DRAFT FINAL
ENGINEERING EVALUATION/COST ANALYSIS FOR NON-TIME CRITICAL REMOVAL ACTION,
FORMER SKEET RANGE MRS TS119, BUCKLEY AFB, COLORADO
W9128F-18-D-0010

PREPARED FOR:

U.S. Army Corps of Engineers, Omaha District
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LIST OF ACRONYMS AND ABBREVIATIONS

ARARs	applicable or relevant and appropriate requirements
BAFB	Buckley Air Force Base
bgs	below ground surface
BMP	Best Management Practice
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CO	Colorado
COANG	Colorado Air National Guard
COC	Contaminants of Concern
CSE	Comprehensive Site Evaluation
DADS	Denver Arapahoe Disposal Site
°F	degrees Fahrenheit
ECs	Engineering Controls
EE/CA	Engineer Evaluation/Cost Analysis
Eco-SSLs	Ecological Soil Screening Levels
FS	Feasibility Study
ft	feet
HDPE	high-density polyethylene
IRP	Installation Restoration Program
JV	Joint Venture
LTM	Long Term Monitoring
LUCs	Land Use Controls
mg/kg	milligram per kilogram
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
NTCRA	Non-Time Critical Removal Action
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
PAHs	Polycyclic Aromatic Hydrocarbons
PWS	Performance Work Statement
RALs	Removal Action Levels
RAOs	Remedial Action Objectives
RDP	Remedial Design Plan
RI	Remedial Investigation
ROD	Record of Decision
RSLs	Regional Screening Levels
SVOC	semi-volatile organic compound
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Procedure

LIST OF ACRONYMS AND ABBREVIATIONS

The Range	The Tri-Services Skeet Range
The Site	Former Skeet Range Munitions Response Site TS119
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
UU/UE	unlimited use/unrestricted exposure
VOC	volatile organic compound
Whitetail Environmental	Whitetail Environmental, LLC
XRF	X-ray fluorescence
yd^3	cubic yards

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), Omaha District, contracted the Chimera-Tehama Joint Venture (JV) to execute a Non-Time-Critical Removal Action (NTRCA), under the Military Munitions Response Program (MMRP), at the Former Skeet Range Munitions Response Site (MRS) TS119 (the Site), located at Buckley Air Force Base (BAFB), Colorado (CO). As a requirement of this contract, the JV has completed a Draft-Final Engineering Evaluation/Cost Analysis (EE/CA) for a NTCRA at the Site (Figure 1 and 2).

In April 2019, Whitetail Environmental, LLC (Whitetail Environmental) completed a Phase II Comprehensive Site Evaluation (CSE) at the Site. Information from the CSE (including previous Site sampling results) was used to justify the need for preparation of an EE/CA in order to develop remedial action alternatives for the Site.

This EE/CA has been prepared to document the April 2019 field investigation and to determine whether a NTCRA is required. If deemed necessary, the objective of this EE/CA is to develop removal action objectives (RAOs) to evaluate the effectiveness, implementability, and costs of various potential removal action alternatives that could be implemented for the remediation of contaminant source materials and contaminated soils present at the Site; and to recommend a specific removal action alternative. The primary threat to human health and the environment from Site contaminants is via direct exposure pathways, including inhalation or airborne particulates, dermal absorption, and incidental ingestion.

The recommended removal action alternative proposed in this EE/CA addresses identified Site contaminants present in soils within the development areas only. Long-term remedial action at the Site will be implemented following the completion of a Remedial Investigation (RI)/Feasibility Study (FS), Proposed Plan and Record of Decision (ROD).

RAOs for the NTCRA are:

- Eliminate direct exposure pathways (incidental ingestion, dermal absorption, and inhalation of airborne particulates) for human and ecological receptors to site-related contaminants in soil;
- Mitigate the potential for erosion of contaminated soil, transport of contaminants, and subsequent exposure; and,
- Ensure post-removal action conditions provide an acceptable level of protection for ecological receptors against direct exposure to lead and polycyclic aromatic hydrocarbons (PAHs) in soil.

The Removal Action Levels (RALs) proposed for the Site include applicable Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) for lead and PAHs in residential soils (EPA, November 2020), as dictated by current and anticipated future land use.

The RAOs along with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) evaluation criteria were used to develop, evaluate, and compare various NTCRA alternatives that are intended to represent the full range of possibilities for the restoration of the four designated development areas addressed by this EE/CA. The four NTCRA alternatives developed in this EE/CA are as follows:

- Alternative 1: Land Use Controls (LUCs).
- Alternative 2: Containment/Cover
- Alternative 3: Excavation and Off-site Disposal
- Alternative 4: No Action Alternative

Based on a comprehensive assessment and comparison of the NTCRA alternatives developed for this EE/CA, Alternative 3, Excavation and Off-site Disposal, is recommended for the Site. Alternative 1 would not achieve the applicable RAOs developed in Section 2.3 of this EE/CA. It would reduce, but not eliminate the risk to human health and the environment by limiting direct exposure to contaminant source material (lead shot and clay pigeon fragments) and contaminated soil through a new LUC program. Because contaminant source material and contaminated soil would remain as it currently exists at the Site, the potential for direct exposure would always be present.

To varying degrees, Alternatives 2 and 3 each address the primary potential threat to human health and the environment posed by direct exposure to contaminant source material and contaminated soil present at the Site. Through a combination of containment and covering of the contaminated soil with LUCs, Alternative 2 would be more effective than Alternative 1; however, it would not be as effective as Alternative 3, which will effectively remove the potential direct exposure threat to human health and the environment.

1.0 INTRODUCTION

The Chimera-Tehama JV was retained by the USACE Omaha District, under Contract No. W9128F-18-D-0010, Delivery Order No. W9128F19F0321, to complete an EE/CA for an NTCRA located at the Former Skeet Range MRS TS119 (the "Site"), BAFB, CO. The Site encompasses an area of 39 acres with three main areas of concern (Figure 2):

- Area A: Shot Fall Area;
- Area B: Clay Target Fall Area; and,
- Area C: Muzzle Exhaust Area.

A previously completed CSE Phase II, performed by Whitetail Environmental, was used to justify the need for preparation of this EE/CA in order to quantify and develop removal action alternatives. Additional sampling required to delineate the horizontal extent of lead contamination along the northern and southern boundaries of the Site is proposed to occur simultaneously as part of the removal activities.

The Chimera-Tehama JV has prepared this EE/CA in accordance with CERCLA, United States Environmental Protection Agency (USEPA) Guidance, and the Contract Performance Work Statement (PWS) in order to document the evaluation of alternatives for a removal action at the Site. This EE/CA addresses contaminated soil resulting from historical skeet range operations at the Site. Contaminants of concern (COC) are lead and PAHs in soils. The evaluation of removal alternatives to address COC in the Site soil is necessary to mitigate risk and eliminate the potential for future contaminant migration. RAOs have been created to evaluate the effectiveness, implementability, and cost of potential removal action alternatives that could be implemented for the remediation of contaminated soil present at the Site, and to recommend removal action alternatives.

The following RAOs have been identified for this removal action:

- Eliminate direct exposure pathways (incidental ingestion, dermal absorption, and inhalation or airborne particulates) for human and ecological receptors to site-related contaminants in soil;
- Mitigate the potential for erosion of contaminated soil, transport of contaminants, and subsequent exposure; and,
- Ensure post-removal action conditions provide an acceptable level of protection for ecological receptors against direct exposure to lead and PAHs in soil.

The four removal action alternatives developed and evaluated in this EE/CA are the following:

- Alternative 1: LUCs;
- Alternative 2: Containment/Cover;
- Alternative 3: Excavation and Off-site Disposal; and,
- Alternative 4: No Action Alternative.

This EE/CA compares the four removal action alternatives on the basis of their effectiveness, implementability, and cost. Based on the results of this comparison, the preferred NTCRA, Alternative 3, is recommended for implementation at the Site. The preferred NTCRA involves the excavation of contaminated soils to achieve the cleanup goals for the COCs, confirmatory sampling to ensure the Site has met the unlimited use/unrestricted exposure (UU/UE) goal for the property, and off-site disposal of the excavated waste. Approximately 28,287 cubic yards (yd^3) of lead and PAH contaminated soil will be excavated from depths of 0-0.5 feet (ft) below ground surface (bgs), 0-1 ft bgs, and 0-2 ft bgs from various areas and hauled off-site for disposal at the Denver Arapahoe Disposal Site (DADS) Subtitle D landfill. Prior to disposal, excavated soils will be sampled and submitted to the analytical laboratory for Toxicity Characteristic Leaching Procedure (TCLP) analysis for lead. If analytical results exceed 5.0 milligrams per liter (mg/L), the excavated materials will require treatment for lead stabilization, which is a process of encapsulating lead particles to render them non-leachable and to allow for disposal as non-hazardous waste. Excavated soils will not be transported for off-site disposal until TCLP results from analytical samples indicate the

materials are non-hazardous. Following removal activities, confirmation sampling will occur to ensure the COCs have been removed, and if still present additional excavation will be performed. After confirmation that the RAOs for contaminated soil have been achieved, clean fill and topsoil will be used to restore the excavated areas followed by vegetation restoration.

