FINAL
FEASIBILITY STUDY
SITE-WIDE REMEDIAL INVESTIGATION/FEASIBILITY STUDY
SPRING VALLEY FORMERLY USED DEFENSE SITE

SPRING VALLEY, WASHINGTON, DC
Contract No.: W912DR-09-D-0061, Delivery Order 0011
DERP FUDS MMRP/CWM Project No. C03DC091801 and
DERP FUDS HTRW Project No. C03DC091802

Prepared for:

US ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT

US Army Corps of Engineers®
BUILDING STRONG®

JANUARY 22, 2016

January 22, 2016

Attn: Dan Noble
CENAB-EN-HN
10 S. Howard Street
Baltimore, MD 21201-1715

Dear Mr. Noble,

ERT, Inc., is pleased to present the Final Feasibility Study for the Spring Valley FUDS Integrated Site-Wide Remedial Investigation/Feasibility Study, Washington, DC. This report is submitted under Contract W912DR-09-D-0061, Delivery Order 0011, and it incorporates USEPA, DOEE, AU, and RAB TAPP comments on the September 2015 Draft-Final version of the document.

Please do not hesitate to call me at 301-323-1442 if you need anything more.

Sincerely,

Thomas J. Bachovchin, P.G.
Project Manager

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Site-Wide Remedial Investigation/Feasibility Study
Spring Valley Formerly Used Defense Site (SVFUDS)
Washington, D.C.

Contract: W912DR-09-D-0061, Delivery Order 0011
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Prepared for:
U.S. Army Corps of Engineers
Baltimore District

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ELECTRONIC SIGNATURE

	01/22/16
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	04/24/15
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COMPLETION OF SENIOR TECHNICAL REVIEW

This document has been produced within the framework of the ERT, Inc. (ERT) quality management system. As such, a senior technical review has been conducted. This included review of all elements addressed within the document, proposed or utilized technologies and alternatives and their applications with respect to project objectives and framework of U.S. Army Corps of Engineers regulatory constraints under the current project, within which this work has been completed.

04/24/15

Michael Dorman, PMP — Date
Senior Technical Reviewer

COMPLETION OF INDEPENDENT TECHNICAL REVIEW

This document has been produced within the framework of ERT's quality management system. As such, an independent technical review, appropriate to the level of risk and complexity inherent in the project, has been conducted. This included a review of assumptions; alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the project objectives. Comments and concerns resulting from review of the document have been addressed and corrected as necessary.

04/22/15

Barry Millman — Date
Independent Technical Reviewer

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ACRONYMS and ABBREVIATIONS

AC	Advanced Classification
AOI	Area of Interest
ARARS	Applicable or Relevant and Appropriate Requirements
ARB	Anomaly Review Board
AU	American University
AUES	American University Experiment Station
CENAB	U.S. Army Corps of Engineers, Baltimore District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CWM	Chemical Warfare Materiel
DCMR	DC Municipal Regulations
DCRA	DC Department of Consumer and Regulatory Affairs
DDOE	District of Columbia Department of the Environment
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DMM	Discarded Military Munitions
DoD	Department of Defense
DOEE	District of Columbia Department of Energy and Environment
EE/CA	Engineering Evaluation/Cost Analysis
EU	Exposure Unit
FS	Feasibility Study
FUDS	Formerly Used Defense Site
GPO	Geophysical Proveout
HHRA	Human Health Risk Assessment
HI	Hazard Index
HTW	Hazardous and Toxic Waste
ITRC	Interstate Technology & Regulatory Council
LUCs	Land Use Controls
MC	Munitions Constituents
MD	Munitions Debris
MDEH	Material Documented as an Explosive Hazard
MEC	Munitions and Explosives of Concern
MEC HA	MEC Hazard Assessment
MMRP	Military Munitions Response Program
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NTCRA	Non-time Critical Removal Action
OSR FUDS	Operation Safe Removal FUDS
OU	Operable Unit
PAHs	Polynuclear aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
POI	Point of Interest
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act

RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
RSLs	Regional Screening Levels
SVFUDS	Spring Valley Formerly Used Defense Site
TBC	To Be Considered
TCRA	Time Critical Removal Action
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UU/UE	Unlimited use/Unrestricted exposure
UXO	Unexploded Ordnance

EXECUTIVE SUMMARY

Introduction

ERT, Inc., (ERT) was tasked with drafting an Integrated Site-Wide Feasibility Study (FS) report for the U.S. Army Corps of Engineers (USACE), at the Spring Valley Formerly Used Defense Site (SVFUDS), located in Washington, D.C. The work was performed under the Munitions Response and Environmental Remediation Services Contract (W912DR-09-D-0061, Delivery Order 0011), which is administered by the Baltimore District (CENAB). This project falls under the Military Munitions Response Program (MMRP) of the Defense Environmental Restoration Program (DERP)/Formerly Used Defense Sites (FUDS) and includes Hazardous and Toxic Waste (HTW)-impacted media. The MMRP addresses munitions constituents (MC), and munitions and explosives of concern (MEC) (comprising unexploded ordnance [UXO], discarded military munitions [DMM], and MC in high enough concentrations to pose an explosive threat) that are located on certain properties, including FUDS.

Purpose

The purpose of this FS is to develop, screen, and provide a detailed analysis of remedial alternatives to mitigate: 1) unacceptable risks posed by soil contamination resulting from chemicals of concern (COCs), and 2) potential unacceptable explosive hazards due to MEC that may remain within the SVFUDS. It is based on information, site characterization, and determination of potential risks or hazards to human health which is contained in the *Site-Wide Remedial Investigation Report for the SVFUDS* (RI Report). In this FS, these two identified levels of risk/hazard are addressed separately.

Background and Site History

The SVFUDS comprises 661 acres in northwest Washington, D.C. During World War I, the U.S. Government established the American University Experiment Station (AUES) to research the testing, production, development and effects of noxious gases, chemical warfare materiel (CWM), antidotes and protective masks. The AUES was located on the grounds of the present American University (AU) and used portions of the adjoining properties.

Nature and Extent of Contamination

The determination of the nature and extent of HTW/MC/CWM and MEC/Munitions Debris (MD) contamination for the SVFUDS is based on the findings of each of the primary types of activities conducted at the SVFUDS (investigation/characterization, geophysical investigations, and removals), as detailed in the RI Report. Several discrete areas of the SVFUDS have proceeded through quantitative human health risk assessments (HHRAs) and any conclusions indicating remaining risk have been addressed in follow-on investigation or removal actions such that characterization of those discrete areas was considered to be complete. Removal actions at the SVFUDS have been concurrent with other investigations, being expedited through the time critical removal action (TCRA) and non-time critical removal action (NTCRA) process. Based on these activities, the nature and extent of contamination of the SVFUDS has been identified, as detailed in the RI Report.

Risk Assessment – Human Health

Quantitative HHRAs were completed (in the RI Report) for the following exposure units (EUs): the AOI 9 EU; the Spaulding-Rankin EU; and the Southern AU EU. The HHRAs concluded that:

- For the residential Area of Interest (AOI) 9 EU, further assessment is not required.

- For the residential Spaulding-Rankin EU, cobalt was determined to be a COC that poses unacceptable risks and follow-on actions are required to address it. For the Spaulding-Rankin outlier locations, arsenic, cobalt, lead, and mercury were determined to be COCs that pose unacceptable risk and follow-on actions are required to address them.
- For the Southern AU EU (excluding outlier locations), cobalt was determined to be a COC that poses unacceptable risks and follow-on actions are required to address it. For the Southern AU EU outlier locations, mercury, vanadium, and cobalt in soil are associated with non-carcinogenic risks, and carcinogenic polynuclear aromatic hydrocarbons (PAHs) in soil are associated with carcinogenic risks that exceed USEPA's risk range. Thus, these chemicals are COCs that pose unacceptable risks and follow-on actions are required to address them.

Risk Assessment – Explosive Hazards

The MEC hazard was determined partly by using the MEC hazard assessment (HA) methodology. The MEC HA was organized around the past SVFUDS activities most likely to result in MEC at the site, including ballistically fired testing, statically fired testing, and disposal (known and possible burial areas). The impact areas for both the Livens and the Stokes mortars received a MEC HA score of 3 (moderate potential explosive hazard conditions) based on current use activities. The moderate potential explosive hazard conditions that this score represents, suggests that follow-on actions may be required to mitigate unacceptable explosive hazards that may exist on the properties within the impact areas.

The static test fire areas may suggest the presence of munitions burial pits (DMM) near the testing locations. The potential for remaining burial pits suggests that follow-on actions may be required to mitigate unacceptable explosive hazards associated with the known static fire test areas and the 150 foot (ft) buffer zones around them. For the locations identified as possible disposal areas, a generic MEC HA that assumed a worst case scenario was completed and the score was a 3. The unknowns associated with the possible disposal areas and the moderate potential explosive hazard conditions they represent suggest that follow-on actions may be required to mitigate unacceptable explosive hazards that could exist in these three areas.

Remedial Action Objectives (RAOs)

Combining the COCs, the affected media, the exposure pathways, and the project goals, the SVFUDS RAOs include:

- Prevent direct contact with arsenic*, mercury* or vanadium-contaminated soil having a non-carcinogenic hazard index (HI) exceeding 1. This HI will be reached by achieving a 95% upper confidence limit (UCL) of the mean of the EU for mercury of 1.3 mg/kg, and for vanadium of 390 mg/kg.
- Prevent direct contact with cobalt-contaminated soil having a non-carcinogenic HI exceeding 2. This HI will be reached by achieving a 95% UCL of the mean of the EU for cobalt of 43 mg/kg.
- Prevent direct contact with lead* contaminated soil that could result in a blood lead level exceeding 5 micrograms per deciliter (ug/dL) for a child (the recommended upper reference level for a child's blood lead).

- Prevent direct contact with arsenic* or carcinogenic PAH-contaminated soil having a cancer risk in excess of 1 x 10^{-4}. As this represents the upper end of the acceptable cancer risk range, USACE will exceed this goal by remediating PAHs to background levels (presented in the *SVFUDS Background Soil Sampling Report*, USACE 2008). These are:

Benzo(a)anthracene = 0.358 ppm	Benzo(k)fluoranthene = 0.357 ppm
Benzo(a)pyrene = 0.375 ppm	Dibenz(a,h)anthracene = 0.51 ppm
Benzo(b)fluoranthene = 0.366 ppm	Indeno(1,2,3-c,d)pyrene = 0.335 ppm

- Reduce the potential for encountering MEC in the identified areas of focus for potential explosive hazards, and

- On a site-wide basis, reduce the probability of residents, contractor/maintenance workers, and visitors/passers-by from handling MEC encountered during residential or construction/maintenance activities conducted within the SVFUDS.

** See discussion in Section 2.1.3 for additional information on arsenic, lead, and mercury, as COCs at the Spaulding-Rankin EU.*

Identification and Screening of Technologies

To develop remedial alternatives, Applicable or Relevant and Appropriate Requirements (ARARs) were identified. General response actions to satisfy the RAOs were developed for each medium of interest defining containment, treatment, excavation, or other actions. Following this, remedial technologies were screened for effectiveness in remediating the response action areas, using the significant previous experience with similar contamination in the SVFUDS.

Four technologies were identified for potential use in performing remedial activities for contaminated soil at the SVFUDS: phytoremediation; soil stabilization; soil washing; and excavation and off-site disposal. Of these, phytoremediation and excavation and off-site disposal were retained as technologies for more detailed analysis. The primary technology with regard to potential explosive hazards was Digital Geophysical Mapping (DGM) followed by anomaly removal, and it was retained for more detailed analysis.

Development and Screening of Alternatives

Based on the contaminated soil technologies reviewed, four remedial alternatives were identified to mitigate the unacceptable risks posed by soil contamination:

- Alternative 1: No Further Action
- Alternative 2: Land Use Controls (LUCs)
- Alternative 3: Phytoremediation
- Alternative 4: Excavation and Off-site Disposal

These were screened against effectiveness, implementability, and cost, and the conclusion was that Alternative 3 (phytoremediation) and Alternative 4 (excavation and off-site disposal) met key elements of the effectiveness and implementability criteria and they were retained for the detailed comparative analysis.

Based on the explosive hazards mitigation technologies reviewed, six remedial alternatives were identified to mitigate the potential unacceptable explosive hazards that may remain:

- Alternative 1: No Further Action
- Alternative 2: LUCs
- Alternative 3: Full DGM Coverage, Remove All Anomalies
- Alternative 4: Full DGM Coverage, Remove Selected Anomalies
- Alternative 5: DGM of Accessible Areas, Remove All Anomalies
- Alternative 6: DGM of Accessible Areas, Remove Selected Anomalies

These were also screened against effectiveness, implementability, and cost, and the conclusion was that Alternatives 3, 4, 5, and 6, met key elements of the effectiveness and implementability criteria and they were retained for the detailed comparative analysis.

<u>Detailed Analysis of Alternatives – Contaminated Soil</u>

For contaminated soil risk mitigation, the phytoremediation and excavation and off-site disposal alternatives were assessed against the nine Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) evaluation criteria (threshold, balancing and modifying), by focusing on whether and how the alternative is favorable, moderately favorable, or not favorable, relative to the criterion.

For the threshold criteria, both contaminated soil remedial alternatives were considered protective of human health and the environment. However, Alternative 3 requires an assumption that a treatability study will demonstrate that phytoremediation can successfully treat the site-specific COCs. Both alternatives were compliant with ARARs.

For the balancing criteria, Alternative 3 was only moderately effective in the long term due to the need to potentially have different types of plants targeting different COCs. Further, the phytoremediation process could take a substantial length of time to reach RAOs. Alternative 4 was the most effective as it is a permanent remedy that leaves no residual risk at the site. Both alternatives were ranked as not favorable with regard to reducing toxicity, mobility, and volume of contaminants because contaminants in soil or plants would not be treated, but would be transferred to a landfill. Alternative 3 was not ranked favorable in meeting the short-term effectiveness criterion because the plants have a growing cycle that requires sufficient time. Alternative 4 was favorable in meeting the short-term effectiveness criterion because the time required to meet the RAOs is minimal. Alternative 3 was moderately favorable for technical feasibility sub-criterion because it has not been successfully demonstrated for the site-specific COCs, and implementation would be delayed pending a treatability study. The administrative feasibility sub-criterion is moderately favorable because it will require significant coordination with the property owner during the growing and maintenance cycle. Alternative 4 was favorable overall for the implementability criteria because the reliability of excavation and disposal to address the contaminants is well established.

For the costing criterion, on a per grid basis, phytoremediation is less expensive than excavation and disposal. However, phytoremediation contains more unknowns as treatability studies may need to be conducted to address different COCs in different climate and/or soil conditions. The primary cost unknown associated with excavation is the potential to chase contamination horizontally or vertically through confirmation sampling, requiring increasing volumes to remove. Based on experience with both alternatives within the SVFUDS, the unknowns associated with phytoremediation costs are considered to be significant enough that its lower costs ranked only slightly more favorable than the higher excavation and disposal costs.

While state and community acceptance cannot be determined until after the public review of the Proposed Plan, both alternatives have been successfully demonstrated previously within the SVFUDS. Finally, both alternatives will allow for unlimited use and unrestricted exposure (UU/UE).

Detailed Analysis of Alternatives – Explosive Hazards

For explosive hazards mitigation for the identified areas of focus, the four retained alternatives were also assessed against the nine CERCLA evaluation criteria. Each of the four alternatives was considered protective of human health and the environment. However, Alternatives 3 and 5, which remove all anomalies, were considered to have fewer unknowns than the other alternatives. All four alternatives were compliant with ARARs.

Only Alternative 3 was favorable in the long term due to the higher DGM coverage and anomaly removal quantity standards. The other three alternatives were moderately favorable because either they had less DGM coverage, or removed fewer anomalies. Similarly, only Alternative 3 was ranked slightly higher with regard to reducing volume of contaminants (MEC) because more acreage would be covered and more anomalies removed. With regard to the short-term effectiveness criterion and the time required to achieve the RAOs, the higher DGM coverage standard of Alternatives 3 and 4, and the resulting additional time and logistics involved in cutting more areas of vegetation, ranked those alternatives as less favorable than Alternatives 5 and 6. Alternatives 3 and 4 were ranked as moderately favorable for the implementability criteria primarily because the higher DGM coverage standard could present challenges to the technical feasibility sub-criterion, and the administrative feasibility sub-criterion could require significant coordination with the property owner to implement extensive vegetation and/or tree removal and restoration activities, if required. Alternatives 5 and 6 were ranked as favorable for the implementability criteria because fewer areas of landscaped vegetation would be removed and less coordination with the owner would be required under the accessible areas DGM standard.

Costs for the explosive hazards remedial alternatives were primarily a function of DGM coverage and the assumptions of how much additional work was involved in cutting and restoring landscaped areas of vegetation. The full DGM coverage alternatives (3 and 4) were more costly than the accessible areas DGM coverage alternatives (5 and 6). Secondarily, costs were a function of the anomaly removal quantity; removing all anomalies was more costly than removing selected anomalies. Accordingly, the least costly alternative was Alternative 6, where less DGM would be conducted, and fewer anomalies would be removed.

While state and community acceptance cannot be determined until after the public review of the Proposed Plan, these alternatives have been successfully demonstrated previously within the SVFUDS. Finally, these alternatives will allow for UU/UE.

The site-wide RAO addresses potential explosive hazards for the properties within the SVFUDS that are not part of the areas of focus. To achieve this RAO, the response alternatives were limited to education and awareness initiatives as other more direct action-oriented alternatives are not practical. Education and awareness initiatives would include community-wide mailings of educational material such as understanding the 3 'R's (recognize, retreat, and report) with regard to areas where potential munitions may be encountered. These will be formalized in an Institutional Analysis Report that describes the development, implementation, and maintenance of an institutional controls program to help manage explosive hazards and identify stakeholder participation. However, as this alternative does not achieve UU/UE, periodic reviews would supplement the education and awareness initiatives, further providing the opportunity to evaluate new information and ensure that the community remains aware of the potential for MEC to be encountered within the SVFUDS.

Conclusions - Contaminated Soil Remedial Alternatives

Based on the detailed analysis of contaminated soil remedial alternatives for the SVFUDS, Alternative 4, Excavation and Off-site Disposal, is the most favorable remedial alternative to achieve the RAOs, but final selection of a preferred alternative will be proposed and documented in the forthcoming Proposed Plan. Relative to Alternative 3, it was ranked as favorable in three out of seven of the nine criteria that were ranked (not including the two modifying criteria). While Alternative 3 is initially less costly than Alternative 4, the unknowns associated with it render the costing criterion only slightly more favorable than Alternative 4. Alternative 4 will meet the RAOs in the shortest time, with the fewest unknowns. It will address all COCs under all site-specific conditions and it has been successfully conducted many times throughout the SVFUDS.

Conclusions - Explosive Hazards Remedial Alternatives

Based on the detailed analysis of remaining explosive hazards remedial alternatives for the areas of focus, Alternative 6, DGM of Accessible Areas, Remove Selected Anomalies, is the most favorable remedial alternative to achieve the RAOs, but final selection of a preferred alternative will be proposed and documented in the forthcoming Proposed Plan**.** Alternative 6 was ranked as favorable in three out of seven of the nine criteria that were ranked (not including the two modifying criteria). On an individual property basis, Alternative 6 is the least costly of the four alternatives. Alternative 6 is protective of human health and the environment, is compliant with ARARs, and will meet the RAOs in the shortest time period.

To achieve the site-wide RAO to address potential explosive hazards for the properties within the SVFUDS that are not part of the areas of focus, education and awareness initiatives are the most favorable remedial alternative, but final selection of a preferred alternative will be proposed and documented in the forthcoming Proposed Plan.

1.0 INTRODUCTION

ERT, Inc., (ERT) was tasked with drafting an Integrated Site-Wide Feasibility Study (FS) report for the U.S. Army Corps of Engineers (USACE), at the Spring Valley Formerly Used Defense Site (SVFUDS), located in Washington, D.C. The work was performed under the Munitions Response and Environmental Remediation Services Contract (W912DR-09-D-0061, Delivery Order 0011), which is administered by the Baltimore District (CENAB). The U.S. Army Engineering and Support Center, Huntsville (USAESCH) provides additional oversight for activities involving chemical warfare materiel (CWM). For purposes of this FS report, CENAB and USAESCH are referred to jointly as "USACE", unless specific district responsibilities are discussed.

This project falls under the Military Munitions Response Program (MMRP) of the Defense Environmental Restoration Program (DERP)/Formerly Used Defense Sites (FUDS). The Department of Defense (DoD) established the MMRP under the DERP to address munitions constituents (MC), and munitions and explosives of concern (MEC) (comprising unexploded ordnance [UXO], discarded military munitions [DMM], and MC in high enough concentrations to pose an explosive threat) that are located on certain properties – including FUDS. This also includes Hazardous and Toxic Waste (HTW)-impacted media.

Under the DERP, the U.S. Army is the DoD's lead Agent for FUDS, and USACE executes FUDS for the Army. USACE performs (and has been performing) its response activities throughout SVFUDS in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). FUDS is administered pursuant to the DERP statute, the CERCLA, Executive Orders 12580 and 13016, the NCP, and DoD and Army policies in managing and executing the FUDS program. (The NCP constitutes the regulations that implement CERCLA.) USACE is the lead agency for carrying out the response action at this CERCLA site. The DC Department of Energy and Environment (DOEE) is the lead regulator.

This FS is based on historical information, site characterization, analytical data, and determination of potential risks or hazards to human health which are contained in the *Site-Wide Remedial Investigation Report for the SVFUDS* (USACE, 2014) (RI Report), and the conclusions and recommendations presented in that report. The RI Report documents the site characterization work and removal actions initiated by USACE to ensure that the immediate threats to the public and environment from MEC, CWM (i.e., chemical munitions and chemical agent in other than a munitions configuration), and HTW-impacted soil were addressed concurrently. This FS addresses response actions to mitigate unacceptable risks posed by soil contamination and unacceptable explosive hazards due to MEC that may remain within the SVFUDS.

1.1 Purpose of the FS

The purpose of an FS, in accordance with U.S. Environmental Protection Agency (USEPA) guidance, is "to provide the decision makers with an assessment of the remedial alternatives, including their relative strengths and weaknesses, and trade-offs in selecting one alternative over another." An FS typically develops alternatives, screens alternatives, and provides a detailed analysis of alternatives.

The purpose of this FS is to develop, screen, and provide a detailed analysis of remedial alternatives to mitigate: 1) unacceptable risks posed by soil contamination resulting from chemicals of concern (COCs), and 2) potential unacceptable explosive hazards due to MEC that may remain within the SVFUDS.

1.2 Report Organization

The organization of this FS follows both the *USEPA's Guidance for Conducting RI/FS Studies under CERCLA* (USEPA, 1988) and the *US Army Munitions Response RI/FS Guidance* (USACE, 2009). However, it most closely aligns with the suggested FS Report Format provided by Table 6-5 of the USEPA Guidance. It is organized into six sections and three appendices:

- Section 1.0: Introduction
- Section 2.0: Remedial Action Objectives
- Section 3.0: Identification and Screening of Technologies
- Section 4.0: Development and Screening of Alternatives
- Section 5.0: Detailed Analysis of Alternatives
- Section 6.0: References
- Appendix A: Site Figures
- Appendix B: Costing Backup
- Appendix C: Index of Properties Recommended for Further Action

For the discussions in Sections 2.0 through 5.0, the two identified levels of risk/hazard to be mitigated, as described in Section 1.1, are addressed separately.

1.3 Background Information

All background and site history presented in this FS is summarized from the RI Report.

1.3.1 Site Description

The SVFUDS comprises 661 acres in northwest Washington, D.C. This is a largely residential area with local shops and restaurants, surrounded by a cluster of dense apartment buildings and/or townhouses, and spreading out into single-family homes. The character of these areas is more suburban in nature, with a greater concentration of cul-de-sacs than anywhere else in the city. Land use in and around the SVFUDS is primarily low-density residential, with smaller portions zoned for commercial use. The campus of American University (AU) is considered institutional use. The Dalecarlia Woods area on the western edge of the SVFUDS is zoned as Federal or public use.

1.3.2 Site History

During World War I, the U.S. Government established the American University Experiment Station (AUES) to research the testing, production, development and effects of noxious gases, CWM, antidotes and protective masks. Mustard and lewisite agents, adamsite, irritants and smokes were among the chemicals researched and tested. The SVFUDS includes property occupied by the former AUES between 1917-1920. The AUES was located on the grounds of the present AU and used portions of the adjoining properties. Figure 1 shows the SVFUDS boundary (all figures referenced in this FS are presented in Appendix A).

1.3.3 Previous Investigation Activities

The SVFUDS is an extremely complex site involving several ongoing and concurrent activities over many years, focusing on different potential hazards and/or different investigation locations. In order to manage and track all of the site activities and present them in a cohesive manner, all previous activities were organized primarily by the following key types of activities completed for the SVFUDS: initial investigation and characterization, follow-on investigation and characterization, geophysical investigations, and removal actions. All of the activities conducted at the SVFUDS fall under one (or more) of these activity types. The descriptions of key previous investigations organized by activity type are summarized briefly below for context. More detailed descriptions of these investigations can be found in the RI Report.

1.3.3.1 Initial Investigation and Characterization

On January 5, 1993, a contractor unearthed buried munition items while digging a utility trench on 52nd Court. Upon notice of the discovery, the U.S. Army Technical Escort Unit initiated an emergency response, known as Operation Safe Removal (OSR) FUDS Phase I, which was completed on February 2, 1993.

OSR FUDS Phase II was the start of the RI phase for the SVFUDS. Using historical documentation including reports, maps and photos, USACE established Points of Interest (POIs) and performed geophysical investigations at POIs considered to be potential munitions burial locations and conducted sampling of environmental media at 17 POIs. POIs and the findings were documented in the 1995 OSR FUDS RI report (USACE, 1995), which recommended no further action for the SVFUDS with the exception of the Spaulding and Captain Rankin Area (a single property that contained former shell pits/bunkers associated with AUES activities designated as POIs). The RI report was followed by a No Further Action Record of Decision in June 1995.

In June 1994, an Engineering Evaluation/Cost Analysis (EE/CA) was conducted for the Spaulding and Captain Rankin Areas. The EE/CA identified risk associated with the soil within the former shell pits (bunkers). Based on these findings, a Non-Time-Critical Removal Action (NTCRA) was conducted in this location to remove the soil debris found within the POI structures. A separate RI for the Spaulding and Captain Rankin Area, prepared in 1996, addressed exposures to subfloor soils and concrete and pipe drain termini at POIs 21, 22, and 23 for construction workers. In the June 1996 Spaulding and Captain Rankin RI Report, USACE recommended no further action for this area (USACE, 1996).

In 1999, the USEPA prepared a human health risk assessment (HHRA) for the SVFUDS (USEPA, 1999), conducting an analysis of soil sampling data collected between 1993 and 1995 at 16 locations throughout Spring Valley and AU property (taking splits of the USACE OSR FUDS RI samples).

