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Remedial Investigation/Feasibility Study for the U.S. Border Patrol Firing Range

Nogales, Arizona

Contract Number: W9126G-06-D-0016
Task Order 0039

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ES.0 EXECUTIVE SUMMARY

This Remedial Investigation/Feasibility Study (RI/FS) report describes the methods and results of data evaluation and site characterization performed; and presents the assessment, development, screening, and evaluation of remedial alternatives to reduce the potential risk to current and future site receptors, the general public, and the environment at the U.S. Border Patrol (USBP) firing range in Nogales, Arizona.

ES.1 REMEDIAL INVESTIGATION

The primary purpose of the Remedial Investigation (RI) at the USBP firing range, located at 1651 W. Target Range Road in Nogales, Arizona Santa Cruz County is to present the results of the RI and provide information to assess the potential risks/hazards to human health and the environment. This report also evaluates the success of the RI in terms of meeting the objectives of the investigation.

The study area is a leased portion of the Arbo property (parcel no. 112-29-100B) and covers approximately 0.5 acres.

Previous Phase I and Phase II investigations completed on properties adjoining the USBP firing range have found bullet fragments, shotgun wadding and clay pigeon target fragments, in the vicinity of the USBP firing range. During the Phase II soil investigation completed on the properties adjoining the USBP firing range one hundred and thirty five soil samples were taken and analyzed for lead, antimony, arsenic and polynuclear aromatic hydrocarbons (PAH)s. Results of the samples showed lead constituents and limited antimony, arsenic and PAHs soil concentrations exceeding U. S. Environmental Protection Agency (USEPA) residential regional screening levels.

To characterize the USBP firing range for small arms constituents of concern (COC)s, the RI evaluated existing historical information, geophysical and chemical data; and collected new data to determine the nature and extent of potential small arms COCs within the boundaries of the existing firing range. In order to meet the objectives of the RI a conceptual fate, transport and exposure (CFTE) site model was developed. The two components of the CFTE site model are 1) determination of fate and transport processes related to the constituents' ability to be isolated, degraded or migrate in the environment, and 2) an assessment of potential exposure pathways to evaluate the impacts of released materials on human and ecological receptors.

During the current investigation by TPMC a total of sixty soil samples below ground surface (bgs) were collected at the USBP firing range in Nogales, Arizona. Thirty eight soil samples (sixteen composite samples and twenty two discrete 'grab' samples) were collected from the surface (0-12 inches bgs), and twenty two soil samples (sixteen composite samples and six 'grab' discrete samples) were collected at the shallowest depth below 12 inch where the X-Ray Fluorescence instrument reading did not exceed USEPA residential Regional Screening Levels (RSL) s for antimony, arsenic, and lead. All sixty soil samples were analyzed for the presence of antimony, arsenic, and lead. Ten surface soil samples were analyzed for the presence of PAHs and five samples containing high concentrations of constituents of concern (COC) metals were analyzed for toxicity characteristic leaching potential (TCLP). All of the COC metals are found throughout the firing range. The highest concentration of metals for both shallow (0-12 inches) and deep (12-42 inches) are found in the southwest corner of the firing range. The area consists of the major portion of the back-stop berm and firing range area between the berm and last target area. The highest concentration of PAHs is also found in the southwest corner of the firing range. Four of the five TCLP samples exceeded USEPA standards for lead and none of the arsenic samples exceeded the USEPA TCLP standards. There are no USEPA TCLP standards for PAHs and antimony.

Potential routes of vadose zone soil COC migration at the USBP firing range are aeolian (wind) transport, sediment transport by storm water, mass wasting and leachate transport. Site conditions at the USBP firing range relevant to these modes of COC migration indicate that COCs are actively migrating off-site from vadose zone soils.

Off-site COC particle transport by aeolian (wind) methods is considered to be the primary mode of COC migration at the USBP firing range. COCs may also migrate by sediment transport from flashy storm water discharges produced by seasonal heavy precipitation. Mass wasting is expected to result in on-site transport of contaminated surface soils and shooting range debris. The area of the USBP firing range subject to mass wasting COC migration is restricted to the backstop berm area.

Off-site COC dissolved transport by storm water is also expected to transport relatively minute amounts of COC metals and, to a lesser degree, PAHs, as a dissolved fraction. COC media present in the dissolved phase in storm water discharges may release relatively small amounts of dissolved COCs. Storm water transport of COCs as a dissolved fraction increases the distance and rate of migration of COCs compared to transport of bed load sediments. The dissolved COC load carried by storm water runoff may potentially combine with the local permanent surface water pathway, Santa Cruz River, in a highly diluted state.

Leachate transport is expected to cause vertical on-site and off-site COC migration. Leachate resulting from infiltration of rain water may transport dissolved COC metals and PAHs downward through vadose zone soils towards the water table. Due to the slow rate of leachate COC transport anticipated at this site (a few inches of downward transport per year) and the depth to groundwater at the site ranging from 40 to 135 feet bgs, leachate transport will not migrate COCs to the water table in the near term.

The human and environmental risk posed by the lead concentrations in soil exceed both the human health and ecological screening levels, in all of the soil samples collected on site and immediately adjacent to the site in 2011. Concentrations of antimony and arsenic and PAHs exceed both human and ecological screening levels in surface soils, although exceedances are not as widespread as lead. Based on the widespread exceedances of the lead USEPA RSLs and Arizona Department of Environmental Quality Soil Remediation Levels (SRL) in the fine soil fraction, remedial decisions to address current soil conditions would be warranted. Concentrations of antimony, arsenic, and PAHs are co-located with elevated lead concentrations, thus the physical remedial actions that would address fine grained particulate lead in soil would also address these fine grained constituents. Based on this comparison to regulatory and risk-based screening criteria, further estimation of risk under a baseline exposure scenario, which is captured in the screening criteria, is unlikely to provide additional information that would impact the remedy selection in the FS. Thus, no additional risk assessment is recommended until a strategy to address lead, in soils has been developed.

ES.2 FEASIBILITY STUDY

The Feasibility Study (FS) describes alternatives to address COC hazards at the U.S. Border Patrol (USBP) firing range in Nogales, Arizona. The USBP firing range contains structural improvements and buildings related to small-arms shooting and target practice activities.

The purpose of this FS is to identify Remedial Action Objectives (RAOs), identify and screen potential response actions that may meet the RAOs, assemble the response actions into remedial alternatives to address any potential COC hazards at the USBP firing range, and evaluate the remedial alternatives using established criteria. The objective of the FS is the development, screening and detailed analysis of remedial action alternatives to remediate the (USBP) firing range in Nogales, Arizona. The remediation of the COCs will be the final remedial action to be taken by the USBP. CERCLA requires that the FS prepare detailed analyses of remedial alternatives using nine criteria. The analyses include:

Threshold Criteria

1. Overall protection of human health and the environment;
2. Compliance with environmental screening levels (ARARs);

Primary Balancing Criteria

3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume;
5. Short-term effectiveness;
6. Implementability;
7. Cost;

Modifying Considerations

8. Government acceptance; and
9. Community acceptance.

The FS approach described in the guidance documents was tailored to site-specific circumstances and modified to consider the inherently unique aspects of conducting remedial activities at the Firing Range. The FS consists of two general steps as listed below:

1. Identification and screening of a focused list of possible remedial technologies; and
2. Detailed evaluation of remedial alternatives using process options within viable technology types.

RAOs drive the formulation and development of response actions. The primary RAOs for the USBP firing range are based upon the hazard assessment results presented in the RI Report and the USEPA threshold criteria. Based upon the hazard assessment and the RI/FS Guidance, the following RAOs were developed for the protection of human health and environment:

- Prevent or reduce the potential for receptors to come in direct contact with soil COCs and COC source materials remaining at USBP firing range.
- Prevent the potential for receptors to ingest the soil COCs at the USBP firing range.
- Prevent the potential for receptors to inhale the soil COCs at the USBP firing range.
- Interrupt USBP firing range COC migratory pathways to human or ecological targets

Soil COCs related to historical USBP operations within the firing range site were detected in soil samples collected during the RI. The specific COCs are summarized as follows:

- Lead, antimony and arsenic originated from spent munitions from small arms firing at the USBP firing range. Lead, antimony and arsenic are constituents used in the manufacture of bullets and shot gun pellets.
- Polynuclear Aromatic Hydrocarbons (PAH) also originated from spent munitions from small arms firing at the USBP firing range. The PAHs are components used in the manufacture of plastic shotgun shell wadding and clay pigeon targets.

A screening evaluation was conducted to determine remedial technologies that may be effective components for the remedial action alternatives. Technologies were screened using the criteria of effectiveness, implementability and cost. The following lists the potential remediation technologies screened using these criteria:

1. No Action
2. Grade and Cap
3. Soil Stabilization
4. Off-Site Landfill
5. Soil Solidification
6. Sieve, Sort and Removal
7. Bioremediation/Phytoremediation

The following remedial technologies were retained after screening for effectiveness, implementability, and cost:

- Alternative 1: Limited Off-Site Landfilling, Soil Stabilization and Cap and Grade
- Alternative 2: Sieving, Soil Stabilization and Cap and Grade
- Alternative 3: Off-Site Landfilling, Soil Solidification and Cap and Grade

- Alternative 4: Off-Site Landfilling

The following remedial alternatives were developed, evaluated against the CERCLA nine criteria, and retained for comparative analysis from the retained remedial technologies:

- *Limited Off -Site Landfilling, Soil Stabilization and Cap and Grade* – This developed alternative includes the removal of COC metal and PAH contaminated soils that are above USEPA RSLs and Arizona SRLs, and the subsequent treatment of the remaining stockpiled soils and in-place soils with a soil stabilization amendment. This method stabilizes lead and arsenic using Apatite II, derived from processed fish bones, which chemically binds lead and arsenic into stable, insoluble minerals. The third step involves installation of an impervious cap and soil layer over the site and subsequent grading that isolates antimony and PAHs.

- *Sieving, Soil Stabilization and Cap and Grade* - This alternative removes the metals fraction that is greater than ¼ inch in diameter using sieving and recycling the metals (for free-flowing sandy soils with little oversize material other than spent projectiles, simple dry screening may be sufficient), and treating the remaining metals in place and loose soils with a soil stabilization amendment Apatite II. This method stabilizes metals using Apatite II, derived from processed fish bones, which chemically binds metals into stable, insoluble minerals. The third step involves installation of an impervious cap over the site and subsequent grading that isolates antimony and PAHs.

- *Off-Site Landfilling* - This alternative removes the COC metals and PAHs from all contaminated soils that are above USEPA RSLs and Arizona SRLs to an appropriate land fill. The removal areas comprise the backstop berm, firing range proper and parking lot.

The retained alternatives listed above meet the threshold criteria. Each one of the retained remedial alternatives is a complete alternative, a selection of which will allow the US Customs and Border Protection (CBP) to meet the assumed remedial objective. Following the USEPA (1988)outline, further comparative assessment of the alternatives was reserved for the more detailed analyses covered under the primary balancing criteria: 3) long-term effectiveness and permanence, 4) reduction of toxicity, mobility or volume, 5) short-term effectiveness, 6) implementability and 7) cost. The retained alternatives were then compared to evaluate the relative merits and deficiencies of each alternative relative to one another so that the alternatives can be identified and ranked in terms of the various evaluation criteria.

The CBP will identify a preferred remedial alternative based upon comments received from the regulatory agencies and project stakeholders during the review period of the Draft Final RI/FS Report. The preferred alternative will be presented along with other alternatives in the Proposed Plan. The Proposed Plan will be prepared after the FS is finalized. The preferred alternative will be presented in a public meeting and the public will be allowed to comment on the Proposed Plan during a 30-day public comment period. Following the 30-day public comment period, a Decision Document (DD) will be prepared that (1) summarizes the results of the RI/FS, (2) includes a responsiveness summary that summarizes any public comments received on the Proposed Plan and includes responses to comments, and (3) specifies the details of the selected remedy(s), including plans for development and submittal of a RD/RA Work Plan.

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Volume I-Remedial Investigation

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LIST OF ACRONYMS

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AMA	Active Management Area
amsl	above mean sea level
APP	Accident Prevention Plan
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society of Testing and Materials
bgs	below ground surface
CADD	Computer Aided Design Drawing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CFTE	Conceptual Fate, Transport and Exposure
CO_2	Carbon Dioxide
COC	Constituent of Concern
COPC	Constituent of Potential Concern
COPEC	Constituent of Potential Ecological Concern
CAP	Customs and Border Protection
DD	Decision Document
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
ESSL	Ecological Soil Screening Level
°F	degrees Fahrenheit
FS	Feasibility Study
ft	feet
gpm	gallons per minute
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations
HHA	Human Health Assessment
HQ	Hazard Quotient
ID	Identification
IDW	Investigation Derived Waste

LIST OF ACRONYMS (CONTINUED)

in	inches
ITRC	Interstate Technology and Regulatory Council
K_{oc}	Organic Carbon-water Partitioning Coefficient
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LOD	Limit of Detection
LOQ	Limit of Quantitation
MCL	Maximum Contaminant Level
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MQO	Measurement Quality Objective
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NCP	National Oil and Hazardous Substance National Contingency Plan
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PRG	Preliminary Remediation Goal
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAO	Remedial Action Objective
RD	Remedial Design
RCRA	Resource Conservation and Recovery Act
REC	Recognized Environmental Condition
RI	Remedial Investigation
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SLERA	Screening Level Ecological Risk Assessment
SMDP	Scientific/Management Decision Point
SOP	Standard Operating Procedure

LIST OF ACRONYMS (CONTINUED)

SRL	Soil Remediation Level
SSHP	Site Safety and Health Plan
TCLP	Toxicity Characteristic Leaching Potential
TPMC	TerranearPMC, LLC
USACE	U.S. Army Corps of Engineers – Fort Worth District
USBP	U.S Border Patrol
USEPA	U.S. Environmental Protection Agency
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compound
XRF	X-ray Fluorescence

1.0 INTRODUCTION

This Remedial Investigation (RI) and Feasibility Study (FS) investigation incorporates the approximately one-half acre U. S. Border Patrol (USBP) firing range property, referred to hereafter as the USBP firing range, located on the west side of Nogales, Arizona. The firing range consists of two buildings, parking area, covered firing area, three concrete target rectangles and an earthern backstop berm. The RI/FS report is divided into two parts: the RI is Volume 1 and the FS is Volume 2. The RI field investigation phase of work has been completed for the Property. This RI/FS report is focused on the USBP firing range as US Customs and Border Protection (CBP) intends to close the firing range and terminate the lease.

This RI was performed to characterize the site for small arms constituents of concern (COCs) resulting from the firing range exercises.

The FS is developed to document the evaluation of remedial alternatives developed to reduce the potential exposures of small arms constituents of concern (COC) to current and future property owners and the general public.

The RI/FS meets the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substance National Contingency Plan (NCP). The RI/FS report will be used in developing the Proposed Plan and making a decision on Remedial Action (RA).

1.1 PURPOSE

The primary purpose of the RI report (Volume 1) is to present the results of the RI and provide information to assess the potential risks/hazards to human health and the environment. Information presented in the RI report supports the FS in order to determine a remedy for the firing range. This report also evaluates the success of the RI in terms of meeting the objectives of the investigation and filling data gaps that existed for the firing range prior to the RI.

To characterize the USBP firing range for small arms COCs, the RI evaluated existing historical information, geophysical and chemical data; and collected new data to determine the nature and extent of potential small arms COCs within the boundaries of the existing firing range. In coordination with the U.S. Army Corps of Engineers– Fort Worth District (USACE) and the CBP, TerranearPMC, LLC (TPMC) completed the RI activities in October 2011 and developed this RI report to present the results of the investigation, provide a Conceptual Fate, Transport And Exposure (CFTE) site model, and perform a screening-level risk assessment for small arms COCs for the firing range.

1.2 REPORT ORGANIZATION

This RI is generally organized according to the report outline in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA,1988. The RI report outline provided in USEPA, 1988 has been modified and augmented to accommodate unique aspects of this project.

The RI report presents information on the Site in the following sections:

1.0 **Introduction:** This section describes the purpose of the RI report, general characteristics of the firing range, physical geography, cultural resources, current land use, and provides a summary of the previous investigations performed at the Site.

2.0 **Project Remedial Action Objectives:** This section discusses the objectives stated in the USBP firing range work plan. It includes the remedial response objectives established for the site, a description of the approach for the RI and review of the data needs and data quality objectives (DQOs) for the project.

3.0 **Nature and Extent of Constituents of Concern:** This section characterizes the types of COCs present at the firing range, identifies the compounds that are potentially present and describes the strategies and methods utilized to characterize the nature and extent of COCs.

4.0 **Constituent of Concern Fate and Transport:** This section provides a characterization of migration pathways of the COCs present at the firing range, including information from previous investigations and persistence of the COCs in the environment.

5.0 **Risk Assessment:** This section discusses the risk assessment conducted to evaluate the potential risks the site poses to human health and the environment. In accordance with the SOW, the risk assessment consists of a human health assessment (HHA) and an ecological risk assessment (ERA).

6.0 **Summary and Conclusions:** This section provides summaries dependant on the results of the RI on the extent of the COCs, the migration of the COCs and the assessment of risk from the COCs to the human and ecological targets. Provides conclusions concerning the data limitations and recommendation for future work and a statement of recommended Remedial Action Objectives (RAOs) based on current extent of the COC migration.

7.0 **Quality Assurance:** This section presents the quality assurance (QA) and data validation procedures used to ensure 100 percent validation and usability of the data collected during the RI of the USBP firing range. This section also presents the QA procedures for data validation and the intrusive investigation.

8.0 **References:** This section provides references for outside sources of information used in the development of this RI report.

1.3 SITE DESCRIPTION, POTENTIAL CONSTITUENTS OF CONCERN AND PREVIOUS WORKS

1.3.1 Site Location

The USBP firing range is located at 1651 W. Target Range Road in Nogales, Arizona (Figure 1). The study area is a leased portion of the Arbo property (parcel no. 112-29-100B) and a portion of the Barr property (parcel no. 113-49-027) (Figure 2). The study area is shown by the sixteen square grids and covers approximately 0.5 acres (Figure 3). The site on the Arbo property is surrounded by three adjacent properties: the Barr property (parcel no. 113-49-027), Garcia Property (parcel no. 113-49-006) and the Kyriakis property (parcel no. 113-49-002A).

The study area is located in a portion of section 13, Township 24 south, Range 13 east, Santa Cruz County, Arizona with its center located at latitude of approximately 31.347139 North and longitude of approximately 110.969525 West.

1.3.2 Potential Environmental Constituents of Concern

Usage of the property as a firing range indicates the potential for COCs to be present in the surface and subsurface soils. COCs at the property include those associated with abandoned spent small-arms ammunition, clay pigeon targets and shotgun wadding, namely lead, arsenic, antimony and polynuclear aromatic hydrocarbons (PAHs). The source of COCs at the property is the firing area and back stop berm of the USBP firing range. The scope of this RI includes sampling and analysis to determine if the potential COCs are present at the site in surface and subsurface soils.

1.3.3 Site Description

The USBP firing range site description, including general site characteristics, potential environmental contamination risks, topography, site buildings and structures, climate, hydrology, soils and vegetation, geology, hydrogeology and prehistoric and cultural resources are discussed in the following subsections.

1.3.3.1 Topography

The majority of the USBP firing range study area has been graded by heavy machinery, and is essentially flat. The topography of the remainder of the study area and of the surrounding property is typical of dry desert lowlands present throughout the Basin and Range province of the western United States. The land surface is generally rugged and hilly. Several dry creek beds (arroyos) separate steep hills and ridges present throughout this area. The elevation ranges from approximately 3,960 to 4,130 feet above mean sea level (amsl) (Allwyn Environmental, 2009).

1.3.3.2 Site Buildings and Structures

The USBP firing range contains structural improvements and buildings related to small-arms shooting and target practice activities (Figure 3). The buildings and structures at the site consist of:

- An open-sided covered firing deck on concrete slab, located at the eastern end of the range, approximately 60 feet x 15 feet.
- Two wooden storage sheds, one adjoining the southern end of the covered firing deck (approximately 10 feet x 15 feet), and the other located east of the firing deck (approximately 8 feet x 5 feet). The sheds are used for the storage of firing range maintenance supplies and targets.
- Three concrete slab target staging pads (60 x 10 feet, 60 x 5 feet and 60 x 5 feet), each oriented parallel to and west of the covered firing deck.
- An approximately 12 foot-high earthen back-stop berm at the western edge of the site.

1.3.3.3 Climate

Nogales' climate is typically sunny and dry, with low relative humidity. Average monthly high temperatures recorded at the Nogales 6 N climate station from 1952 to 2010 range from a low of 64.3 degrees Fahrenheit (°F) in January to a high of 95.3°F in June. Average monthly low temperatures range from 27.3°F in January to 63.9°F in June during the same time period (Western Regional Climate Center, 2011).

Nogales' climate is classified as arid, which is defined by average annual precipitation less than half of evaporation and mean temperature of the coldest month above freezing (32°F). The USBP firing range receives little rain or snow, averaging about 17.21 inches of precipitation per year. Most precipitation occurs during the summer monsoon season, typically from July through mid-September. The monthly average precipitation recorded at the Nogales 6 N climate station from 1952 to 2010 ranges from a low average of 0.22 inches for May to a high average of 4.38 inches for August. The summer monsoon season for regional precipitation is characterized by incidences of sudden, dramatic downpours of heavy rain within a short period of time. Such events have been known to cause flash flooding. The Nogales 6 N climate station has recorded an extreme value of 3.67 inches of precipitation within one day, occurring on the 25th of August, 1993. Hourly rainfall amounts were not available (Western Regional Climate Center, 2011). The average pH of rainwater for southern Arizona is approximately 5.4 (USGS, 2001)

Prevailing wind at the Nogales Airport generally flows from the South (Western Regional Climate Center, 2011).

1.3.3.4 Surface Water Hydrology

No permanent surface water features exist at the USBP firing range. An unnamed dry creek bed (arroyo) borders the site on the northwest side. Arroyos are seasonal drainage features, which drain ephemeral storm water during heavy rain events (usually during the summer monsoon rain events) and usually become dry again within a few hours or even minutes of the end of the rain event. The unnamed arroyo at the USBP firing range drains to the northeast, towards an automobile salvage yard.

1.3.3.5 Geology

The physiography of the USBP firing range study area is characterized by mountains and basins formed by large scale normal faulting during the Basin and Range disturbance about 14 to 6 million years ago. The site is underlain by the sediments of the Tertiary-age Nogales Formation and Mesozoic-age intrusive volcanics, unconformably overlaid with a veneer of Quaternary-age sediments in the valleys. The Nogales Formation consists of mechanically deposited basin-fill volcanic conglomerate with layers of sandstone and grit. The Nogales Formation is estimated to reach a depth of 250 to 700 meters bgs (USGS and ADEQ, 2011).

1.3.3.6 Soils and Vegetation

The soils in the study area are primarily shallow and rocky with unweathered clasts of andesite and rhyolite tuffs, granites, and small areas of clay shales. The steeper slopes have numerous rock outcroppings and shallow loamy soils. Five soil associations dominate the area: Comoro-Pima, Continental-Sonoita, Caralampi-White House - Hathaway, Lampshire-Chiracahua-Graham, and Faraway-Rock Outcrop-Barkerville. The first three are typically deep soils and sandy loams with varying amounts of gravel and clay, generally appearing in or along floodplains and streambeds. The latter two are typically shallow cobbled clay or sandy loams occurring in the upper elevations on foothills and mountains (Allwyn Environmental, 2009). Soil pH ranges from slightly acidic (pH 6) to slightly alkaline (pH 8) (USDA, 1979).

Most of the ground surface is covered with vegetation; however, some portions are bare. The vegetation that grows in these soils is representative of desert shrub land. Common vegetation includes several varieties of cacti, mesquite, creosote bush, ocotillo, acacia trees, desert willow, and yucca (National Park Service, 2011). USBP firing range vegetation did not significantly hinder the RI field activities.

1.3.3.7 Hydrogeology

Regional Groundwater Conditions

The property lies within the boundaries of the Santa Cruz Active Management Area (AMA). The Santa Cruz AMA was designed to address groundwater overdraft in the area, as a result, water management in this area is intensive. Within the Santa Cruz AMA, groundwater can be withdrawn legally only through a groundwater right or permit, unless groundwater is withdrawn from an exempt well (maximum capacity of 35 gallons per minute [gpm] or less) (Allwyn, 2009).

