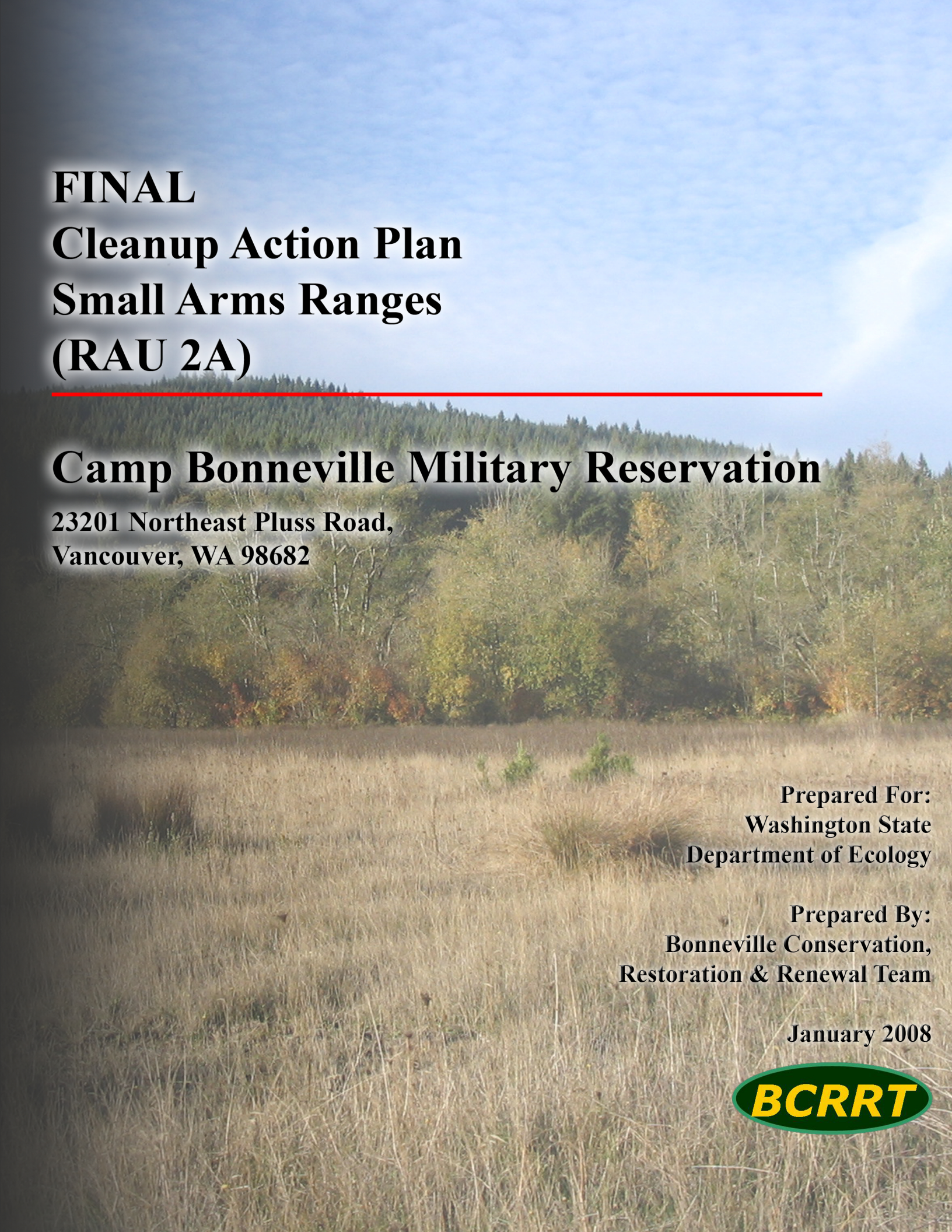

FINAL
Cleanup Action Plan
Small Arms Ranges
(RAU 2A)

Camp Bonneville Military Reservation

23201 Northeast Pluss Road,
Vancouver, WA 98682

Prepared For:
Washington State
Department of Ecology

Prepared By:
Bonneville Conservation,
Restoration & Renewal Team

January 2008

BCRRT

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LIST OF ACRONYMS AND ABBREVIATIONS

2, 4 DNT	2,4 Dinitrotoluene
ACES	Area Covered by Environmental Services
AEM	Atlanta Environmental Management, Inc.
AOC	Area of Concern
AOPC	Area of Potential Concern
APP	Accident Prevention Plan
AR	Army Regulation
ARARs	Applicable or Relevant and Appropriate Requirements
ARNG	Army National Guard
ARPA	Archaeological Resource Protection Act
ASB	Anomaly Selection Board
ASR	Archives Search Report
bgs	Below Ground Surface
BOCC	Board of County Commissioners
BRAC	Base Realignment and Closure
BCRRT	Bonneville Conservation Restoration and Renewal Team, LLC
BMV	Benchmark Values
CAA	Clean Air Act
CAAA	Clean Air Act Ammendment
CAP	Clean-up Action Plan
CBMR	Camp Bonneville Military Reservation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CCA	Conservation Conveyance Authority
CCC	Civilian Conservation Corps
CERFA	Community Environmental Response Facilitation Act
CITA	Central Impact Target Area
CMTC	Citizens Military Training Camps
COPC	Chemicals of Potential Concern
CRAP	Conceptual Remedail Action Plan
CRZ	Contamination Reduction Zone
CSM	Conceptual Site Model
CWA	Clean Water Act
DA	Department of Army
DAESC	Department of the Army Explosive Safety Council
DGM	Digital Geologic / Geophysical Mapping
DNR	Department of Natural Resources
DOD	Department of Defense
DOE	Washington State Department of Ecology

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

EA	Environment Assessment
E&R	Excavation and Restoration
EBS	Environment Baseline Study
EIS	Environmental Impact Statement
EE/CA	Engineering Evaluation / Cost Analysis
EHS	Environmental Health and Safety
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ESA	Environmental Study Area
ESCA	Environmental Services Cooperative Agreement
ESH	Explosive Safety Hazard
ESS	Explosive Safety Submission
FBI	Federal Bureau of Investigation
FS	Feasibility Study
FOSET	Finding of Suitability for Early Transfer
GIS	Geographical Information System
GOCO	Government Owned, Contracts Operated
GPS	Global Positioning System
HASP	Site Wide Health and Safety Plan
HAZWOPER	Hazardous Waste Operation and Emergency Response Standard
HE	High Explosive
HEAT	High Explosive Anti-Tank
HSR	Hazard Severity Ranking
HSWA	Hazardous and Solid Waste Ammendments
HWMA	Hazardous Waste Management Act
IAWP	Interim Action Work Plan
ICs	Institutional Controls
ID	Identification
IDW	Investigation Derived Waste
LAW	Light Anti-tank Weapon
LDR	Land Disposal Restrictions
LRA	Local Redevelopment Authority
MD	Munition Debris
MEC	Munitions and Explosives of Concern
mg/L	miligrams per liter
MRE	Meal, Ready-to-Eat
msl	mean sea level
MTCA	Model Toxics Control Act

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

N/A	Not Applicable
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NFA	No Further Action
N/A	Not Applicable
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge
NPL	National Priority List
NSPS	New Source Performance Standards
OB/OD	Open Burn / Open Detonation
OE	Ordnance and Explosive
OSHA	Occupational Safety and Health Act
PETN	Pentaerythritol Tetranitrate
PHA	Project Hazard Analysis
PDA	Personal Digital Assistant
PPCD	Prospective Purchaser Consent Decree
PPCE	Personal Protective Clothing and Equipment
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goals
PSD	Prevention of Significant Deterioration
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assuance / Quality Control
RAU 2 A	Remedial Action Unit 3
RCRA	Resource Conservation and Recovery Act
RCW	Reveised Code of Washington
RI	Remedial Investigation
RI/FS	Remedial Investigation / Feasibility Study
ROTC	Reserve Officer Training Corps
RP	Regional Park
RPC	Reuse Planning Committee
RTES	Rare, Threatened Endangered Species
RV	Recreational Vehicle

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SEPA	State Environmental Policy Act
SI	Site Investigation
SIPS	Stae Implementation Plans
SOP	Standard / Standing Operating Procedure
SOW	Statement of Work
SPRT	Sequential Probability Ratio Test
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time Critical Removal Action
TEC	Topographic Engineering Center
TLVs	Threshhold Limit Values
TSDF	Treatment, Storage and Disposal Facility
TSRS	Technical Specifications and Requirement Statements
UPL	Upper Confidence Level
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering and Support Center, Huntsville
USAR	United States Army Reserve
USATCES	United States Army Technical Center for Explosives Safety
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UXO	Unexploded Ordnance
WAC	Washington Administrative Code
WMA	Wildlife Management Area
WP	White Phosphorus

1.0 INTRODUCTION

1.1 Cleanup Action Summary

This document sets forth the plans for cleanup of soil contamination of Remedial Action Unit (RAU)-2A, the Small Arms Ranges at the former Camp Bonneville Military Reservation (CBMR) in Clark County, Washington (see **Figure 1-1**). This document is submitted by the Bonneville Conservation, Restoration and Renewal Team (BCRRT), the current owner of CMBR.

The general objectives and scope of this cleanup action are established by the Prospective Purchaser Consent Decree (PPCD) for CBMR which was entered October 13, 2006 (WDOE, 2006). The PPCD identifies cleanup action sub-unit RAU-2A, describes RAU 2A as consisting of the 21 small arms range areas, and requires addressing any lead or other contamination associated with those areas and any risks to human health and the environment associated with such contamination. This Cleanup Action Plan (CAP) is written to provide specific descriptions of the work to be done and the methods to be employed in meeting the prescriptions of the applicable sections of the PPCD. This CAP is further intended to meet the specifications of regulations promulgated under the Washington State Model Toxics Control Act (MTCA) as set forth in Title 173-340 of the Washington Administrative Code (WAC) Sections 380 – Cleanup Action Plans and 400(4) – Plans Describing Cleanup Actions [WAC 173-340-380 and WAC 173-340-400(4)].

The Final Remedial Investigation/Feasibility (RI/FS) Report for RAU-2A dated August 13, 2007 (BCRRT, 2007b) identified areas needing cleanup, presented remedial objectives, identified general response actions, identified specific cleanup technologies applicable to the site along with cleanup action alternatives, evaluated those alternatives with respect to the requirements contained in WAC 173-340-360, and identified the preferred cleanup actions for Small Arms Ranges site soils as “excavation and removal of contaminated soil” for the nine ranges that that had been shown to warrant further action. This plan implements those mandates. When the work described in this CAP is completed, it will have satisfied all the remedial activities contemplated in the Interim Cleanup Action Work Plan for the Small Arms Ranges Berms and Fire Support Areas (Calibre, 2005) and the Final RI/FS Report for the Small Arms Firing Range Floors (BCRRT, 2007b).

In addition, this plan satisfies the applicable requirements of the Environmental Services Cooperative Agreement (ESCA) as those two documents relate to the small arms ranges.

The technical and scoping bases for this CAP are established by integrating the cleanup activities specified in two prior documents, as follows:

- Draft Final Work Plan for Interim Actions at Small Arms Range Berms and Fire Support Areas (Calibre, 2005) which defines soil excavation to be done at the berms and firing points at nine small arms ranges at CBMR. That Work Plan outlines excavation scenarios for free standing berms, hillside berms, and pop-up target berms as well as for impact zones behind these berms and for fire support areas (i.e. small arms firing positions). Based on the history of these excavation areas and the observed physical

conditions at these areas, the Work Plan was developed without a soil sampling program in these areas because these areas clearly contain lead and will be subject to cleanup actions.

- Final Remedial Investigation/Feasibility Study RI/FS Report for RAU-2A (BCRRT; 2007b) which defines soil excavation to be done in the range floor areas between the berms and the fire support areas. The remedial investigation element of this RI/FS identifies locations of soils with elevated lead concentrations based on analysis of samples from a grid pattern on these range floors. Based on relevant human health and ecological standards, as established at WAC 173-340-360, the feasibility study element of this RI/FS identified the preferred cleanup action for these soils to be excavation and removal.

