DRAFT FINAL SITE SPECIFIC FINAL REPORT

Interim Remedial Action
Solid Waste Management Unit (SWMU) 2
Tooele Army Depot – South Area
Stockton, Utah

PREPARED FOR:

U.S. Army Engineering & Support Center – Huntsville

Contract Number: W912DY–10–D–0027
Task Order Number: 0006
Project Number: DCD-03-R-01
Geographic District: U.S. Army Corps of Engineers, Sacramento District

PREPARED BY:

KEMRON Environmental Services, Inc.

25 May 2016

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Prepared by:

As Approved by:

KEMRON Environmental Services, Inc.
1359-A Ellsworth Industrial Blvd.
Atlanta, GA 30318
Phone: 404.636.0928

Brian Barker

Digitally signed by: Brian Barker
DN: CN = Brian Barker email = bbarker@kemron.com C = US O = KEMRON Environmental Services
Date: 2016.05.25 14:57:20 -05'00'

Brian Barker, P.E.
Project Manager

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SUMMARY OF REVISIONS

Revision #	Date	Summary of Revisions
1	25 May 2016	Addressed comments on Draft Site Specific Final Report

Acronym	Definition
ABPs	Agent Breakdown Products
AEL	Airborne Exposure Limit
AQS	Analytical Quality Solutions
BATFE	Bureau of Alcohol, Tobacco, Firearms, & Explosives
CAR	Corrective Action Request
CBUs	Cluster Bomb Units
CD	Cultural Debris
CFR	Code of Federal Regulations
COPCs	Chemicals of Potential Concern
CSM	Conceptual Site Model
CSS	Chemical Safety Submission
CWM	Chemical Warfare Material
CY	Cubic Yard
DA	Department of the Army
DAAMS	Depot Area Air Monitoring Systems
DAF	Dilution Attenuation Factor
DCD	Deseret Chemical Depot
DD	Department of Defense
DGM	Digital Geophysical Mapping
DID	Data Item Description
DMM	Discarded Military Munitions
DoD	Department of Defense
DQOs	Data Quality Objectives
DRO	Diesel Range Organics
DSHW	State of Utah Division of Solid and Hazardous Waste
DUs	Decision Units
ECBC	Edgewood Chemical Biological Center
ELAP	Environmental Laboratory Accreditation Program
EPA	Environmental Protection Agency
EPCs	Exposure-point Concentrations
ERAs	Ecological Risk Assessments
ERIS	Environmental Restoration Information System
FLSC	Flex Linear Shape Charge
GIS	Geographic Information System
GPS	Global Positioning System
HTRW	Hazardous, Toxic, and Radioactive Wastes
IDW	Investigation Derived Waste
IRA	Interim Remedial Action
IS	Incremental Sampling
ISM	Incremental Sampling Methodology
ISOs	Industry Standard Objects
IVS	Instrument Verification Strip
LODs	Limits of Detections
MC	Munitions Constituents
MCL	Maximum Contaminant Level
MD	Munitions Debris
MDAS	Material Documented as Safe
MDL	Method Detection Limit
MEC	Munitions & Explosives of Concern

Acronym	Definition
MPPEH	Material Potentially Presenting an Explosive Hazard
N/A	Not applicable
ND	Non-Detect
NFA	No Further Action
OB	Open Burn
OB/OD	Open Burn/Open Detonation
OD	Open Detonation
PBL	Planetary Boundary Layer
PCBs	Polychlorinated biphenyls
PCE	Tetrachloroethene
PID	Photoionization Detector
PM	Project Manager
PMP	Project Management Professional
PMT	Project Management Team
PPE	Personal Protective Equipment
PWS	Performance Work Statement
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QASP	Quality Assurance Surveillance Plan
QC	Quality Control
RA	Removal Action
RAD	Risk Assumptions Document
RCRA	Resource Conservation and Recovery Act
RIC	Reactivity, Ignitability, Corrosivity
ROS	Regression on Order Statistics
RRD	Range Related Debris
RSLs	Regional Screening Levels
RTK	Real-time Kinematic
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SQLs	Sample Quantitation Limits
SRA	Saturated Response Areas
SSFR	Site Specific Final Report
SSLs	Soil Screening Levels
SSLs	Soil sampling at locations S2GP-0104
SUXOS	Senior UXO Supervisor
SVOCs	Semi-volatile Organic Compounds
SWMU	Solid Waste Management Unit
TCLP	Toxicity Characteristic Leaching Procedures
TEAD-S	Toole Army Depot – South Area
TGDs	Tear Gas Degradates
TNT	Tri-nitro Toluene
TO	Task Order
TSD	Team Separation Distance
UAC	Utah Administrative Code
UCL	Upper Confidence Limit
UDEQ	Utah Department of Environmental Quality
USACE	US Army Corps of Engineers
USC	United States Code

Acronym	Definition
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
UTL	Upper Tolerance Limit
UXO	Unexploded Ordnance
UXOQC	Unexploded Ordnance Quality Control
UXOQCS	UXO QC Specialist
UXOSO	UXO Safety Officer
VOCs	Volatile Organic Compounds
VSP	Visual Sampling Plan
WERS	Worldwide Environmental Remediation Services
XRF	X-Ray Fluorescence

Executive Summary

UXB-KEMRON Remediation Services, LLC (UXB-KEMRON) was contracted by the US Army Engineering and Support Center, Huntsville (USAESCH) under contract W912DY-10-D-0027, Task Order (TO) 0006 to perform an interim remedial action of Solid Waste Management Unit (SWMU) 2. In order to receive a response complete KEMRON needed to remove all Discarded Military Munitions (DMM), other military related devices buried, and debris in SWMU 2; perform confirmatory sampling and analysis from the bottom of the burial area and from spoils piles, as needed; and remove contaminated soil, as necessary. This objective was accomplished in accordance with Resource Conservation and Recovery Act (RCRA), Department of Defense (DoD, US Army, US Army Corps of Engineers regulations, guidance and applicable Data Item Descriptions, TEAD-S Permits, and State regulations.

USAESCH awarded the contract to the UXB-KEMRON Joint Venture on 29 August 2011. Notice to proceed with fieldwork was issued by USAESCH on 9 January 2013 following approval of the Work Plan and Chemical Safety Submission (CSS). During 2013, the UXB-KEMRON Joint Venture underwent a business operational change culminating in June 2013 with KEMRON Environmental Services completing an asset purchase from UXB, which included W912DY-10-D-0027, TO 0006. For ease of reading, hereafter, the term “KEMRON”, short for “KEMRON Environmental Services, Inc.”, will be used throughout the text instead of “UXB-KEMRON Remediation Services, LLC or “UXB- KEMRON”. The reader should understand that the activities prior to June of 2013 were carried out under the joint venture, and thereafter were carried out by KEMRON Environmental Services, Inc.

Project objectives included removing all DMM, other military related devices buried, and debris in SWMU 2; perform confirmatory sampling and analysis from the bottom of the burial area and from spoils piles, as needed; and remove contaminated soil, as necessary. KEMRON accomplished these objectives by performing the following tasks:

- Preparing and submitting of a Work Plan in accordance with Data Item Description (DID) WERS-001 that described the specific work required to complete the Performance Work Statement (PWS) specifications, including the Quality Assurance Surveillance Plan (QASP) and Chemical Safety Submission (CSS).

- Removing all DMM, other military devices under soil cover in SWMU 2 and debris, and transport and perform demilitarization activities on Material Potentially Presenting an Explosive Hazard (MPPEH), as specified in the PWS.

- Performing environmental sampling to identify the nature and extent of MC-impacted soil to guide source removal as well as to ensure IRA activities resulted in acceptable risk-based levels and protection of groundwater to support risk-based closure and, ultimately, an NFA determination for the Site.

- Submitting a Site Specific Final Report (SSFR) that outlines the results of the Munitions Response (MR) and Removal Action (RA) activities using DID WERS-013.01 as guidance.

In total, KEMRON cleared all 10 acres of the SWMU 2, removing 123,094 DMM items, approximately 915,000 pounds of material documented as safe (MDAS), no munitions debris (MD), and no chemical warfare materiel (CWM) over a period of time from 10 January 2013 to 4 November 2015 to include two, two month winter shut-down periods. The 2013/2014 winter shut-down of the project was initiated by the Project Manager (PM), Senior UXO Supervisor (SUXOS), and Unexploded Ordnance (UXO) Safety Officer (UXOSO) due to MEC items in frozen soil conditions. The 2014/2015 winter shut down was initiated through a joint decision by KEMRON, USAESCH, and TEAD-S due to unfavorable air quality conditions for burning of the MEC items.

No additional soil investigation or excavation is recommended for the SWMU 2 Burial Pit based on evidence of successful source removal and data suggesting minimal impacts to groundwater. Compounds of concern are below residential RSLs. The extent of the SWMU 2 Burial Pit has been surveyed and backfilled using stockpiles previously approved for use as on-site backfill in accordance with the specifications outlined in the SWMU 2 IRA Work Plan.

On 10 March, 2016, KEMRON completed the contracted scope of work and reported no unresolved or outstanding issues and concerns associated with this project.

1 PROJECT ACTIVITIES AND OPERATIONS

1.1 INTRODUCTION

1.1.1 General

1.1.1.1 KEMRON Environmental Services (KEMRON) was contracted by the US Army Engineering and Support Center, Huntsville (USAESCH) under contract W912DY-10-D-0027, Task Order (TO) 0006 to perform an Interim Remedial Action (IRA) of Solid Waste Management Unit (SWMU) 2 at Toole Army Depot – South Area (TEAD-S), Utah. TEAD-S was known as Deseret Chemical Depot (DCD) at the time of TO award, and some documents/figures associated with this Site-Specific Final Report (SSFR) may identify the installation by its former name. This SSFR was prepared in accordance with DID WERS-013.01 and provides the results of the activities performed.

1.1.2 Objectives and Scope

1.1.2.1 The purpose of this project was to conduct Interim Measures to control or eliminate the release or potential release of hazardous wastes or hazardous constituents from SWMU-2 by removing all Discarded Military Munitions (DMM), other military related devices, and surface and sub-surface debris; perform confirmatory sampling and analysis from the bottom of the burial area and from spoils piles, as needed; and remove contaminated soil, as necessary. The goal is to achieve No Further Action (NFA) per Utah Administrative Code (UAC) R315-101.

1.1.2.2 The IRA involved the following tasks as specified in the contract performance work statement (PWS):

1.1.2.2.1 Prepare required project plans.

1.1.2.2.2 Conduct Interim Removal fieldwork.

1.1.2.2.3 Manage Geospatial Data.

1.1.2.2.4 Provide Site Specific/Response Complete Final Report.

1.1.2.2.5 Conduct project meetings.

1.1.2.2.6 Upload project data to Environmental Restoration Information System (ERIS), if required: and

1.1.2.2.7 Conduct DCD surety and security training, as required.

1.1.3 **Project Location and History**

1.1.3.1 TEAD-S encompasses 19,364 acres and is located approximately 60 miles southwest of Salt Lake City in Rush Valley, Tooele County, Utah. TEAD-S is one of the Army installations in the United States that formerly stored chemical weapons. The primary mission of TEAD-S is to plan and execute the disposal of secondary waste in a manner that is safe, secure, environmentally sound, and protective of its workers and the public. The regional vicinity of TEAD-S is identified in Figure 1-1. The installation map of TEAD-S, including the location of SWMU 2, is presented as Figure 1-2.

Figure 1-1: Regional Vicinity of the Tooele Army Depot – South Area

1.1.3.2 TEAD-S has been used since the 1940s for storage, renovation, and disposal of many types of chemical agent munitions. These munitions included mustard (H, HD, and HT), Lewisite (L), Sarin (GB), Tabun (GA), O-ethyl S-[2-(diisopropylamino)ethyl] methylphosphonothioate (VX), Phosgene (CG), O-chlorobenzylidene malononitrile (CS), cyanogen chloride (CK), sulfur trioxide (FS), hexachloroethane (HC) smoke, white phosphorous (WP), thermite, and napalm. (NUS, 1987)

1.1.3.3 SWMU 2 occupies approximately 10 acres within the southwest portion of the Chemical Munitions Storage Area (SWMU 11). SWMU 2 includes an oval-shaped burial pit approximately 300 feet long by 60 feet wide. It was reported that this burial pit had previously been used to dispose of munitions without demilitarization. Interpretation of historical aerial photographs shows evidence that around 1974 the area now identified as SWMU 2 was excavated and used as quarry for construction materials. Following termination as a quarry, the pit was used as a dump site for unknown material. An aerial photograph from 1981 indicates mounding and stacked material in the western portion of the site.

1.1.3.4 A RCRA Phase I Facility Investigation was conducted by Ebasco Services, Inc. for the U.S. Army Environmental Center in 1993. This investigation encompassed all TEAD-S SWMUs, including SWMU 2. Prior to that, various installation-wide surveys, assessments, and investigations occurred dating back to 1979. (EBASCO, 1993)

1.1.3.5 The Phase I Facility Investigation Report recommended postponing any Phase II investigation or Corrective Measures Study activities at SWMU 2 until the closure of SWMU 11 because of the proximity of the buried munitions in SWMU 2 to known chemical agents stored at that time in SWMU 11. (EBASCO, 1993)

1.1.3.6 SWMU 11 is essentially the area within the fence line encompassing TEAD–S Area 10, minus the area delineated by SWMU 2. All stockpile chemical munitions have been removed from TEAD-S Area 10 (SWMU 11) igloos.

1.1.3.7 The only documentation of potential munitions items in SWMU 2 was an employee disposition referenced in the Installation Assessment (USATHAMA, 1979). This disposition, dated 1 April 1959, documents interviews with installation employees indicating that SWMU 2 was used for burial of munitions without demilitarization. No dates of burial are provided in any of the referenced documentation. Potential munitions reportedly buried at the site include M2 ignition cartridges, squibs, hand grenades, blasting caps, M21 Incendiary Bomb Clusters, smoke pots, Tri-nitro Toluene (TNT) blocks, M74 Incendiary Bombs, and M19 Incendiary Bomb Clusters.