The basin-fill sediments along the Santa Cruz River form three aquifers (listed in ascending order): the Nogales Formation, the Older Alluvium, and the Younger Alluvium. These three aquifers are shared between the U.S. and Mexico. Both alluvial units are generally unconfined, hydraulically connected, and yield water to wells. The Younger Alluvium ranging in depth from 40 to 150 feet is present along the river and some of its tributaries. According to the Arizona Department of Water Resources (ADWR), this aquifer is the most productive and widely used in the region providing about 75 percent of the total water in the Santa Cruz AMA, with some wells yielding more than 1,000 gpm (Allwyn, 2009).

Although the Older Alluvium aquifer (ranging from a few meters to about 1,000 feet bgs is the most extensive geologic unit within the Santa Cruz AMA, its transmissivity is generally low and well yields are often small. The Nogales Formation, at least 5,000 feet thick is not generally considered an aquifer, since groundwater occurs primarily in fracture zones and unconsolidated layers within the formation (average yields are less than 30 gpm) (Allwyn, 2009C).

The highly seasonal nature of surface water flow, the high transmissivity of the Younger Alluvium and the discharge of effluent from the Nogales International Wastewater Treatment Plant complicate the analysis of water level change. According to the Arizona Department of Water Resources, the water level elevations (elevation of the water table amsl) range from 3,000 to 4,000 feet in the Santa Cruz AMA. The Santa Cruz River serves as a major source of recharge for the Younger Alluvium by seasonal methods: mountain front recharge, irrigation seepage, effluent discharge, and natural surface water flow (Allwyn, 2009C).

Local water table levels fluctuate with variations in weather patterns, water withdrawals within the project area Santa Cruz River basin (in Mexico and the U.S.), and incidental recharge from agricultural irrigation and Nogales International Wastewater Treatment discharge. The shallow depth of the basin’s aquifers and the high transmissivity of the alluvium make many portions responsive to precipitation events and susceptible to droughts (Allwyn, 2009C).

Site Groundwater

Based on the information provided in a well driller report from a well located within close proximity to the site (ADWR Well No.55-636229), the local groundwater is located approximately 135 feet bgs in this well which is cased to 420 feet bgs. No perched water appears to exist in the area as no intermittent clay layers were noted. Based on site topography, the groundwater flow in the vicinity of the subject property is likely to the north to northeast.

1.3.3.8 Prehistoric and Historic Cultural Resources

There are no identified prehistoric or historic cultural resources within the immediate vicinity of the USBP firing range property.

1.4 SITE HISTORY

The region encompassing the City of Nogales, including the USBP firing range, has been a significant link between the Arizona and Sonora regions since before European occupation in the 16th century. The Nogales area was utilized as Native American trade route in prehistory, and was known as the "Camino Real". The area was later used as a Spanish trade route. Following the U.S. acquisition of the area in the 1852 Gadsden Purchase, the area became an important link between Mexico and the Arizona Territory. The City of Nogales, including the study area, was the site of a confrontation between the U.S. Army and the Mexican nationalist Pancho Villa in the mid-1910s (City of Nogales, 2011).

Camp Little, a U.S. military base, was established on 26 November 1910 to protect U .S interests at the border. Camp Little was a training and staging facility during World War I. Improvements to the site were made during 1910 to 1933 when the camp was under DOD controls. More than 100 buildings, including streets, sewers, utilities, hospitals, shops, stables and a theater were constructed during DOD tenancy. The site was declared surplus on 1 January 1933. The improvements to the land were offered for sale to the original land owners and it is believed that the owners bought them. The land owners then leased their land with improvements to the State of Arizona. Today, the site is mostly residential with two local government buildings, a school, a grocery store, two restaurants, farm land and commercial buildings. The former Camp Little is located approximately two and one half miles northwest of the USBP firing range.

An aerial photograph review conducted by Allwyn Environmental, LLC in a 2009 Phase I ESA of a property adjacent to the study area revealed that the USBP firing range structures present at the study area were constructed in 1992, and that no previous development had occurred at the site. The areas immediately surrounding the study area have never been developed. The study area property was used as a shooting range and target practice facility for the U.S. Border Patrol after 1992. The property is currently idle. It has not been determined when the site ceased to be used as a shooting range. The current property owner, Mr. Arbo, still leases the property to the USBP. The chain of property ownership for this site has not been determined and was not under the scope of this RI. (Allwyn Environmental, 2009B)

1.5 PREVIOUS INVESTIGATIONS

1.5.1 2009 Phase I ESA Parcel 113-49-006

This report presents the findings of the Phase I ESA performed in March 2009 on the La Loma Grande Property (currently the Garcia property) located adjacent to the Barr property in the Mariposa Canyon area of Nogales, Arizona. This property is northwest of the USBP firing range (Figure 2). The entire property consists of one parcel (113-49-006) and covers approximately 66.84 acres. The subject property has its center located at latitude of approximately 31.347952 North and longitude of approximately 110.973038 West.

The Phase I ESA was completed for Santa Cruz County to document known environmental risks and conditions associated with the property. The Phase I ESA was completed in accordance with the requirements of the *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Proces*s (American Society of Testing and Materials [ASTM] Designation: E1527-05). The objective of the Phase I ESA was to identify RECs at the property (Allwyn, 2009A).

This assessment revealed evidence of the following recognized environmental conditions (RECs) in connection with the property (Allwyn, 2009A):

- Large quantities of bullet fragments were observed throughout the northeast portion of the subject property, which is located west of a practice shooting range used by the USBP.
- Bullet fragments varied in size and were found in large concentrations in the wash and hillside directly behind the shooting range.
- Bullet fragments were observed as far as 600 feet west of the shooting range.
- The bullet fragments would likely result in elevated concentrations of lead in the soil.

1.5.2 2009 Phase I ESA Parcel 113-49-027

This report presents the findings of the March 2009 Phase I ESA performed on the Barr Property adjacent to the USBP firing range in the Mariposa Canyon area of Nogales, Arizona. This property adjoins the USBP firing range on the northwest and south (Figure 2).

The Phase I ESA was completed for Santa Cruz County to document known environmental risks and conditions associated with the property. The Phase I ESA was completed in accordance with the requirements of the *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* (ASTM Designation: E1527-05). The objective of the Phase I ESA was to identify RECs at the property. Allwyn Environmental performed historical research review, environmental records and databases evaluation, site reconnaissance, and interviews with persons knowledgeable with the site.

The subject property consists of the northern portion of one parcel (113-49-027) and covers approximately 41 acres. The subject property consists of rugged and hilly undeveloped native desert land, with evidence of vehicular traffic occurring on the subject property. There are no structures located on the subject property. However, there are two parcels that are entirely enclosed by the subject property. The first enclosed parcel (113-49-010B) is located in the northwest portion of the subject property and contains an automobile salvage yard and the USBP firing range study area. The automobile salvage yard appeared to encroach onto the subject property on the small narrow strip next to the northern boundary in the northwest portion of the subject property. The second enclosed parcel (113-49-029) is located near the western boundary and contains a cell tower owned by AT&T. In the northeast portion of the subject property on the northern boundary, the fence from the Swift Trucking Company facilities appeared to encroach onto the subject property. There are dirt roads located on the subject property.

1.5.3 2009 Phase II ESA Parcel Nos. 113-49-006 and 113-49-027

A Phase II ESA was completed in December 2009 for two parcels (Parcel Nos. 113-49-006 and 113-49-027) located immediately west and adjacent to the USBP firing range. Small arms target practice activities were suspected of impacting the two parcels, potentially resulting in elevated concentrations of lead, arsenic, antimony, and PAHs. The on-site assessment activities were conducted from October 19, 2009 through November 12, 2009. The assessment was conducted in accordance with a U.S. Environmental Protection Agency (USEPA)-approved Quality Assurance Project Plan (QAPP), dated July 2, 2009, and a site-specific Sampling and Analysis Plan (SAP), dated October 6, 2009 and approved by USEPA on November 5, 2009 (Allwyn, 2009C).

Soil samples from 51 of 135 sampling cells contained lead in a concentration above the Arizona Department of Environmental Quality (ADEQ) Residential SRL of 400 milligrams per kilogram (mg/kg) and, of these, 33 contained lead in a concentration above the non-residential SRL of 800 mg/kg. Subsurface soil samples from 28 sampling cells contained lead in a concentration above the residential SRL and, of these 28 sampling cells, 14 contained lead in a concentration above the non-residential SRL.

Soil samples from one of the 135 sampling cells contained antimony in a concentration above the residential SRL. Soil samples from two of the 135 sampling cells contained one PAH, benzo (a) pyrene, in a concentration above the residential SRL for the 10^{-6} excess lifetime cancer risk level.

The horizontal extent of lead impacts in the assessment area has been generally defined to the west of the shooting range, but has not been defined to the north and south of the shooting range. The vertical extent of lead impacts has not been defined. Antimony and PAHs, while present in soil samples above the residential SRLs in two and one sampling cells, respectively, are present only in cells in which lead is also present in soil samples in a concentration above the residential SRLs. Therefore; lead was considered the target COC for further assessment and/or remediation at the site.

The extent of lead impacts in the wash immediately behind the small arms shooting range was delineated. Lead is present at concentrations above the non-residential SRL in the wash soil extending between 250 and 300 feet and above residential SRLs between 450 and 500 feet northeast (downstream) of the small arms shooting range. Antimony, arsenic, and PAHs are not present in concentrations above the residential SRLs in samples collected from the wash. Therefore, lead was considered to be the target COC for further assessment and/or remediation in the wash.

Toxicity, Characteristic Leaching Potential (TCLP) analysis to evaluate the hazardous waste classification of on-site soil was performed on two samples containing lead above the non-residential SRL (2,200 mg/kg and 3,400 mg/kg) and one containing lead above the residential SRL (400 mg/kg). The samples collected for the hazardous waste classification demonstrated that the unscreened material and material passing through a #8 sieve would be classified as a hazardous waste based on lead toxicity (0008 waste code). In addition, one sample collected from material passing through a #50 sieve (WD-S) also demonstrated the hazardous waste characteristic for lead following TCLP analysis.

This assessment revealed evidence of the two following RECs in connection with the property:

- Bullet fragments were observed on the subject property (parcel no. 113-49-006), in the vicinity of the USBP firing range in the northwest portion of the subject property.

- Bullet fragments varied in size and were found in large concentrations in the wash and hillside directly behind the shooting range on subject property parcel no. 113-49-027. The bullet fragments likely result in elevated concentrations of lead in the soil. Further assessment of the soil through soil sample collection and analysis, and/or alternate means (e.g. X-ray fluorescence) should be conducted to evaluate the extent and magnitude of potential lead impact of the soil.

There is an automobile salvage yard (parcel no. 113-49-010B) that is enclosed within the northwest portion of the subject property (parcel no. 113-49-027) and encroaches onto the subject property. The position of the wash and local topography on parcel no. 113-49-027) indicates that storm water, potentially containing petroleum hydrocarbons and metals, could run on and through the subject property from the automobile salvage yard. This report states that one of the focuses of further investigations for parcel no. 113-49-027 should be on the migratory pathways from parcel no. 113-49-010B that are most likely to represent significant sources of COCs for parcel no. 113-49-027 (Figure 2).

2.0 PROJECT REMEDIAL MODEL, SETTING AND RESPONSE

2.1 CONCEPTUAL FATE, TRANSPORT, AND EXPOSURE MODEL

A CFTE site model is a description of the site, its environment, and the nature and extent of the COCs at the site, based on existing knowledge. The CFTE site model describes sources of chemical COCs, mechanisms of release and migration, actual and potentially complete or incomplete exposure pathways, overall migration of released materials, current or reasonably anticipated land use, and potential site receptors. The scope and focus of the investigation of the nature and extent of COCs at the site, specifically with respect to shallow soils, was determined by the fate and transport of spent ammunition and targets associated with past site activities. The CFTE site model is based on two dependant components:

1) COC fate and transport principles related to the constituents' ability to be degraded or migrate in the environment, and stabilization, solidification, abiotic and/or biological degradation, advection, diffusion and dispersion of materials in the environment.

2) An assessment of potential exposure pathways to evaluate the potential impacts of released materials on human and ecological receptors.

The potential contact of human and ecological receptors to released materials in environmental media is evaluated in the context of the physical fate and transport of sources and the presence of receptors at various exposure points or areas. The exposure assessment identifies the preliminary receptors, exposure media, exposure routes, and exposure points/areas that require further evaluation in a risk assessment.

The fate, transport and exposure assessment follows current USEPA guidance for sampling and risk analysis (USEPA, 2000, 2003). This guidance focuses the investigation on receptors and exposure pathways to be affected from significant sources of COCs.

2.1.1 Facility Profile

The USBP firing range facility and the surrounding industrial, commercial and recreational facilities; parks and roads in the vicinity of the firing range are presented in Figure 1 and 2. The USBP leased property was actively used as a USBP practice firing range from 1992 to 2011 and is currently idle.

2.1.2 Physical Profile

The topography of the USBP firing range site is essentially flat. The topography of the surrounding property is generally rugged and hilly. The elevation at the USBP firing range ranges from approximately 3,960 to 3,970 feet amsl. Several arroyos separate steep hills and ridges present throughout this area. These arroyos, including an unnamed arroyo bordering the site to the northwest, drain to the northeast.

Soil thickness exceeds 1,000 feet with less than five percent moisture content. Site surface soils mainly consist of relatively transmissive sands and sandy loams. The USBP firing range is mostly non-vegetated; however surrounding areas are mostly covered with vegetation representative of desert grassland.

2.1.3 Constituents of Concern Source Release Profile

The discharge of small arms at the range over time released amounts of regular and irregular shaped lead alloy particles of bullets and shot gun pellets to the surface areas of the range and at various depths into the earthen entrapment berm. Shot gun waddings were released to the surface area of the USBP firing range as a result of the discharging of shot guns.

2.1.4 Land Use and Exposure Profile

According to the 2006 Census, the population of the city of Nogales was 21,017. The USBP firing range encompasses approximately one-half acre of shooting range property and empty rangeland. The property has been previously used as a USBP small arms firing range. This activity has since ceased. The property is currently idle. There are no major thoroughfares in the vicinity of the site.

The USBP firing range property is unfenced, although there is a locked gate on the main road to the site. There is no signage at the site to indicate property boundaries or to ward off trespassers. It is possible for cattle and other livestock from surrounding properties to enter the site.

The only persons with access to the USBP firing range are the USBP staff and the property owners. A potential does exist for trespassers to enter the area. Additionally, fire fighting personnel and equipment may be required to enter the site to suppress brush fires.

There are currently no known plans to redevelop the firing range.

There is currently no residential land use immediately adjacent to, or located within, the USBP firing range.

2.1.5 Ecological Profile

The USBP firing range is situated within the Arizona Upland region of the Sonora Desert. This area is characterized by high elevation and rugged terrain, containing diverse habitats for a variety of desert and mountain-dwelling species. The site is located within a valley of the Arizona Upland region. The acreage surrounding the site contains multiple arroyos which serve as dry riparian habitats. Because the USBP firing range property is unfenced, it is possible that local wildlife (including endangered species) from these habitats could enter the site. There are no known sensitive or threatened habitat areas in close proximity to the USBP firing range. (Arizona-Sonora Desert Museum, 2011)

2.1.6 Migration Pathways and Mechanisms

Groundwater beneath the USBP firing range flows in a north to northeasterly direction (Allwyn, 2009C). Based on the topography of surrounding land it is assumed groundwater flow mimics the general direction of the topographic gradient. Surface water flows at the site result from storm water runoff into arroyos. Historical firing range practices that could have potentially resulted in COC impacts to the groundwater would have infiltrated along a path through regolith and bedrock discharging to groundwater. Historical analytical data indicate that some of the COCs were deposited onto or sorbed to the surface and subsurface soils at various random locations.

Based on the low amount of precipitation and the desert climate, saltation by wind and water are the major transport mechanism for COCs and soil particles. The rugged terrain surrounding the site would cause multidirectional migration of both intermittent wind borne and water borne particles and dissolved material causing a random depositional pattern.

Current migration pathways are similar to historical ones. The cessation of firing range activity at the site may reduce migration of COCs as the site is not disturbed thus providing fewer loose particles for wind and storm water migration

2.2 PROJECT APPROACH

Based on the Conceptual Fate, Transport, Exposure model, and evaluation of available data, the TPMC project team developed the project approach presented in this section. The TPMC project team's objective for this RI/FS was to perform a comprehensive review of existing data and implement a sampling methodology involving subsurface soil sampling to collect sufficient data to conduct a thorough evaluation of remedial alternatives. The RI/FS Work Plan (TPMC, 2011) was prepared to address data gaps regarding site conditions, and collect and evaluate sufficient data necessary to confirm the presence or absence of COCs in site soils. The RI/FS Work Plan also contains methodology for performance of composite and discrete sampling of subsurface soils in order to collect the required data. Soil sampling field activities were conducted from 26 September to 5 October, 2011. The approach for soil sampling at the USBP firing range is detailed below.

The RI/FS project field activities consisted of sampling and analysis of subsurface site soils. Soil samples were analyzed to confirm the presence or absence, concentration, and horizontal and vertical extent of the following COCs: lead, arsenic, and antimony. PAHs samples were taken only to a depth of 12 inches bgs based on previous work sampling and analysis and no penetration of source material for PAHs. Soil samples that exceeded TCLP toxicity characteristic for lead by twenty times were selected for TCLP analysis. The sample analysis results are presented in Section 3.

Both discrete and composite soil samples were collected at the USBP firing range. Twenty two discrete "grab" samples were collected within the USBP firing range at locations determined by the Field Manager on the basis of visual evidence of soil contamination (bullet fragments, shotgun wadding, unusual soil characteristics, sediment accumulation from contaminated areas, etc.). Composite soil samples were collected from within sampling grids established by TPMC at the USBP firing range. The USBP firing range was divided into sixteen 50 foot by 50 foot sampling grids. Each grid was divided into four 25 foot by 25 foot sub-grids. A sample was collected in each sub-grid at a location of visual evidence of soil contamination, and subsequently combined with samples from the other sub-grids within the parent grid to form the composite sample. Soil sample locations are presented in Figure 3.

One shallow and one deep subsurface soil sample was collected at each sampling location. Shallow subsurface soil samples were collected from 0 to 12 inches bgs using a disposable plastic scoop. Deep subsurface soil samples were collected at the shallowest depth below 12 inches bgs at which an X-Ray Fluorescence (XRF) sensing instrument did not register a value for lead, arsenic, and/or antimony that was above the USEPA Region 9 Residential Regional Screening Levels (RSLs). These samples did not exceed a depth of 48 inches bgs. Subsurface soil samples were collected using a decontaminated hand auger or spud bar. All soil samples were passed through a number 8 and number 50 sieve prior to packaging and shipment to retain only the fine soil fraction.

2.3 PRELIMINARY REMEDIATION GOALS

Preliminary Remediation Goals (PRGs) is a term used to describe a project team's early and evolving identification of possible remedial goals. For the USBP firing range RI/FS PRGs are based on USEPA residential RSLs (USEPA, 2011) and ADEQ SRLs. The PRGs are used to determine whether levels of contamination found at the site may warrant further investigation or site cleanup, or whether no further investigation or action may be required. For this project, the residential exposure scenario is assumed for the USBP firing range, which represents the most stringent and protective PRGs.

The USEPA RSL and ADEQ SRLs presented in Table 1 are chemical-specific concentrations for individual COCs associated with soil. It should be emphasized that USEPA RSLs are used as preliminary cleanup standards. Screening levels should not be used as cleanup levels for a CERCLA site until the other remedy selections identified in the relevant portions of the National Contingency Plan (NCP) (NCP, 40 Code of Federal Regulations [CFR] Part 300) have been evaluated and considered.

2.4 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d)(l) of CERCLA states that Remedial Action (RA) on CERCLA sites must attain (or the decision document must justify the waiver of) Applicable or Relevant and Appropriate Requirements (ARARs), which include environmental regulations, standards, criteria, or limitations promulgated under federal or more stringent state laws. An ARAR may be either applicable or relevant and appropriate, but not both. The NCP (40 CFR Section 300.5) definition of applicable or relevant and appropriate is presented below:

> *Applicable requirements mean those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, COC, remedial action, location, or other circumstance found at a CERCLA site. Relevant and appropriate requirements mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, COC, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.*

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be: 1) a standard, requirement, criterion, or limitation under a state environmental or facility siting law; 2) promulgated (of general applicability and legally enforceable); 3) substantive (not procedural or administrative); 4) more stringent than the federal requirement; 5) identified by the state in a timely manner; and 6) consistently applied.

ARAR identification considers a number of site-specific factors including potential Remedial Action (RA), compounds at the site, physical characteristics, and the site location. ARARs are usually divided into three categories: chemical-specific, location-specific, and action-specific.

USEPA guidance (USEPA, 1988a) recommends that the lead federal agency consult with the applicable state when identifying state ARARs for RAs. CERCLA and NCP requirements (40 CFR Section 300.515) for RAs specify that the lead federal agency will request that the state identify chemical-and location-specific state ARARs after completion of site characterization. The requirements also specify that the lead federal agency request identification of all categories of state ARARs (chemical-, location-, and action-specific) upon completion of identification of remedial alternatives for detailed analysis.

This section addresses potential ARARs for CERCLA hazardous substances.

2.4.1 Potential Chemical-Specific ARARs

Chemical-specific ARARs are health- or risk-based numerical values or methodologies. These values are protective of human health and the environment, and establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment. For the USBP firing range site the potential media of concern is soil. Lead, antimony, arsenic and PAH contamination was detected above ADEQ Residential SRLs and USEPA Residential RSLs for soil, indicating a chemical hazard to human health or the environment exists at the USBP firing range. The ADEQ residential SRLs and USEPA residential RSLs for soil have been selected for the preliminary cleanup levels for chemical COCs at the site and are shown in the following table:

Preliminary Site Cleanup Levels

Constituent	Arizona SRLs		USEPA RSLs		Units
	Residential ASRL (1)	Non-Residential ASRL (1)	Residential RSL	Industrial RSL	
Inorganics					
Antimony	31	410	31	410	mg/kg
Arsenic	10	10	0.39	1.6	mg/kg
Lead	400	800	400	800	mg/kg
Poly-Aromatic Hydrocarbons					
Benzo(a)anthracene	0.69	21	0.15	2.1	mg/kg
Benzo(a)pyrene	0.069	2.1	0.015	0.21	mg/kg
Benzo(b)fluoranthene	0.69	21	0.15	0.21	mg/kg
Benzo(g,h,i)perylene	NA	NA	NA	NA	mg/kg
Benzo(k)fluoranthene	6.9	210	1.5	21	mg/kg
Chrysene	68	2,000	15	210	mg/kg
Fluoranthene	2,300	22,000	2,300	22,000	mg/kg

SRL = Arizona soil remediation levels
RSL = USEPA regional screening levels

Groundwater and surface water were removed from consideration in the RI planning phase as potential chemical exposure pathways because there was no indication of lead, arsenic, antimony or PAH contamination of these media from USBP activities. Also, based upon evidence from climate, site geology, and depth to groundwater, vertical solution migratory pathways were seen as incomplete pathways to groundwater.

2.4.2 Potential Location-Specific ARARs

Location-specific ARARs govern activities in certain environmentally sensitive areas. These requirements are triggered by the particular location and the proposed remedial activity at a site. No potential location-specific ARARs have been indentified for the USBP firing range

2.4.3 Potential Action-Specific ARARs

Action-specific ARARs are restrictions that define acceptable treatment and disposal procedures for hazardous substances. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on remedial measures. The following potential action-specific ARARs have been identified for the USBP firing range:

- CFR - 40 CFR 262, Standards Applicable to Generators of Hazardous Waste,
- 40 CFR 266, Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities.
- 40 CFR 262 and 266 requirements for waste generators to consider if any contaminated soils are generated during remediation that require disposal.

2.5 DATA NEEDS AND DATA QUALITY OBJECTIVES

The data and information derived from previous investigations presented in Section 1.5 was used to conduct a data evaluation. The data evaluation presented in this section documents data gaps and specific data needs established for the project to obtain representative data of sufficient quality to support the Human Health Assessment (HHA) and Ecological Risk Assessment (ERA), to provide a basis for the RAOs, and to evaluate a focused set of remedial alternatives for the USBP firing range.

The following subsections discuss the procedures used to evaluate data from previous investigations and assess data needs of the RI.

2.5.1 Data Needs Evaluation Methodology

This section presents the methodology used to evaluate COC data for the USBP firing range RI. The objective was to determine if sufficient data was available to characterize the nature and extent of COCs, and support the evaluation of RAs in the FS. The nature and extent of COCs in site soils were evaluated based on data collected during the 2009 Phase II ESA (Allwyn, 2009C).