This plan details the ways and means by which these mandates will be implemented at the following nine small arms ranges:

- Combat Pistol Range
- Undocumented Pistol Range
- 1,000-inch Rifle Range and Machine Gun Range
- 25-meter M60 and Pistol Range
- 25-meter Machine Gun Range
- 25-meter Record Firing Range and Field Firing Range
- Field Ranges No. 1 and No. 2
- Field Fire Ranges No. 1 and No. 2
- Rifle Ranges No. 1 and No. 2

Soil cleanup for lead at these nine small arms ranges will be initiated only after completion of the brush clearance and munitions and explosives of concern (MEC) surface clearance activities in these work areas. These brush and MEC surface clearance activities are being conducted under an Interim Action Work Plan (IAWP) for MEC-related activities (BCRRT, 2007a) [approved by the Washington State Department of Ecology (WDOE)] and an Explosive Safety Submittal (MKM, 2006) that was approved by the United States Army Technical Center for Explosives Safety (USATCES).

It is noted that different documents relating to the small arms ranges at CBMR identify differing numbers of those ranges. These apparent discrepancies arise from changes over the history of the site in range designations by range name and range number and the construction and use of multiple ranges at the same or overlapping locations at different times and the sharing of berm materials by more than one range. The site investigations also demonstrated that clean up actions were not required at certain identified ranges. The list of nine ranges presented above is an accurate and complete list of the small arms ranges areas where cleanup is required.

1.2 Summary of Cleanup Action Objectives

As set forth in the RI/FS, cleanup actions at the Small Arms Ranges would have the objective of preventing potential exposure of human and ecological receptors to concentration of lead in site soils at concentrations greater than applicable cleanup standards for the proposed re-use of the

site. Potential human receptors at the Small Arms Ranges may include on-site workers, visitors to the site, and adjacent residents. Potential ecological receptors include plants and wildlife that may use or inhabit the affected areas.

As described in the RI/FS, soil cleanup standards based on MTCA Method A unrestricted residential use have been determined appropriate for the Small Arms Ranges based on the potential future land use. In addition, the ecological indicator concentrations and cleanup levels shown are applicable to these site soils. These concentrations, as established under MTCA Regulations, are as follows:

- Unrestricted or residential land uses: 250 mg/kg (see WAC 173-340- 900, Table 740-1 – Method A Soil Cleanup Levels for Unrestricted Land Uses)
- Industrial or commercial land uses: 1,000 mg/kg (see WAC 173-340-900, Table 745-1 – Method A Cleanup Levels for Industrial Properties)
- Ecological indicator soil concentration for plants: 50 mg/kg (see WAC 173-340-900, Table 749-3 – Ecological Indicator Soil Concentrations)
- Ecological indicator soil concentration for wildlife: 118 mg/kg (see WAC 173-340-900, Table 749-3 – Ecological Indicator Soil Concentrations)
- Ecological indicator soil concentration for soil biota: 500 mg/kg (see WAC 173-340-900, Table 749-3 – Ecological Indicator Soil Concentrations)

MTCA requires the soil cleanup levels be based on estimates of the reasonable maximum exposure expected under both current and future site use conditions. Historically, the CBMR was an Army military reservation with controlled access and used for short-term, small unit training exercises (AEM, 2005). Future uses proposed for the site may include development of a regional park and environmental preservation area. The proposed future land uses may include educational activities, law enforcement training, and public recreation. The possible public uses may involve short-term camping and group use of existing or new structures for overnight programs (CBLRA, 2003). This CAP will meet these objectives as follows:

- Areas where the average lead concentration has been determined to exceed 118 mg/kg will be remediated by general excavation of those “hot spots”
- Areas where the average concentration is greater than 50 mg/kg but less than 118 mg/kg will be remediated by focused remediation of the area of elevated lead concentration with confirmatory sampling
- Areas where the average concentration is less than 50 mg/kg and no individual sample result exceeds 118 mg/kg will not be subject to further remedial action.

These remediation standards and procedures are described more fully in the following sections of this CAP.

1.3 Organization of this Cleanup Action Plan

- **Section 1.0 Introduction** presents an overview of the regulatory basis for this Corrective Action Plan and reviews the organization of this document.

- **Section 2 Site Description and Background** presents a general description of the CBMR

- **Section 3 Description, Background, and Current Condition of the Small Arms Ranges** presents information describing the locations, history of use, and history of prior investigations with a summary sampling and analysis results for lead at the Small Arms Ranges

- **Section 4 Applicable Laws and Regulations and Cleanup Standards** identifies the applicable laws, regulations, and standards governing this cleanup action with brief digests of the applicable or relevant provisions and identifies the cleanup action objectives established by those laws and regulations. In addition to the requirements for protection of human health and ecological receptors discussed in Section 1.2, these standards also include protection of surface waters, erosion prevention, protection of site workers, visitors, and the public, protection of natural resources (e.g. wetlands), and protection of cultural and historic resources during implementation of this cleanup action. These standards also include appropriate management of the recovered lead by recycling and of the contaminated soils by stabilization or sequestration.

- **Section 5 Cleanup Action Design and Methods** presents the design of the cleanup action including definitions of the work areas and specifications of the methods to be employed for excavation. Soil handling, screening, stabilization, and recycling or disposal. This section also addresses explosives safety and procedures to meet the applicable laws and regulations discussed in Section 4.

- **Section 6 Task-Specific Health and Safety Plan** presents health and safety plan information.

- **Section 7 Schedule** presents a task milestone schedule

- **Section 8 Compliance Monitoring and Cleanup Action Reporting** describes the plans and reports required by the PPCD to guide future monitoring and operations (if needed) and to document the cleanup actions conducted as part of this CAP.

- **Section 9 References**

- A**ppendix A** summarizes the soil sampling locations and results for lead from the RI/FS Report for the floors of the Small Arms Ranges

- **Appendix B** CBMR Permits

Camp Bonneville Military Reservation

Vancouver, Washington

Figure 1-1 - Regional Map

BONNEVILLE
CONSERVATION, RESTORATION & RENEWAL TEAM, LLC

BCRRT

0 1 2 3 4 mi
0 1 2 3 4 km

Scale - 1:100,000; 1 in equals 5.6 mi
Projection - Lambert Conformal Conic
Coordinate System - State Plane Washington South FIPS 4602
Data - Parsons & U.S. Army Corps of Engineers

2.0 SITE DESCRIPTION AND BACKGROUND

2.1 Location

CBMR is located in southwestern Washington and comprises approximately 3,840 acres (see **Figure 2-1**). CBMR is located in southeastern Clark County, approximately five miles east of the city limits of Vancouver and approximately 3.5 miles north of the city limits of Camas. The site is approximately seven miles north of the Columbia River. The site is located in Township 2 North and Township 3 North of Range 3 East in the Washington Public Lands Survey system.

2.2 General Site Description and Topography

CBMR is mostly undeveloped forested hillsides and creek side drainages. Former military barracks and classrooms are concentrated at the Camp Killpack and Camp Bonneville cantonment areas, which cover approximately 30 acres. Other developed areas include firing ranges, a paved two-lane road connecting the main gate with the two containment areas, and a network of unpaved roads. The main gate to CBMR is located on the western boundary of the camp, approximately one mile north of Pluss Road.

The 3,840-acre camp is located in the western foothills of the Cascade Mountains, in the Lacamas Creek valley. The land surrounding the camp has scattered residences and is used primarily for agriculture and livestock grazing. The nearest town is Proebstel, an unincorporated community about two and one-half miles to the southwest of the western entrance to the camp.

2.3 Summary of Site History

The Army used CBMR for a variety of infantry training exercises in the wooded portions of the site and for live fire of small arms, assault weapons, mortars and artillery at firing ranges, firing points and target areas located on-site between 1910 and 1995. In the early 1950s, the Department of Defense (DoD) to lease an additional 840 acres from the State of Washington to expand training possibilities at post. The primary use of the facility by the United States Department of the Army (Army) has been for training of company-size infantry and artillery units (many from Forts Vancouver and Lewis). In addition, the facility has been used for training by the Army Reserve units in Southern Washington and Northern Oregon. Other Reserve and National Guard components, as well as U.S. Navy Construction Battalions (Sea Bees), the Federal Bureau of Investigation (FBI), and local law enforcement units, have also used the site.

In July of 1995, CBMR was selected for closure under the 1995 Base Realignment and Closure (BRAC) process. Since the CBMR was officially closed, investigations were conducted by the Army and its consultants in order to characterize the nature and extent of contamination at the site and to develop a plan for potentially transferring ownership. Clark County (County) expressed interest in the site and began the process for obtaining the property by developing a Reuse Plan (CBLRA, 2003). The reuse plan developed called for the majority of Camp Bonneville to be transferred to the County for the public benefit – education, law enforcement, parks, and conservation areas with no financial gain to the county.

In October 2006 the Army transferred ownership of the property to the County via a conservation conveyance. The County subsequently transferred ownership to BCRRT. BCRRT will hold the deed of the property during investigation and clean-up activities at the site. After the property is remediated to DOE standards, BCRRT will transfer the property back to the county. The County will then begin implementing the reuse plan.

The Small Arms Ranges have been used as firing ranges for a variety of weapon systems. In the initial post-closure site investigations, approximately 25 potential ranges were been identified from maps and records dating back to 1958. These firing ranges were used for small arms, large-caliber machine guns, rifles, grenades, light anti-tank weapon rockets, and sub caliber weapons. Further review of the maps and other documents as well as on-site reconnaissance activities identified duplications and overlaps in the initial inventory. Of the original 25 potential ranges, some had historically different names and were determined to be at the same location and double counted. As the results of the initial investigations and Remedial Investigation (RI) planning, seventeen discrete firing ranges were identified for investigation during the RI. The RI at the Small Arms Ranges was designed to evaluate the potential for soil contamination from lead or other munitions-related chemicals at these ranges.

2.4 Site Geology and Hydrogeology

A detailed summary of existing information on the geology and hydrogeology of the Camp Bonneville area has been prepared in prior investigation reports. The following sections provide excerpts of the information previously prepared and information collected during the conduct of the RI at CBMR.

2.4.1 Regional Geology

CBMR is situated on the margin of the western foothills of the southern Cascades in the transition zone between the Puget Trough and the Willamette Trough Provinces. The geology of this area generally consists of Eocene and Miocene volcanic and sedimentary rock types overlain by unconsolidated clays, silts, sands, and gravels of the Troutdale Formation.

2.4.2 Site Geology and Soils

CBMR is situated along the structural and physiographic boundary between the western flank of the southern Cascade Mountains and the Portland-Vancouver Basin. The geology of the CBMR vicinity is known primarily from geologic mapping (Mundorff, 1964 and Phillips, 1987), a limited number of well logs available from the general area, and a Multi-Sites Investigation conducted by Shannon & Wilson, (1999a).

The geology at CBMR can be divided into three general areas that correspond approximately to topographic divisions. The area west of Lacamas Creek is composed of a series of predominantly gravel and semi-consolidated conglomerate layers with scattered lenses and stringers of sand (Upper Troutdale Formation).

Underlying the Troutdale Formation and comprising the area to the north and east of Lacamas Creek are predominantly basalt flows and flow breccia, with some pyroclastic and andesitic rocks that are folded and faulted. The bottomland along Lacamas Creek is composed of unconsolidated silt, sand, and gravel valley fill, with some clay. Because of the thick soil and dense vegetation, faults have not been identified within CBMR (ESE, 1983).

The CBMR soils are mainly low-permeability clays, which results in considerable runoff after storms and occasional minor flooding of Lacamas Creek. Upland soils have mainly developed from basalt and are generally gravelly or stony and fairly shallow. Bottomland soils along Lacamas Creek tend to be clayey (Geo Recon, 1981). Shannon & Wilson (1999a) described the four distinctive stratigraphic units that underlie CBMR:

- Quaternary floodplain and stream channel alluvium and lacustrine deposits, which mantle the Lacamas Creek valley floor (Qa).
- A Quaternary landslide deposit (Qls) of surface soils and bedrock displaced from the steep slope along David Creek.
- A thick sequence of Quaternary to Pliocene-age gravel, fine-grained sand, and sand with cobbles and boulders known as the Troutdale Formation (Pt), which underlies areas to the west of the Bonneville cantonment.
- Oligocene volcanic bedrock (Tv), which is exposed at the surface in the eastern part of Camp Bonneville.

Quaternary alluvium deposits comprise the shallow surface soils of the Lacamas Creek valley floor, which is composed of stream channel, floodplain, and alluvial fan sediments. These deposits are expected to consist of a thin layer of clay and silt, underlain by layers of sand/silt and clay. During drilling and excavation activities associated with the removal of an underground storage tank (UST) in Camp Killpack (Hart Crowser, 1996), at least 25 feet of silty clay was encountered and interpreted to be older alluvium. Borings from the Multi-Sites Investigation (Shannon & Wilson, 1999a) also encountered alluvial clays and silts overlying a relatively thick, silty clay deposit in the Camp Bonneville cantonment. These clayey soils probably originated as water borne sediments that were deposited on the valley floor in Quaternary time as a result of catastrophic flooding along the Columbia River (Shannon & Wilson, 1999a).

