reviews will be required to assess long term protectiveness; however, if inclusion of LUCs does not support an acceptable end state, the project team must consider additional response actions, and return to the Remedial process.

[21]Consideration of LUCs at this decision point should be included as a discussion in the Feasibility Study, and Proposed Plan/Decision Document. Consideration of LUCs as part of a remedial alternative may occur if the physical remedy alone is not anticipated to achieve the RAO, and these measures will further reduce Matrix 4 to an acceptable end state. Alternatively, (post physical remedy) there may be cases where the physical remedy alone is anticipated to achieve the RAO, and if after the physical remedy is complete this is not the case, a decision document amendment or an explanation of significant differences (ESD) may be required to include LUCs or include additional remedial measures. The DERP Manual requires consideration of a remedial alternative that includes LUCs. The implementation of a LUC is (or may be part of) a remedial action, so a determination that LUCs are necessary after completion of a remedy that does not include LUCs should be infrequent.

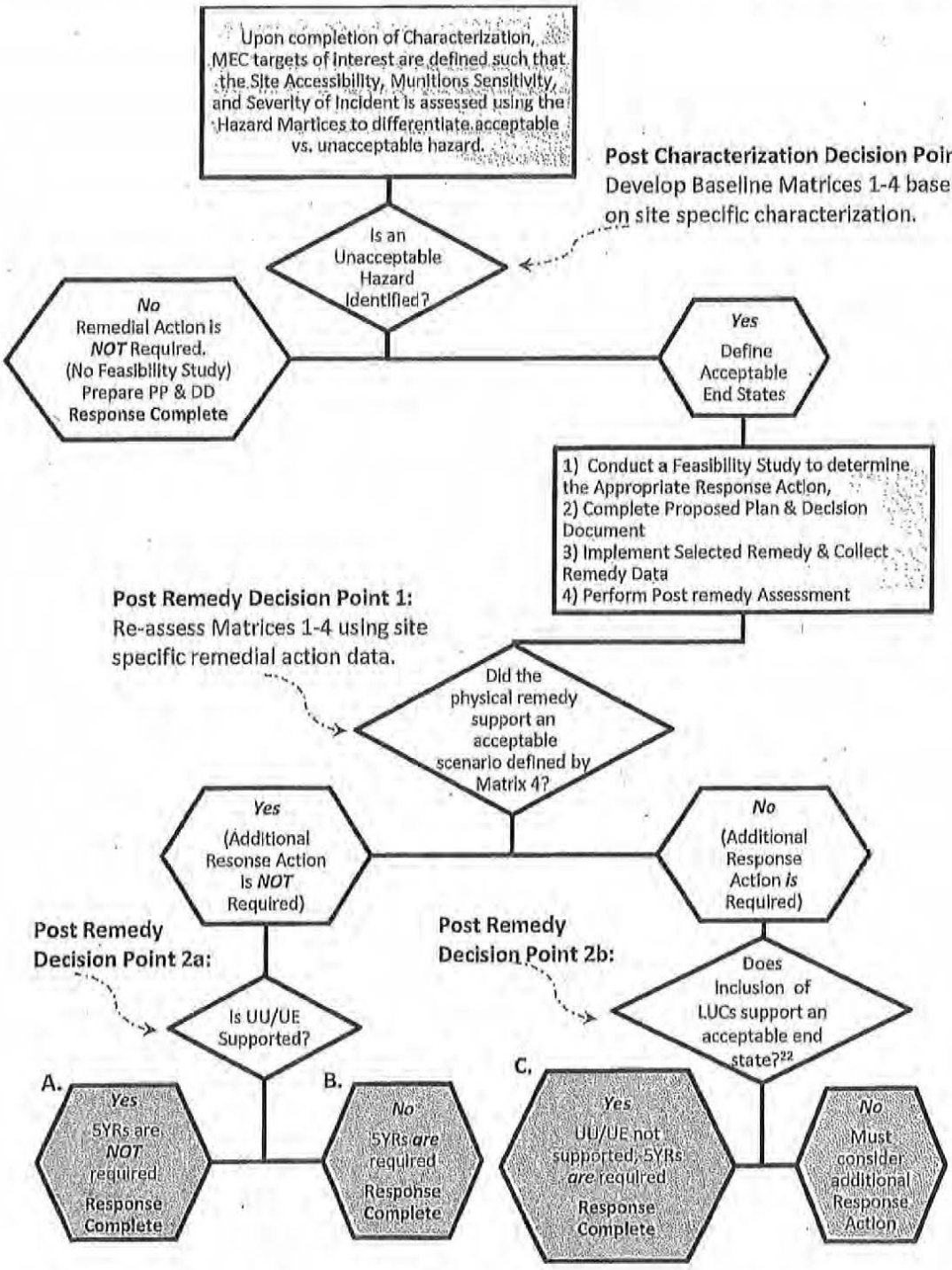

Figure A3-1. Decision Logic for post-Remedial Action data assessment, where a physical remedy is conducted. End States A, B, or C are the potential outcomes of a remedial action. Figures A3-2 and A3-3 illustrate additional consideration of UU/UE for outcome of A vs. B, where the RAO is achieved.

As illustrated below, achievement of the RAO when physical remediation is conducted should be assessed post remedy in order to determine whether the RAO is met or if additional response is required to meet the RAO. Furthermore, if the RAO is met, then assessment of UU/UE is evaluated separately from the remedial process, also conducted post remedy. If UU/UE cannot be supported by the data, Five-Year Reviews will be required.