1.3.3.2 Follow-on Investigation and Characterization

The D.C. Department of Consumer and Regulatory Affairs (DCRA) prepared a report in 1996 based on USACE's work at the SVFUDS and recommended site-wide comprehensive geophysical investigations, soil sampling, and a health study. Following further USACE review of the issues, it was determined that the location of POI 24 (a possible mustard agent burial pit) was on the grounds of 4801 Glenbrook Road instead of AU property. Based on the revised location of POI 24, USACE conducted field investigations in the vicinity of the revised POI 24 location, on 4801 Glenbrook Road, where two large burial pits (Pits 1 and 2) were discovered and excavated.

To further address DCRA concerns, the USEPA collected soil samples in and around these properties (4801, 4825, and 4835 Glenbrook Road) to supplement their HHRA and based on the interim results from the USEPA sampling, and historical information, it was determined that the soil of the three properties (4801, 4825, and 4835 Glenbrook Road) may have been impacted by AUES activities in the vicinity of the two burial pits.

Based on these findings, it was determined in 2000 that the area of investigation should be expanded beyond operable unit (OU) 3. The expanded area of investigation was designated as OU-4 and it included approximately 80 private residences and significant portions of the AU campus. This investigation was primarily intended to characterize these properties for arsenic in the soil.

In response to significant community and regulator concerns regarding possible soil contamination, the USACE, in consultation with the USEPA Region 3 and the District of Columbia Department of the Environment (DDOE), developed a comprehensive plan to conduct arsenic soil sampling on every property within the SVFUDS and conduct additional geophysical investigations focusing on identifying additional potential burial pits as well as individual buried munition items. The expanded area of investigation, some 577 acres, was designated as OU-5.

The soils of both OU-4 and OU-5 were characterized for arsenic and selected CWM compounds associated with AUES activities under an EE/CA, which addressed the findings of the OU-4 and OU-5 investigations. Under this EE/CA, more focused sampling of properties was conducted if the initial arsenic screening composite results were above 12.6 milligrams per kilogram (mg/kg), the 95th percentile of the background data set, indicating the possible presence of arsenic above the 20 mg/kg arsenic removal goal. The 20 mg/kg arsenic removal goal was established through consensus of the Partners (including USACE, the USEPA Region 3, and DDOE) and supported by the independent Scientific Advisory Panel, established to assist the community in understanding the overall approach to technical issues affecting Spring Valley. A total of 151 properties were identified in the EE/CA with one or more 20 by 20 foot square grids with arsenic concentrations above the 20 mg/kg arsenic removal goal. On a case by case basis some sites received tighter 10 by 10 foot square grid sampling. An additional 32 properties were identified post-EE/CA with one or more grids above the arsenic removal goal as a result of removal actions identifying 20 mg/kg arsenic extending onto adjacent properties or delayed property owner permission to sample for arsenic.

Additional follow-on investigations resulted from the findings of the previous ones, many of these focusing on discrete areas of AU within OU-4. Individual investigation efforts were conducted for these areas within AU:

- Child Development Center
- Small Disposal Area
- Athletic Fields
- Lot 18 Disposal Area
- Public Safety Building
- Bamboo Area
- Kreeger Hall Area
- AU Ground Scars

In addition, in 2000, the USEPA completed an HHRA specific to the southern portion of the AU campus. The focus of this HHRA was to evaluate the potential risk to human health from exposures to metals in the soil at AU.

Localized groundwater sampling was conducted as part of the OSR FUDS RI in 1993 (USACE 1993), but the groundwater data were not suggestive of contamination at that time. The plan for the comprehensive study of groundwater and the procedures to complete these characterization activities began in 2005. Since then, over 50 monitoring wells, including three deep bedrock wells, have been sampled at least once as part of the SVFUDS groundwater study.

1.3.3.3 Geophysical Investigations

In some areas, geophysical surveys were the only investigations performed. Geophysical investigations were conducted on 99 residential properties between 1998 and 2011. Properties were prioritized for investigation using a complex classification scheme. The investigations were conducted in two phases: properties were first non-intrusively geophysically surveyed to identify buried metallic anomalies, then following analysis of the geophysical survey results by the Anomaly Review Board (ARB), intrusive investigations of metallic anomalies with characteristics of possible buried WWI munition items were conducted.

In addition to the investigations performed on residential properties, many geophysical investigations were conducted on the discrete areas of AU described above. Geophysical investigations were also completed on approximately 60 acres of D.C. and federal property located in the western edge of the SVFUDS, just east of the Dalecarlia Reservoir, using the same geophysical survey approach employed for the residential and AU investigations.

1.3.3.4 Removal Actions

Concurrent with ongoing SVFUDS investigations, for specific areas, removal actions were determined to be warranted. Removal actions were completed as Time Critical Removal Action (TCRA) or NTCRAs. For the SVFUDS, these removals were primarily excavations of arsenic contaminated soil. TCRAs were conducted on the AU Child Development Center and portions of the athletic fields. USACE determined that TCRAs were also needed for several residential properties. The prioritization of these properties was based on the results of the arsenic testing. The TCRA work began in July 2002 and concluded in September 2003. USACE conducted NTCRAs on 100 properties and 9 lots during the period of 2004-2012.

While soil removal was the primary removal action method, for selected properties, USACE also used ferns that naturally extract arsenic from soil. This process, known as phytoremediation, was used to fully or partially address 21 properties and one lot.

In August 2010, several agencies within the DoD as well as the Partners, agreed to separate the 4825 Glenbrook Road property from the remainder of the SVFUDS and place it on its own CERCLA process pathway. Accordingly, 4825 Glenbrook Road activities are only discussed to the extent that they provide useful information and experience relevant to this FS.

1.3.4 <u>Nature and Extent of Contamination</u>

The determination of the nature and extent of HTW/MC/CWM and MEC/Munitions Debris (MD) contamination for the SVFUDS is based on the findings of each of the three primary types of activities conducted at the SVFUDS (investigation/characterization, geophysical surveys, and removals), as detailed in the RI Report.

The investigation and characterization activities were completed as standalone reports performed at discrete areas of the SVFUDS. Several discrete areas of the SVFUDS have proceeded through quantitative HHRAs and any conclusions indicating remaining risk have been addressed in follow-on investigation or removal actions such that characterization of those discrete areas was considered to be complete. More recent supplemental sampling not captured in previous HHRAs has been incorporated into the quantitative HHRA discussed in Section 1.3.5 below.

Removal actions at the SVFUDS have been concurrent with other investigations, being expedited through the TCRA and NTCRA process. The nature and extent of contamination in the areas of removals has been bounded through the removal actions, with soil excavations continuing until clean confirmation samples are obtained. No additional sampling or removal actions are currently required to complete the nature and extent soil characterization of the SVFUDS. The investigation of the nature and extent of groundwater contamination is ongoing.

1.3.5 Risk Assessment Summary

This risk assessment discussion summarizes the conclusions of the RI Report with regard to both unacceptable risks posed by soil contamination and potential unacceptable explosive hazards due to MEC that may remain within the SVFUDS.

1.3.5.1 Human Health Risks

The comprehensive risk screening process, as described in the RI Report, included goals of reviewing previous (pre-2005) HHRAs to assess whether they remain protective, supplemental additional soil sampling to address data gaps, and identification of specific areas where further risk assessment was warranted. To achieve these goals, three separate efforts were conducted, each one building off the findings of the previous one. These efforts focused on identifying specific areas where further risk assessment was warranted, concluding with the identification of the exposure units (EUs) requiring full quantitative HHRAs.

The first of these efforts was the completion of the *Final Evaluation Document for the Spring Valley FUDS Integrated Site-Wide Remedial Investigation/Feasibility Study, Washington, DC* (USACE, 2012). This was essentially a work plan presenting the methodology to review pre-2005 HHRAs to determine whether the chemicals of potential concern (COPCs) identified, the exposure pathways considered, and the toxicity evaluations, would still be appropriate when considering updated USEPA guidance and site-specific background concentrations, and to identify remaining areas that require additional risk screening and risk assessment.

The second effort was the completion of the *Final Pre-2005 Human Health Risk Assessment (HHRA) Review* (USACE, 2013a). It provided the results of the review of the five pre-2005 HHRAs where re-screening of all soil data from SVFUDS was done using updated risk-based screening levels and background data, to ensure that any potential risks associated with soils still in place were evaluated.

The third effort was the completion of *Addendum 1 to the Final Pre-2005 Human Health Risk Assessment Review* (USACE, 2013b). This document presents the results of the completion of the recommended activities identified in the Pre-2005 HHRA Review report. Starting with the five EUs and COPCs identified in the Pre-2005 HHRA Review document, and using the screening procedure developed for that review, Addendum 1 presented a follow-on screening effort of the larger EUs that incorporated additional, more recent sampling.

The follow-on screen determined that for three of the five larger EUs, COPCs remained that may present a risk. Based on the COPCs identified and the risks calculated, that is, non-carcinogenic hazard quotients that exceeded one, and, for some chemicals, estimated incremental cancer risks greater than the USEPA acceptable range, quantitative HHRAs were recommended for:

- The AOI 9 EU;
- The Spaulding-Rankin EU; and
- The Southern AU EU.

These EUs are shown in Figure 2. The HHRAs completed for these three EUs, presented in the RI Report, estimate the magnitude of exposure to COCs, identify potential exposure pathways, and quantify exposures to estimate the risks posed to human receptors associated with exposure to the soil at each of the EUs. The HHRAs describe how the COCs were determined and concluded that (summarized in Table 1.1):

- For the residential AOI 9 EU, non-cancer HIs and incremental cancer risks are below a level of concern. Therefore, further assessment or action at the AOI 9 EU is not required.

- For the residential Spaulding-Rankin EU, cobalt was determined to be a COC that poses unacceptable risks and follow-on actions are required to address it. For the Spaulding-Rankin outlier locations, arsenic, cobalt, lead, and mercury were determined to be COCs that pose unacceptable risk and follow-on actions are required to address them.

- For the Southern AU EU (excluding outlier locations), cobalt was determined to be a COC that poses unacceptable risks and follow-on actions are required to address it.

- For the smaller outlier locations at the Southern AU EU, three locations are associated with risks: mercury (one location) and vanadium and cobalt (one location) in soil are associated with non-carcinogenic risks, and carcinogenic polynuclear aromatic hydrocarbons (PAHs) in soil (one location) are associated with carcinogenic risks that exceed USEPA's risk range. Thus, these chemicals in soil at these outlier locations are COCs that pose unacceptable risks and follow-on actions are required to address them.

Table 1.1: Summary of Risk Assessment Findings

Exposure Unit	Conclusion	Risk Driver (soil)
AOI 9	No Further Action	None
Spaulding-Rankin	Unacceptable non-carcinogenic risk	Cobalt
Spaulding-Rankin Outlier Locations	Unacceptable carcinogenic and non-carcinogenic risk	Arsenic, Cobalt, Lead, and Mercury
Southern AU (excluding outlier locations)	Unacceptable non-carcinogenic risk	Cobalt
Southern AU Outlier Locations	Unacceptable non-carcinogenic risk	Mercury, Vanadium, and Cobalt
	Unacceptable carcinogenic risk	Carcinogenic PAHs

The RI Report provides recommendations to mitigate these unacceptable risks posed by HTW/MC/CWM contaminated soil, as follows:

- **Conduct an FS to address unacceptable carcinogenic and non-carcinogenic risks in soil in the Spaulding-Rankin EU.**
- **Conduct an FS to address unacceptable non-carcinogenic risks in soil at the Southern AU EU (excluding outlier locations), and carcinogenic and non-carcinogenic risks in soil in three outlier locations in the Southern AU EU.**

Figure 3 presents the locations of the unacceptable carcinogenic and non-carcinogenic risk areas recommended for follow-on actions. The specific nature of the follow-on actions will be determined through the alternatives analysis presented in this FS.

1.3.5.2 Explosive Hazards

For the OSR FUDS investigation, 492 properties, with a focus on the identified POIs, were geophysically surveyed with an objective to locate burial pits and trenches. Since 2001, a structured classification scheme to prioritize properties for geophysical investigations has been followed. While this process has provided high quality geophysical data of all key areas based on historical review of past practices and likelihood of MEC or MD being present, the presence of individual munitions-related items in the SVFUDS will remain a possibility.

As described in the RI Report, the MEC hazard was determined by using the MEC HA methodology. The MEC HA is the 'explosive hazard' component of an HHRA, assessing potential explosive hazards to human receptors at the SVFUDS. The methodology evaluates the potential explosive hazard associated with an area, given current conditions and under various cleanup scenarios, land use activities, and land use controls alternatives.

At the SVFUDS, the MEC HA was organized around the past activities most likely to result in MEC at the site, including ballistically fired testing, statically fired testing, and disposal (known and possible burial areas). Table 1.2 summarizes the MEC HA scoring for current use conditions, indicating that three of the four activities scored result in a MEC HA hazard level category of 3 (moderate potential explosive hazard conditions). The MEC HA provides the basis for the evaluation and implementation of effective management response alternatives, but the scores are qualitative references only and should not be interpreted as quantitative measures of explosive hazard, or as the sole basis for determining whether further action is necessary at a site.

Table 1.2: Summary of MEC HA Findings

	Current Use Conditions	
Area	**Hazard Level Category**	**Associated Relative Explosive Hazard**
Safety Buffer for Livens	4	Low potential explosive hazard conditions
Function Test Range for Stokes	3	Moderate potential explosive hazard conditions
Function Test Range for Livens	3	Moderate potential explosive hazard conditions
Generic Disposal Area	3	Moderate potential explosive hazard conditions

Table 1.2 indicates that the Livens Safety Buffer scored a hazard level category of 4 (low potential explosive hazard conditions) based on current use activities. This reflects that few MEC items would be expected in a buffer area. The Function Test Ranges or impact areas for both the Livens and the Stokes mortars received a MEC HA score of 3 (moderate potential explosive hazard conditions) based on current use activities. The moderate potential explosive hazard conditions that this score represents for this documented impact area suggests that follow-on actions may be required to mitigate unacceptable explosive hazards that could exist on the properties within the impact areas.

The static test fire areas do not typically represent MEC concerns in that the testing process would have monitored and controlled individual items and any munition item not properly firing would have been identified in real time and not left behind. However, similar to the findings at the initial 52nd Court trenches (POI 13 disposal area), static testing activities may suggest the presence of munitions burial pits (DMM) near the testing locations. The potential for remaining munitions burial pits suggests that follow-on actions may be required to mitigate unacceptable explosive hazards associated with possible munitions burial pits in the known static fire test areas and the 150 ft buffer zones around them.

For the possible disposal areas, a generic MEC HA that conservatively assumed a worst case disposal area/burial pit scenario was completed and the resulting score was a 3. The unknowns associated with the three possible disposal areas (AU Public Safety Building [PSB], AOI 13, and POI 2 / Fordham Road area) and the moderate potential explosive hazard conditions they represent (using conservative assumptions) suggest that follow-on actions may be required to mitigate unacceptable explosive hazards that could exist in these three areas.

The RI Report provides recommendations to mitigate these potential unacceptable explosive hazards posed by MEC possibly remaining within the SVFUDS, as follows:

- **Conduct an FS to address potential unacceptable explosive hazards associated with munitions possibly remaining within the impact areas of the Function Test Ranges for the 3" Stokes, 4" Stokes, and the 8" Livens.**
- **Conduct an FS to address potential unacceptable explosive hazards associated with possible munitions burial pits in the known Static Fire test areas and the 150 ft buffer zones around them.**
- **Conduct an FS to address potential unacceptable explosive hazards associated with possible munitions disposal burial pits that may be present in the Possible Disposal Areas (AU PSB, AOI 13, and POI 2 / Fordham Road area).**

Figure 4 indicates the locations of these areas of potential unacceptable explosive hazards recommended for follow-on actions. The specific nature of the follow-on actions will be determined through the alternatives analysis presented in this FS.

2.0 REMEDIAL ACTION OBJECTIVES

2.1 Remedial Action Objectives

Remedial action objectives (RAOs) specify the contaminants, military munitions, and media of concern, receptors and exposure pathways, and preliminary remediation goals that permit a range of treatment alternatives to be developed.

For the following discussions, the two identified levels of risk/hazard to be mitigated, unacceptable risks posed by soil contamination and unacceptable hazards posed by MEC potentially remaining within the SVFUDS, are addressed separately.

2.1.1 Contaminants and Media of Concern

Based on the conclusions of the HHRAs completed for the three EUs, as presented in the RI Report, the COCs for the Spaulding-Rankin EU are cobalt, arsenic, lead, and mercury, in soil. The COCs for the Southern AU EU are mercury, vanadium, cobalt, and carcinogenic PAHs, in soil. No COCs were identified for the AOI 9 EU.

The Function Test Ranges represent moderate potential explosive hazard conditions due to MEC that may remain in these impact areas. The static testing activities may present unacceptable explosive hazards associated with possible munitions burial pits in the testing areas and within the150 foot (ft) buffer zones around the known static fire test areas. The unknowns associated with the possible disposal areas may represent moderate potential explosive hazard conditions that could exist in these areas.

2.1.2 Receptors and Exposure Pathways

Receptors and exposure pathways discussed below are based on the HHRA presented in the RI Report.

2.1.2.1 Spaulding-Rankin EU

The Spaulding-Rankin EU is limited to a single residential property previously known as the Spaulding-Rankin area, where the Range Fan firing point and concrete shell pits were located. The EU includes POIs 21, 22, 23, and 25 (POI 25 location as identified and as sampled for the 1995 RI). The future use of this residential EU is not expected to change.

Current potential exposures to surface soil were evaluated in the HHRA for:

- Outdoor workers (i.e., landscapers); and
- Adult and child residents.

Future exposures to mixed surface/subsurface soil were evaluated for:

- Outdoor workers (i.e., landscapers);
- Construction workers; and
- Adult and child residents.

Two different soil exposure intervals were evaluated. The current potential residential receptors were evaluated using an exposure interval of 0 to 2 feet below ground surface (bgs), to represent routine landscaping, gardening, and outdoor play activities. The soil exposure interval for future potential receptors includes mixed soils from 0 to 10 feet bgs, which includes the 0 to 2 foot interval to which current receptors could be exposed. This exposure interval takes into account soil mixing that may occur due to construction.

For this EU, the potential soil exposure pathways, both currently to surface soil and in the future to mixed surface/subsurface soil, include the exposure pathways of incidental soil ingestion, dermal contact, and inhalation outdoors for all receptors, with the addition of inhalation of vapors indoors if the USEPA criteria for volatility are met, and home-produced vegetable ingestion for residents. For both current and future scenarios, the inhalation of dust indoors is discussed qualitatively, based on published studies of transfer factors for outdoor-to-indoor transfer of dust.

2.1.2.2 Southern AU EU

The Southern AU EU is an active university campus with no full time permanent residences, and the EU boundary defines an area with common receptors and exposure pathways.

Current potential exposures to surface soil were evaluated in the HHRA for:

- Outdoor workers (i.e., landscapers and maintenance); and
- Student recreational users (as associated with a 4-year college student).

Future exposures to mixed surface/subsurface soil were evaluated for:

- Outdoor workers;
- Student recreational users;
- Construction workers, and
- Adult and child residents, if residences were to be built on the AU campus.

The same soil exposures were evaluated as described in Section 2.1.2.1 above. Outdoor workers and students spending time outdoors could be exposed to surface soil (0 to 2 foot interval) by incidental soil ingestion, dermal contact, and inhalation. The vegetable ingestion exposure pathway is included for the 0 to 2 foot depth for current students and for the 0 to 10 foot depth for future students to account for any gardening that may be occurring on campus, although the frequency of consumption of home-produced vegetables on the campus is uncertain.

In the future, construction workers, outdoor workers, and students using outdoor areas could be exposed to mixed surface/subsurface soil (0 to 10 foot interval) by incidental soil ingestion, dermal contact, and inhalation outdoors. Also, possible future exposures to mixed surface/subsurface soil for future residents were evaluated, and include the exposure pathways of incidental soil ingestion, dermal contact, inhalation outdoors, home-grown vegetable ingestion, and inhalation of vapors indoors for the COPCs that meet the USEPA criteria for volatility.

2.1.2.3 Explosive Hazard Receptors

Finally, with regard to potential unacceptable explosive hazards, the MEC pathway is considered to be complete for the subject properties because there is a source, potential receptors, and the potential for interaction between them.

2.1.3 <u>Remediation Goals</u>

Based on the HHRA presented in the RI Report, for soil potentially posing unacceptable carcinogenic or non-carcinogenic risks, the remediation goals are: reduce the reasonable maximum exposure (RME) HI due to arsenic, mercury or vanadium to less than or equal to 1, reduce the RME HI due to cobalt to less than or equal to 2, reduce the risk associated with concentrations of lead in soil that could result in a blood lead level exceeding 5 micrograms per deciliter (ug/dL) for a child, and reduce the total estimated RME cancer risk due to arsenic or carcinogenic PAHs to less than 1×10^{-4}. For areas potentially posing unacceptable explosive hazards, the remediation goal is to remove geophysically identified anomalies that may represent MEC, thereby reducing the potential for encountering MEC.

Note: The COCs for the Spaulding-Rankin EU include arsenic, lead, and mercury. However, while carried through to this FS, the determination of these metals as COCs was based on single grab samples which are not sufficient to characterize risk. Further, no additional samples can be collected as these old bunker floor samples are from areas under gravel and concrete slab floors, with structures above them, and finally, no other areas of the EU indicate risk for these metals. Therefore, no further remediation for arsenic, lead, or mercury, at the Spaulding-Rankin EU is proposed in this FS. Consequently, cobalt is the remaining soil COC for the Spaulding-Rankin EU that is evaluated in this FS.

2.1.4 Proposed Remedial Action Objectives

Regarding unacceptable risks posed by soil contamination, based on the quantitative HHRA presented in the RI Report, the COCs are cobalt, arsenic, lead, mercury, vanadium, and carcinogenic PAHs, in soil. In addition, unacceptable explosive hazards may be posed by MEC potentially remaining within the SVFUDS. Combining the COCs, the affected media, the exposure pathways, and the project goals, the SVFUDS RAOs include:

- Prevent direct contact with arsenic*, mercury* or vanadium-contaminated soil having a non-carcinogenic HI exceeding 1. This HI will be reached by achieving a 95% UCL of the mean of the EU for mercury of 1.3 mg/kg, and for vanadium of 390 mg/kg.
- Prevent direct contact with cobalt-contaminated soil having a non-carcinogenic HI exceeding 2. This HI will be reached by achieving a 95% UCL of the mean of the EU for cobalt of 43 mg/kg.
- Prevent direct contact with lead* contaminated soil that could result in a blood lead level exceeding 5 ug/dL for a child (the recommended upper reference level for a child's blood lead).
- Prevent direct contact with arsenic* or carcinogenic PAH-contaminated soil having a cancer risk in excess of 1 x 10^{-4}. As this represents the upper end of the acceptable cancer risk range, USACE will exceed this goal by remediating PAHs to background levels (presented in the *SVFUDS Background Soil Sampling Report*, USACE 2008). These are:

Benzo(a)anthracene = 0.358 ppm	Benzo(k)fluoranthene = 0.357 ppm
Benzo(a)pyrene = 0.375 ppm	Dibenz(a,h)anthracene = 0.51 ppm
Benzo(b)fluoranthene = 0.366 ppm	Indeno(1,2,3-c,d)pyrene = 0.335 ppm

- Reduce the potential for encountering MEC in the identified areas of potential explosive hazards, and
- On a site-wide basis, reduce the probability of residents, contractor/maintenance workers, and visitors/passers-by from handling MEC encountered during residential or construction/maintenance activities conducted within the SVFUDS.

** See discussion in Section 2.1.3 for additional information on arsenic, lead, and mercury, as COCs at the Spaulding-Rankin EU.*

The areas recommended for follow-on actions are shown in Figures 3 and 4, respectively.

2.2 Applicable or Relevant and Appropriate Requirements

Applicable or Relevant and Appropriate Requirements (ARARs) must be identified during the development of remedial alternatives. ARARs include federal and/or state promulgated standards, requirements, criteria, and limitations. Chemical-, location-, and action-specific ARARs are identified. Pursuant to CERCLA/NCP, compliance with ARARs is a threshold requirement that a remedial alternative must meet in order to be eligible for selection (unless the ARAR is waived).

The ARAR analysis is directed at substantive, promulgated regulations with regard to on-site activities. [CERCLA § 121(d), 42 U.S.C. § 9621(d); NCP, 40 C.F.R. § 300.5]. Furthermore, CERCLA response actions, per CERCLA/NCP, are exempt from permits and similar procedural requirements with regard to on-site activities. 42 USC § 9621(e)(1); 40 C.F.R. § 300.400(e)(1).

All properties within the SVFUDS are "on-site" for purposes of CERCLA and the NCP (as are other support areas related to the SVFUDS, such as the Spring Valley Resident Office or USACE headquarters for SVFUDS operations). As for off-site activities (e.g., transportation), compliance is required for applicable substantive and procedural requirements. NCP, 40 C.F.R. § 300.400(e)(2). Such off-site activities are not part of the ARAR analysis, but rather may be discussed under the Implementability factor, to the extent that they pose challenges for certain alternatives.

2.2.1 Definition of ARARs

Pursuant to the NCP, 40 C.F.R. § 300.5, a regulation may qualify as an ARAR if it meets the definition of being either "applicable" or "relevant and appropriate." Each of these components is discussed below.

"Applicable" requirements means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

"Relevant and appropriate" requirements means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. Only those state standards that are promulgated, are identified by a state in a timely manner, and are more stringent than federal requirements may be relevant and appropriate.

Pursuant to the NCP, the term "State" includes the District of Columbia (DC). 40 C.F.R. § 300.5.

Whether or not a requirement is appropriate (in addition to being relevant) will vary depending on factors such as the existence of wetlands or endangered species on or near the site, the duration of the response action, the form or concentration of the chemicals present, the nature of the release, the availability of other standards that more directly match the circumstances at the site, and other factors. In some cases only a portion of the requirement may be relevant and appropriate. The identification of relevant and appropriate requirements is a two-step process; only those requirements that are considered both relevant and appropriate must be addressed at CERCLA sites.

In addition to ARARs, advisories, criteria, or guidance may be identified as "to be considered" (TBC) information for a particular scenario. TBC information may be developed by EPA, other Federal agencies, or states. TBCs are typically considered only if no promulgated requirements exist that are either applicable or relevant and appropriate. Table 2.1 lists the TBCs.

2.2.2 Identification of ARARs

Because of their site-specific nature, identification of ARARs calls for evaluation of federal and state environmental and facility siting laws regarding contaminants of concern, site characteristics, and proposed remedial alternatives. Requirements that pertain to the remedial response at a CERCLA site can be categorized into three different categories:

- **Chemical-specific ARARs** set health- or risk-based concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. These ARARs establish either protective cleanup levels for the COPCs in the designated media or indicate the appropriate level of concern.
- **Location-specific ARARs** protect against damage to unique or sensitive areas such as floodplains, wetlands, and fragile ecosystems. They also restrict activities that may be harmful as a result of the characteristics of the site or the immediate environment.
- **Action-specific ARARs** set controls or restrictions on specific removal/remedial activities at a site. They specify performance levels, actions, or technologies, as well as specific levels for discharges or residual chemicals.