Alternative 3 is the preferred NTCRA as it is the most effective, easily implementable, cost-effective, and would meet all of the above stated RAOs. Implementation of this alternative would be effective in permanently eliminating the lead and PAH concentrations in soil at the Site, thus eliminating the potential for unacceptable risks to human health and ecological receptors from exposure to contaminants in soil. The preferred NTCRA is technically and administratively feasible, and it constitutes a permanent remedy to the existing contamination at the Site. The cost to complete the NTCRA is $2,287,150.96 and will require approximately 2 months to complete.

1.1 SITE BACKGROUND AND DESCRIPTION

BAFB was first established as Buckley Field in 1942, when the Army Air Corps purchased the land for use as a training center for B-17 Flying Fortress and B-24 Liberator bombardiers, and armorer training. It was transferred to the Colorado Air National Guard (COANG) in 1946. The COANG's first period of ownership ended when the Department of the Navy took charge in 1947, renaming the installation Naval Air Base-Denver. The Navy decommissioned the installation on 30 June 1959, and it became the property of the Air Force, which in turn licensed it to the State of Colorado. On 18 April 1960, the installation was renamed Buckley Air National Guard Base. Air Force Space Command's 821st Space Group assumed host command responsibilities on 1 October 2000, and the installation was re-designated as BAFB. The 460th Air Base Wing was activated on 1 October 2001 at BAFB, following the 821st Space Group's inactivation. The primary mission of BAFB is to provide combatant commanders with superior global surveillance, worldwide missile warning, homeland defense, and expeditionary forces. The 460th Space Wing operates BAFB and reports to Headquarters.

The Tri-Services Skeet Range (the Range), also known as the Site, was established in the mid-1960s on the northeast portion of BAFB (refer to Figure 1) and it was operated as such until its closure in 2014. The Site is composed of five skeet ranges, two trap ranges, a Club House (Building 1110), an equipment shed (Building 1101), the Range Officer's Shed (Building 1108), two 40- foot trailers used to store clay targets (assumed to be labeled Building 1109), and a gazebo for shelter from the sun. An aerial photograph review conducted as part of the Phase I Environmental Baseline Survey (Booz-Allen Hamilton, 2003) indicated that before establishment of the Range, the only building that existed at the site was an equipment shed (Building 1101) which was built in 1952. Aerial photographs from 1956 and 1963 indicate that the site may have been used as a Range before the other buildings were installed. Operations ceased at the property in 2014 and it is no longer used as an active firing range.

Spent shot has reportedly been removed from the Range approximately every four to five years. During reclamation the ground surface was reportedly excavated to a depth of two to four inches, shot was removed from the soil, and the soil was replaced. Collected lead shot was subsequently sent to a recycling facility. Approximately 180 tons of shot have been recycled as a result of reclamation activities conducted in September 1989 (14.0 tons), September 1995 (52.7 tons), and June 2002 (114 tons). The Range members removed the skeet range targets by March 2003 (Stauss, 2005). The Range attempted to use biodegradable targets in 2000; however, the breakage factor was unacceptable. The manufacturer subsequently modified the skeet target formulation and biodegradable target use began in August 2003. The biodegradable targets are composed of calcium carbonate, sulfur, bentonite, lignin, and latex paint and are reported to decompose within approximately 12 months. The last lead shot recovery effort was completed in 2014 just prior to the range complex closing; however, no records of the reclamation efforts were provided to the United States Air Force (USAF).

1.1.1 *Site Location*

Buckley AFB is located in the Denver-Boulder-Greeley Consolidated Metropolitan Statistical Area, Colorado (Figure 1). The former Skeet Range and associated buildings are located in the northeast section of Buckley AFB, and encompass approximately 39 acres. It is bordered by vacant federally-owned land on the north, the Navy and Marine Corps Reserve Center on the east, the Aerospace Data Facility/Remote Terminal Facility on the southeast, Building 1103 and the Power Check Pad and Engine Test Pad on the south, and Williams Lake on the west (Figure 2).

1.1.2 *Land Use and Land Use Controls*

Currently, land use for the site is limited, with one building on the site occasionally used for dance classes. There is no security fencing or access restrictions to the Site. However, there are general access restrictions to the BAFB. The range property is signed and patrolled and is not open to the general public.

1.2 PREVIOUS SITE INVESTIGATIONS

In 2003, Booz-Allen Hamilton completed a Phase I Environmental Baseline Survey, during which three distinct areas of concern were identified: the muzzle exhaust area, the clay target fall area, and the Range Fall area otherwise referred to as the Shot Fall area. There are two constituents of concern at these three identified areas, lead and PAHs. Lead contamination, from current and past use of lead shot, is the contaminant of concern at the shot fall and muzzle exhaust areas. PAH contamination is of concern at the clay target fall area. The Range has used PAH free biodegradable targets since August 2003. Historically, clay targets have been made with petroleum/asphalt binder and coated in latex paint. The PAHs in clay targets are not readily bioavailable to ecological or human receptors due to the tight bond formed with the clay or limestone base of the target. Booz-Allen concluded surface and subsurface soil sampling was necessary to further identify contaminants in the soil and sediment of the identified areas of concern.

In 2005, URS Group, Inc. completed a supplemental Phase I. A temporary well was also installed to a depth of 45 ft bgs, down gradient of the range area to determine the extent of contamination in groundwater. A total of 16 soil samples, both surface and subsurface, and one groundwater sample were collected from the impacted Range area. Six soil samples were collected from the lead shot fall area, four soil samples from the muzzle exhaust area, four soil samples from the clay target fall area, and two soil samples from a nearby drainage area where lead is most likely to be transported by surface water. Samples collected from the lead shot fall area and muzzle exhaust area were analyzed for lead content. Samples collected from the clay target fall area were analyzed for PAH content. All soil samples were reported below the screening level. The groundwater sample collected from the temporary well (TW01), reported a lead concentration of 0.015 mg/L, which was consistent with other interpreted background lead levels in groundwater from Installation Restoration Program (IRP) sites at Buckley.

Soil analytical results showed reclamation for lead shot was effective within the managed areas, but did not encompass all areas that had been lead impacted. Range activities continued beyond 2005, into 2014 so new soil sampling would be necessary to fully delineate current levels of contamination at the Range. PAH results showed that previous reclamation activities for used clay targets were not successful in mitigating PAH impacts to soil.

1.3 PHYSICAL AND ENVIRONMENTAL SETTING

<u>Climate</u>

The climate at BAFB is mild and dry, with monthly mean high temperatures ranging from 39 degrees Fahrenheit (°F) in January to 86°F in July, and monthly mean low temperatures ranging from 21°F in January to 61°F in July. Average annual precipitation is approximately 16 inches. The annual mean snowfall of 52 inches melts relatively quickly. The area receives an average of 300 days of sunshine per year (Whitetail Environmental, LLC. 2019).

Topography

BAFB is situated on high ground dividing the Sand Creek and Toll Gate Creek drainage basins. The ground surface elevation of the Base ranges from 5,700 feet above mean sea level at the southeast corner to 5,480 feet above mean sea level at the northwest corner (Whitetail Environmental, LLC. 2019).

Hydrology

Surface water at the Site flows north-northeast following surface topography. The nearest surface water body to the Site is Lake Williams. However, a topographic high is present between the Site and Lake Williams, preventing surface water runoff from entering the Lake. Samples were not collected from Lake Williams due to the low probability of surface water or groundwater from the Site entering the lake (Whitetail Environmental, LLC. 2019).

Soil and Vegetation Types

BAFB is located within the Denver Basin on the Colorado Piedmont section of the Great Plains. This section is between the High Plains to the east and the Front Range of the Rocky Mountains to the west. There are three major soil associations occurring on the installation:

- Alluvial Land-Nunn – deep, loamy, and sandy; well-drained; gently sloping (0-3 percent);
- Fondis-Weld – deep loamy, silty, wind-deposited materials; well-drained; gently sloping (0-3 percent); and,
- Renohill-Buick-Litle – moderately deep with a loamy to clayey texture; well drained; moderately steep (3-30 percent).

These soils have a moderate to high water-holding capacity and therefore are subject to expansion. The exact age of residual soils in and around BAFB is unknown; however, they have weathered in place with few, if any, geomorphic rejuvenating events, or processes since the early to late Wisconsin stage (70,000 to 12,000 years ago). Silty soils, which usually vary from 2.5 to 6 ft generally occur in areas dominated by deciduous forest. Beneath the silty soil is a sandy gravel horizon varying from 6 to 29 ft thick. A peat layer 0.5 ft thick over a silt horizon that varies from 2.5 to 4.5 ft in depth is typically dominated by spruce debris. Horizons of sand, silt, and gravel combinations or Denver Formation underlie the peat layer. BAFB is located in the short-grass prairie ecosystem where blue grama and buffalo grass are dominant. Trees of the short grass prairie are restricted to riparian corridors, and typically include cottonwood, willow, and box elder (USAF, 2002). Surveys divide the vegetation on BAFB into the following types:

- Midgrass blue grama/western wheatgrass prairie
- Crested wheatgrass prairie
- Bottomland meadows
- Cottonwood/willows
- Weedy disturbed areas
- Landscaped areas

Weedy, disturbed areas are created by the excessive presence of prairie dogs or construction activities. These areas become the most likely sources of noxious weeds for the entire installation (Whitetail Environmental, LLC. 2019).