1.2 SCHEDULE DATA

1.2.1 Table 1.2- provides the start and end dates for key field activities.

Table 1.2-1: Key Field Activity Start and End Dates

Key Task	Start Date	Date Completed
Mobilization / Site Set Up	10 January 2013	17 January 2013
Training, Pre-Operational Surveys and Exercise	15 January 2013	25 February 2013
Conduct Geophysical Surveys	4 March 2013	28 March 2013
Reacquisition / Single Point Anomaly Investigation	1 April 2013	14 June 2013
Burial Pit Excavation	6 May 2013	14 June 2013
Funding Shutdown	17 June 2013	2 August 2013
Remobilization / Site Set Up	5 August 2013	7 August 2013
Burial Pit Excavation	8 August 2013	17 October 2013
Single Point Anomaly Investigation	8 August 2013	17 October 2013
Winter Standby / Caretaker Operations	28 October 2013	7 March 2014
Remobilization / Site Set Up / Training	10 March 2014	28 March 2014
Pre-Operational Surveys and Exercise / Training	31 March 2014	11 April 2014
Burial Pit Excavation	14 April 2014	25 July 2014
Single Point Anomaly Investigation	14 April 2014	25 July 2014
DM Candle Packaging, Transportation, and Disposal	9 June 2014	31 July 2014
Soil Stockpile Sampling and Analysis	31 July 2014	24 September 2014

Key Task	Start Date	Date Completed
Sampling and Analysis of Soil in Burial Pit	7 August 2014	18 December 2014
Excavation of Contaminated Soil in Burial Pit	11 August 2014	12 August 2014
Backfill of Excavation Area (Burial Pit)	12 August 2014	18 August 2014
Preparation of SWMU 2 OB Area	11 August 2014	12 December 2014
Soil Sampling and Analysis of OB Area (Baseline)	11 August 2014	9 January 2015
Smoke Pot Packaging, Transportation, and Disposal	25 August 2014	8 October 2014
Preparation and Conduct of Test Open Burn (Located in SWMU 1 & 25 OB Area)	11 September 2014	15 September 2014
Winter Standby / Caretaker Operations	12 December 2014	12 March 2014
Remobilization / Site Set Up / Training	13 March 2015	24 March 2015
Conduct Open Burn Operations	25 March 2015	4 November 2015
Tear Down of Burn Operations and Equipment / Demobilization	2 November 2015	17 November 2015
Follow-up Soil Sampling of OB Area	8 March 2016	8 March 2016
Seeding of OB Area	8 March 2016	10 March 2016

1.3 OVERALL APPROACH AND METHODS USED

1.3.1 Vegetation Removal and Surface Clearance

1.3.1.1 SWMU 2 primarily contained light vegetation throughout some of the 10 acres. The brush to be cleared consisted primarily of grasses and low brush generally no higher than four feet. These types of vegetation were present only in certain areas, whereas much of SWMU 2 consisted of sparse short grasses, rock, and soil. After the perimeter of SWMU 2 was staked-out by a UXO - escorted Utah licensed Land Surveyor, the vegetation removal was required to safely see and access the surface and subsurface removal areas. The brush cutting was accomplished primarily with vehicle mounted mowers/mulching equipment. Manual brush cutting involved gas-powered hand tools. No incidents occurred during vegetation removal.

1.3.1.2 Following the vegetation removal, a grid stake-out and surface clearance utilizing a Minelab F3 all-metals detector was performed throughout SWMU 2. The purpose of this clearance was to remove surface debris so that it would not interfere with the geophysical survey. No MEC or MD was discovered during the surface clearance and only cultural debris was removed from the surface of SWMU 2.

1.3.2 Geophysical Survey

1.3.2.1 An Instrument Verification Strip (IVS) was established adjacent to, and north of SWMU 2 and used to validate geophysical instrument functioning and operator performance. The IVS was located in an area that was investigated and determined to be free of any anomalies and consisted of four small Industry Standard Objects (ISOs). The ISO's were buried at various depths and orientation in order to attain an instrument response curve whereby the target selection threshold of 5 millivolts (mV) above local background was established. All geophysical instruments were verified on the IVS daily both before and after use.

1.3.2.2 Digital Geophysical Mapping (DGM) of SWMU 2 was performed utilizing a Geonics EM61-Mk2. The EM61-Mk2 is a high-resolution time-domain electromagnetic induction sensor that is capable of detecting both ferrous and non-ferrous metallic objects. Real-time kinematic (RTK) global positioning system (GPS) equipment capable of providing horizontal position accuracy of 3 cm was used for subsurface geophysical mapping with the EM61-Mk 2. Daily quality control (QC) procedures as described in the Final Work Plan were utilized to ensure that the equipment was functioning properly and that the data collected was valid. After collection, the data was processed and interpreted in order to identify locations for intrusive investigation.

1.3.2.3 Digital Geophysical Mapping (DGM) of SWMU 2 was performed utilizing a Geonics EM31-Mk2. The EM31-Mk2 is a terrain conductivity meter which is capable of detecting buried metal as well as mapping subsurface changes across a site, such as transitions in soil. RTK GPS equipment capable of providing horizontal position accuracy of 3 cm was also used for subsurface geophysical mapping with the EM31-Mk 2. No additional targets or areas of interest were identified with the EM31-Mk2 data alone; however, this data was used to confirm the location of the burial pit and other high density anomalous areas detected with the EM61-Mk2.

1.3.2.4 Figure 1-3 displays the mosaic of data collected with the EM61-Mk2, and Figures 1-4 and 1-5 display the mosaic of data collected with the EM31-Mk2. A system of 100 foot by 100 foot grids is utilized to divide SWMU 2 into smaller areas for better data management. The DGM data indicated that there was an area with a large concentration of subsurface metal within grid F3. This area was identified as the burial pit. In addition to the burial pit, single point anomalies were identified for intrusive investigation throughout the remainder of SWMU 2, utilizing EM61-Mk2 data and minimum threshold value of 5 mV above local background. No additional targets or areas of interest were identified with the EM31-Mk2 data alone; however, this data was used to confirm the location of the burial pit and other high density anomalous areas detected with the EM61-Mk2. All targets that were selected for intrusive investigation were given a unique target ID number, which identifies the grid containing the anomaly as well as a unique number within that grid. All targets were reacquired with an RTK GPS unit by the licensed Utah Land Surveyor and flagged with the respective target ID number for excavation. As each single point anomaly was investigated by the dig team, an EM61-Mk2 operator embedded with the team refined the flag position and aided in ensuring that the contact was removed.

1.3.3 **Air Monitoring**

1.3.3.1 Air monitoring was conducted by the U.S. Army Edgewood Chemical Biological Center (ECBC). The monitoring utilized Depot Area Air Monitoring Systems

(DAAMS) and Miniature Continuous Air Monitoring Systems (MINICAMS). The primary CWM Chemical of Concern was the blister agent distilled sulfur mustard (HD). Monitoring was conducted during all excavation/intrusive operations in SWMU 2 with perimeter and workspace monitoring. There was no chemical agent detected during air monitoring and no chemical munitions were discovered during excavation.

1.3.4 On-site Medical Support

1.3.4.1 Medical personnel were on-site during all intrusive activities. The Medical team consisted of a minimum of two EMTs with an ambulance and mobile treatment trailer. They were responsible for taking and recording the vital signs for each of member of the intrusive team both at the beginning and end of each intrusive day. They were also on hand in case emergency medical treatment was required.

1.3.5 Single Point Anomaly Excavation

1.3.5.1 Excavation procedures were initiated by locating a target flag and verifying that the information it provided matched the dig sheet. The EM61-Mk2 was then used to pinpoint the location of the anomaly. Intrusive investigations were then performed utilizing manual and/or mechanical excavation methods. Mechanical excavation methods were only used when manual excavation was not feasible, and in these circumstances the excavation would be initiated with mechanical methods and then completed with manual methods. Upon removing one or more pieces of metal suspected to be the source of the anomaly, the EM61-Mk2 was used to verify that the target was then below the threshold of 5 mV. In the event that the threshold was not initially satisfied, this excavation process continued until the criteria was met. Items found in the excavation process were placed conspicuously to the side of the excavation for recording. As the areas were cleared, the team leader evaluated the sites and, when satisfied that they were clear, requested the KEMRON UXO QC Specialist (UXOQCS) conduct a formal quality control (QC) of the target area.

1.3.5.2 After approximately 57% of the single point anomalies had been intrusively investigated, all of the anomalies were identified as cultural debris. At this time, recovered items included aluminum cans, angle iron, asphalt, bolts, brackets, bucket, cables, cargo hooks, cargo ratchets, c-clamps, concrete, drill bits, fence posts, jackhammer bits, metal bars, metal plates, metal rods, metal scrap, nails, nuts, oil plugs, empty paint cans, pickaxe heads, pipe, railroad spikes, rebar, scrap metal, screws, sheet metal, shovel/sledgehammer heads, spigot handles, vehicle parts, washers, wire, and wrenches. The majority of the cultural debris causing the anomalies was located within 0 to 2 feet of the ground surface. There were several locations where it was necessary to mechanically dig large excavations in order to clear multiple anomalies. One excavation in grid D4 was approximately 40 feet by 30 feet wide and 11 feet deep. This pit contained mostly nails, screws, unidentifiable pieces of metal, and other pieces of cultural debris. Another excavation in grid C4 was approximately 50 feet by 40 feet wide and 14 feet deep.

This pit contained mostly glass bottles, unidentifiable metal machine parts, and other cultural debris. A third excavation in grid E3 was performed on a mounded area approximately 190 feet long and between 25 and 50 feet wide. The vertical dimension of the third excavation was approximately 18 feet from the ground surface to the top of the mound. This area contained unidentifiable pieces of metal, pipe, and pieces of ammunition boxes such as screws and hinges. The excavated soil from each of the three excavations was sifted to verify the contents and clear the anomalies, and the sifting operations did not identify any signs of munitions debris.

1.3.5.3 The Field Change Request dated 16 June 2014, in coordination with US Army Corps of Engineers (USACE), TEAD-S, and the State of Utah, recommended a trenching and confirmation sampling approach for the remainder of the single point anomaly area. Following approval of this Field Change Request, three trenches were investigated with one trench in each of grids B2, D3, and D4 where the highest remaining density of geophysical readings was present. Investigation of the three trenches yielded cultural debris consistent with the remainder of the single point anomaly area previously investigated and no MEC or MPPEH was discovered. The results of the investigations in the trenches and excavated single point anomalies were agreed upon by the Project Management Team (PMT) to be representative of the areas outside of the main burial pit. Incremental MC samples were additionally collected to evaluate the area outside of the burial pit as described in Chapter 5.

1.3.6 Burial Pit Excavation

1.3.6.1 Intrusive investigation of the burial pit was initiated with mechanical equipment to remove approximately seven feet of overburden soil and several feet of soil to one side. The last foot or more of soil above or adjacent to munitions was removed with manual methods. Under this soil a large number of stacked munitions were identified, including squibs, smoke pots, grenades, candles, fuzes, boosters, and cluster bomb units (CBUs). Although the exact type of munitions differed, all recovered munitions were consistent with the information referenced in the Installation Assessment. The recovered DMM was well organized with distinct vertical and horizontal boundaries. There were no areas in which there was a large gap between the DMM. All recovered DMM was packaged, palletized, and labeled with a control number prior to being stored in magazines within TEAD-S Area 10 while awaiting final disposal.

1.3.6.2 Overburden and excavated soil were stockpiled in order to be sampled and either returned to the burial pit for grading or disposed of, as appropriate. Soil sampling was also conducted underneath the burial pit following excavation. Soil with chemicals of potential concern (COPCs) above site specific criteria was disposed of off-site. Soil approved for backfill was returned to the burial pit and the area was graded to match the surrounding slope.

1.3.7 Winter Shutdown and Caretaking Operations

1.3.7.1 KEMRON provided a SUXOS and UXO Technician II to provide caretaking operations during the shutdown periods over the winters of 2013-2014 and 2014-2015. They performed daily visual inspections of the magazines used for the storage of MEC and Hazardous waste, weekly recordable/reportable magazine inspections filed with TEAD-S, and ensured weather did not disturb the plastic sheeting placed over piles of soil on the work site.

1.3.8 DMM Disposal

1.3.8.1 Air modeling was conducted to ensure that emissions from the open burn of DMM recovered from SWMU 2 would be within regulatory parameters in the State of Utah. Not all of the recovered DMM could be disposed of by open burn. A portion of the DMM was shipped off site for incineration. A small portion of the DMM was disposed of by detonation.

1.3.8.2 The recovered M1 & M4 smoke pots, M2 candles, and M6 CN/DM grenades were shipped to the Veolia ES Technical Solution LLC Trade Waste Incineration facility in Sauget, Illinois for destruction via rotary kiln incineration. Due to emissions limitations allowed by the facilities' permit, it was necessary to repackage the DMM prior to shipment. All items that were shipped for incineration were repackaged on-site into quantities required by the incineration facility into 1H2 drums as required by 49 CFR. Repackaging operations were conducted in accordance with a Standard Operating Procedure (SOP) dated 29 May 2014 which is included in Appendix G.

1.3.8.3 Open burn (OB) and open detonation (OD) operations were originally intended to take place at the existing OB/OD area used for operations within SWMUs 1 & 25. Due to active use of this area by another contractor, KEMRON was unable to utilize this OB/OD area. Prior to constructing an open burn area for SWMU 2 operations, the SWMU 1 & 25 OB/OD area was used to conduct a test burn of one E46 CBU to ensure that the planned method and burn pan construction would result in a successful operation. This test burn was conducted on 12 September 2014.

1.3.8.4 Construction of the SWMU 2 open burn area was completed in August through December 2014. Construction consisted of clearing vegetation to ensure that there was no vegetation within 200 feet of each of eight burn pans, installing a silt fence around the perimeter of the cleared area, and burying the firing wires that would be used to initiate the open burn.

1.3.8.5 Demolition of the recovered M101A1, M101A2, M103, & M127 Fuzes and M14 boosters was performed on 4 October 2014. The demolition was performed using conventional OB/OD methods in a trench at the OD area utilized for SWMU1 & 25 operations.

1.3.8.6 OB of the recovered E46 CBUs, M69 bomblets, M1, M4, and M77 fuzes was performed from 26 March 2015 to 30 October 2015. OB operations were conducted within the SWMU 2 OB Area. The locations of the OB Area and processing area [used for preparing dunnage, securely storing Materials documented as safe (MDAS), etc.] are shown on Figure 1-6. Eight constructed burn pans were utilized for simultaneous open burns. Burn trays were loaded with dunnage and one E46 CBU (or other item) and then placed into the burn pans. A piece of flex linear shape charge (FLSC) was strategically placed on each CBU to cut the banding and allow the M69 bomblets to fall out of the CBU to ensure a complete burn. Diesel fuel was added as an accelerant and the burn was ignited by a squib placed in a bag of smokeless powder. The FLSC and squib in all burn pans were initiated simultaneously. All OB operations were conducted in accordance with an SOP dated 31 March 2015 which is included in Appendix G.

1.4 WORK AUTHORIZATION DOCUMENTS

1.4.1 USAESCH awarded the contract to KEMRON on 29 August 2011. Notice to proceed with fieldwork was issued by USAESCH on 9 January 2013 following acceptance of the Work Plan and Chemical Safety Submission (CSS). The IRA phase of the project was completed in March 2015.