There are no current chemical-specific ARARs identified for the COCs in soil. Chemical-specific risks identified in the HHRA (RI Report) will be addressed by compliance with the RAOs.

Because no endangered species, floodplains, or wetlands will be impacted by the remediation activities at the Spaulding-Rankin or Southern AU EUs, no location-specific ARARs are included for these properties. The project area is developed with few large contiguous wooded areas, and it provides very little habitat for rare, threatened, or endangered species. According to the U.S. Fish and Wildlife Service, "Except for occasional transient individuals, no proposed or federally listed endangered or threatened species are known to exist within the Spring Valley site" (U.S. Department of the Interior, 2003).

There are small intermittent streams within the SVFUDS, but they are not expected to be impacted by contaminants from any of the properties where intrusive work is recommended. Groundwater is not used for public water supply at the property and surrounding area. Municipal water is provided to the area.

To comply with the identified action-specific ARARs (Table 2.2), all appropriate control measures will be in place to prevent impacts to local air and water during property remediation. For alternatives requiring excavation and removal of contaminated soils to an off-site location, the selected remedial action will comply with all applicable substantive and procedural construction management and hazardous waste transportation requirements associated with the off-site activities. In particular, all applicable Resource Conservation and Recovery Act (RCRA) and other hazardous waste identification and transportation requirements, both substantive and procedural, will be complied with for off-site activities.

Table 2.2 lists the state and federal action-specific ARARs for the remedial alternatives under evaluation for the SVFUDS properties. The ARARs that pertain to each remedial alternative are discussed in greater detail in Section 5.0, Detailed Analysis of Alternatives.

Table 2.1: Summary of TBCs

Requirement	Citation	Synopsis	Evaluation/Action To Be Taken
CHEMICAL-SPECIFIC:			
U.S. EPA, Regional Screening Levels (RSLs) (formerly Risk-Based Concentrations (RBCs))	EPA Region III Regional Screening Table	Tables of risk-based screening levels, calculated using the latest toxicity values, default exposure assumptions, and physical and chemical properties.	Used for screening chemicals in soil in the HHRA portion of the RI Report.
U.S. EPA, Toxicity values for selected chemicals of concern (Cancer Slope Factors and Reference Doses)	U.S. EPA, Integrated Risk Information System	Values used to estimate potential cancer and non-cancer human health risks due to site-related exposures.	These values were used in the HHRA portion of the RI Report in the calculation of site risks.

Table 2.2: Summary of ARARs

Requirement	Citation	Synopsis	Evaluation/Action To Be Taken
ACTION-SPECIFIC:			
U.S. Chemical and Biological Warfare Program	50 United States Code (USC) 1518	No chemical or biological warfare agent shall be disposed “unless such agent has been detoxified or made harmless to man and his environment” (unless immediate disposal is clearly necessary, in an emergency, to safeguard human life).	Action-Specific ARAR for explosive hazards alternatives involving disposal/destruction of CWM.
DCMR	20 DCMR § 605.1	CONTROL OF FUGITIVE DUST. Reasonable precautions shall be taken to minimize the emission of any fugitive dust into the outdoor atmosphere.	Action-Specific ARAR for Contaminated Soil Alternatives 3 and 4 and Explosive Hazards Remedial Alternatives 3, 4, 5, and 6 (as well as Contaminated Soil Alternative 2 and Explosive Hazards Alternative 2 – if land use controls involve construction).

2.3 General Response Actions

General response actions are actions that must be taken to satisfy the RAOs for the property. These are developed for each medium of interest defining containment, treatment, excavation, or other actions. Volumes or areas of media are identified for which the general response actions might be applicable. The actions consider the requirements for protectiveness as identified in the RAOs and the chemical and physical characterization of the site. The NCP also requires consideration of an alternative that will allow for unlimited use and unrestricted exposure (UU/UE).

This FS addresses response actions to mitigate the following two levels of identified risk or hazard:

1. Unacceptable risks posed by contaminated soil resulting from the identified COCs, and
2. Potential unacceptable explosive hazards due to MEC that may remain within the SVFUDS.

The areas of the SVFUDS that require response actions are derived from the information presented in the RI Report's nature and extent of contamination discussion and the HHRA conclusions.

2.3.1 <u>Contaminated Soil Response Action Areas</u>

Typical response actions for contaminated soil include: Land Use Controls (LUCs) such as fencing (also includes institutional controls such as environmental covenants and/or education), containment (capping, barriers), excavation (and disposal), and treatment. The excavation and treatment actions are reviewed in more detail in Section 3.0.

Volumes or areas of media are broadly identified in the RI Report for the contaminated soil general response actions. These include elevated areas of the COCs (i.e., individual soil sample locations) at the Spaulding-Rankin and Southern AU EUs, and the three outlier locations at the Southern AU EU. During the remedial design phase, additional delineation sampling will be conducted to better define areas for response actions. That is, soil removal volumes will be based on mean concentrations of the EU and will not be determined by single grab samples. Figure 3 shows the locations where a contaminated general response action will be required.

There have been multiple time-critical and non-time critical soil excavations throughout the history of the SVFUDS, and standard procedures for grid-based excavation and confirmation sampling have been established. These procedures will be applied to any excavation based response action. The actual volume of soil to be removed will be delineated through confirmation sampling and recalculations of carcinogenic and non-carcinogenic risks following soil excavation, until the RAOs are achieved.

Given the history of the SVFUDS, wherever intrusive response actions are recommended, it will be crucial to identify those areas that will need to be completed under low-probability or high-probability protocols. Low-probability protocols are for areas where it is unlikely that MEC/CWM will be encountered. A "low" determination may only be assigned to those areas for which a search of available historical records and on-site investigation data indicates that, given the military or munitions related activities that occurred at the property, the likelihood that MEC/CWM is present is low. High-probability protocols are for areas where MEC/CWM are suspected. A "high" determination may be assigned to those areas for which a search of available historical records or on-site investigation data indicates that, given the military or munitions-related activities that occurred at the property, there is more than a low probability that MEC/CWM is present.

For this document, the designation of low or high probability is tentative and for planning purposes only based on analysis of existing data; formal determinations will be made through probability assessments developed as part of the remedial action planning. Section 3.1.4.5 details the basic differences in level of effort depending on these considerations.

2.3.2 Potential Explosive Hazards Response Action Areas of Focus

Typical response actions for potential explosive hazards include: LUCs such as fencing (also including institutional controls such as environmental covenants and/or education), and Digital Geophysical Mapping (DGM) followed by anomaly investigation/removal. The DGM/anomaly removal response actions are reviewed in more detail in the Section 3.0.

Volumes or areas of media identified for the potential explosive hazard general response actions are described in the RI Report as properties where MEC may remain based on the historical activities at these locations. Figure 4 shows these properties where mitigation of potential explosive hazards was recommended, and Appendix C provides the complete index of the properties.

There have been multiple DGM/anomaly removal efforts throughout the history of the SVFUDS, and standard procedures have been established. Section 3.0 reviews in detail how DGM/anomaly removal procedures will be applied to the subject properties, with regard to acreage covered and quantity of anomalies removed, acknowledging that many of these properties have already undergone some level of DGM/anomaly removal.

As described in Section 2.3.1 above, where investigation/removal of anomalies requires intrusive activities, formal determinations of low or high probability protocols will be made through probability assessments developed as part of the remedial action planning.

2.3.2.1 Site-Wide RAO for Potential Explosive Hazards

In addition to the potential explosive hazards in the identified areas of focus discussed in Section 2.3.2, Section 2.1.4 includes a site-wide RAO. The site-wide RAO addresses the remainder of the properties within the SVFUDS, i.e., not just those identified in Figure 4 as areas of focus for potential explosive hazards. The intent of this site-wide RAO is to acknowledge that there will always be some potential for encountering MEC anywhere within the SVFUDS, and therefore response actions to mitigate this potential hazard are also required.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

At this step of the FS process, the universe of potentially applicable technology types is reduced by evaluation with respect to implementability, screening out those technologies that are clearly ineffective or unworkable at a given site. In general, this is accomplished by using actual data and on-site experience, focusing on technologies that have been successfully employed previously for similar situations within the SVFUDS. This section separately reviews technologies for each of the two identified levels of risk/hazard to be mitigated.

3.1 Contaminated Soil Technologies

A brief description of contaminated soil technologies, their applicability to SVFUDS in general, and a broad screening of each against the needs of the identified response action areas, is provided in the sections below. Previous EE/CAs and FSs for specific areas of the SVFUDS have been conducted, addressing elements relevant to the contaminated soil response actions being addressed in this FS. Some of this information is taken from those previous documents.

Four technologies have been identified for potential use in performing remedial activities for contaminated soil at the SVFUDS:

- Phytoremediation
- Soil Stabilization
- Soil Washing
- Excavation and Off-site Disposal

3.1.1 <u>Phytoremediation</u>

Phytoremediation is a remedial technology that uses plants to remove contaminants from the environment. In the case of metals-contaminated soils, this method can also be described as phytoaccumulation/phytoextraction and refers to the uptake and translocation of metal contaminants in the soil by plant roots into the aboveground portions of the plants. Plants called hyperaccumulators absorb unusually large amounts of metals in comparison to other plants. One or a combination of these plants is selected and planted at a site based on the type of contaminants present and other site conditions.

USACE conducted a greenhouse and feasibility study for phytoremediation in 2004 following the OU-4/OU-5 EE/CA (USACE, 2003) recommendations and it was concluded that phytoremediation was an acceptable alternative for arsenic-contaminated soil in very limited applications, primarily to save mature landscape and hardscape features at individual residences. Individual treatability studies would need to be conducted to determine the effectiveness and site-specific feasibility of this technology for the identified COCs (cobalt, mercury, vanadium, and carcinogenic PAHs).

In general phytoremediation is effective for metals (including the COC metals) with numerous plant species having been identified as hyperaccumulators of metals, but it has also been used to remediate PAHs, according to *Phytotechnology Technical and Regulatory Guidance and Decision Trees, Revised* [Interstate Technology & Regulatory Council *(ITRC, 2009)*].

Thus, while the technical feasibility of this alternative for the site-specific conditions for the COCs is unknown, given the past history of success with phytoremediation at the SVFUDS, however limited, <u>this alternative will be further evaluated in this FS</u>.

3.1.2 Soil Stabilization

Soil stabilization is a remediation technique in which contaminated soil is treated with a binding/stabilizing agent, such as iron or Portland cement, to minimize the rate of contaminant migration and to reduce the toxicity of the soil. Stabilization may be achieved through in situ (in place) or ex situ (out of place) treatment approaches. Soil in those areas identified as requiring removal would be treated on site, either in situ or excavated and transported to an on-site treatment facility, and then replaced in the excavation. Proper controls would minimize dust generated during the excavation and mixing process. Backfill from an off-site source would be used on top of the replaced soil to fill the excavation to grade.

Additional site-specific feasibility and treatability studies would be required to fully determine the appropriateness of this technology. Although this technology could achieve protection of human health and the environment through immobilization of the COCs, thus reducing toxicity and mobility, short-term effectiveness would be negated due to the need for further research. Long-term effectiveness of this technology is questionable; one consideration would be residual risks associated with the long-term stability of the treated material (i.e., the potential that the material would degrade under site conditions, thus releasing COCs back into the environment). The clayey silt soils found throughout the SVFUDS may cause problems with the stabilization process (the higher the clay content the more difficult successful soil stabilization becomes). Construction of an on-site treatment plant would be labor intensive and may not be permitted due to the location on an active university campus or within a residential neighborhood, thereby preventing ex situ treatment. Physical bulking or hardening of soil during soil stabilization could also potentially cause future difficulties for landscaping and/or construction activities.

Finally, soil stabilization has previously been screened as a remedial technology for arsenic-contaminated soils at the SVFUDS; it was rejected due to limited favorable criteria based on much of the same considerations as described above. Therefore, this alternative will not be further evaluated in this FS.

3.1.3 Soil Washing

Soil washing is a remediation technique in which contaminants are separated from the soil particles to which they are sorbed. This is achieved through excavating and washing the soil with a leaching agent, surfactant, or chelating agent or through pH adjustments. An on-site treatment facility would be designed and constructed. A portion of the treated soil could be used as backfill although it would be necessary to supplement this soil with backfill from off site. This is due to the fact that some of the soil volume would be included in the contaminated sludge generated during the process. This sludge would be disposed at an appropriate off-site facility.

Additional site-specific feasibility and treatability studies would be required to fully determine the appropriateness of soil washing which would negate the short-term effectiveness. This technology could provide protection of human health and the environment by removing the COCs from site soils, thus reducing the mobility, toxicity, and volume of contaminated soil; however, it is unknown if the materials used in the washing process may pose a risk to human health and the environment during implementation of this technology. Further, this technology has the potential to impact landscaping efforts due to soil sterility issues. Similar to soil stabilization, the clayey silt content of the soils at the SVFUDS would make it more difficult to achieve the desired RAOs using this technology.

This technology is labor intensive and the materials and services required to implement it are not widely available. Construction of an on-site treatment plant may not be permitted due to the chemicals used in washing and the potential release or spill of chemicals on an active university campus or within a residential neighborhood. Soil washing has previously been screened as a remedial technology for arsenic-contaminated soils in the SVFUDS; it was rejected due to limited favorable criteria based on much of the same considerations as described above. Therefore, <u>this alternative will not be further evaluated in this FS</u>.

3.1.4 <u>Excavation and Off-site Disposal</u>

Previously, excavation and landfill disposal was selected as the preferred technology to address arsenic-contaminated soil for the OU-3 EE/CA (USACE, 2000) and the OU-4/OU-5 EE/CA (USACE, 2003). Consequently, excavation and landfill disposal of arsenic contaminated soil has been done extensively at the SVFUDS; more than 150 residential properties with arsenic-contaminated soil have been cleaned up using this method.

This technology involves removal of contaminated soil following standard procedures for excavation and confirmation sampling. The actual volume of soil to be removed will be delineated through confirmation sampling and recalculations of carcinogenic and non-carcinogenic risks following soil excavation, until the RAOs are achieved. The procedural details, which will be provided in the Remedial Design/Remedial Action Work Plan, will describe the process of identifying actual outlier footprints, where a target area of approximately ¼ acre will be centered over the outlier location for potential excavation. This “remediation EU” will then be excavated in accordance with standard practice of stepping out the excavation both horizontally and vertically until sampling shows that soil remaining in the floor and on the sidewalls of the hole achieves the RAOs for the EU.

Given the significant successful excavation and landfill disposal operations conducted at the SVFUDS, <u>this alternative will be further evaluated in this FS</u>.

Specific wastestreams that may be encountered at the identified response action areas, and their likely off-site disposal methods based on previous experience at other sites throughout the SVFUDS, is part of the screening of this technology. A brief discussion is presented below to acknowledge and reflect that multiple wastestreams beyond contaminated soil may be generated and that some of them may require special disposal considerations.

3.1.4.1 Soil

Excavated soil will be disposed of, consistent with 40 CFR § 300.440, in a treatment, storage, or disposal facility permitted to receive such material. If the excavated soils are characterized as RCRA hazardous, they would have to be stabilized by the RCRA Subtitle C hazardous waste treatment facility and then deposited in the landfill. If they are not RCRA hazardous, they can be disposed of directly into a sanitary landfill. Note that the extensive previous experience at the SVFUDS suggests that the vast majority of the soil would be characterized as non-hazardous. Excavated soils characterized as containing CWM would go to an incineration facility, with the ash ultimately placed in a Subtitle C landfill.

3.1.4.2 Wastewater

Aqueous investigation derived waste, primarily water from equipment or personnel decontamination, will similarly be characterized as RCRA hazardous or non-hazardous, and disposed accordingly.

3.1.4.3 MD and Non-munitions, Non-AUES Scrap

MD from the SVFUDS has historically been incinerated prior to landfill disposal. More recently, MD has been disposed at a metal smelter facility. All non-munitions, non-AUES related scrap items will be disposed in a nonhazardous waste landfill.

3.1.4.4 MEC, DMM, RCWM, and MDEH

Should any MEC, DMM, including Recovered Chemical Warfare Materiel (RCWM), Conventional DMM, or Material Documented as an Explosive Hazard (MDEH) be recovered during the remedial action, it will be disposed of in accordance with USACE's February 2010 *Action Memorandum, Disposal of Discarded Military Munitions (DMM), including Recovered Chemical Warfare Materiel (RCWM), Conventional DMM, and Material Documented as an Explosive Hazard (MDEH), Spring Valley Formerly Used Defense Site, Washington, D.C* (Action Memo). The selected removal action for RCWM in the Action Memo is On-site Demilitarization using the Explosive Destruction System at the Spring Valley federal property. The selected removal action for conventional DMM/MDEH is On-Site Demilitarization using Contained Destruction Technologies at the Spring Valley federal property. Note that in some specific cases, off-site demilitarization has also been the selected removal action for DMM.

3.1.4.5 Excavation and Off-site Disposal Logistics

It is crucial to identify whether the response action areas would need to be excavated under low-probability protocols or high-probability protocols. The designation of low or high-probability in this FS is tentative and for planning purposes only; formal determinations will be made through probability assessments developed as part of the remedial action planning. Note that because some areas requiring response actions have been previously investigated, probability assessments may already have been prepared and may only need to be updated.

Low-probability work involves construction-type excavation activity with standard safety procedures observed. This will include screening and sifting of the soil to ensure no MEC, CWM, or AUES-related items are present. High-probability work entails an assumption of MEC or CWM as 'unlikely but possible' to be encountered and therefore incorporates significant safety protocols including engineering controls (such as working within vapor containment structures). Many previous SVFUDS investigations have been completed under high-probability protocols and USACE has significant experience implementing these operations.

3.2 Explosive Hazards Mitigation Technologies

A brief description of DGM/anomaly removal technologies and procedures, their previous use within the SVFUDS, and how they would be applied to the areas of focus properties (see Figure 4) in this FS analysis, is provided in the sections below.

3.2.1 <u>Current DGM/Anomaly Removal Technologies and Procedures</u>

For the SVFUDS, DGM, followed by anomaly removal, has been the primary technology to investigate and reduce potential explosive hazards due to MEC. There have been multiple

DGM/anomaly removal efforts throughout the history of the SVFUDS, and standard procedures have been established. The current procedure summarized below is taken, in part, from Section 4.1.2 of the RI Report.

For the SVFUDS, geophysical surveys have been the primary initial tool used to investigate the presence of MEC or MD, as well as burial pits or trenches. Geophysical techniques have evolved and have been refined over the many years of SVFUDS work. Electromagnetic instruments such as the EM61 (a time-domain electromagnetic metal locator), and magnetic instruments such as the G-858, as well as other instruments, have been used at the SVFUDS. The current procedures (conducted as recently as 2012) are largely based on the results of a geophysical prove out (GPO) that concluded the EM61-MK2 (a smaller and more sophisticated version of the EM61) and the G-858 instruments were the primary tools to be used for geophysical investigation of the SVFUDS.

A crucial element of the use of geophysics is the interpretation of the collected geophysical data. At the SVFUDS, there have been several classification schemes to assess the nature of the anomalies. These interpretation systems are then used by the ARB to recommend which anomalies are investigated further (i.e., excavated), and which are likely to represent non-munitions related metallic debris. The ARB has included Army experts in MEC and geophysical detection methods, as well as regulatory agency representatives from the SV Partners. Historically, for SVFUDS investigations, ARB decisions were documented in ARB memoranda (these are included in the RI Report).

In the earlier SVFUDS geophysical investigations, the evaluation of anomalies relied on experience and professional judgment, but these often resulted in excavation of anomalies that were not related to munitions, expending time and resources. In 2008, USACE formalized a scheme for anomaly classification and evaluation using geophysical factors such as anomaly size and coincident signatures between instrument types (EM61-MK2 and G-858) to initially score each anomaly. Based on this scoring, an anomaly was placed into one of four categories, A, B, C, and D, with 'A' most likely to represent a buried MEC item, while 'D' was considered not indicative of MEC. While formalized in 2008, this scheme was first used in approximately 2007.

3.2.1.1 Advance Classification Technology

Advanced classification (AC) is a new approach to improve the efficiency of munitions response DGM. It will be used at the SVFUDS to supplement the current procedures (EM61-MK2 plus G-858, with A-B-C-D classification of anomalies, as described above).

For future DGM efforts, following the current procedures, geophysicists will use advanced electromagnetic induction sensors (such as TEMTADS or MetalMapper) specifically designed to support geophysical classification to collect additional data, which geophysicists can use to estimate the depth, size, wall thickness, and shape of each buried item. AC is the process of using these data to make a more informed decision as to whether a buried metal item is a potentially hazardous munition, or metal clutter that can be left in the ground. Use of AC would be an improvement over the A-B-C-D classification scheme, effectively replacing it, because it can focus a munitions response on excavating only those geophysical anomalies identified as potential munitions, resulting in a more efficient, more rigorous, better understood, and better documented munitions response *[Interstate Technology & Regulatory Council, Geophysical Classification for Munitions Response Technical Fact Sheet* (ITRC, October 2014)].

3.2.2 Application of DGM/Anomaly Removal to the Areas of Focus Properties

The basic technology/procedures described above were reviewed with respect to how they should be applied to the different situations that the individual subject properties may represent.

3.2.2.1 Investigation Objective of Burial Pits vs Single Items

As described in Section 1.3.5.2, some of the subject properties may have been the location of static fire testing that may be associated with the presence of munitions burial pits (DMM) near the testing locations, while properties associated with ballistic fire testing into impact areas would more likely result in single munition items. Therefore, this evaluation considered whether the DGM procedures should be designed to reflect the different objectives of searching for burial pits versus single items. That is, for burial pits, the G-858 (without the EM61 or AC technology) would be the preferred instrument, while for single items, the EM61 instrument (supplemented by AC) would be preferred. However, it is acknowledged that there is some uncertainty associated with how and where MEC may have been deposited, and the specific boundaries of static testing areas versus impact areas may not be completely known. Therefore, to conservatively reflect this uncertainty, it was decided that regardless of the past history, DGM investigations should focus on the possibility of both burial pits and single items on each property investigated.

With regard to the physical removal of anomalies detected, as a practical means to conduct the FS evaluation, the detailed analysis of alternatives presented in Sections 4 and 5 uses the term anomaly removal in the capacity of single items. However, as described above, an anomaly could represent a burial pit rather than a single item; in such a situation, the pit would be remediated through excavation and disposal in accordance with the procedures provided in a property-specific Remedial Design/Remedial Action Work Plan.

3.2.2.2 Properties with Previous DGM/Anomaly Removal Work

Section 1.3.3.3 summarizes the geophysical investigations previously completed to help characterize the SVFUDS. DGM/anomaly removals have been conducted as recently as 2012. Figure 4 shows all the subject properties, color-coded to indicate those that have received previous DGM/anomaly removal investigations (pink) and those that have not (blue). Forty-five (45) properties, or individual lot portions of larger properties such as the Dalecarlia Woods (federal property owned by the Washington Aqueduct), received previous DGM/anomaly removal work. While many anomalies were removed during this previous work, based on ARB decisions as described in Section 3.2.1 above, numerous anomalies that were evaluated as likely innocuous metallic debris, were left in the ground.

For these properties, should additional DGM/anomaly removal be recommended through this FS analysis, the application of AC would involve re-locating those remaining anomalies and using AC to better determine whether they should be removed or not; AC would provide an updated anomaly classification overriding the previous A-B-C-D or professional judgment anomaly removal rationale.

However, note that this FS was prepared to address an individual generic representative property within the SVFUDS, and it is acknowledged that as geophysical technologies evolve, it may be necessary to design specific approaches to properties presenting different logistical challenges. For example, in a situation where the existing DGM coverage on a given property indicates only

G-858 magnetic data were obtained because the EM61 instrument was too large, newer EM instruments may now be available to supplement the coverage. Or, where combined G-858 magnetic and EM (EM61) data identified only magnetic anomalies, this might indicate that AC (which is also an EM technology), may not be useful. These situations would be addressed in the Remedial Design/Remedial Action Work Plan.

Three of the subject properties, where DGM was completed in approximately 2000 using older techniques (prior to the more sophisticated EM61-MK2 instrument), were considered to have insufficient quality DGM data and are treated in this FS as though they had no previous DGM at all; they are included with the properties described below.

3.2.2.3 Properties with No Previous DGM/Anomaly Removal Work

Fifty-three (53) properties (including the three mentioned above) are shown in blue on Figure 4, indicating they have received no previous DGM/anomaly removal work. For these properties, should DGM/anomaly removal be recommended through this FS analysis, the approach would be to use the current technology/procedures, supplemented by AC.

Response alternatives for mitigating explosive hazards using the DGM/anomaly removal procedures described above, varying DGM coverage amount (acreage) and quantity of anomalies to be removed, <u>will be further evaluated in this FS.</u>

3.2.3 <u>Site-Wide RAO Applicable Technologies</u>

The site-wide RAO addresses potential explosive hazards for the properties within the SVFUDS that are not part of the areas of focus. The identification and screening of technologies to achieve this RAO, with respect to implementability, is limited to education and awareness initiatives as other more direct action-oriented alternatives are not practical. Education and awareness initiatives are considered institutional controls (non-engineered administrative or legal controls) that fall within the definition of LUCs. In addition, as this would not allow for UU/UE, periodic reviews (commonly referred to as "5-year reviews") would supplement the education and awareness initiatives, further providing the opportunity to evaluate new information and ensure that the community remains aware of the potential for MEC to be encountered within the SVFUDS.

<u>More direct action response alternatives, beyond education and awareness initiatives, are not practical in terms of achieving the site-wide RAO, and they are not further evaluated in this FS.</u>

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

4.1 Introduction

At this stage of the FS, the technology screening and the media of concern are combined to develop and assemble alternatives that meet the RAOs. Defined alternatives are evaluated against the short and long-term aspects of three broad criteria: effectiveness, implementability, and cost. In this section, these criteria are applied separately to the two identified levels of risk/hazard to be mitigated. The purpose of the screening evaluation at this stage is to reduce the number of alternatives that will undergo the more thorough and detailed analysis in the next section (Section 5.0), and is therefore, a broader, more general screening.

The remedial alternatives presented in Section 4.2 represent scenarios that meet the RAOs for each identified risk/hazard to varying degrees. The broad criteria against which they are screened are defined as follows:

4.1.1 Effectiveness

This criterion is evaluated with respect to effectiveness in protecting human health and the environment, and providing reduction in toxicity, mobility, and volume. The short-term (construction and implementation period) and long-term components (effective period after the remedial action is complete) are also evaluated.

4.1.2 Implementability

This criterion is evaluated as a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial alternative. Technical feasibility is the ability to construct, reliably operate and maintain (as required) an alternative, while administrative feasibility refers to the ability to obtain approvals from agencies, and the availability of required goods and services.