The Troutdale Formation, which underlies the western-most portion of the camp, ranges from poorly consolidated sand and gravel to a well indurated conglomerate in its upper part. Based on regional boring logs, the Upper Troutdale Formation locally is about 150 feet thick and consists of cemented sand, gravel, sandy clay, and boulders. It is underlain by up to 150 feet of the Lower Troutdale Formation, which contains considerably more clay interspersed with sandy and gravelly layers. There is considerable variation in the lithology and thickness of the Troutdale Formation. In general, the formation thins eastward against the underlying bedrock, and the lower part of the formation reportedly is typically coarser grained toward the east (Mundorff, 1964).

The bedrock that underlies the alluvial deposits and Troutdale Formation is exposed at the surface in the eastern part of CBMR. This bedrock consists of Oligocene-age

andesite and basaltic andesite flows, minor flow breccias, tuffs, and volcaniclastic sandstones. According to the logs of borings from the Multi-Sites Investigation (Shannon & Wilson, 1999a), the uppermost bedrock is severely weathered. This weathered bedrock tends to form surface soils that contain gravel of basalt lithology. During drilling for the Multi-Sites Investigation, bedrock was encountered in 10 soil borings at depths ranging from approximately 6 to 37 feet below ground surface (bgs).

2.4.3 Site Hydrogeology

Limited information is available about the hydrogeology of CBMR. Most prior work throughout the County area has focused on the Troutdale Formation (Mundorff, 1964). CBMR resides over the eastern edge of the Troutdale Formation where it is pinched out by the underlying bedrock. There are two drinking water wells at CBMR: a 385-foot-deep well at the Camp Bonneville cantonment, and a 193-foot-deep well at the Camp Killpack cantonment (ESE, 1983). The latter well is apparently different from the 516-foot-deep well at the Camp Killpack cantonment (Mundorff, 1964). In addition, a well was drilled at the FBI range during 1998, which extends to a depth of 105 feet bgs (Shannon & Wilson, 1999b). Several groundwater monitoring wells associated with the sewage lagoons are located east of the Camp Bonneville cantonment. Based on regional information (Mundorff, 1964) and the reported depths of the wells at the camp, water supply wells in the area generally extend into the Troutdale Formation or underlying bedrock. Most of the nearby wells apparently obtain groundwater from depths of 150 to as much as 500 feet bgs.

The water table is typically within a few feet of the surface in areas underlain by alluvium and appears to fluctuate seasonally by several feet. A rising water table occurs in the early fall through spring during the rainy season, and a declining water table occurs throughout the summer. The localized groundwater flow generally follows local topography toward tributaries and creeks.

Generally, groundwater flows from the uplands towards Lacamas Creek. The elevation of the water table in the alluvial valley areas of CBMR is expected to be fairly shallow (in the range of 5-20 feet bgs) based on the presence of shallow bedrock, multiple creeks, tributaries, and boggy areas.

Two monitoring wells were installed as part of the investigation of Landfill 4, an upland area of CBMR (Shannon & Wilson, 1999b). The depths to water in the wells ranged from 10.4 feet bgs to 18.8 feet bgs. The limited groundwater elevation data suggested a groundwater flow direction towards the creek, which is consistent with the surface topography.

Previous upgradient investigations (Landfill 4) detected explosives and volatile organic compounds in groundwater samples collected from specific wells. Other upgradient land uses that could have contributed chemicals of potential concern (COPCs) include firing ranges, open burning and open detonation grounds, and one or more underground storage tanks that have been removed.

2.5 Surface Water Resources

The principal surface water feature in the vicinity of the investigation area is Lacamas Creek, which flows southward from the confluence of two branch streams in the north-central part of CBMR, exiting the installation at its southwest corner. From the southwestern property boundary, Lacamas Creek flows southwestward to Proebstel, where it turns toward the southeast and continues to its confluence with the Columbia River at the town of Camas. Numerous minor tributaries, that drain adjacent uplands, flow into Lacamas Creek. Buck Creek and David Creek, the largest of these streams, drain the southeastern hills of CBMR.

2.6 Summary of Natural Resources and Rare, Threatened, or Endangered Species

Most of CBMR is forested undeveloped land that provides habitat for many plant and animal species, including some special status species (United State Army Corps of Engineers [USACE], 2001). Wetlands and riparian areas are primarily associated with Lacamas Creek at CBMR (PBS, 2007). Vegetation and wildlife are described in terms of their association with five plant communities:

- Coniferous forest
- Mixed forest
- Scrub-shrub
- Meadows
- Open-water wetlands

The United States Fish and Wildlife Service (USFWS) has indicated that no listed animal species and one proposed animal species (coastal cutthroat trout) were within CBMR (USACE, 2001). The National Marine Fisheries Service stated that the Lower Columbia River steelhead, Lower Columbia River Chinook salmon, and Columbia River chum may be present at CBMR.

On April 5, 1999, the coastal cutthroat trout was proposed as a threatened species for the Southwest Washington/Columbia River Ecologically Sensitive Unit and may be present at CBMR. Coastal cutthroat trout require relatively cold water for spawning, and continuous forest canopy is important in maintaining cold temperatures. Lacamas Dam blocks upstream fish passage on Lacamas Creek approximately 10 miles downstream from the CBMR western boundary. As a result, Lower Columbia River steelhead, Lower Columbia River chinook salmon, and Columbia River chum are not found above Lacamas Dam. However, coastal cutthroat trout can become resident above a dam and have been found in surveys of Lacamas Creek. It is assumed that the now-resident population of coastal cutthroat trout above the dam still has downstream access over Lacamas Dam and provides flow of genetic material to downstream populations.

The 1995 endangered species survey identified certain Washington State special status target species at CBMR (USACE, 2001). The species that were found during the survey were small-flowered trillium (*Trillium parviflorum*), hairy-stemmed checker-mallow (*Sidalcea hirtipes*), red-legged frog (*Rana aurora*), Vaux's swift (*Chaetura vauxi*), pileated woodpecker (*Drycopus pileatus*), and the brush prairie or northern pocket gopher (*Thomomys talpoides douglasi*).

Two state-listed plant species were found at CBMR. Two populations of small-flowered trillium (state-listed as sensitive) were found within mixed woodland communities. This species likes moist, shady woods. Numerous individuals were found within these populations. Only one population of hairy-stemmed checker-mallow (state-listed as endangered) was found, and included approximately 25 individuals. While this plant is often found along streams and in open fields, it was located at CBMR along a road in association with a ditch.

Two state-listed candidate bird species have been observed at CBMR. Both Vaux's swifts and pileated woodpeckers are found throughout the installation. Vaux's swifts occur in coniferous forested areas. No nesting or roosting sites for Vaux's swifts were found during the survey, but four individuals were sighted. These may not have been residents and may have only been passing through. No nesting sites were found for the pileated woodpecker, but suitable nesting areas exist within the installation, so nesting is possible. This species typically is found in mixed coniferous and deciduous forests. However, resources within the installation are unlikely to support more than two pairs. No spotted owns (*Strix occidentalis caurina*), a federally-threatened and state-listed endangered species, were observed during the spotted owl survey.

Signs of a mammal species that is a federal- and state-listed candidate were observed during the surveys at CBMR. Fresh brush prairie pocket gopher burrows were sighted during the surveys, indicating that the burrows were active and that the species exists on the installation. These pocket gophers are commonly found in meadows.

2.7 Summary of Cultural and Historic Resources

As a result of Base Realignment and Closure (BRAC) procedures, the Army performed a cultural resources assessment and survey in selected parcels not previously inventoried for cultural resources but considered to have a high probability for prehistoric and/or historic archaeological sites. These areas included the Lacamas Creek valley, Munsell Hill and the Little Baldy (Bald Mountain)/Buck Creek vicinity in the eastern part of the base (Sadler, 2003).

The archaeological survey resulted in the discovery of two historic sites (45CL528 and 45CL529), eight historic isolated finds, and a single prehistoric isolated find. In addition, one previously recorded prehistoric site was revisited (45CL318). None of the sites are recommended as eligible for the National Register of Historic Places (Sadler, 2003).

For information on site geology and hydrogeology, surface water hydrology, a summary of natural resources and rare, threatened, or endangered species, and a summary of cultural and historic resources (see **Appendix B).**

3.0 DESCRIPTION, BACKGROUND, AND CURRENT CONDITION OF THE SMALL ARMS RANGES

3.1 General Description of the Small Arms Ranges

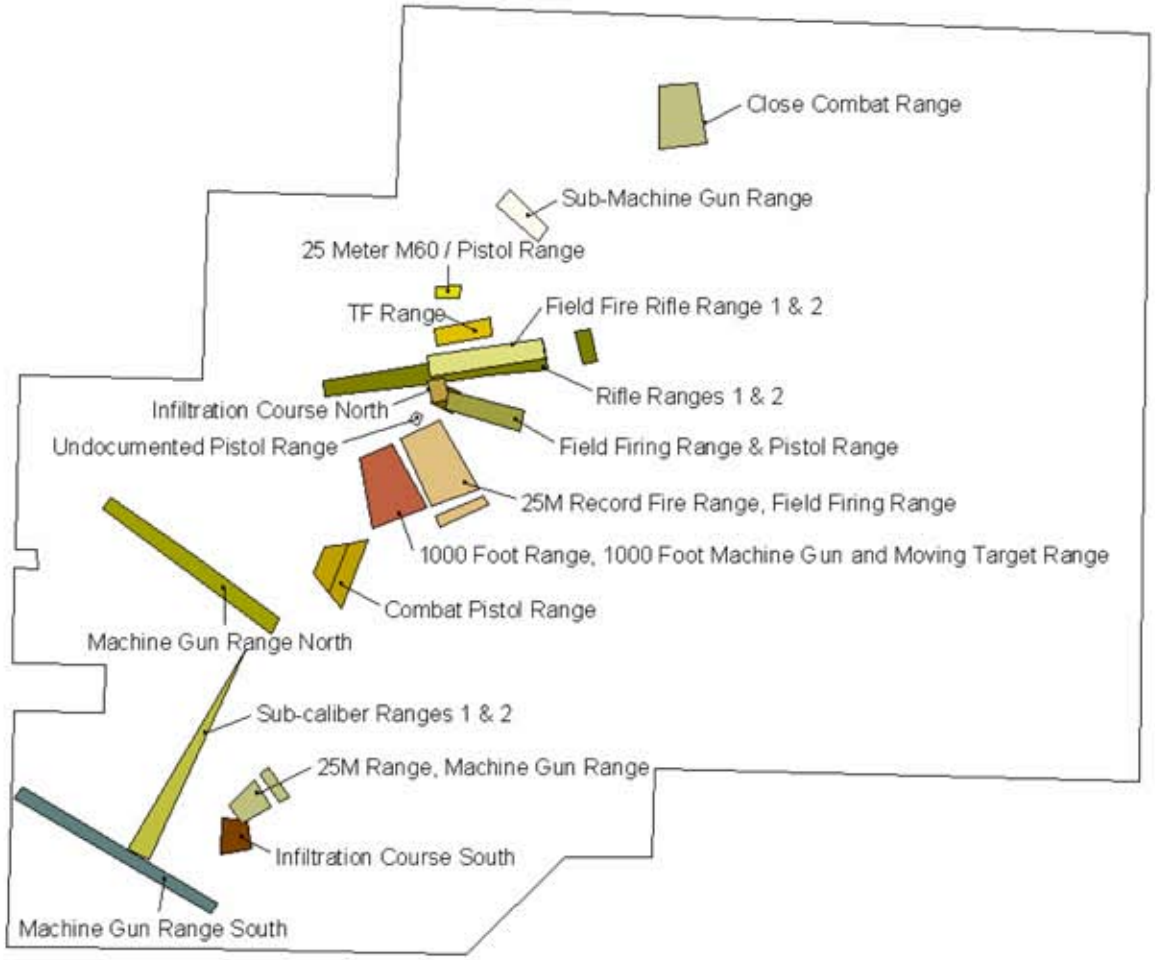
Approximately 25 potential Small Arms Ranges were previously identified within the boundaries of CBMR from maps dating back to 1958. The firing ranges were used for small arms, large-caliber machine guns, rifles, grenades, light antitank weapon rockets, and sub-caliber weapons. Of the 25 potential ranges, it was determined during the RI/FS that eight of the ranges were redundant or double counts from the same range location having different names historically (AEM, 2005 and BCRRT, 207b).