1.5 PUBLIC INVOLVEMENT

1.5.1 No public involvement activities were required for this project.

1.6 FUTURE PLANNED/REQUIRED ACTIVITIES

1.6.1 No future activities are required to attain project close-out.

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2 MEC & MC REMOVAL/REMEDIAL ACTION RESULTS

2.1 REPORTABLE MATERIAL DISCOVERED

2.1.1 In accordance with the PWS, KEMRON conducted surface and subsurface clearance to a depth of detection over 10 acres. The burial pit contained various DMM items including E46 cluster bomb units (CBUs), M2 candles, M4 smoke pots, M6 grenades, atlas squibs, and fuzes. Each MEC item was positively identified and all required data elements that could be safely collected were collected prior to any transportation or disposal operation. The MEC Log and complete documentation of the final disposition of all DMM items is included in Appendix A, while a summary is found below in Table 2.1-**1**.

Table 2.1-1: Representative Reportable Material Discovered

Reportable Material	**No. of Items**
Discarded Military Munitions (DMM)	123,094
Discernible items included: • Atlas Squibs (112,243) • M6 CN/DM Grenades (640) • M2 Candles (6,116) • M4 Smoke Pots (1,119) • AN 101A2 Fuses (550) • E46 Cluster Bomb Units (701) • M127 Fuzes (7) • M103 Fuzes (13) • M14 Boosters (29) • M69 Incendiary Bomblets (200) • M1 Smoke Pots with Ignitor (329) • M1 & M4 Fuzes (446) • M101A1 Fuzes (7) • M101A2 Fuzes (16) • M201 (M6) Fuzes (635) • M77 Fuzes (28) • M77 HC bomblets Non-fuzed (13) • Ignitor Scrap from M1 Smoke Pots (1)	
Reportable Material	**Amount**
Munitions Constituents (MC) • Arsenic • Hexachlorobenzene • Hexachloroethane • Hexachlorophenol • Iron • Pentachlorophenol	Approximately 1,108 cubic yards of soil removed.

Reportable Material	Weight (lbs.)
Materials Documented as Safe (MDAS)	915,000

2.1.2 Inspection and Certification

2.1.2.1 KEMRON implemented an inspection procedure to ensure MPPEH items did not present an explosive hazard. The UXO Tech IIs performed a 100% inspection of each item as it was recovered and segregated items requiring demilitarization or venting procedures from those items ready for certification. UXO Tech IIIs then performed a 100% re-inspection of all recovered items to verify the previous inspection results. Collected scrap brought in on a daily basis was inspected by the Tech III Team Leader and one UXO Tech II. The SUXOS and UXOQCS completed the consolidation of MPPEH for re-inspection and reclassification to Material Documented as Safe (MDAS) for final disposition of containerization and sealing, segregating MDAS and Range Related-Debris (RRD).

2.1.2.2 The UXOQCS conducted daily audits of the procedures used by UXO teams and individuals for processing MPPEH, and performed random sampling of all MPPEH collected from the various teams to ensure no items with explosive hazards, engine fluids, illuminating dials and other visible liquid hazardous, toxic, and radioactive wastes (HTRW) materials were identified as munitions debris or range-related debris. The SUXOS and UXOQCS completed the Requisition and Turn-in Document, Department of Defense (DD) Form 1348-1A, which are also included as part of Appendix A. The UXOSO ensured the specific procedures and responsibilities for processing MPPEH for certification as MDAS, specified in the work plan, were followed and all procedures for processing MPPEH were being performed safely and consistent with applicable regulations. The SUXOS was responsible for ensuring all DD Forms 1348-1A were completed for all munitions debris to be transferred for final disposition and inspected debris was properly secured in a closed, labeled and sealed container. The 1348-1A document has signatures of the SUXOS, UXOQC and/or UXOSO certifying to the best of our knowledge all containerized MD, RRD, and cultural debris (CD) have been 100% inspected to be explosives and or explosives related materials free.

2.1.3 Chain of Custody and Final Disposition

2.1.3.1 KEMRON ensured that MDAS was properly inspected in accordance with the procedures outlined in the USAESCH-approved Work Plan. DD Forms 1348-1As were used as certification/verification documentation and are presented in Appendix A. The Certificates of Destruction for items shipped off-site for incinerations are also provided in Appendix A

2.1.4 Explosives Accountability

2.1.4.1 KEMRON acquired FLSC from Accurate Energetic Systems of McEwen, TN, and electric detonators from WESCO in Salt Lake City, UT. Appendix B summarizes the explosives accountability for the project and the associated purchases.

2.1.4.2 The Demolition Supervisor was a UXO Tech III listed on the KEMRON Bureau of Alcohol, Tobacco, Firearms, & Explosives (BATFE) Notice of Clearance as being cleared to receive, use, and possess explosives, maintained all explosives documentation as required in paragraph 5.4 of the work plan. He performed all explosive related duties to include, receipt, physical inventory, and assumed responsibility for the explosives.

2.1.4.3 Explosive demolition materials were ordered for delivery prior to scheduled demolition operations. Explosives demolition materials were stored in the TEAD-S provided magazine within Area 10 for use by KEMRON.

2.1.4.4 Explosive demolition materials were transported to the open burn or demolition site in a day box affixed to the bed of KEMRON's dedicated on-site explosives transport vehicle, which met all local, state and federal requirements. Blasting caps were placed into the MK 663 or IME22 cap container and locked in the Explosives Transport Vehicle.

2.2 REMOVAL ACTION LOCATION

2.2.1 The removal action was conducted entirely within the TEAD-S property boundaries, and the project location is shown in Figure 2-1.

2.2.2 Site Boundaries

2.2.2.1 The site consists of approximately 10 acres. The entire site was characterized as potentially containing CWM. Primary concern for the CWM was the known burial pit in the mid southern section of the site covering an area of approximately 4,200 square feet. Figure 2-1 displays the locations of the cleared areas and the location of the recovered DMM. Site boundaries are also provided in the GIS electronic submittal, prepared in accordance with DID WERS-007.01.

2.2.3 Areas Avoided

2.2.3.1 No areas of SWMU 2 were avoided. As described in Subchapter 1.3.4, 100% of the anomalies outside of the burial pit were not investigated. This approach was approved by the PMT and documented in a Field Change Request dated 16 June 2014.

2.2.4 Dig Locations and Results

2.2.4.1 A total of 711 single point anomalies were investigated during the intrusive clearance effort. No MEC or MPPEH items were discovered in the area outside of the burial pit. All of the single point anomalies contained cultural debris. Figure 2-1 shows the cleared area and location of the burial pit where all MEC items were found during the investigation. The MEC Log is presented in Appendix A.

2.2.4.2 Copies of the dig sheets are included as Appendix C of this report.

2.2.5 Locations of MEC Items

2.2.5.1 Figure 2-2 shows the location of the burial pit which contained all DMM. The MEC Log is presented in Appendix A.

2.2.6 Anomalies Associated with Site Cultural Features

2.2.6.1 There were no anomalies discovered within SWMU 2 that were associated with site cultural features such as utilities, roads, or other structures, however, there are anomalies cited in the dig results database associated with warning signs and fence posts within and adjacent to SWMU 2.

2.2.7 Archaeology Sites

2.2.7.1 No archaeology sites were encountered during the RA.

2.2.8 Environmentally Sensitive Areas

2.2.8.1 No environmentally sensitive areas were encountered during the RA.

2.2.9 Damage to Trees/Utilities/Facilities

2.2.9.1 There were no trees, utilities, or facilities located within SWMU 2.

2.2.10 Acreage of Re-vegetation/Reseeding

2.2.10.1 Re-vegetation/reseeding was not required within SWMU 2 as the entire site is a gravel pit. Reseeding of the SWMU 2 OB Area was conducted over approximately 12 acres. An additional acre of reseeding was performed at the setup/processing area used for OB operations. The reseeded areas are displayed on Figure 2-2.

2.2.11 Daily Reports

2.2.11.1 Daily reports were prepared during field operations and are included in Appendix D.

3 QUALITY CONTROL ACTIVITIES AND RESULTS

3.1 CONTRACTOR QC ACTIVITIES

3.1.1 Data Collection and Management

3.1.1.1 The SUXOS was responsible for the overall quality of the collected data during fieldwork. The UXOQCS conducted the following actions to ensure the data collected met the requirements of the Work Plan-specified Data Quality Objectives (DQOs):

3.1.1.1.1 Reviewed a random sample of data collection sheets for completeness and conformance to data protocols;

3.1.1.1.2 Reviewed the accompanying photographic records for visual verification of the data sheets; and

3.1.1.2 The KEMRON PM reviewed the completed electronic forms and accompanying photographs to ensure accurate input and matching. KEMRON Corporate Director of Safety and Quality reviewed a random sampling of the completed electronic forms and compared them with the field forms to ensure the field data was correctly entered.

3.1.1.3 The SUXOS kept a daily running log of grids completed with grid data acquired and quality assurance/quality control (QA/QC) completion dates in his logbook.

3.1.2 Equipment Calibrations/Prove Out

3.1.2.1 The KEMRON clearance teams used Minelab F3 all metals detectors to conduct clearance operations and an EM61-Mk2 to initially locate and clear the targets. The instruments used by KEMRON were factory calibrated in accordance to the manufacturer's schedule. KEMRON performed a daily prove-out of each instrument in the designated IVS. Instruments that did not pass the daily prove out were not used until repaired and re-checked to assure adequate performance.

3.1.2.2 These procedures were repeated after battery changes, or if the instruments were suspected of any malfunction or improper operation. At the end of each work shift, the instruments used during the daily activities were again tested to ensure that the instrument's performance remained working within acceptable parameters throughout the work shift. During the course of the project, no instrument failed this end-of-shift QC testing, so there were no cleared areas that were required to be re-swept due to instrument failure.

3.1.3 Anomaly Investigation

3.1.3.1 The DQO for this task was to clear each anomaly location of metal objects large enough to have been detected during the DGM. To achieve this, KEMRON used an EM61-Mk2 for pinpointing the surface location of the anomaly around the re-acquired point. The clearance team intrusively investigated the anomaly. The Geophysical team then used the EM61-Mk2 to verify that the excavation was sufficiently cleared. If required, the clearance team removed additional metal debris from the excavation until no additional metal above the target mV reading was detected by the instrument. Upon completion of the excavation, dig results were recorded and the excavation was left open for inspection by the KEMRON UXOQCS and the Geophysical QC team to ensure that all metal was removed from the anomaly location.

3.1.4 Open Burn Operations

3.1.4.1 In accordance with the air permit for conducting open burn operations at the site, atmospheric and site conditions were verified to be within acceptable parameters prior to daily operations. The following conditions were verified to be present before initiating any open burn:

- Planetary Boundary Layer (PBL) or "Mixing" height greater than or equal to 500 meters;
- Wind speed greater than or equal to 3 miles per hour;
- Wind speed less than or equal to 15 miles per hour;
- No air quality advisories or alerts for Tooele County; and
- Time of open burn is between 9 AM and 5 PM.

3.2 LESSONS LEARNED

3.2.1 Blind Seeding Program

3.2.1.1 The safe process of intrusive seed emplacement in a potential chemical environment was not addressed in the planning process. The seeding program is a robust method to ensure that all aspects of the geophysical data collection and investigation are functioning as designed.

3.2.1.2 Upon completion of the pre-op in 2013, an advanced team should have deployed into SWMU 2 (with the entire rescue, safety support services and hot line up and running). This team should have been equipped to emplace all of the seeds required for the geophysical investigation area. At a minimum, if intrusive seed emplacement was deemed to be unsafe, seeds could have been emplaced on the surface, under rocks/duff at the site.

3.2.2 Team Separation Distance

3.2.2.1 SWMU 2 is a very small area for working, considering the Team Separation Distance (TSD) of 200 feet. Once removal operations in the burial pit (Grid F3) began, the other intrusive team performed single point anomaly investigations outside the 200 feet TSD. All single point anomalies within 200 feet TSD of grid

F3 and the burial pit operation should have been completely resolved prior to beginning removal operations in grid F3.

3.2.3 Saturated Response Areas

3.2.3.1 During the project planning process, no provisions were made in the event that the geophysics encountered obstructions (OBS) or saturated response areas (SRA). An SRA refers to an area with numerous subsurface anomalies such that individual items cannot be distinguished from one another. A contingency procedure to identify the boundaries of such areas using the geophysical data; resolve anomalies within such areas using procedures (e.g. mag and dig or sifting); and determine the nature and extent of the source of the obstruction or saturation was needed.

3.2.3.2 Grids B2, D3, and D4, were all grids determined to have saturated response, caused by cultural debris primarily including nails and wire, rather than munitions related material. These areas had many single point anomalies within them that were very difficult to clear. While the Change Order approving excavation and sampling of the trenches ultimately satisfied all of the stakeholders, provisions for dealing with areas like this could have been resolved more efficiently had the need for an SRA contingency plan been anticipated.

3.2.4 Personnel Turnover

3.2.4.1 From the outset, the project was a geophysical intensive operation. The UXOQCS appointed did not have significant experience in dealing with and understanding the current required QC geophysical metrics. KEMRON resolved this by establishing a QC team, headed up by the UXOQCS, but with a highly functional geophysicist to ensure compliance with the QC metrics, both in the field and in deliverables. This approach additionally ensured a smoother transition when a new UXOQCS was appointed to the project.

3.2.5 Geophysical Database Maintenance

3.2.5.1 Maintenance of the geophysical database was a challenge due to a number of issues which have been previously mentioned, all which had bearing on the database maintenance and the ability to “close out” individual anomaly investigations. KEMRON ultimately resolved geophysical database maintenance issues by examining and resolving each anomaly and ensuring the database was properly populated.

3.2.6 Burn Pans

3.2.6.1 During the course of open burn operations, E46 CBUs were encountered that were considerably more energetic than those burned during the beginning of operations. While the burn equipment performed as anticipated for the majority of the CBUs, these highly energetic CBUs caused extensive damage to the burn pans, trays, and lids which led to increased project costs and delays. The design of the burn pans was modified over the course of operations, while staying within the parameters identified in the CSS, to further strengthen the pans and achieve a higher number of burns per pan before repair was required. The parameters of the burn pans identified in the CSS should have specified a larger burn pan in order to allow further pressure dissipation before reaching the pan walls or set a range of parameters so that the design could be modified based on observed performance in the field.

3.2.7 UXOQCS During OB Operations

3.2.7.1 The KEMRON Corporate Quality Control Manager performed an internal QC audit of site activities during May and June 2015. Due to a reduction in the number of personnel required during OB operations, one person initially served in the dual hat role of UXOQCS/SO. Following the findings of the QC audit, an additional individual was added to serve in the role of UXOQCS to separate the two responsibilities. The UXOQCS was then able to spend the majority of his time overseeing down range activities while the UXOSO could focus on his own responsibilities.

3.2.8 MEC Log

3.2.8.1 Errors in the electronic MEC Log were identified at the end of open burn operations. Complete QC checks of the electronic MEC Log were not adequately conducted. The following process should have been implemented in order to prevent and/or correct any errors in the MEC Log.