Firing range operations resulted in the accumulation of spent small-arms ammunition, shotgun wadding, fragments of clay pigeon targets and other small arms-related solid waste on the ground surface. The Interstate Technology and Regulatory Council (ITRC) *Classification and Remediation of Soils and Closed Small Arms Firing Ranges* guidance document (ITRC, 2003) states that “Small arms ranges may contain lead, antimony, copper, zinc, arsenic, and PAHs that may leach from bullets and fragments, bullet jackets, and related sporting material (e.g. clay targets)”. Lead, antimony, arsenic, and PAHs are regulated under the Resource Conservation and Recovery Act (RCRA) and CERCLA, and therefore are considered to be Constituents of Potential Concern (COPCs).

Sixteen discrete surface soil samples, 135 composite surface soil samples, and 135 composite subsurface soil samples were collected on the adjacent Parcel Numbers 113-49-006 and 113-49-027 (west of the firing range) and analyzed for lead, arsenic, and antimony. Thirty one composite surface soil samples and thirty one composite subsurface soil samples were also collected from the same parcels and were analyzed for PAHs. Lead, antimony and PAHs were detected in soil samples from the Phase II ESA study area in concentrations exceeding USEPA residential RSLs. The project team determined that none of the soils sampled and analyzed in the Phase II ESA were taken on the USBP firing range and that no soil samples were taken below 6 inches bgs. This requires that on-site sampling and analysis of the USBP firing range site was necessary. The project team identified these as the data gaps.

2.5.2 Data Quality Objectives Reconciliation

DQOs are qualitative and quantitative statements that specify the quality of data required to support decisions. DQOs are developed and implemented to achieve a level of data quality required to meet project goals, and are both legally and scientifically defensible. Development of DQOs for a specific site must consider project needs, types of data, data uses, and data collection. These factors determine whether the quality and quantity of data are adequate for their end use. TPMC followed USEPA *Guidance on Systematic Planning using the Data Quality Objectives Process* (USEPA, 2006). The DQOs developed for COC sampling are presented in the QAPP (TPMC, 2011). Data types applicable to project DQOs include Global Positioning System (GPS) sample location, and soil sample laboratory analytical results. Reconciliation of GPS data to project DQOs was accomplished by proper use, maintenance, and calibration procedures as evidenced in the project field notebooks (Appendix 3). Reconciliation of soil sample analytical results to chemical-specific DQOs is presented in Table 1.

3.0 NATURE AND EXTENT OF CONSTITUENTS OF CONCERN

This section presents a summary of COC characterization performed at the USBP firing range during the RI, details the extent of COCs, and provides a revised CFTE site model. This information has been verified by project QA procedures, and may be utilized to evaluate possible RAs.

A total of sixty soil samples were collected at the USBP firing range in Nogales, Arizona. Thirty eight soil samples (sixteen composite samples and twenty two discrete 'grab' samples) were collected from 0-12 inches bgs. Twenty two soil samples (sixteen composite samples and six 'grab' discrete samples) were collected at a depth below 12 inches bgs where the XRF instrument reading did not exceed USEPA Residential RSLs for antimony, arsenic, and lead. All sixty soil samples were analyzed for the presence of antimony, arsenic, and lead. Ten surface soil samples were analyzed for the presence of PAHs.

Soil sample locations are provided in Figure 3. Shallow and deep soil sample analytical results are provided in Figures 4 through 11 and Tables 2 through 4, and are summarized in the paragraphs below.

Arsenic

Sixty out of sixty soil samples contained concentrations of arsenic above the USEPA residential RSL of 0.39 mg/kg. Arsenic concentrations ranged from 4.4 mg/kg (composite sample BPN-14D14, central firing range) to 22.8 mg/kg (composite sample BPN-13S, west central firing range, east side of backstop berm). However, it should be noted that in the 2009 Phase II ESA of Parcel Numbers 113-49-006 and 113-49-027, Allwyn Environmental collected five background samples north of the USBP firing range (outside of the USBP firing range area), each of which contained arsenic concentrations that exceeded the USEPA industrial RSL 410 of mg/kg. Additionally, the USBP firing range property is located within an area that contains sediments and soils primarily derived from volcanic rocks. Shacklette and Boerngen, 1984 sampled soils derived from volcanic rocks in northern New Mexico which contained naturally-occurring levels of arsenic ranging from10 mg/kg to 40 mg/kg. Arsenic is therefore not considered a prominent COC for the USBP firing range because it has been demonstrated that the concentrations of arsenic in site soils are consistent with naturally occurring levels of arsenic for the area.

Lead

Fifty out of sixty soil samples contained concentrations of lead above the USEPA residential RSL of 400 mg/kg. Forty six out of sixty soil samples contained concentrations of lead above the USEPA industrial RSL of 800 mg/kg (Figures 4 and 8). The highest concentration of lead was detected in a discrete 'grab' sample BPG-3S (southwest firing range, on eastern slope of backstop berm) at 49,300 mg/kg.

Antimony

Twenty seven out of sixty soil samples contained concentrations of antimony above the USEPA residential RSL of 31 mg/kg. Four out of sixty soil samples contained concentrations of antimony above the USEPA Industrial RSL of 410 mg/kg. The highest concentrations of antimony were detected in the soil samples BPN-13S (composite, west part of the firing range on the east slope of backstop berm) and BPG-3S (discrete 'grab', southwest part of the firing range on the east slope of backstop berm) at 454 mg/kg.

Polynuclear Aromatic Hydrocarbons

PAH compounds were detected in six of the nine shallow composite soil samples and in one discrete shallow 'grab' soil sample (BPG-20S) analyzed for PAHs. Five composite soil samples and the discrete 'grab' soil sample contained concentrations exceeding their respective USEPA residential RSLs for at least one of the following PAH compounds: benzo (a) anthracene, benzo (a) pyrene, and benzo (b) fluoranthene. Benzo (g, h, i) perylene, a PAH which does not currently have a designated RSL or ADEQ SRL, was detected in one composite surface soil sample and in the discrete 'grab' soil sample.

Toxicity Characteristic Leaching Potential

Five soil samples were analyzed by TCLP arsenic and lead. Each TCLP lead sample result was above the laboratory Limit of Quantitation (LOQ), and ranged from 3.4 milligrams per liter (mg/L) to 1,930 mg/L. Four of the five samples contained concentrations of lead above the USEPA TCLP toxicity characteristic concentration of 5 mg/L. Soil sample BPG-3S was the only TCLP sample that yielded a concentration of Arsenic above the LOQ, at a concentration of 0.25 mg/L.

3.1 SOURCES

The COC sources at the site are related to firing range operations. The primary source for COCs is the presence of abandoned bullets, bullet fragments buried and on the surface. Surface sources of PAHs are plastic shotgun wadding, and fragments of clay pigeon targets littering the ground surface at the USBP firing range. These source materials were also present in soil samples collected from the firing range soils prior to sieving. The number of spent ammunition and shooting target-related source material items extracted from USBP firing range soil samples during sieving is provided in Table 5. The bullets and bullet fragments present on the ground surface have contributed particles of lead, antimony, and arsenic to site soils as they have weathered over time. Similarly, the PAH compounds present in site soils are a result of the gradual degradation of the plastic shotgun wadding and clay pigeon targets littering the ground surface (USEPA, 2003).

Secondary sources of COCs at the USBP firing range are areas of the firing range that have been reworked by earth moving equipment and storm water runoff. The earthwork bullet trap berm and parking lot areas have been reworked moving the initial COCs to different locations, vertically and horizontally in terms of the surface and subsurface.

Site sediments have migrated along the storm water pathway in a northeast direction from the USBP firing range.

3.2 VADOSE ZONE AND PHREATIC ZONE

Vadose Zone

The vadose zone is defined as the layer of regolith and/or bedrock between ground surface and the upper limit of the phreatic zone (the confined or unconfined water table). Based on the information provided in a well driller report from a well located within close proximity to the site (ADWR Well No.55-636229), and regional groundwater levels, groundwater is located approximately 40 to 135 feet bgs. The RI characterized vadose zone soils in two intervals, vadose zone soils from 0-12 inches bgs (shallow), and vadose zone soils from 12 to 42 inches bgs (deep).

Arsenic, lead, and antimony have been detected in shallow vadose zone soils above USEPA residential RSLs. The PAH compounds benzo (a) anthracene, benzo (b) fluoranthene, and benzo (a) pyrene have also been detected in surface vadose zone soils above USEPA residential RSLs. PAHs were not analyzed from the deep vadose zone soil (> 12 inches) based on previous studies on adjacent properties showing no PAHs below 3 to 4 inches bgs and only two surface samples out of 135 samples showing PAHs above USEPA residential RSLs..

The horizontal extent of COCs in vadose zone soils includes the whole firing range area with the exception of northwestern grid square N-4 outside of the firing range (Figure 4). Generally, the highest concentrations of COCs are found in the southwestern portion of the USBP firing range, along the southern half of the backstop berm (Figures 4-13, Table 2). Elevated concentrations of lead were also identified near debris piles at the southeastern corner of the firing range (8,480 mg/kg 0-2 inches bgs and 4,120 mg/kg at 30 inches bgs in the composite soil sample from grid N-59) (Figure 4).

The vertical extent of COCs in the vadose zone soils was found to be less than 42 inches bgs in all but one sample. The deepest vadose zone soil sample, sample BPG-22 at 42 inches bgs, in the southwest back stop berm (Figure 8) contained a concentration of lead sixty two times greater than the USEPA residential RSL and 31 times greater that the USEPA industrial RSL, as well as concentrations of arsenic and antimony above USEPA residential RSLs. However, seven out of the sixteen total subsurface composite samples (to a maximum depth of 30 inches bgs) did not contain concentrations of lead or antimony above their respective USEPA residential RSLs. The vertical extent of COCs within the vadose zone soils is presented in Figures 4 through 13 and Table 3.

These results have been determined to be reliable and usable. Analytical results of QA/QC rinsate samples demonstrating that cross-contamination did not occur during sample collection are provided in Table 6.

Phreatic Zone

The phreatic zone is defined as the saturated area of regolith and bedrock below the water table or confined saturated zone. The groundwater beneath the firing range was not sampled and analyzed for the firing range COCs based on the referenced depth to groundwater, 40 to 135 feet bgs, the low rainfall (less than 18 inches per year) the high evapotransporation and evaporation rate and the low solubility of the firing range COCs. Based on these physical and chemical conditions characterization of migration of site constituents to groundwater was not considered to be a relevant migration pathway for this RI.

3.3 REVISED CONCEPTUAL FATE, TRANSPORT, AND EXPOSURE MODEL

Based on the findings of the RI, the CFTE site model for the USBP firing range has been revised to incorporate new data regarding the nature and extent of contamination. The revised CFTE site model describes sources of chemical contamination, mechanisms of release and migration, actual and potentially complete or incomplete exposure pathways, overall migration of released materials, current or reasonably anticipated land use, and potential site receptors. The revised CFTE site model is based on two dependant components:

1) COC fate and transport principles related to the constituents' ability to be degraded or migrate in the environment, and stabilization, solidification, abiotic and/or biological degradation, advection, diffusion and dispersion of materials in the environment.

2) An assessment of potential exposure pathways to evaluate the potential impacts of released materials on human and ecological receptors.

The potential contact of human and ecological receptors to released materials in environmental media is evaluated in the context of the physical fate and transport of sources and the presence of receptors at various exposure points or areas. The exposure assessment identifies the preliminary receptors, exposure media, exposure routes, and exposure points/areas that require further evaluation in a risk assessment. The revised site conceptual model is presented in Section 4.

The fate, transport and exposure assessment follows current USEPA guidance for sampling and risk analysis (USEPA, 2000, 2003). This guidance is applied to focus the investigation on receptors and exposure pathways that are most likely to represent potentially significant sources of COCs.

3.3.1 Facility Profile

The facility profile characterization has not been affected by RI findings.

3.3.2 Physical Profile

The physical profile characterization has not been affected by RI findings.

3.3.3 Constituents of Concern Release Profile

The discharge of small arms at the range over time deposited amounts of regular and irregular shaped lead alloy particles of bullets and shot gun pellets on to the surface and into the subsurface of the firing range and at various depths into the back stop berm. Plastic wadding and fragments of clay pigeon target debris were deposited on the surface and in the subsurface of the USBP firing range as a result of the discharging of shot guns. The presence of these items on the ground surface and in the subsurface has been confirmed by RI findings. Photographs of these items exposed on the ground surface are provided in Appendix 4. Bullets, bullet fragments, shot gun pellets, and shotgun plastic wadding and fragments of clay pigeon target debris have been identified in the RI as being the source of COCs detected in site soils.

3.3.4 Constituents of Concern Source Origins

Historical and RI analytical data indicate that COCs were deposited onto the surface or sorbed to the soils throughout the USBP firing range study area. Based on the low amount of precipitation and the desert climate, saltation by wind and water is the major transport mechanism for COCs and regolith particles. The rugged terrain surrounding the site would cause multidirectional migration of both intermittent wind borne and water borne particles and dissolved material causing an inconsistent depositional pattern.

The TCLP analysis indicates the potential for lead to leach from site surface soils into the subsurface and surface runoff waters during seasonal heavy rain events. Leaching of COCs is considered to be limited based on the chemical and physical properties of the COCs and the known climate and hydrologic conditions at the firing range site. If COCs were to leach into the soils and/or runoff waters and remain in solution for a significant amount of time, the COCs may reach surface drainages (arroyos) and groundwater (dependant on actual site depth to groundwater).

3.3.5 Land Use and Exposure Profile

The land use and exposure profile characterization has not been affected by RI findings. Potential receptors identified in Section 2.1.4 have been evaluated in the Human Health Risk Assessment provided in Section 5.1.

3.3.6 Ecological Profile

The ecological profile characterization has not been affected by RI findings. Potential ecological receptors identified in Section 2.1.5 have been evaluated in the ERA provided in Section 5.2.

4.0 CONSTITUENTS OF CONCERN FATE AND TRANSPORT

The RI has determined that COCs are present in surface and subsurface soils at the USBP firing range at concentrations above regulatory screening levels. The fate of COCs in USBP firing range soils is affected by geological, meteorological, and human factors which are anticipated to remain relatively constant. COCs that have been determined to be present in the USBP firing range vadose zone soils include lead, antimony, and PAHs. Arsenic is not being considered as a COC for determination of COC fate and transport because concentrations of arsenic detected in firing range soil samples are within the range of naturally occurring concentrations.

The following subsections provide the analysis of potential routes of migration for USBP firing range COCs and detail the persistence and active migration of these COCs. The information presented in these sections has been obtained by research of Agency for Toxic Substances and Disease Registry Toxicological Profiles for lead, antimony, and PAHs; as well as scientific publications regarding fate and transport of firing range COCs. Lead and antimony present in the fine fraction of USBP firing range vadose zone soils will gradually oxidize, and may be subject to on-site and off-site transport. PAHs present in vadose zone soils will eventually decompose by microbial degradation, and also may be subject to on-site and off-site transport.

4.1 POTENTIAL MECHANISMS OF MIGRATION

Aeolian (wind)Transport - USBP firing range COC particles originating from bullets, bullet fragments, clay pigeon targets and plastic shotgun wadding may be transported by wind. Migration would occur either down slope or along the prevailing wind direction. COCs would migrate by suspension or saltation, a specific type of particle transport by which a fluid removes loose material from the ground surface, carries the material, and deposits it back onto the surface at some distance from the previous position, and then repeats. Distance of transport may range from a few inches to many miles over the course of one day.

Mass Wasting - Mass wasting is the geomorphic process by which regolith, or rock moves down slope under the force of gravity. When the gravitational force acting on a slope exceeds its resisting force, slope failure (mass wasting) occurs. This form of transport is mainly relevant to the slopes of the backstop berm, which contains COCs that are subject to mass wasting, transporting these materials down slope. Mass wasting of such a feature may be expected to occur at a very slow rate. Mass wasting should be considered a primarily on-site form of COC migration.

Dissolution by Storm Runoff -The USBP firing range site experiences occasional, short periods of heavy precipitation during the late summer months capable of producing flash floods. Runoff resulting from heavy precipitation may produce dissolved COCs from spent small arms munitions. The amount of soluble COC metals in storm water depends upon the pH of the water and the dissolved salt content. The solubility of lead at pH>5.4 is 50 micrograms per liter (µg/L) in water of high salt content, and 200 µg/L in water with low salt content. These concentrations of lead exceed the USEPA Maximum Contaminant Level (MCL) of 15 µg/l. Solubility increases as pH decreases. Because pH of rainwater at the USBP firing range may be expected to be <5.4, lead and lead compounds may be considered to be soluble in storm water discharges. Antimony is not significantly soluble in water.

The PAH compounds benzo (a) anthracene, benzo (b) fluoranthene, and benzo (a) pyrene have low solubilities (10 µg/L, 2.3 µg/L, and 1.2 µg/L, respectively), which are soluble to concentrations above their respective USEPA screening levels. Because of their low solubility and high affinity for organic carbon, PAHs in aquatic systems are primarily found sorbed to particles that have either settled to the bottom or are suspended in the water column. Lead, lead compounds, and to a lesser degree PAHs, may be transported on-site or off-site by storm water discharges resulting from heavy precipitation. The distance of transport may range from a few meters to many miles.

Sediment Transport by Storm Runoff - COCs and source materials may be transported in arroyos as sediments by flashy runoff discharges following heavy precipitation. The COCs and source media would migrate by suspension and/or saltation. This form of migration could transport COCs downstream during rain events. Storm runoff sediment transport can result in off-site COC migration.

Leachate Transport - COC leachate traveling downward through the vadose zone has the potential of migrating COCs downward towards the phreatic zone. Leachate is any liquid that, in passing through matter, extracts solutes, suspended solids or any other component of the material through which it has passed. Firing range soil leachate may contain dissolved COCs. TCLP samples from the USBP firing range have demonstrated that lead has the potential for entering water at concentrations above the USEPA toxicity characteristic of 5 mg/L. There is no TCLP analysis for antimony and PAHs.

Once in solution, lead is likely to precipitate as less soluble lead compounds, absorb on to mineral or organic soil components, or be taken up by plants or other organisms that inhabit the soil. Antimony is not significantly soluble in water. Dissolved lead, lead compounds, and to a much lesser degree PAHs, may be transported downward by infiltrated water towards the groundwater; however, geologic conditions at the USBP firing range limit the migration of leachate to groundwater. The soil present in the vadose zone at the USBP firing range "acts like a large sponge to hold infiltrated water and percolation increases as soils get wetter until the point of saturation, which is rare in dry areas like Nogales, where the soil mantle has the first opportunity to intercept the precipitation and little to no groundwater recharge occurs" (USGS and ADEQ, 2002). Lead, lead compounds, and PAHs are able to migrate downward through the subsurface at very slow rates (a few millimeters to a few inches every year, depending on physical and chemical factors), and are unlikely to reach the phreatic zone at approximately (40 to 100 feet bgs. (Hardison, 2003)

Volatilization - PAH compounds have a limited potential to volatilize, transporting contamination from USBP firing range surface soils into the atmosphere. Once present in vapor form, PAHs may be transported hundreds of miles from the site by air currents.

However, volatilization is not an important migration mechanism for the PAH compounds detected in USBP firing range soils above USEPA residential RSLs. Volatilization is not expected to be a significant migration pathway for PAH contamination. Lead and antimony do not undergo volatilization and would not migrate into the atmosphere.

Biotic Uptake - Lead may be taken up in edible plants from the soil via the root system. The amount of lead in the total plant body correlates strongly with the concentration of lead in the soil. Biotic uptake is not a significant migration pathway for antimony and PAHs, as these COCs are not readily taken up by plant life. This mode of transport is primarily on-site. Animal life may ingest COCs present in plant tissues. An ERA, including an assessment of biotic uptake of COCs, in included in Section 5.

4.2 CONSTITUENTS OF CONCERN PERSISTENCE

COCs expected to persist in vadose zone soils at the USBP firing range can be segregated into two categories: elemental COCs and compound COCs. Lead and antimony are elemental COCs, meaning that concentrations of these COCs will neither decrease nor increase significantly with time, unless RA is performed or another release occurs. PAHs are compound COCs and, unlike elemental COCs, are subject to gradual degradation and formation of breakdown products.

Elemental lead present in site soils is anticipated to gradually oxidize, forming a variety of oxide and carbonate minerals including Anglesite ($PbSO_4$), Massicot and Litharge (PbO), Cerrusite ($PbCO_3$), and Hydrocerrusite [$Pb_3(CO_3)_2(OH)_2$]. Each of these minerals have low solubility, and therefore are unlikely to migrate, but are still of environmental concern to on-site receptors because of the negative health effects of high concentrations of lead even when present in compounds. Metallic lead is transformed to secondary lead minerals at rate of approximately 4.8% over a period of 20-25 years. (ATSDR, 2007; Cao et. al., 2003; Hardison, 2003)

Little is known about the behavior of antimony in soil during weathering. In aerobic surface soils, oxidation generally occurs. Weathered antimony would be expected to form oxide and carbonate minerals in USBP firing range soils. However, the fraction of antimony transformed to secondary minerals would be expected to make up only a small amount of the total antimony, leaving the majority of the antimony present in the elemental metallic form, for the foreseeable future. Antimony is not readily oxidized under neutral conditions. The rate of transformation of antimony to secondary antimony minerals has not been defined, but may be expected to occur at an extremely low rate. (ATSDR, 1992)

PAH compounds present in USBP firing range soils will degrade and break down over time by the process of aerobic biodegradation. Abiotic degradation is insignificant for PAHs containing four or more aromatic rings, which is the case for PAHs detected in USBP firing range soils above USEPA residential RSLs. Based on laboratory experimentation, the estimated half-lives of the COC PAHs in firing range soils are: benzo (a) anthracene, 162-261 days; benzo (b) fluoranthene, 211-294 days; benzo (a) pyrene, 229-309 days. Although the pathways of microbial degradation are well known for benzo (a) pyrene, degradation pathways for the other COC PAH compounds are largely unknown. Metabolism of PAHs by bacteria and eukaryotic microorganisms includes the formation of dihydrodiols and carboxylic acids. (ATSDR, 1992; Mrozik et al., 2004)

4.2.1 Physical Factors

Physical factors affecting COC persistence in USBP firing range vadose zone soils include temperature, precipitation, soil moisture content, and soil compaction. Weathering of lead and antimony, and biodegradation of PAHs, should correlate positively with higher temperatures, the presence of water, and aeration of firing range soils. The corrosion of lead is dependent on a water layer that forms on the metal surface, which acts as a medium for the diffusion of atmospheric gases (demonstrates the importance of aeration of site soils), which attack the metal surface and leads to the formation of secondary lead minerals and subsequent dissolution of lead into solution. This process should also apply to antimony, although antimony would generally be more resistant to corrosion and weathering. Bacteria responsible for biodegradation of PAH compounds are more active in environments with greater availability of water and oxygen. Nogales' climate is typically sunny and dry, with low relative humidity. Temperatures range from 27.3°F in January to a high of 95.3°F in June. The USBP firing range receives little rain or snow, averaging about 17.21 in of precipitation per year. Soil types present at the USBP firing range may be considered fairly aerated.

4.2.2 Chemical Factors

Chemical factors affecting COC persistence in USBP firing range vadose zone soils include:

Soil pH - The transformation of lead to lead carbonates is influenced by elevation in soil pH. As soil pH increases the amount of lead that is transformed is dramatically decreased. Although little is known about the weathering processes for antimony, it is likely that the same effect would occur for the formation of antimony carbonates, but that the effect would be less dramatic due to antimony's general resistance to weathering. The soil pH at the USBP firing range ranges from slightly acidic (pH 6) to slightly alkaline (pH 8) (USDA, 1979).

Availability of Carbonate - The greater availability of carbon dioxide (CO_2) and carbonate in soil allows for a more rapid transformation of lead and antimony into secondary carbonate minerals. The soil types present at the USBP firing range contain low amounts of carbonate (~1%)

Availability of Phosphorus - High availability of phosphorus in site soils with constituents of lead would allow for the formation of the secondary lead phosphate minerals. Lead phosphate minerals, in contrast to lead carbonates, sulfates, and oxides; are extremely insoluble and are not bioavailable. The soil types present at the USBP firing range contain little to no phosphorus.