4.1.3 Cost

The cost of each alternative is also evaluated. However, at this stage, it is not necessary to define the cost with the same level of detail or accuracy required for the detailed analysis presented in Section 5.0. Prior estimates, sound engineering judgment, and most importantly, real-world cost experience based on having previously completed many of these efforts within the SVFUDS, are sufficient to help evaluate one alternative against another.

4.2 Identification of Remedial Alternatives

4.2.1 Contaminated Soil Remedial Alternatives

Based on the contaminated soil technologies review in Section 3.1 and the inclusion of phytoremediation and excavation/disposal as technologies to be further evaluated, four remedial alternatives have been identified to mitigate the unacceptable risks posed by soil contamination resulting from the identified COCs:

- Alternative 1: No Further Action
- Alternative 2: LUCs
- Alternative 3: Phytoremediation
- Alternative 4: Excavation and Off-site Disposal

4.2.2 Explosive Hazards Remedial Alternatives

Based on the explosive hazards mitigation technologies review in Section 3.2, six remedial alternatives have been identified to mitigate the potential unacceptable explosive hazards due to MEC that may remain within the SVFUDS:

- Alternative 1: No Further Action
- Alternative 2: LUCs
- Alternative 3: Full DGM Coverage, Remove All Anomalies
- Alternative 4: Full DGM Coverage, Remove Selected Anomalies
- Alternative 5: DGM of Accessible Areas, Remove All Anomalies
- Alternative 6: DGM of Accessible Areas, Remove Selected Anomalies

4.3 Screening of Contaminated Soil Remedial Alternatives

The following sections provide a brief description of each alternative to mitigate the unacceptable risks posed by soil contamination resulting from the identified COCs.

4.3.1 Alternative 1: No Further Action

The NCP requires that a no further action alternative be developed for an FS. The no further action alternative would involve leaving the identified area of risk in its current condition. This alternative provides a comparative baseline against which other alternatives can be evaluated. Under this alternative, no remedial action will be taken, and any identified contaminants are left "as is," without the implementation of any containment, removal, treatment, or other protective actions. This alternative does not provide for the monitoring of soil and does not provide for any active or passive land use controls to reduce the potential for exposure (e.g., physical barriers, deed restrictions).

Effectiveness: The no further action alternative would not provide for protection of human health and the environment. Contaminant concentrations in soil would not be expected to decrease significantly over time without removal or treatment. Therefore, this alternative would not be effective in achieving the RAOs in the short-term or the long-term, it does not reduce toxicity, mobility, or volume of contaminants, and it does not allow for UU/UE.

Implementability: The no further action alternative is easy to implement. No services or materials would be required to implement this alternative. However, it will be technically ineffective and administratively unfavorable and will fail to achieve the RAOs.

Cost: There are no costs associated with the no further action alternative.

Outcome: Alternative 1 will not be evaluated further because it fails the effectiveness and implementability criteria.

4.3.2 Alternative 2: Land Use Controls

The LUCs alternative would include limiting access to all or portions of the identified area of risk and would call for environmental covenants, among other controls. Access could be limited in a variety of ways. The success of access limitations would depend on what portions of the area are involved and the effectiveness of their implementation including the cooperation of the regulators, the government, stakeholders, and the current and future property owners.

Options for limiting access include fencing specific areas (e.g., outlier areas known to contain soil contamination, or areas of maximum concentrations of the COCs); covering the areas with concrete or brick (e.g., restricting the use as a parking area or patio); or planting the areas with groundcover plants that do not require routine maintenance. These options would prevent physical contact with contaminated soil and reduce or eliminate runoff from contaminated surface soil, thereby, reducing the potential spread of contamination.

The LUC alternative would also include the development of environmental covenants to legally bind the current and future property owner to the appropriate access and use restrictions. The environmental covenants would include prohibition of routine landscaping activities in these areas. USACE would develop an LUC plan, which would include a delineation of enforcement and maintenance responsibilities, in coordination with the property owner and local agencies.

As the need for LUCs indicates UU/UE has not been achieved, periodic or 5-year reviews would be part of this alternative. These reviews generally are required by CERCLA when hazardous substances remain on site above levels which permit UU/UE. Periodic reviews provide an opportunity to evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment. The objective is to ensure that USACE is aware of and responds to new information or data that affects the selected response action. A Periodic Review Plan would be prepared describing periodic site visits and stakeholder interviews to determine whether or not the level of risk should be changed.

Effectiveness: The LUCs alternative would provide protection of human health and the environment by preventing physical contact with the contaminated soil. However, this alternative would not be effective in achieving the RAOs, it does not reduce toxicity or volume, and does not allow for UU/UE. This alternative can be effective in the short-term and the long-term with the cooperation of the current owner and the proper protection of workers involved in the implementation. Instituting LUCs requires cooperation and coordination between the federal government, state environmental regulators, local governments, private stakeholders and current and future property owners. In order for LUCS to be effective, the parties must consult and work collaboratively to take responsibility for their implementation, management and enforcement.

Implementability: The LUCs alternative can be readily implemented by designing and installing physical barriers such as fences, concrete or brick patios, or groundcover plantings to limit access to the surface soils. Environmental covenants can be developed. LUCs would be placed on the deed. The materials and services required to implement this alternative are available. The administrative feasibility of LUCs would call for the cooperation of current and future property owners who would have to reside in a limited access environment. An LUC plan describing the controls and delineating responsibility for enforcement and maintenance of the controls would need to be developed. Significant administrative services would be necessary in the implementation of this alternative to draft deed restrictions and LUC documentation. Although the LUCs alternative is protective, it does not achieve the RAOs.

Cost: The costs for this alternative would not be prohibitive. LUCs would include things such as installation and maintenance of decorative fencing and concrete patio, ground cover plants, and legal fees for development of environmental covenants. The cost for periodic reviews would also be included.

Outcome: Alternative 2 would not be effective in reducing toxicity or volume of contaminants. Acceptance by the property owner, in particular, American University, and the ability to commit future owners to living in restricted surroundings, would be difficult to obtain. Accordingly, the LUCs alternative will not be evaluated further for the remaining soil COCs at the Spaulding-Rankin and AU EUs, because it does not meet key elements of the effectiveness and implementability criteria.

4.3.3 Alternative 3: Phytoremediation

Alternative 3 entails installing selected plants in the contaminated areas, based on treatability studies conducted to determine the appropriateness of this alternative to site-specific conditions. The plants would be harvested periodically and disposed appropriately. The harvested plants would be replaced with new plants, as necessary, in order to achieve the RAO for the COCs in that area. The treatment program would be monitored and maintained on a regular basis and would likely require some temporary access controls such as fencing to address exposure to contamination in the interim between installing the plants and achieving the remediation endpoints. The duration of operation and maintenance for this technology is very site-specific and can vary depending on the COC, COC concentrations, growth rate of the plantings, depth of contamination, and climate factors (e.g., temperature and precipitation).

Effectiveness: Phytoremediation has generally been shown to be effective in removing the COCs from soils, but a treatability study would be required to determine the true effectiveness of this alternative for the specific COCs at the site-specific locations. Lasat has identified phytoremediation as promising for addressing cobalt, mercury, and vanadium (Lasat, 2002), while ITRC notes that phytoremediation groundcovers have been widely applied to soils impacted with recalcitrant compounds such as PAHs, polychlorinated biphenyls (PCBs), and other persistent organic pollutants that are typically less mobile, soluble, biodegradable, and bioavailable (ITRC, 2009).

If the treatability study indicates that phytoremediation is appropriate to site-specific conditions, this alternative would be protective of human health and the environment by eliminating the mobility of the COCs and reducing the toxicity and volume of contaminated soil at the site. However, it is recognized that, unless treated, the mobility, toxicity, or volume of the toxic constituents is not reduced, but simply transferred to the plants which would require periodic harvesting and disposal (e.g., a landfill). Phytoremediation is effective in the long-term as the plants will be harvested and disposed offsite, significantly reducing any residual risk, and allowing for UU/UE. Phytoremediation is less effective in the short-term as the plants have a growing and harvesting cycle. Appropriate health and safety precautions would be required during construction and maintenance of this alternative in order to protect workers and the community during implementation.

Implementability: At this screening stage, this alternative is considered technically and administratively feasible. Technical feasibility is satisfied in that the ability to construct, reliably operate, and maintain a phytoremediation design has been demonstrated (although, as described above, this alternative would require a treatability study to fully determine its technical feasibility for the COCs at the site-specific locations). Administratively, this alternative would require long-term plans for maintenance and monitoring. Enforcement would also be required during the interim between installing the plants and reaching the RAOs to ensure that the plants are being maintained, and to ensure compliance with access controls established to protect human health in the interim. The materials and services required to implement phytoremediation are also readily available, and DDOE (now the DOEE), USEPA, and general community acceptance has been established during the previous phytoremediation conducted at the SVFUDS. Therefore, the administrative feasibility for this alternative is met.

Cost: The cost to implement this alternative is moderate. This is based on its application to arsenic-contaminated soil within the SVFUDS as described previously. Costs are per grid (20 ft by 20 ft by 4 ft deep) of treated soil and include planting of the selected species, harvesting and disposal. The cost will vary based on various factors including the type of plant(s) required, climate factors (e.g., amount of irrigation needed), nutrient requirements, the number of harvesting and replanting cycles required, and disposal requirements. This alternative may also involve additional costs for installation and maintenance of fencing that may be necessary to restrict access to the area during treatment, and for a treatability study required to determine the technical feasibility and design parameters for the site-specific COCs.

Outcome: Alternative 3 meets key elements of the effectiveness and implementability criteria and will be retained for the detailed comparative analysis in the next section.

4.3.4 Alternative 4: Excavation and Off-site Disposal

Alternative 4 entails excavation of contaminated soils in the areas identified and backfilling the areas with clean soil. As described in Section 3.1.4, additional soil sampling would be completed and the new sample data would be used to recalculate the human health risks for that location. Once the RAOs are met, as determined by the recalculated carcinogenic and/or non-carcinogenic risks, the limits of contamination would be established. Excavation would then be conducted and confirmatory samples would be collected to ensure complete removal.

Excavated soil would be characterized and transported to an appropriate off-site disposal facility. The excavated soil would be characterized in accordance with the requirements of the disposal facility. If the soil is characterized as RCRA hazardous, it would be transported to a RCRA subtitle C landfill where it would be pretreated and disposed. If the soil is characterized as RCRA non-hazardous, it would be transported to a sanitary landfill for disposal. Past SVFUDS experience has shown that the vast majority of the soil would be characterized as non-hazardous. Sanitary landfills are required to have liners and caps such that the residential human health hazard presented by the soils would be controlled.

This alternative would require consideration of the following issues:

- Hazards from the operation of heavy equipment, damage to underground utilities, or other occupational injuries;
- Noise control;
- Erosion control;
- Airborne contaminated dusts and waste materials;
- Confirmatory sampling; and
- Storage, labelling, and transportation requirements.

Effectiveness: Excavation and off-site disposal is protective of human health and the environment. It will remove any chemical contaminants from site soils eliminating their mobility and reducing the toxicity and volume of contaminated soil at the site. However, it is recognized that, unless treated, the mobility, toxicity, or volume of the contaminated soil is not reduced, but simply transferred to another site (i.e. a permitted landfill). Excavation and off-site disposal is effective in the long-term as the soils with elevated chemical concentrations will be removed from the site, significantly reducing any residual risk, and allowing for UU/UE. This also provides short-term effectiveness as the RAOs can be achieved in a short period of time and no further treatability or feasibility studies are required. During implementation of this alternative, controls would be required to minimize dust generated during the excavation, and appropriate health and safety precautions would be required to protect workers and the community.

Implementability: This alternative is considered technically and administratively feasible. Technical feasibility is satisfied in that the ability to excavate soil and backfill the areas has been demonstrated. An assessment of technical feasibility includes a formal determination of whether the excavation can be done as a low-probability operation, or a high-probability operation. As discussed in Section 3.1.4.5, formal determinations of low or high-probability operations will be made through probability assessments developed as part of the remedial action planning. Based on the significant past experience with excavations within the SVFUDS, it is likely that this alternative would be conducted under low-probability protocols.

The materials and services required to implement this alternative are also readily available, and DOEE, USEPA, and general community acceptance has been established for excavation during the previous activities performed throughout the SVFUDS. Therefore, the administrative feasibility for this alternative is met.

Cost: The cost to implement this alternative is moderate to high. This is based on having conducted contaminated soil removals throughout the SVFUDS as described previously. Costs are per ton of soil removed/disposed, with disposal at a RCRA non-hazardous sanitary landfill being less costly than disposal as RCRA hazardous at a RCRA Subtitle C landfill. Costs include backfilling the excavation with clean soil obtained from an off-site source, and restoration and planting of the area to approximate original conditions.

Outcome: Alternative 4 meets key elements of the effectiveness and implementability criteria and will be retained for the detailed comparative analysis in the next section.

4.4 Screening of Explosive Hazards Remedial Alternatives

The following sections provide a brief description of each alternative to mitigate the potential unacceptable explosive hazards due to MEC that may remain within the SVFUDS.

4.4.1 Alternative 1: No Further Action

The NCP requires that a no further action alternative be developed for an FS. The no further action alternative would involve leaving the subject properties in their current condition. This alternative provides a comparative baseline against which other alternatives can be evaluated. Under this alternative, no remedial action will be taken, and any potential explosive hazards contaminants are left "as is," without the implementation of any containment, removal, treatment, or other protective actions. This alternative would leave any MEC items potentially present, in place, without further investigation or removal. This alternative does not provide for additional investigation for or removal of MEC items, and does not provide for any active or passive land use controls to reduce the potential for exposure (e.g., physical barriers, deed restrictions).

Effectiveness: The no further action alternative would not provide for protection of human health and the environment. The potential explosive hazards associated with MEC would not be expected to decrease significantly over time without removal. Therefore, this alternative would not be effective in achieving the RAOs in the short-term or the long-term, it does not reduce the volume of MEC, and it does not allow for UU/UE.

Implementability: The no further action alternative is easy to implement. No services or materials would be required to implement this alternative. However, it will be technically ineffective and administratively unfavorable and will fail to achieve the RAOs.

Cost: There are no costs associated with the no further action alternative.

Outcome: Alternative 1 will not be evaluated further because it fails the effectiveness and implementability criteria.

4.4.2 Alternative 2: Land Use Controls

The LUCs alternative would include limiting access to all or portions of the subject properties and would call for environmental covenants, among other controls. Access could be limited in a variety of ways. The success of access limitations would depend on what portions of the property they involve and the effectiveness of their implementation including the cooperation of the regulators, the government, stakeholders, and the current and future property owners.

Options for limiting access include fencing specific areas (e.g., areas where intrusive activities or digging of any type might otherwise be carried out) or covering these areas with concrete or brick (e.g., further restricting the ability to perform intrusive activities). These options would limit potential encounters with any MEC by preventing people from digging to depths where they may be encountered.

The LUCs alternative would include the development of environmental covenants to legally bind the current and future property owner to the appropriate access and use restrictions. The environmental covenants would include prohibition of intrusive activities in these areas. USACE would develop an LUC plan, which would include a delineation of enforcement and maintenance responsibilities, in coordination with the property owner and local agencies.

As the need for LUCs indicates UU/UE has not been achieved, periodic or 5-year reviews would be part of this alternative. These reviews generally are required by CERCLA when hazardous substances remain on site above levels which permit UU/UE. Periodic reviews provide an opportunity to evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment. The objective is to ensure that USACE is aware of and responds to new information or data that affects the selected response action. A Periodic Review Plan would be prepared describing periodic site visits and stakeholder interviews to determine whether or not the level of risk should be changed.

Note: Section 1.3.5.2 describes the potential unacceptable explosive hazards associated with possible munitions disposal burial pits that may be present in the AU PSB Possible Disposal Area. However, as the PSB is an active building on the AU campus, so long as it remains in place, it effectively acts as a cap or control to contain any potential explosive hazard. The explosive hazard mitigation alternatives that include DGM and anomaly removal cannot be applied with the building present. Therefore, no further evaluation of alternatives is provided in this FS for the PSB. It is anticipated that with the building no longer in place, the DGM and anomaly removal mitigation preferred alternative will be applied to the area and any burial pits will be properly addressed.

<u>Effectiveness</u>: The LUCs alternative would provide protection of human health and the environment by limiting the potential for an encounter with MEC that may be present. However, this alternative would not be effective in achieving the RAOs, does not reduce toxicity or volume of MEC, and it does not allow for UU/UE. This alternative can be effective in the short-term and the long-term with the cooperation of the current owner and the proper protection of workers involved in the implementation. Instituting LUCs requires cooperation and coordination between the federal government, state environmental regulators, local governments, private stakeholders and current and future property owners. In order for LUCS to be effective, the parties must consult and work collaboratively to take responsibility for their implementation, management and enforcement.

<u>Implementability</u>: The LUCs alternative can be readily implemented by designing and installing fences, concrete or brick patios, to limit access to the subsurface soils. Environmental covenants can be developed. LUCs would be placed on the deed. The materials and services required to implement this alternative are available. The administrative feasibility of LUCs is less certain as it would call for the cooperation of current and future property owners who would have to reside in a limited access environment. An LUC plan describing the controls and delineating responsibility for enforcement and maintenance of the controls would need to be developed. Significant administrative services would be necessary in the implementation of this alternative to draft deed restrictions and land use control documentation. Although the LUCs alternative is protective, it does not achieve the RAOs.

<u>Cost</u>: The costs for this alternative would not be prohibitive. LUCs might include installation and maintenance of decorative fencing and concrete patio, and legal fees for development of environmental covenants. The cost for periodic reviews would also be included.

<u>Outcome</u>: Alternative 2 is not effective in reducing toxicity or volume of MEC. Acceptance by the property owner and the ability to commit future owners to living in restricted surroundings, would be difficult to obtain. Accordingly, the LUCs alternative will not be evaluated further for the areas of focus because it does not meet key elements of the effectiveness and implementability criteria.

4.4.2.1 Site-Wide RAO Alternative

The LUCs alternative is not retained as a means to mitigate the potential unacceptable explosive hazards in the identified areas of focus. However, as described in Section 3.2.3, for purposes of achieving the site-wide RAO, institutional controls (a subset of LUCs) in the form of education and awareness initiatives, are a response alternative that meets key elements of the effectiveness and implementability criteria. These initiatives, which will include community-wide mailings of educational material such as understanding the 3 ‘R’s (recognize, retreat, and report) with regard to areas where potential munitions may be encountered, will be formalized in an Institutional Analysis Report. This report will describe the development, implementation, and maintenance of an institutional controls program to help manage explosive hazards and identify stakeholder participation. In addition, as this alternative would not allow for UU/UE, periodic reviews would supplement the education and awareness initiatives, further providing the opportunity to evaluate new information and ensure that the community remains aware of the potential for MEC to be encountered within the SVFUDS.

4.4.3 Alternative 3: Full DGM Coverage, Remove All Anomalies

Alternative 3 entails conducting DGM/anomaly removal on a given subject property, using the procedures and methods described in Section 3.2. The alternative, which is designed to meet the RAO of reducing the potential for encountering MEC in the identified areas of focus for potential explosive hazards, specifies standards for DGM coverage (acreage) and quantity of anomalies to be removed.

The DGM coverage standard is ‘full’ coverage. While the DGM coverage objective is always intended to be 100% coverage, there are practical considerations for residential properties. Accordingly, full coverage is defined as using the geophysical instruments to survey all of the acreage of the property, not including beneath constructed buildings (such as houses, garages, or in-ground swimming pools) or trees older than approximately 100 years (i.e., the tree was in existence during the AUES activities and it is unlikely that MEC items would be beneath it). Full coverage would include hardscape features such as driveways, sidewalks, or patios, meaning these areas would be geophysically surveyed. It also includes gardens, landscaped areas, and small trees or ornamental plants, and would therefore potentially involve the cutting of vegetation in these areas in order to conduct the DGM. Fences would be temporarily removed (and replaced after the DGM) in order to survey the ground below and adjacent to them without interference. This represents a higher standard of coverage than has historically been done during the RI phase, reflecting the remedial action phase of the project.

For the properties that have previously undergone DGM/anomaly removal work, some areas of the property that were not included before would now be surveyed under this alternative. For example, areas of vegetation not previously cut by USACE, would now be cut in order to effect full DGM coverage under this alternative. Coverage determinations would be made on a property-specific basis during the preparation of the Remedial Design/Remedial Action Work Plan. It is possible that for the previously completed properties, no additional acreage would be available to be geophysically surveyed even under the higher standard of full coverage. In order to conduct this FS analysis and to account for the fact that each property would present different conditions in terms of coverage, simplifying assumptions were made. In general, for the full coverage alternative, it was assumed that a given property would contain two areas that required cutting of vegetation (areas that would not have been cut during the earlier RI phase work).

The anomaly removal quantity standard is that all identified geophysical anomalies be removed (excavated). Removing all anomalies means that no discrimination of anomalies is necessary; anything identified as an anomaly would be excavated. Since all anomalies would be excavated, neither A-B-C-D nor AC classification of anomalies is needed, as the objective of those schemes is to reduce the number of anomalies to excavate through characterization as munitions items. Consequently, the DGM method associated with this alternative is the use of the EM61 plus the G-858; no AC instrumentation is needed under this alternative.

For the properties that have previously undergone DGM/anomaly removal work, Section 3.2.2.2 describes that based on ARB decisions, numerous anomalies that were evaluated as likely innocuous metallic debris, were left in the ground. Those remaining anomalies would be re-acquired and removed under this alternative.

Following excavation of anomalies, the property would be restored to approximate original conditions.

Effectiveness: This alternative would be protective of human health and the environment. It will remove all identified geophysical anomalies, thus reducing the potential explosive hazard at the property. It is effective in the long-term as MEC will be removed from the site, eliminating any residual explosive hazards, allowing for UU/UE. This alternative also provides short-term effectiveness as the RAO can be achieved in a short period of time and no further treatability or feasibility studies are required. During implementation of this alternative, appropriate health and safety precautions would be required to protect workers and the community from accidental detonation of buried MEC items.

However, effectiveness in protecting human health and the environment, and reducing potential explosive hazards associated with MEC, is limited in that any areas not geophysically surveyed, such as beneath the house, will remain in their current state.

Implementability: This alternative is considered technically and administratively feasible. Technical feasibility is satisfied in that the ability to conduct DGM and anomaly removal has been demonstrated throughout the SVFUDS. An assessment of technical feasibility includes a formal determination of whether the anomaly removals can be done as a low probability operation, or a high probability operation. As discussed in Section 3.1.4.5, formal determinations low or high-probability operations will be made through probability assessments developed as part of the remedial action planning. Based on the significant past experience with anomaly removals within the SVFUDS, it is likely that this alternative would be conducted under low-probability protocols.

The materials and services required to implement this alternative are also readily available, and DOEE, USEPA, and general community acceptance has been established during the previous DGM and anomaly removal activities performed throughout the SVFUDS. Therefore, the administrative feasibility for this alternative is met.

Cost: The cost to implement this alternative is moderate to high. This is based on having conducted DGM and anomaly removal activities throughout the SVFUDS as described previously. Costs include geophysical survey team field activities and specially trained UXO Technicians to safely conduct the anomaly excavations. The costing assumptions for this alternative also include cutting of vegetation in two separate areas of the property and the restoration to approximate original conditions, temporary removal and then replacement of a small section of fence, and that one-half of a driveway would require replacement.

Outcome: Alternative 3 meets key elements of the effectiveness and implementability criteria and will be retained for the detailed comparative analysis in the next section.

4.4.4 Alternative 4: Full DGM Coverage, Remove Selected Anomalies

Alternative 4 entails conducting DGM/anomaly removal on a given subject property, using the procedures and methods described in Section 3.2. The alternative, which is designed to meet the RAO of reducing the potential for encountering MEC in the identified areas of focus for potential explosive hazards, specifies standards for DGM coverage (acreage) and quantity of anomalies to be removed.

The DGM coverage standard is ‘full’ coverage, as defined for Alternative 3 in Section 4.4.3. Full coverage does not include surveying beneath constructed buildings (such as houses, garages, or in-ground swimming pools) or older trees, but does include hardscape features such as driveways, sidewalks, or patios, as well as gardens, landscaped areas, and small trees or ornamental plants, and would therefore potentially involve the cutting of vegetation in these areas in order to conduct the DGM. Full coverage also includes the temporary removal and replacement of fencing in order to survey the ground below and adjacent to them without interference.

For the properties that have previously undergone DGM/anomaly removal work, some areas of the property that were not included before, would now be surveyed under this alternative. Coverage determinations would be made on a property-specific basis during the preparation of the Remedial Design/Remedial Action Work Plan. It is possible that for the previously completed properties, no additional acreage would be available to be geophysically surveyed even under the higher standard of full coverage. In order to conduct this FS analysis and to account for the fact that each property would present different conditions in terms of coverage, it was assumed that a given property would contain two areas that required cutting of vegetation (areas that would not have been cut during the earlier RI phase work).

The anomaly removal quantity standard is that only selected geophysical anomalies be removed. Removing selected anomalies means that only those anomalies recommended for excavation through the AC methodology would be removed. Consequently, the DGM method associated with this alternative is the use of the EM61 plus the G-858 as supplemented by the AC instrumentation.

For the properties that have previously undergone DGM/anomaly removal work, Section 3.2.2.2 describes that based on ARB decisions, numerous anomalies that were evaluated as likely innocuous metallic debris, were left in the ground. The application of AC for these properties would involve re-acquiring those remaining anomalies and using AC methodology to better determine whether they should be removed or not (overriding the previous A-B-C-D or professional judgment anomaly removal rationale).

Following excavation of anomalies, the property would be restored to approximate original conditions.

Effectiveness: This alternative would be protective of human health and the environment. It will remove geophysical anomalies identified as likely to be MEC, thus reducing the potential explosive hazard at the property. It is effective in the long-term as MEC will be removed from the site, eliminating any residual explosive hazards, allowing for UU/UE. This alternative also provides short-term effectiveness as the RAO can be achieved in a short period of time and no further treatability or feasibility studies are required. During implementation of this alternative, appropriate health and safety precautions would be required to protect workers and the community from accidental detonation of buried MEC items.

However, effectiveness in protecting human health and the environment, and reducing potential explosive hazards associated with MEC, is limited in that any areas not geophysically surveyed, such as beneath the house, will remain in their current state.

Implementability: This alternative is considered technically and administratively feasible. Technical feasibility is satisfied in that the ability to conduct DGM and anomaly removal has been demonstrated throughout the SVFUDS. An assessment of technical feasibility includes a formal determination of whether the anomaly removals can be done as a low probability operation, or a high probability operation; based on the significant past experience with anomaly removals within the SVFUDS, it is likely that this alternative would be conducted under low-probability protocols.

The materials and services required to implement this alternative are also readily available, and DOEE, USEPA, and general community acceptance has been established during the previous DGM and anomaly removal activities performed throughout the SVFUDS. Therefore, the administrative feasibility for this alternative is met.