3.2.8.2 Unofficial records would not be maintained for internal or external use. Any alternate presentation of data would be developed using formulas and/or macros within the official MEC Log. The official MEC Log would be periodically saved in PDF format, approved by the SUXOS and UXOQCS, and saved with a file name indicating the date it was approved. All files submitted to the government would be approved by the SUXOS, UXOQCS, and PM. Approval of the official MEC Log would include comparison to magazine inventories and field logs, as applicable.

3.3 SUPPORTING QC DOCUMENTATION

3.3.1 All QC records and documentation are included in Appendices C and D of this report. The dig sheets documenting the QC status of each grid are included in Appendix C. The Daily QCI Reports are included in Appendix D.

4 QUALITY ASSURANCE ACTIVITIES AND RESULTS

4.1 GOVERNMENT QA ACTIVITIES

4.1.1 Government QA activities were performed in accordance with the government-provided QASP. General QA activities conducted at the project site included:

4.1.1.1 Periodic USAESCH Safety Specialist inspections of KEMRON's compliance with DoD, Department of the Army (DA), and USACE explosives safety requirements and explosives-related procedures described in the approved Work Plan;

4.1.1.2 Unscheduled, periodic USAESCH Safety Specialist site visits; and

4.1.1.3 On-site QA inspections of clearance and open burn activities.

4.2 QA FAILURES REQUIRING CORRECTIVE ACTIONS

4.2.1 Blind Seeds

4.2.1.1 KEMRON received a Corrective Action Request on 22 March 2013 for failure to use blind seeds as specified in the IRA Work Plan.

4.2.1.2 Root Cause Analysis – KEMRON was prevented from installing blind seeds by the on-site Ordnance and Explosives Safety Specialist (OESS). The OESS determined that blind seeds could not be safely installed because, prior to conducting intrusive fieldwork, it was suspected that glass items potentially containing mustard were present within SWMU 2.

4.2.1.3 Corrective Action Taken – A Work Plan Variance was submitted on 25 March 2013 to modify the Geophysical System Verification (GSV) process. In lieu of the installation of blind seeds, a repeat line program was established. Two repeat lines per dataset were collected to demonstrate dynamic detection repeatability in the field. The position and amplitude of anomalies that existed within the repeat lines were then compared and evaluated. Appendix C provides all of the repeat line data in graph form and shows that data collected at the beginning and end of the data set are comparable. Note that slight variations do exist between the two repeat lines; however they are due to minor positional variations of the EM61 when the repeat lines were collected. Positional variations between each repeat line are shown in the graph located at the bottom of each page (Appendix C).

4.2.2 Grid Failure

4.2.2.1 Two grids failed inspection 16 October 2013. These grids were grid I2 and I3.

4.2.2.2 Root Cause Analysis – The grids failed QA due to failure to completely remove metal in the soil to achieve the required post excavation response.

4.2.2.3 Corrective Action Taken – Corrective actions were taken including re-excavation of each of the anomalies called out in order to remove all metal to achieve the required post excavation response. These grids passed re-inspection on 11/1/13. Of the 29 grids requiring clearance, 27 passed on first government QA inspection and all 29 passed their government QA inspections.

4.2.3 MEC Inventory

4.2.3.1 KEMRON received a CAR on 13 November 2015. This CAR identified inconsistencies in the number of CBUs which had been reported to have been placed into storage in the Area 10 magazines with the number of CBUs which were destroyed during open burn operations.

4.2.3.2 Root Cause Analysis – Following receipt of the CAR, KEMRON utilized an empirical process to cross reference data from primary documentation generated during field work. It was determined that errors were made in the electronic MEC Log when the SUXOS assigned control numbers. This resulted in duplicate entries for several items (i.e. 20 control numbers were assigned when only 19 items were tagged). This was complicated by a mouse infestation in the storage magazines which resulted in the destruction of the original paper labels. Additionally, complete QC checks of the electronic MEC Log were not adequately conducted.

4.2.3.3 Corrective Action Taken – On future projects, or if this project was ongoing, the following actions would be taken. Unofficial records would not be maintained for internal or external use. Any alternate presentation of data would be developed using formulas and/or macros within the official MEC Log. The official MEC Log would be periodically saved in PDF format, approved by the SUXOS and UXOQCS, and saved with a file name indicating the date it was approved. All files submitted to the government would be approved by the SUXOS, UXOQCS, and PM. Approval of the official MEC Log would include comparison to magazine inventories and field logs, as applicable.

4.3 SUPPORTING QA DOCUMENTATION

4.3.1 All QA documentation is included in Appendix C of this report.

5 MUNITIONS CONSTITUENTS (MC) SAMPLING ACTIVITIES AND RESULTS

5.1 APPROACH AND METHODOLOGY

5.1.1 Environmental sampling was performed during the TEAD-S SWMU 2 IRA to evaluate the nature and extent of potential MC contamination as well as to determine the disposition of waste generated by IRA field activities. The general approach and methodology to perform environmental sampling at SWMU 2 was consistent with the Sampling and Analysis Plan (SAP) of the SWMU 2 Work Plan. This SAP addresses all HTRW tasks related to the acquisition and reporting of chemical data and complies with the requirements of DID WERS-001.01, DID WERS-009.01, Engineering Manual (EM) 1110-1-4009, and the Unified Federal Policy - Quality Assurance Project Plan (UFP-QAPP). The UFP-QAPP describes QA/QC procedures and field sampling procedures as they pertain to field activities, laboratory activities, and contract deliverables. Any variances to the sampling approach are outlined in memorandums to the State of Utah Department of Environmental Quality (UDEQ) and referenced in this Report accordingly.

5.1.2 Environmental sampling was conducted in support of the SWMU 2 IRA to identify the nature and extent of MC-impacted soil to guide source removal as well as to ensure IRA activities resulted in acceptable risk-based levels and protection of groundwater to support risk-based closure and, ultimately, an NFA determination for the Site. Environmental sampling was organized as four separate tasks under this IRA, as follows:

1) <u>Burial Pit</u> – Samples collected within the disturbed area of the gravel pit where bulk disposal of DMM occurred;
2) <u>Incremental Sample Area</u> – Samples collected within the undisturbed area of SWMU 2, outside of the Burial Pit, within four Decision Units (DUs) using Incremental Sampling Methodology (ISM);
3) <u>Waste Characterization</u> – Samples collected to support disposition of generated waste at the Site; and
4) <u>Open Burn Area</u> – Samples collected within the area of burn operations.

5.2 REGULATORY GUIDANCE

5.2.1 Risk-Based Closure

5.2.1.1 The primary objective of the SWMU 2 IRA was to remove the source of all waste and contaminated soil so that SWMU 2 will qualify for residential land use or no further action (NFA). Risk-based closure of SWMU 2 was managed under the following regulations and guidance:

- TEAD-S RCRA part B permit [US EPA ID Number UT5210090002];
- Utah Administrative Code (UAC) R315-101
- TEAD-S Risk Assumptions Document (RAD) (AQS, 2015)

5.2.1.2 An NFA designation means SWMU 2 will no longer be regulated as part of the TEAD-S RCRA part B permit. The TEAD-S RAD formalizes the assumptions and methods stated under the RCRA part B permit conditions for human health and ecological risk assessment. The TEAD-S RAD follows approved State of Utah Division of Solid and Hazardous Waste (DSHW) guidance and regulations (R315-101) for risk-based closure and federal (USEPA) guidance for conducting risk assessments. The TEAD-S RAD served as the primary guidance document for SWMU 2 IRA activities.

5.2.2 Permits and Regulations Governing Waste Management

5.2.2.1 Investigation Derived Waste (IDW) generated during SWMU 2 IRA activities were managed in compliance with the following permits, regulations, and other applicable requirements:

- DCD RCRA Parts A and B permit (UDEQ) 2005);
- RCRA (42 United States Code (USC) 6901) and its regulations, Title 40 CFR, Parts 260 – 280;
- Utah Solid and Hazardous Waste Act, 19-6-101 et seq. Utah Code Annotated, 1953, as amended, and its regulations, Utah Administrative Code R315; and
- Department of Transportation Regulations, Title 49 CFR Parts 170 – 175.

5.3 CONCEPTUAL SITE MODEL

5.3.1 A SWMU 2 site-specific conceptual site model (CSM) was developed early in the investigation process to aid in providing direction to sampling efforts and risk screening objectives. The necessary components included in CSMs include the following: sources of contamination, release mechanisms, affected media, potential receptors, and exposure pathways. The CSM (Figure 5-2) presents the current understanding of the site, helps to identify data gaps, and supports development of data collection efforts.

5.3.2 Background

5.3.2.1 The purpose of the sampling program was to collect environmental samples after removal of discarded military munitions (DMM) to determine whether residual munitions constituents (MC) remained at concentrations greater than risk-based screening criteria for residential land use. Additionally, samples were collected to characterize the waste streams for appropriate disposal. The objective was to obtain environmental data to support and justify recommendation for either no further action required or additional sampling necessary to evaluate the nature and extent of contamination.

5.3.2.2 Sampling performed included:

- Environmental confirmation soil sampling of the IRA excavation where bulk disposal of DMM occurred. Chemical data was used to support identification of COPCs for comparison to appropriate EPA risk-based screening levels protective of future residential land use.
- Environmental sampling of soil directly beneath isolated DMM and other waste identified during the geophysical investigation located outside of the SWMU 2 burial pit bulk disposal areas.
- Waste characterization sampling of excavated soil and other waste materials generated for disposal at an appropriate disposal facility.
- Environmental sampling of soil in the Open Burn Area located outside of SWMU 2.

5.3.3 **Source**

5.3.3.1 Sources of contamination at SWMU 2 are primarily related to the storage and demilitarization of conventional munitions and potentially chemical agent munitions and activities that supported these operations. Sources of MC may include wastes contaminated with chemical agents, agent breakdown products (ABPs), organics [volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs)], polychlorinated biphenyls (PCBs), explosives, inorganics (metals, nitrate/nitrite, white phosphorus, perchlorate), pesticides, herbicides, and/or dioxin/furans.

5.3.3.2 Potential munitions reportedly buried at SWMU 2 include M2 ignition cartridges, squibs, hand grenades, blasting caps, M21 Incendiary Bomb Clusters, smoke pots, trinitrotoluene (TNT) blocks, M74 Incendiary Bombs, and M19 Incendiary Bomb Clusters. Upon completion of excavation it was discovered that the burial pit contained various DMM items including E46 cluster bomb units (CBUs), M2 candles, M4 smoke pots, M6 grenades, atlas squibs, and fuzes.

5.3.3.3 Previous documentation also mentioned the potential for encountering “mustard” in SWMU 2; however, no source or containerization was identified during IRA activities. Because of the age and unknown condition of the items buried in SWMU 2, it was assumed that MC may have leached into the surrounding soil.

5.3.4 Release and Transport Mechanisms and Affected Media

5.3.4.1 Release and transport mechanisms by which contaminants may have migrated from the source are from direct discharge from the source into soil, such as chemical release. At SWMU 2 chemicals leached to soil from buried munitions that degraded over time. Once contaminants are discharged into soil, transport mechanisms include infiltration, volatilization, generation of windborne particles, and potentially leaching to groundwater (Figure 5-2).

5.3.4.2 Environmental media affected by SWMU 2 site activities and transport mechanisms may include soil, soil gas, groundwater, and air. Surface water was not observed at or adjacent to SWMU 2. The lack of permanent surface water is primarily due to low precipitation and high evaporation rates. No wetlands are present at SWMU 2.

5.3.5 Land Use Scenarios

5.3.5.1 Land use at TEAD-S, and therefore SWMU 2 is currently designated as industrial, and is expected to remain industrial under Army control in the future. However, residential land use has been considered as a conservative measure. Additionally the assumption of future residential land use is necessary to determine if the requirements of a no further action decision have been met allowing the site to be removed from the TEAD-S RCRA part B permit.

5.3.5.2 Human Receptors

5.3.5.2.1 Potential receptors at SWMU 2 include humans that may be exposed to site related contaminants in impacted site media. Following US EPA guidance (1989), current and reasonably anticipated future land use were considered when selecting potential receptors. Potential human receptors may include:

- Current and future industrial worker (adult),
- Construction worker (adult), and
- Future resident (adult/child)

5.3.5.2.2 Industrial workers may include test operators, security officers, inspectors or office workers. These receptors spend some time both outdoors and indoors, but are not involved in construction, digging, or excavation activities. It is assumed that the worker spends most of their time inside of a building (existing or future) located at the facility.

5.3.5.2.3 A construction worker receptor was also considered. Construction workers spend most of their time outdoors and may be engaged in construction, digging, or excavation activities at TEAD-S.

5.3.5.2.4 Residential receptors were evaluated at SWMU 2 during the initial screening assessment. In addition, since the end goal is NFA, the residential scenario must be evaluated and shown to meet acceptable risk levels (UAC R315-101).

5.3.5.2.5 Other receptors may include a hunter/recreation, trespasser and future ranchers (cattle or horse ranchers). The residential scenario is deemed protective of the construction worker, industrial worker, hunter/recreation and trespasser and as such, none of these receptors will be independently evaluated if risk to a residential user is considered acceptable.

5.3.5.3 Ecological Receptors

5.3.5.3.1 As stated in the TEAD-S RAD, ecological risk assessments (ERAs) will be conducted at all TEAD-S sites where it has been determined that exposure pathways are potentially complete for ecological receptors. Complete exposure pathway consists of: 1) a source; 2) a mechanism of contaminant release; 3) a receiving or contact medium; 4) a potential receptor population; and 5) an exposure route. In order for a potential receptor population to exist, sites must contain open areas that would allow plant growth and suitable habitat for wildlife. Pathways are incomplete for ecological receptors at sites that are completely filled in with buildings, concrete, or pavement.

5.3.5.3.2 Exclusion criteria are defined as those conditions at an affected property which eliminate the need for an ERA (AQS, 2015). The three criteria are as follows:

- Affected property does not include viable ecological habitat;
- Affected property is not utilized by potential receptors; and
- Complete or potentially complete exposure pathways do not exist due to affected property setting or conditions of affected property media.

5.3.5.3.3 Ecological receptors are not present at SWMU 2 because it is a former gravel pit consisting of a gravel/rock substrate that does not support vegetation, burrowing species, or viable ecological habitat. Other than deer using the gravel pit for movement between bedding and feeding areas, ecological receptors were not observed during on-site activities. Because exclusion criteria for SWMU 2 are met for ecological receptors (e.g., no habitat or receptors), an ERA was not performed at SWMU 2.

5.3.6 **Exposure Pathways**

5.3.6.2 Exposure pathways are “the course a chemical takes from a source to an exposed organism. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., air) or media (in cases of intermedia transfer) is included" (US EPA 1989). Exposure pathways for SWMU 2 include exposure to soil, groundwater, and air.