Soil Organic Matter - The absence of soil organic matter impedes the transformation of metallic lead to massicot and lead carbonates. This is most likely due to the decreased availability of CO_2 as a result of the lack of organic matter. Microbial communities oxidize organic matter in soil, producing CO_2. As a result, CO_2 in soil air is often several hundred times more concentrated that what is typically found in the earth's atmosphere. Also, organic acids (such as formic and acetic acid) have been implicated in the accelerated corrosion of lead bullets in shooting range soils. In soil rich with humus the rate of lead transformation to secondary minerals is elevated to 15.6% within a 20-25 year span, compared to a rate of 4.8% in mineral soils over that same time period.

Concentration of Lead and Antimony in USBP Firing Range Soil - The rate of biodegradation of PAHs may be altered by the degree of lead and antimony contamination. Half-lives of PAHs may be longer in soils containing concentrations of lead and/or antimony that are toxic to degrading microorganisms. Reduced biodegradation of PAHs have been reported in soil containing a chemical toxic to microorganisms.

4.2.3 Biological Factors

Biological factors affecting contamination persistence in USBP firing range vadose zone soils include the prevalence of vegetation and PAH-degrading microorganisms. Antimony contamination persistence is not affected by biological factors. As described in Section 4.1, plants are able to take up lead into the plant tissues. Total uptake of lead into plant biomass is expected to correlate positively with the amount of plant biomass present at the residential USBP firing range.

The biodegradation of PAHs in USBP firing range soils is dependent upon the presence and prevalence of microorganisms capable of degrading PAHs. Common bacterial genera with species capable of degrading PAHs include *Arthrobacter, Bacillus, Burkholderia, Mycobacterium, Pasteurella, Psuedomonas, Rhodococcous, Staphylococcus, Sphingomonas, and Terrabacter*. (Seo et al., 2009)

4.3 CONSITUENTS OF CONCERN MIGRATION

Potential mechanisms of vadose zone soil COC migration at the USBP firing range are analyzed in Section 4.1. Of these, aeolian transport, sediment transport by storm water runoff, mass wasting, and leaching are considered to be the significant modes of COC migration. Site conditions at the USBP firing range relevant to these modes of COC migration indicate that COCs are actively migrating on-site and off-site (Figure 15).

Aeolian transport is considered to be the primary mode of COC migration at the USBP firing range. The property lacks significant vegetative cover, allowing for surface COC particles to become airborne and driven by winds. Aeolian transport of COC surface particles is further facilitated by the relatively sandy, low density nature of the soil types present at the surface. COCs are expected to migrate on-site and off-site by aeolian transport down slope and along the prevailing wind direction. Consequently, COCs should migrate to the north and to the northeast of the firing range. It is unclear if detections of COCs during the Phase II ESA of properties to the north of the firing range are a result of aeolian COC migration, shooting activities at these areas, or both.

COCs may also migrate by sediment transport from flashy storm water discharges produced by seasonal heavy precipitation. The property has been graded to a point that the topography represents a shallow bowl, with the exception of the backstop berm, and resides in a topographic low point relative to the surrounding landscape. Storm water discharges are anticipated to concentrate COCs at the low point of the bowl, resulting in a net on-site transport of COCs from the more heavily impacted backstop berm into the bowl depression of the firing range.

Off-site sediment transport migration along storm water pathways is likely to occur at the USBP firing range. An arroyo borders the USBP firing range along the western side, and directly abuts the backstop berm along its western slope. Flash flood conditions that regularly occur on a seasonal basis within this arroyo will erode the backstop berm along its western slope and release contaminated soils into the bed of the arroyo. Rudimentary erosion control materials (tires) are in place along the western slope of the backstop berm, but do not sufficiently mitigate the threat of release. Once present in the bed of the arroyo, COCs will be transported downstream along the bed of the arroyo by storm water discharges. The arroyo drains to the northeast of the firing range. Arroyo sediments directly northeast of the backstop berm were sampled during the 2009 Phase II ESA of the properties adjacent to the USBP firing range, and contained concentrations of lead exceeding the USEPA RSL of 400mg/kg. This finding provides supporting evidence that lead COCs have migrated off-site due to sediment transport by storm water action.

Secondary storm water drainage also runs northeast-southwest directly northeast of the covered firing area, and drains into the aforementioned bowl depression on site. However, this secondary drainage should not be expected to receive significant drainage and sediment transport under most rainfall event conditions.

Mass Wasting is expected to result in on-site and off-site transport of COC and small arms debris. The area of the USBP firing range subject to mass wasting COC migration is restricted to the backstop berm area. Migration would occur primarily to the east and west. Mass Wasting works at a very slow rate, moving several inches per year. Migration distance is restricted to the toe of the backstop berm slope, on either side. However, mass wasting along the western slope of the backstop berm allows COCs to move toward and into the arroyo, a location where the migration potential of COC media by storm water is dramatically increased. Mass Wasting may be considered a contributing factor to COC migration by sediment transport from storm water discharges.

Storm water is also expected to transport relatively minute amounts of COC metals and, to a lesser degree, PAHs, as a dissolved fraction. COC metals and PAHs have low solubility, but are soluble above their respective residential USEPA RSLs. COC media present in the storm water discharges may release relatively small amounts of dissolved COCs. Storm water transport of COCs as a dissolved fraction increases the rate of migration of COCs compared to the slower transport of bed load sediments. Storm water discharges may transport dissolved COCs downstream until they either; precipitate COCs by sorbing them onto particles suspended in the water (an important mechanism for PAHs), which then become subject to sediment transport; lose sufficient flow and infiltrate into the ground surface; or combine with permanent surface water pathways (e.g. Santa Cruz River). The dissolved COC transport risk is different for lead and PAHs. PAHs are not likely to remain in solution for a significant length of time, and so the transport of dissolved PAHs in storm water functionally increases the rate of migration by a small fraction. Conversely, dissolved lead will not readily precipitate from the water column in an agitated environment and is likely to remain in solution until the storm water discharge infiltrates into the soil. However, dissolved concentrations of lead in storm water discharges are not expected to pose a risk to off-site receptors as storm water would have insufficient exposure time to uptake large amounts of lead from impacted soils, and should be fairly diluted in the water column.

Leachate transport is expected to cause vertical COC migration. Leachate resulting from on-site infiltrated storm water will transport dissolved lead and minor amounts of dissolved antimony downward through vadose zone soils towards groundwater. Due to the slow rate of leachate COC transport anticipated at this site (a few inches of downward transport per year) and that the estimated depth to groundwater at the site ranges from 40 to 135 feet bgs, leachate will not transport COCs to the water table in the near term. The RI subsurface soil sample analytical results indicate that lead at levels above the USEPA residential RSL has migrated to a maximum depth of approximately four feet bgs. Given an assumed time of activity at the range of eighteen years the rate of infiltration would be approximately 2 inches per year, lead concentrations in excess of the USEPA residential RSL would be expected to enter the phreatic zone (the water table contact of 40 feet bgs) in approximately 240 years. This is a conservative estimate. Previous studies of Florida Shooting Range soils [Hardison, 2003] have determined a rate of only 0.4 inches per year.

4.3.1 Physical Factors

Physical factors for COC migration include wind speed, direction and duration, and frequency and intensity of rain events. The severity of aeolian COC migration correlates to wind speed and wind duration, which control how far wind transports contaminated soil and source material. Wind speeds and duration vary on a seasonal basis. The directionality of aeolian transport of COCs and source materials is controlled by wind direction. Prevailing wind direction is from the south.

The intensity of precipitation determines the severity of flash flood events, correlating to the distance traveled and amount of sediment containing COCs and source materials transported by storm water. Nogales area rain events are seasonally very intense, reaching approximately 2 inches per hour in some cases. Transport of COCs may be retarded by the presence of clayey soils covering an area of ground surface, preventing COC soils from being susceptible to storm water or wind action.

4.3.2 Chemical Factors

The chemical factors for COC migration are soil moisture pH, surface water pH, the availability of carbonate, and the availability of phosphorus. These factors are only significantly applicable to lead. A lower soil moisture pH correlates to an increased downward mobility of lead due to an increased uptake of lead into leachate of a lower pH. A lower surface water pH correlates to an increased uptake of lead into storm water discharges, resulting in an increased mobility of lead through surface water pathways.

The availability of carbonate and phosphorus in site soils would correlate with a decreased mobility of lead. The greater availability of carbonate and phosphorus allows for a more rapid transformation of elemental lead into less soluble carbonate and phosphate lead minerals. These minerals dissolve into leachate and into surface water less readily than does elemental lead and lead oxide. The effect is much more pronounced for lead phosphate minerals, which are very insoluble and are also marginally bioavailable.

4.3.3 Biological Factors

The biological factors for COC migration are the prevalence of plant life able to uptake lead, antimony, and PAHs; and the ability of animal species to enter the site and consume plants that have taken up COCs. The prevalence of plant life should weakly correlate with increased COC migration through biotic uptake. Bioconcentration in plant life has not been observed in studies for any of the COCs that are present at the site and it is documented that biotic uptake is not a major transport mechanism for these COCs (ASTDR, 1992, 1997, and 2007). Therefore, ecological receptors are not a complete pathway for significant COC migration.

5.0 RISK ASSESSMENT

A risk assessment was conducted to evaluate the potential risks the site poses to human health and the environment. In accordance with the SOW, the risk assessment consists of a HHA and an ERA. Because the site is an unremediated firing range, a phased approach was employed to focus the risk assessment on implementation of remedial alternatives that will reduce risks to within the acceptable risk range. These components are discussed in more detail below.

5.1 HUMAN HEALTH EVALUATION

The HHA evaluated whether potential carcinogenic risks and non-carcinogenic hazards to human health posed by the site exceed acceptable threshold levels. The HHA focused on identifying whether potentially unacceptable concentrations of COCs may exist in soil on site, the extent of potentially unacceptable concentrations of COCs in soil, and on potential hazards associated with off-site migration of COCs. The HHA involved the identification of potential exposure scenarios and comparison of soil data to regulatory and risk-based screening criteria that are protective for the potential exposure scenarios. This phase of the assessment includes the exposure assessment and comparison of site data to screening criteria. Consistent with USEPA guidance, the HHA focused on concentrations of COCs in the fine fraction of soil (USEPA, 2000).

5.1.1 Exposure Assessment

The exposure assessment provides a framework for problem definition and assists in the identification of potentially exposed populations and appropriate remedial technologies, if necessary. This assessment is based on the potential COC pattern and potential migration mechanisms associated with the past use of the site as a firing range. COCs related to former firing range operations include lead, arsenic, antimony, and PAHs.

5.1.1.1 Constituent Fate and Transport Characteristics

An evaluation of constituent mobility and fate and transport characteristics was performed for the COCs detected in site soil; Table 7 lists the COC physiochemical properties. The propensity for constituents to preferentially partition to soil can be evaluated based upon partitioning coefficients, such as the organic carbon-water partitioning coefficient (K_{oc}). Constituents with a log10 K_{oc} of less than three when released to soil would be expected to be mobile and leach to groundwater (low to negligible soil sorption). Based on this criterion, all of the organic COCs identified at the site are not considered to be mobile. Water solubility (S_W), also known as aqueous solubility, is the maximum amount of a substance that can dissolve in water at equilibrium at a given temperature and pressure. The form of inorganic constituents such as elemental metal or metal salts results in differing solubility's; inorganic constituents associated with ammunition are expected to be in metallic form and therefore, the solubility of these COCs is limited. The COCs listed in Table 7 are not considered to be highly soluble (greater than 100 mg/L). Thus, potential exposure to COCs focuses on direct contact with COCs in soil.

5.1.1.2 Human Health Site Conceptual Model

A human health site conceptual model was developed to document site conditions and data regarding potential releases to the environment. The site conceptual model was developed and used to compare the relative potential for COC at the site to impact human health and the environment. The identification of potential receptors and exposure points is presented in Figure 14. The following paragraphs evaluate these potential release mechanisms and additional mechanisms for particulate materials in soil.

Constituents related to past activities are found in particulate form in soils at the site. Although the particle size varies from the silt-sized fraction to gravel-sized fraction, the majority of the mass of spent ammunition and targets remains in gravel-sized material. A portion of the material is found in the smaller fraction and may be subject to release mechanisms that would transport chemical constituents to additional media where receptors may be exposed. USEPA guidance for performing risk analysis on small arms ranges identifies incidental ingestion of soil as the main exposure pathway (USEPA 2003). Additional exposure pathways that are likely to be significant include inhalation of dust or soil particles and offsite ingestion of homegrown vegetables.

Leaching of COCs from soil is not considered to be a significant potential migration pathway based on the chemical and physical properties of the COCs and the known physical, topographic, meteorological, and hydrologic conditions at the site described in Section 4. Based on USEPA guidance, this pathway is considered to be an incomplete exposure pathway, both on and off site (USEPA 2003).

Surface water runoff associated with storm water flow may have transported particulate COCs from exposed surface soils. Based on physical, topographic and meteorological conditions, the potential for COCs to migrate with soils in the arroyo is potentially complete. Because the arroyo is located on an adjacent property, this migration pathway has greater potential for receptor exposure off-site than on-site. However, based on the limited size of the arroyo and the infrequent surface water flow within the arroyo, exposure to surface water is considered to be insignificant. Potential off-site contact with site-related constituents in arroyo soils is a complete pathway.

Potential inhalation exposure to COCs in dust may be a complete exposure pathway both on and off-site. During active operations of the site, the surface soil was reworked frequently as a result of projectile impact and reshaping of the back stop berm and parking lot. Surface soil disturbance results in exposed particulate COCs that may have been available for release and transport. Based on the low amount of precipitation and the desert climate saltation by wind, aeolian transportation is the major offsite transport mechanism for COCs. Although this exposure pathway is complete for all of the potentially exposed populations both on and surrounding the site, potential exposure to dust is insignificant, relative to direct contact with soils, for on-site workers and a potential recreational user off site.

5.1.1.3 Potentially Exposed Populations

Land use characteristics of a site and the surrounding area define the potentially exposed populations. Potential receptors that could be exposed to COCs were selected based on the current and future potential land use of the firing range and based on the potential transport mechanisms of site COCs. The former firing range is currently inactive and surrounded by undeveloped land. Future land use of the site and the surrounding area is uncertain, therefore, conservative assumptions regarding potentially exposed populations were selected to ensure that the risk assessment provided a conservative evaluation of potential risks.

Direct contact with soil is a significant exposure pathway for all potentially exposed populations both on and off site. Surface and subsurface soil contamination has been indentified in on-site areas. Due to soil reworking and bullet penetration, potential receptors could have had direct exposure both surface and subsurface soils.

Potentially exposed populations were selected based on current and potential future land use both on and off-site. The current site land use is an inactive small arms firing range, thus, if activity were to resume, only workers would be expected to have contact with COCs on site. Under the current land use, if use of the range were to resume, USBP agents would be expected to visit the site several times a month for training exercises; however, training activities would be limited to a short duration. During infrequent earthmoving activities, a construction worker could have contact with site COCs. Under current land use, the off site area is undeveloped, thus potential exposure to populations including industrial workers at adjacent properties, infrequent recreational use, or potentially residential land use could occur. Under future land use conditions, an assessment of potentially unrestricted land use both on and off-site is assessed based on potential residential exposure.

This exposure assessment identified direct exposure to soil and dust as potentially complete and significant exposure pathways for both on-site and off-site receptors. The identification of potential exposure scenarios was the basis for selection of regulatory and risk-based screening criteria that are protective for the selected exposure scenarios.

5.1.2 Selection of Screening Criteria

Based on this exposure assessment, risk based screening levels were selected to provide an assessment of the potential for site conditions to pose potentially unacceptable risks to human health.

This section provides a summary of the screening criteria selected to assess environmental data collected as part of the RI. Constituent concentrations detected in soil were compared to screening levels to identify constituents of potential concern (COPC) for human health and the environment and constituents that exceed the applicable screening criteria are identified as COCs. The screening levels were selected based on current and potential future land use assumptions. Exceedances of screening levels do not necessarily indicate that an unacceptable exposure exists. Rather, the screening levels serve to identify areas that do not require further consideration and those areas that will be considered further in the FS.

5.1.2.1 Current Onsite Receptor Screening Levels

Surface soil and subsurface soil contamination is found within the study area. The current land use of the site is a firing range, thus the only human receptors would be workers who are covered by the Occupational Safety and Health Administration (OSHA) exposure standards (ITRC, 2003). Therefore, screening for the protection of on-site workers using an industrial exposure scenario was conducted as a conservative assessment of potential site exposures.

5.1.2.2 Current Offsite Receptor Screening Levels

Off-site soil contamination was identified in the earthen berm immediately adjacent to the site boundary during the 2011 sampling. Screening for the protection of off-site residents or recreational users was performed using a residential exposure scenario. This scenario is conservative for evaluation of potential off-site residential or recreational exposure because the default exposure assumptions inherent in the residential screening level overestimate potential exposure under the current off-site land use:

- 30-year duration of exposure to soil immediately adjacent to the site or in the channel of the arroyo
- 350-days/year frequency of soil immediately adjacent to the site or in the channel of the arroyo.

5.1.2.3 Future On and Off-site Receptor Screening Levels

Future land use of the site and the surrounding area will not be controlled by USBP; therefore, residential land use was conservatively estimated as the future land use.

5.1.2.4 Screening Criteria Protective of Current and Future Land use

After identification of potential receptors is complete, a toxicity assessment is undertaken to identify appropriate criteria to assess potential risks posed by site conditions. In this screening risk assessment, the toxicity assessment is an integral component the screening criteria development. For this risk assessment, the current and future land use and potentially exposed populations resulted in the selection of screening criteria that were consistent with the ARARs. As a result, most of the elements of the toxicity assessment were performed by the regulatory agencies that developed the screening criteria.

Two sources of screening criteria were identified for comparison to COPC concentrations in soil. The first is the potentially applicable Arizona regulatory standards, the ADEQ SRLs (State of Arizona, 2007). Based on the exposure assessment, on site soils were compared to nonresidential ADEQ SRLs to assess current land use while comparison of soils to both residential and nonresidential ADEQ SRLs was performed to assess potential unrestricted future land use. Surface soil concentrations were also compared to the USEPA regional RSLs for residential and industrial exposure screening criteria (see Table 2) (USEPA, 2011) because these levels incorporate inhalation of particulate emissions. The RSLs were based on a cancer risk of 1×10^{-6} and a hazard quotient (HQ) of 1.0 (for noncarcinogens).

In addition, an assessment of toxicological endpoints for RSL-based screening criteria was performed to determine if COPCs were detected with common toxicological endpoints. Table 8 presents the detected COCs and their toxicological endpoints. In the event that COCs with a shared endpoint had been detected, these constituents would have been screened using RSLs based on a HQ of 0.1. Any positively detected constituent that lacked a screening criterion was evaluated on a weight-of-evidence basis to determine if it should be considered as a COPC.

Risk-based screening for lead was performed using Arizona and USEPA screening levels that are calculated based on potential blood lead concentrations. The blood lead models used to develop these screening levels consider both direct contact with soils and potential incidental ingestion of lead through aeolian dust and dietary sources.

5.1.3 Comparison to Risk-Based Screening Levels

Evaluation of potential risks and hazards posed by exposure to soil was performed using the COPC concentration in the fine fraction. Use of the fine fraction of soil for the exposure point concentration was undertaken because this is the fraction of soil that is likely to reflect enrichment of COPCs as a result of site activities and to be representative of windblown dust, indoor dust, the fraction that would be incidentally ingested and was used to calibrate relevant human health models (USEPA 2000, 2003). In this assessment, all soil particles that passed through the #50 sieve size (less than 300 µm) are considered to represent the fine fraction of soil.

A comparison of shallow soil data to applicable screening criteria is presented on Table 2. Lead concentrations in shallow soil exceed both the Arizona and USEPA nonresidential screening levels in all but one shallow soil sample. In addition, all but one shallow soil sample also exceeds the Arizona and USEPA residential screening level. Concentrations of antimony and arsenic exceed both residential and nonresident ADEQ SRLs in surface soils, although exceedances are not as widespread as lead. PAH compounds exceed applicable residential and industrial RSLs in five shallow soil samples.

Exceedances of the nonresidential screening levels suggest that potentially unacceptable risks or hazards could exist as a result of exposure to onsite soils under the current land use if an agent or worker were exposed in a manner that is consistent with the default exposure assumptions. Exceedances of the residential screening levels suggest that potentially unacceptable risks or hazards may exist under the future unrestricted land use scenario. Although data from outside of the firing range were not considered in this risk assessment, comparison of onsite soils to residential screening levels was conservatively assessed to estimate potential offsite exposure. Exceedances of the onsite soils to residential screening levels are likely to overestimate potential risks or hazards to offsite receptors as a result of the following:

- The exposure duration and frequency to potentially impacted off site soils in the arroyo is anticipated to be lower the default residential scenario,
- Offsite concentrations of lead in dust or soil as a result of firing range activities are not anticipated to be as high as soils sampled on site.

In conclusion, based on the widespread exceedances of the lead ADEQ SRL in the fine soil fraction, remedial decisions to address current soil conditions would be warranted. Concentrations of antimony, arsenic, and PAHs are co-located with elevated lead concentrations, thus RAs that would address fine grained particulate lead in soil would also address these constituents. Based on the distribution and concentration of lead in the fine fraction of the soil, this constituent is the risk driver for remedial decisions.

5.2 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

A screening level ecological risk assessment (SLERA) describes potential ecological receptors, exposure pathways, and identifies constituents of potential ecological concern through a comparison of the COC concentrations in soil to applicable ecotoxicity screening values. Based upon the chemical release and transport mechanisms, potential ecological receptor direct contact with COPCs in soil was identified as the most significant exposure pathway. The methods used in conducting this assessment are discussed below.

In the absence of ERA guidance from the State of Arizona, the SLERA was conducted based on the USEPA's primary guidance, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997). USEPA guidance recommends an eight-step process for ERA, of which this SLERA represents the completion of the first two steps. These steps include:

- Screening-Level Problem Formulation and Ecological Effects Evaluation (Step 1); and
- Screening-Level Exposure Estimate and Risk Calculation (Step 2).

At the conclusion of these two steps of the SLERA, according to USEPA, a Scientific/Management Decision Point (SMDP) is reached, which is a risk management review of the findings of the SLERA that leads to one of the following conclusions:

- Ecological risks are negligible and there is no need for remediation;
- Information is inadequate and further work is required to address data gaps;
- The information indicates a potential risk, and a more thorough evaluation is warranted.

It is notable that under the USEPA protocol for SLERA, a decision to remediate the site is not a standard risk management option at the conclusion of the SLERA process. In practice, however, risk management decisions are frequently made at various stages of the ERA process, and a screening assessment is sufficient to guide remedy selection, especially for former firing range sites.

5.2.1 Problem Formulation

Problem formulation establishes the goals and focus of the SLERA. Major tasks of screening-level problem formulation consist of an assessment of the following:

- Environmental Setting;
- Site COCs;
- COC Fate and Transport Mechanisms and Migration Pathways;
- Potential Ecological Receptors;
- Complete Exposure Pathways; and
- Ecological (Assessment and Measurement) Endpoints.

The second and third bullets, site COCs and fate and transport mechanisms, were presented in the HHA and have not been repeated in the SLERA. For the constituents detected in soil at this site, both the COPCs and fate and transport mechanisms are the same for human and ecological receptors.

5.2.1.1 Environmental Setting

Information from field observation indicates that no regionally significant and/or unique habitats occur in the USBP firing range and adjacent parking lot. Habitat quality of the site is low because the site is entirely disturbed as a result of mechanical earth reworking in support of previous firing range activities. Most of the vegetation has been removed on site, with the exception of pioneer grasses that are revegetating small portions of the firing range and along a narrow strip adjacent to the earthwork back stop. Vegetation remaining on site is typical of disturbed areas, consisting primarily of grassland and scrub-shrub and Cholla cactus species. Immediately adjacent to the site, the area is undeveloped and vegetation also represented by grassland and scrub-shrub. This vegetation is not considered sensitive ecological habitat.

5.2.1.2 Identification of Potential Ecological Receptors

Potential ecological receptors were identified based on information collected during the field investigation. Potential receptor identification focused on identifying receptors inhabiting and potentially utilizing the terrestrial habitats under investigation. Based on the disturbed nature of the site, limited wildlife usage of the site is anticipated.

The potential for sensitive ecological receptors to inhabit or use the site was considered as part of the SLERA. Potentially sensitive habitats such as riparian or aquatic ecosystems are not present on or adjacent to the site. A review of the threatened or endangered species for Santa Cruz County did not reveal any listed plant or animal species that would be likely to use the site due to disturbed conditions associated with the current land use.