A final total of 17 firing ranges were confirmed and identified for investigation during the RI/FS of the Small Arms Ranges:

- Close Combat Range
- 25 Meter M60 Range/Pistol Range
- Sub Machine Gun Range
- TF Range
- Rifle Ranges 1 & 2
- Field Fire Rifle Ranges 1 & 2
- Infiltration Course North
- Field Firing Ranges 1 & 2 & Pistol Range
- Undocumented Pistol Range
- 1,000 Foot Range, Machine Gun & Moving Target Range
- Combat Pistol Range
- Machine Gun Range North
- Machine Gun Range South
- M31 Sub-Caliber Ranges 1 & 2
- 25 Meter and Machine Gun Range
- Infiltration Course South
- 25 M Record Fire Field/Field Firing Range

Figure 3-1 shows the geographic locations of the 17 ranges addressed in the RI/FS.

Figure 3-1
General Site Map Showing Small Arms Ranges



Range Footprints

- 1000 Foot Range, 1000 Foot Machine Gun and Moving Target Range
- 25 Meter M60 / Pistol Range
- 25M Range, Machine Gun Range
- 25M Record Fire Range, Field Firing Range
- Close Combat Range
- Combat Pistol Range
- Field Fire Rifle Range 1 & 2
- Field Firing Range & Pistol Range
- Infiltration Course North
- Infiltration Course South
- Machine Gun Range North
- Machine Gun Range South
- Pistol Range
- Rifle Ranges 1 & 2
- Sub-Machine Gun Range
- Sub-caliber Ranges 1 & 2
- TF Range
- Undocumented Pistol Range
- Camp Bonneville Boundary

1 0 1 2 Miles

N W E S

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BCRRT

3.2 History of Small Arms Range Use

CBMR was used by the Army as firing range for small arms, artillery, and other munitions from the approximately 1910 through 1995. CBMR was established in 1909 as a drill field and rifle range. Troops from Vancouver Barracks began to use part of the facility for a target range in 1910. Installation use grew to include a range for assault weapons, and artillery between 1910 and 1995. The original reservation, consisting of approximately 3,020 acres, was acquired by the federal government in 1918. It was officially named CBMR in 1926. The Camp Bonneville cantonment area was built in the late 1920s. The Camp Killpack cantonment area was built and occupied by the Civilian Conservation Corps (CCC) in 1935. The facilities were used for a variety of military training programs, in addition to being used by Vancouver Barracks. During World War II, the facility was also used to house Italian prisoners of war.

In 1950, many of the buildings and systems at the facility were rehabilitated to use for training Army Reserve units. In the early 1950s, an additional 840 acres of land were leased from the State of Washington. Vancouver Barracks, which included CBMR, became a sub-installation of Fort Lewis, Washington, in 1959.

Since World War II, CBMR has been used as a training camp for active Army, USAR, Army National Guard (ARNG), Marine Corps Reserve, Navy Reserve, and Coast Guard Reserve units, as well as other DOD and government personnel. When not required for military training exercises, CBMR was made available until the late 1980s to local equestrians and hunters, as well as for overnight use of the cantonment areas by 4-H groups and school districts for outdoor schools (CBLRA, 2003).

The FBI currently makes frequent use of one of the firing ranges and will be responsible for cleanup of that range. In 1996, following the selection of Camp Bonneville for closure by the BRAC Commission, all active military training units ceased operations at the camp. All out-grants for using the facilities were cancelled, with the exception of the FBI range.

3.3 History of Investigations of Small Arms Ranges

In July of 1995, CBMR was selected for closure under the 1995 BRAC process. Since the installation was officially closed, investigations were conducted by the Army and its consultants in order to characterize the nature and extent of contamination at the site and to develop a plan for potentially transferring ownership.

The Army implemented RI activities at the Small Arms Ranges in 2002 and 2003. The general investigative approach at each of the 17 Small Arms Ranges collected the following data:

- The concentration of lead residues in the top 0-6 inches of soil at 307 sample areas (one-half acre grids) within the firing ranges.
- The background concentrations of lead in 20 samples from the top 0-6 inches of soil at undisturbed/unused locations within CBMR, and

- The concentrations of explosive residues in soil in 12 muzzle blast areas within the firing ranges, where the firing location was known.

3.3.1 Document and Map Reviews

The following documents and maps were incorporated into this CAP:

- Site Investigation Report – Small Arms Ranges and Demolition Areas 2 and 3, by Atlanta Environmental Management, Inc. (AEM), September 2005
- Draft Final Work Plan for the Interim Actions at the Small Arms Range Berms and Fire Support Areas by Calibre Systems, March 2005
- Final Remedial Investigation/ Feasability Report (RI/FS) Small Arms Ranges (RAU 2A) by Bonneville Conservation Restoration & Renewal Team (BCRRT), January 2007
- Geology and Groundwater Conditions in Clark County Washington, Mundorff (U.S. Geological Survey), 1964
- Geologic Map of the Vancouver Quadrangle – Oregon and Washington, Phillips (Washington Division of Geology and Earth Resources), 1987

3.3.2 Initial Investigations

A Site Investigation (AEM, 2005) became part of the U.S. Army's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) investigation of lead-contaminated ranges and Demolition Areas (DA) 2 and 3 at CBMR. This investigation was conducted under a WDOE Enforcement Order and in accordance with the MTCA.

3.3.3 Remedial Investigation and Feasibility Study (RI/FS)

The RI (BCRRT, 2007b) at the Small Arms Ranges was designed to evaluate the potential for soil contamination from the firing lines of the ranges to the berms and/or potential impact areas. Previous investigations at other ranges had detected lead and explosives in the range soils. The RI included the soil investigation of the 17 Small Arms Ranges, 12 muzzle blast zones (within the ranges where the firing location was known), and background soil sampling. The RI was conducted to characterize soils at these areas at CBMR in order to provide data upon which to base decisions for further actions.

Based on the results of the RI, the FS (BCRRT, 2007b) was conducted to identify and evaluate cleanup action alternatives and select a cleanup action for the Small Arms Ranges. The initial RI/FS was conducted by the Army in accordance with the requirements of the MTCA regulations, which are contained in Chapter 173-340 of the WAC (WAC 173-340).

3.4 Summary of Soil Contamination Information by Range

Variable concentrations of lead were known to exist at CBMR within the surface and near-surface soils at firing ranges. The sources of this lead were the bullets from the firing of small arms, assault weapons, artillery, and field artillery. Most of the lead bullet mass deposited in the impact area

was in the form of intact bullets or large fragments; however small fragments were also present. The majority of lead bullets were likely to have impacted the range berms; however, lead could be present between the firing line and the range berms. Over time elemental lead may corrode and form oxidized products consisting primarily of lead hydroxide and lead carbonates (ITRC 2003). Due to the low mobility of lead in soil, the majority of the lead contamination was expected to have remained near the surface of the soil. The major risk posed by any metal residues arises from direct contact and ingestion of surface soil or fragments.

Sampling of the berms for lead was not included since the berms were identified for remedial action prior to the RI/FS.

3.4.1 RI Sampling

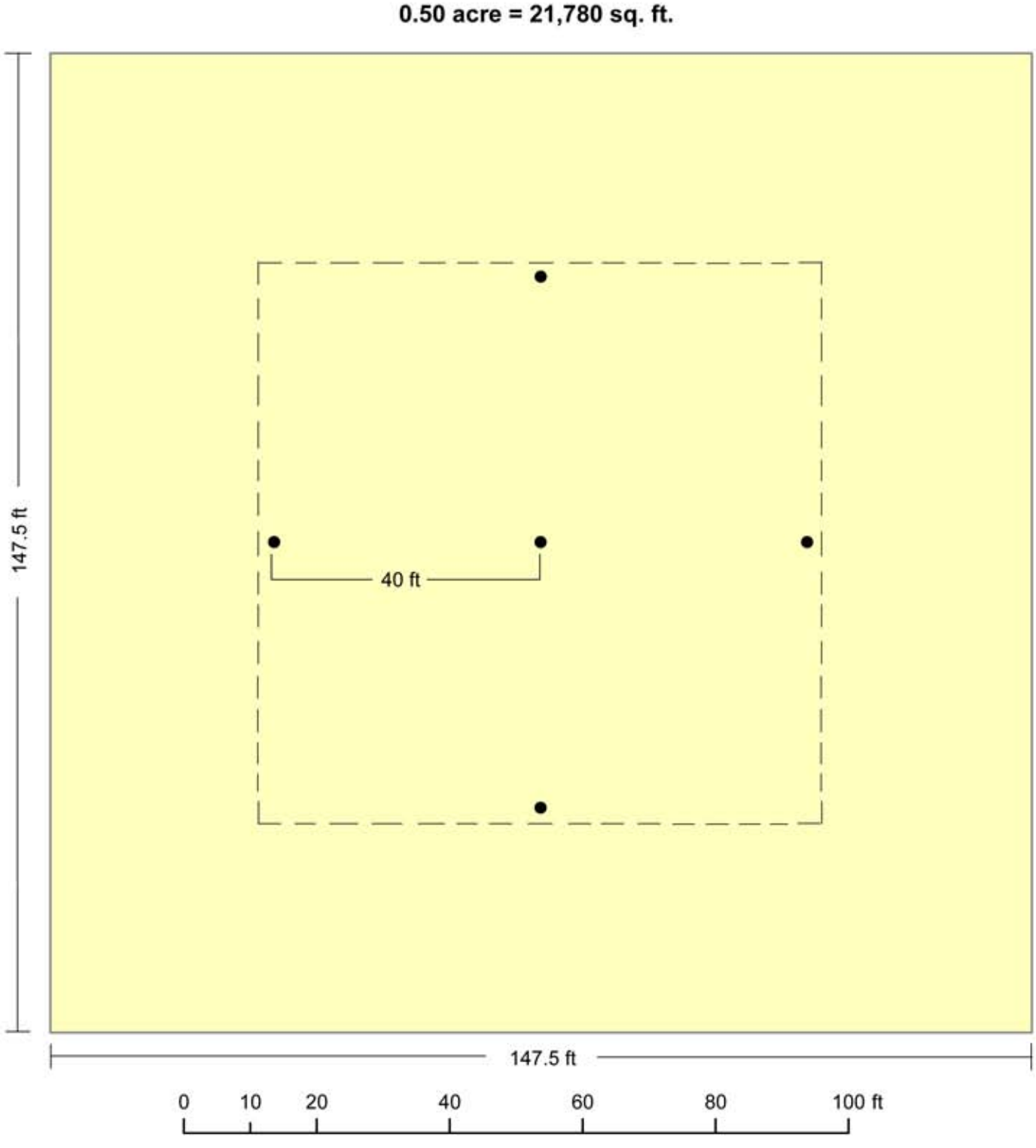
RI soil samples were collected from 307 approximately half-acre grids across all the Small Arms Ranges, in accordance with the approved Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) (AEM, 2003a). All of the range samples were analyzed for lead. The range berms and backstops (where bullets have accumulated) were excluded from this soil sampling program since they were identified for remedial action prior to the RI/FS.

RI Grid Samples - Soil samples in each of the 307 half-acre grids (established in the firing ranges) consisted of five grab soil samples that were collected from 0 – 6 inches in depth below ground surface (bgs). Specific locations were determined by latitude and longitude coordinates, as presented in the approved Sampling and Analysis Plan - Soil (SAP) and the center point of each grid was determined using a GPS unit. After a center point was determined, the field team measured approximately 40 feet north (magnetic), south, east, and west of the grid center. A soil sample was taken at each of these four compass and center point locations. The total sampling area size in each ½ acre grid was approximately 80 feet by 80 feet and covered an area approximately 6,400 square feet (see **Figure 3-2**).

Some sample grids were not square due to obstructions such as target berms/ backstops, and natural barriers such as streams, standing water, and boulders. In those cases, the distance to samples from the center of the grid varied and the modified location was measured with a GPS unit and the compass direction and distance from the planned location was noted.

The number of half-acre plots sampled, the number of muzzle blast zones sampled, and the QA/QC samples collected at each of the 17 locations are detailed in **Table 3-1**.

Figure 3-2
Small Arms Ranges Grid Sampling Example



Muzzle Blast Zones - For ranges where the firing line has been determined, a muzzle blast zone has been designated as a strip in front of and parallel to the firing line. Samples were collected along that strip at approximately 30-foot intervals within 10 feet of the firing line. A point at the end of the firing line was designated and sampled. A line was then run parallel to the firing line from that first sample and subsequent samples taken every 30 feet.