Geology and Hydrogeology

Shallow groundwater flow in the area is generally north-northeast from the Range firing lines, which approximately follows surface topography. The depth to water in a temporary well installed in 2005 was 26.5 ft bgs (URS, 2005). This flow orientation is consistent with previously reported potentiometric data collected at Site 5, located approximately 1,000 ft south of the Range (URS, 2002). Shallow groundwater in the vicinity of BAFB is typically not utilized as a potable or irrigation water source. According to records from the Colorado State Engineers Office, there are no registered wells tapping the shallow aquifer within one mile of the Site (Whitetail Environmental, LLC. 2019).

1.4 CURRENT OCCURENCE, NATURE, AND EXTENT OF CONTAMINATION

The current occurrence, nature, and extent of contamination within the Site addressed in this EE/CA is based on the results of the August 2019 CSE, Phase II Report conducted by Whitetail Environmental and is specific to surface and subsurface soil only.

Screening limits for residential use were selected using the more stringent value of the EPA RSL, Colorado Department of Public Health and the Environment (CDPHE), and Ecological Soil Screening Levels (Eco-SSLs) for mammalian wildlife.

- Lead = 400 milligrams per kilogram (mg/kg) (EPA RSL)
- Lead = 56 mg/kg (Eco-SSLs)
- PAHs = A combination of RSL and CDPHE limits were used. EPA has screening criteria for each of the carcinogenic PAHs, while soil cleanup target level has a screening limit for Benzo(a)pyrene equivalent. Either criterion was used to determine exceedance.

The following is a summary of the current occurrence, nature, and extent of soil contamination at the Site as it relates to residential land use. As indicated below, and for reference purposes, note that the background concentration of lead in soils at BAFB is 30 mg/kg. Figures 3 through 13 provides further detail on sample locations and extent of contamination.

Whitetail Environmental collected a total of 128 primary soil samples for the CSE Phase II, which were all submitted for laboratory analysis of lead; with sample points located within the clay target fall area and the erosion area additionally submitted for PAHs. Lead samples were collected in a grid format with 47 200-foot grid nodes and four 100-foot nodes submitted for lead analysis. The 200-foot nodes had two samples collected at surficial soil (0-1 ft bgs) and subsurface soil (1-2 ft bgs). The four 100-foot nodes were collected only at 0-0.5 ft bgs.

- 9 surficial soil samples collected exceeded the lead EPA RSL, and none of the subsurface soil samples exceeded the lead EPA RSL.
- 25 surficial soil samples exceeded the lead EPA Eco-SSL, and none of the subsurface soil samples exceeded the lead Eco-SSL.
- 27 surficial soil samples exceeded the lead background level of 30 mg/kg, and none of the 1-2 feet bgs samples exceeded the background level.

Four 200-foot grid nodes were sampled within the Clay Target Area for lead and PAH analysis. These four grid nodes also fall within the Muzzle Exhaust Area. Samples were collected from surficial soil and subsurface soil. Additionally, five samples were collected from surficial soil, subsurface soil, 2-4 ft. bgs, and 4-6 ft. bgs from the middle of the Clay Target Area and submitted for lead and PAH laboratory analysis.

- None of the Clay Target Area points exceeded the EPA RSL for lead.
- 2 surficial soil sample points exceeded the lead Eco-SSL, and one subsurface soil sample exceeded the lead EPA Eco-SSL.
- 5 surficial soil samples exceeded the lead background level of 30 mg/kg, and one sample collected from subsurface soil exceeded the lead background level of 30 mg/kg.
- 8 surficial samples exceeded EPA RSLs for six PAHs, and one surficial soil sample exceeded the EPA Eco-SSLs for low molecular weight PAHs.
- 14 samples exceeded the EPA Eco-SSLs for high molecular weight PAHs, with 8 surficial soil samples and 6 subsurface samples.

The following is a summary of the current source, nature, and extent of soil contamination determined by Whitetail Environmental's CSE Phase II, as it relates to residential land use. The lead and PAH contamination has been delineated vertically. There are multiple locations with lead exceedances of the EPA Eco-SSLs and/or the EPA RSLs at surficial soil. One lead sample was detected in subsurface soil exceeding the EPA Eco-SSL. There are no

exceedances at 2-4 ft. bgs or 4-6 ft bgs. Lead contamination has been delineated horizontally in all directions, with the exception of elevated X-ray Fluorescence (XRF) results along the northern boundary and southern boundary.

PAH contamination has been delineated vertically. There are multiple PAH exceedances of the EPA Eco-SSLs and/or the EPA RSLs at surficial and subsurface soils. There are no PAH exceedances at 2-4 ft bgs or 4-6 ft bgs. The horizontal extent of PAH contamination has not been delineated due to Whitetail Environmental only collecting samples for PAH analysis within areas expected to have PAH contamination; however, PAH contamination is located within the lead contamination area and any remedial actions for lead will also address the PAH contamination (Whitetail Environmental, LLC. 2019).

2.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

Section 2.0 identifies the scope, purpose, and objectives for the potential NTCRA which may be conducted at the Site. In addition, the Applicable or Relevant and Appropriate Requirements (ARARs) for the potential NTCRA are identified.

2.1 SCOPE AND PURPOSE OF REMOVAL ACTION

The scope and purpose of removal action is based off the CSE Phase II Investigation completed by Whitetail Environmental from October 15-19, 2018. As discussed in Section 1.4, numerous sample locations showed lead and PAH exceedances above the EPA RSLs, the EPA Eco-SSLs, and the lead background level of 30 mg/kg within surficial soil (0-1 ft bgs). There were no exceedances of the EPA RSLs and only one exceedance of the EPA Eco-SSLs for lead in subsurface soil between 1 and 6 ft bgs. There were exceedances of the EPA RSLs and the EPA Eco-SSLs for PAHs in subsurface soils (1-2 ft bgs), with no exceedances in subsurface soils at the 2-4 ft. bgs or 4-6 ft bgs depth intervals.

Based on the Phase II investigation, lead and PAH are present throughout the site. As a result of the exceedances discussed above, a potential risk to human health and the environment is present. Removal action is a potential means to prevent, minimize, and mitigate the potential threat to public health, welfare, and the environment posed by these contaminants at the site.

2.2 REMOVAL ACTION OBJECTIVES

The principal goal of this EE/CA is to determine if an NTCRA is necessary to mitigate the potential threat to human health and the environment created by the presence of contaminant source material (lead shot and clay pigeon fragments) and contaminated soil at the Site. If necessary, a NTCRA will consist of a response action to meet the following RAOs:

- Eliminate direct exposure pathways (incidental ingestion, dermal absorption, and inhalation or airborne particulates) for human and ecological receptors to site-related contaminants in soil;
- Mitigate the potential for erosion of contaminated soil, transport of contaminants, and subsequent exposure; and
- Ensure post-removal action conditions provide an acceptable level of protection for ecological receptors against direct exposure to lead and PAHs in soil.

The RALs proposed for the Site include the applicable EPA RSLs (EPA, November 2020) for lead and PAHs as dictated by current and anticipated future land use.

Table 2-1 - Project RALs

Compound	EPA RSL (mg/kg)
Metals	
Lead	400

Compound	EPA RSL (mg/kg)	Compound	EPA RSL (mg/kg)
PAHs		PAHs	
Acenaphthene	3600	Benzo(a)anthracene	1.1
Acenaphthylene	-	Benzo(a)pyrene	0.11
Anthracene	18,000	Benzo(b)fluoranthene	1.1
Fluoranthene	2,400	Benzo(g,h,i)perylene	-
Fluorene	2,400	Benzo(k)fluoranthene	11
1-Methylnaphthalene	18	Chrysene	110
2-Methylnaphthalene	240	Dibenzo(a,h)anthracene	0.11
Naphthalene	2	Indeno(1,2,3-cd)pyrene	1.1
Phenanthrene	-	Pyrene	1,800

2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT-BASED GOAL

Section 121 of CERCLA states that actions for cleanup of hazardous substances must comply with requirements or standards under federal law or the most stringent state environmental laws that are applicable or relevant and appropriate (but not both) to the hazardous substances or particular circumstances at a Site (EPA, 1992). According to EPA CERCLA guidance, ARARs are divided into three categories: chemical-, location-, and action-specific.

1. Chemical-specific ARARs establish protective cleanup levels for COCs in various media and/or set safe concentrations of discharge for remedial activities. These ARARs could be concentration-based cleanup goals or could provide the basis for calculating the cleanup goals.

2. Location-specific requirements set restrictions based on concentrations of hazardous substances at distinct geographical locations (i.e. wetlands, floodplains etc.) or have certain land use concerns (i.e. areas of historical or cultural significance). Location-specific ARARs are intended to limit activities within the distinct designated areas.

3. Action-specific ARARs apply to specific actions that are associated with the selected remedy. These ARAR requirements include operation, performance, and design limitations or requirements based on waste types, media, and response actions such as limiting or restricting certain procedures.