5.2.1.3 Identification of Complete Exposure Pathways

The primary exposure pathways to be addressed in a SLERA are influenced by the physio-chemical properties of the COPCs and the biology and behavior of receptors. These factors interact to define the various routes by which the chemicals originating at the property could affect potentially exposed populations. Based on information generated in the previous tasks, exposure pathways for soil are focused on potential direct contact with COPCs. In particular, avian species specifically select grit that may fall within the shot-sized particle fraction, thus avian incidental ingestion of ammunition fragments represents a significant potential exposure pathway at the USBP firing range.

5.2.1.4 Definition of Ecological Endpoints

The final component of the Problem Formulation phase of the SLERA is the definition of ecological endpoints. Ecological endpoints are defined as measurable or estimable biological or ecological attributes associated with one or more levels of biological organization that serve as the focus of the risk assessment (USEPA, 1997). Levels of biological organization can span and encompass the biochemical and cellular levels through individuals, populations, communities and ecosystems.

5.2.1.5 Assessment Endpoints

Assessment endpoints are explicit expressions of the unique or critical ecosystem characteristics or features that are to be protected. Because assessment endpoints often cannot be measured directly, measurement endpoints are developed that can be related, either qualitatively or quantitatively, to the selected assessment endpoint(s).

Assessment endpoints were developed as part of the SLERA based on the characteristics of the ecosystem potentially at risk and the COC pathways within that ecosystem. COC pathways originate from contaminated media (soil) and end at a potential receptor where adverse effects may occur.

The assessment endpoint for the USBP firing range is the maintenance of a terrestrial ecosystem characterized by the sustained populations of wildlife and vegetative communities that are not impacted by anthropogenic chemicals introduced by site activities.

5.1.2.6 Measurement Endpoints

Measurement endpoints are biological or ecological variables that can be measured or observed and are related to the valued characteristic of the ecosystem as described by the selected assessment endpoints. In this assessment it is assumed that healthy, unimpacted ecosystems are characterized by chemical parameters in various media which are less than ecological screening criteria and guidelines. Therefore, the measurement endpoints for this SLERA are the chemical parameters measured in shallow soil and their comparison to the ecological effects screening values. This measurement was made by comparing the site-specific concentration to the constituent specific guideline value. If the site soil concentration is greater than the screening value the constituent will be identified as a constituent of potential ecological concern (COPECs).

5.2.2 Ecological Effects Evaluation

Two types of stressors are typically evaluated as part of an ERA. These include chemical and physical stressors. Potential chemical stressors include a variety of COC that may have been released to the environment and potentially pose a threat to ecological habitats or wildlife. Physical stressors include habitat alteration or destruction typically associated with the implementation of remedial activities or background conditions. The SLERA focused on potential chemical stressors; however, physical features that influence exposure are noted.

The purpose of the Ecological Effects Evaluation is to identify ecological screening levels that represent conservative thresholds for adverse ecological effects. Such screening levels are based on agency criteria, guidelines, or ecological benchmarks. Conservative soil screening criteria were selected to assess the potential hazard to ecological receptors. USEPA Ecological Soil Screening Levels (ESSLs) were used as the screening criterion for each of the detected constituents. The lowest ESSL was selected as the screening criterion for each COPC. These soil screening criteria are appropriate for potential ecological receptors because no sensitive habitats or species were identified that may be inhabiting the site. Table 9 presents the ESSLs and the most sensitive receptor that the screening level is based on.

5.2.3 Screening-Level Exposure Estimate and Risk Characterization

This final task of the SLERA consists of estimating exposure levels for potential ecological receptors to site-related constituents and evaluating whether potentially unacceptable concentrations exist for the identified receptors. Based on the results of this task, conclusions were developed regarding the likelihood that site-related impacts to ecological receptors are occurring.

In soil, ecological effects due to chemical stressors are typically associated with the top two feet only (i.e., the root zone). Therefore, only soil samples collected from the surface interval were considered in the ERA. Analytical data were only available for the fine particle size fraction, thus screening was performed on this fraction. This is believed to represent a conservative estimate of site-related impacts because “enrichment” of site related constituents in the fine fraction relative to the total soil is anticipated as a result of the firing range activities (USEPA 2000). Surface soil data collected from areas in and around the USBP firing range were screened on a point-by-point based using the ecological screening benchmarks presented on Table 9.

Six constituents were detected in the fine fraction soil during the 2011 sampling event at concentrations that exceed the ESSLs (Table 10). Lead exceeded the ESSL in all of the locations that were sampled in 2011. Antimony exceeded the ESSL in all but one location. Arsenic, benzo(b)fluoranthene, benzo(k)fluoranthene , and chrysene were detected infrequently at concentrations greater than ESSLs.

There are a number of uncertainties involved in the assessment of ecological risks. A major source of uncertainty is the extrapolation of laboratory-derived data to the natural environment. Many factors that will influence a toxicological response are encountered in the real world which cannot be predicted in the laboratory. Often it is not possible to identify the causative agents, and dose-response parameters are thus difficult to characterize. Synergistic or antagonistic interactions further complicate risk extrapolation procedures. Antagonistic interactions are more commonly encountered with metals. For example, iron may reverse the harmful effects of lead. The following summarizes the uncertainty factors involved with this evaluation, most of which result in an over-estimation of potential risk.

- Estimates of bioavailability of metals in soils to animals are much lower than the 100% assumed in development of the standards. Although the actual bioavailability of COPECs is likely to be lower, site concentrations are unlikely to pose no unacceptable risk under current conditions.

- Exposure is limited due to daily and seasonal migratory patterns, home ranges, and available food supply for many larger animals. Potential effects to populations of animals with smaller home ranges such as soil invertebrates are limited due to the small aerial extent of the affected areas. Thus, the assumption of a 100% use factor greatly over-estimates the potential exposure to many receptors.

- The study area is highly disturbed due to historical site activities thus; overall exposure of wildlife is low due to the generally poorer quality habitat that exists in the study area as compared to the available surrounding areas.

In conclusion, the site is covered by clean cover, cement or exposed soil. Thus the physical stressors associated with the poor habitat quality are likely to represent the greatest ecological stressor. Based on the distribution of lead in the soil, remedial decisions to address the concentration of lead in soils would address the other COPECs.

6.0 SUMMARY AND CONCLUSIONS

6.1 SUMMARY

6.1.1 Nature and Extent of Constituents of Concern

The COCs at the USBP firing range are lead, arsenic, antimony and certain PAHs [benzo(a)anthracene, benzo(a) pyrene, benzo(b)fluoranthene, benzo (g,h.i)perylene, benzo(k)fluoranthene, chrysene and fluoranthene]. The concentration distribution for the metals above USEPA residential/industrial RSL and Arizona residential/industrial SRL levels are found in figures 4, 5, 6, 8, 9 and 10. The number of hits for PAHs above detection limits is found in Figures 7 and 11.

All of the COC metals are found throughout the firing range. The highest concentration of metals for both shallow (0-12 inches) and deep (12-42 inches) are found in the southwest corner of the firing range. The area consists of the major portion of the back stop berm and firing range area between the back stop berm and last target area. The highest concentration of PAHs is also found in the southwest corner of the firing range. Because the source of the PAHs are plastic shot gun wadding and fragments of clay pigeon targets distributed only on the surface, only shallow soil samples were collected for PAHs

6.1.2 Fate and Transport of Constituents of Concern

The fate of the small arms projectiles was to impact the back stop berm, targets or areas other than the back stop berm. Upon impact, physical abrasion of the metal projectiles occurred creating a fine faction of the metal fragments. Once the small arms munitions debris was on or penetrated into the ground the fate was controlled by minor amounts of chemical weathering through oxidation and exsolution by the atmosphere and meteoric waters. Physical weathering occurred by wind abrasion and was enhanced by mechanical disturbance during the reworking of the berm.

The majority of the transport for COC metals and PAHs was caused by the firing of small arms munitions throughout the firing range mainly directed toward the berm. The natural transport mechanisms for the small arms munitions debris and COCs occurs by horizontal transport by mass wasting through creep and micro-debris flows for short distances, aeolian transport by saltation and suspension and water transportation by suspension and saltation along drainage pathways during occasional rain events. Vertical transport occurs intermittently by exsolution and colloidal transport during rain events. All transportation mechanisms are of short duration and incremental distances because of the arid climate and density of the COCs metals.

6.1.3 Risk Assessment

Lead concentrations in soil exceed both the human health and ecological screening levels, in all of the soil samples collected on site and immediately adjacent to the site in 2011. Concentrations of antimony and arsenic and PAHs exceed both human and ecological screening levels in vadose zone soils, although exceedances are not as widespread as lead. Based on the widespread exceedances of the lead USEPA RSL and ADEQ SRL in the fine soil fraction, remedial decisions to address current soil conditions would be warranted. Concentrations of antimony, arsenic, and PAHs are co-located with elevated lead concentrations, thus RAs that would address fine grained particulate lead in soil would also address these constituents. Based on this comparison to regulatory and risk-based screening criteria, further estimation of risk under a baseline exposure scenario, which is captured in the screening criteria, is unlikely to provide additional information that would impact the remedy selection in the FS. Thus, no additional risk assessment is recommended until a strategy to address lead in soils has been developed.

6.2 CONCLUSIONS

6.2.1 Data Limitations and Recommendations for Future Work

The deepest penetration when sampling the back stop berm was 42 inches bgs which was insufficient to penetrate to the base and portions of the interior of the back stop berm to determine the concentrations of COC metals at the base and interior of the back stop berm. When excavating the back stop berm for treatment or removal, the soils will be field screened by a XRF to determine soils to be treated, removed or used as backfill without treatment.

The determination of the depth to groundwater was not determined on site, but by reference to a water well on a property in the immediate area where the total well depth was 435 bgs. The casing depth was 420 bgs and depth to groundwater was determined to be 135 feet bgs. Because the water level in this well is most likely recording the depth to water associated with the aquifer horizon at a level beneath the well casing, 420 to 435 bgs, it most likely represents the depth to the water below the casing and not the water table.

6.2.2 Recommended Remedial Action Objectives

RAOs drive the formulation and development of response actions. The primary RAOs for the USBP firing range are based upon the hazard assessment results presented in this RI Report and USEPA’s threshold criteria of “Overall Protection of Human Health and the Environment” and “Compliance with ARARs. Based upon the hazard assessment and the RI/FS Guidance, the following RAOs were developed for the protection of human health and environment.

- Prevent or reduce the potential for receptors to come in direct contact with soil COCs remaining after remediation on USBP firing range.
- Prevent the potential for receptors both human and ecological to ingest the soil COCs on the USBP firing range.
- Prevent the potential for receptors to inhale the soil COCs at the USBP firing range.

- Interrupt USBP firing range COC migratory pathways to human or ecological targets.

7.0 QUALITY ASSURANCE

This section presents the QA program activities performed to achieve a standard of quality for the project that meets or exceeds those required by the DQOs for the RI at the USBP firing range. The program is designed to ensure that test results and field procedures are reproducible and corroborate the accuracy of the analytical methodologies employed. These activities were performed as stated in the QAPP, contained in the USBP firing range RI/FS Work Plan (TPMC, 2011).

7.1 GENERAL

7.1.1 Data Management

The primary data management activities for the USBP firing range RI included:

- Review and confirmation that appropriate data were collected in accordance with work plan and QAPP requirements;
- Transfer of data from field and laboratory activities to project databases;
- Storage and management of data in appropriate databases;
- Appropriate level of analytical data validation; and
- Organization and use of data from databases for statistical analyses, interpretations, assessments, and report conclusions.

Data collected in the field were recorded in the field logbook along with their corresponding sample identifications (IDs). Once compiled, the data were reviewed by a qualified team member to ensure completeness, consistency, and conformance with site conditions; then the data were entered into appropriate databases.

Sampling location data obtained during field surveys were directly uploaded to a GIS database for use with Computer Aided Design Drawing (CADD) files. Data layers, including roads, buildings, and geology, were extracted from the CADD drawings and saved in a GIS database. Aerial photographs were scanned and rectified to allow overlay of site map layers and sampling data.

7.1.2 Location Surveys and Mapping

Location surveys and mapping QA procedures provided field teams with guidance for collection and documentation of survey and map data collected within the USBP firing range.

7.1.2.1 General

Location surveys were required for soil sample collection. Location survey equipment for the project consisted of a handheld geographic-information mobile-mapping system, equipped with a high-accuracy kit.

7.1.2.2 Accuracy

All survey points were established using the geographic-information mobile-mapping system. This system provided sub-foot accuracy using standard Differential GPS and Auto GPS functions. Field location accuracy was continuously monitored throughout RI field activities. Topcon GRS-1 field accuracy was determined prior to the RI by surveying the location of GIS base stations and survey, and comparing the results to their documented locations.

Horizontal control for the site was based on North American Datum 83 (NAD 83)using the Universal Transverse Mercator (UTM) zone 12N, in meters. Vertical control was based on the metric system and referenced to the North American Vertical Datum of 1988 (NAVD 88).

7.1.2.3 Plotting

All of the control points (monuments, aerial targets, grid corners, feature of interest locations, sample locations, and property corners) recovered and/or established at the site were plotted at the appropriate coordinate points on reproducible electronic media for production of plan-metric maps at scales appropriate for the area being described.

7.1.2.4 Mapping

The location, identification, coordinates, and elevations of all the control points recovered and/or established at the site were plotted on reproducible media for plan-metric and topographic maps at the scale most suited to review.

Each map includes a true north. An explanation is provided which shows the standard symbols used for the mapping and a location map showing the site in relationship to all other sites within the boundary lines of the project area.

7.1.3 Remote Sensing Instrument Standardization and Calibration

Instrument standardization, calibration and QC tests of the portable XRF unit were conducted in accordance with procedures presented the instrument users/owner's manual(s). Operational and test procedures conformed to manufacturer's standard instructions. All remote sensing instruments and equipment used to gather and generate field data were calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results were consistent with the manufacturer's specifications.

7.1.4 Field Documentation

Field documentation consisted of field logbooks, field forms, and photographs. Project personnel submitting completed documentation for retention in project records ensured documents are legible, accurate, complete, and reproducible. Requirements and procedures used for maintaining the various types of documentation records are discussed in the subsections below.

7.1.4.1 Logbooks

Field logbooks provide a daily handwritten record of all field activities performed at the USBP firing range. All logbooks are permanently bound and have a hard cover. The logbooks are ruled or ruled and gridded and have sequentially numbered pages. All entries into field logbooks were made with indelible ink. Field logbooks are detailed daily records that are kept in real time and are assigned to specific activities, positions, or areas within the site.

7.1.4.2 Field Photographs

Photographs were taken with a digital camera to photo-document field activities. There was no specified number of photographs required for each location or each activity; however, a sufficient number to accurately represent site conditions and work activities were taken.

7.1.4.3 Final Evidence File Documentation

All evidential file documentation is maintained under an internal project file system in accordance with TPMC Records Management procedures. The Project Manager ensures that all project documentation and QA records are properly stored and retrievable.

7.1.5 Process/Training Plan

Project personnel had the appropriate education, experience, and site-specific training to perform the duties of the job for which they were tasked. The Project Manager ensured that all personnel received appropriate indoctrination and training. The field team leader conducted and documented site-specific training and maintained records documenting the required qualifications and training for each site worker. He monitored expiration dates in order to advise employees of refresher training or other requirements and maintained training records for personnel and visitors, as required by the work plan. Routine training consisted of daily safety briefings which were conducted by the site health and safety officer. This training addressed safety issues, plan of the day, team assignments, potential issues, and resolutions. Required training records were maintained on site for all personnel during field activities.

Training for field personnel included:

- Current 40-hour OSHA Hazardous Waste Operations (HAZWOPER) certification and 8-hour refresher for all workers, including medical surveillance.
- Field team orientation and kick-off briefing was conducted with all project field personnel prior to start of each phase of field activities. This orientation included through review of the project SAP, Accident Prevention Plan (APP), and Site Safety and Health Plan (SSHP).
- Review of Standard Operating Procedures (SOPs) prior to commencement of each new task.
- Periodic briefings for site-specific technical and quality issues and procedures as they relate to each worker's duties [e.g. DQOs, shipping protocols, biological and cultural resources issues, and management of investigation derived wastes (IDW)].
- Daily "tailgate" meetings to discuss site-specific health and safety and QA topics related to project specific work assignments.

All site visitors were given a field safety briefing by the field team leader before entering the active investigation area. All visitors signed in on a visitor log that was maintained on site.

7.2 DATA QUALITY OBJECTIVES

DQOs were developed for soil sampling based on USACE guidance. The selected analytical methods meet the DQOs for sensitivity, which were required to compare soil sample results to the regulatory criteria.

7.2.1 Measurement Quality Objectives for Chemical Data Measurement

Measurement Quality Objectives (MQOs) for chemical data measurements include the routine, standard Quality Control (QC) measurements typically made on laboratory-prepared, standard materials and samples. The MQOs are used to monitor accuracy and precision.

Analytical data were to be reported using the Limit of Quanitation (LOQ) with positive values qualified between the Limit of Detection (LOD) and the LOQ. A "J" qualifier was used to flag data above the LOD but below the LOQ. Chemical data during this project were collected and validated to ensure that the procedures defined in the Work Plan have been followed, and that the quantity of data adequately supports the intended use of the data, as described in EPA's DQO Process (QA/G-4, February 2006). For laboratory-generated QC measurement data, the accuracy (or bias) MQOs are acceptance limits provided by USACE (DOD, 2010) and project-specific precision MQO values approved by the USACE, Fort Worth District staff.

7.2.2 Sample Receipt

The sample receipt custodian is responsible for the inspection of shipping containers upon laboratory receipt and verification of sample integrity. This ensured that the contents were not altered or tampered with during transit. If tampering were apparent, the sample receipt custodian would have immediately contact the assigned Accutest Project Manager. The sample custodian would have documented any deficiencies at the time of sample receipt at the laboratory on the Cooler Receipt Form. A lot number was assigned to each group of samples received, recorded on both the COCs and each sample container submitted with the project, and noted in the Laboratory Information Management System (LIMS). Proper and complete sample documentation was provided on the COC form in order to log samples into the LIMS.

7.2.3 Analytical Procedures

Surface and subsurface soil samples from each sampling location were analyzed for Antimony, Arsenic, and Lead using EPA Method SW-846 6010B. Ten (10) surface soil samples were also analyzed for PAHs using EPA Method SW-846-8270C. Accutest laboratory retained sufficient sample volume for all soil samples in order to conduct TCLP analysis by EPA Method SW-846 1311, in the event that as many as five (5) soil samples exceeded the TCLP toxicity characteristic for lead. Five (5) soil samples were selected to be analyzed for TCLP. The specific implementation of the analytical methods followed proprietary laboratory Standard Operating Procedures (SOP)s and the DOD Quality Systems Manual for Environmental Laboratories (Version 4.2, October 2010). Table 1 lists the respective chemical-specific DQOs and reporting limits for soil sample analyses.

7.2.3.1 Laboratory QC Procedures

Generally, laboratory QC checks included the following:

- Calibration checks
- LODs
- LOQs
- Holding Times
- Laboratory control samples (LCSs)
- Surrogate spikes
- Serial Dilutions
- Matrix Spike (MS) samples
- Matrix Spike Duplicate (MSD) samples

- Method Blank samples
- Performance/System audits

7.2.3.2 Calibration Checks

Calibration checks were performed regularly on each instrument to verify that response characteristics for the instrument remained within prescribed limits.

7.2.3.3 Laboratory Control Samples

Laboratory Control Samples (LCS) were prepared for each analysis batch by adding known concentrations of target compounds to a clean laboratory matrix material. The LCSs were extracted and analyzed along with the associated project samples. Concentrations for the spiked target compounds were determined and reported as a Percent Recovery. The recovery for each compound was compared with the project QC recovery limits and used to assess accuracy for the associated analysis batch.

7.2.3.4 Laboratory Blanks

A laboratory blank, comprised of a clean laboratory matrix material, accompanied each analysis batch. These blanks were extracted and analyzed along with the associated project samples to assess possible contamination of samples during the extraction and analysis process.

7.2.3.5 Surrogate Spikes

A known concentration of a surrogate spike compound was added to each investigative and QC sample prior to extraction and analysis. The concentration of the surrogate compound was determined and reported as a Percent Recovery to assess accuracy for the analysis of each sample.

7.2.3.6 Serial Dilutions

The laboratory prepared and analyzed serial dilutions for each batch. The QC limits for serial dilutions are generally calculated as the percentage difference between the original and diluted result, where the original has a concentration greater than 50 times the detection limit. Different acceptance criteria are used depending upon the project requirement. The analytical method uses a criterion where the diluted value should be within 90-110% of the original value.

7.2.3.7 MS/MSD Samples

MS/MSD samples were prepared by adding known concentrations of target compounds to separate aliquots of selected project samples. The MS/MSDs were extracted and analyzed along with the associated project samples. Concentrations for the spiked target compounds were determined and reported as a Percent Recovery to assess accuracy for the associated analysis. The relative percent difference of spiked compound results for the MS/MSD were used to assess precision for the associated analysis.

7.2.3.8 Performance/System Audits

The contracted laboratory QA Officer regularly conducts performance and system audits to ensure that data of known and defensible quality are produced by the laboratory.

The performance audit is a quantitative evaluation of the measurement systems of a program. It requires testing the measurement systems with samples of known composition or behavior to evaluate precision and accuracy. The performance audit is carried out by or under the auspices of the QA Officer without knowledge of the analyst. Based on this evaluation, the laboratory QA Officer would implement corrective actions as necessary to ensure that reliable data is obtained.

System audits are qualitative evaluations of components of the laboratory QC measures systems. They determine if the measurement systems are being used appropriately. The audits may be carried out before all systems are operational, during the laboratory program, or after the completion of the program. Such audits typically involve a comparison of the activities specified in the QAPP with activities actually scheduled or performed. The data management audit addresses only data collection and management activities.

7.2.3.9 Field Quality Assurance Samples

Field duplicates were collected during the field effort. Field duplicates are samples collected individually, as separate samples, at the same sampling location, and put into separate containers. Duplicate samples were analyzed for the same constituents as the parent samples. Field duplicate samples were collected at a frequency of 10 percent. Each QC duplicate sample was given a separate sample ID number

Rinsate blank samples were also collected during the field effort. Rinsate blanks are samples of water used to rinse field sampling equipment after decontamination following collection of the parent soil sample. The purpose of the rinsate blank sample is to evaluate the effectiveness of field sampling equipment decontamination procedures, to ensure that cross-contamination of environmental samples did not occur. Rinsate blank samples were analyzed for the same constituents as the parent samples. Rinsate blank samples were collected at a frequency of 5 percent. Each QC rinsate blank sample was given a separate sample ID number.

7.2.4 TPMC Data Validation

All analytical data associated with the project received a comprehensive data review. This was comprised of a preliminary review of the laboratory data package and Electronic Data Deliverables (EDDs) to verify that all necessary paperwork (e.g., COCs, analytical reports, laboratory personnel signatures) and deliverables were present. This was followed by a detailed QA review by the subcontracted Neptune and Company, Inc.

chemist to verify the qualitative and quantitative reliability of the data as reported. The review included an evaluation and interpretation of all data generated by the laboratory, and was performed using the UFP-QAPP, applicable analytical method (e.g. SW-846 Method 8270C, 6010B), and the *DOD Quality Systems Manual for Environmental Laboratories*, Version 4.2, October 2010.

The findings of the review were summarized in the Data Validation Report, which presents qualifying statements that should be taken into consideration for the analytical results to best be utilized. The Data Validation Report is presented in Appendix 1. Data qualifiers were added to sample results in the laboratory EDD to serve as an indication of the qualitative and quantitative reliability of the data.

7.2.5 Data Usability

Review of the QA evaluations associated with the field soil samples indicates project sample analysis results are reliable and fulfill project DQOs. A complete discussion of the QA evaluations is provided in Appendix 1. A summary of the findings is presented in the remaining portion of this Data Usability discussion.

All samples were received by the laboratory in acceptable condition. The samples were analyzed for antimony, arsenic, lead, PAHs, and TCLP in accordance with the protocols presented in Test Methods for Evaluating Solid Waste, USEPA SW-846 Manual, October 2006, and the guidance provided in the DOD Quality Systems Manual for Environmental Laboratories, Version 4.2, October 25, 2010 (DOD QSM). Prior to extraction, all samples were processed according to the laboratory protocols specified in the appropriate EPA methodologies. The analyses were performed within the required holding times. There were no target compounds detected in any of the laboratory method blanks. Acceptable performance was observed for all LCSs, initial calibration standards, and calibration check standards. Marginal exceedances were observed with the MS/MSD samples, and certain serial dilutions and surrogate samples.