5.3.6.3 Soil Exposure Pathways

5.3.6.2.1 Human exposure to contaminants in soil can occur through several mechanisms (Figure 5-2). A receptor may be directly exposed to contaminants in surface soil and subsurface soil through incidental ingestion and/or dermal contact, while indirect exposure to contaminants in surface may occur through inhalation of dust (particulates) and volatiles.

5.3.6.2.2 It is assumed that industrial/indoor workers would only be exposed to surface soils (0-0.5 ft bgs). Industrial workers evaluated at TEAD-S (test operators, security officers, inspectors, and office workers) spend most of their time indoors with some time outdoors, but are not involved in construction or digging.

5.3.6.2.3 A construction worker is assumed to be exposed to surface and subsurface soils up to depths of 0-10 ft bgs. Construction workers are involved in digging, excavation, maintenance and building construction projects and could be exposed to surface as well as subsurface soil.

5.3.6.2.4 Future residents could be exposed to surface and subsurface soils during home maintenance activities, yard work, landscaping, and outdoor play activities. Therefore, an exposure soil interval of 0-10 ft bgs will be assumed when evaluating soil exposure by a residential receptor.

5.3.6.2.5 Residents and industrial workers may be exposed to VOCs through the vapor intrusion pathway. For this pathway, VOCs detected at any depth in soil will be considered to account for volatilization and migration through pore spaces in soil into indoor air if development were to occur in the future.

5.3.6.2.6 Soil, to include dense soil vapors that may sink, may also act as a source for contamination of groundwater. The evaluation of the potential for contaminants in soil to migrate to groundwater is addressed in Section 5.3.5.2.

5.3.6.4 Groundwater Exposure Pathways

5.3.6.3.1 Current human exposure to groundwater could be complete if construction workers encounter contaminated groundwater at depths less than 10 ft bgs, regardless of water quality. It is unlikely that this scenario would occur, as depths to groundwater at SWMU2 are greater than 10 ft below ground surface (bgs). However, in the event this does occur, the intrusive worker (construction worker) could be exposed through dermal contact and inhalation of VOCs in groundwater.

5.3.6.3.2 Future residents could be exposed through ingestion or dermal contact with groundwater if the SWMU 2 area were developed. Future residents could also be exposed through direct and indirect inhalation of VOCs in groundwater (Figure 5-2).

5.3.6.3.3 There are no complete ecological exposure pathways for groundwater. There are no springs or other areas where groundwater directly discharges to the ground surface.

5.3.6.5 Air Exposure Pathways

5.3.6.4.1 Air exposure pathways include both indoor and outdoor air. The predominant exposure pathway is inhalation of particulate matter and contaminants volatilized from surface soil. VOCs could also migrate through pore spaces in the vadose zone, through a future building foundation into indoor air or from inhalation of contaminants volatilized from groundwater.

5.3.6.4.2 The indoor and outdoor air pathways through which receptors could be exposed include:

- Inhalation of particulates/dust,
- VOCs volatilized from subsurface soil, and
- VOCs volatilized from groundwater.

5.3.6.4.3 Ecological receptors may also be exposed to contaminants through the air pathway; however, due to lack of inhalation toxicity and uncertainty in quantifying exposure, inhalation exposures will not be quantitatively evaluated in risk assessments.

5.4 DATA EVALUATION

5.4.1 This section describes the steps that were taken in order to identify data that was used in the risk screenings. This process included identifying the lists of COPCs, conducting site attribution analyses, reviewing site boundaries, and the methodology for calculating the exposure-point concentrations (EPCs).

5.4.2 Prior to consideration of analytical data for use in the risk screenings, data was evaluated for usability following the TEAD-S QAPP (UXB/KEMRON, 2012), site-specific QAPPs, and per US EPA guidance. In general, the following steps were taken:

- Data validated and a data qualifier attached to each datum;
- Data grouped by medium;
- Analytical methods evaluated for adequacy for use in risk assessments;

- Data quality evaluated with respect to completeness, comparability, representativeness, precision, and accuracy in accordance with the QAPP;
- Data review conducted with respect to sample quantitation limits (SQLs);
- SQLs presented for non-detect results; and
- Tentatively identified compounds identified.

5.4.3 Data that have been "R" flagged (rejected data) are not considered to be reliable for use in risk screening and were not included in the site data sets.

5.4.4 Data that flagged as "J" (estimated detections) are considered to be reliable for use in risk screening and were included in the data sets.

5.4.5 Data that have been flagged as "U" (i.e., non-detect) or "UJ" (i.e., not-detected with an estimated SQL) are considered non-detects and were evaluated using the appropriate methodology (such as regression on order statistics, ROS) outlined in the most current ProUCL User's Manual. Note that use of one-half the method detection limit (MDL) as a surrogate for non-detects is not acceptable and were not used in the risk screening.

5.4.6 Chemicals that are 100% non-detected in a given medium within the exposure area (i.e., SWMU) were eliminated from further consideration in the risk screening. Chemicals with data sets that are 100% non-detects, but had SQLs greater than the risk-based screening levels (i.e., residential regional screening levels [RSLs]) were retained for evaluation in the risk screening.

5.4.7 A Data Quality Assessment was performed to assess the overall quality and usability of the data collected to support the SWMU2 IRA, included in Appendix H.

5.5 RISK-BASED DECISION CRITERIA

5.5.1 Detected concentrations of analytes associated with samples collected in the Burial Pit were compared to risk-based decision criteria detailed in the Interim Remedial Action Work Plan (UXB-Kemron, 2012). A screening level risk assessment was conducted under a future residential land use scenario to determine potential risks and hazards to hypothetical residents from exposure to contaminants at TEAD-S sites.

5.5.2 Soil sample results, including pre- and post-removal soil samples, ISM soil samples, and soil samples collected from within and outside the burial pit were initially screened against:

- EPA Regional Screening Levels (RSLs) protective of residential use (ingestion, inhalation, and dermal contact);

- EPA RSL Risk-Based Soil Screening Levels protective of groundwater (SSLs);
- EPA RSL Maximum Contaminant Level (MCL)-Based SSLs protective of groundwater; and
- Site Specific TEAD-S SWMU 2 SSLs protective of groundwater (calculated value of dilution attenuation factor [DAF] 38).

5.5.3 Residential Use Risk Screening

5.5.3.1 A risk screening was conducted at SWMU 2 assuming a residential land use scenario to determine potential risks and hazards to future residents from exposure to contaminants. Based on the results of the residential risk screening, it will be determined if: 1) the site qualifies for NFA or risk-based closure under the requirements of UAC R315-101-5 and 6; 2) if further evaluation is necessary under an industrial/construction land use scenario; or 3) if additional actions are required at the site (such as removal or post closure care). Possible completed exposure pathways at TEAD-S that were evaluated under a residential land use exposure scenario at SWMU 2 are:

- Ingestion of soil (Included in soil RSLs),
- Dermal contact with soil (Included in soil RSLs),
- Inhalation of volatiles/particulates from soil (Included in soil RSLs), and
- Maximum detected concentrations in soil were used as the initial EPCs for the residential risk screening.

5.5.3.2 To address the ingestion, inhalation, and dermal contact pathways, EPCs were compared directly to published generic EPA RSLs protective of residential exposure to contaminants in soils.

5.5.3.3 While it is unlikely that a hypothetical resident would be exposed to the maximum detected concentration over their lifetime, use of the maximum detected site concentration was used for the initial screening assessment for determinations of NFA or risk-based closure and is deemed a conservative estimate of the RME individual required by UAC R315-101.

5.5.4 Soil-to-Groundwater Migration Pathway

5.5.4.1 As required by UAC R315-101-3, future impacts to groundwater were addressed at SWMU 2 by evaluating the potential for detected concentrations in soil to contaminate groundwater via the soil-to-groundwater migration pathway. The procedures for this evaluation follow the tiered approach as outlined in the TEAD-S Final RAD (AQS, 2015). For the initial screen, detected compounds were compared to the MCL-based SSL; if an MCL-based value was not available, the Risk-based SSL was to be used for comparison.

5.5.4.2 Compounds that exceeded the initial screening were evaluated under the Tier 2 screening. Site-specific soil-to-groundwater SSLs and DAFs were calculated based on fate and transport modeling following Equation 16 and Equation 17 of the Final RAD guidance (AQS, 2015) as well as US EPA guidance (US EPA 1996a and US EPA 2002b). A DAF was calculated based on Equation 17 of the RAD, and was used to identify the site-specific SSLs for the Soil to Groundwater Migration Pathway (using Tap Water RSLs) as shown in Equation 16.

5.5.4.3 Using the equations summarized above, several iterations of DAF calculations were performed using site-specific inputs from various sources. For example, hydraulic conductivity ranges from 10^{-3} to 10^{-5} cm/s at the site, and multiple values of aquifer thickness were noted for Rush Valley (ranging from 67 m to 163 m). The infiltration rate is based on Figure 8 of a 2011 U.S. Geological Survey (USGS) document which shows the TEAD-S facility as receiving less than 1 inch/year of groundwater recharge. Applying the site specific inputs resulted in a calculated SWMU 2 DAF of 38. The calculated SWMU 2 DAF of 38 is consistent with site-specific DAFs at SWMU 3 (DAF = 52) (CH2MHill, 2014) and SWMU 19 (DAF = 12.31) (Parsons, 2014).

5.5.4.4 The following site-specific inputs were used to calculate the site-specific DAF for SWMU 2:

Table 5.5-1 – SWMU 2 DAF Parameters

PARAMETERS	SWMU 2	SOURCE
i = hyd gradient (m/m)	0.011	Parsons, 2013 based on data for well S-3-82
D = mixing zone depth (m)	9.703	Calculated [1]
I = infiltration rate m/yr	0.01	USGS
L = source length parallel to GW flow (m)	91.44	UXB-KEMRON Work Plan, 2011
Da = aquifer thickness (m)	100	USGS, 2011
k = hyd cond	315	Parsons, 2013 based on data for well S-3-82

1. D (mixing zone) = (0.0112 x Lx2)0.5 + Da(1-exp[-L * I/K * i * Da])

5.5.4.5 The soil/water partition equation (Equation 16) was used to calculate site-specific SSLs based on the Tap Water RSLs for several compounds including each of the COPCs. The SWMU 2 site-specific SSL applying a DAF of 38 are presented in Table 5.5-2. Under this scenario, several site-specific SSLs for the compounds of concern remain below the laboratory detection limits.

Table 5.5-2 – SWMU 2 Site-Specific SSLs

Chemical	Koc (L/Kg) Organic Carbon Partition Coefficient	Kd Soil/Water Partition Coefficient	H' Henry's Law Constant	Tap Water Screening Level (mg/L)	DAF38 SSL (mg/kg)
Bis(2-chloroethyl)ether	32.21	0.19326	0.000695	0.000014	0.0002129
Bis(2-chloro-1-methylethyl) ether	82.92	0.49752	0.0030335	0.00036	0.0097137
Dinitro-o-cresol, 4,6-	754.4	4.5264	0.0000572	0.0015	0.2741466
Dinitrobenzene, 1,3-	351.6	2.1096	2.0033E-06	0.002	0.1786189
Dinitrotoluene, 2,4-	575.6	3.4536	2.2077E-06	0.00024	0.0339073
Hexachloroethane	196.8	1.1808	0.1590352	0.0009	0.0485342
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	89.07	0.53442	8.217E-10	0.0007	0.0198794
Nitroaniline, 4-	109.1	0.6546	5.1513E-08	0.0038	0.1255761
Nitrobenzene	226.4	1.3584	0.0009812	0.00014	0.0084371
Nitroso-di-N-propylamine, N-	275.4	1.6524	0.00022	0.000011	0.0007879
Nitrosodimethylamine, N-	22.79	0.13674	0.0000744	4.9E-07	6.381E-06
Nitrotoluene, m-	363.2	2.1792	0.0003802	0.0017	0.1564035
Nitrotoluene, o-	370.6	2.2236	0.000511	0.00031	0.029053
Tetrachloroethane, 1,1,2,2-	94.94	0.56964	0.0150041	0.000076	0.0022657
Trichloropropane, 1,2,3-	115.8	0.6948	0.0140229	7.5E-07	2.599E-05
Tetrachloroethene	94.94	0.56964	0.7236304	0.011	0.3540477
Pentachlorophenol (PCP)	4959	29.754	1.0016E-06	0.00004	0.0463314
Benzene	145.8	0.8748	0.2269011	0.00045	0.0190447
naphthalene	1544	9.264	0.0179886	0.00017	0.0622237
n-nitrosodiphenylamine	2632	15.792	0.000205	0.012	7.4207047
trichloroethylene	60.7	0.3642	0.4026983	0.00049	0.0113516
carbon tetrachloride	43.89	0.26334	1.1283729	0.00045	0.0097642
Hexachlorobenzene	6195	37.17	0.0695012	0.000049	0.070819

5.5.5 Background Data Set and Comparison Values for Soil

5.5.5.1 A soil background data set has been collected and established for soil at TEAD-S (US Army, 2006). The background sample locations were collected from independent sample areas across TEAD-S. To derive the background value, ProUCL was used to calculate the 95% estimate of the upper tolerance limit (UTL) based on nonparametric statistics (AQS, 2015). In the event that too few detections (less than eight) occurred to calculate an UTL, the maximum detected concentration was used as the background reference value (AQS, 2015).

5.5.5.2 An exception for using the UTL as the background reference value is for arsenic. Background data contained in historic reports indicate that arsenic concentrations vary significantly across TEAD-S with levels as high as 52 mg/kg and with a maximum concentration commonly reported around 35-38 mg/kg (AQS, 2015). In order to address the high variability of arsenic in soils at TEAD-S, the background reference value for arsenic was established at 35 mg/kg. However, if site history indicates a potential that arsenic is present as a breakdown product or other byproduct of past operations, then the original UTL of 12.1 mg/kg must be applied. Examples where arsenic may be site-related include a history of Lewisite or DM/Adamasite being stored, used or treated at the site.

5.5.5.3 Naturally occurring background values for inorganic compounds are identified in Table 5 of the TEAD-S RAD (AQS, 2015) and Table 1-2 of Appendix H.

5.6 IDENTIFICATION OF COPCS

5.6.1 The methods for identifying COPCs differ between organic and inorganic constituents. These methods are outlined in Sections 5.6.2 (organic constituents) and 5.6.3 (inorganic constituents).

5.6.2 Organic Constituents

5.6.2.1 For organic constituents, it was assumed that all detections are site-related since organic constituents are not considered naturally occurring. If an organic constituent was detected at least once in a given medium, then it was retained as a COPC for that medium.

5.6.2.2 The exception to this is in cases where samples were contaminated by field or laboratory activities. Samples containing detections of common laboratory contaminants were compared with field and laboratory blanks to determine if the detections were attributed to field or laboratory contamination. Per US EPA (1989), detections of laboratory contaminants are generally considered positive only if the detected concentration in the sample is greater than ten times the detected concentration in the blank. The ten-times rule was assessed on a site-specific basis to determine applicability and lines of evidence to support its application. Otherwise, samples with detections of laboratory contaminants were "B" qualified and eliminated if they were detected in field or laboratory blanks.