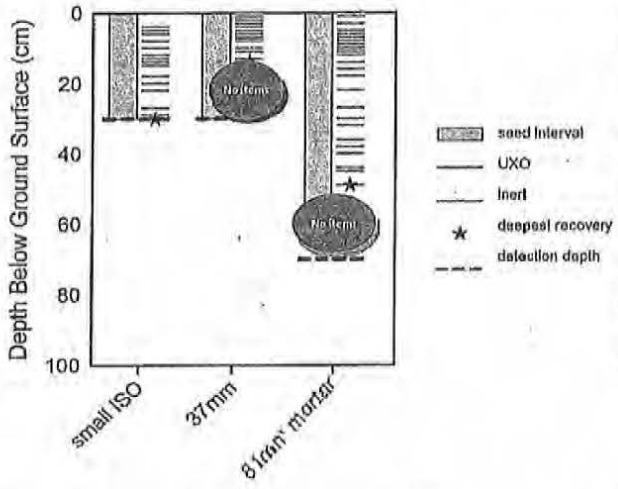

Figure A3-2. Example Outcome A. After a physical response action for 100% of the MRS, the data assessment shows that all targets of interest (TOI) were recovered from the MRS and all were well within the detection capabilities of the instrument such that there is high confidence that any potential residual presence of UXO is negligible. The end state for the MRS from Matrix 4 is 3-D. This is defined by the "Unlikely" resulting from Matrix 1, and "Inconsequential" rating in Matrix 3. There are no detections below 50 cm down to the instrument detection depth of 65 cm for the 81mm, nor below 15 cm down to the instrument detection depth of 30 cm for the 37mm. This "buffer" in the detection data versus instrument capability provides confidence that UU/UE can be reasonably supported for the MRS.

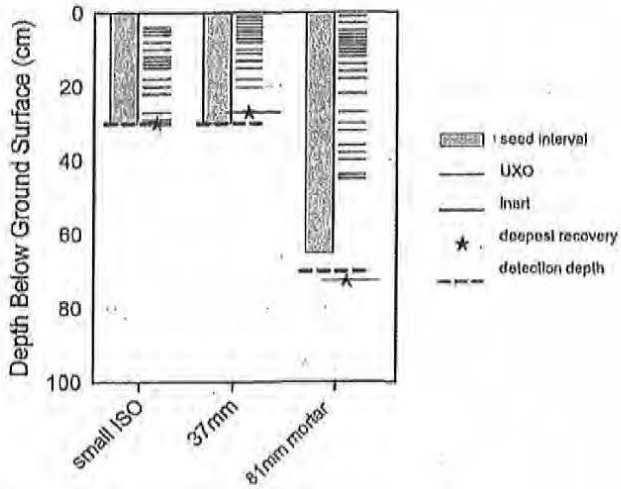

Figure A3-3. Example Outcome B. After a physical response action for 100% of the MRS, the data assessment shows that all detectable targets of interest were recovered from the MRS, but few TOI were recovered near the limits of the detection capabilities of the instrument. Like Outcome A, the supported end state within the recovery area for the MRS, Matrix 4, is 3-D. In this case, there is lower confidence in accepting the residual presence of TOI below detection depth for the MRS. UU/UE may not be supported if there is some evidence of residual hazard remaining on the MRS with some likelihood of exposure. If UU/UE is not supported, Five-Year Reviews will be required.