2.3.1 *Description of ARARs for Site*

Table 2-2 - Potential Federal Chemical-Specific ARARs

Type	Authority	Medium	Requirement	ARAR/TBC Status	Status	Action to be Taken to Attain Requirement
EPA Regional Screening Levels (Nov 2020 Update)	EPA	Soil	Provides chemical-specific risk-based screening levels for chemical contaminants, calculated using the latest toxicity values, default exposure assumptions and physical and chemical properties.	TBC	Surface soils at the site currently exceed the EPA RSLs, for residential soils, for lead and PAH compounds.	The selected RA will be implemented to prevent exposure to soil contaminants at the Site that exceed applicable EPA RSLs.

Table 2-3 - Potential Federal Location-Specific ARARs

Type	Authority	Medium	Requirement	ARAR/TBC Status	Status	Action to be Taken to Attain Requirement
Migratory Bird Treaty Act (MBTA)	16 U.S.C. § 703	Wildlife	Prohibits the unlawful taking, possession, or sale of any migratory bird native to the United States or its territories.	Applicable	The design may require construction activity while migratory birds are present. Migratory birds known to inhabit BAFB include, but are not limited to, bald eagles, ferruginous hawks, and burrowing owls.	Avian surveys will be completed at each site approximately two weeks prior to the initiation of remedial action construction.
Bald and Golden Eagle Protection Act (BGEPA)	16 U.S.C. § 668(a)	Wildlife	Prohibits the unlawful taking of bald and golden eagles, including their parts, nests, or eggs.	Applicable	The design may require construction activity while bald and/or golden eagles are present.	Avian surveys will be completed at each site approximately two weeks prior to the initiation of remedial action construction.
Executive Order	Executive Order 11988	Floodplain	Requires action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values, including impacts to fish and wildlife and their habitats.	TBC	This site is directly adjacent to surface waters and floodplains associated with Sand Creek (off-installation) and Lake Williams (on-installation).	The selected remedy will be designed and constructed to minimize impacts to floodplain resources.

Table 2-4 - Potential Federal Action-Specific ARARs

Type	Authority	Medium	Requirement	ARAR/TBC Status	Status	Action to be Taken to Attain Requirement
Colorado Hazardous Waste Management Act	6 Code of Colorado Regulations (CCR) 1007-3 Part 261, 262, and 263.20-22	Soil	Establishes requirements regulating the use, handling, storage, treatment, and disposal of hazardous waste.	Applicable	The Potential for subsurface MEC exists at each site.	Any excavated MEC will be handled and disposed of IAW these regulatory requirements, when applicable.
Standards Applicable to Generators of Hazardous Wastes	40 CFR 261, 262, and 263.20-22	Soil	Gives USEPA and delegated states the authority to control hazardous waste from “cradle-to-grave” including the generation, transportation, treatment, storage, and disposal of hazardous waste and sets forth a framework to manage non-hazardous solid wastes.	Relevant and Appropriate	The potential for subsurface MEC exists at each site.	Any excavated MEC will be handled and disposed of IAW these regulatory requirements, when applicable.
Miscellaneous Units	40 CFR 264 Subpart X	Soil	Requires miscellaneous units 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	Disposal of waste explosives could require open burning or open detonation.	Any excavated MEC will be handled and disposed of IAW the substantive requirements of these regulatory requirements, when applicable.
Department of Defense (DoD) Ammunition and Explosives Safety Standards	Number 6055.09M, (2010)	Soil	Establishes explosive safety standards for the DoD.	TBC	The potential for subsurface MEC exists at each site.	TBC for managing risks associated with DoD--titled ammunition and explosives by providing protection criteria to minimize serious injury, loss of life and damage to property.

Type	Authority	Medium	Requirement	ARAR/TBC Status	Status	Action to be Taken to Attain Requirement
Air Force Manual (AFMAN) Explosive Safety Standards	91-201	Soil	Establishes explosive safety standards for Air Force Installations	TBC	The potential for subsurface MEC exists at each site.	TBC for managing risks associated with DoD--titled ammunition and explosives by providing protection criteria to minimize serious injury, loss of life and damage to property.
Defense Explosives Safety Regulation (DESR)	Number 6055.09, (2019)	Soil	Establishes explosive safety standards for the DoD.	TBC	The potential for subsurface MEC exists at each site.	TBC for managing risks associated with DoD--titled ammunition and explosives by providing protection criteria to minimize serious injury, loss of life and damage to property.
USACE Explosives Safety and Health Requirements Manual	EM 385-1-97, 15 September 2008	Soil	Prescribes the safety and health requirements for all USACE activities and operations that involve explosives related work. Follows 27 CFR 555; Bureau of Alcohol, Tobacco, Firearms, and Explosives, Department of Justice Part 555-Commerce in Explosives.	TBC	The potential for subsurface MEC exists at each site.	TBC for managing risks associated with DoD-titled ammunition and explosives by providing protection criteria to minimize serious injury, loss of life and damage to property.

2.4 TO BE CONSIDERED

To Be Considered (TBC) requirements are advisories or guidance issued by Federal or State government that are not legally binding, but are similar in form to required ARARs. These may be considered along with ARARs to assist with determining risk, removal action, and additional requirements.

3.0 IDENTIFICATION AND EVALUATION OF REMOVAL ACTION ALTERNATIVES

The purpose of this section is to identify, screen, develop, and evaluate removal action alternatives that may be applicable for achieving the RAOs established in Section 2.0 for soil within the Site and to be addressed by this EE/CA.

3.1 IDENTIFICATION OF POTENTIALLY APPLICABLE REMEDIATION TECHNOLOGIES FOR SOIL

Selected technologies for soil were screened based on Site-specific effectiveness, technical implementability, and relative life-cycle cost. Those technologies that passed screening were used to develop removal action alternatives for soil at the development areas addressed by this EE/CA, and these alternatives are subjected to detailed analysis and comparison later in this document. Those technologies that were not effective, had implementation concerns, and/or were excessively expensive in comparison to other technologies were rejected from further evaluation.

The following soil remediation technologies were identified for consideration to achieve soil RAOs:

- LUCs;
- Containment/Covers;
- Excavation and Off-Site Disposal; and,
- No-Action

A description of the aforementioned soil remediation technologies for lead and PAH contamination present in soil at the development areas addressed by this EE/CA is provided in Section 3.2.

3.2 DESCRIPTION OF POTENTIALLY APPLICABLE SOIL REMEDIATION TECHNOLOGIES

Alternatives identified in Section 3.1 are described further in the following subsections.

3.2.1 *Land Use Controls*

LUCs may include engineering or institutional controls. They are designed to protect human health and the environment. Institutional controls can be legally binding and are administrative in nature, while Engineering Controls (ECs) are physical mechanisms. Legal mechanisms, or institutional control, as used in the National Contingency Plan, consist of enforcing property restriction through ownership (e.g., deed notices, restrictive covenants, negative easements). Administrative mechanisms are essentially regulatory in nature and include notices, local land use plans and ordinances, construction permits, and land use management systems to ensure compliance with use restrictions.

ECs include physical mechanisms, such as placing fencing or signage to protect property owners and the public from hazards by limiting access or preventing public access to areas. Physical mechanisms are a useful deterrent to prevent unintentional access to a hazardous site and commonly work in conjunction with non-engineering controls to provide the best protection to the public.

3.2.2 *Containment/Covers*

Containment/Covers are engineered physical barriers placed between the contaminated Site medium (i.e., soil) and the atmosphere. Covers can include clean soil, asphalt, liners, or concrete to considerably reduce the risk to the public and the environment by preventing direct exposure to contaminants and also by preventing the migration of the existing contaminants deeper into the medium. No matter the type of containment/cover, these barriers are subject to damage and require periodic inspection and maintenance to ensure they last an extended period of time.

3.2.3 *Excavation and Off-Site Disposal*

Excavation and off-site disposal involves mechanical removal of impacted Site media. This material is typically excavated, then either stockpiled and hauled off-site using roll off containers, or directly loaded into over-the road trucks with end dumps. The media must be classified prior to disposal in order to determine what type of facility will accept it. As a result, the material(s) must be tested prior to disposal to determine its leachability by Toxicity Characteristic Leaching Procedure (TCLP). In order to be disposed as non-hazardous waste at a Subtitle D landfill, TCLP results must be below 5 mg/L for lead as listed in Table 1 of 40 Code of Federal Regulations (CFR) § 261.24. If the media does not meet these criteria, it must either be treated to meet the regulatory level of 5 mg/L for Subtitle D landfill disposal, or it must be disposed in a Subtitle C landfill as hazardous waste.

3.2.4 *No- Action Alternative*

Under this alternative, no control or active treatment would be performed at the site. All soils and lead shot that has not been previously removed will remain in place. No LUC or monitoring would occur. As required, this alternative is included in this EE/CA as a baseline comparison for the other alternatives.

3.3 DEVELOPMENT AND EVALUATION OF REMOVAL ACTION ALTERNATIVES

Four removal action alternatives have been developed in this EE/CA, with each evaluated for effectiveness, implementability, and cost. Effectiveness evaluates the ability to meet the RAOs established in Section 2.2, adherence to ARARs, and other criteria while limiting or removing any short-term or long-term risk to human health and the environment during implementation. Implementability addresses the technical and administrative feasibility of executing the alternative and the availability of various services and materials required for implementation. Cost estimates for the alternatives provided are for comparison purposes only, are order-of-magnitude level, and have an estimated range of accuracy of -30% to +50%.