5.6.3 Inorganic Constituents

5.6.3.1 In order to identify inorganic COPCs in soil, a tiered approach was used to determine if detected concentrations of inorganic constituents were related to site activities or if they were similar to naturally occurring background levels. If the evaluation concluded that detections of inorganics are different than background, they were retained as COPCs. Alternatively, if it was shown that site contaminant concentrations were similar to background levels they were eliminated as COPCs. If there was no background value available the chemical was retained for further evaluation.

5.7 Analytical Laboratories

5.7.1 Two environmental laboratories were used in support of analytical services under the IRA.

5.7.2 Edgewood Chemical and Biological Center (ECBC) at Edgewood Arsenal, Maryland was contracted to analyze field screening and fixed laboratory samples for potential chemical agent before release and shipment to the commercial laboratory. ECBC conducted headspace monitoring of all soil samples onsite in accordance with the ECBC Site-Specific Air Monitoring Plan to ensure the media were below the applicable airborne exposure limit (AEL) before shipping the collected samples to the ECBC analytical laboratory in Edgewood, Maryland for further CWM analysis. The ECBC laboratory in Maryland analyzed the samples for sulfur mustard agent (H/HD) in accordance with the Work Plan. All samples analyzed by ECBC under this IRA were non-detect for chemical agent.

5.7.3 Following receipt of ECBC data confirming the absence of chemical agent from all collected samples, the remaining sample aliquots were shipped to an accredited DoD ELAP commercial laboratory (TestAmerica Laboratory in Sacramento, CA) for subsequent analysis of the remaining compounds of interest in accordance with the Work Plan.

5.8 Environmental Sampling

5.8.1 The SWMU 2 IRA consisted of DMM and associated MC removal to control or eliminate the release or potential release of hazardous wastes or hazardous constituents. Environmental sampling was conducted throughout the SWMU 2 IRA to identify the nature and extent of MC-impacted soil to guide source removal as well as to ensure IRA activities resulted in acceptable risk-based levels and protection of groundwater to support risk-based closure and, ultimately, an NFA determination. Environmental samples were collected in accordance with the procedures and methods outlined in the SWMU 2 Work Plan as well as various UDEQ-approved memorandums (Appendix G). All sample coolers were received by the laboratory in accordance with the temperature requirements as outlined in the QAPP. Environmental sampling was organized as four separate tasks under this IRA, as follows:

- Burial Pit;
- Incremental Sample Area;
- Waste Characterization; and
- Open Burn Area.

5.8.2 The boundaries of environmental sampling within the Burial Pit, Incremental Sample area, and Open Burn area are presented on Figure 5-1.

5.8.3 SWMU 2 BURIAL PIT

5.8.3.1 Burial Pit Sampling Procedures

5.8.3.1.1 Three discrete rounds of soil sampling were performed to delineate the nature and extent of MC-impacted soil within the SWMU 2 Burial Pit. Sample data were evaluated to determine if additional excavation was necessary or if the data could be used to support risk-based closure and a subsequent NFA determination. A summary of sample collection/analysis methods as well as procedures and results for each sampling event is presented in this section.

5.8.3.1.2 Samples collected within the Burial Pit are identified with location information, sampling round number, and grid location embedded in the sample ID. For example, S2GP-0103 was collected at the SWMU 2 Gravel Pit (S2GP-), Round 1 Grid 3 (-0103).

5.8.3.2 Burial Pit Results

5.8.3.2.1 **<u>Round 1 Burial Pit Sampling</u>**

5.8.3.2.1.1 Round 1 soil sampling was conducted on September 15 and 16 2014 from the surface of the Burial Pit floor following the removal of DMM and co-mingled soil. A total of nine composite soil samples (S2GP-0101-0109) were collected as 5-point composites along a 30 foot x 30 foot grid, as determined by Visual Sampling Plan (VSP), in accordance with Appendix E of the Work Plan. A summary of Round 1 samples, including sample IDs and analytical methods, is presented in Table 5.8-1.

Table 5.8-1 – Round 1 Sample Summary

SAMPLE ID	TYPE	ANALYSIS
S2GP-0101 S2GP-0102 S2GP-0103 S2GP-0104 S2GP-0105	5-point composite 30-ft grid	Chemical Agent Headspace (ECBC mobile lab) 1,4-Dithiane (ECBC fixed lab) 1,4-Thioxane (ECBC fixed lab) TGD (ECBC fixed lab) VOC (SW8260B)

S2GP-0106 S2GP-0107 S2GP-0108 S2GP-0109		SVOC (SW8270C) CWM Degradates (SW8321A) Organosulfur and TCDs (SW8270C) Explosives (SW8330B) Perchlorate (SW6850) Metals (SW6010B and SW7471A) White Phosphorous (SW7580)

5.8.3.2.1.2 Miscellaneous detections of organic compounds (benzene, hexachloroethane, N-Nitrosodiphenylamine, and, tetrachloroethene [PCE]) were reported in some of the burial pit confirmation soil samples. However, with the exception of hexachloroethane, all detected organic concentrations were below the site-specific SWMU 2 Action Limits. Miscellaneous metals including zinc, molybdenum, iron, arsenic were also detected at concentrations exceeding background range but below residential standards (AQS, 2015). A summary table including COPCs identified above risk-based criteria during Round 1 sampling is presented in Table 5.8-4 at the end of this section.

5.8.3.2.1.3 Round 1 sample locations exhibiting residential and/or soil-to-groundwater exceedances were flagged for additional delineation and/or removal. Sample locations exhibiting analytes below criteria, including S2GP-0101, S2GP-0102, S2GP-0103, S2GP-0108, and S2GP-0109, were retained to support an NFA determination (Figure 5-3). Results of the Round 1 Burial Pit Sampling Event were presented for UDEQ concurrence in a memorandum dated 18 November 2014 (Appendix G). A comprehensive, searchable data table including all Burial Pit data collected during the SWMU 2 IRA is included as Table 1-2 in Appendix H.

5.8.3.2.2 **<u>Round 2 Burial Pit Sampling</u>**

5.8.3.2.2.1 Round 2 soil sampling was conducted on 19 December 2014 from surface and subsurface soils within the Burial Pit to vertically delineate remaining MC-impacted soils. UDEQ, in a memorandum dated 17 December 2014 (Appendix G), approved additional soil sampling at locations S2GP-0104, S2GP-0105, S2GP-0106, and S2GP-0107. The purpose of additional vertical delineation was to generate soil data to support development of an Excavation Plan and to estimate quantities of contaminated soils requiring excavation. Each existing 30 ft x 30 ft Burial Pit grid was further divided into four 15 ft x 15 ft quadrants, with five discrete soil sample locations collected from each grid (Figure 5-4). Two grids were partial grids (S2GP-0105 and S2GP-0107) with one discrete sample being collected to represent a footprint of 225 square feet. Vertical delineation soil samples were collected from 6- to 12-inches, 12- to 24-inches, and 24 to 36-

inches below the Burial Pit floor, screened using an X-Ray Fluorescence (XRF) and photoionization detector (PID), and analyzed at a fixed laboratory for VOCs, SVOCs, and metals in accordance with the procedures outlined in the memorandum dated 3 March 2015 (Appendix G). A summary of Round 2 samples, including sample IDs and analytical methods, is presented in Table 5.8-2.

Table 5.8-2 – Round 2 Sample Summary

SAMPLE ID	TYPE	ANALYSIS
S2GP-0204CP S2GP-0204NE S2GP-0204NW S2GP-0204SE S2GP-0204SW S2GP-0205NW S2GP-0206CP S2GP-0206NE S2GP-0206NW S2GP-0206SE S2GP-0206SW S2GP-0207SE	Grab Sample 15-ft grid For each sample: 6”-12” bgs (suffix -1.0) 12”-24” bgs (suffix -2.0) 24”-36” bgs (suffix -3.0)	VOC (SW8260B) SVOC (SW8270C) Metals (SW6010B and SW7471A)

5.8.3.2.2.2 Round 2 exceedances included hexachloroethane, PCE and arsenic, as well as compounds not previously detected above criteria including hexachlorobenzene and pentachlorophenol. Trichloroethene was detected in one sample below residential and soil-to-groundwater water screening levels. Benzene and N-Nitrosodiphenylamine were not detected in Round 2 sampling, and were eliminated as COPCs.

5.8.3.2.2.3 Round 2 residential and/or soil-to-groundwater SSL exceedances were flagged for excavation. Excavation proceeded in 1-foot lifts or 4-foot lifts depending on the extent of contamination identified during Round 2 sampling. Some portions of the Burial Pit floor were over-excavated to simplify field operations and to ensure removal of potential source material, including an area of staining identified near the northern boundary of the Burial Pit. All stained soil was removed in this area, in the vicinity of S2GP-0307OS-SDW5045, as shown on Figure 5-4. A summary table including COPCs identified above project criteria during Round 2 sampling is presented in Table 5.8-4 at the end of this section.

5.8.3.2.2.4 Sample locations exhibiting analytes below criteria were retained to support an NFA determination. Results of the Round 2 Burial Pit Sampling Event were presented for UDEQ concurrence in the memorandum dated 23 June 2015 (Appendix G).

5.8.3.2.3 **Round 3 Burial Pit Sampling**

5.8.3.2.3.1 Round 3 soil sampling was conducted within the Burial Pit on 19 December 2014 following the second iteration of excavation to confirm source removal. Round 3 post-excavation confirmation samples were collected from the Burial Pit and analyzed for VOCs, SVOCs, and metals. Floor samples were collected along the same 15' grid used during Round 2 sampling, while sidewall samples were collected at locations not previously characterized by a floor sample. Each sidewall sample was collected as a 5-point composite at 2-foot depth intervals as shown on Figure 5-4. VOC samples were collected from the center of the sidewall as grab samples, two inches below the surface of the sidewall. A summary of Round 3 samples, including sample IDs and analytical methods is presented in Table 5.8-3.

Table 5.8-3 – Round 3 Sample Summary

SAMPLE ID	TYPE	ANALYSIS
S2GP-0204CP S2GP-0204NE S2GP-0204NW S2GP-0204SE S2GP-0204SW S2GP-0205NW S2GP-0206CP S2GP-0206NE S2GP-0206NW S2GP-0206SE S2GP-0206SW S2GP-0207SE	Grab Sample 15-ft grid For each sample: 6"-12" bgs (suffix -1.0) 12"-24" bgs (suffix -2.0) 24"-36" bgs (suffix -3.0)	VOC (SW8260B) SVOC (SW8270C) Metals (SW6010B and SW7471A)

5.8.3.2.3.2 All Round 3 post-removal samples yielded results below residential standards, while hexachloroethane was detected in three samples above soil-to-groundwater SSLs (DAF38) as shown on Figure 5-4. These exceedances included one floor sample (S2GP-0306CP), one sidewall sample along the northern edge of the Burial Pit (S2GP-0304NE-SDW5045), and one sidewall sample adjacent to the area of excavated stained soil (S2GP-0307OS-SDW5045). No additional COPCs identified during Round 1 and Round 2 sampling events were detected at concentrations exceeding soil-to-groundwater SSLs (DAF38) during the Round 3 sampling event. Sample locations exhibiting analytes below criteria were retained to support an NFA determination (Figure 5-4). Results of the Round 3 Burial Pit Sampling event were presented for UDEQ concurrence in the memorandum dated 23 June 2015 (Appendix G). A comprehensive, searchable data table including all Burial Pit data collected during the SWMU 2 IRA is included as Table 1-2 in Appendix H. Table 5.8-4 presents a summary of Burial Pit sample locations removed as a result of COPC exceedances. Table 5.8-5 summarizes the Burial Pit samples retained for NFA determination.

Table 5.8-4- Sample Exceedances and Locations Removed From SWMU 2 Burial Pit

Sample ID	COPC (driver for excavation)	Concentration	Units	Residential	Background	DAF38	Units
ROUND 1 SAMPLES							
S2GP-0104	Arsenic	46	mg/kg		12.1/35		mg/kg
S2GP-0105	Hexachloroethane	0.32	mg/kg	13		0.0485	mg/kg
S2GP-0106	Hexachloroethane	0.32	mg/kg	13		0.0485	mg/kg
S2GP-0107	Hexachloroethane	0.23	mg/kg	13		0.0485	mg/kg
S2GP-0107	Arsenic	150	mg/kg		12.1/35		mg/kg
ROUND 2 SAMPLES							
S2GP-0204CP-1.0	Arsenic	31	mg/kg		12.1/35		mg/kg
S2GP-0204CP-1.0	Hexachloroethane	7.7	mg/kg	13		0.0485	mg/kg
S2GP-0204CP-1.0	Iron	58000	mg/kg	55000	15460		mg/kg
S2GP-0204CP-2.0	Hexachloroethane	8.8	mg/kg	13		0.0485	mg/kg
S2GP-0204NE-1.0	Hexachloroethane	0.12	mg/kg	13		0.0485	mg/kg
S2GP-0204NE-2.0	Hexachlorobenzene	0.61	mg/kg	0.33		0.0708	mg/kg
S2GP-0204NE-2.0	Hexachloroethane	2.7	mg/kg	13		0.0485	mg/kg
S2GP-0204NE-2.0	Tetrachloroethene	1	mg/kg	24		0.354	mg/kg
S2GP-0204NE-3.0	Hexachlorobenzene	6.3	mg/kg	0.33		0.0708	mg/kg
S2GP-0204NE-3.0	Hexachloroethane	4.1	mg/kg	13		0.0485	mg/kg
S2GP-0204SE-1.0	Arsenic	120	mg/kg		12.1/35		mg/kg
S2GP-0204SE-1.0	Hexachloroethane	2.1	mg/kg	13		0.0485	mg/kg
S2GP-0204SE-2.0	Arsenic	34	mg/kg		12.1/35		mg/kg
S2GP-0204SE-2.0	Hexachloroethane	1.2	mg/kg	13		0.0485	mg/kg
S2GP-0204SW-1.0	Arsenic	45	mg/kg		12.1/35		mg/kg
S2GP-0204SW-1.0	Hexachloroethane	0.91	mg/kg	13		0.0485	mg/kg
S2GP-0205NW-1.0	Hexachloroethane	6.1	mg/kg	13		0.0485	mg/kg
S2GP-0206CP-1.0	Arsenic	41	mg/kg		12.1/35		mg/kg
S2GP-0206CP-1.0	Hexachlorobenzene	0.23	mg/kg	0.33		0.0708	mg/kg
S2GP-0206CP-1.0	Hexachloroethane	32	mg/kg	13		0.0485	mg/kg
S2GP-0206CP-2.0	Hexachloroethane	1.1	mg/kg	13		0.0485	mg/kg
S2GP-0206CP-3.0	Hexachloroethane	0.17	mg/kg	13		0.0485	mg/kg