Cost: The cost to implement this alternative is moderate to high. This is based on having conducted DGM and anomaly removal activities throughout the SVFUDS as described previously. Costs include geophysical survey team field activities and specially trained UXO Technicians to safely conduct the anomaly excavations. The costing assumptions for this alternative also include cutting of vegetation in two separate areas of the property and the restoration to approximate original conditions, temporary removal and then replacement of a small section of fence, and that one-third of a driveway would require replacement (assuming the use of AC would identify more anomalies as innocuous metallic debris and would reduce the percentage of driveway that would require intrusive investigation).

Outcome: Alternative 4 meets key elements of the effectiveness and implementability criteria and will be retained for the detailed comparative analysis in the next section.

4.4.5 Alternative 5: DGM of Accessible Areas, Remove All Anomalies

Alternative 5 entails conducting DGM/anomaly removal on a given subject property, using the procedures and methods described in Section 3.2. The alternative, which is designed to meet the RAO of reducing the potential for encountering MEC in the identified areas of focus for potential explosive hazards, specifies standards for DGM coverage (acreage) and quantity of anomalies to be removed.

The DGM coverage standard is 'accessible areas'. Accessible areas coverage is defined as excluding those things not surveyed under the full coverage standard, but additionally excluding rare or valuable plants and large ornamental trees (regardless of age), and areas under fences (i.e., no fence removal). However, it does include coverage of hardscape features such as driveways, sidewalks, or patios, as well as gardens and small trees or plants, and would therefore potentially involve the cutting of vegetation in these areas in order to conduct the DGM.

For the properties that have previously undergone DGM/anomaly removal work, some areas of vegetation not previously cut by USACE, would now be cut in order to effect the coverage standard under this alternative. While this represents a slightly lower standard than full coverage, it is still a higher standard of coverage than was done during the RI phase, reflecting the remedial action phase of the project. The intent is to provide a standard that more realistically acknowledges the trade-off of additional investigation benefits versus disruptive impacts to a residential property.

To conduct this FS analysis and to account for the fact that each property would present different conditions in terms of coverage, it was assumed under this alternative that a given property would contain one area that required cutting of vegetation (an area that would not have been cut during the earlier RI phase work). As noted in Section 3.2.2.2, it is acknowledged that with regard to accessible areas, as geophysical technologies evolve, it may be necessary to design specific approaches to properties presenting different access and logistical challenges. Actual coverage determinations would be made on a property-specific basis during the preparation of the Remedial Design/Remedial Action Work Plan. It is possible that for the previously completed properties, no additional acreage would be available to be geophysically surveyed even under the higher accessible areas coverage standard.

The anomaly removal quantity standard is that all identified geophysical anomalies be removed. As previously noted in Alternative 3, removing all anomalies means that no discrimination of anomalies is necessary. Consequently, the DGM method associated with this alternative is the use of the EM61 plus the G-858 and no AC instrumentation is needed.

Following excavation of anomalies, the property would be restored to approximate original conditions.

Effectiveness: This alternative would be protective of human health and the environment. It will remove all identified geophysical anomalies, thus reducing the potential explosive hazard at the property. It is effective in the long-term as MEC will be removed from the site, eliminating any residual explosive hazards, allowing for UU/UE. This alternative also provides short-term effectiveness as the RAO can be achieved in a short period of time and no further treatability or feasibility studies are required. During implementation of this alternative, appropriate health and safety precautions would be required to protect workers and the community from accidental detonation of buried MEC items.

However, effectiveness in protecting human health and the environment, and reducing potential explosive hazards associated with MEC, is limited in that any areas not geophysically surveyed, such as beneath the house, will remain in their current state.

Implementability: This alternative is considered technically and administratively feasible. Technical feasibility is satisfied in that the ability to conduct DGM and anomaly removal has been demonstrated throughout the SVFUDS. An assessment of technical feasibility includes a formal determination of whether the anomaly removals can be done as a low probability operation, or a high probability operation; based on the significant past experience with anomaly removals within the SVFUDS, it is likely that this alternative would be conducted under low-probability protocols.

The materials and services required to implement this alternative are also readily available, and DOEE, USEPA, and general community acceptance has been established during the previous DGM and anomaly removal activities performed throughout the SVFUDS. Therefore, the administrative feasibility for this alternative is met.

Cost: The cost to implement this alternative is moderate to high. This is based on having conducted DGM and anomaly removal activities throughout the SVFUDS as described previously. Costs include geophysical survey team field activities and specially trained UXO Technicians to safely conduct the anomaly excavations. The costing assumptions for this alternative also include cutting of vegetation in one area of the property and the restoration to approximate original conditions, and that one-half of a driveway would require replacement.

Outcome: Alternative 5 meets key elements of the effectiveness and implementability criteria and will be retained for the detailed comparative analysis in the next section.

4.4.6 Alternative 6: DGM of Accessible Areas, Remove Selected Anomalies

Alternative 6 entails conducting DGM/anomaly removal on a given subject property, using the procedures and methods described in Section 3.2. The alternative, which is designed to meet the RAO of reducing the potential for encountering MEC in the identified areas of focus for potential explosive hazards, specifies standards for DGM coverage (acreage) and quantity of anomalies to be removed.

The DGM coverage standard is 'accessible areas'. Accessible areas coverage is defined as excluding those things not surveyed under the full coverage standard, but additionally excluding rare or valuable plants and large ornamental trees (regardless of age), and areas under fences (i.e., no fence removal). However, it does include coverage of hardscape features such as driveways, sidewalks, or patios, as well as gardens and small trees or plants, and would therefore potentially involve the cutting of vegetation in these areas in order to conduct the DGM.

For the properties that have previously undergone DGM/anomaly removal work, some areas of vegetation not previously cut by USACE, would now be cut in order to effect the coverage standard under this alternative. In order to conduct this FS analysis and to account for the fact that each property would present different conditions in terms of coverage, it was assumed under this alternative that a given property would contain one area that required cutting of vegetation (an area that would not have been cut during the earlier RI phase work). Actual coverage determinations would be made on a property-specific basis during the preparation of the Remedial Design/Remedial Action Work Plan. It is possible that for the previously completed properties, no additional acreage would be available to be geophysically surveyed even under the higher accessible areas coverage standard.

The anomaly removal quantity standard is that only selected geophysical anomalies be removed. As noted for Alternative 4, removing selected anomalies means that only those anomalies recommended for excavation through the AC methodology would be removed. Consequently, the DGM method associated with this alternative is the use of the EM61 plus the G-858 as supplemented by the AC instrumentation. For the properties that have previously undergone DGM/anomaly removal work, the application of AC would involve re-acquiring anomalies remaining in the ground and using AC methodology to better determine whether they should be removed or not.

Following excavation of anomalies, the property would be restored to approximate original conditions.

Effectiveness: This alternative would be protective of human health and the environment. It will remove geophysical anomalies identified as MEC, thus reducing the potential explosive hazard at the property. It is effective in the long-term as MEC will be removed from the site, eliminating any residual explosive hazards, allowing for UU/UE. This alternative also provides short-term effectiveness as the RAO can be achieved in a short period of time and no further treatability or feasibility studies are required. During implementation of this alternative, appropriate health and safety precautions would be required to protect workers and the community from accidental detonation of buried MEC items.

However, effectiveness in protecting human health and the environment, and reducing potential explosive hazards associated with MEC, is limited in that any areas not geophysically surveyed, such as beneath the house, will remain in their current state.

Implementability: This alternative is considered technically and administratively feasible. Technical feasibility is satisfied in that the ability to conduct DGM and anomaly removal has been demonstrated throughout the SVFUDS. An assessment of technical feasibility includes a formal determination of whether the anomaly removals can be done as a low probability operation, or a high probability operation; based on the significant past experience with anomaly removals within the SVFUDS, it is likely that this alternative would be conducted under low-probability protocols.

The materials and services required to implement this alternative are also readily available, and DOEE, USEPA, and general community acceptance has been established during the previous DGM and anomaly removal activities performed throughout the SVFUDS. Therefore, the administrative feasibility for this alternative is met.

Cost: The cost to implement this alternative is moderate to high. This is based on having conducted DGM and anomaly removal activities throughout the SVFUDS as described previously. Costs include geophysical survey team field activities and specially trained UXO Technicians to safely conduct the anomaly excavations. The costing assumptions for this alternative also include cutting of vegetation in one area of the property and the restoration to approximate original conditions, and that one-third of a driveway would require replacement (assuming the use of AC would identify more anomalies as innocuous metallic debris and would reduce the percentage of driveway that would require intrusive investigation).

Outcome: Alternative 6 meets key elements of the effectiveness and implementability criteria and will be retained for the detailed comparative analysis in the next section.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 Introduction

In Section 4.0 the remedial alternatives were screened against the three broad criteria of effectiveness, implementability, and cost. Alternative 1 (No Further Action), and Alternative 2 (LUCs), for each of the two risks/hazards to be mitigated, did not pass the broad criteria screening and were not retained for further evaluation. In this section, the remaining remedial alternatives undergo a detailed analysis that is intended to allow decision makers to select the appropriate response.

During the detailed analysis, each alternative is assessed against the evaluation criteria described below. The results compare the alternatives and identify the key tradeoffs among them. This approach is designed to provide decision makers with sufficient information to adequately compare the alternatives, select the appropriate remedy for the property, and demonstrate satisfaction of the CERCLA remedy selection requirements.

Nine evaluation criteria have been developed by the USEPA to address CERCLA requirements and technical and policy considerations that have proven to be important for selecting among remedial alternatives. These criteria serve as the basis for analyzing proposed remedial alternatives to determine the most appropriate alternatives to address remediation. The nine criteria are divided into three categories; threshold, balancing and modifying. They are as follows:

- Threshold
  - Overall Protection of Public Health and Environment
  - Compliance with ARARs
- Balancing
  - Long-Term Effectiveness
  - Reduction of Toxicity, Mobility and Volume Through Treatment
  - Short-Term Effectiveness
  - Implementability
    - Technical Feasibility
    - Administrative Feasibility
    - Availability of Materials and services
  - Cost
- Modifying
  - State (Regulator) Acceptance
  - Community Acceptance

5.1.1 <u>Threshold Criteria</u>

Assessments against two of the criteria relate directly to statutory findings that must ultimately be made in the Decision Document; therefore, these are categorized as threshold criteria and the remedial alternative chosen must meet the two criteria within this category (USEPA 1988).

5.1.1.1 Overall Protection of Public Health and Environment

This threshold criterion assesses whether each alternative provides adequate protection of human health and the environment. The overall assessment of protection considers assessments conducted under other evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

5.1.1.2 Compliance with ARARs

This threshold criterion is used to determine whether each alternative will meet all of the ARARs (as defined in CERCLA Section 121) that have been identified in Table 2.2. For each alternative, the following should be addressed: compliance with chemical-specific ARARs, location-specific ARARs, and action-specific ARARs, and compliance with other criteria, advisories, or guidance.

5.1.2 Balancing Criteria

Balancing criteria are those that form the basis for comparison among alternatives that meet the threshold criteria. The five criteria in this category represent the primary criteria upon which the analysis is based.

5.1.2.1 Long-Term Effectiveness

This criterion addresses the remedial action in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by residuals and/or any untreated wastes. The primary focus of the analysis is on:

- The magnitude of residual risk following completion of the remedial activities; and
- The adequacy and reliability of any controls (e.g., access limitations, deed restrictions, long-term monitoring, etc.) used to manage the treated residuals or untreated wastes that remain at the site.

5.1.2.2 Reduction of Toxicity, Mobility or Volume Through Treatment

Based on USEPA's preference that a chosen removal alternative will reduce toxicity, mobility, or volume through treatment, an alternative must be evaluated based upon the following specific factors:

- The treatment processes employed and the materials it will treat;
- The amount of hazardous materials to be destroyed or treated;
- The degree of reduction expected in toxicity, mobility or volume;
- The degree to which the treatment will be irreversible;
- The type and quantity of residuals that will remain after treatment; and
- Whether the alternative meets the USEPA's preference for treatment.

5.1.2.3 Short-Term Effectiveness

This criterion addresses the effects of an alternative during the implementation phase, until the removal objectives are met. More specifically, each alternative will be evaluated for:

- Protection of the community and workers during the remedial action;
- Adverse environmental impacts resulting from construction and implementation; and
- The time required to meet the remedial objectives.

5.1.2.4 Implementability

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. This criterion focuses on analysis of the following sub-criterion factors:

Technical Feasibility

This sub-criterion evaluates the ease of implementing a specific alternative. This criterion evaluates:

- The reliability of the alternative and any technical operational difficulties;
- The reliability of the alternative to complete the remediation without significant schedule delays;
- The ease of conducting additional remedial actions following the initial undertaking; and
- The environmental conditions with respect to set-up, construction and operation of the alternative.

Administrative Feasibility

This sub-criterion focuses on the planning stages for each alternative and includes evaluation of:

- Adherence to non-environmental laws (e.g., siting of a treatment plant in a residential neighborhood);
- Coordinating services needed to carry out an alternative;
- Arranging the delivery of services in a timely manner; and
- Addressing the concerns of other regulatory agencies.

Availability of Materials and Services

This sub-criterion evaluates the following:

- Availability of the personnel needed to perform the operations based on schedule;
- Availability of adequate off-site treatment, storage and disposal for materials; and
- Availability of supporting services (e.g., power lines, laboratory services, etc.).

5.1.2.5 Cost

This criterion evaluates projected costs associated with implementing the alternative. These costs include direct capital costs (i.e., costs of the technology or to perform the alternative), indirect capital costs (e.g., design expenses, legal fees, and permit fees), and post remedial site control costs (e.g., monitoring, and operation and maintenance costs). The USEPA RI/FS Guidance (USEPA 1988) indicates that order-of-magnitude cost estimates having an accuracy of -30% to +50% should suffice for the detailed analysis of response alternatives.

5.1.3 Modifying Criteria

The final two criteria will be evaluated following comment on the RI/FS reports and the Proposed Plan and will be addressed once a final decision is being made (USEPA 1988).

5.1.3.1 State (Regulator) Acceptance

This criterion evaluates the technical and administrative issues and concerns the state may have for each of the alternatives (for this project, State/Regulator is defined as including both the USEPA and the DOEE). This criterion will be fully addressed in the Decision Document once comments on the RI/FS reports and Proposed Plan have been processed during the public comment period.

5.1.3.2 Community Acceptance

This criterion evaluates the issues and concerns the public may have for each of the alternatives. Similar to state acceptance, this criterion will be fully addressed in the Decision Document once comments on the RI/FS reports and Proposed Plan have been processed during the public comment period.

5.2 Individual Analysis of Contaminated Soil Remedial Alternatives

The broad screening performed in Section 4.3 against effectiveness, implementability, and cost, eliminated remedial Alternative 1 - No Further Action, and Alternative 2 – LUCs, from further consideration. This section individually evaluates the two remaining alternatives against the nine criteria, while Section 5.4 compares the two alternatives to each other. The following discussions focus on how, and to what extent, the alternatives address each of the criteria by qualitatively assessing whether the alternative is favorable, moderately favorable, or not favorable, relative to the criterion (note that for the threshold criteria, which must be met, ‘favorable’ means criteria will be met while ‘unfavorable’ means criteria will not be met). Table 5.1 presents the summary of the detailed analysis of the remaining contaminated soil remedial alternatives.

5.2.1 <u>Alternative 3: Phytoremediation</u>

5.2.1.1 Threshold Criteria

Alternative 3 is protective of public health and the environment assuming a successful treatability study. Based on the results of previous phytoremediation efforts in the SVFUDS, and the general success with metals in soil, the primary COCs to be addressed, this criterion is ranked as favorable.

Alternative 3 was reviewed with respect to TBCs and compliance with ARARs (see Tables 2.1 and 2.2). The phytoremediation alternative (depending on the results of the treatability study) is expected to attain all chemical-specific TBCs and action-specific ARARs (as discussed in Section 2.2 and listed in Tables 2.1 and 2.2). Chemical-specific TBCs for soil are applicable and focus on ensuring that health-protective cleanup standards are met (under CERCLA). This alternative will comply with CERCLA criteria for soil by remediating the subject soils to the RAOs. Action-specific ARARs focus on the protection of public health and the environment during remedial activities, such as controlling fugitive dust that may be inhaled by workers. All action-specific ARARs will be complied with during and following remedial activities under Alternative 3.

Therefore, Alternative 3 is favorable for the threshold criteria.

5.2.1.2 Balancing Criteria

Alternative 3 is moderately favorable for the long-term effectiveness criterion due to the need to potentially have different types of plants targeting different COCs, and the possibility that pending a treatability study, these may be needed in the same areas of contaminated soil, i.e., where more than one COC needs to be addressed in a single area. The differing plant growth needs, such as water, nutrients, and sunlight, may have the overall effect of reducing long-term effectiveness in a small area where multiple plants are competing. Temporary land use controls (e.g., fencing) would also be required to limit access to the remediation locations, affecting use of that area of the property on a potentially long-term basis.

Alternative 3 is not favorable in reducing toxicity, mobility and volume of contaminants at the property because it is recognized that, unless treated, the mobility, toxicity, or volume of the toxic constituents is not reduced, but rather transferred to the plants which would require periodic harvesting and disposal (e.g., a landfill).

Alternative 3 is not favorable in meeting the short-term effectiveness criterion because the plants have a growing and harvesting cycle that requires sufficient time; contaminants are not addressed in the short-term under this alternative.

Alternative 3 is moderately favorable overall in meeting the implementability criterion (technical and administrative feasibility, and availability of materials and services). It is moderately favorable for the technical feasibility sub-criterion because it has worked previously within the SVFUDS, but not for the site-specific COCs, and therefore, implementation would be delayed pending completion of a treatability study. The administrative feasibility sub-criterion is moderately favorable because it will require coordination with the property owner and regulatory agencies. While materials and services are generally available, site-specific plant needs (yet to be determined) may impact implementation of this alternative.

The cost to implement this alternative is moderate. As detailed in Appendix B, the total estimated cost for Alternative 3 is approximately $15,000 per grid (20 ft by 20 ft by 4 ft deep) of contaminated soil. These costs include planting of a variety of selected species, maintenance, harvesting and disposal. Work Plan, treatability study, and report preparation costs are also included. The cost will vary for different discrete areas of contaminated soil, based on various factors including the type of plant(s) required, climate factors (e.g., amount of irrigation needed), nutrient requirements, the number of harvesting and replanting cycles required, and disposal requirements. This alternative includes costs for installation and maintenance of fencing (three foot high wooden picket fence with gate) which may be necessary to restrict access to the area during treatment. The estimated cost for the treatability study required to determine the technical feasibility and design parameters is $5,000, using previous costs for similar phytoremediation studies within the SVFUDS and an assumed economy of scale for multiple individual discrete areas of contaminated soil.

These estimates are based on prior costs for similar work completed throughout the SVFUDS (provided by USACE) and engineering judgment.

5.2.1.3 Modifying Criteria

State and community acceptance cannot be fully assessed until comments are processed following the public review period on the Proposed Plan. Therefore, these modifying criteria have not been included in this analysis, but will be included following review and input from those parties. However, this alternative has been successfully conducted previously within the SVFUDS, having obtained state and community acceptance.

5.2.2 Alternative 4: Excavation and Off-site Disposal

5.2.2.1 Threshold Criteria

Alternative 4 provides protection of public health and the environment by excavating site soils and achieving the RAOs for contaminated soil. As discussed in Section 3.1.4, under this alternative, areas of contaminated soil would be delineated through additional sampling, and excavated. Confirmation sampling would be completed and the new sample data would be used to recalculate the human health risks for that location. Excavation and confirmation sampling would continue until the RAOs are met, as determined by the recalculated carcinogenic and/or non-carcinogenic risks.

Alternative 4 was reviewed with respect to TBCs and compliance with ARARs (see Tables 2.1 and 2.2). The excavation and off-site disposal alternative is expected to attain all chemical-specific TBCs and action-specific ARARs (as discussed in Section 2.2 and listed in Tables 2.1 and 2.2). Chemical-specific TBCs for soil are applicable and focus on ensuring that health-protective cleanup standards are met (under CERCLA). This alternative will comply with CERCLA criteria for soil by removing the contaminated soils and leaving in-place soil that meets the RAOs. Action-specific ARARs focus on the protection of public health and the environment during remedial activities, such as controlling fugitive dust that may be inhaled by workers. All action-specific ARARs will be complied with during and following remedial activities under Alternative 4.

Alternative 4 is protective of public health and the environment and compliant with ARARs, and therefore favorable for the threshold criteria.

5.2.2.2 Balancing Criteria

Alternative 4 is favorable regarding the long-term effectiveness criterion as the contaminated soils will be removed from the site, eliminating residual risk, and it will require only a short period of time until the endpoints are reached. During implementation of this alternative, controls would be required to minimize dust generated during the excavation.

Alternative 4 is not favorable in reducing toxicity, mobility and volume of contaminants at the property because it is recognized that while the material is excavated and disposed offsite, the preference to permanently and significantly reduce contaminants through treatment is not met (assuming landfill disposal) as the soil contaminants simply transfer to a landfill.

Alternative 4 is favorable in meeting the short-term effectiveness criterion because the time required to meet the RAOs is minimal. The community, workers, and the environment can be protected during implementation, and the engineering controls to do this work safely and effectively have been well established for this type of operation in the SVFUDS.

Alternative 4 is favorable overall in meeting the implementability criterion (technical and administrative feasibility, and availability of materials and services). Construction and operational considerations and the reliability of the alternative are well established. All services, materials, and equipment required to perform the excavations are readily available.

The cost to implement this alternative is moderate to high, based on having conducted contaminated soil removals throughout the SVFUDS as described previously. As detailed in Appendix B, the total estimated cost for Alternative 4 is approximately $30,000 per grid (20 ft by 20 ft by 4 ft deep) of contaminated soil. These costs include delineation and confirmation sampling, excavation and disposal, backfilling with clean soil, and restoration of the land. Work Plan and report preparation costs are also included.

Costs will vary at site-specific locations based on factors such as volume of soil removed, with disposal at a RCRA non-hazardous sanitary landfill being less costly than disposal as RCRA hazardous at a RCRA Subtitle C landfill. Further, as discussed in Sections 3.1.4.5 and 4.3.4, should an excavation need to be conducted as a high-probability operation, this alternative cost would be significantly higher. However, based on the significant past experience with excavations within the SVFUDS, it is likely that this alternative would be conducted under low-probability protocols.

These estimates are based on prior costs for similar work completed throughout the SVFUDS (provided by USACE) and engineering judgment.

5.2.2.3 Modifying Criteria

State and community acceptance cannot be fully assessed until comments are processed following the public review period on the Proposed Plan. Therefore, these modifying criteria have not been included in this analysis, but will be included following review and input from those parties. However, this alternative has been successfully conducted previously within the SVFUDS, having obtained state and community acceptance.

5.3 Individual Analysis of Explosive Hazards Remedial Alternatives

The broad screening performed in Section 4.4 for explosive hazards remedial alternatives against effectiveness, implementability, and cost, eliminated remedial Alternative 1 - No Further Action, and Alternative 2 – LUCs, from further consideration. This section individually evaluates the four remaining explosive hazards remedial alternatives against the nine criteria, while Section 5.5 compares the four alternatives to each other. The following discussions focus on how, and to what extent, the alternatives address each of the criteria by qualitatively assessing whether the alternative is favorable, moderately favorable, or not favorable, relative to the criterion (note that for the threshold criteria, which must be met, 'favorable' means criteria will be met while 'unfavorable' means criteria will not be met). Table 5.2 presents the summary of the detailed analysis of the remaining explosive hazards alternatives.

5.3.1 Alternative 3: Full DGM Coverage, Remove All Anomalies

5.3.1.1 Threshold Criteria

Alternative 3 is protective of public health and the environment based on the removal of any identified anomalies that could pose an unacceptable explosive hazard. Under this alternative, no identified anomalies would be left in the ground. Any MEC or MD removed would be inspected to determine its explosive safety status and properly disposed of per applicable policy and regulations.

Alternative 3 was reviewed with respect to compliance with ARARs (see Table 2.2). The TBCs identified (Table 2.1) are applicable to chemicals in soil and have been addressed in Section 5.2.

Action-specific ARARs will be complied with for Alternative 3. Action-specific ARARs focus on the protection of public health and the environment during completion of remedial activities, as listed in Table 2.2.

Alternative 3 is protective of public health and the environment, compliant with ARARs, and therefore favorable for the threshold criteria.

5.3.1.2 Balancing Criteria

Alternative 3 is favorable for the long-term effectiveness criterion because it best addresses the magnitude of remaining hazard by employing the standard of full DGM coverage and removal of all anomalies identified.

Alternative 3 is favorable in reducing the volume of contaminants (MEC) at the property because by employing the standard of full DGM coverage and removal of all anomalies identified, the type and quantity of anomalies that could pose explosive hazards will be reduced significantly. For the anomalies removed, this alternative also meets the USEPA's preference to permanently and significantly reduce contaminants through treatment (i.e., MEC items are rendered safe and are no longer contaminants).

Alternative 3 is only moderately favorable in meeting the short-term effectiveness criterion because while the community, workers, and the environment can be protected during implementation, and engineering controls to do this work safely and effectively have been well established for this type of operation in the SVFUDS, the higher DGM coverage standard and removal of all anomalies will increase the time required to meet the RAOs. Further, additional adverse environmental impacts are possible with full coverage DGM where more vegetation and even large tree removal may be part of the implementation of the alternative.

Alternative 3 is moderately favorable in meeting the implementability (technical and administrative feasibility, and availability of materials and services) criterion. Operational considerations and the reliability of the alternative are well established. However, the technical feasibility sub-criterion is only moderately favorable in that the higher DGM coverage standard, that may involve removal and restoration of two discrete areas of landscaped vegetation or trees, could present challenges. The administrative feasibility sub-criterion is only moderately favorable in that it will require significant coordination with the property owner to implement the extensive vegetation and/or tree removal and restoration activities that may be required. All materials, services, and equipment required to perform the DGM and anomaly removals are readily available.

While this alternative would be applied to 98 properties, costs are estimated based on an individual generic representative property. The cost to implement Alternative 3 is moderate to high, based on having conducted many DGM and anomaly removal efforts throughout the SVFUDS as described previously. As detailed in Appendix B, the total estimated cost for Alternative 3 is approximately $230,000 per property. This includes the assumptions under the full DGM coverage standard of two discrete areas requiring vegetation cutting and restoration, and a small portion of fencing to be removed and replaced. Further, under the remove all anomalies standard, it was assumed that on average, one-half of a driveway would need to be intrusively investigated and replaced (or that every other one of the 98 properties would require full driveway replacement). Additionally included are costs for Work Plan and report preparation.

These estimates are based on prior costs for similar work completed throughout the SVFUDS (provided by USACE) and engineering judgment. In actual implementation, an economy of scale would reduce the per property cost considerably, as (for example) a single Work Plan addressing all 98 properties would be prepared rather than 98 separate Work Plans.