MS/MSDs were prepared for samples: BPG7S, BP78S6, and BPG3D30. Low or elevated recoveries were obtained for some compounds in these MS/MSD samples, and the associated detections for these compounds in the parent samples were qualified to indicate that they are biased quantitative estimates.

Marginal exceedances of Quality Control criteria were also observed for the serial dilutions of samples BPG7S and BPDN16S6. Serial dilution of Arsenic in sample BPG7S was above the Quality Control limit at 11.5 % difference. The value is outside the 90-110% range specified by the method. Serial dilution of arsenic, lead, and antimony in sample BPDN16S6 was above the 110% upper limit for antimony, arsenic, and lead. These results indicate possible matrix interference. The associated COC detections in these samples have been qualified to indicate that they are potentially biased quantitative estimates.

Additionally, low surrogate recoveries were obtained for nitrobenzene-d5 for samples BPN9S6 and BPN10S6, and Terphenyl-d14 for samples BPN16S and BPDN16S. The laboratory attributed these low recoveries to matrix interference- viscous matrix. These low recoveries are an indication of a potential low bias of the analytical results of these samples for the following associated compounds: 1-Methylnaphthalene, 2-Methylnapthalene, and Naphthalene for samples BPN9S6 and BPN10S6; and Benzo (a) anthracene, Benzo (a) pyrene, Benzo (b) fluoranthene, Benzo (g, h, i) perylene, Benzo (k) fluoranthene, Dibenzo (a, h) anthracene, Ideno (1, 2, 3-cd) pyrene, and Pyrene for samples BPN16S and BPDN16S. With the exception of Benzo (b) fluoranthene in sample BPN16S, all of these compounds were reported as non-detects in the samples containing low surrogate spike recoveries. The associated COC analytical results for these compounds have been qualified to indicate that they are potentially low biased quantitative estimates.

All of the serial dilution, surrogate spike, and MS/MSD recovery exceedances were marginal and the affected LODs were also below the associated screening levels. Consequently, these qualified "non-detect" results constitute usable and valid data. Data validation procedures have rejected zero percent of the analytical data. Overall, data precision, accuracy, completeness, representativeness, comparability, and execution of data deliverables for the RI analytical data were acceptable, and valid conclusions may be drawn from the soil sample analysis results.

8.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ASTDR), Toxicological Profile for Antimony, December, 1992.

Agency for Toxic Substances and Disease Registry (ASTDR), Toxicological Profile for Lead, August, 2007.

Agency for Toxic Substances and Disease Registry (ASTDR), Toxicological Profile for Polycyclic Aromatic Hydrocarbons, August, 1995.

Allwyn Environmental, 2009C. Phase II Environmental Site Assessment, Two Properties Impacted by Small Arms Shooting Range Nogales, Arizona (Parcel Nos. 113-49-006 and 113-49-027), December 2009.

Allywn Environmental, 2009A. Phase I Environmental Site Assessment Hazardous Substances, La Loma Grande, LLC Property Nogales, Arizona (Parcel No. 113-49-006), March 2009.

Allywn Environmental, 2009B. Phase I Environmental Site Assessment Hazardous Substances, Barr Property Nogales, Arizona (Parcel No. 113-49-027), May 2009.

Arizona Administrative Code, Title 18. Environmental Quality, Chapter 7. Department of Environmental Quality Remedial Action, Article 2. Soil Remediation Standards, Appendix A. Soil Remediation Levels (SRLs); adopted December 4, 1997; updated May 5, 2007.

Arizona Department of Environmental Quality (ADEQ) and United States Geological Survey (USGS); *Critical U.S. –Mexico Borderland Watershed Analysis, Twin Cities Area of Nogales, Arizona and Nogales, Sonora*; by Laura Margaret Brady, Floyd Gray, Mario Castaneda, Mark Bultman, and Karen Sue Bolm; 2002.

Arizona-Sonora Desert Museum website, Images and Descriptions of the Sonoran Desert, accessed 13 December 2011, http://www.desertmuseum.org/desert/sonora.php

Cao, X., L.Q. Ma, D. Hardison Jr., and W.G. Harris. 2003. *Weathering of Lead Bullets and their Environmental Effects at Outdoor Shooting Ranges*. Journal of Environmental Quality 32:526-534.

City of Nogales website, The History of Nogales, Arizona, accessed 13 December 2011, http://www.nogalesaz.gov/History/

Hardison Jr., D., *Environmental Fate of Lead in Florida Shooting Range Soils*, University of Florida, 2003.

Interstate Technology Regulatory Council (ITRC) Small Arms Firing Range Team, *Technical/Regulatory Guidelines: Characterization and Remediation of Soils at Closed Small Arms Firing Ranges*, January 2003.

Mrozik, A., Piotrowska-Seget, Z., Labuzek, S., *Bacterial Degradation and Bioremediation of Polycyclic Aromatic Hydrocarbons*, Polish Journal of Environmental Studies Vol. 12, No. 1 (2003), 15-25.

National Park Service, U.S. Department of the Interior, Tonto National Monument, *Common Plants of the Sonoran Desert*, website accessed 12 December 2011, http://www.nps.gov/tont/forteachers/upload/Sonoran%20Desert%20Plants.pdf

Nogales area average and record monthly temperature and precipitation data
Period of Record: 1952-2010
Western Regional Climate Center, http://www.wrcc.edu/cgi-bin/cliMAIN.pl?az5924

Nogales Airport station prevailing wind direction
Period of Record: 1992-2002
Western Regional Climate Center
http://www.wrcc.dri.edu/htmlfiles/westwinddir.html#ARIZONA

Seo, J., Keum, Y., and Li, Q., *Bacterial Degradation of Aromatic Compounds*, International Journal of Environmental Research and Public Health. 2009 January; 6 (1): 278-309.

Shacklette, H. T., Boerngen, J. G., 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. U.S. Geological Survey Professional Paper 1270. United States Government Printing Office Washington: 1984.

Southern Arizona rainwater pH
Period of Record: November-December 2001
United States Geological Survey
http://water.usgs.gov/nwc/NWC/pH/html/ph.html

TerranearPMC, LLC (TPMC); Final Quality Assurance Project Plan for Remedial Investigation/Feasibility Study (RI/FS) of the U.S. Border Patrol Firing Range, Nogales, Arizona, December 2011.

TerranearPMC, LLC (TPMC); Final Work Plan for the U.S. Border Patrol Firing Range Remedial Investigation/Feasibility Study (RI/FS), Nogales, Arizona, December 2011.

U.S. Army Corps of Engineers (USACE), 2004, *Environmental Quality Formerly Used Defense Sites (FUDS) Program Policy*, Engineer Regulation (ER) 200-3-1, 10 May 2004.

U.S. Army Corps of Engineers (USACE), 2005. EM 200-1-10, 2005, *Environmental Quality - Guidance for Evaluating Performance-Based Chemical Data*, 30 June 2005, Revised June 2009.

U.S. Army Corps of Engineers (USACE), 1997, EM 200-1-6, 1997, *Chemical Quality Assurance for HTRW Projects*, 10 October, 1997.

U.S. Department of Agriculture, Soil Conservation Service, *Soil Survey of Santa Cruz and Parts of Cochise and Pima Counties, Arizona*, 1979.

U.S. Department of Defense (DOD), 2009, Quality Systems Manual for Environmental Laboratories, Version 4.2, 25 October 2010.

U.S. Environmental Protection Agency (USEPA), 40 CFR 261.20-24 (Subpart C).

U.S. Environmental Protection Agency (USEPA), 40 CFR 262.21-23.

U.S. Environmental Protection Agency (USEPA), 40 CFR 268.7.

U.S. Environmental Protection Agency (USEPA) 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, 540/G-89/004 OSWER Directive 9355.3-01, Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 1987, *a Compendium of ERT Groundwater Sampling Procedures*. USEPA/540/P-87/001. Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 1989, *Risk Assessment Guidance for Superfund*, Part D Tables 1, 2,3,4,5 and 6. Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA) 1990. *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*. August 1990. Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 1994, *Nation Oil and Hazardous Substance Pollution Contingency Plan*, Sections 300.120 (d) 300.400(d) and 300.430 (e) (2) (i). Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 1994 *Remediation Technologies Screening Matrix and Reference Guide* (USEPA 1994). October 1994.

U.S. Environmental Protection Agency (USEPA), 1999. *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*. July 1999. Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 2000. Short Sheet: TRW Recommendations for Sampling and Analysis of Soil at Lead (Pb) Sites. April 2000. OSWER #9285.7-38 Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 2001, *Risk Assessment Guidance for Superfund (RAGS): Volume I - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments) Final December 2001*. Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S Environmental Protection Agency (USEPA), 2002. *Region 9 Preliminary Remediation Goals 2002 Table*. October 10, 2002. Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 2003. *TRW Recommendations for Performing Human Health Risk Analysis on small Arms Shooting Ranges*. March 2003. OSWER #9285.7-37 Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 2005. *Ecological Soil Screening Levels for Antimony Interim Final*. OSWER Directive 9285.7-61

U.S. Environmental Protection Agency (USEPA), 2005. *Ecological Soil Screening Levels for Arsenic Interim Final*. OSWER Directive 9285.7-62

U.S. Environmental Protection Agency (USEPA), 2005. *Ecological Soil Screening Levels for Lead Interim Final*. OSWER Directive 9285.7-70

U.S. Environmental Protection Agency (USEPA), 2007. *Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) Interim Final*. OSWER Directive 9285.7-78

U.S. Environmental Protection Agency (USEPA), 2011. Regional Screening Level Table. November. http://www.epa.gov/region6/6pd/rcra_c/pd-n/screen.htm

United States Geological Survey (USGS) and Arizona Department of Environmental Quality (ADEQ), primary author: Laura Brady, USGS; *Critical U.S.-Mexico Borderland Watershed Analysis, Twin Cities Area of Nogales, Arizona and Nogales, Sonora*, online document accessed 12 December 2011 (no date on document as read on webpage), http://proceedings.esri.com/library/userconf/proc01/professional/papers/pap1006/p1006.htm

INDEX MAP

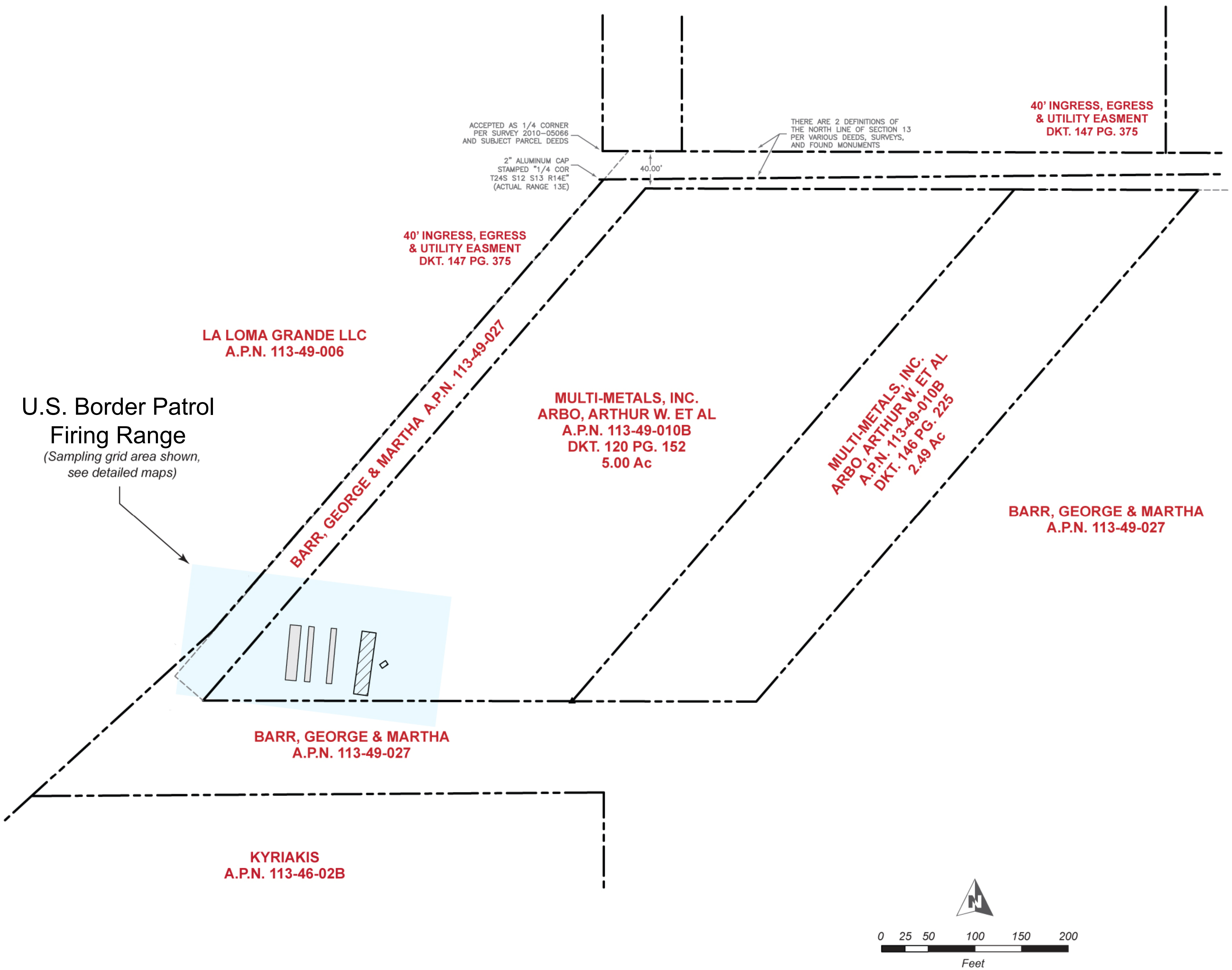
TerranearPMC

U.S. Border Patrol Firing Range

FIGURE 1

Site Location

Date: December 1, 2011
Drafted by: TPMCrl
Rev: February 9, 2012
Checked by: E. Klingel
File Name: NogalesFR_Location



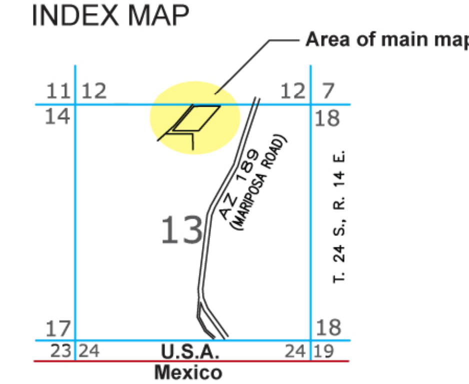
Ownership boundary

Easment

Structure

Concrete pad

INDEX MAP



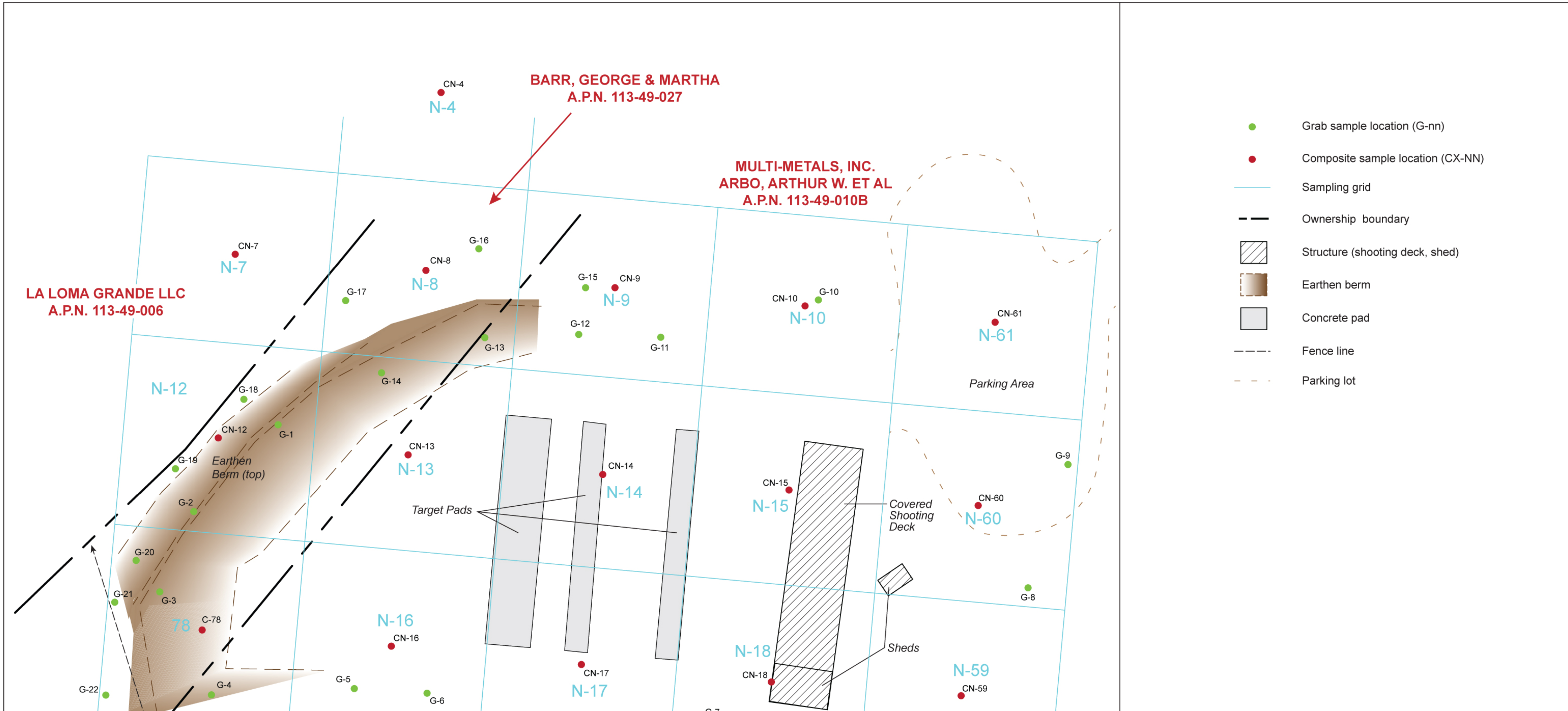
A PORTION OF SECTION 13, T. 24 S., R. 13 E., G. & S. R. M., SANTA CRUZ COUNTY, ARIZONA

TerranearPMC

U.S. Border Patrol Firing Range

FIGURE 2
Site Map

Date: December 8, 2011 Rev: February 9, 2012
Drafted by: TPMCrl Checked by: E. Klingel File Name: NogalesFR_SiteMap



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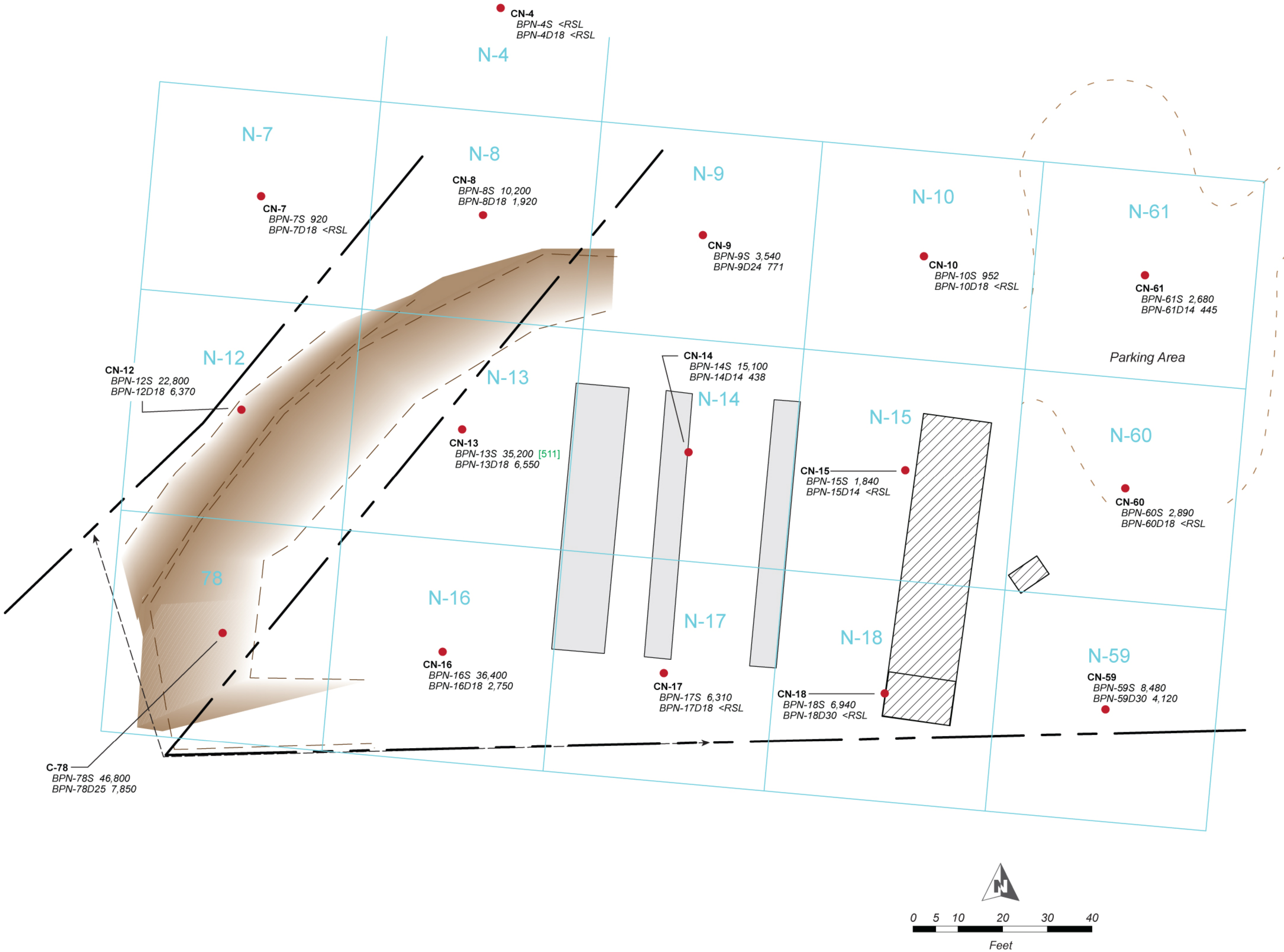
U.S. Border Patrol Firing Range

FIGURE 3
Sampling Grid and Sample Locations

Date: December 21, 2011 Rev: February 9, 2012
Drafted by: TPMCrl Checked by: E. Klingel File Name: NogalesFR_SampleLocs



Composite sample
(*Sample No. Result mg/kg* [TCLP mg/l])

Sampling grid

Ownership boundary

Structure (shooting deck, shed)