Attachment 4: Glossary- (Hazard versus Risk)

Definitions of Terms Found in DA Pam 385-30:[22]

Hazard. Hazard is a condition with the potential to cause injury, illness, or death of personnel; damage to or loss of equipment or property; or mission degradation. Therefore, a hazard can have several possible negative outcomes or losses (for example, injury, death, damage, mission failure, mission degradation, increased resource(s) expenditures, and adverse public relations).

Risk. Risk is determined after hazards are identified and analyzed. Risk is defined as the probability and severity of loss linked to hazards. It is simply the measure of the expected loss from a given hazard or group of hazards, usually estimated as the combination of the likelihood (probability) and consequences (severity) of the loss.

Residual risk. The risk associated with a hazard that remains after implementing all planned countermeasures or controls to eliminate, reduce, or control the impact of the hazard. The residual risk may be equal to the initial risk, especially when the initial risk is so low that the hazard does not warrant expenditure of funds to mitigate.

Probability. An approximation of the likelihood of a hazard scenario or mishap occurring. Probability is assessed as frequent, likely, occasional, seldom, or unlikely.

Severity. An approximation of the amount of potential harm, damage, or injury associated with a given mishap.

Additional definitions added to this study for purposes of munitions risk management:

Sensitivity. An approximation of the likelihood that a human receptor will be able to interact with a MEC item such that it will detonate.

[22] The DA Pam 385-30 definition for "hazard" includes some aspects, such as "damage, mission failure, mission degradation," etc., that have no specific application for the MMRP conducted under CERCLA. As such, the definitions were used as a benchmark for this study, and are included here only as a guide to users in making risk management evaluations to recognize the presence of MEC as the "hazard", but to separate the term from the determination of "risk" as the *probability* of an incident and severity of loss due to a hazard and conditions around it. It is not intended to expand CERCLA response authority past death or injury. Additionally, these definitions recognize cases where some "residual hazard" may be determined to be acceptable, as discussed in section 4.2.

Attachment 5: Acronyms

AR	Army Regulation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMUA	Concentrated Munitions Use Area
DA Pam	Department of the Army Pamphlet
DD	Decision Document
DMM	Discarded Military Munitions
DODI	Department of Defense Instruction
EM	Engineer Manual
FS	Feasibility Study
HE	High Explosive
HTRW	Hazardous Toxic and Radioactive Wastes
LUCs	Land Use Controls
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MEC HA	MEC Hazard Assessment
MMRP	Military Munitions Response Program
MRS	Munitions Response Sites
MRSPP	Munitions Response Site Prioritization Protocol
NCMUA	Non Concentrated Munitions Use Area
PA	Preliminary Assessment
PDT	Project Delivery Team
PP	Proposed Plan
RAO	Remedial Action Objective
RC	Response Complete
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RIP	Response in Place
SI	Site Inspection
TOI	Targets of Interest
UFP QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USACE	U.S. Army Corps of Engineers
UU/UE	Unlimited Use, Unrestricted Exposure
UXO	Unexploded Ordnance

NEW RISK MANAGEMENT METHODOLOGY FEEDBACK FORM

Decision Logic to Assess Risks Associated with Explosive Hazards, and to Develop Remedial Action Objectives (RAOs) for Munitions Response Sites

FUDS Property/Project Number:
Property Name:
Project Name:
MRSPP Overall Score:

1. List historically known or suspected munitions and specify what evidence of MEC was found during characterization. (If multiple munitions exist, and or different areas are identified, these areas may be presented separately):

Amount of MEC Justification: _____

_____

Sensitivity Justification: _____

_____

Severity Justification: _____

_____

2. Specify Land Use and Site Receptors. (If multiple Land Use/Receptors exist as different areas, these areas may be identified separately):

Access Condition Justification: _____

_____

Likelihood to Impart Energy Justification: _____

_____

3. For each area having separate conditions above, indicate the Risk Management Results for the following:

Matrix 1:	Frequent	Likely	Occasional	Seldom	Unlikely
Matrix 2:	A	B	C	D	
Matrix 3:	1	2	3		
Matrix 4:	(result of combining Matrices 2 and 3 above, e.g., A-2, B-1, etc.)				
Risk Determination:	Acceptable		Unacceptable		

4. Other Comments, (Please identify limitations or suggestions, if any.):

_____

_____

5. Compare use of RAO methodology to MEC HA, if applied:

_____

_____