The following subsections provide a detailed description and evaluation for each of the removal action alternatives proposed in this EE/CA.

3.3.1 *Alternative 1: Land Use Controls*

The purpose of the LUC program is to limit human exposure and to protect human health and the environment by restricting activity, use, and access to contamination present at the Site. LUCs will be implemented as engineering controls by placing fencing or signage to protect the public from hazards on Site by limiting access.

There are currently no LUCs in place at the Site. The Site has unrestricted access, with a single access road leading to the Site. LUC components would include the following:

- Public education resources such as distribution of information about lead and PAH exposure, educational meetings with area stakeholders and the public, and adding data to the facility information repository;
- Restricting physical access using fencing and signage notifying that lead and PAH contaminated soil exits and access is restricted;

- Restricting land use by prohibiting residential or industrial use;
- Conducting Long Term Monitoring (LTM). This includes inspection/maintenance on physical barriers annually; and,
- CERCLA Five Year Reviews of the RA to be conducted every five years to ensure it is protective of human health and the environment.

Legal restrictions have been put in place to restrict the property from being used for residential or industrial purposes. In addition to legal restrictions, physical access restrictions will be put into place to prevent contact with contaminated soil. Physical restrictions will include a fence surrounding the Site, and installation of signage on the fence warning of contaminated soil. The fence will consist of approximately 5,400 linear ft. of six-foot tall, nine-gauge chain-link fence to be installed along the perimeter of the Site. A 16-foot wide double swing gate will be installed to allow for equipment access as needed. The fence would be installed in accordance with standard fence inspections provided by the USACE. A Remedial Design Plan (RDP) would be created to provide more detailed information on the fence location and design.

LTM and maintenance will be implemented to ensure LUCs are effective. Goals of the LTM are to ensure that fencing and signage remain intact, and that contaminated soils are not migrating offsite. Annual inspection of the fence and signage is required.

3.3.1.1 *Effectiveness*

Using the RAOs established in Section 2.2 and the CERCLA EE/CA guidance criteria (EPA, August 1993), the effectiveness of Alternative 1 is evaluated below.

Achievement of Removal Action Objectives. This alternative would meet the objective of minimizing direct exposure pathways for human and ecological receptors to contaminants identified in soil at the Site; however, it will not attain either industrial or residential RALs.

Overall Protectiveness of Public Health and the Environment. Alternative 1 would reduce, but not eliminate the risk to human health by limiting direct exposure to contaminant source material (lead shot and clay pigeon fragments) and contaminated soil via LUCs. The potential for direct exposure would remain at the Site, as the contaminant source material and contaminated soil would remain above screening criteria. Personnel working at the Site during construction of the LUCs could potentially be exposed to existing contamination by walking, working, and/or parking in contaminated areas; however, this can be minimized through the use of personal protective equipment (PPE) and the implementation of worker safety practices. No monitoring other than quarterly LUC surveillance would be conducted to confirm that the risk posed by exposure to soil contaminants identified in the development areas had not increased.

Compliance with ARARS and Other Criteria, Advisories, and Guidance. All identified ARARs for this EE/CA apply to Alternative 1.

Reduction of Toxicity, Mobility, Volume Through Treatment. There would be no reduction of toxicity, mobility, or volume through treatment, as no treatment to the contaminated soil would occur under Alternative 1.

Short-Term Effectiveness. LUCs do not currently exist at the Site; however, the Site has a single access road making short-term effectiveness a moderate risk for limiting human exposure and human health and protection of any residents in the surrounding area due to limited access. Additionally, short-term exposure would occur during construction of the fence and installation of the signs, adding to the moderate risk for human exposure.

Long-Term Effectiveness and Permanence. Similar to short-term effectiveness, long-term effectiveness and permanence of Alternative 1 would be moderate if the LUCs are maintained. An LTM plan would be required to ensure fence, signage and surrounding vegetation is maintained to ensure RAOs are still met. The LTM Plan could

include biennial or annual inspection with sampling of soils outside the perimeter of the fence line to see if lead and PAHs are migrating outside of the perimeter.

3.3.1.2 *Implementability*

Technical Feasibility. Due to the location of the Site on BAFB, availability to an access road, and topography of the Site, Alternative 1 is technically feasible.

Administrative Feasibility. Alternative 1 is also administratively feasible, as the required administration for the LUCs would be established with BAFB and agencies as necessary. No permits or waivers would be required to construct the fence.

Availability of Services and Materials. Personnel and materials required to construct fencing and signage around the perimeter of the Site to protect the public from hazards by limiting access are readily available. Maintenance and routine inspection of the fence and signage will be required.

3.3.1.3 *Cost*

The cost for Alternative 1 for LUCs and operations and maintenance (O&M) is relatively low compared to the other Alternatives. The 30-year present worth cost of Alternative 1 is $405,050. Table 3-1 located in Appendix A summarizes costs associated with Alternative 1.

3.3.2 *Alternative 2: Containment/Covers*

Under Alternative 2, a containment system would be constructed to cover the soil and create a barrier between the contamination and would minimize infiltration and leaching of contaminants. Alternative 2 would not reduce the volume or toxicity of the contamination, but it would minimize the mobility. These types of containments are typically used on landfills.

Alternative 2 would vary in complexity from a simple soil cover to a multilayered cap design to ensure it meets federal and state requirements. For Alternative 2, factors to consider include physical condition of the contaminated media (i.e. soil), topography, slope stability, chemical leachability, hydrogeology, annual precipitation, and future land use.

Currently, the contamination extends approximately 23.47 acres across the site. The design will include a cap made of a 30-mil high-density polyethylene (HDPE) liner installed between two six-inch layers of clay and top soil as the top cover. An estimated total of 37,864.94 yd^3 of clay and top soil will be hauled to the site. The area will be cleared to removed trees, stumps, and brush utilizing a tractor with a brush mower attachment. Clean excavated clay will be transported to the project site area and spread to a depth of 6 inches as the base to cover bedrock shards that outcrop in the area. The Site will then be covered with a 30-mil HDPE liner that will be welded at the seams to prevent leakage. These liners are specifically designed for containment of hazardous waste and are resistant to ultra violet light. Once the liner is installed, a mixture of clean clay and topsoil will be spread to a depth of 12 inches above the liner and graded to match the surface level as best as possible. The area will then be reseeded with native grasses.

3.3.2.1 *Effectiveness*

Using the RAOs established in Section 2.2 and the CERCLA EE/CA guidance criteria (EPA, August 1993), the effectiveness of Alternative 2 is evaluated below.

Achievement of Removal Action Objectives. Alternative 2, which would include containment and capping of soil that contains contaminant exceedances of the RAL for residential land use, would fully meet the RAOs established in Section 2.0.

Overall Protectiveness of Public Health and the Environment. Alternative 2 would reduce the risk to human health and the environment by limiting exposure to contaminant source materials (lead shot and clay pigeon debris) and contaminated soil by capping and containment of all soil exceeding EPA RSLs, and by the continuation of LUCs. LUCs and soil containment are effective ways to reduce the transport of contaminants above and below ground. Biannual LUC surveillance would be continued to ensure that the risk posed by exposure to remaining contamination at the Site does not increase.

Compliance with ARARS and Other Criteria, Advisories, and Guidance. The Occupational Safety and Health Administrations (OSHA) requirements for NTCRA workers in the field potentially applies to this alternative. Personnel responsible for oversight of containment activities would also be subject to those OSHA requirements. Provisions for meeting applicable OSHA requirements would be included in the work plan and health and safety plan developed for Alternative 2. Capping would prevent exposure to soils remaining on site with contamination at levels above the RSL, the TBC for contaminants at the site.

Reduction of Toxicity, Mobility, Volume Through Treatment. This alternative would not be effective at reducing the toxicity or volume of contaminants identified at the Site. While not treatment, it would reduce the mobility of contaminants at the site.

Short-Term Effectiveness. Alternative 2 would effectively limit human exposure and risk to human health and also afford protection of the community and workers in the short term. An inherent short-term risk would be associated with the placement of the base layer of clay and construction of the HDPE liner on the contaminated soils; however, this can be minimized through the use of PPE and the implementation of worker safety practices.

Long-Term Effectiveness and Permanence. The long-term effectiveness of this alternative would be high since contaminated soil with concentrations above the EPA RSLs and/or CDPHE levels, and contaminant source material, would be capped and contained underneath a permanent cover of soil and an insoluble HDPE liner. Additionally, the implementation of LUCs would add to the long-term effectiveness. LUC's for Alternative 2 would include biannual inspection of the vegetation and topsoil with repair when necessary.

3.3.2.2 *Implementability*

Technical Feasibility. While more difficult to implement than Alternative 1, Alternative 2 is technically feasible, highly implementable, and does not involve any advanced technology.

Administrative Feasibility. Alternative 2 is also administratively feasible. Hauling of clay and topsoil and installation of the HDPE liner would require a contractor and oversight for operations.

Availability of Services and Materials. Resources for LUC monitoring would be readily available. Additionally, the contractors required for clay and topsoil hauling and installation of the HDPE liner are readily available.