The muzzle blast samples were grab samples of soil from 0 – 6 inches in depth bgs. Samples collected in muzzle blast zones were analyzed in the laboratory for explosives (via USEPA Method 8330 Modified). The muzzle blast zone samples included collection of 68 grab samples from the 12 ranges where the firing lines were known. The ranges and number of muzzle blast zones sampled are presented in **Table 3-1**. There were no contaminants of concern in the muzzle blast zones sampled.

Table 3-1 Grids and Samples from Samll Arms Ranges, Muzzle Blast Zones, and QA/QC

Small Arms Range	Number of Half-Acre Grids Sampled	Number of Samples from each Range	Number of Muzzle Blast Zones Samples	QA/QC Samples (duplicates)	Total Number of Samples
Close Combat Range	24	120	-	11	131
25 Meter M60 Range/Pistol Range	4	20	6	1	27
Sub Machine Gun Range	7	35	-	3	38
TF Range	8	40	2	4	46
Rifle Ranges 1 & 2	32	160	7	14	181
Filed Fire Rifle Ranges 1 & 2	22	110	2	10	122
Infiltration Course North	4	20	2	2	24
Field Firing Range & Pistol Range	14	70	6	16	92
Undocumented Pistol Range	1	5	5	0	10
1,000 Foot Range, Machine Gun & Moving Target Range	30	150	-	15	165
Combat Pistol Range	17	85	6	9	100
Machine Gun Range North	33	165	-	16	181
Machine Gun Range South	26	130	-	13	143
M31 Sub-Caliber Ranges 1 & 2	25	125	6	12	143
25 Meter and Machine Gun Range	13	65	10	7	82
Infiltration Course South	7	35	14	4	53
25M Record Fire Field/Field Firing Range	40	200	2	20	222
Total	307	1,535	68	157	1,760

Background Soil Samples - Soil samples were also collected from 20 background locations using the following criteria:

- Within the CBMR site boundary;
- Within similar geology/geomorphology as range grid samples;
- Not within small arms ranges in the Work Plan or SAP;
- Not within small arms range fan as shown on Plate 30 of July 1997 *Final Archives Search Report – Report Plates* (USACE, 1997);
- Not downslope of range or fan (locate upslope of range or fan if possible);
- Not downrange of firing line; if the firing line is not indicated in the SAP, it was assumed that the firing line was at the low-elevation end of the range and that the direction of fire was toward higher ground surface elevations;
- Not in demolition areas; and
- Not in artillery impact area (for Unexploded Ordnance [UXO] safety reasons).

Table 3-2 lists the locations of the background samples.

Table 3-2. Location Description of Background Samples

Location Description
Up slope from Close Combat Course
Up slope from 25 Meter M60/Pistol Range
Side slope from Close Combat Course
Side slope of TF record Fire and behind firing line
Side slope from Rifle Range and behind firing line
Flat area on east side of creek in vicinity of Rifle Range, Infiltration Course, Field Firing Range, and Undocumented Pistol Range
Same as S506YMMDDC on west side of creek
Flat area on south side of creek behind firing line of 1000 Foot Range, 1000 Foot Machine Gun and Moving Target Range
Side slope from 1000 Foot Range, 1000 Foot Machine Gun and Moving Target Range
Side slope from Combat Pistol Range
Side slope from Machine Gun Range and Combat Pistol Range
Side slope of Machine Gun Range, side slope from and behind firing line of Sub-caliber Artillery
Side slope from 25M Range, Machine Gun Range and up slope from Sub-caliber Artillery
Side slope from Infiltration Course, Machine Gun Range
Up slope from Machine Gun range
Up slope from Machine Gun range
Up slope from Machine Gun range
Side slope from Sub-Machine Gun range
Side slope from Sub-Machine Gun range
Flat area on south side of creek behind firing line of 25M Range, Record Firing Range, Field Firing Range

3.4.2 Sampling and Analysis Results

A total of 1,535 samples, not including duplicate samples, were collected and analyzed for lead from 307 grids sampled. Soil samples collected from the Small Arms Range grid locations were analyzed for lead. Results of the lead analyses were reported on a dry-weight basis.

At ten of the Small Arms Range grid locations, ten samples were randomly selected from the range soils and analyzed for the nine Priority Pollutant Metals. No concentrations of metals were detected in the ten range grid samples at concentrations above MTCA Method A for unrestricted land use, or if no MTCA criteria were available, the USEPA Region 9 Preliminary Remediation Goals (PRGs).

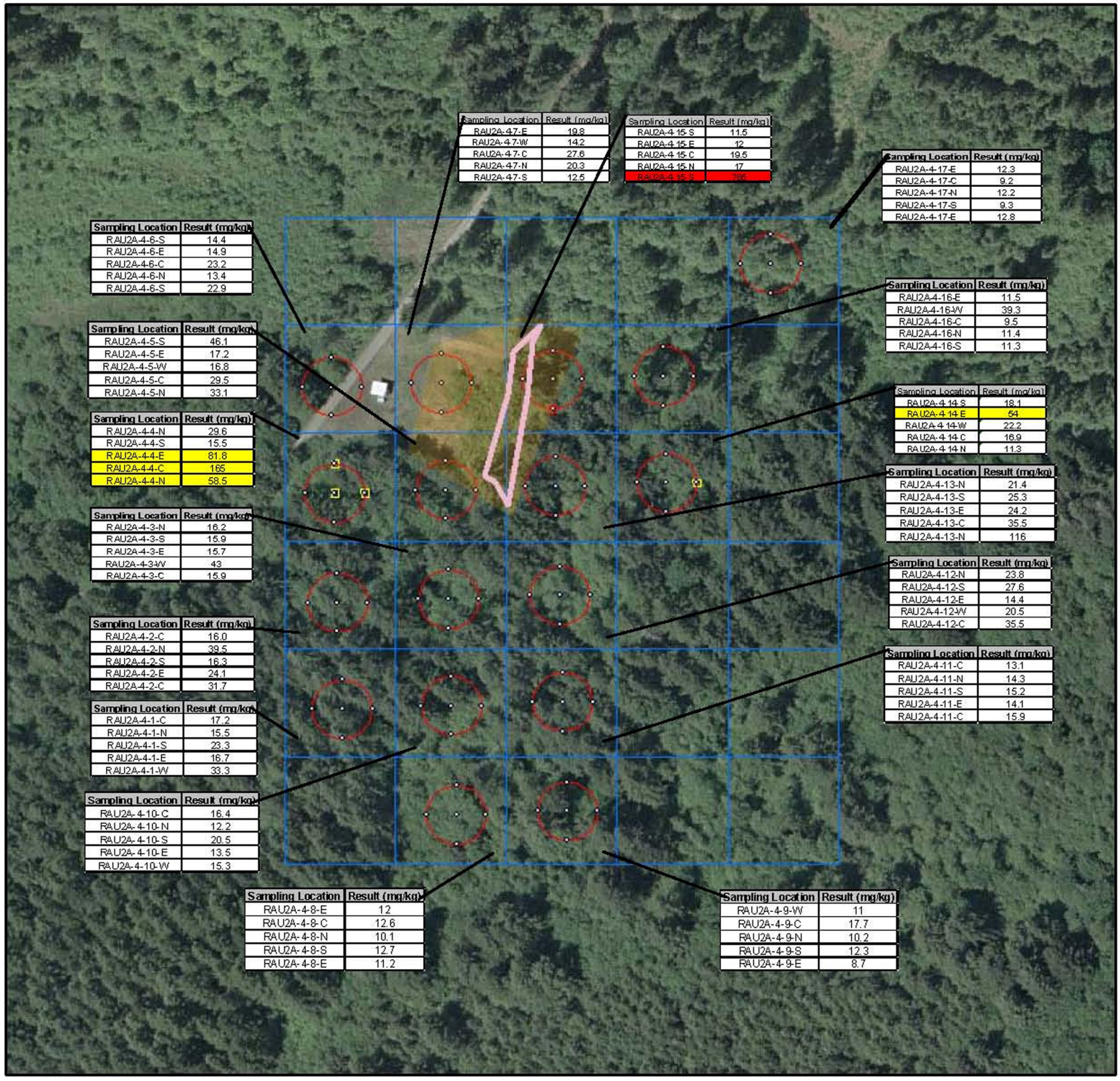
Samples collected from the 12 Muzzle Blast Zones were analyzed for explosive residues, including picric acid and pentaerythritol tetranitrate (PETN). The explosive residue 2,4-dinitrotoluene (2,4-DNT) was detected in 8 of the 10 muzzle blast zone samples from the 25 –Meter and Machine Gun Range. Concentrations of 2,4-DNT detected ranged from 4.9 to 20 mg/kg and were significantly below the PRG value of 120 mg/kg for residential soil.

Background soil samples were analyzed for lead and two randomly selected background samples were also analyzed for Priority Pollutant Metals. Concentrations of lead detected ranged from 9.7 mg/kg to 80.8 mg/kg. The average lead concentration detected was 24.3 mg/kg and were below the most stringent MTCA or PRG value for lead. The 95th percentile upper confidence limit (UCL) on the mean lead background concentration is 33.6 mg/kg. Metals detected were within normal background ranges.

Concentrations of lead were larger than at least one of the benchmark values (BMV) at 12 of the 17 small arms ranges sampled during the SI.

3.4.3 Quantity Estimates by Lead Concentrations

Concentrations of lead in Small Arms Range grid samples exceeded the lowest screening level (50 mg/kg) at 14 of the 17 ranges. Approximately 12% of the samples collected at the 17 firing ranges had concentrations above 50 mg/kg. The number of samples with lead concentrations exceeding 118 mg/kg was 78 (approximately 5%). The percent of samples exceeding 250 mg/kg, 500 mg/kg, and 1,000 mg/kg were approximately 2.5%, 1.7%, and 1%, respectively.



Sampling Location	Result (mg/kg)
RAU2A-4-7-E	19.8
RAU2A-4-7-W	14.2
RAU2A-4-7-C	27.6
RAU2A-4-7-N	20.3
RAU2A-4-7-S	12.5

Sampling Location	Result (mg/kg)
RAU2A-4-15-S	11.5
RAU2A-4-15-E	12
RAU2A-4-15-C	19.5
RAU2A-4-15-N	17
RAU2A-4-15-S	780

Sampling Location	Result (mg/kg)
RAU2A-4-17-E	12.3
RAU2A-4-17-C	9.2
RAU2A-4-17-N	12.2
RAU2A-4-17-S	9.3
RAU2A-4-17-E	12.8

Sampling Location	Result (mg/kg)
RAU2A-4-6-S	14.4
RAU2A-4-6-E	14.9
RAU2A-4-6-C	23.2
RAU2A-4-6-N	13.4
RAU2A-4-6-S	22.9

Sampling Location	Result (mg/kg)
RAU2A-4-16-E	11.5
RAU2A-4-16-W	39.3
RAU2A-4-16-C	9.5
RAU2A-4-16-N	11.4
RAU2A-4-16-S	11.3

Sampling Location	Result (mg/kg)
RAU2A-4-5-S	46.1
RAU2A-4-5-E	17.2
RAU2A-4-5-W	16.8
RAU2A-4-5-C	29.5
RAU2A-4-5-N	33.1

Sampling Location	Result (mg/kg)
RAU2A-4-14-S	18.1
RAU2A-4-14-E	54
RAU2A-4-14-W	22.2
RAU2A-4-14-C	16.9
RAU2A-4-14-N	11.3

Sampling Location	Result (mg/kg)
RAU2A-4-4-N	29.6
RAU2A-4-4-S	15.5
RAU2A-4-4-E	81.8
RAU2A-4-4-C	165
RAU2A-4-4-N	58.5

Sampling Location	Result (mg/kg)
RAU2A-4-13-N	21.4
RAU2A-4-13-S	25.3
RAU2A-4-13-E	24.2
RAU2A-4-13-C	35.5
RAU2A-4-13-N	116

Sampling Location	Result (mg/kg)
RAU2A-4-3-N	16.2
RAU2A-4-3-S	15.9
RAU2A-4-3-E	15.7
RAU2A-4-3-W	43
RAU2A-4-3-C	15.9

Sampling Location	Result (mg/kg)
RAU2A-4-12-N	23.8
RAU2A-4-12-S	27.6
RAU2A-4-12-E	14.4
RAU2A-4-12-W	20.5
RAU2A-4-12-C	35.5