Sample ID	COPC (driver for excavation)	Concentration	Units	Residential	Background	DAF38	Units
S2GP-0206NE-1.0	Hexachlorobenzene	0.17	mg/kg	0.33		0.0708	mg/kg
S2GP-0206NE-1.0	Hexachloroethane	28	mg/kg	13		0.0485	mg/kg
S2GP-0206NE-2.0	Hexachloroethane	0.96	mg/kg			0.0485	mg/kg
S2GP-0206NE-3.0	Iron	180000	mg/kg	55000	15460		mg/kg
S2GP-0206NW-1.0	Arsenic	59	mg/kg		12.1/35		mg/kg
S2GP-0206NW-1.0	Hexachloroethane	1.9	mg/kg	13		0.0485	mg/kg
S2GP-0206NW-2.0	Hexachlorobenzene	0.12	mg/kg	0.33		0.0708	mg/kg
S2GP-0206NW-2.0	Hexachloroethane	1.4	mg/kg	13		0.0485	mg/kg
S2GP-0206SW-1.0	Hexachlorobenzene	0.21	mg/kg	0.33		0.0708	mg/kg
S2GP-0206SW-1.0	Hexachloroethane	28	mg/kg	13		0.0485	mg/kg
S2GP-0206SW-2.0	Hexachlorobenzene	0.24	mg/kg	0.33		0.0708	mg/kg
S2GP-0206SW-2.0	Hexachloroethane	1.1	mg/kg	13		0.0485	mg/kg
S2GP-0206SW-2.0	Pentachlorophenol	0.53	mg/kg	0.99		0.0463	mg/kg
S2GP-0206SW-3.0	Hexachloroethane	1.2	mg/kg	13		0.0485	mg/kg
S2GP-0207SE-1.0	Hexachloroethane	1.4	mg/kg	13		0.0485	mg/kg
S2GP-0207SE-1.0	Iron	61000	mg/kg	55000	15460		mg/kg
ROUND 3 SAMPLES * not excavated *							
S2GP-0304NE-SDW5045	Hexachloroethane	0.091	mg/kg	13		0.0485	mg/kg
S2GP-0307OS-SDW5045	Hexachloroethane	0.22	mg/kg	13		0.0485	mg/kg
S2GP-0306CP	Hexachloroethane	0.65	mg/kg	13		0.0485	mg/kg
S2GP-0306CP-FD	Hexachloroethane	1.5	mg/kg	13		0.0485	mg/kg

Table 5.8-5- Non-Exceedances: Samples Supporting NFA at the SWMU 2 Burial Pit

Sample ID	COPC	Concentration	Units	Residential	Background	DAF38	Units
S2GP-0101	Arsenic	13	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg	0.33		0.0708	mg/kg
S2GP-0102	Arsenic	12	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0103	Arsenic	15	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0108	Arsenic	13	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0109	Arsenic	15	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg

Sample ID	COPC	Concentration	Units	Residential	Background	DAF38	Units
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0204NW-1.0	Arsenic	11	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0204SW-2.0	Arsenic	11	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0304CP	Arsenic	9.5	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0304NE	Arsenic	6.3	mg/kg		12.1		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0304SE	Arsenic	7.4	mg/kg		12.1		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0304NE-SDW5045	Arsenic	19	mg/kg		35		mg/kg
	Hexachloroethane	0.091	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0304SE-SDW5044	Arsenic	16	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0306NW	Arsenic	10	mg/kg		12.1		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0306SW	Arsenic	8.3	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0306CP	Arsenic	9.9	mg/kg		12.1		mg/kg
	Hexachloroethane	0.65	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0306CP-FD	Arsenic	11	mg/kg		12.1		mg/kg
	Hexachloroethane	1.5	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0306NE	Arsenic	13	mg/kg		12.1		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0206SE-1.0	Arsenic	12	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg

Sample ID	COPC	Concentration	Units	Residential	Background	DAF38	Units
S2GP-0306NE-SDW5047	Arsenic	18	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0306SE-SDW5047	Arsenic	18	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0205NW-2.0	Arsenic	9.8	mg/kg		12.1		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0305NW-SDW5047	Arsenic	14	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0307OS	Arsenic	16	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0307OS-SDW5045	Arsenic	15	mg/kg		35		mg/kg
	Hexachloroethane	0.22	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg
S2GP-0207SE-2.0	Arsenic	15	mg/kg		35		mg/kg
	Hexachloroethane	ND	mg/kg	13		0.0485	mg/kg
	Hexachlorobenzene	ND	mg/kg				mg/kg

NOTE: The background reference value for arsenic has been established at 35 mg/kg, and the UTL of 12.1 mg/kg is used for the samples located within the footprint of the DM sources.

5.8.4 SWMU 2 INCREMENTAL SAMPLE AREA

5.8.4.1 SWMU 2 IS Procedures

5.8.4.1.1 Analytical soil samples were collected using Incremental Sampling (IS) methodology to characterize the remaining SWMU 2 area outside and adjacent to the Burial Pit boundaries exhibiting geophysical anomalies. IS methodology was selected to characterize this area based on the lack of evidence associated with disposal of RCRA-regulated waste, MEC, or CWM. The IS approach was used to provided sufficient and statistically defensible data to assess potential surface contamination and demonstrate surface soil in the area is below risk-based levels. IS sampling at SWMU 2 was conducted in accordance with the IS SOP (Appendix G).

5.8.4.1.2 The IS area at SWMU 2 was segregated into three DUs based on acreage and density of geophysical anomalies (e.g. inert cultural debris) and analyzed for SVOCs, metals, and explosives. A separate background DU (DU #4) was located based on its status as an area that has not been impacted by previous site activities while maintaining geologic conditions similar to DUs #1, #2, and #3. Data from background DU #4 was used to estimate site specific mean background or ambient concentrations of metals. The SWMU 2 IS areas are presented in Figure 5-5.

5.8.4.1.3 IS methodology included full drying and sieving on all primary, duplicate, and triplicate IS samples collected from DUs 1-4 in accordance with USEPA Method 8330B (USEPA 2006). A subset of each dried and sieved sample was segregated for metals analysis. The remaining sample aliquot was ground to less than 2 millimeters for SVOC and explosives analysis. The laboratory then performed the extraction and analysis on the entire final subsampled portions. Documentation of IS laboratory preparation and analysis methods are included in Appendix I.

5.8.4.2 SWMU 2 IS Results

5.8.4.2.1 A 95% upper confidence limit (UCL) was calculated based on the results of the triplicate samples within each DU and evaluated according to the screening process outlined in Section 5.5.

5.8.4.2.2 SVOCs and explosives were not detected in DUs #1, #2, and #3. All metals detected in DUs #1, #2, and #3 as well as background DU #4 were below or within the reasonable range of naturally occurring background levels presented in Table 5 of the RAD (AQS, 2015). Note the limits of detection (LODs) for selenium, thallium, and antimony exceeded the published background concentrations (AQS, 2015).

5.8.4.2.3 Detections of elements and compounds identified in DUs #1 through #4, as well as the calculated 95% UCL for each compound and their respective LODs are summarized in Table 5.8-6.

Table 5.8-6- IS Detections Summary Table

Method	Analyte	2015 RAD BACKGROUND VALUE (metals) (mg/kg)	Decision Unit 01									Decision Unit 02								
			S2IS-DU01A		S2IS-DU01B		S2IS-DU01C					S2IS-DU02A		S2IS-DU02B		S2IS-DU02C				
			Result (mg/Kg)	LOD (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	sdev	%RSD	95% UCL (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	sdev	%RSD	95% UCL (mg/Kg)
SW6010B	Aluminum	17610	7900	10	7300	10	7900	10	346.410	4.499	8284.000	8200	9.9	8700	10	8700	10	288.675	3.383	9020.000
SW6010B	Antimony	0.96	ND	2	ND	2	ND	2	0.000	0.000	2.000	ND	2	ND	2	ND	2	0.000	0.000	2.000
SW6010B	Arsenic	35/12.1	11	2.5	11	2.5	11	2.5	0.000	0.000	11.000	12	2.5	13	2.5	13	2.5	0.577	4.558	13.640
SW6010B	Barium	239.8	80	0.5	74	0.5	76	0.5	3.055	3.985	81.817	74	0.5	79	0.5	76	0.5	2.517	3.297	80.576
SW6010B	Beryllium	0.97	0.39	0.1	0.37	0.1	0.37	0.1	0.012	3.066	0.396	0.39	0.099	0.44	0.1	0.42	0.1	0.025	6.040	0.459
SW6010B	Cadmium	1.2	0.97	0.1	0.89	0.1	0.98	0.1	0.049	5.211	1.030	1	0.099	1	0.1	1	0.1	0.000	0.000	1.000
SW6010B	Chromium	19.8	14	0.5	14	0.5	15	0.5	0.577	4.028	15.307	15	0.5	15	0.5	16	0.5	0.577	3.765	16.307
SW6010B	Cobalt	5.7	4.2	0.5	3.9	0.5	4.2	0.5	0.173	4.225	4.392	4.5	0.5	4.8	0.5	4.7	0.5	0.153	3.273	4.924
SW6010B	Copper	32.4	14	0.5	13	0.5	14	0.5	0.577	4.225	14.640	14	0.5	14	0.5	14	0.5	0.000	0.000	14.000
SW6010B	Iron	15460	12000	5	12000	5	12000	5	0.000	0.000	12000.000	13000	5	13000	5	13000	5	0.000	0.000	13000.000
SW6010B	Lead	39.3	31	0.5	30	0.5	32	0.5	1.000	3.226	32.686	32	0.5	30	0.5	32	0.5	1.155	3.685	33.280
SW6010B	Manganese	698.7	360	0.5	350	0.5	360	0.5	5.774	1.619	366.400	380	0.5	390	0.5	380	0.5	5.774	1.506	393.067
SW6010B	Molybdenum	0.9	1.1	1	1.1	1	1.1	1	0.000	0.000	1.100	1.2	0.99	1.2	1	1.3	1	0.058	4.681	1.331
SW6010B	Nickel	14.5	17	0.5	16	0.5	17	0.5	0.577	3.464	17.640	18	0.5	19	0.5	19	0.5	0.577	3.093	19.640
SW6010B	Potassium	9131	2400	25	2200	25	2400	25	115.470	4.949	2528.000	2500	25	2600	25	2500	25	57.735	2.279	2630.667
SW6010B	Selenium	1.4	ND	2.5	ND	2.5	ND	2.5	0.000	0.000	2.500	ND	2.5	ND	2.5	ND	2.5	0.000	0.000	2.500
SW6010B	Silver	N/A	0.2	0.2	0.13	0.2	0.22	0.2	0.047	25.777	0.263	0.25	0.2	0.35	0.2	0.26	0.2	0.055	19.212	0.380
SW6010B	Thallium	N/A	ND	1	ND	1	ND	1	0.000	0.000	1.000	ND	0.99	ND	1	ND	1	0.006	0.579	1.006
SW6010B	Vanadium	27.94	19	0.5	19	0.5	20	0.5	0.577	2.986	20.307	20	0.5	21	0.5	22	0.5	1.000	4.762	22.686
SW6010B	Zinc	77.1	68	1	66	1	70	1	2.000	2.941	71.372	74	0.99	83	1	120	1	24.379	26.403	133.433
SW7471A	Mercury	0.05	0.027	0.01	0.027	0.01	0.03	0.01	0.002	6.186	0.031	0.029	0.01	0.039	0.01	0.032	0.01	0.005	15.395	0.042

Table 5.8-6 - IS Detections Summary Table

Method	Analyte	2015 RAD BACKGROUND VALUE (metals) (mg/kg)	Decision Unit 03									Decision Unit 04								
			S2IS-DU03A		S2IS-DU03B		S2IS-DU03C					S2IS-DU04A		S2IS-DU04B		S2IS-DU04C				
			Result (mg/Kg)	LOD (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	sdev	%RSD	95% UCL (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	Result (mg/Kg)	LOD (mg/Kg)	sdev	%RSD	95% UCL (mg/Kg)
SW6010B	Aluminum	17610	8500	10	8700	10	8300	9.9	200.000	2.353	8837.173	11000	10	11000	10	11000	10	0.000	0.000	11000.000
SW6010B	Antimony	0.96	ND	2	ND	2	ND	2	0.000	0.000	2.000	ND	2	ND	2	ND	2	0.000	0.000	2.000
SW6010B	Arsenic	35/12.1	11	2.5	12	2.5	11	2.5	0.577	5.094	12.307	8.8	2.5	9.1	2.5	8.8	2.5	0.173	1.946	9.192
SW6010B	Barium	239.8	65	0.5	66	0.5	64	0.5	1.000	1.538	66.686	150	0.5	150	0.5	160	0.5	5.774	3.765	163.067
SW6010B	Beryllium	0.97	0.46	0.1	0.44	0.1	0.44	0.099	0.012	2.585	0.466	0.51	0.1	0.52	0.1	0.53	0.1	0.010	1.923	0.537
SW6010B	Cadmium	1.2	0.93	0.1	0.98	0.1	0.93	0.099	0.029	3.049	0.995	1.1	0.1	1.1	0.1	1.1	0.1	0.000	0.000	1.100
SW6010B	Chromium	19.8	16	0.5	16	0.5	16	0.5	0.000	0.000	16.000	16	0.5	16	0.5	16	0.5	0.000	0.000	16.000
SW6010B	Cobalt	5.7	5	0.5	5.1	0.5	4.7	0.5	0.208	4.220	5.284	4.8	0.5	4.8	0.5	4.8	0.5	0.000	0.000	4.800
SW6010B	Copper	32.4	12	0.5	12	0.5	12	0.5	0.000	0.000	12.000	18	0.5	17	0.5	18	0.5	0.577	3.268	18.640
SW6010B	Iron	15460	13000	5	13000	5	13000	5	0.000	0.000	13000.000	12000	5	13000	5	13000	5	577.350	4.558	13640.000
SW6010B	Lead	39.3	24	0.5	26	0.5	25	0.5	1.000	4.000	26.686	41	0.5	39	0.5	41	0.5	1.155	2.863	42.280
SW6010B	Manganese	698.7	370	0.5	360	0.5	350	0.5	10.000	2.778	376.859	550	0.5	530	0.5	560	0.5	15.275	2.794	572.419
SW6010B	Molybdenum	0.9	1.2	1	1.3	1	1.2	0.99	0.058	4.681	1.331	0.92	1	0.8	1	0.9	1	0.064	7.362	0.982
SW6010B	Nickel	14.5	20	0.5	21	0.5	19	0.5	1.000	5.000	21.686	16	0.5	16	0.5	16	0.5	0.000	0.000	16.000
SW6010B	Potassium	9131	1800	25	1900	25	1800	25	57.735	3.149	1930.667	4100	25	4200	25	4000	25	100.000	2.439	4268.586
SW6010B	Selenium	1.4	ND	2.5	ND	2.5	ND	2.5	0.000	0.000	2.500	ND	2.5	ND	2.5	ND	2.5	0.000	0.000	2.500
SW6010B	Silver	N/A	0.11	0.2	0.12	0.2	ND	0.2	0.049	34.415	0.226	0.22	0.2	0.17	0.2	0.12	0.2	0.050	29.412	0.254
SW6010B	Thallium	N/A	ND	1	ND	1	ND	1	0.000	0.000	1.000	ND	0.99	ND	1	ND	1	0.006	0.579	1.006
SW6010B	Vanadium	27.94	21	0.5	22	0.5	21	0.5	0.577	2.706	22.307	21	0.5	21	0.5	21	0.5	0.000	0.000	21.000
SW6010B	Zinc	77.1	67	1	71	1	67	0.99	2.309	3.380	72.227	80	1	78	1	78	1	1.155	1.468	80.613
SW7471A	Mercury	0.05	0.031	0.01	0.029	0.01	0.029	0.01	0.001	3.892	0.032	0.028	0.01	0.026	0.01	0.043	0.01	0.009	28.737	0.048