3.3.2.3 *Cost*

The 30-year present worth costs of Alternative 2 are estimated to be $3,253,096. First year capital costs for Alternative 2 include preparation of a health and safety plan and work plans, mobilization and demobilization, soil transport and spreading, HDPE liner install, and seeding. Table 3-1 located in Appendix A summarizes the estimated costs associated with Alternative 2.

3.3.3 *Alternative 3: Excavation and Off-Site Disposal to Achieve RSLs for Residential Soils*

Alternative 3 includes the excavation and off-site disposal of contaminated soil containing lead and/or PAH at concentrations exceeding the EPA RSLs for residential soils.

The estimated quantity of soil to be excavated from each of the project areas under Alternative 3 was calculated using all XRF and analytical laboratory soil sample data from the 2019 CSE Phase II Report. Based on the data, the vertical excavation depths within each area were set by using the deepest sample depths at which contamination above the EPA RSLs for residential soils were detected. The lateral excavation extent within each proposed excavation depth was set to be halfway between a contaminated sample point and the next adjacent clean sample point in all directions. Additional delineation sampling will occur along the northern tree line and the parking lot south of the Clay Target Fall Area as part of the removal activities, with confirmatory sampling occurring following excavation. Confirmation soil sampling would be performed during excavation activities to verify that residential land use standards were met.

Site Preparation

Site preparation includes mobilization and setup of support facilities, utility clearance surveys, vegetation removal, temporary road construction, and establishment of soil erosion and sediment controls. Equipment and support facilities (e.g., excavators, loaders, office trailer, storage containers, sanitary facilities, etc.) would be mobilized to the site and set up or staged at approved locations. Utility clearance surveys and temporary road construction would be conducted where necessary to expose or provide access to the areas marked for excavation. No vegetation removal will be necessary that would impact excavation activities on the Site.

Erosion and sediment control measures would be established to ensure that soil disturbance activities do not impact down gradient surface water bodies, floodplains, or wetlands. During road construction, soil excavation and stockpiling, waste loading, backfilling, and re-grading operations, erosion and sediment controls would be regularly inspected and maintained until excavation and backfilling is complete and the site vegetation is re-established.

Soil Excavation

Soil volumes to be excavated from each area were estimated for 0-0.5 ft. bgs, 0-1 ft. bgs, and 0-2 ft. bgs based off of the CSE Phase II sampling data. The total volume for removal is estimated to be 28,287 yd^3.

The estimated quantity of soil to be excavated under Alternative 3 at the Site, by depth, is as follows:

- 0-0.5 ft. bgs: 11,435 yd^3
- 0-1 ft. bgs: 12,778 yd^3
- 0-2 ft. bgs: 4,074 yd^3

Figures 14 and 15, presented with the EE/CA, depict the excavation and confirmatory sampling areas with associated depth contours for Alternative 3.

A 50 ft. x 50 ft. grid system will be used to guide investigation, removal, and confirmatory sampling activities. The grid system will be an extension of the 100 ft. x 100 ft. grid system that was detailed in the CSE Phase II Report. The 50 ft. x 50 ft. grid system contains 409 proposed grid soil removal and confirmatory sampling boxes, with 247 grid boxes

for 0-0.5 ft. removal depth, 140 grid boxes for 0-1 ft. removal depth, and 22 grid boxes for 0-2 ft. removal depth. It is anticipated that the removal of lead impacted soils will also address PAH impacted soils and achieve the EPA RSLs for both lead and PAH contamination in residential soils. In order to ensure the excavation activities have met the UU/UE goal for the Site, confirmatory samples will be collected throughout the 50 ft. x 50 ft. grid system utilizing a five-point composite sample method (e.g., samples collected from the four grid corners and center and composited into one sample for laboratory analysis). Following the excavation, in areas where confirmation samples are found to exceed the EPA RSLs for lead and/or PAHs, an additional 6 inches of soil will be removed and the excavation floor will be re-sampled. This process will be repeated until all confirmation samples result in a concentration of lead/PAHs below their respective EPA RSLs.

Under Alternative 3, the excavated soil from the Site is anticipated to be non-hazardous following TCLP analysis and will subsequently be transported to the closest Subtitle D landfill, DADS for disposal. However, if the soil does not meet the Subtitle D landfill criteria discussed in Section 3.2.3, excavated soils will either be treated to meet disposal requirements or will be disposed in a Subtitle C landfill as hazardous waste.

Site Restoration

Following confirmation that the remedial objectives for contaminated soil have been achieved, clean backfill and topsoil (minimum of top 2 inches) will be used to restore the excavated areas. Prior to import of backfill and topsoil, the materials will be sampled and submitted for laboratory analysis, to be screened against the following EPA RSLs, in order to confirm the borrow materials do not contain contaminants that could create a new environmental condition at the site:

- Volatile organic compounds (VOCs);
- Semi-volatile organic compounds (SVOCs);
- PAHs;
- Metals;
- Pesticides;
- Herbicides; and,
- Polychlorinated biphenyls.

The excavation will be backfilled in 1-ft. lifts and compacted to 85% of the standard maximum density for cohesive soils based on the Unified Facilities Guide Specifications. All removal areas will be returned to original grade contours, promoting positive drainage, and will be re-seeded per BAFB requirements, followed by a 90-day maintenance period.

3.3.3.1 *Effectiveness*

Using the RAOs established in Section 2.2 and the CERCLA EE/CA guidance criteria (EPA, August 1993), the effectiveness of Alternative 3 is evaluated below.

Achievement of Removal Action Objectives. Alternative 3 would fully meet all of the RAOs established in Section 2.2. Contaminated soil would be permanently removed, thereby eliminating unacceptable risks and minimizing the potential for future contaminant migration on the Site.

Overall Protectiveness of Public Health and the Environment. Alternative 3 would provide the greatest reduction in the risk to human health and the environment by eliminating exposure to contaminant source materials and contaminated soil through the removal of all soil exceeding EPA RSLs for residential soils.

Compliance with ARARS and Other Criteria, Advisories, and Guidance. All ARARs are applicable to Alternative 3. Alternative 3 also meets all RAOs, and is the most permanent option through excavation and off-site disposal of contaminated soil and source material.

Reduction of Toxicity, Mobility, Volume Through Treatment. While not treatment (unless soils must be treated to reduce toxicity), this alternative would effectively eliminate toxicity, mobility, and volume of contaminants on the Site due to soil excavation activities.

Short-Term Effectiveness. Establishment of temporary storm water silt fences at the Site during soil excavation and stock pile activities would be effective in the short-term for limiting human exposure and risk to human health and the environment, and also for protection of the community and workers by limiting the potential migration of contaminated soil. However, risks to site workers could be lessened through the use of standard personal protective equipment, conventional dust suppression techniques, and site health and safety monitoring.

Long-Term Effectiveness and Permanence. The long term effectiveness of this alternative would be the highest of the alternatives as this alternative is the most permanent and completely eliminates the contaminated soil and source material. Additionally, the selected off-site disposal facility would be an existing, permitted Subtitle D landfill. The landfill would operate under the restrictions of its specific operating permit, thereby ensuring the long-term effectiveness of the disposal option for the excavated soil. As noted previously in this document, prior to disposal, excavated soils will be sampled and submitted to the analytical laboratory for TCLP analysis for lead. If analytical results exceed 5.0 mg/L, the excavated materials will require treatment for lead stabilization to allow for disposal as non-hazardous waste. Excavated soils will not be transported for off-site disposal until TCLP results from analytical samples indicate the materials are non-hazardous.

3.3.3.2 *Implementability*

Technical Feasibility. While more difficult to implement than Alternative 1, Alternative 3 is technically feasible, as the implementation of storm water pollution prevention measures as well as soil excavation does not involve any unusual technology, significant engineering, or construction difficulties. All soil removal will be completed with a scraper, track loader, water truck and haul vehicles.

Administrative Feasibility. Alternative 3 is administratively feasible. The required administration for the LUCs is already in place and would not require extensive administration or coordination with other offices or agencies. Waste Manifesting will be prepared by DADS and signed by USACE/USAF representatives for each load transported for off-site disposal.

Availability of Services and Materials. The labor, equipment, and materials necessary to implement this alternative are conventional and readily available. The contractors required for soil excavation and disposal are readily available and have the capacity to perform the activities specified for this alternative, and disposal facilities permitted to accept contaminated soils classified as either hazardous or non-hazardous waste are available.

3.3.3.3 *Cost*

The present worth cost of Alternative 3 is estimated to be $2,287,151. A summary of capital costs is summarized in Table 3-1 located in Appendix A.

3.3.4 *Alternative 4: No Action Alternative*

This alternative assumes no further action will be taken to address the RAOs. As required, this alternative is included in this EE/CA as a baseline comparison for the other alternatives.

3.3.4.1 *Effectiveness*

Under this alternative, there is potential for unacceptable risk to human health and the environment. The alternative includes no LUCs or measures to ensure that the potential hazard of lead and PAHs in the soil will be monitored. With no means of monitoring and no controls in place, the No Action Alternative would not comply with the RAOs, would not be protective of human health and the environment, and would not reduce the toxicity or limit the mobility of lead and PAH in the soil.