Sampling Location	Result (mg/kg)
RAU2A-4-2-C	16.0
RAU2A-4-2-N	39.5
RAU2A-4-2-S	16.3
RAU2A-4-2-E	24.1
RAU2A-4-2-C	31.7

Sampling Location	Result (mg/kg)
RAU2A-4-11-C	13.1
RAU2A-4-11-N	14.3
RAU2A-4-11-S	15.2
RAU2A-4-11-E	14.1
RAU2A-4-11-C	15.9

Sampling Location	Result (mg/kg)
RAU2A-4-1-C	17.2
RAU2A-4-1-N	15.5
RAU2A-4-1-S	23.3
RAU2A-4-1-E	16.7
RAU2A-4-1-W	33.3

Sampling Location	Result (mg/kg)
RAU2A-4-10-C	16.4
RAU2A-4-10-N	12.2
RAU2A-4-10-S	20.5
RAU2A-4-10-E	13.5
RAU2A-4-10-W	15.3

Sampling Location	Result (mg/kg)
RAU2A-4-8-E	12
RAU2A-4-8-C	12.6
RAU2A-4-8-N	10.1
RAU2A-4-8-S	12.7
RAU2A-4-8-E	11.2

Sampling Location	Result (mg/kg)
RAU2A-4-9-W	11
RAU2A-4-9-C	17.7
RAU2A-4-9-N	10.2
RAU2A-4-9-S	12.3
RAU2A-4-9-E	8.7

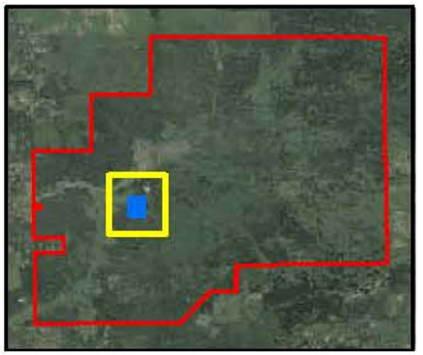


Figure 3-3
Range Floor Grid Sample Locations and Results - Combat Pistol Range

Legend

- Camp Bonneville Property Perimeter
- Firing Ranges
- Berm
- RAU-2A-4 All Sampling Locations
- RAU-2A-4 40 ft Ring from Center Points
- Grids
- 10 ft Box for RCRA Excavation Points
- 10 ft Box for MTCA Excavation Points

N
W E
S

0 40 80 160 240 320 Feet

MKM Engineers, Inc.
4153 Bluebonnet Drive
Stafford, TX 77477

PIKA

Combat Pistol Range (RAU-2A-4)
Sampling Locations

Drawn On: 5/23/2007 Drawn By: QX Reviewed By: ES

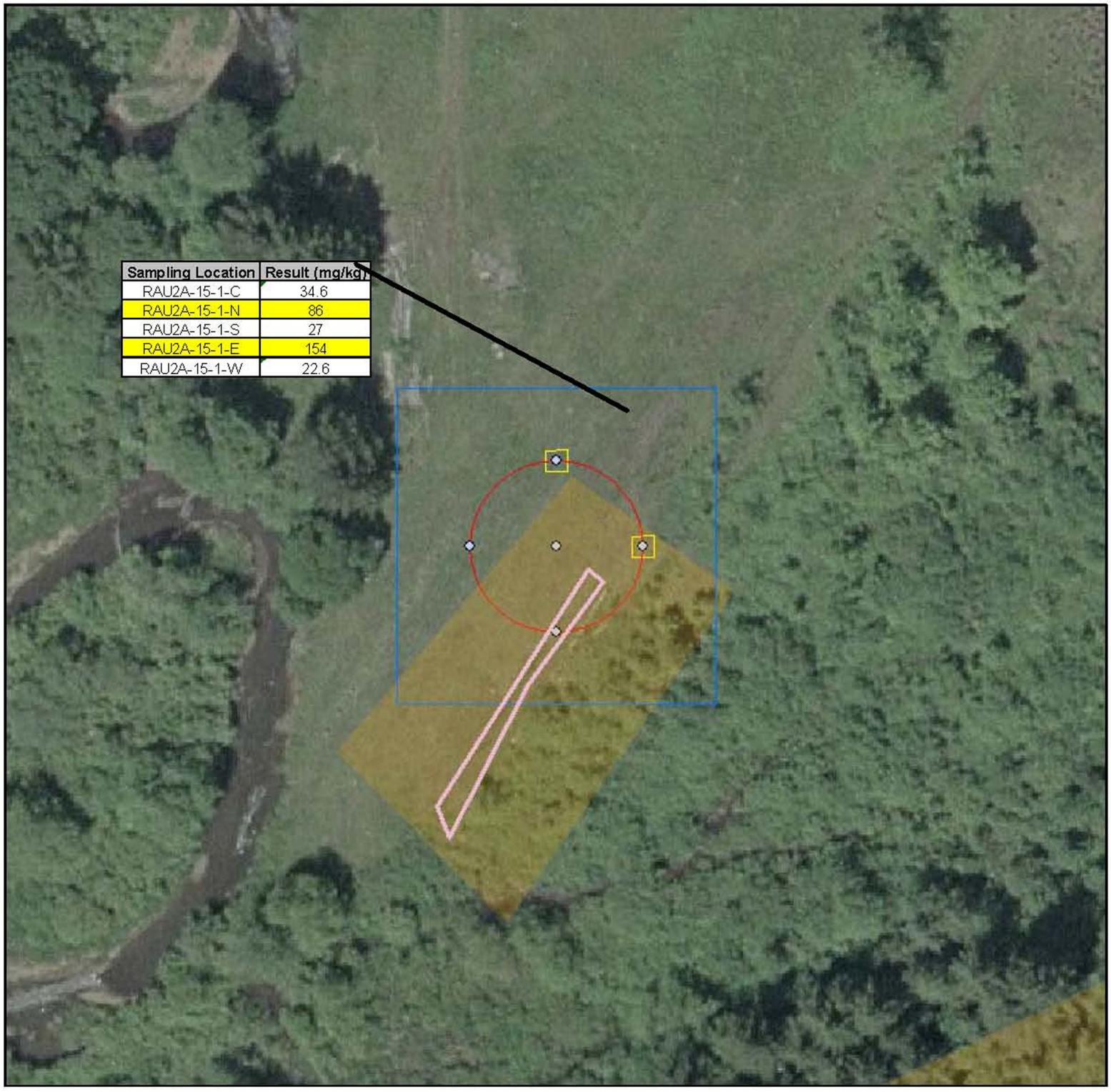


Figure 3-4
Range Floor Grid Sample Locations and Results - Undocumented Pistol Range

Legend
- Camp Bonneville Property Perimeter
- Firing Ranges
- Berm
- RAU-2A-15 All Sampling Locations
- RAU-2A-15 40 ft Ring from Center Points
- Grids
- 10 ft Box for MTCA Excavation Points

N
W E
S

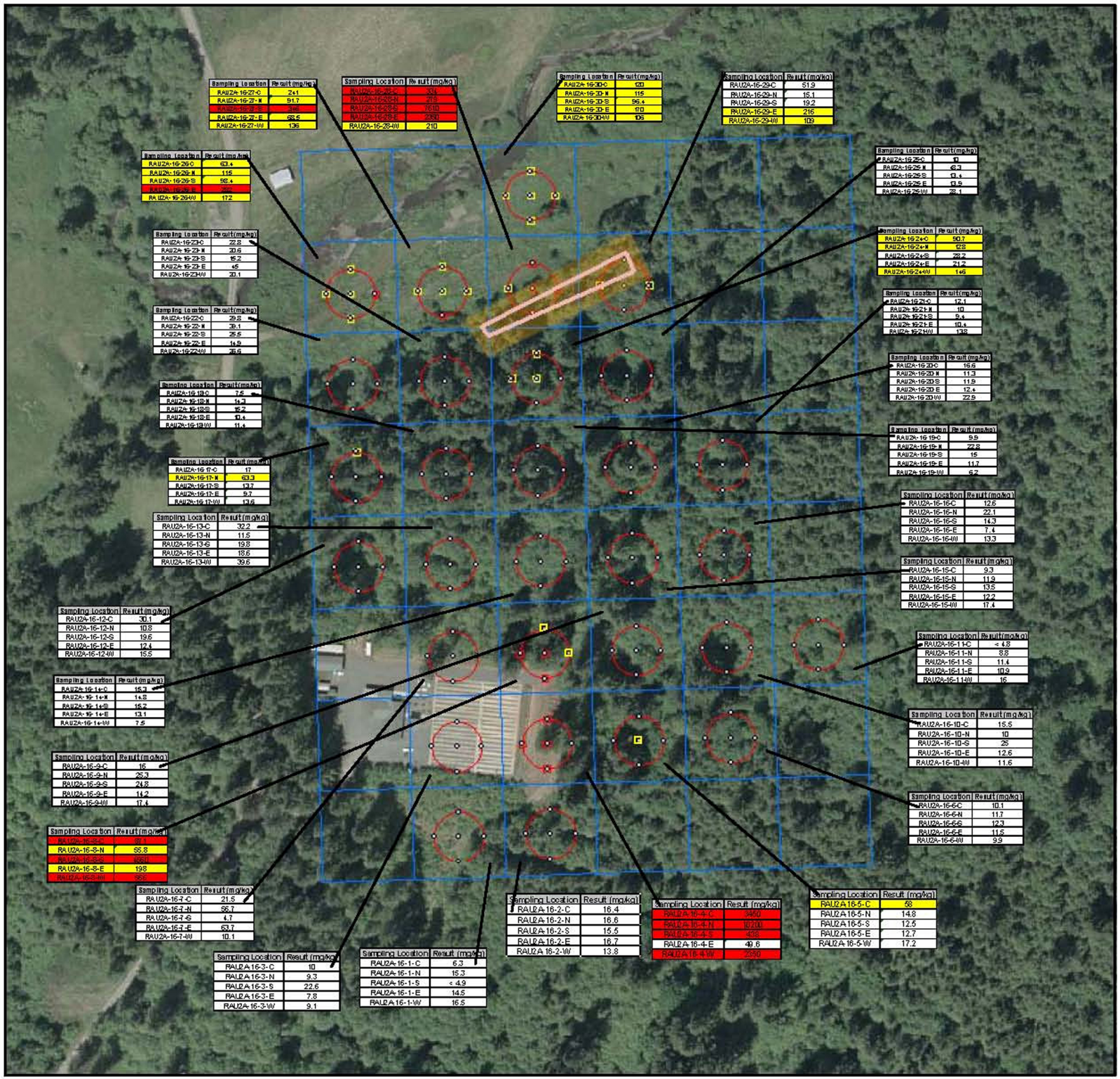
0 12.5 25 50 75 100 Feet

MKM Engineers, Inc.
4153 Bluebonnett Drive
Stafford, TX 77477

PIKA INTERNATIONAL, INC.

Undocumented Pistol Range (RAU-2A-15)
Sampling Locations

Drawn On: 5/23/2007 Drawn By: QX Reviewed By: ES



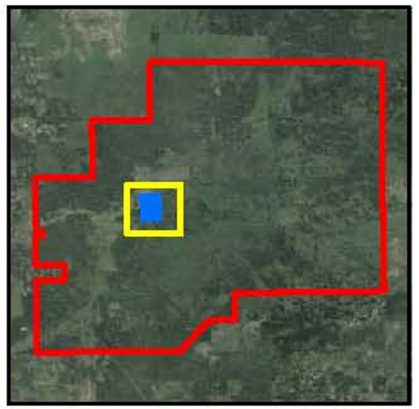


Figure 3-5
Range Floor Grid Sample Locations and Results - 1,000-inch Rifle Range & Machine Gun Range

Legend

- Camp Bonneville Property Perimeter
- Firing Ranges
- Berm
- RAU_2A_16_All_Sampling_Stateplane
- RAU-2A-16 40 ft Ring from Center Points
- Grids
- 10 ft Box for RCRA Excavation Points
- 10 ft Box for MTCA Excavation Points

N
W E
S

0 50 100 200 300 400
Feet

MKM Engineers, Inc.
4153 Bluebonnett Drive
Stafford, TX 77477

PIKA INTERNATIONAL, INC.