Earthen berm

Concrete pad

Fence line

Parking lot

USEPA Region 9 Residential Regional Screening Level (RSL) for LEAD = 400 mg/kg

LEAD Toxicity Characteristic Leaching Potential (TCLP) mg/l

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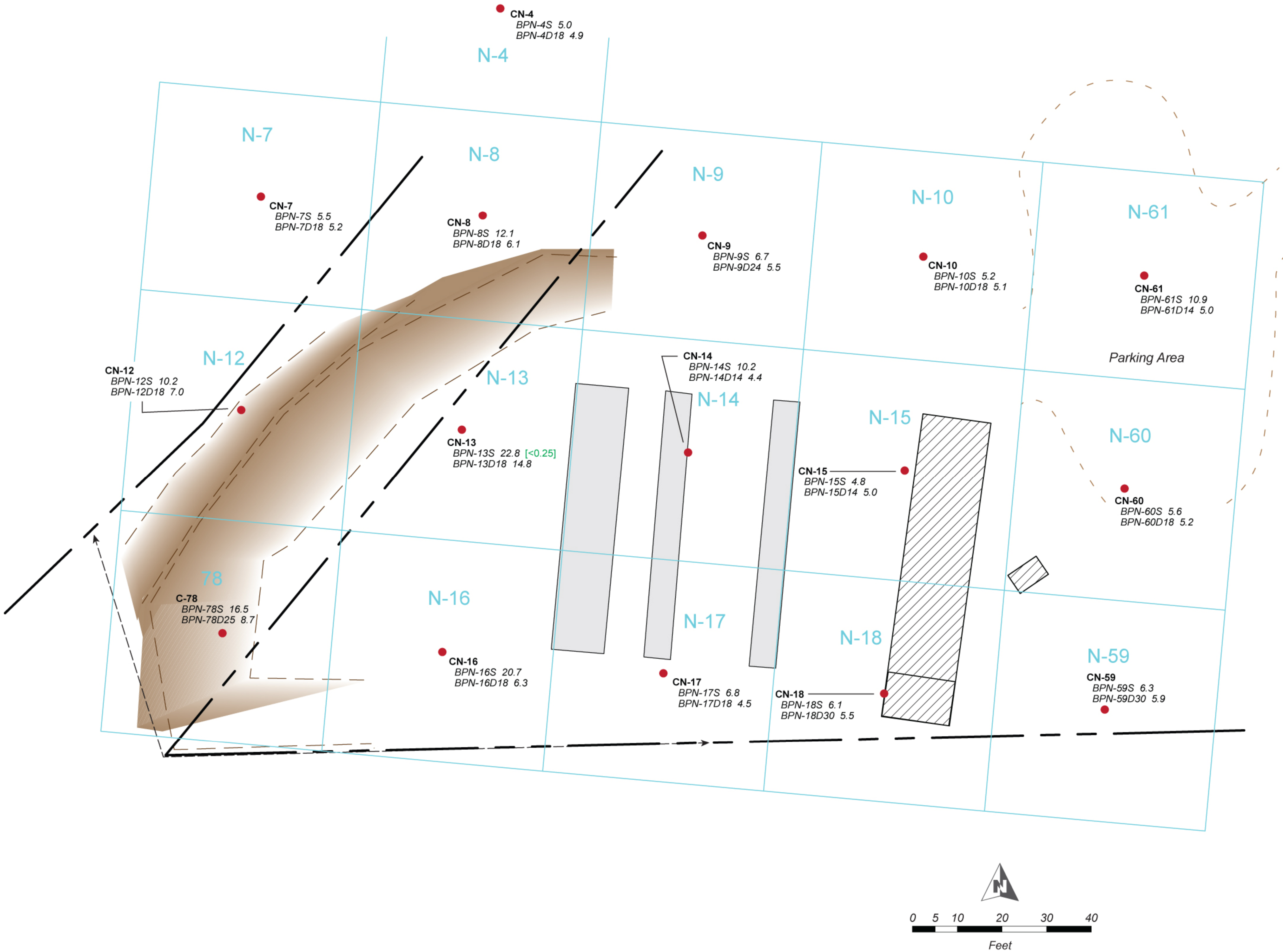
U.S. Border Patrol Firing Range

FIGURE 4 Deep & Shallow Composite Samples for Lead > Residential RSL & TCLP

Date: January 3, 2012 Rev: February 9, 2012
Drafted by: TPMCrl Checked by: E. Klingel
File Name: NogalesFR_Comp_Lead



Composite sample (*Sample No. Result mg/kg* [TCLP mg/l])

Sampling grid

Ownership boundary

Structure (shooting deck, shed)

Earthen berm

Concrete pad

Fence line

Parking lot

USEPA Region 9 Residential Regional Screening Level (RSL) for ARSENIC = 0.39 mg/kg

ARSENIC Toxicity Characteristic Leaching Potential (TCLP) mg/l

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U.S. Border Patrol Firing Range

FIGURE 5 Deep & Shallow Composite Samples for Arsenic > Residential RSL & TCLP

Date: January 3, 2012 Rev: February 9, 2012
Drafted by: TPMCrl Checked by: E. Klingel
File Name: NogalesFR_Comp_Arsenic

Composite sample (*Sample No. Result mg/kg*)

Sampling grid

Ownership boundary

Structure (shooting deck, shed)

Earthen berm

Concrete pad

Fence line

Parking lot

USEPA Region 9 Residential Regional Screening Level (RSL) for ANTIMONY = 31 mg/kg

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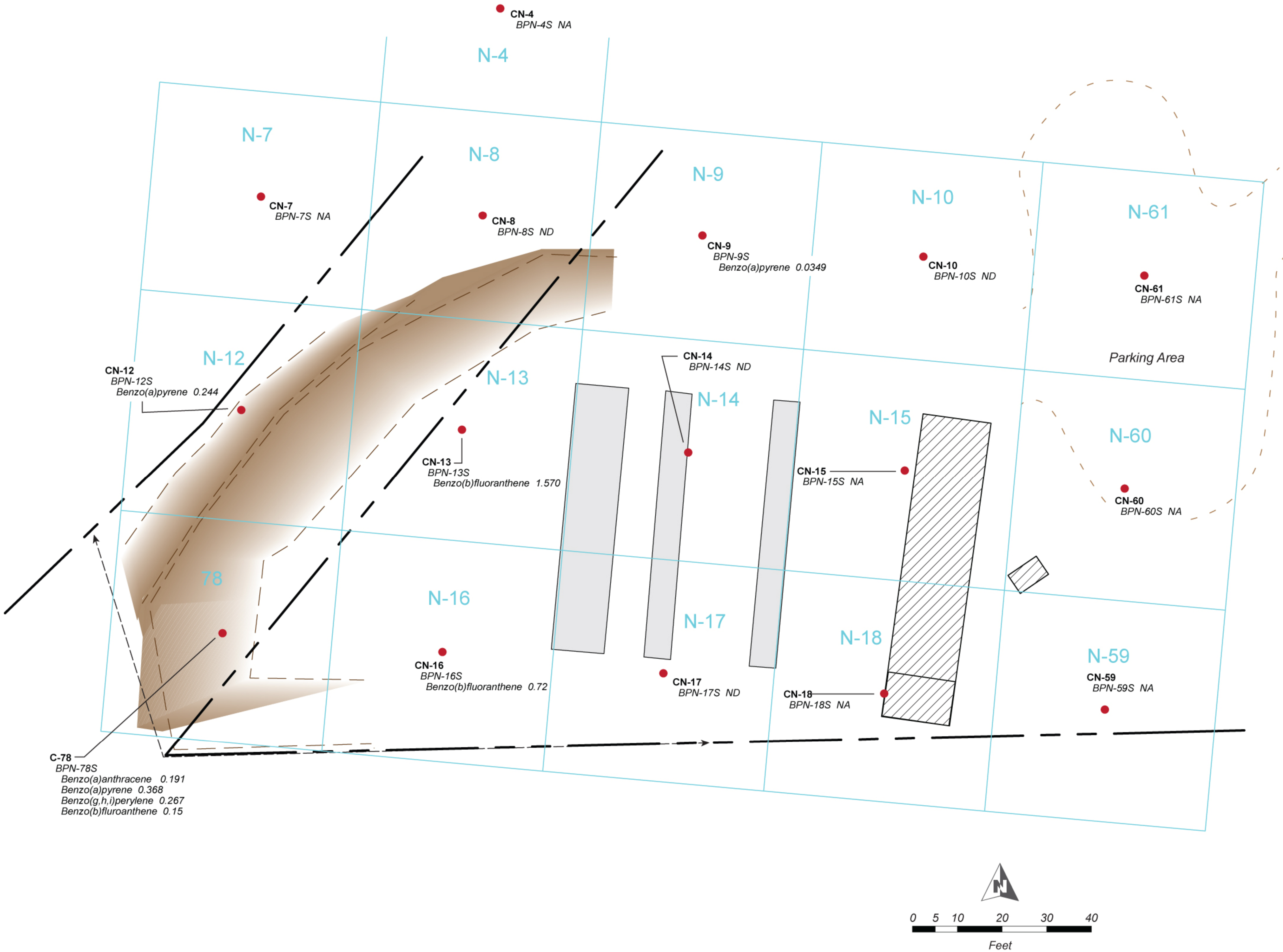
U.S. Border Patrol Firing Range

FIGURE 6 Deep & Shallow Composite Samples for Antimony > Residential RSL

Date: January 3, 2012 Drafted by: TPMCrl
Rev: February 9, 2012 Checked by: E. Klingel
File Name: NogalesFR_Comp_Antimony



Composite sample
(*Sample No. Analyte Result mg/kg*)
> USEPA RSL Analytes Only
NA - not analyzed, ND - non detect

Sampling grid

Ownership boundary

Structure (shooting deck, shed)

Earthen berm

Concrete pad

Fence line

Parking lot

USEPA Region 9 Residential Regional Screening Level (RSL) for POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs):

Benzo(a)anthracene = 0.15 mg/kg
Benzo(a)pyrene = 0.015 mg/kg
Benzo(g,h,i)perylene = no standard
Benzo(b)fluoranthene = 0.15 mg/kg
Benzo(k)fluoranthene = 1.5 mg/kg
Chrysene = 15 mg/kg
Fluroanthene = 2,300 mg/kg

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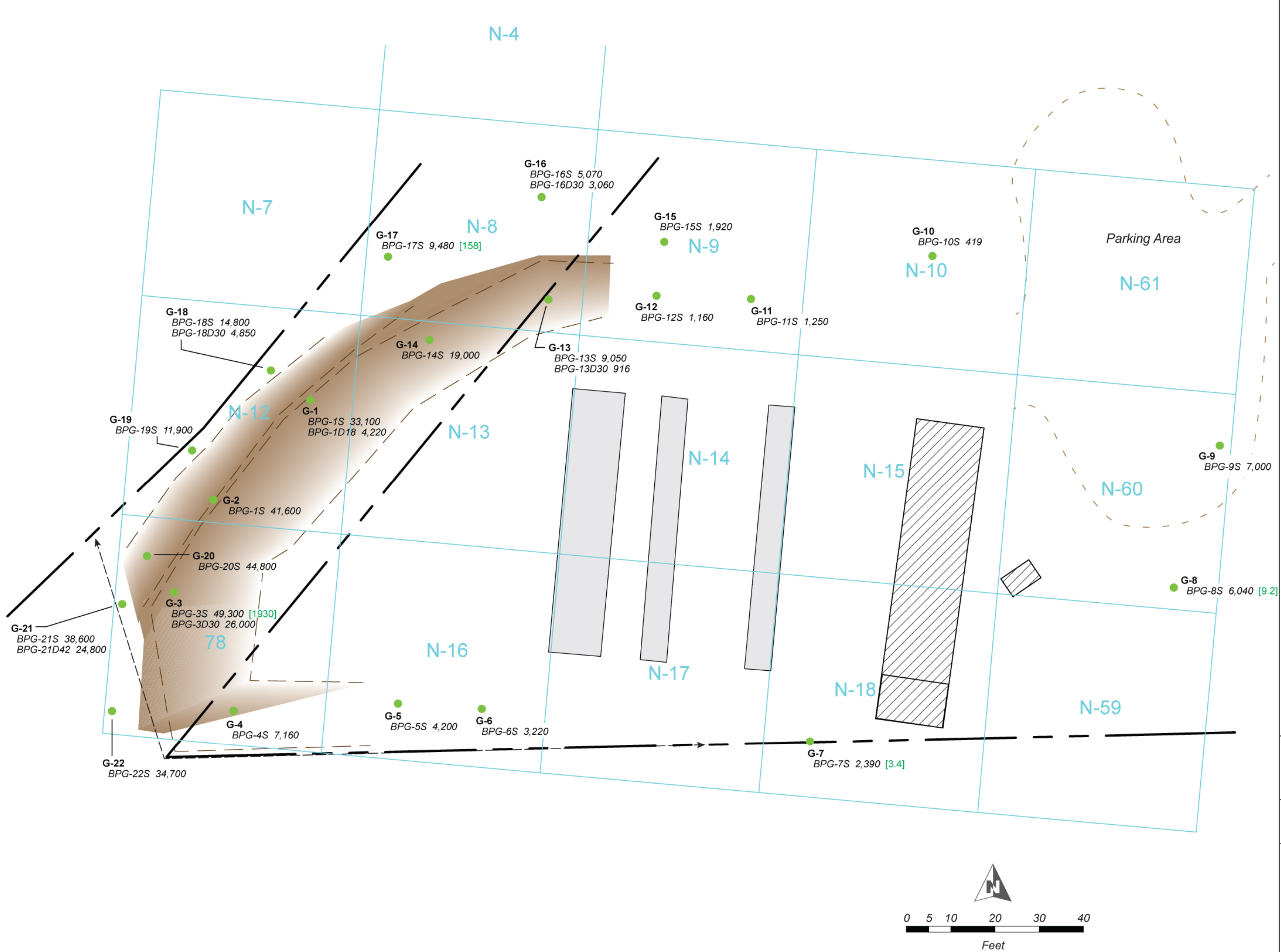
U.S. Border Patrol Firing Range

FIGURE 7
Shallow Composite Samples for PAHs > Residential RSLs

Date: January 3, 2012 Rev: February 9, 2012
Drafted by: TPMCrl Checked by: E. Klingel File Name: NogalesFR_Comp_PAH



Grab sample (*Sample No. Result mg/kg* [TCLP mg/l])

Sampling grid

Ownership boundary

Structure (shooting deck, shed)

Earthen berm

Concrete pad

Fence line

Parking lot

USEPA Region 9 Residential Regional Screening Level (RSL) for LEAD = 400 mg/kg

LEAD Toxicity Characteristic Leaching Potential (TCLP) mg/l

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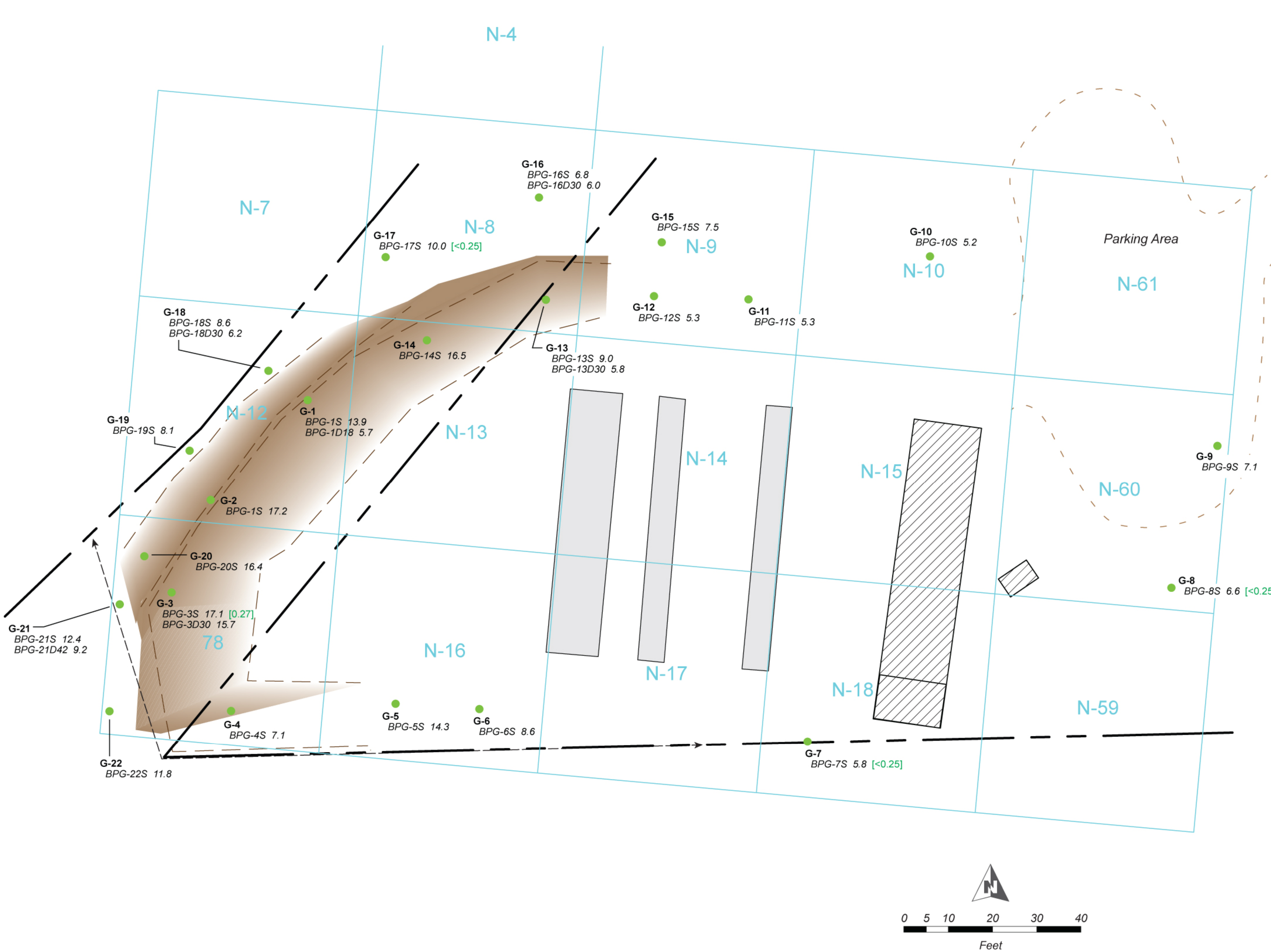
U.S. Border Patrol Firing Range

FIGURE 8 Deep & Shallow Grab Samples for Lead > Residential RSL & TCLP

Date: January 3, 2012 | Rev: February 9, 2012
Drafted by: TPMCrl | Checked by: E. Klingel
File Name: NogalesFR_Grab_Lead



Grab sample
(*Sample No. Result mg/kg* [TCLP mg/l])

Sampling grid

Ownership boundary

Structure (shooting deck, shed)

Earthen berm

Concrete pad

Fence line

Parking lot

USEPA Region 9 Residential Regional Screening Level (RSL) for ARSENIC = 0.39 mg/kg

ARSENIC Toxicity Characteristic Leaching Potential (TCLP) mg/l

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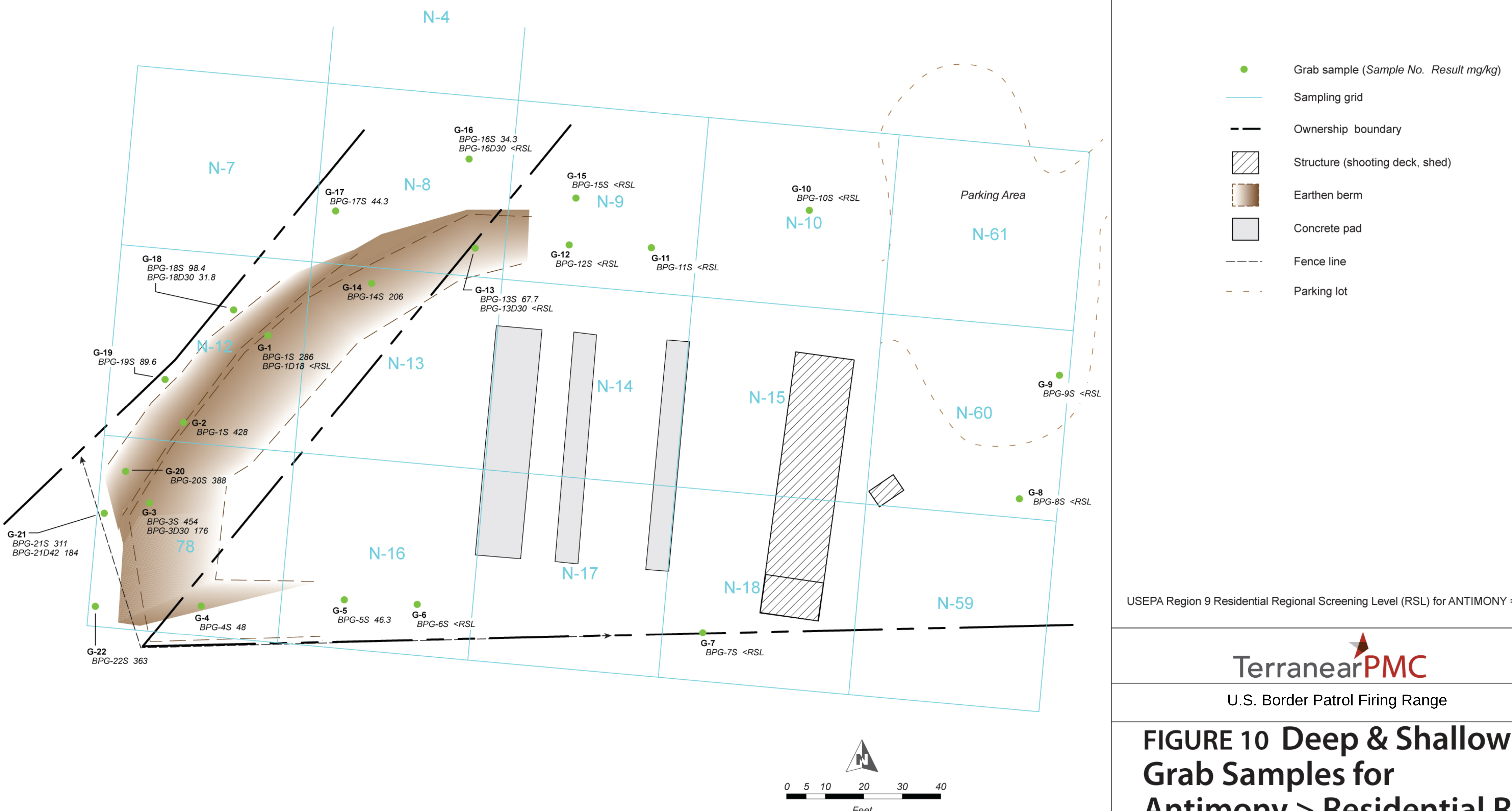
U.S. Border Patrol Firing Range

FIGURE 9 Deep & Shallow Grab Samples for Arsenic > Residential RSL & TCLP

Date: January 3, 2012
Drafted by: TPMCrl

Rev: February 9, 2012
Checked by: E. Klingel

File Name: NogalesFR_Grab_Arsenic



USEPA Region 9 Residential Regional Screening Level (RSL) for ANTIMONY = 31 mg/kg

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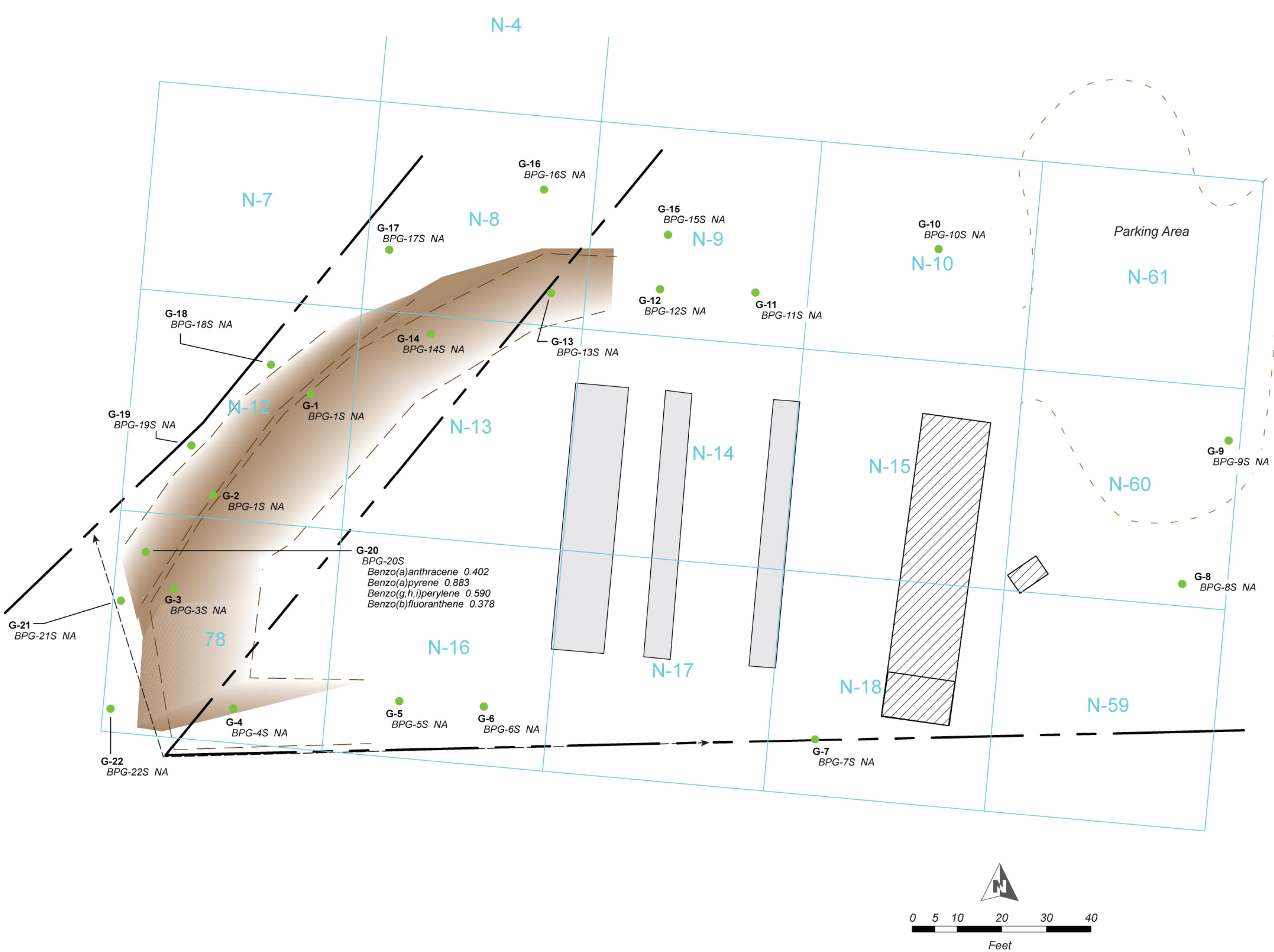
FIGURE 10 Deep & Shallow Grab Samples for Antimony > Residential RSL