5.3.1.3 Modifying Criteria

State and community acceptance cannot be fully assessed until comments are processed following the public review period on the Proposed Plan. Therefore, these modifying criteria have not been included in this analysis, but will be included following review and input from those parties. However, this alternative has been successfully conducted previously within the SVFUDS, having obtained state and community acceptance.

5.3.2 Alternative 4: Full DGM Coverage, Remove Selected Anomalies

5.3.2.1 Threshold Criteria

Alternative 4 is protective of public health and the environment based on the removal of any identified anomalies that could pose an unacceptable explosive hazard. Under this alternative, anomalies identified as innocuous metallic debris, including harmless MD items, would be left in the ground. Any MEC removed would be inspected to determine its explosive safety status and properly disposed of per applicable policy and regulations.

Alternative 4 was reviewed with respect to compliance with ARARs (see Table 2.2). The TBCs identified (Table 2.1) are applicable to chemicals in soil and have been addressed in Section 5.2.

Action-specific ARARs will be complied with for Alternative 4. Action-specific ARARs focus on the protection of public health and the environment during completion of remedial activities, as listed in Table 2.2.

Alternative 4 is protective of public health and the environment, compliant with ARARs, and therefore favorable for the threshold criteria.

5.3.2.2 Balancing Criteria

Alternative 4 is only moderately favorable for the long-term effectiveness criterion in addressing the magnitude of remaining hazard because while it employs the standard of full DGM coverage, it does not remove all anomalies identified. It is ranked moderately favorable in that even though the proper use of AC technology to discriminate munitions-related anomalies would result in only innocuous metallic debris left in the ground, it is possible that a MEC item could still remain.

Alternative 4 is only moderately favorable in reducing volume of contaminants at the property because while it employs the standard of full DGM coverage, it does not remove all anomalies identified. However, the use of AC technology will leave only innocuous metallic debris in the ground, and therefore, the type and quantity of anomalies that could pose explosive hazards will be reduced. For the anomalies removed, this alternative also meets the USEPA's preference to permanently and significantly reduce contaminants through treatment (i.e., MEC items are rendered safe and are no longer contaminants).

Alternative 4 is only moderately favorable in meeting the short-term effectiveness criterion because while the community, workers, and the environment can be protected during implementation, and engineering controls to do this work safely and effectively have been well established for this type of operation in the SVFUDS, the higher DGM coverage standard will increase the time required to meet the RAOs. Further, additional adverse environmental impacts are possible with full coverage DGM where more vegetation and even large tree removal may be part of the implementation of the alternative.

Alternative 4 is moderately favorable in meeting the implementability (technical and administrative feasibility, and availability of materials and services) criterion. Operational considerations and the reliability of the alternative are well established. However, the technical feasibility sub-criterion is only moderately favorable in that the higher DGM coverage standard, that may involve removal and restoration of two discrete areas of landscaped vegetation or trees, could present challenges. The administrative feasibility sub-criterion is only moderately favorable in that it will require significant coordination with the property owner to implement the extensive vegetation and/or tree removal and restoration activities that may be required. All materials, services, and equipment required to perform the DGM and anomaly removals are readily available.

While this alternative would be applied to 98 properties, costs are estimated based on an individual generic representative property. The cost to implement Alternative 4 is moderate to high, based on having conducted many DGM and anomaly removal efforts throughout the SVFUDS as described previously. As detailed in Appendix B, the total estimated cost for Alternative 4 is approximately $225,000 per property. This includes the assumptions under the full DGM coverage standard of two discrete areas requiring vegetation cutting and restoration, and a small portion of fencing to be removed and replaced. Further, under the remove selected anomalies standard, it was assumed that on average, one-third of a driveway would require replacement (or that every third one of the 98 properties would require full driveway replacement; this assumes that the use of AC would identify more anomalies as innocuous metallic debris and would reduce the percentage of driveway that would require intrusive investigation). Additionally included are costs for Work Plan and report preparation.

These estimates are based on prior costs for similar work completed throughout the SVFUDS (provided by USACE) and engineering judgment. In actual implementation, an economy of scale would reduce the per property cost considerably, as (for example) a single Work Plan addressing all 98 properties would be prepared rather than 98 separate Work Plans.

5.3.2.3 Modifying Criteria

State and community acceptance cannot be fully assessed until comments are processed following the public review period on the Proposed Plan. Therefore, these modifying criteria have not been included in this analysis, but will be included following review and input from those parties. However, this alternative has been successfully conducted previously within the SVFUDS, having obtained state and community acceptance. With regard to state and community acceptance, while the AC technology discrimination of anomalies has not previously been done at the SVFUDS, it is an improved system relative to the previous A-B-C-D or professional judgment anomaly removal rationale.

5.3.3 Alternative 5: DGM of Accessible Areas, Remove All Anomalies

5.3.3.1 Threshold Criteria

Alternative 5 is protective of public health and the environment based on the removal of any identified anomalies that could pose an unacceptable explosive hazard. Under this alternative, no identified anomalies would be left in the ground. Any MEC or MD removed would be inspected to determine its explosive safety status and properly disposed of per applicable policy and regulations.

Alternative 5 was reviewed with respect to compliance with ARARs (see Table 2.2). The TBCs identified (Table 2.1) are applicable to chemicals in soil and have been addressed in Section 5.2.

Action-specific ARARs will be complied with for Alternative 5. Action-specific ARARs focus on the protection of public health and the environment during completion of remedial activities, as listed in Table 2.2.

Alternative 5 is protective of public health and the environment, compliant with ARARs, and therefore favorable for the threshold criteria.

5.3.3.2 Balancing Criteria

Alternative 5 is only moderately favorable for the long-term effectiveness criterion in addressing the magnitude of remaining hazard because while it employs the standard of removal of all anomalies identified, the DGM coverage standard is accessible areas, meaning some areas would not be geophysically surveyed.

Alternative 5 is only moderately favorable in reducing volume of contaminants at the property because while it employs the standard of removal of all anomalies identified, the DGM coverage standard is accessible areas, meaning some areas would not be geophysically surveyed. The type and quantity of anomalies that could pose explosive hazards will be reduced, but the areas not surveyed may contain additional anomalies. For the anomalies removed, this alternative also meets the USEPA's preference to permanently and significantly reduce contaminants through treatment (i.e., MEC items are rendered safe and are no longer contaminants).

Alternative 5 is favorable in meeting the short-term effectiveness criterion because the community, workers, and the environment can be protected during implementation, and engineering controls to do this work safely and effectively have been well established for this type of operation in the SVFUDS. The DGM coverage standard of accessible areas will allow the RAOs to be achieved in a shorter time period and additional adverse environmental impacts are not anticipated as part of the implementation of the alternative as fewer areas of landscaped vegetation or trees would be removed.

Alternative 5 is favorable in meeting the implementability (technical and administrative feasibility, and availability of materials and services) criterion. Operational considerations and the reliability of the alternative are well established. The technical feasibility sub-criterion is favorable in that fewer areas of landscaped vegetation or trees would be removed under the accessible areas DGM standard. The administrative feasibility sub-criterion is also favorable in that extensive coordination with the property owner will not be required as fewer areas of landscaped vegetation or trees would be removed. All materials, services, and equipment required to perform the DGM and anomaly removals are readily available.

While this alternative would be applied to 98 properties, costs are estimated based on an individual generic representative property. The cost to implement Alternative 5 is moderate to high, based on having conducted many DGM and anomaly removal efforts throughout the SVFUDS as described previously. As detailed in Appendix B, the total estimated cost for Alternative 5 is approximately $197,500 per property. This includes the assumption under the accessible areas DGM coverage standard of one discrete area requiring vegetation cutting and restoration. Further, under the remove all anomalies standard, it was assumed that on average, one-half of a driveway would need to be intrusively investigated and replaced (or that every other one of the 98 properties would require full driveway replacement). Additionally included are costs for Work Plan and report preparation.

These estimates are based on prior costs for similar work completed throughout the SVFUDS (provided by USACE) and engineering judgment. In actual implementation, an economy of scale would reduce the per property cost considerably, as (for example) a single Work Plan addressing all 98 properties would be prepared rather than 98 separate Work Plans.

5.3.3.3 Modifying Criteria

State and community acceptance cannot be fully assessed until comments are processed following the public review period on the Proposed Plan. Therefore, these modifying criteria have not been included in this analysis, but will be included following review and input from those parties. However, this alternative has been successfully conducted previously within the SVFUDS, having obtained state and community acceptance.

5.3.4 Alternative 6: DGM of Accessible Areas, Remove Selected Anomalies

5.3.4.1 Threshold Criteria

Alternative 6 is protective of public health and the environment based on the removal of any identified anomalies that could pose an unacceptable explosive hazard. Under this alternative, anomalies identified as innocuous metallic debris, including harmless MD items, would be left in the ground. Any MEC removed would be inspected to determine its explosive safety status and properly disposed of per applicable policy and regulations.

Alternative 6 was reviewed with respect to compliance with ARARs (see Table 2.2). The TBCs identified (Table 2.1) are applicable to chemicals in soil and have been addressed in Section 5.2.

Action-specific ARARs will be complied with for Alternative 6. Action-specific ARARs focus on the protection of public health and the environment during completion of remedial activities, as listed in Table 2.2.

Alternative 6 is protective of public health and the environment, compliant with ARARs, and therefore favorable for the threshold criteria.

5.3.4.2 Balancing Criteria

Alternative 6 is only moderately favorable for the long-term effectiveness criterion in addressing the magnitude of remaining hazard because the DGM coverage standard is accessible areas, meaning some areas would not be geophysically surveyed, and even though the proper use of AC technology to discriminate munitions-related anomalies would result in only innocuous metallic debris left in the ground, it is possible that a MEC item could still remain. Even though the use of AC technology to discriminate munitions-related anomalies would result in only innocuous metallic debris left in the ground, some anomalies would still remain.

Alternative 6 is only moderately favorable in reducing volume of contaminants at the property because the DGM coverage standard is accessible areas, meaning some areas would not be geophysically surveyed, and it does not remove all anomalies identified. However, the use of AC technology will leave only innocuous metallic debris in the ground, and therefore, the type and quantity of anomalies that could pose explosive hazards will be reduced, but the areas not surveyed may contain additional anomalies. For the anomalies removed, this alternative also meets the USEPA's preference to permanently and significantly reduce contaminants through treatment (i.e., MEC items are rendered safe and are no longer contaminants).

Alternative 6 is favorable in meeting the short-term effectiveness criterion because the community, workers, and the environment can be protected during implementation, and engineering controls to do this work safely and effectively have been well established for this type of operation in the SVFUDS. The DGM coverage standard of accessible areas will allow the RAOs to be achieved in a shorter time period and additional adverse environmental impacts are not anticipated as part of the implementation of the alternative as fewer areas of landscaped vegetation or trees would be removed.

Alternative 6 is favorable in meeting the implementability (technical and administrative feasibility, and availability of materials and services) criterion. Operational considerations and the reliability of the alternative are well established. The technical feasibility sub-criterion is favorable in that fewer areas of landscaped vegetation or trees would be removed under the accessible areas DGM standard. The administrative feasibility sub-criterion is also favorable in that extensive coordination with the property owner will not be required as fewer areas of landscaped vegetation or trees would be removed. All materials, services, and equipment required to perform the DGM and anomaly removals are readily available.

While this alternative would be applied to 98 properties, costs are estimated based on an individual generic representative property. The cost to implement Alternative 6 is moderate to high, based on having conducted many DGM and anomaly removal efforts throughout the SVFUDS as described previously. As detailed in Appendix B, the total estimated cost for Alternative 6 is approximately $192,500 per property. This includes the assumption under the accessible areas DGM coverage standard of one discrete area requiring vegetation cutting and restoration. Further, under the remove selected anomalies standard, it was assumed that on average, one-third of a driveway would require replacement (or that every third one of the 98 properties would require full driveway replacement; this assumes that the use of AC would identify more anomalies as innocuous metallic debris and would reduce the percentage of driveway that would require intrusive investigation). Additionally included are costs for Work Plan and report preparation.

These estimates are based on prior costs for similar work completed throughout the SVFUDS (provided by USACE) and engineering judgment. In actual implementation, an economy of scale would reduce the per property cost considerably, as (for example) a single Work Plan addressing all 98 properties would be prepared rather than 98 separate Work Plans.

5.3.4.3 Modifying Criteria

State and community acceptance cannot be fully assessed until comments are processed following the public review period on the Proposed Plan. Therefore, these modifying criteria have not been included in this analysis, but will be included following review and input from those parties. However, this alternative has been successfully conducted previously within the SVFUDS, having obtained state and community acceptance. With regard to state and community acceptance, while the AC technology discrimination of anomalies has not previously been done at the SVFUDS, it is an improved system relative to the previous A-B-C-D or professional judgment anomaly removal rationale.

5.4 Comparative Analysis of Contaminated Soil Remedial Alternatives

While Section 5.2 described and individually assessed each of the two remaining contaminated soil alternatives against the nine criteria, this section evaluates the performance of each alternative relative to each other. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs can be identified, and a preferred alternative selected.

The most important evaluation is against the threshold criteria, as these must be met. Both alternatives were considered protective of human health and the environment. However, Alternative 3 requires an assumption that a treatability study will demonstrate that phytoremediation can successfully treat the site-specific COCs, reducing soil contamination and meeting the RAOs. Therefore, Alternative 4 was considered to have fewer performance unknowns than Alternative 3.

Both alternatives were compliant with ARARs.

With regard to the balancing criteria, Alternative 3 was only moderately effective in the long term due to the need to potentially have different types of plants targeting different COCs, and the possibility these may be needed in the same areas of contaminated soil, i.e., where more than one COC needs to be addressed in a single area. Further, the phytoremediation process could take a substantial length of time to reach RAOs, based on plant growth cycles. Alternative 4 was the most effective in the long term as it is a permanent remedy that, based on confirmation sampling, leaves no residual risk at the site.

Both alternatives were ranked as not favorable with regard to reducing toxicity, mobility, and volume of contaminants because soil contaminants would not be treated (assuming landfill disposal), but would be transferred to a landfill.

Alternative 3 is not favorable in meeting the short-term effectiveness criterion because the plants have a growing and harvesting cycle that requires sufficient time; contaminants are not addressed in the short-term under this alternative. However, Alternative 4 is favorable in meeting the short-term effectiveness criterion because the time required to meet the RAOs is minimal. The community, workers, and the environment can be protected during implementation, and the engineering controls to do this work safely and effectively have been well established for this type of operation in the SVFUDS.

Alternative 3 was moderately favorable overall for the implementability criteria (technical and administrative feasibility, and availability of materials and services). It is moderately favorable for technical feasibility sub-criterion because it has not been successfully demonstrated for the site-specific COCs, and therefore, implementation would be delayed pending completion of a treatability study. The administrative feasibility sub-criterion is moderately favorable because it will require significant coordination with the property owner during the growing and maintenance cycle of one or more types of plants. While materials and services are generally available, site-specific plant needs (yet to be determined) could impact implementation of this alternative. However, Alternative 4 was favorable overall for the implementability criteria because construction and operational considerations and the reliability of excavation and disposal to address the contaminants are well established. All services, materials, and equipment required to perform the excavations and properly dispose of contaminated soil are readily available.

Costs generally are a function of time required to achieve the RAOs and volume of soil to be addressed, with Alternative 3 impacted more by time and Alternative 4 impacted more by volume of soil. On a per grid basis, phytoremediation is less expensive than excavation and disposal. However, phytoremediation contains more unknowns. One or more treatability studies may need to be conducted to address different COCs in different climate and/or soil conditions. A study may determine success for one COC but not another. Plants may need to be harvested and replanted over several cycles, depending on the growth success in a specific area (which cannot be known at the planning stages) thereby increasing to estimated costs. The areas would need to be protected by temporary fencing during the growing cycles. The primary cost unknown associated with excavation is the potential to chase contamination horizontally or vertically through confirmation sampling, requiring increasing volumes to address. The excavation costs assume low probability protocols, and the analysis acknowledges the substantial increase in costs should an excavation to have to be conducted as a high-probability operation. However, based on the significant past experience with excavations within the SVFUDS, it is likely that these excavations would be conducted under low-probability protocols.

Therefore, while Alternative 3 is initially less costly than Alternative 4, based on much experience with both alternatives within the SVFUDS, the unknowns associated with phytoremediation costs are considered to be significant enough that the lower phytoremediation costs ranked only slightly more favorable than the higher excavation and disposal costs.

State and community acceptance cannot be fully assessed until comments are processed following the public review period on the Proposed Plan. Therefore, these modifying criteria have not been included in this analysis, but will be included following review and input from those parties. However, both alternatives have been successfully conducted previously within the SVFUDS, having obtained state and community acceptance.

5.5 Comparative Analysis of Explosive Hazards Remedial Alternatives

While Section 5.3 described and individually assessed each of the four remaining explosive hazards alternatives against the nine criteria, this section evaluates the performance of each alternative relative to each other. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs can be identified, and a preferred alternative selected.

The most important evaluation is against the threshold criteria, as these must be met. Each of the four alternatives was considered protective of human health and the environment. However, Alternatives 3 and 5, which remove all anomalies, were considered to have fewer unknowns than the other alternatives.

All four alternatives were compliant with ARARs.

With regard to the balancing criteria, only Alternative 3 was favorable in the long term due to the higher DGM coverage and anomaly removal quantity standards. The other three alternatives were moderately favorable because relative to Alternative 3, either they had less DGM coverage, or removed fewer anomalies. Similarly, only Alternative 3 was ranked slightly higher with regard to reducing volume of contaminants because more acreage would be covered and more anomalies removed.

With regard to the short-term effectiveness criterion and the time required to achieve the RAOs, the higher DGM coverage standard of Alternatives 3 and 4, and the resulting additional time and logistics involved in cutting more areas of vegetation, ranked those alternatives as less favorable than Alternatives 5 and 6.

Alternatives 3 and 4 were ranked as moderately favorable overall for the implementability criteria (technical and administrative feasibility, and availability of materials and services) primarily because the higher DGM coverage standard could present challenges to the technical feasibility sub-criterion, and the administrative feasibility sub-criterion could require significant coordination with the property owner to implement the extensive vegetation and/or tree removal and restoration activities that may be required. However, Alternatives 5 and 6 were ranked as favorable overall for the implementability criteria because fewer areas of landscaped vegetation or trees would be removed and less coordination with the property owner would be required under the accessible areas DGM standard.

Costs for the explosive hazards remedial alternatives were primarily a function of DGM coverage and the assumptions of how much additional work was involved in cutting and restoring landscaped areas of vegetation or trees. The full DGM coverage standard alternatives (3 and 4) were more costly than the accessible areas DGM coverage standard alternatives (5 and 6). Secondarily, costs were a function of the anomaly removal quantity standard. While removing all anomalies was more costly than the removing selected anomalies, there was not a significant difference in that on an individual residential property basis, where a large number of anomalies would not be expected, the addition of the AC technology to discriminate and allow more anomalies to be left in the ground tended to balance out the savings effected by not having to remove all anomalies. However, evaluated across all 98 properties, considering the total number of anomalies anticipated, AC technology used to reduce the total number of digs would result in significant savings. Accordingly, the least costly alternative was Alternative 6, where less DGM would be conducted, and fewer anomalies would be removed.

The anomaly removal costs assume low probability protocols, and the analysis acknowledges the substantial increase in costs should an intrusive effort have to be conducted as a high-probability operation. However, based on the significant past experience with anomaly removals within the SVFUDS, it is likely that these activities would be conducted under low-probability protocols.

Further, in actual implementation, an economy of scale would reduce the per property cost considerably, as (for example) a single Work Plan addressing all 98 properties would be prepared rather than 98 separate Work Plans. It should also be noted that the costing analysis was separately applied to properties with and without previous DGM/anomaly removal investigations, and the relative magnitude of the costs for the four alternatives being analyzed was the same. That is, while the costs of the four alternatives for properties with previous investigations were lower than the costs for the four alternatives for properties with no previous investigations, Alternative 3 costs were higher than Alternative 4 costs, which were higher than Alternative 5 costs, which were higher than Alternative 6 costs.

State and community acceptance cannot be fully assessed until comments are processed following the public review period on the Proposed Plan. Therefore, these modifying criteria have not been included in this analysis, but will be included following review and input from those parties. However, these alternatives have been successfully conducted previously within the SVFUDS, having obtained state and community acceptance.

5.5.1 Site-Wide RAO Alternative

The site-wide RAO addresses potential explosive hazards for the properties within the SVFUDS that are not part of the areas of focus identified in Figure 4. The response alternatives to achieve this RAO were limited to education and awareness initiatives as other more direct action-oriented alternatives are not practical. Education and awareness initiatives will include community-wide mailings of educational material such as understanding the 3 ‘R’s (recognize, retreat, and report) with regard to areas where potential munitions may be encountered. These will be formalized in an Institutional Analysis Report that describes the development, implementation, and maintenance of an institutional controls program to help manage explosive hazards and identify stakeholder participation. In addition, as this alternative does not achieve UU/UE, periodic reviews would supplement the education and awareness initiatives, further providing the opportunity to evaluate new information and ensure that the community remains aware of the potential for MEC to be encountered within the SVFUDS.

5.6 Conclusions - Contaminated Soil Remedial Alternatives

Table 5.1 presents the summary of the detailed analysis of remaining contaminated soil remedial alternatives for the SVFUDS. Alternative 4, Excavation and Off-site Disposal, is the most favorable remedial alternative to achieve the RAOs, but final selection of a preferred alternative will be proposed and documented in the forthcoming Proposed Plan.

Relative to Alternative 3, it was ranked as favorable in three out of seven of the nine criteria that were ranked (not including the two modifying criteria). Three criteria were ranked as equal between the two alternatives. As described in Section 5.4 above, while Alternative 3 is initially less costly than Alternative 4, the unknowns associated with it render the costing criterion only slightly more favorable than Alternative 4. In addition, previous EE/CAs, as described in Section 1.3.3, presented comprehensive screenings of remedial technologies to address contaminated soil within the SVFUDS, concluding that excavation and disposal was the preferred technology. The FS completed for the 4825 Glenbrook Road property within the SVFUDS also concluded that excavation and disposal was the appropriate alternative to address the soil contamination associated with that property.

Alternative 4, excavation and off-site disposal, will meet the RAOs in the shortest time, with the fewest unknowns. It will address all COCs under all site-specific conditions, will achieve UU/UE, and it has been successfully conducted many times throughout the SVFUDS.

5.7 Conclusions - Explosive Hazards Remedial Alternatives

Table 5.1 presents the summary of the detailed analysis of remaining explosive hazards remedial alternatives for the areas of focus. Alternative 6, DGM of Accessible Areas, Remove Selected Anomalies, is the most favorable remedial alternative to achieve the RAOs, but final selection of a preferred alternative will be proposed and documented in the forthcoming Proposed Plan.

Alternative 6 was ranked as favorable in three out of seven of the nine criteria that were ranked (not including the two modifying criteria). Two criteria were ranked as equal among the four alternatives. On an individual property basis, Alternative 6 is the least costly of the four alternatives, and it would show even more savings relative to the other alternatives when evaluated across all 98 properties.

Alternative 6, DGM of accessible areas with removal of selected anomalies, is protective of human health and the environment, is compliant with ARARs, will meet the RAOs in the shortest time period, and will achieve UU/UE.

5.7.1 Conclusion - Site-Wide RAO Alternative

To achieve the site-wide RAO to address potential explosive hazards for the properties within the SVFUDS that are not part of the areas of focus identified in Figure 4, education and awareness initiatives are the most favorable remedial alternative, but final selection of a preferred alternative will be proposed and documented in the forthcoming Proposed Plan. These will be formalized in an Institutional Analysis Report that describes the development, implementation, and maintenance of an institutional controls program to help manage explosive hazards and identify stakeholder participation. However, as this alternative does not achieve UU/UE, periodic reviews would supplement the education and awareness initiatives, further providing the opportunity to evaluate new information and ensure that the community remains aware of the potential for MEC to be encountered within the SVFUDS.

Table 5.1: Summary of Detailed Analysis of Remaining Contaminated Soil Remedial Alternatives

	Screening Criterion	Alternative 3: Phytoremediation	Alternative 4: Excavation and Off-site Disposal
Threshold	Overall Protection of Human Health and Environment	●	●
	Compliance with ARARs	●	●
Balancing	Long-Term Effectiveness	◐	●
	Reduction of Toxicity, Mobility and Volume Through Treatment\1	○	○
	Short-Term Effectiveness	○	●
	Implementability	◐	●
	Technical Feasibility	◐	●
	Administrative Feasibility	◐	●
	Availability of Materials and Services	◐	●
	Cost\2	**$15,000 per grid\3**	**$30,000 per grid\3**
Modifying\4	State Acceptance	TBD	TBD
	Community Acceptance	TBD	TBD

● Favorable ('YES' for threshold criteria)

◐ Moderately Favorable

○ Not Favorable ('NO' for threshold criteria)

\1 – While both alternatives reduce toxicity, mobility, and volume at the property, the statutory preference is permanent reduction through treatment; therefore, assuming landfill disposal, this criterion is not assessed as 'Favorable'.
\2 - Costs are detailed in Appendix B.
\3 - Based on a 20 ft by 20 ft by 4 ft deep grid of contaminated soil.
\4 – The Modifying criteria of state and community acceptance are 'To Be Determined' following review and input from these parties.

Table 5.2: Summary of Detailed Analysis of Remaining Explosive Hazards Remedial Alternatives

	Screening Criterion	Alternative 3: Full DGM Coverage, Remove All Anomalies	Alternative 4: Full DGM Coverage, Remove Selected Anomalies	Alternative 5: DGM of Accessible Areas, Remove All Anomalies	Alternative 6: DGM of Accessible Areas, Remove Selected Anomalies
Threshold	Overall Protection of Human Health and Environment	●	●	●	●
	Compliance with ARARs	●	●	●	●
Balancing	Long-Term Effectiveness	●	◑	◑	◑
	Reduction of Toxicity, Mobility and Volume Through Treatment[\1]	●	◑	◑	◑
	Short-Term Effectiveness	◑	◑	●	●
	Implementability	◑	◑	●	●
	Technical Feasibility	◑	◑	●	●
	Administrative Feasibility	◑	◑	●	●
	Availability of Materials and Services	●	●	●	●
	Cost[\2]	**$230,000 / property**	**$225,000 / property**	**$197,500 / property**	**$192,500 / property**
Modifying[\3]	State Acceptance	TBD	TBD	TBD	TBD
	Community Acceptance	TBD	TBD	TBD	TBD

● Favorable ('YES' for threshold criteria)

◑ Moderately Favorable

○ Not Favorable ('NO' for threshold criteria)

\1 – For MEC, this criterion addresses volume of MEC. The through treatment preference is met for anomalies removed in that they are rendered safe (no longer 'contaminants') prior to disposal.

\2 - Costs are based on a generic individual property that had no previous DGM/anomaly removal investigations. Details are provided in Appendix B.

\3 – The Modifying criteria of state and community acceptance are 'To Be Determined' following review and input from these parties.