1,000-ft Rifle Range/Machine Gun Range (RAU-2A-16) Sampling Locations

(This may be the 1,000 inch range)

Drawn On: 5/23/2007 Drawn By: QX Reviewed By: ES

Figure 3-6
Range Floor Grid Sample Locations and Results - 25-meter M60 and Pistol Range

Legend

- Camp Bonneville Property Perimeter
- Firing Ranges
- Berm
- RAU-2A-17 All Sampling Locations
- RAU-2A-17 40 ft Ring from Center Points
- Grids
- 10 ft Box for MTCA Excavation Points

N
W E
S

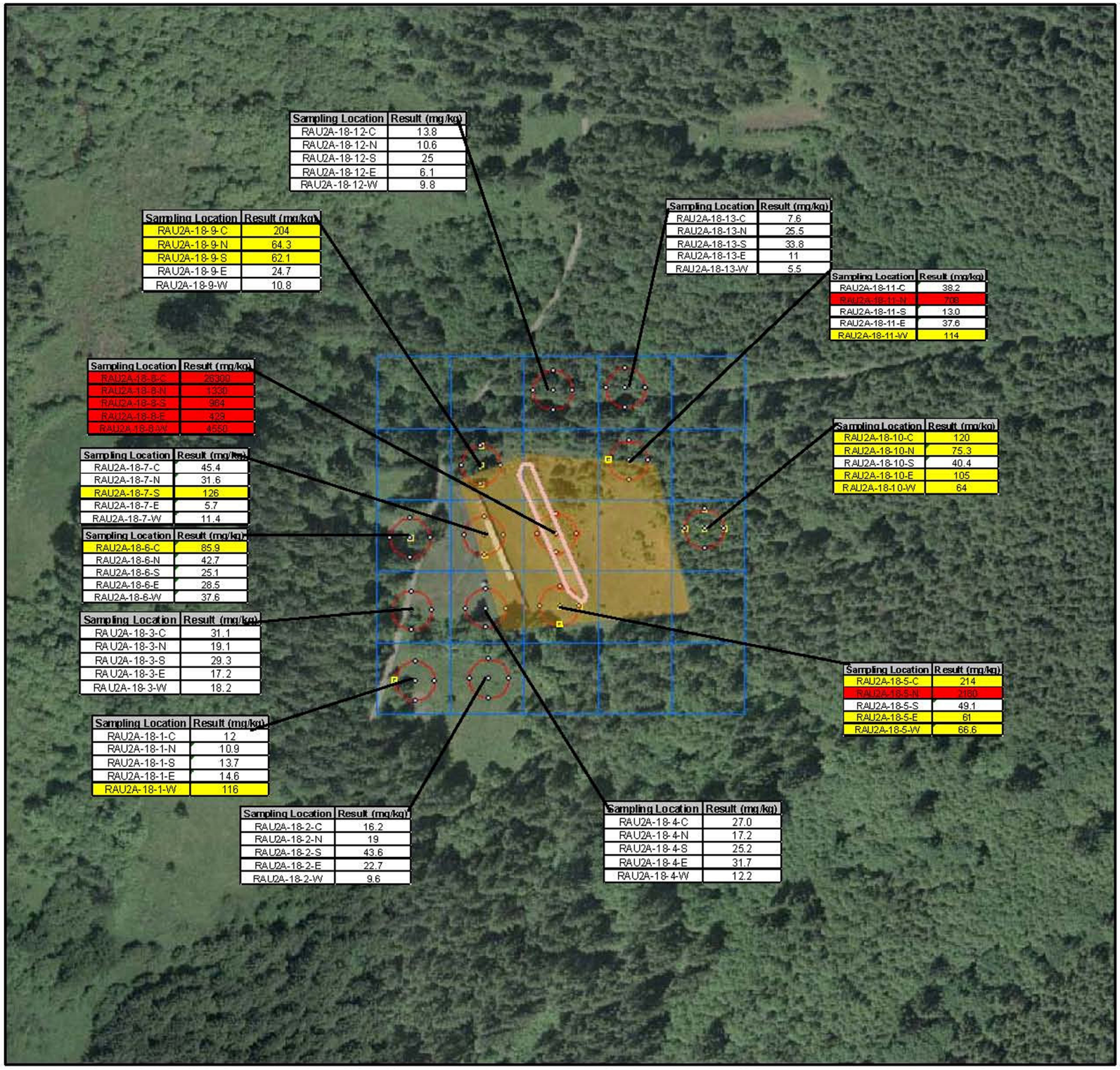
0 25 50 100 150 200 Feet

MKM Engineers, Inc.
4153 Bluebonnett Drive
Stafford, TX 77477

PIKA INTERNATIONAL, INC.

25-meter M60/Pistol Range (RAU-2A-17)
Sampling Locations

Drawn On: 5/23/2007 Drawn By: QX Reviewed By: ES



Sampling Location	Result (mg/kg)
RAU2A-18-12-C	13.8
RAU2A-18-12-N	10.6
RAU2A-18-12-S	25
RAU2A-18-12-E	6.1
RAU2A-18-12-W	9.8

Sampling Location	Result (mg/kg)
RAU2A-18-9-C	204
RAU2A-18-9-N	64.3
RAU2A-18-9-S	62.1
RAU2A-18-9-E	24.7
RAU2A-18-9-W	10.8

Sampling Location	Result (mg/kg)
RAU2A-18-13-C	7.6
RAU2A-18-13-N	25.5
RAU2A-18-13-S	33.8
RAU2A-18-13-E	11
RAU2A-18-13-W	5.5

Sampling Location	Result (mg/kg)
RAU2A-18-11-C	38.2
RAU2A-18-11-N	708
RAU2A-18-11-S	13.0
RAU2A-18-11-E	37.6
RAU2A-18-11-W	114

Sampling Location	Result (mg/kg)
RAU2A-18-8-C	26300
RAU2A-18-8-N	1330
RAU2A-18-8-S	964
RAU2A-18-8-E	429
RAU2A-18-8-W	4550

Sampling Location	Result (mg/kg)
RAU2A-18-10-C	120
RAU2A-18-10-N	75.3
RAU2A-18-10-S	40.4
RAU2A-18-10-E	105
RAU2A-18-10-W	64

Sampling Location	Result (mg/kg)
RAU2A-18-7-C	45.4
RAU2A-18-7-N	31.6
RAU2A-18-7-S	126
RAU2A-18-7-E	5.7
RAU2A-18-7-W	11.4

Sampling Location	Result (mg/kg)
RAU2A-18-6-C	85.9
RAU2A-18-6-N	42.7
RAU2A-18-6-S	25.1
RAU2A-18-6-E	28.5
RAU2A-18-6-W	37.6

Sampling Location	Result (mg/kg)
RAU2A-18-3-C	31.1
RAU2A-18-3-N	19.1
RAU2A-18-3-S	29.3
RAU2A-18-3-E	17.2
RAU2A-18-3-W	18.2

Sampling Location	Result (mg/kg)
RAU2A-18-5-C	214
RAU2A-18-5-N	2180
RAU2A-18-5-S	49.1
RAU2A-18-5-E	61
RAU2A-18-5-W	66.6

Sampling Location	Result (mg/kg)
RAU2A-18-1-C	12
RAU2A-18-1-N	10.9
RAU2A-18-1-S	13.7
RAU2A-18-1-E	14.6
RAU2A-18-1-W	116

Sampling Location	Result (mg/kg)
RAU2A-18-2-C	16.2
RAU2A-18-2-N	19
RAU2A-18-2-S	43.6
RAU2A-18-2-E	22.7
RAU2A-18-2-W	9.6

Sampling Location	Result (mg/kg)
RAU2A-18-4-C	27.0
RAU2A-18-4-N	17.2
RAU2A-18-4-S	25.2
RAU2A-18-4-E	31.7
RAU2A-18-4-W	12.2

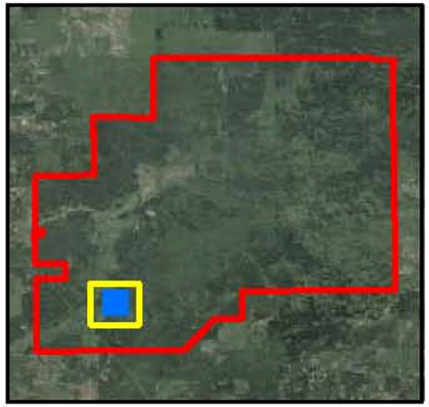


Figure 3-7
Range Floor Grid Sample Locations and Results - 25-meter Machine Gun Range

Legend

- Camp Bonneville Property Perimeter
- Firing Ranges
- Berm
- RAU-2A-18 All Sampling Points
- RAU-2A-18 40 ft Ring from Center Points
- Grids
- 10 ft Box for MTCA Excavation Points
- 10 ft Box for RCRA Excavation Points

N
W E
S

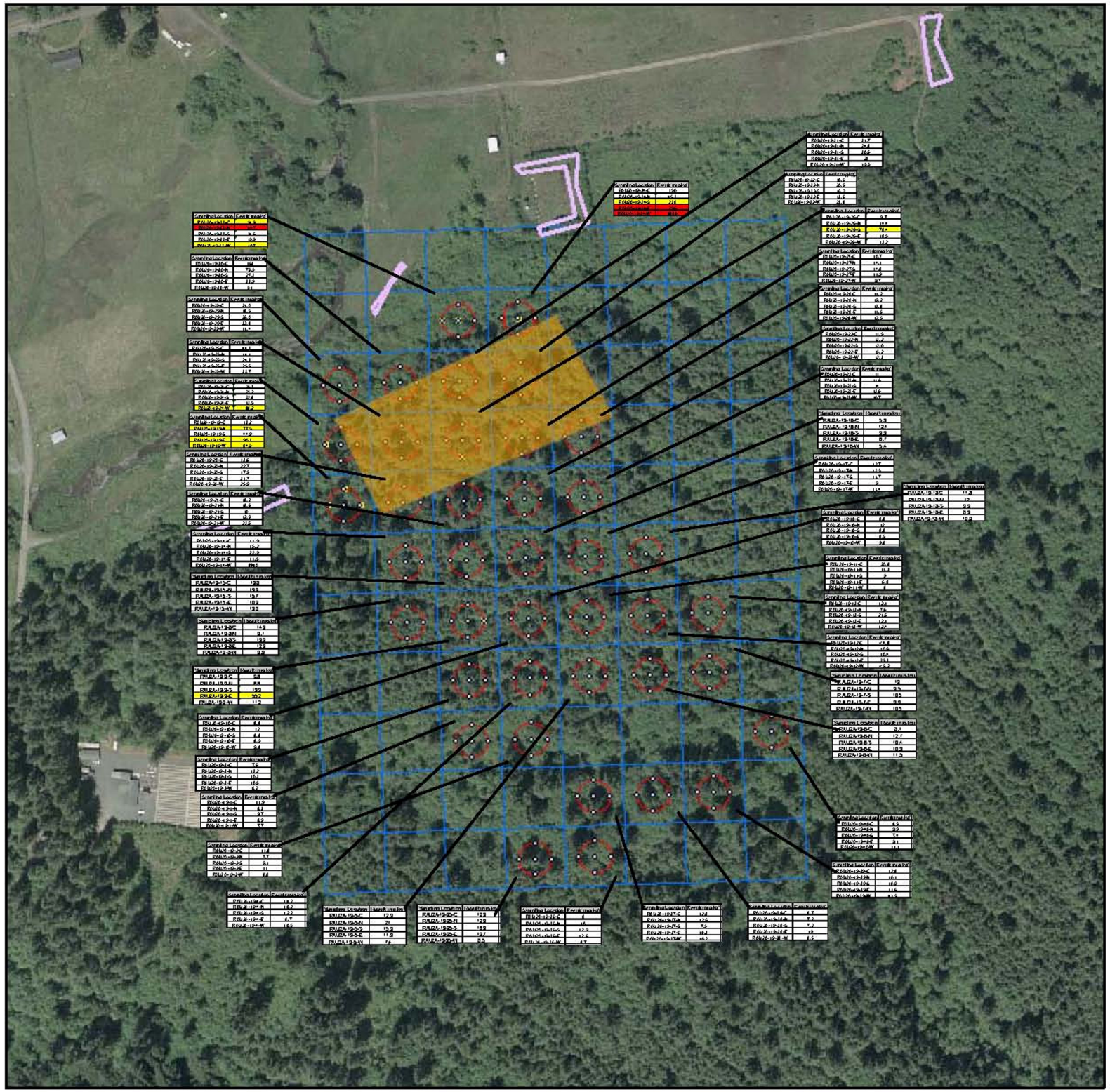
0 60 120 240 360 480
Feet

MKM Engineers, Inc.
4153 Bluebonnett Drive
Stafford, TX 77477

PIKA INTERNATIONAL, INC.