3.3.4.2 *Implementability*

No Action would be technically feasible but not administratively feasible to implement. It would not be administratively feasible to implement because the USEPA would not concur with the No Action Alternative as it does not protect human health or the environment.

3.3.4.3 *Cost*

There would be no cost associated with the No Action Alternative.

4.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

A criterion by criterion comparative analysis of the NTCRA alternatives developed in Section 3.2 is presented in the following subsections. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that key tradeoffs that would affect the removal action selection can be identified.

4.1 ACHIEVEMENT OF REMOVAL ACTION OBJECTIVES

Alternatives 1 and 4 do not meet the RAOs established in Section 2.2, while Alternatives 2 and 3 do fully meet the RAOs for industrial and residential use.

Alternative 1 minimizes direct exposure pathways only through the implementation of LUCs and O&M. While this is an effective method, Alternatives 2 and 3 would limit direct exposure pathways to a greater degree than Alternative 1 via the removal or containment of contaminant source material and contaminated soil. Alternative 4 would be ineffective due to no action in mitigating potential human health risks due to direct exposure to lead and PAH contamination in soils.

4.2 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The four removal action alternatives developed for this EE/CA are protective of human health and the environment to varying degrees. As stated in the RAOs, the primary goal of the NTCRA is to mitigate the potential threat to human health and the environment caused by the presence of contaminant source material and contaminated soil that exists at the four designated development areas. The primary threat to human health and the environment is via direct exposure pathways including inhalation of airborne particulates, dermal absorption, and incidental ingestion.

Alternative 1 would reduce but not eliminate the risk to human health and the environment by limiting direct exposure to contaminant source material (lead shot and clay pigeon fragments) and contaminated soil through implementation of LUCs and O&M at the Site. The potential for direct exposure would always be present. Personnel working at the Site during construction of the fencing could potentially be exposed to existing contamination.

Alternatives 2 and 3 provide greater protection of human health and the environment than Alternative 1, because contaminant source material and contaminated soil would either be excavated and disposed off-site or covered with a

containment system. Alternative 3 would be more protective than Alternative 2 because it would remove all contaminated soil that exists above EPA RSLs.

Alternative 4, No Action Alternative, would not be protective of human health and the environment because it would not remove the contaminants, prevent exposure to the contamination, or monitor the contamination.

4.3 COMPLIANCE WITH ARARs AND OTHER CRITERIA, ADVISORIES AND GUIDANCE

All alternatives except Alternative 4, comply with ARARs and other criteria.

4.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 1, 2, and 4 do not reduce toxicity, mobility, or volume of contaminants present at the Site. While not treatment, Alternative 2 would be more effective than Alternative 1 and 4, as it would significantly reduce the mobility of contaminants in the subsurface due to the presence of a containment/cover, but the contaminants would still be present at the Site. Alternative 3 would only involve treatment if it were necessary to treat the excavated materials for lead stabilization to qualify for disposal as non-hazardous waste (Subtitle D Landfill). It would achieve residential land use standards through removal and off-site disposal to eliminate toxicity and volume of contaminants to the greatest extent of the four alternatives.

4.5 SHORT-TERM EFFECTIVENESS

All alternatives except for Alternative 4 provide some short-term effectiveness. Alternatives 2 and 3 provide roughly equal short-term effectiveness. Implementing LUCs for Alternative 1 would effectively limit human exposure and risk to human health, afford protection to the community, and would involve less risk of exposure to site workers. Constructing a containment/cover over contaminated soils for Alternative 2 would also limit human exposure and risk to human health for workers and the community. Conversely, Alternatives 1 and 2 involve site workers, which have increased risks due to potential exposure to contaminated soils. Alternatives 1, 2, and 3 all pose short-term risks to site workers, which can all be mitigated using personal protective equipment, dust suppression techniques, and site health and safety monitoring. Short-term risks due to transport of excavated material will be mitigated with proper containerization of excavated material and manifesting procedures. Short-term risks to members of the public could be mitigated through compliance with regulatory requirements.

4.6 LONG-TERM EFFECTIVENESS

Alternative 4, No Action, is not protective because no action would be taken to address contamination or prevent exposure. Alternative 2 does attain long-term effectiveness through the use of LUCs to prevent exposure. The long-term effectiveness of Alternatives 2 and 3 is greater than Alternative 1, because either containment material is added (Alternative 2) or contaminated soil is removed (Alternative 3) as part of these alternatives. Alternative 1 is only effective in the long-term reduction of hazards to humans as long as LUCs are complied with in the future. Alternative 3 provides the greatest long-term effectiveness, as contaminated soil above EPA RSLs for residential soils and/or CDPHE levels would be removed.

4.7 TECHNICAL FEASIBILITY

Alternative 4, No Action, would be technically feasible and administratively feasible to implement. However, the USEPA would not concur with the No Action Alternative as it does not protect human health or the environment. The other three alternatives are both technically and administratively feasible. With respect to technical feasibility, Alternative 2 would be the most difficult to implement due to the large size of the site, which would require the construction of a large HDPE liner for containment/cover. This would require the import of substantial quantities of materials for implementation and would pose the highest degree of worker safety concerns during construction.

Alternative 1 would be the easiest to implement, as the implementation of LUCs would pose less risk to worker safety and would require only the construction of a perimeter fence and posting of signage to restrict access. However, routine maintenance and inspections would be required on the installed fencing and signage, which would require additional efforts as long as the LUCs were in-place. With respect to technical feasibility, Alternative 3 is easier to implement than Alternative 2, and more difficult to implement than Alternative 1. Alternative 3 will require personnel and equipment for the excavation, sampling, and transportation and disposal of contaminated soils; as well as the required backfill and site restoration activities. These construction activities could pose a risk to worker safety; however, this can be mitigated through the implementation of PPE and Safety and Health practices. Once completed, Alternative 3 will remove all potential hazards from the Site and allow of UU/UE of the property with no additional technical or administrative requirements following the completion of site work.

4.8 ADMINISTRATIVE FEASIBILITY

There are no administrative feasibility concerns associated with the No Action Alternative because no field activities would be performed. However, the USEPA would not concur with the No Action Alternative as it does not protect human health or the environment. The additional three alternatives are administratively feasible. The most feasible is Alternative 1, due to the fact that it would require a lesser amount of plans, permits, and construction to complete. Alternatives 2 and 3 have the same relative degree of administrative feasibility. Alternatives 2 and 3 would require administrative coordination related to the transportation of soils for both Alternatives and construction of an HDPE liner for Alternative 2. Alternative 2 would require the most coordination because the estimated quantity of soil is significantly greater than the quantity estimated for Alternative 3.

4.9 AVAILABILITY OF SERVICES AND MATERIALS

Alternative 4, No Action Alternative would not require services and materials because no field activities would be performed. Services and materials are readily available for the other three alternatives. Alternatives 2 and 3 would require a greater degree of services and materials as compared to Alternative 1.

4.10 COST

The four alternatives range in cost from the least expensive alternative (Alternative 4) to the most expensive alternative (Alternative 2). The 30-Year Present Worth Costs by Alternative are as follows:

- Alternative 1: $405,050;
- Alternative 2: $3,253,096;
- Alternative 3: $2,287,151; and,
- Alternative 4: No Cost

5.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

The primary goal of this EE/CA is to determine if an NTCRA is necessary to mitigate the potential threat to human health and the environment created by the presence of contaminant source material and contaminated soil at the Site. The main threat to human health and the environment is through direct exposure pathways including dermal absorption, inhalation, and incidental ingestion.

Based on a comprehensive assessment and comparison of the four NTCRA alternatives developed within this EE/CA, Alternative 3: Excavation and Off-Site Disposal to Achieve RSLs for Residential Soils, is recommended to achieve the RAOs for the Site.

Alternative 1 would not fully achieve the applicable RAOs developed in Section 2.2. Alternative 1 would limit direct exposure to contaminant source material, but would not reduce contamination further. Because contaminant source

material and contaminated soil would remain at the Site, the potential for direct exposure would always be present. Personnel working at the Site during construction of the LUCs, could potentially be exposed to existing contamination by walking, working, and/or parking in contaminated areas

To varying degrees, Alternative 2 and 3 both address the primary potential threat to human health and the environment that is posed by direct exposure to contaminant source material and contaminated soil that is present at the Site. Alternative 2 would mitigate exposure to contaminated soil with concentrations above the EPA RSLs and/or CDPHE levels due to the contaminant source being capped and contained underneath a permanent cover of soil and an impermeable HDPE liner. Alternative 3 is more effective than Alternative 2 at eliminating the potential direct exposure threat to human health and the environment by removal and disposal off-site.

Unlike Alternatives 1, 2 and 4, Alternative 3 would achieve the RAOs for the Site by removal of contaminant source material and soils containing lead and/or PAH contamination exceeding the EPA RSLs for residential soil. Alternative 3 would eliminate all potential for direct exposure threats to human health and the environment. The effectiveness, implementability, and cost for Alternative 3 are all easily attainable and technically feasible as discussed in Section 3.3.3. Due to the current and anticipated future land use for the Site, Alternative 3 is the recommended NTCRA alternative for this Site.

6.0 REFERENCES

Booz, Allen, Hamilton. 2003. Environmental Baseline Survey for the Tri-Services Skeet Range. October.