6.0 REFERENCES

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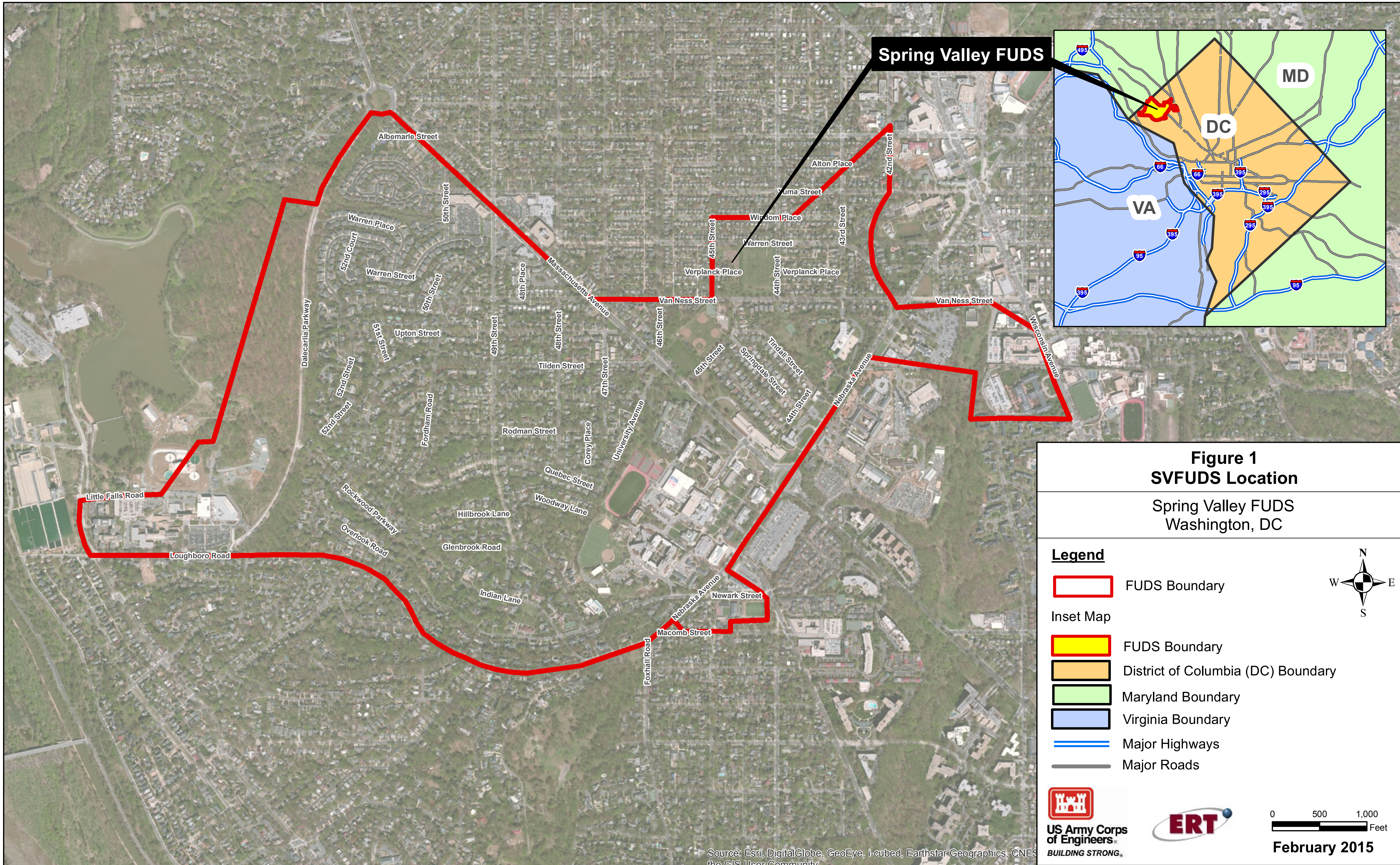
Appendix A:
Site Figures


Spring Valley FUDS
MD
DC
VA
Albemarle Street
Warren Place
52nd Court
Warren Street
50th Street
50th Street
48th Place
Massachusetts Avenue
Van Ness Street
45th Street
Wisdom Place
Warren Street
Verplanck Place
44th Street
Verplanck Place
43rd Street
Alton Place
Yuma Street
42nd Street
Van Ness Street
Wisconsin Avenue
Dalecarlia Parkway
51st Street
Upton Street
49th Street
48th Street
46th Street
45th Street
Springdale Street
Tindall Street
44th Street
Nebraska Avenue
52nd Street
52nd Street
Fordham Road
Tilden Street
47th Street
University Avenue
Rodman Street
Corey Place
Quebec Street
Woodway Lane
Hillbrook Lane
Rockwood Parkway
Overlook Road
Glenbrook Road
Little Falls Road
Loughboro Road
Indian Lane
Nebraska Avenue
Newark Street
Macomb Street
Foxhall Road
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES
the GIS User Community
Figure 1
SVFUDS Location
Spring Valley FUDS
Washington, DC
Legend
FUDS Boundary
Inset Map
FUDS Boundary
District of Columbia (DC) Boundary
Maryland Boundary
Virginia Boundary
Major Highways
Major Roads
N
S
E
W
US Army Corps of Engineers
BUILDING STRONG
ERT
0
500
1,000
Feet
February 2015

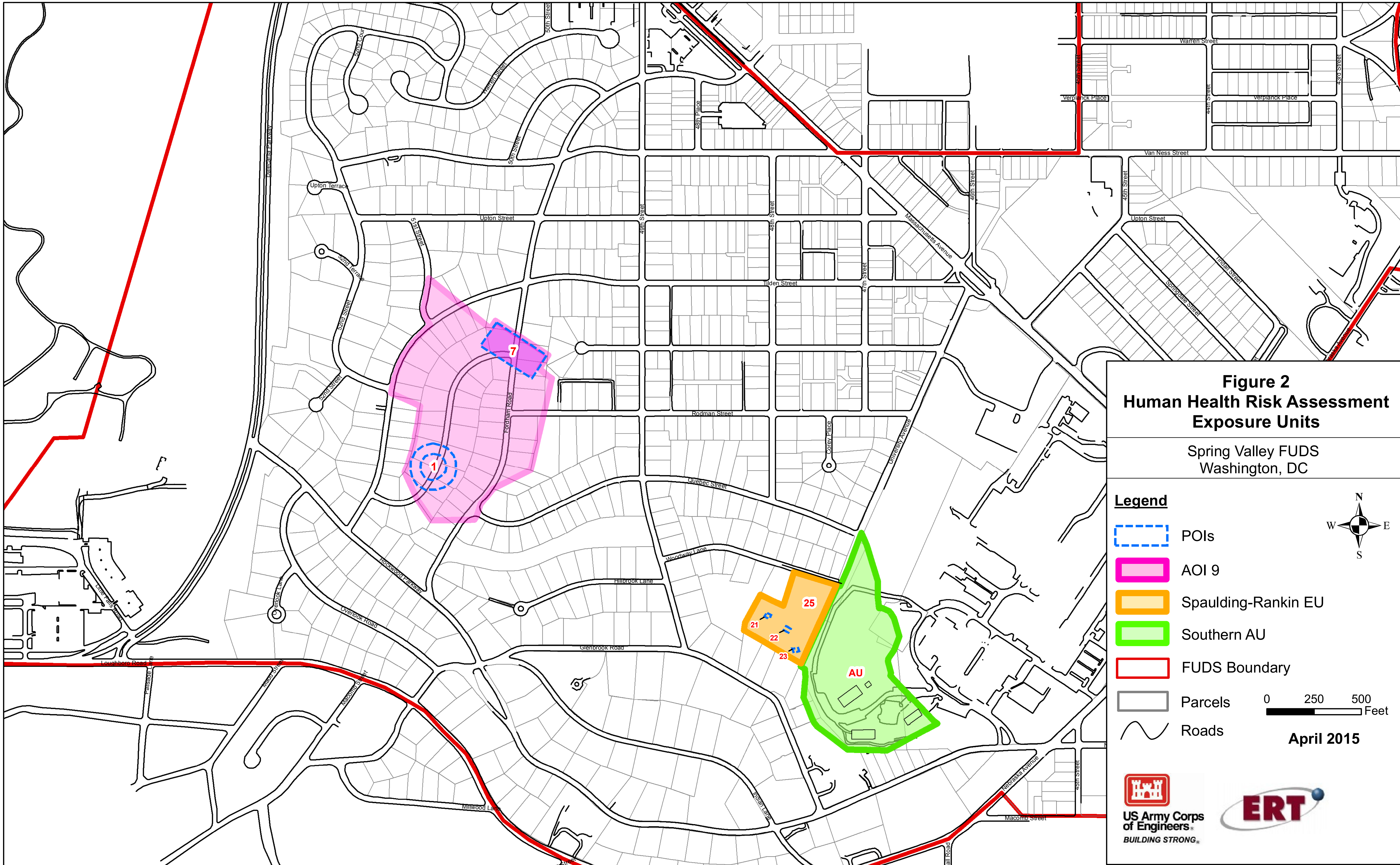
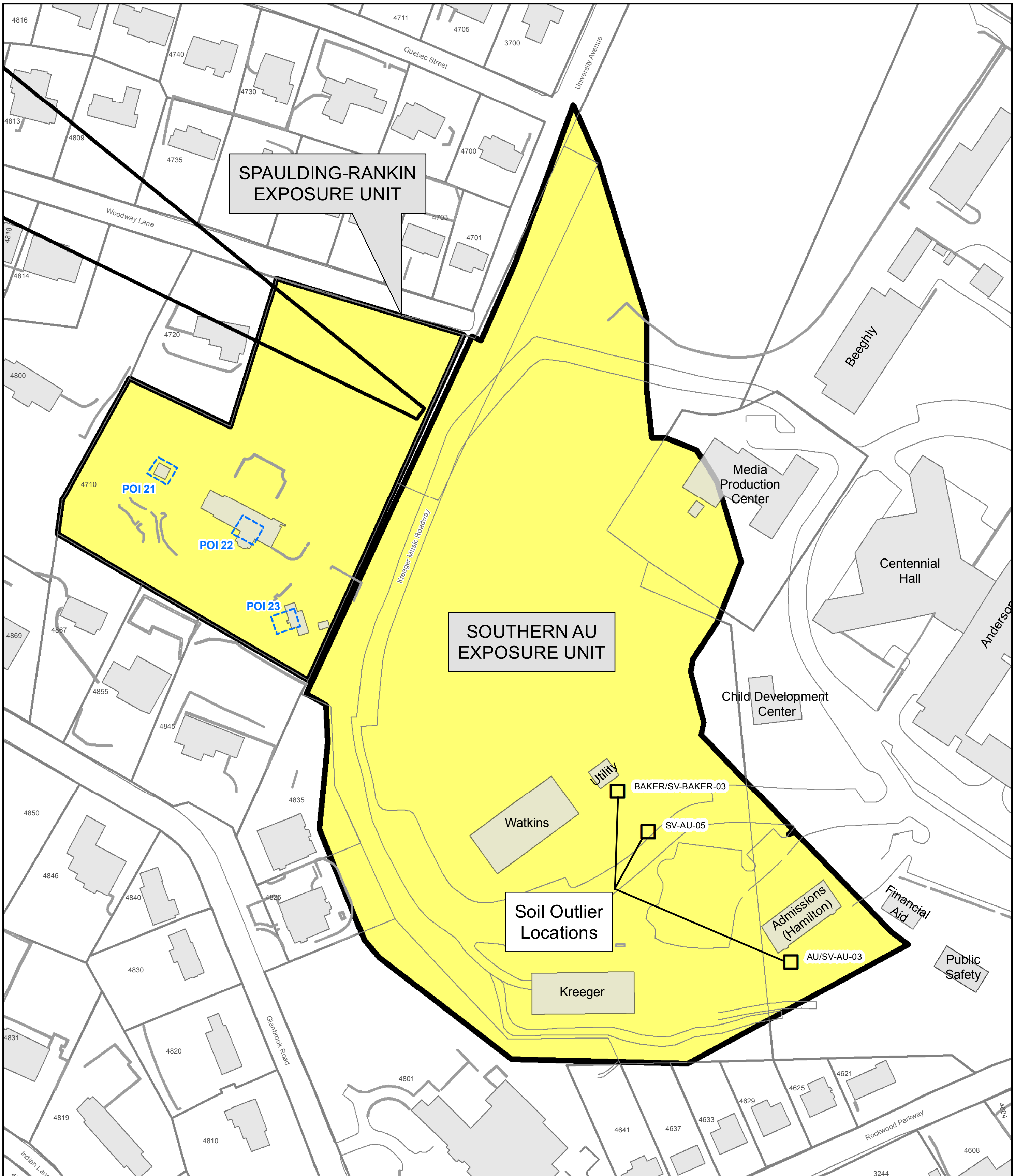


Figure 2
Human Health Risk Assessment
Exposure Units
Spring Valley FUDS
Washington, DC
Legend
POIs
AOI 9
Spaulding-Rankin EU
Southern AU
FUDS Boundary
Parcels
Roads
N
W
E
S
0
250
500
Feet
April 2015
US Army Corps of Engineers
BUILDING STRONG
ERT
7
1
25
21
22
23
AU
Van Ness Street
Upton Street
Tilden Street
Rodman Street
Quebec Street
Woodway Lane
Hillbrook Lane
Glenbrook Road
Rockwood Parkway
Fordham Road
Massachusetts Avenue
University Avenue
Nebraska Avenue
Loughboro Road
Warren Street



US Army Corps of Engineers
BUILDING STRONG
ERT

April 2015

Legend

- Areas of Potential Carcinogenic / Non-Carcinogenic Risk for Evaluation in the FS
- Range Fan
- Parcels
- FUDS Boundary

0 75 150 Feet

Figure 3
Areas of Carcinogenic or Non-Carcinogenic Risk (in soil) for Evaluation in the FS

Spring Valley FUDS
Washington, DC

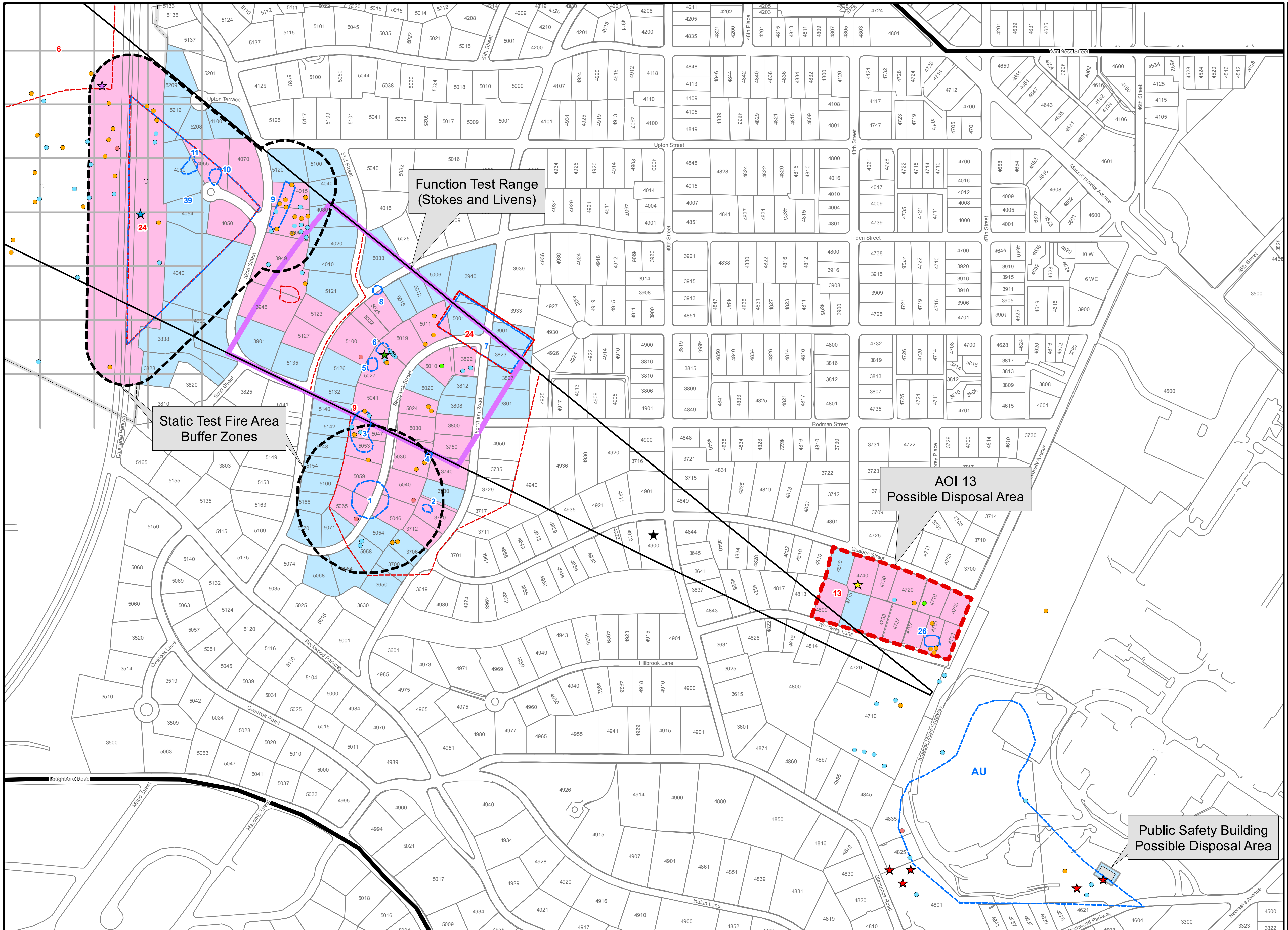


Figure 4
Areas of Focus for Potential Explosive Hazards for Evaluation in the FS

Spring Valley FUDS
Washington, DC

Legend

- Areas for Evaluation in the FS (No Previous DGM / Anomaly Removal)
- Areas for Evaluation in the FS (Previous DGM / Anomaly Removal Property)
- Buffer Zone (150 FT) of Statically Fired Testing Areas
- Function Test Range (Stokes and Livens)
- Area of Interest (AOI)
- Point of Interest (POI)
- Range Fan
- Parcels
- FUDS Boundary

Items

- Livens Projectile (MEC)
- Stokes Mortar (MEC)
- 75 mm Projectile (MEC)
- Thermite Grenade (MEC)
- Pipe with Explosives (MEC)
- Disposal Area (MEC/CWM)
- 75 mm MD
- Livens MD
- Stokes Mortar MD
- MD (miscellaneous)
- Non-AUES MD

0 250 500 Feet

July 2015

US Army Corps of Engineers
BUILDING STRONG
ERT

Appendix B:
Costing Backup

Appendix B-1: Contaminated Soil Remedial Alternatives

Appendix B-2: Explosive Hazard Remedial Alternatives

APPENDIX B-1
SITE-WIDE SVFUDS FEASIBILITY STUDY COSTS
(CONTAMINATED SOIL REMEDIAL ALTERNATIVES)

	TOTAL COST SUMMARY		
	Task	**Total per Task**	
Alternative #3 - Phytoremediation	A. PLANNING	$	60,000
	B. ADMINISTRATION	$	5,000
	C. IMPLEMENTATION	$	87,000
	D. DISPOSAL	$	500
	E. SITE RESTORATION	$	4,700
	F. REPORTING	$	27,500
	TOTAL Alternative #3	**$**	**184,700**

	TOTAL COST SUMMARY		
	Task	**Total per Task**	
Alternative #4 - Excavation and Off-site Disposal	A. PLANNING	$	60,000
	B. ADMINISTRATION	$	5,000
	C. IMPLEMENTATION	$	123,200
	D. MATERIAL TRANSPORT/DISPOSAL	$	64,800
	E. SITE RESTORATION	$	36,200
	F. REPORTING	$	70,000
	TOTAL Alternative #4	**$**	**359,200**

Contaminated Soil Remedial Alternative #3 - Phytoremediation

Cost Item					Costs		
	Task/Subtask	**Item**	**Quantity**	**Units**	**Unit Cost**	**Subtotal**	**Total**
A	**PLANNING**						
	-Plans						
	-Remedial Action Work Plan	Plans	1	LS	$ 25,000	$ 25,000	$ 25,000
	-Treatability Study	Study	1	LS	$ 5,000	$ 5,000	$ 5,000
		CENAB Review	2	WK	$ 15,000	$ 30,000	$ 30,000
		SUBTOTAL A				**$ 60,000**	**$ 60,000**
B	**ADMINISTRATION**						
	- Miscelaneous		1	LS	$ 5,000	$ 5,000	$ 5,000
		SUBTOTAL B				**$ 5,000**	**$ 5,000**
C	**IMPLEMENTATION**						
	- Mob/Demob		1	LS	$ 2,000	$ 2,000	$ 2,000
	- Surveying		2	DAY	$ 1,500	$ 3,000	$ 3,000
	- Protective Fencing	Fence	1000	LF	$ 2.0	$ 2,000	$ 2,000
	- Sample Soil for COCs	Characterization	60	EA	$ 100	$ 6,000	$ 6,000
		Pre-confirmation	60	EA	$ 100	$ 6,000	$ 6,000
		Post-composite	60	EA	$ 100	$ 6,000	$ 6,000
	- Planting						
	Materials		1	LS	$ 5,000	$ 5,000	$ 5,000
	12 grids or hotspots	$5000/day includes 3 person team	6	DAY	$ 4,000	$ 24,000	$ 24,000
	- CENAB Oversight	plus per diem and equipment	1	WK	$ 5,000	$ 5,000	$ 5,000
	- Maintenance						
	Of plants and fencing	2 visits by 2 staff	2	DAY	$ 2,000	$ 4,000	$ 4,000
	- Harvesting						
	12 grids or hotspots		6	DAY	$ 4,000	$ 24,000	$ 24,000
		SUBTOTAL C				**$ 87,000**	**$ 87,000**
D	**DISPOSAL**						
	- Non-Hazardous Refuse	$20/ton disp and $30/ton transp	10	tons	$ 50	$ 500	$ 500
		SUBTOTAL D				**$ 500**	**$ 500**
E	**SITE RESTORATION**						
	- Backfill Material	Minor misc backfill	50	CY	$ 14	$ 700	$ 700
	- Labor (fence removal, general restoration)		2	DAY	$ 2,000	$ 4,000	$ 4,000
		SUBTOTAL E				**$ 4,700**	**$ 4,700**

Contaminated Soil Remedial Alternative #3 - Phytoremediation

Cost Item					Costs		
	Task/Subtask	Item	Quantity	Units	Unit Cost	Subtotal	Total
F	**REPORTING**						
	-Closure Report	Report	1	LS	$ 20,000	$ 20,000	$ 20,000
		CENAB Review	1.5	WK	$ 5,000	$ 7,500	$ 7,500
		SUBTOTAL F				**$ 27,500**	**$ 27,500**

TOTAL COST SUMMARY	
Task	Total per Task
A. PLANNING	$ 60,000
B. ADMINISTRATION	$ 5,000
C. IMPLEMENTATION	$ 87,000
D. DISPOSAL	$ 500
E. SITE RESTORATION	$ 4,700
F. REPORTING	$ 27,500
TOTAL	**$ 184,700**

ASSUMPTIONS		
A.	**PLANNING**	-The Work Plan is a single document covering all areas requiring a response action
B.	**ADMINISTRATION**	-Miscellaneous administrative costs.
C.	**IMPLEMENTATION**	-Single mobilization of team/equipment for all hotspots/grids -All low probability work; costs for work done under high probability protocols not included -12 total hotspots (or grids), 6 on Spaulding-Rankin, 6 on AU -Day rate is for 3 person team (3 planters). $2500 for 10 hr day, $1000 per diem, $500 equipment. -6 days to plant all grids, 6 days to harvest all grids -2 additional days for 2 staff for maintenance between planting and harvesting -Estimate 5 samples per hotspot/grid for characterization, pre-confirmation, post confirmation
D.	**DISPOSAL**	-Disposal of harvested plant materials
E.	**SITE RESTORATION**	-Remove any protective fencing, general maintenance of site to original conditions
F.	**POST REMEDIATION REPORT**	-Basic closure report that describes the activities conducted.