5.9 WASTE MANAGEMENT

5.9.1 Burial Pit Soil

5.9.1.1 Soil samples were collected from all stockpiles generated during the Burial Pit excavation in accordance with the procedures outlined in the Interim Remedial Action Work Plan (UXB-KEMRON, 2012). Overburden soil representing historical backfill situated above DMM was segregated from soils mixed with and situated below DMM. Overburden stockpiles were sampled at a different frequency than mixed stockpiles since contamination was not anticipated in overburden soils. Waste soils were analyzed for all compounds listed in Section 5.8.1, plus the following Toxicity Characteristic Leaching Procedures (TCLP):

- TCLP VOC (SW1311/8260B)
- TCLP SVOC (SW1311/8270C)
- TCLP Pesticides (SW1311/8081A)
- TCLP Herbicides (SW1311/8151A)
- TCLP Metals (SW1311/6010B/7470A)
- Reactivity, Ignitability, Corrosivity (RIC)

5.9.1.2 All stockpiles were staged on a plastic liner and covered pending receipt of results and/or off-site shipment. A summary of waste soil stockpile data is presented in Table 5.9-1, and includes the stockpile type, estimated volume, sample frequency, and waste disposition. Stockpile waste characterization sample results are included in Table 1-2, Appendix H.

5.9.1.3 Excavated soil with analytical data results less than residential RSLs and site specific SSLs (DAF 38) were presented to UDEQ for approval for use as on-site backfill. Stockpiles #1, #3 through #7, and #11 representing approximately 2,564 cy were approved for use as backfill within the Burial Pit in memorandums dated 1 October 2013, 9 June 2014, and 17 October 2014 (Appendix G).

5.9.1.4 Excavated soil with analytical data results above site specific SSLs (DAF 38) were retained for off-site disposal. Stockpiles #2, #8 through #10, and #11 through #15 representing approximately 1,856 cy were approved for disposal as non-hazardous solid waste based on analytical results. Waste profiles and waste disposal records for these stockpiles are presented in Appendix J.

Table 5.9-1- Waste Stockpile Summary - SWMU 2 Burial Pit

Stockpile #	Type (Overburden or Mixed)	Estimated Volume (cy)	State of Utah-Approved Backfill?	# Samples	Sample Type	Disposition
1	Overburden	245	YES	(1) S2WC-0101	G	On-Site Backfill (Burial Pit)
2	Overburden	400	**NO**	(4*) S2WC-0201 through S2WC-0204	G	Off-Site Disposal (Wasatch)
3	Overburden	120	YES	(1) S2WC-0301	G	On-Site Backfill (Burial Pit)
4	Overburden	1012	YES	(3) S2WC-0401 through S2WC-0403	G	On-Site Backfill (Burial Pit)
5	Overburden	678	YES	(2) S2WC-0501 and S2WC-0502	G	On-Site Backfill (Burial Pit)
6	Overburden	274	YES	(1) S2WC-0601	G	On-Site Backfill (Burial Pit)
7	Overburden	228	YES	(1) S2WC-0701	G	On-Site Backfill (Burial Pit)
8	Mixed	534	**NO**	(6) S2WC-0801 through S2WC-0806	C	Off-Site Disposal (Wasatch)
9	Overburden	525	**NO**	(2) S2WC-0901 and S2WC-0902	G	Off-Site Disposal (Wasatch)
10	Mixed	113	**NO**	(2) S2WC-1001 and S2WC-1002	C	Off-Site Disposal (Wasatch)
11	Mixed	7	YES	(1) S2WC-1101	C	On-Site Backfill (Burial Pit)
12	Mixed	90	**NO**	(1) S2WC-1201	C	Off-Site Disposal (Grassy Mountain)
13	Mixed	90	**NO**	(1)	C	Off-Site Disposal

Stockpile #	Type (Overburden or Mixed)	Estimated Volume (cy)	State of Utah-Approved Backfill?	# Samples	Sample Type	Disposition
				S2WC-1301		(Grassy Mountain)
14	Mixed	90	**NO**	(1) S2WC-1401	C	Off-Site Disposal (Grassy Mountain)
15	Mixed	14	**NO**	(1) S2WC-1501	C	Off-Site Disposal (Grassy Mountain)

G = grab sample collected at a frequency of 1 per 500 cy for soil determined to be overburden
C = composite sample collected at a frequency of 1 per 100 cy for soil determined to be mixed with potential DMM
* = Stockpile #2 additional samples collected based on initial exceedances

5.9.2 Miscellaneous Waste

5.9.2.1 Diesel-Impacted Soil

5.9.2.1.1 A small quantity (< 1 gallon) of diesel fuel was spilled during fueling of a project support generator located adjacent to the operations trailer. Field personnel excavated the impacted soil and adjacent non-impacted soil and staged in a 55-gallon drum for characterization and disposal. One sample (S2WC-CD-GP-16) was collected for diesel range organics (DRO) to ensure proper disposal. DRO-impacted soil was disposed of during OB operations as diesel was the accelerant used for the burn.

5.9.2.2 Ash

5.9.2.2.1 Ash generated from munitions burn operations was sampled to evaluate waste characteristics and identify disposal options for the anticipated waste stream. An initial ash sample (S2OB-ASH01) was collected from the waste created during the burning of E46 incendiary bombs and electric squibs and analyzed for constituents required by the disposal facility, including:

- Method 8330B – Nitroaromatics and Nitramines
- Method 6010B – TCLP Metals
- Method 7470A – TCLP Mercury
- RIC

5.9.2.2.2 Four explosive compounds were detected in S2OB-ASH01, all below the residential RSL. All other compounds and elements were not detected.

5.9.2.2.3 A second ash sample (S2OB-ASH02) was collected from a separate waste stream that included the use of lead shape charges. The same analytes were evaluated for this sample, plus sulfur (Method 6010B) to evaluate potential influence from the use of the lead shape charges. Sulfur was analyzed in support of the waste disposal facility's permitted total sulfur limit and to satisfy disposal requirements. A summary of detections are presented in Table 5.9-2. Complete results are included in Table 1-2 of Appendix H.

5.9.2.2.4 All ash generated as part of SWMU 2 munitions burn operations were combined based on similar waste characteristics and staged in a 20 cubic yard (cy) roll-off until burn operations were complete. 14.64 tons of ash was generated as a part of this process. The 20 cy ash roll-off was transported off-site on 10 November to Wasatch Regional Landfill and disposed of as non-hazardous solid waste. Waste disposition and waste profile records are included in Appendix J.

Table 5.9-2- Open Burn Ash - Summary of Detections

Sample ID	Date Sampled	Method	Analyte	Result	Qualifier	Units	Residential MCL
S2OB-ASH01	11/18/2014	SW8330B	2,4,6-Trinitrotoluene	0.56	J	mg/Kg	21
S2OB-ASH01	11/18/2014	SW8330B	2,6-Dinitrotoluene	0.12	J	mg/Kg	0.36
S2OB-ASH01	11/18/2014	SW8330B	RDX	0.031	J	mg/Kg	6.1
S2OB-ASH01	11/18/2014	SW8330B	Tetryl	0.13	J	mg/Kg	160
S2OB-ASH02	4/16/2015	SW6010B	Sulfur	4800	-	mg/Kg	-

5.9.2.3 PPE

5.9.2.3.1 Used personal protective equipment (PPE) in the form of nitrile gloves, Tyvek™ protective suits, latex booties, and miscellaneous waste associated with field equipment was staged in (43) 55-gallon drums throughout the field effort. One composite sample was collected from PPE clippings from ten representative drums and analyzed for TCLP VOC, TCLP SVOC, TCLP Pesticides, TCLP Metals, TCLP Herbicides, and RIC. All compounds yielded results below their respective regulatory limits with the exception of chromium. The concentration of TCLP chromium (13 mg/l) exceeded its regulatory limit of 5 mg/l. As a result, PPE generated during SWMU 2 IRA field operations was characterized as hazardous solid waste. All 55-gallon drums containing PPE were emptied into one 40 cy roll-off and disposed of accordingly. Waste disposition and waste profile records are included in Appendix J.

5.10 SWMU 2 OPEN BURN AREA

5.10.1 Pre (baseline) and Post-Burn soil samples were collected from the Open Burn Area to evaluate potential impacts to surface soils resulting from munitions burn operations. Samples were analyzed for VOCs, SVOCs, explosives, organosulfur and tear gas degradates (TGDs), CWM degradates, ABPs, perchlorate, dioxin/furans and metals to evaluate compounds of potential concern identified in the Work Plan. Due to the Open Burn Area being located outside of SWMU 2, the results of the Open Burn Area sampling will be submitted in a separate letter report.

5.11 CONCLUSIONS

5.11.1 Data from three sampling rounds conducted within the SWMU 2 Burial Pit support the conclusion that the source of soil contamination has been successfully removed. Prior to removal, all DMM items within the burial pit were found palletized and/or containerized exhibiting moderate visual and/or olfactory evidence of leakage. Following receipt of soil delineation data, up to four feet of MC-impacted soil was excavated from beneath the footprint of DMM, as shown in Figure 5-1. All exceedances of the residential soil standard have been excavated from the Burial Pit removing possible complete exposure pathways addressing ingestion, dermal contact, and inhalation of particulates from soil.

5.11.2 Impacts to groundwater and the soil vapor pathway from remaining residual hexachloroethane concentrations are considered limited based on several factors, including:

- Source Removal – Evidence supports the successful removal of the source and associated contamination as detailed above;
- Remaining concentrations of COPCs below risk levels - The residential scenario was evaluated and shown to meet acceptable human health risk levels in accordance with UAC R315-101. The exposure scenario includes ingestion of soil and dust, inhalation of contaminants, dermal contact with chemicals in soil, and direct contact with contaminants that have migrated to groundwater;
- Limited *frequency* of detection - of the 29 sample locations currently remaining in the Burial Pit, only three exhibit concentrations of hexachloroethane above site-specific SSLs;
- Limited *magnitude* of detection – the highest pre-removal concentration of hexachloroethane in the source area at the site was 32 mg/kg; remaining post-removal residual contamination ranges from 1.5 mg/kg to 0.091 mg/kg. The site-specific soil-to-groundwater SSL (DAF38) is 0.0485 mg/kg;
- Groundwater monitoring results – According to the most recent groundwater monitoring report, monitoring wells downgradient and cross-gradient of the SWMU 2 Burial Pit (S-3-82 and S-46-90) reported no detections of hexachloroethane in monitoring wells between 2005 and 2010 (2010 Final

Groundwater Monitoring Report). The most recent groundwater monitoring event occurred in 2010, prior to SWMU 2 source removal;

- Soil Profile – Groundwater surrounding the SWMU 2 Gravel Pit is considered unconfined. A fine-grained, sandy silt layer exists below the coarse gravel was identified during vertical delineation (Round 2 sampling) beginning at an average depth of 4.5' below the pre-excavation surface. According to the 2010 Hydrogeological Assessment Report, this gradation extends into the screened interval at S-3-82 beginning at 24.4' bgs. Based on this soil profile and its soil adsorption factor, migration of any remaining residual hexachloroethane is likely to have low mobility through this soil horizon;
- Horizontal Delineation - Incremental samples were collected from three Decision Units north of the SWMU 2 Burial Pit as shown on Figure 5-1 (DU1, DU2, and DU3). Incremental sample data was collected to evaluate and subsequently eliminate magnetic anomalies as sources of contamination within these DUs. Hexachloroethane was not detected in these DUs, which are north of the sidewall exceedances (S2GP-0304NE-SDW5045 and S2GP-0307OS-SDW5045), or in all other samples surrounding these sidewall samples above site-specific groundwater criteria. The detection of hexachloroethane in the floor sample at S2GP-0306CP represents a *deminimis* volume of residual contamination based on its limited horizontal footprint and its concentration is below its residential RSL.
- IS soil samples were collected to characterize the remaining SWMU 2 area outside of the Burial Pit boundaries that exhibited geophysical anomalies. SVOCs and explosives were not detected at concentrations above the LOD in DUs #1, #2, and #3.

5.12 RECOMMENDATIONS

5.12.1 No additional soil investigation or excavation is recommended for the SWMU 2 Burial Pit based on evidence of successful source removal and data suggesting minimal potential impacts to groundwater. Compounds of concern are below residential RSLs. Although a *deminimis* volume of residual hexachloroethane remains in the Burial Pit above the site-specific SSL (DAF38), the footprint of hexachloroethane appears to be limited in area and does not represent a significant source of groundwater contamination based on the results of the adjacent DU samples and floor samples. The detection of hexachloroethane in the floor sample at S2GP-0306CP has not been vertically delineated but concentrations are below the residential RSL.

5.12.2 The extent of the SWMU 2 Burial Pit has been surveyed and backfilled using stockpiles previously approved for use as on-site backfill in accordance with the specifications outlined in the SWMU 2 IRA Work Plan.

6 EXPOSURE DATA

Item	Cumulative
Hours worked in direct support of the contract (field personnel only)	68,836.2
Number of lost workday accidents	0
Number of lost workdays due to on-the-job accidents	0
Number of property damage accidents (includes vehicles) (property loss value is $2,000 or more)	0

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Figures

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Appendix A Documentation for Final Disposition of MPPEH
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Appendix B Explosives Accountability Records
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Appendix C Dig Sheet Data
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Appendix D Daily Reports/Logs
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Appendix E Breakout of Project Costs
Data provided in separate enclosure

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Appendix F Project Photographs

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Appendix G Memorandums and Standard Operating Procedures Electronic Only

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Appendix H Data Quality Assessment
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Appendix I Incremental Sampling Methodology and Results
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Appendix J Waste Management
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