25 meter Machine Gun Range (RAU-2A-18)
Sampling Locations

Drawn On: 5/23/2007 Drawn By: QX Reviewed By: ES



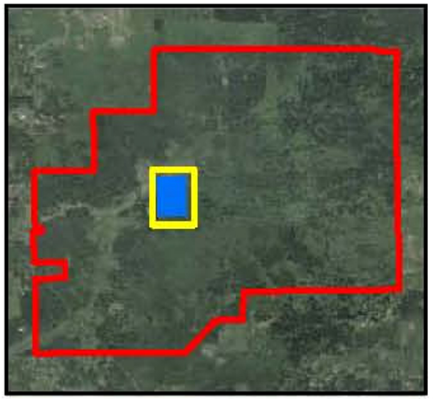


Figure 3-8
Range Floor Grid Sample Locations and Results - 25-meter Record Firing and Field Firing Range

Legend

- Camp Bonneville Property Perimeter
- Firing Ranges
- Berm
- RAU-2A-19 All Sampling Locations
- RAU-2A-19 40 ft Ring from Center Points
- Grids
- 10 ft Box for MTCA Excavation Points
- 10 ft Box for RCRA Excavation Points

N
W E
S

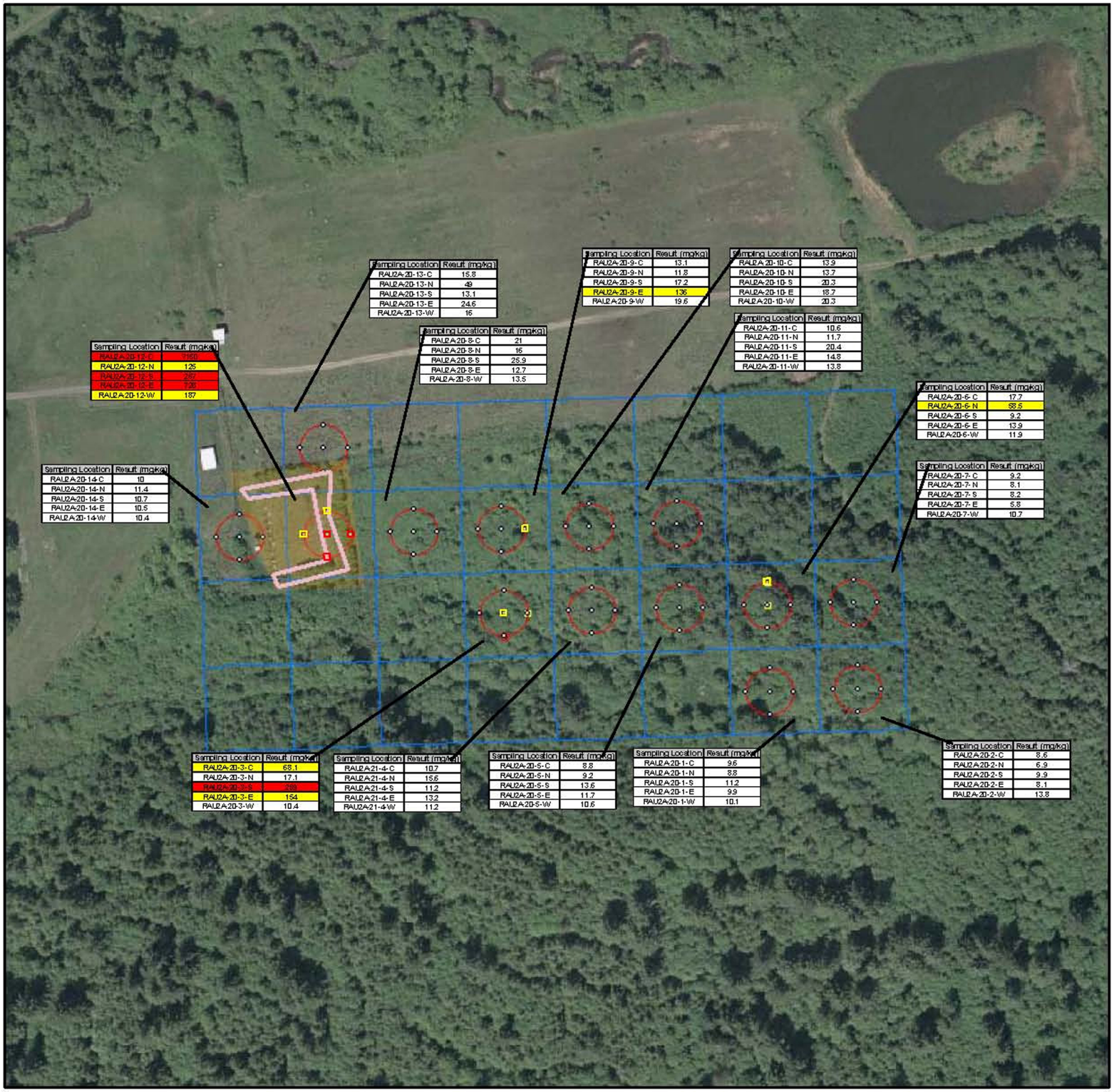
0 70 140 280 420 560 Feet

MKM Engineers, Inc.
4153 Bluebonnett Drive
Stafford, TX 77477

PIKA

25-meter Record Firing/Field Firing Range
(RAU 2A-19) Sampling Locations

Drawn On: 5/23/2007 Drawn By: QX Reviewed By: ES



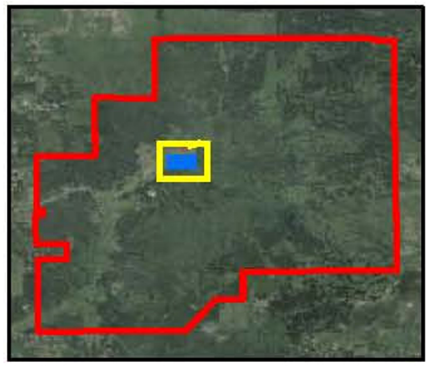


Figure 3-9
Range Floor Grid Sample Locations and Results - Field Firing Ranges No. 1 and No. 2

Legend

- Camp Bonneville Property Perimeter
- Firing Ranges
- Berm
- RAU-2A-20 All Sampling Locations
- RAU-2A-20 40 ft Ring from Center Points
- Grids
- 10 ft Box for RCRA Excavation Points
- 10 ft Box for MTCA Excavation Points

N
W E
S

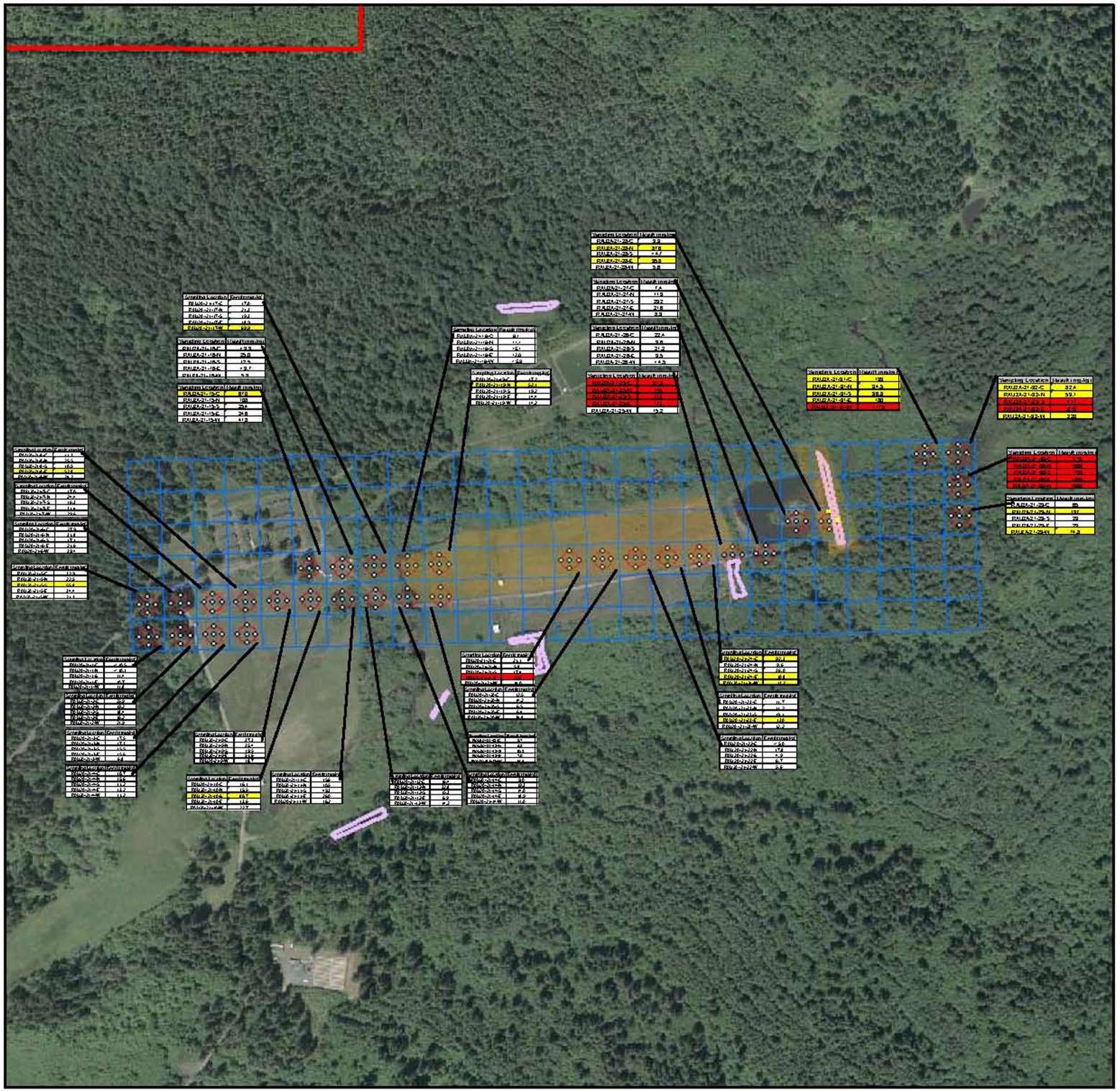
0 50 100 200 300 400 Feet

MKM Engineers, Inc.
4153 Bluebonnett Drive
Stafford, TX 77477

PIKA INTERNATIONAL, INC.

Field Firing Ranges No. 1 & 2
(RAU-2A-20) Sampling Locations

Drawn On: 5/23/2007 Drawn By: QX Reviewed By: ES



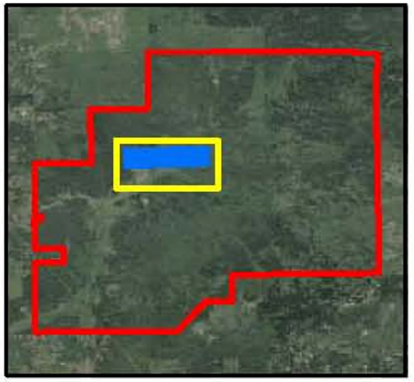


Figure 3-10
Range Floor Grid Sample Locations and Results - Rifle Ranges No. 1 and No. 2

Legend

- Camp Bonneville Property Perimeter
- Firing Ranges
- Berm
- RAU-2A-21 All Sampling Locations
- RAU-2A-21 40 ft Ring from Center Points
- Grids
- 10 ft Box for RCRA Excavation Points
- 10 ft Box for MTCA Excavation Points

N
W E
S

0 140 280 560 840 1,120
Feet

MKM Engineers, Inc.
4153 Bluebonnett Drive
Stafford, TX 77477

PIKA INTERNATIONAL, INC.

Rifle Ranges No. 1 and No. 2 (RAU-2A-21)
Sampling Locations

Drawn On: 5/23/2007 Drawn By: QX Reviewed By: ES

Figure 3-11
Range Floor Grid Sample Locations and Results - Field Fire Ranges No. 1 and No. 2

Legend

- Camp Bonneville Property Perimeter
- Berm
- 10 ft Box for RCRA Excavation Points
- 10 ft Box for MTCA Excavation Points
- RAU-2A-22 All Sampling Locations
- RAU-2A-22 40 ft Ring from Center Points
- Grids

These samples are in the wrong locations, but are according to the RI/FS locations.

N
W E
S

0 55 110 220 330 440 Feet

MKM Engineers, Inc.
4153 Bluebonnett Drive
Stafford, TX 77477

PIKA INTERNATIONAL, INC.

Field Fire Ranges No. 1 and No. 2 (RAU 2A-22) Sampling Locations

Drawn On: 5/23/2007 Drawn By: QX Reviewed By: ES