Abbreviations:

LS = lump sum
WK = week
EA = each
CY = cubic yard

Contaminated Soil Remedial Alternative #4 - Excavation and Off-site Disposal

Cost Item					Costs		
	Task/Subtask	Item	Quantity	Units	Unit Cost	Subtotal	Total
A	**PLANNING**						
	-Plans	Plans	1	LS	$ 30,000	$ 30,000	$ 30,000
	Plans include Remedial Design/ Remedial Action Work Plan to address all site activities	CENAB Review	2	WK	$ 15,000	$ 30,000	$ 30,000
		SUBTOTAL A				**$ 60,000**	**$ 60,000**
B	**ADMINISTRATION**						
	- Miscellaneous		1	LS	$ 5,000	$ 5,000	$ 5,000
		SUBTOTAL B				**$ 5,000**	**$ 5,000**
C	**IMPLEMENTATION**						
	- Construction team Mob/Demob		1	LS	$ 5,000	$ 5,000	$ 5,000
	- Surveying		2	DAY	$ 1,500	$ 3,000	$ 3,000
	- Erosion/Sediment Control	Silt Fence	1000	LF	$ 1.0	$ 1,000	$ 1,000
		Hay Bales	400	LF	$ 8.0	$ 3,200	$ 3,200
	- Sample Soil	Analytical Costs - TCLP	20	EA	$ 250	$ 5,000	$ 5,000
		Analytical Costs - COCs	50	EA	$ 100	$ 5,000	$ 5,000
	- Miscellaneous Equipment Contingencies		1	LS	$ 5,000	$ 5,000	$ 5,000
	LOW PROBABILITY **- Soil Excavation** 12 grids or hotspots = 720 CY 60 CY/day (six 10 CY trucks/day)	$5000/day includes 4 man team plus per diem plus $1000/day equipment	12	DAY	$ 5,500	$ 66,000	$ 66,000
	- Contractor Management		3	WK	$ 5,000	$ 15,000	$ 15,000
	- CENAB Management	This includes time for mob/demob	3	WK	$ 5,000	$ 15,000	$ 15,000
		SUBTOTAL C				**$ 123,200**	**$ 123,200**
D	**MATERIAL TRANSPORT and DISPOSAL**						
	- Non-Hazardous Soil to Landfill (648 CY)	$20/ton disp and $30/ton transp	972	tons	$ 50	$ 48,600	$ 48,600
	- Hazardous Soil to Landfill (72 CY)	$90/ton disp and $60/ton transp	108	tons	$ 150	$ 16,200	$ 16,200
		SUBTOTAL D				**$ 64,800**	**$ 64,800**
E	**SITE RESTORATION**						
	- Backfill Material	Material Only (720 CY + ~10%)	800	CY	$ 14	$ 11,200	$ 11,200
	- Labor (assumes 140 CY/day)	2-1/2 CY Loader w/ Operator	5	DAY	$ 5,000	$ 25,000	$ 25,000
		SUBTOTAL E				**$ 36,200**	**$ 36,200**

Contaminated Soil Remedial Alternative #4 - Excavation and Off-site Disposal

Cost Item					Costs		
	Task/Subtask	Item	Quantity	Units	Unit Cost	Subtotal	Total
F	REPORTING						
	-Closure Report	Report	1	LS	$ 30,000	$ 30,000	$ 30,000
		CENAB Review	4	WK	$ 5,000	$ 20,000	$ 20,000
		CEHNC Review	4	WK	$ 5,000	$ 20,000	$ 20,000
		SUBTOTAL F				**$ 70,000**	**$ 70,000**

TOTAL COST SUMMARY	
Task	**Total per Task**
A. PLANNING	$ 60,000
B. ADMINISTRATION	$ 5,000
C. IMPLEMENTATION	$ 123,200
D. MATERIAL TRANSPORT/DISPOSAL	$ 64,800
E. SITE RESTORATION	$ 36,200
F. REPORTING	$ 70,000
TOTAL	**$ 359,200**

ASSUMPTIONS		
A.	**PLANNING**	-The Work Plan is a single document covering all areas requiring a response action
B.	**ADMINISTRATION**	-Miscellaneous administrative costs.
C.	**IMPLEMENTATION**	-Single mobilization of construction team/equipment for all excavation required -All low probability excavation; costs for work done under high probability protocols not included -12 total hotspots (or grids), 6 on Spaulding-Rankin, 6 on AU -Each hotspot or grid is conservatively sized at 20ft x 20ft x 4ft deep. This is 1600 cu ft or approx 60 CY (90 tons). -Assumes a 1.5 factor for the soil conversion of CY to TON -Hole does not extend deep enough to require elaborate shoring -Day rate is for 4 man team (3 diggers and one safety). $3000 for 10 hr day, $1500 per diem, $1000 equipment/gas. -60 CY of soil (one hot spot) removed per day -20 TCLP samples at $250/sample, and 50 samples for COC metals or PAHs at $100/sample
D.	**MATERIAL TRANSPORT / DISPOSAL**	-90% of soil will be nonhazardous soil and 10% will be hazardous -Assumes trucks rather than roll-offs
E.	**SITE RESTORATION**	-10% more soil required for backfill to allow for compaction. Assume 140 CY/day.
F.	**POST REMEDIATION REPORT**	-Basic closure report that describes the activities conducted

Abbreviations:

LS = lump sum
WK = week
EA = each
CY = cubic yard
LF = linear foot

APPENDIX B-2
SITE-WIDE SVFUDS FEASIBILITY STUDY COSTS
(EXPLOSIVE HAZARD REMEDIAL ALTERNATIVES)

Alternative #3 - Full DGM Coverage, Remove All Anomalies	**TOTAL COST SUMMARY**		
	Task		**Total per Task**
	A. PLANNING	$	50,000
	B. DGM FIELD ACTIVITIES	$	13,000
	C. ANOMALY REMOVAL FIELD ACTIVITIES	$	37,000
	D. SITE RESTORATION	$	60,000
	E. REPORTING	$	70,000
	TOTAL Alternative #3	**$**	**230,000**

Alternative #4 - Full DGM Coverage, Remove Selected Anomalies	**TOTAL COST SUMMARY**		
	Task		**Total per Task**
	A. PLANNING	$	50,000
	B. DGM FIELD ACTIVITIES	$	23,500
	C. ANOMALY REMOVAL FIELD ACTIVITIES	$	26,500
	D. SITE RESTORATION	$	55,000
	E. REPORTING	$	70,000
	TOTAL Alternative #4	**$**	**225,000**

Alternative #5 - DGM of Accessible Areas, Remove All Anomalies	**TOTAL COST SUMMARY**		
	Task		**Total per Task**
	A. PLANNING	$	50,000
	B. DGM FIELD ACTIVITIES	$	10,500
	C. ANOMALY REMOVAL FIELD ACTIVITIES	$	37,000
	D. SITE RESTORATION	$	35,000
	E. REPORTING	$	65,000
	TOTAL Alternative #5	**$**	**197,500**

Alternative #6 - DGM of Accessible Areas, Remove Selected Anomalies	**TOTAL COST SUMMARY**		
	Task		**Total per Task**
	A. PLANNING	$	50,000
	B. DGM FIELD ACTIVITIES	$	21,000
	C. ANOMALY REMOVAL FIELD ACTIVITIES	$	26,500
	D. SITE RESTORATION	$	30,000
	E. REPORTING	$	65,000
	TOTAL Alternative #6	**$**	**192,500**

Explosive Hazard Remedial Alternative #3 - Full DGM Coverage, Remove All Anomalies

Cost Item					Costs			
	Task/Subtask	**Item**	**Quantity**	**Units**	**Unit Cost**	**Subtotal**	**Total**	
A	**PLANNING**							
	- DGM Work Plan	Plans	1	LS	$ 10,000	$ 10,000	$ 10,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
	- Anomaly Removal Work Plan	Plans	1	LS	$ 10,000	$ 10,000	$ 10,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
		SUBTOTAL A				**$ 50,000**	**$ 50,000**	
B	**DGM FIELD ACTIVITIES**							
	- Surveying		1	LS	$ 2,000	$ 2,000	$ 2,000	based on quote from previous work
	- Vegetation Removal	Labor, not replacement	1	DAY	$ 2,500	$ 2,500	$ 2,500	brush cutting
	- Fence Removal	Labor, not replacement	1	DAY	$ 2,500	$ 2,500	$ 2,500	
	- DGM team Mob/Demob		1	LS	$ 3,000	$ 3,000	$ 3,000	assumes mob from relatively local area
	- DGM Surveying (EM61+G-858)		1	DAY	$ 3,000	$ 3,000	$ 3,000	labor and equipment for one field day
	- Anomaly re-acquisition		0	DAY	$ 3,000	$ -	$ -	
	- AC team Mob/Demob		0	LS	$ 6,000	$ -	$ -	AC not needed this Alternative
	- AC Survey		0	DAY	$ 3,000	$ -	$ -	
		SUBTOTAL B				**$ 13,000**	**$ 13,000**	
C	**ANOMALY REMOVAL FIELD ACTIVITIES**							
	- Dig team mob/demob		1	LS	$ 16,000	$ 16,000	$ 16,000	SUXOS, UXOSO, 1 T3, 2 T2, 2 T1 (7 staff)
	- Dig team daily rate		1	DAY	$ 8,000	$ 8,000	$ 8,000	assumes < 100 anoms per property
	- Anomaly re-acquisition		1	DAY	$ 3,000	$ 3,000	$ 3,000	
	- USACE oversight (all field activities)		1	WK	$ 5,000	$ 5,000	$ 5,000	
	- Contingencies		1	LS	$ 5,000	$ 5,000	$ 5,000	
		SUBTOTAL C				**$ 37,000**	**$ 37,000**	
D	**SITE RESTORATION**							
	- Replace driveway		0.5	LS	$ 30,000	$ 15,000	$ 15,000	average of 2 quotes
	- Replace vegetation		2	LS	$ 20,000	$ 40,000	$ 40,000	50% of quote for large NTCRA prop
	- Replace fence		1	LS	$ 5,000	$ 5,000	$ 5,000	
		SUBTOTAL D				**$ 60,000**	**$ 60,000**	

Explosive Hazard Remedial Alternative #3 - Full DGM Coverage, Remove All Anomalies

Cost Item					Costs			
	Task/Subtask	Item	Quantity	Units	Unit Cost	Subtotal	Total	
E	**REPORTING**							
	-DGM Report (EM61, G-858)	Report	1	LS	$ 25,000	$ 25,000	$ 25,000	No AC, so lower cost than Alts 4 and 6
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
	-Anomaly Removal Report	Report	1	LS	$ 15,000	$ 15,000	$ 15,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
		SUBTOTAL E				**$ 70,000**	**$ 70,000**	

TOTAL COST SUMMARY	
Task	**Total per Task**
A. PLANNING	$ 50,000
B. DGM FIELD ACTIVITIES	$ 13,000
C. ANOMALY REMOVAL FIELD ACTIVITIES	$ 37,000
D. SITE RESTORATION	$ 60,000
E. REPORTING	$ 70,000
TOTAL	**$ 230,000**

ASSUMPTIONS		
	GENERAL	-All costs are for an individual property. Not every property will require the same effort; some will cost more, some less. -Property has not previously been geophysically surveyed or intrusively investigated for anoms.
A.	**PLANNING**	-A programmatic work plan costs the same across all alternatives. These costs are for brief property-specific plans.
B.	**DGM FIELD ACTIVITIES**	-One day to survey a property -2 discrete areas of vegetation removal -Small section of fence to be temp removed
C.	**ANOMALY REMOVAL FIELD ACTIVITIES**	-Full UXO team of 7 staff -One day to dig all anomalies (max of 100)
D.	**SITE RESTORATION**	-On average, half of driveway needs to be replaced -2 discrete areas of vegetation replanting -Small section of fence replaced
E.	**REPORTING**	-Anomaly Removal Report includes all anomalies (max of 100)

Explosive Hazard Remedial Alternative #4 - Full DGM Coverage, Remove Selected Anomalies

Cost Item					Costs			
	Task/Subtask	**Item**	**Quantity**	**Units**	**Unit Cost**	**Subtotal**	**Total**	
A	**PLANNING**							
	-DGM Work Plan	Plans	1	LS	$ 10,000	$ 10,000	$ 10,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
	-Anomaly Removal Work Plan	Plans	1	LS	$ 10,000	$ 10,000	$ 10,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
		SUBTOTAL A				**$ 50,000**	**$ 50,000**	
B	**DGM FIELD ACTIVITIES**							
	- Surveying		1	LS	$ 2,000	$ 2,000	$ 2,000	based on quote from previous work
	- Vegetation Removal	Labor, not replacement	1	DAY	$ 2,500	$ 2,500	$ 2,500	brush cutting
	- Fence Removal	Labor, not replacement	1	DAY	$ 2,500	$ 2,500	$ 2,500	
	- DGM team Mob/Demob		1	LS	$ 3,000	$ 3,000	$ 3,000	assumes mob from relatively local area
	- DGM Surveying (EM61+G-858)		1	DAY	$ 3,000	$ 3,000	$ 3,000	labor and equipment for one field day
	- Anomaly re-acquisition		0.5	DAY	$ 3,000	$ 1,500	$ 1,500	labor and equipment for one field day
	- AC team Mob/Demob		1	LS	$ 6,000	$ 6,000	$ 6,000	economy of scale for AC instrument use
	- AC Survey		1	DAY	$ 3,000	$ 3,000	$ 3,000	labor and equipment for one field day
		SUBTOTAL B				**$ 23,500**	**$ 23,500**	
C	**ANOMALY REMOVAL FIELD ACTIVITIES**							
	- Dig team mob/demob		1	LS	$ 12,000	$ 12,000	$ 12,000	SUXOS, UXOSO, 1 T3, 1 T2, 1 T1 (5 staff)
	- Dig team daily rate		0.5	DAY	$ 6,000	$ 3,000	$ 3,000	assumes < 25 anomalies per property
	- Anomaly re-acquisition		0.5	DAY	$ 3,000	$ 1,500	$ 1,500	
	- USACE oversight (all field activities)		1	WK	$ 5,000	$ 5,000	$ 5,000	
	- Contingencies		1	LS	$ 5,000	$ 5,000	$ 5,000	
		SUBTOTAL C				**$ 26,500**	**$ 26,500**	
D	**SITE RESTORATION**							
	- Replace driveway		0.3	LS	$ 30,000	$ 10,000	$ 10,000	average of 2 quotes
	- Replace vegetation		2.0	LS	$ 20,000	$ 40,000	$ 40,000	50% of quote for large NTCRA prop
	- Replace fence		1.0	LS	$ 5,000	$ 5,000	$ 5,000	
		SUBTOTAL D				**$ 55,000**	**$ 55,000**	

Explosive Hazard Remedial Alternative #4 - Full DGM Coverage, Remove Selected Anomalies

Cost Item					Costs			
	Task/Subtask	Item	Quantity	Units	Unit Cost	Subtotal	Total	
E	**REPORTING**							
	-DGM Report (EM61, G-858, AC)	Report	1	LS	$ 30,000	$ 30,000	$ 30,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
	-Anomaly Removal Report	Report	1	LS	$ 10,000	$ 10,000	$ 10,000	Fewer digs due to AC,
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	so lower cost than Alts 3 and 5
		SUBTOTAL E				**$ 70,000**	**$ 70,000**	

TOTAL COST SUMMARY	
Task	**Total per Task**
A. PLANNING	$ 50,000
B. DGM FIELD ACTIVITIES	$ 23,500
C. ANOMALY REMOVAL FIELD ACTIVITIES	$ 26,500
D. SITE RESTORATION	$ 55,000
E. REPORTING	$ 70,000
TOTAL	**$ 225,000**

ASSUMPTIONS		
	GENERAL	-All costs are for an individual property. Not every property will require the same effort; some will cost more, some less. -Property has not previously been geophysically surveyed or intrusively investigated for anoms.
A.	**PLANNING**	-A programmatic work plan costs the same across all alternatives. These costs are for brief property-specific plans.
B.	**DGM FIELD ACTIVITIES**	-One day to survey a property -2 discrete areas of vegetation removal -Small section of fence to be temp removed, then replaced
C.	**ANOMALY REMOVAL FIELD ACTIVITIES**	-Smaller UXO team (5 staff) than for digging all anoms -Half a day to dig all anomalies (max of 25)
D.	**SITE RESTORATION**	-On average, AC results in only 1 of 3 driveways needing to be replaced -2 discrete areas of vegetation replanting -Small section of fence replaced
E.	**REPORTING**	Anomaly Removal Report includes fewer anomalies (max of 25) and all AC discussions

Explosive Hazard Remedial Alternative #5 - DGM of Accessible Areas, Remove All Anomalies

Cost Item					Costs			
	Task/Subtask	**Item**	**Quantity**	**Units**	**Unit Cost**	**Subtotal**	**Total**	
A	**PLANNING**							
	-DGM Work Plan	Plans	1	LS	$ 10,000	$ 10,000	$ 10,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
	-Anomaly Removal Work Plan	Plans	1	LS	$ 10,000	$ 10,000	$ 10,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
		SUBTOTAL A				**$ 50,000**	**$ 50,000**	
B	**DGM FIELD ACTIVITIES**							
	- Surveying		1	LS	$ 2,000	$ 2,000	$ 2,000	based on quote from previous work
	- Vegetation Removal	Labor, not replacement	1	DAY	$ 2,500	$ 2,500	$ 2,500	brush cutting
	- Fence Removal		0	DAY	$ 2,500	$ -	$ -	not applicable for this Alternative
	- DGM team Mob/Demob		1	LS	$ 3,000	$ 3,000	$ 3,000	assumes mob from relatively local area
	- DGM Surveying (EM61+G-858)		1	DAY	$ 3,000	$ 3,000	$ 3,000	labor and equipment for one field day
	- Anomaly re-acquisition		0	DAY	$ 3,000	$ -	$ -	
	- AC team Mob/Demob		0	LS	$ 6,000	$ -	$ -	AC not needed this Alternative
	- AC Survey		0	DAY	$ 3,000	$ -	$ -	
		SUBTOTAL B				**$ 10,500**	**$ 10,500**	
C	**ANOMALY REMOVAL FIELD ACTIVITIES**							
	- Dig team mob/demob		1	LS	$ 16,000	$ 16,000	$ 16,000	SUXOS, UXOSO, 1 T3, 2 T2, 2 T1 (7 staff)
	- Dig team daily rate		1	DAY	$ 8,000	$ 8,000	$ 8,000	assumes < 100 anoms per property
	- Anomaly re-acquisition		1	DAY	$ 3,000	$ 3,000	$ 3,000	
	- USACE oversight (all field activities)		1	WK	$ 5,000	$ 5,000	$ 5,000	
	- Contingencies		1	LS	$ 5,000	$ 5,000	$ 5,000	
		SUBTOTAL C				**$ 37,000**	**$ 37,000**	
D	**SITE RESTORATION**							
	- Replace driveway		0.5	LS	$ 30,000	$ 15,000	$ 15,000	average of 2 quotes
	- Replace vegetation		1	LS	$ 20,000	$ 20,000	$ 20,000	50% of quote for large NTCRA prop
	- Replace fence		0	LS	$ 5,000	$ -	$ -	
		SUBTOTAL D				**$ 35,000**	**$ 35,000**	

Explosive Hazard Remedial Alternative #5 - DGM of Accessible Areas, Remove All Anomalies

Cost Item					Costs		
	Task/Subtask	**Item**	**Quantity**	**Units**	**Unit Cost**	**Subtotal**	**Total**
E	**REPORTING**						
	-DGM Report (EM61, G-858, AC)	Report	1	LS	$ 20,000	$ 20,000	$ 20,000
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000
	-Anomaly Removal Report	Report	1	LS	$ 15,000	$ 15,000	$ 15,000
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000
		SUBTOTAL E				**$ 65,000**	**$ 65,000**

No AC, so lower cost than Alts 4 and 6

TOTAL COST SUMMARY	
Task	**Total per Task**
A. PLANNING	$ 50,000
B. DGM FIELD ACTIVITIES	$ 10,500
C. ANOMALY REMOVAL FIELD ACTIVITIES	$ 37,000
D. SITE RESTORATION	$ 35,000
E. REPORTING	$ 65,000
TOTAL	**$ 197,500**

ASSUMPTIONS		
	GENERAL	-All costs are for an individual property. Not every property will require the same effort; some will cost more, some less. -Property has not previously been geophysically surveyed or intrusively investigated for anoms.
A.	**PLANNING**	-A programmatic work plan costs the same across all alternatives. These costs are for brief property-specific plans.
B.	**DGM FIELD ACTIVITIES**	-One day to survey a property -1 discrete area of vegetation removal
C.	**ANOMALY REMOVAL FIELD ACTIVITIES**	-Full UXO team of 7 staff -One day to dig all anomalies (max of 100)
D.	**SITE RESTORATION**	-On average, half of driveway needs to be replaced -1 discrete area of vegetation replanting
E.	**REPORTING**	-Anomaly Removal Report includes all anomalies (max of 100)

Explosive Hazard Remedial Alternative #6 - DGM of Accessible Areas, Remove Selected Anomalies

Cost Item					Costs			
	Task/Subtask	Item	Quantity	Units	Unit Cost	Subtotal	Total	
A	**PLANNING**							
	-DGM Work Plan	Plans	1	LS	$ 10,000	$ 10,000	$ 10,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
	-Anomaly Removal Work Plan	Plans	1	LS	$ 10,000	$ 10,000	$ 10,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
		SUBTOTAL A				**$ 50,000**	**$ 50,000**	
B	**DGM FIELD ACTIVITIES**							
	- Surveying		1	LS	$ 2,000	$ 2,000	$ 2,000	based on quote from previous work
	- Vegetation Removal	Labor, not replacement	1	DAY	$ 2,500	$ 2,500	$ 2,500	brush cutting
	- Fence Removal		0	DAY	$ 2,500	$ -	$ -	not applicable for this Alternative
	- DGM team Mob/Demob		1	LS	$ 3,000	$ 3,000	$ 3,000	assumes mob from relatively local area
	- DGM Surveying (EM61+G-858)		1	DAY	$ 3,000	$ 3,000	$ 3,000	labor and equipment for one field day
	- Anomaly re-acquisition		0.5	DAY	$ 3,000	$ 1,500	$ 1,500	labor and equipment for one field day
	- AC team Mob/Demob		1	LS	$ 6,000	$ 6,000	$ 6,000	economy of scale for AC instrument use
	- AC Survey		1	DAY	$ 3,000	$ 3,000	$ 3,000	labor and equipment for one field day
		SUBTOTAL B				**$ 21,000**	**$ 21,000**	
C	**ANOMALY REMOVAL FIELD ACTIVITIES**							
	- Dig team mob/demob		1	LS	$ 12,000	$ 12,000	$ 12,000	SUXOS, UXOSO, 1 T3, 1 T2, 1 T1 (5 staff)
	- Dig team daily rate		0.5	DAY	$ 6,000	$ 3,000	$ 3,000	assumes < 25 anomalies per property
	- Anomaly re-acquisition		0.5	DAY	$ 3,000	$ 1,500	$ 1,500	
	- USACE oversight (all field activities)		1	WK	$ 5,000	$ 5,000	$ 5,000	
	- Contingencies		1	LS	$ 5,000	$ 5,000	$ 5,000	
		SUBTOTAL C				**$ 26,500**	**$ 26,500**	
D	**SITE RESTORATION**							
	- Replace driveway		0.3	LS	$ 30,000	$ 10,000	$ 10,000	average of 2 quotes
	- Replace vegetation		1.0	LS	$ 20,000	$ 20,000	$ 20,000	50% of quote for large NTCRA prop
	- Replace fence		0.0	LS	$ 5,000	$ -	$ -	
		SUBTOTAL D				**$ 30,000**	**$ 30,000**	

Explosive Hazard Remedial Alternative #6 - DGM of Accessible Areas, Remove Selected Anomalies

Cost Item					Costs			
	Task/Subtask	Item	Quantity	Units	Unit Cost	Subtotal	Total	
E	**REPORTING**							
	-DGM Report (EM61, G-858, AC)	Report	1	LS	$ 25,000	$ 25,000	$ 25,000	
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	
	-Anomaly Removal Report	Report	1	LS	$ 10,000	$ 10,000	$ 10,000	Fewer digs due to AC,
		USACE Review	1	WK	$ 15,000	$ 15,000	$ 15,000	so lower cost than Alts 3 and 5
		SUBTOTAL E				**$ 65,000**	**$ 65,000**	

TOTAL COST SUMMARY	
Task	**Total per Task**
A. PLANNING	$ 50,000
B. DGM FIELD ACTIVITIES	$ 21,000
C. ANOMALY REMOVAL FIELD ACTIVITIES	$ 26,500
D. SITE RESTORATION	$ 30,000
E. REPORTING	$ 65,000
TOTAL	**$ 192,500**

ASSUMPTIONS		
	GENERAL	-All costs are for an individual property. Not every property will require the same effort; some will cost more, some less. -Property has not previously been geophysically surveyed or intrusively investigated for anoms.
A.	**PLANNING**	-A programmatic work plan costs the same across all alternatives. These costs are for brief property-specific plans.
B.	**DGM FIELD ACTIVITIES**	-One day to survey a property -2 discrete areas of vegetation removal
C.	**ANOMALY REMOVAL FIELD ACTIVITIES**	-Smaller UXO team (5 staff) than for digging all anoms -Half a day to dig all anomalies (max of 25)
D.	**SITE RESTORATION**	-On average, AC results in only 1 of 3 driveways needing to be replaced -2 discrete areas of vegetation replanting
E.	**REPORTING**	Anomaly Removal Report includes fewer anomalies (max of 25) and all AC discussions

Appendix C:
Index of Properties Recommended for Further Action

INDEX OF PROPERTIES RECOMMENDED FOR FURTHER ACTION
(EXPLOSIVE HAZARD MITIGATION)

	Address	DGM Completed	Comments
PROPERTIES WITH PREVIOUS DGM/ANOMALY REMOVAL WORK (Pink shading on Figure 4)			
1	3712 FORDHAM	2009	
2	3720 FORDHAM	2004/2010	Recent work supersedes older work
3	3740 FORDHAM	2008	
4	3750 FORDHAM	2009	
5	3800 FORDHAM	2009	
6	3822 FORDHAM	2007	
7	3945 52ND	2008	
8	3949 52ND	2007	
9	4005 52ND	2004	
10	4015 52ND	2005	
11	4050 52ND	2008	
12	4055 52ND	2008	
13	4070 52ND	2005	
14	4700 QUEBEC	2010	
15	4701 WOODWAY	2009	
16	4703 WOODWAY	2009	
17	4707 WOODWAY	2007	
18	4710 QUEBEC	2005	
19	4720 QUEBEC	2007	
20	4727 WOODWAY	2007	
21	4730 QUEBEC	2009	
22	4733 WOODWAY	2009	
23	4740 QUEBEC	2009	
24	4809 WOODWAY	2009	
25	5010 SEDGWICK	2008	
26	5011 SEDGWICK	2004	
27	5019 SEDGWICK	2008	
28	5024 SEDGWICK	2009	
29	5026 TILDEN	2007	
30	5027 SEDGWICK	2008	
31	5030 SEDGWICK	2009	
32	5032 TILDEN	2007	
33	5036 SEDGWICK	2007	
34	5040 SEDGWICK	2003	
35	5041 SEDGWICK	2008	
36	5046 SEDGWICK	2003	
37	5047 SEDGWICK	2008	
38	5053 SEDGWICK	2008	
39	5059 SEDGWICK	2003	
40	5065 SEDGWICK	2003	
41	5100 TILDEN	2008	
42	5123 TILDEN	2008	
43	5127 TILDEN	2008	
44	DC Right-of Way	multiple lots, one owner	
45	Dalecarlia Woods	multiple lots, one owner	

INDEX OF PROPERTIES RECOMMENDED FOR FURTHER ACTION
(EXPLOSIVE HAZARD MITIGATION)

	Address	DGM Completed	Comments
PROPERTIES WITH NO PREVIOUS DGM/ANOMALY REMOVAL (Blue shading on Figure 4)			
1	3650 FORDHAM		
2	3700 FORDHAM		
3	3730 FORDHAM		
4	3801 FORDHAM		
5	3807 FORDHAM		
6	3808 FORDHAM		
7	3812 FORDHAM		
8	3823 FORDHAM		
9	3828 52ND		
10	3838 52ND		
11	3901 52ND		
12	3901 FORDHAM		
13	3940 FORDHAM		
14	4000 52ND		
15	4010 51ST		
16	4020 51ST		
17	4030 51ST		
18	4040 51ST		
19	4040 52ND		
20	4054 52ND		
21	4060 52ND		
22	4100 52ND		
23	4735 WOODWAY		
24	4800 QUEBEC		
25	5001 SEDGWICK		
26	5006 TILDEN		
27	5012 TILDEN		
28	5018 TILDEN		
29	5020 SEDGWICK		
30	5033 TILDEN		
31	5064 SEDGWICK		
32	5068 SEDGWICK		
33	5071 SEDGWICK		
34	5100 UPTON		
35	5120 UPTON		
36	5121 TILDEN		
37	5126 TILDEN		
38	5132 TILDEN		
39	5135 TILDEN		
40	5140 TILDEN		
41	5142 TILDEN		
42	5148 TILDEN		
43	5154 TILDEN		
44	5160 TILDEN		
45	5166 TILDEN		
46	5170 TILDEN		
47	5208 UPTON		
48	5209 UPTON		
49	5212 UPTON		
50	AU PSB	No DGM under building	
51	3706 FORDHAM	2000/2004	Insufficient quality DGM data; treated in this FS as though they had no previous DGM
52	5054 SEDGWICK	2000	
53	5058 SEDGWICK	2000	