Stauss, Ron. 2005. Tri-Service Sportsmen's Club Fact Sheet.

URS Group, Inc. 2002. IRP Sites 1, 4, and 5, 4th Quarter Groundwater Monitoring Report. September.

URS Group, Inc. 2005. Phase I Environmental Baseline Survey, Addendum Report. November.

Whitetail Environmental, LLC. 2019. Comprehensive Site Evaluation, Phase II Report Munitions Response Site TS119 (former Skeet Range) Buckley AFB, Colorado

APPENDIX A

Alternatives Cost Estimates

EE/CA for NTCRA Former Skeet Range MRS TS119, Buckley AFB, Colorado

Alternative 1 - Land Use Controls — Cost Estimate Worksheet

Site: Former Skeet Range MRS TS119
Location: Buckley Air Force Base, Colorado
Base Year: 2020

Cost Analysis

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls					
Public Meeting, Admin Record Update	1	LS	$ 5,000	$ 5,000	Develop a WP and survey the IC area
Master Plan Input	1	LS	$ 10,000	$ 10,000	Update Post - wide planning
Fencing	5,400	LF	$ 35	$ 189,000.00	Fencing Estimate
Oversight	60	Day	$ 1000	$ 60,000.00	
Remedial Action Completion Report	1	LS	$ 35,000	$ 35,000.00	
Project Contingency	25%			$ 27,000	
Program Management	15%			$ 1,050	Does not include Fencing
			TOTAL CAPITAL COST	$ 327,050	
Annual Operation and Maintenance (O&M) Costs					
Description					
Annual Fence Maintenance	30	EA	$ 2000	$ 60,000	
Annual Program Maintenance	30	EA	$ 500	$ 15,000	
Five Year Review	6	EA	$ 500	$ 3,000	
			SUBTOTAL	$ 78,000	
			TOTAL ANNUAL COST	$ 78,000	
			TOTAL COST	$ 405,050	

EE/CA for NTCRA Former Skeet Range MRS TS119, Buckley AFB, Colorado

Alternative 1 - Land Use Controls — Present Worth Summary

Site: Former Skeet Range MRS TS119
Location: Buckley Air Force Base, Colorado
Base Year: 2020

Present Value Analysis
Annual Percentage Rate 7%

YR	Capital	O&M Annual	Review 5-Year	Total Cost	Present Worth
0	$327,050	-	-	$327,050	$327,050
1	-	$2,500	-	$2,500	$2,336
2	-	$2,500	-	$2,500	2183.596821
3	-	$2,500	-	$2,500	2040.744692
4	-	$2,500	-	$2,500	
5	-	$2,500	$ 500	$3,000	
6	-	$2,500	-	$2,500	
7	-	$2,500	-	$2,500	
8	-	$2,500	-	$2,500	
9	-	$2,500	-	$2,500	
10	-	$2,500	$ 500	$3,000	
11	-	$2,500	-	$2,500	
12	-	$2,500	-	$2,500	
13	-	$2,500	-	$2,500	
14	-	$2,500	-	$2,500	
15	-	$2,500	$ 500	$3,000	
16	-	$2,500	-	$2,500	
17	-	$2,500	-	$2,500	
18	-	$2,500	-	$2,500	
19	-	$2,500	-	$2,500	
20	-	$2,500	$ 500	$3,000	
21	-	$2,500	-	$2,500	
22	-	$2,500	-	$2,500	
23	-	$2,500	-	$2,500	
24	-	$2,500	-	$2,500	
25	-	$2,500	$ 500	$3,000	
26	-	$2,500	-	$2,500	
27	-	$2,500	-	$2,500	
28	-	$2,500	-	$2,500	
29	-	$2,500	-	$2,500	
30	-	$2,500	$ 500	$3,000	
Totals	$327,050	$75,000	$3,000	$405,050	

EE/CA for NTCRA Former Skeet Range MRS TS119, Buckley AFB, Colorado

Alternative 2 - Containment/Covers — Cost Estimate Worksheet

Site: Former Skeet Range MRS TS119
Location: Buckley Air Force Base, Colorado
Base Year: 2020

Capital Costs

Description	QTY	UNIT		UNIT COST		TOTAL	NOTES
Institutional Controls							
None		LS	$	-	$	-	
				SUBTOTAL	$	-	
Excavation and Disposal Cost							
Mobilization	1	LS	$	83,000.00	$	83,000.00	
Clean Soil	37,865	CY	$	10.00	$	378,650.00	
Soil Transport	37,865	LS	$	20.00	$	757,300.00	
Soil Spreading and Compaction	37,865	LS	$	6.00	$	227,190.00	
HDPE Liner and Install	23.5	Acre		25,000.00		587,500.00	
Seeding	25	Acres	$	2,300.00	$	57,500.00	
Oversight	1	LS		70,000.00		70,000.00	
Remedial Action Reporting	1	LS		37,000.00		37,000.00	
Work Plan Development	1	LS	$	125,500.00	$	125,500.00	
				SUBTOTAL	$	2,323,640.00	
Other Project Costs							
Project Contingency	25%				$	580,910.00	10% scope + 15% bid
Program Management	15%				$	348,546.00	
				TOTAL CAPITAL COST	$	3,253,096.00	
Annual Operation and Maintenance (O&M) Costs							
See Below	0	EA	$	-	$	-	
				SUBTOTAL	$	-	
				TOTAL ANNUAL COST	$	-	
Periodic Costs							
None	0	EA	$	-	$	-	
				TOTAL PERIODIC COST	$	-	
				TOTAL COST	$	3,253,096	

EE/CA for NTCRA Former Skeet Range MRS TS119, Buckley AFB, Colorado

Alternative 2 - Containment/Covers — Present Worth Summary

Site: Former Skeet Range MRS TS119
Location: Buckley Air Force Base, Colorado
Base Year: 2020

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Present Value	Notes
0		$0	-		-	$0
1		-	$11,500		-	$11,500
2		-	$11,500		-	$11,500
3		-	$11,500		-	$11,500
4		-	$11,500		-	$11,500
5		-	$11,500	$	500	$12,000
6		-	$11,500		-	$11,500
7		-	$11,500		-	$11,500
8		-	$11,500		-	$11,500
9		-	$11,500		-	$11,500
10		-	$11,500	$	500	$12,000
11		-	$11,500		-	$11,500
12		-	$11,500		-	$11,500
13		-	$11,500		-	$11,500
14		-	$11,500		-	$11,500
15		-	$11,500	$	500	$12,000
16		-	$11,500		-	$11,500
17		-	$11,500		-	$11,500
18		-	$11,500		-	$11,500
19		-	$11,500		-	$11,500
20		-	$11,500	$	500	$12,000
21		-	$11,500		-	$11,500
22		-	$11,500		-	$11,500
23		-	$11,500		-	$11,500
24		-	$11,500		-	$11,500
25		-	$11,500	$	500	$12,000
26		-	$11,500		-	$11,500
27		-	$11,500		-	$11,500
28		-	$11,500		-	$11,500
29		-	$11,500		-	$11,500
30		-	$11,500	$	500	$12,000
Totals		$0	$345,000		$3,000	$348,000

EE/CA for NTCRA Former Skeet Range MRS TS119, Buckley AFB, Colorado

Alternative 3 - Excavation to Residential RSLs, and Disposal — Cost Estimate Worksheet

Site: Former Skeet Range MRS TS119
Location: Buckley Air Force Base, Colorado
Base Year: 2020

Capital Costs

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls					
None		LS	$ -	$ -	
			SUBTOTAL	$ -	
Excavation and Disposal Cost					
Mobilization	1	LS	$ 21,879.21	$ 21,879.21	
MC-Contaminated Soil Removal	1	LS	$ 1,373,827.05	$ 1,373,827.05	
Site Restoration	1	LS	$ 201,424.39	$ 201,424.39	
Demobilization	1	LS	$ 9,228.75	$ 9,228.75	
NTCRA After Action Report	1	LS	$ 26,012.71	$ 26,012.71	
Manpower Reporting	1	LS	$ 1,307.15	$ 1,307.15	
			SUBTOTAL	$ 1,633,679.26	
Other Project Costs					
Project Contingency	25%			$ 408,419.82	10% scope + 15% bid
Program Management	15%			$ 245,051.89	
			TOTAL CAPITAL COST	$ 2,287,150.96	
Annual Operation and Maintenance (O&M) Costs					
None	0	EA	$ -	$ -	
			SUBTOTAL	$ -	
			TOTAL ANNUAL COST	$ -	
Periodic Costs					
None	0	EA	$ -	$ -	
			TOTAL PERIODIC COST	$ -	
			TOTAL COST	$ 2,287,151	

EE/CA for NTCRA Former Skeet Range MRS TS119, Buckley AFB, Colorado

Alternative 4 - No Action — Cost Estimate Worksheet

Site: Former Skeet Range MRS TS119
Location: Buckley Air Force Base, Colorado
Base Year: 2020

Cost Analysis

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization			$ 0	$ 0	
Oversight		Days	$ 0	$ 0	
Reporting					
				$ 0	
			Subtotal	$ 0	
PM			15% Subtot	$ 0	
Contingency			25% Subtot	$ 0	
			TOTAL	$ 0	