Date: January 3, 2012
Drafted by: TPMCrl
Rev: February 9, 2012
Checked by: E. Klingel
File Name: NogalesFR_Grab_Antimony



Grab sample
(*Sample No. Analyte Result mg/kg*)
> USEPA RSL Analytes Only
NA - not analyzed

Sampling grid

Ownership boundary

Structure (shooting deck, shed)

Earthen berm

Concrete pad

Fence line

Parking lot

USEPA Region 9 Residential Regional Screening Level (RSL) for POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs):

Benzo(a)anthracene = 0.15 mg/kg
Benzo(a)pyrene = 0.015 mg/kg
Benzo(g,h,i)perylene = no standard
Benzo(b)fluoranthene = 0.15 mg/kg
Chrysene = 15 mg/kg
Fluroanthene = 2,300 mg/kg

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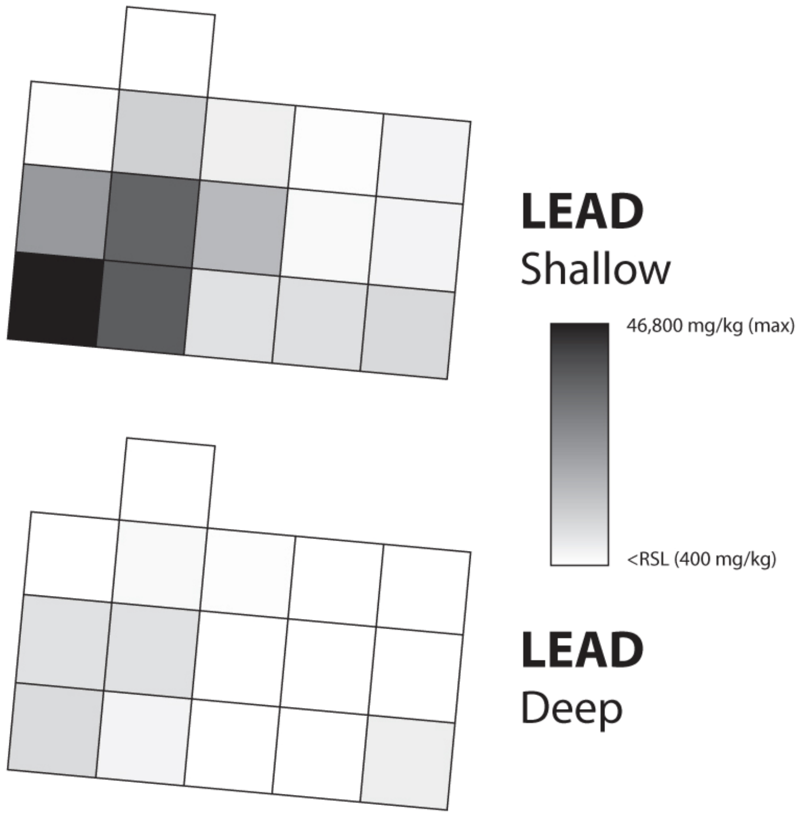
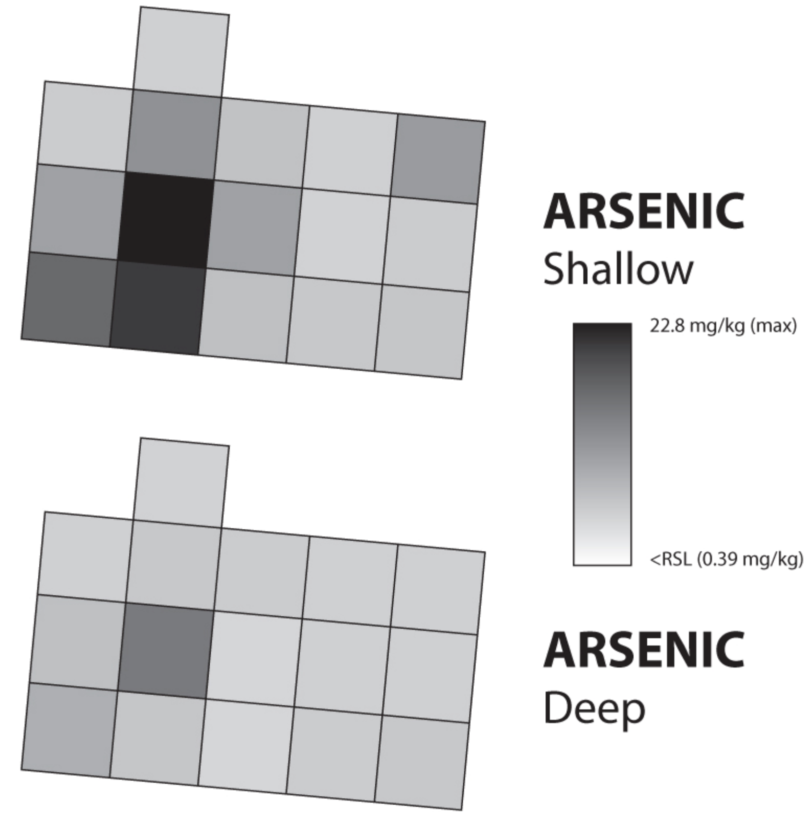
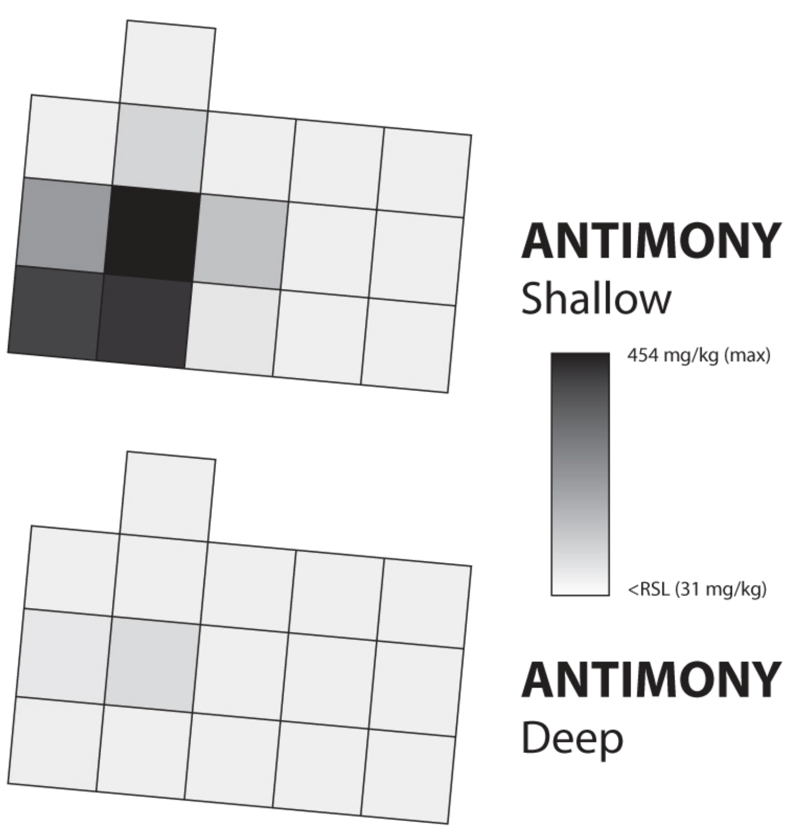
FIGURE 11

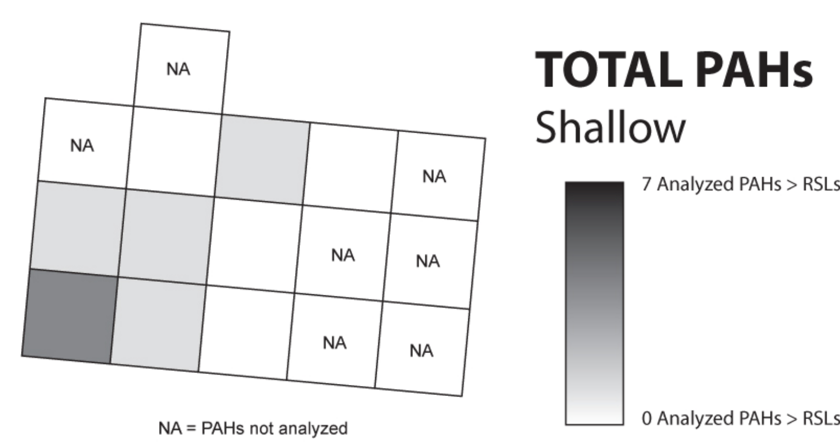
Shallow Grab Samples for PAHs > Residential RSLs

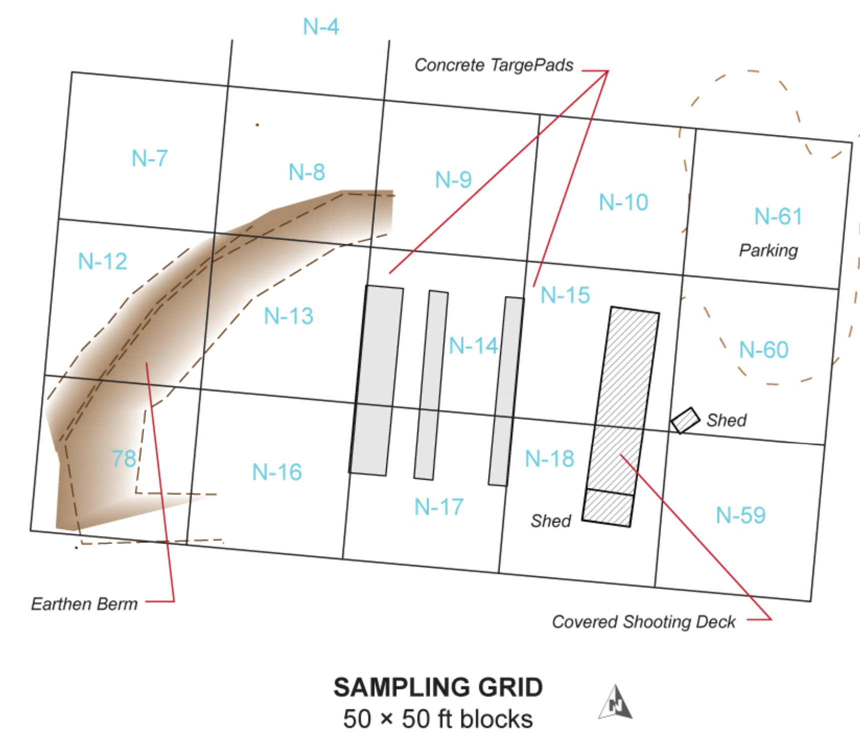
Date: January 3, 2012
Drafted by: TPMCrl
Rev: February 9, 2012
Checked by: E. Klingel
File Name: NogalesFR_Grab_PAH











USEPA Region 9 Residential Soil Screening Level (RSL) for *ANALYZED* METALS:

LEAD = 400 mg/kg
ARSENIC = 0.39 mg/kg
ANTIMONY = 31 mg/kg

ANALYZED POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs):

Benzo(a)anthracene
Benzo(a)pyrene
Benzo(g,h,i)perylene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Chrysene
Fluroanthene

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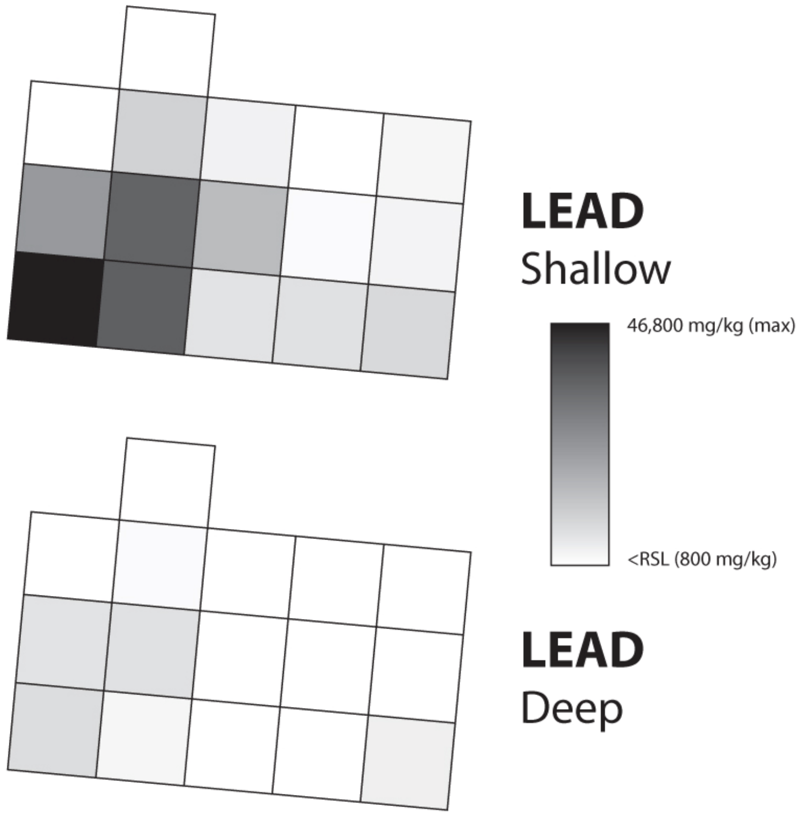
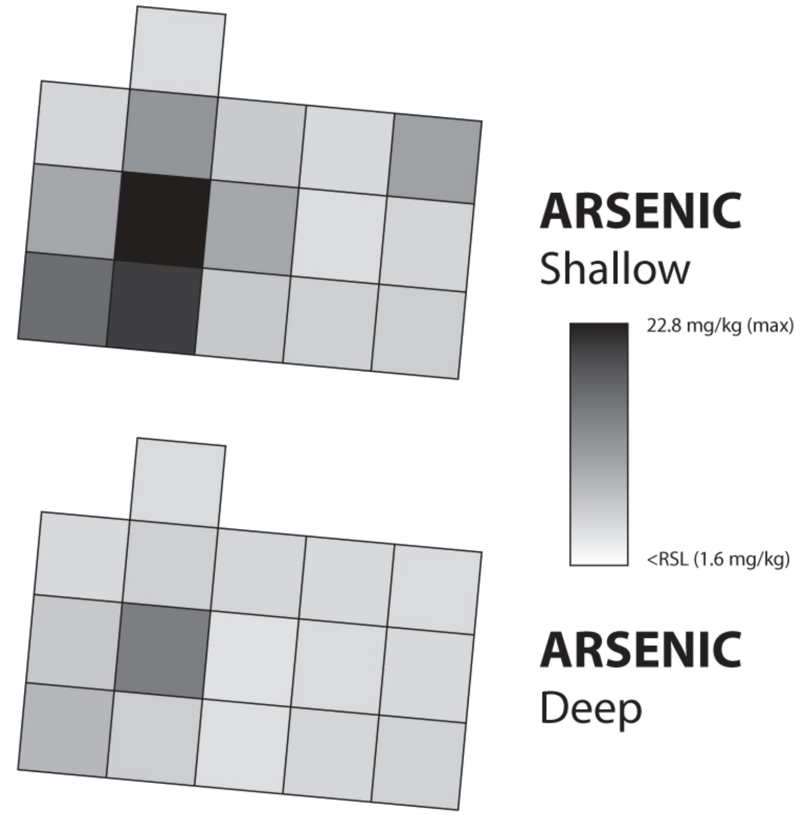
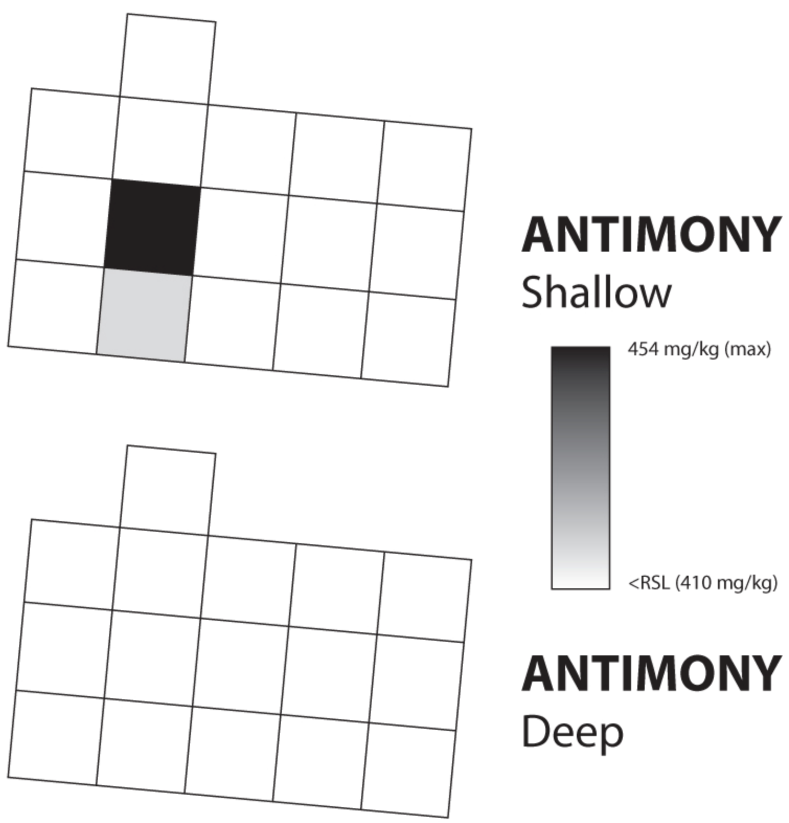
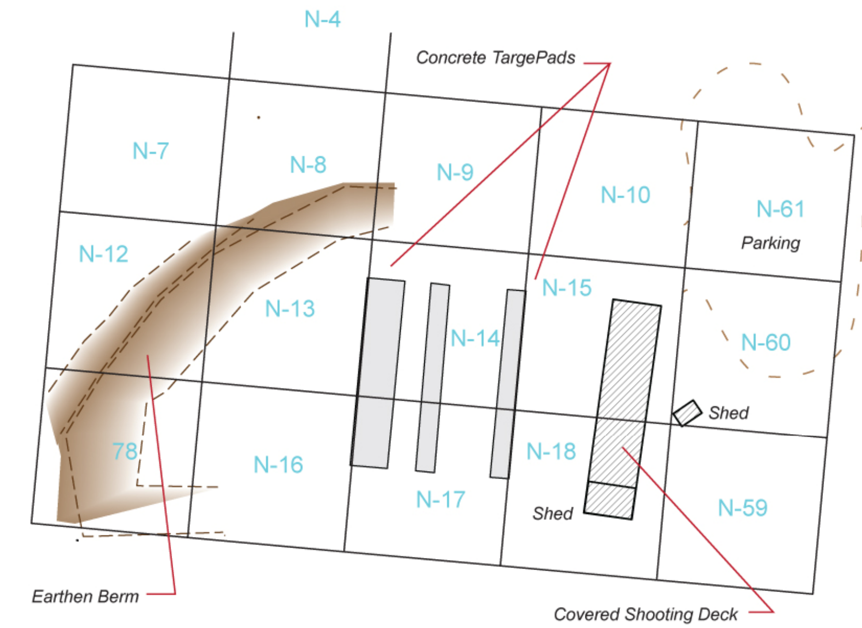
FIGURE 12 Deep & Shallow Composite Samples Analyte Comparison > Residential RSLs

Date: January 12, 2012
Drafted by: TPMCrl
Rev: February 9, 2012
Checked by: E. Klingel
File Name: NogalesFR_Comp_AnalyteComp_Res









SAMPLING GRID
50 × 50 ft blocks

USEPA Region 9 Industrial Regional Screening Level (RSL) for *ANALYZED* METALS:
LEAD = 800 mg/kg
ARSENIC = 1.6 mg/kg
ANTIMONY = 410 mg/kg

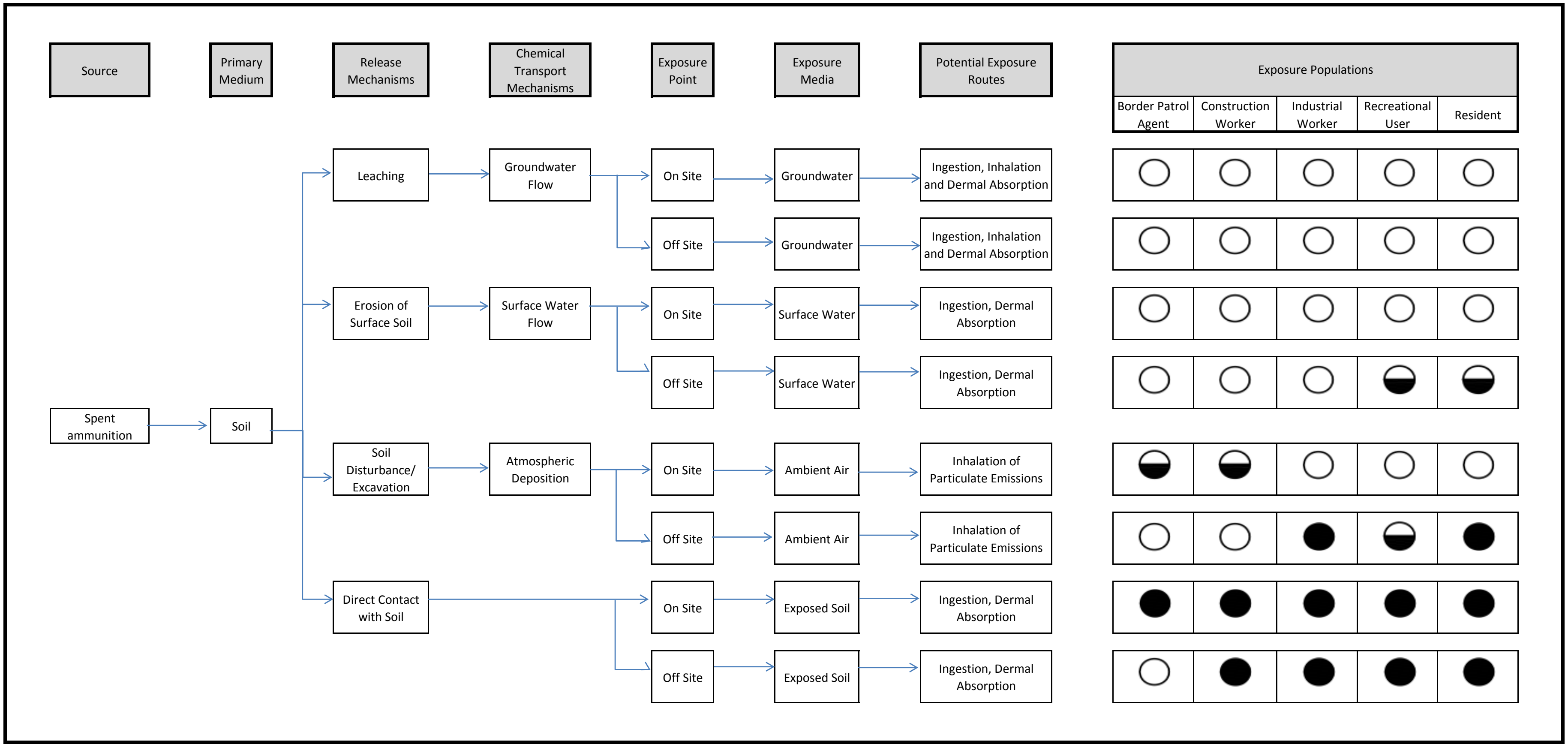
TerranearPMC

U.S. Border Patrol Firing Range

FIGURE 13 Deep & Shallow Composite Samples Analyte Comparison > Industrial RSLs

Date: February 7, 2012
Drafted by: TPMCrl
Rev: February 9, 2012
Checked by: E. Klingel
File Name: NogalesFR_Comp_AnalyteComp_Ind

Figure 14
Conceptual Fate, Transport and Exposure Model
U.S. Border Patrol Firing Range Nogales, Arizona



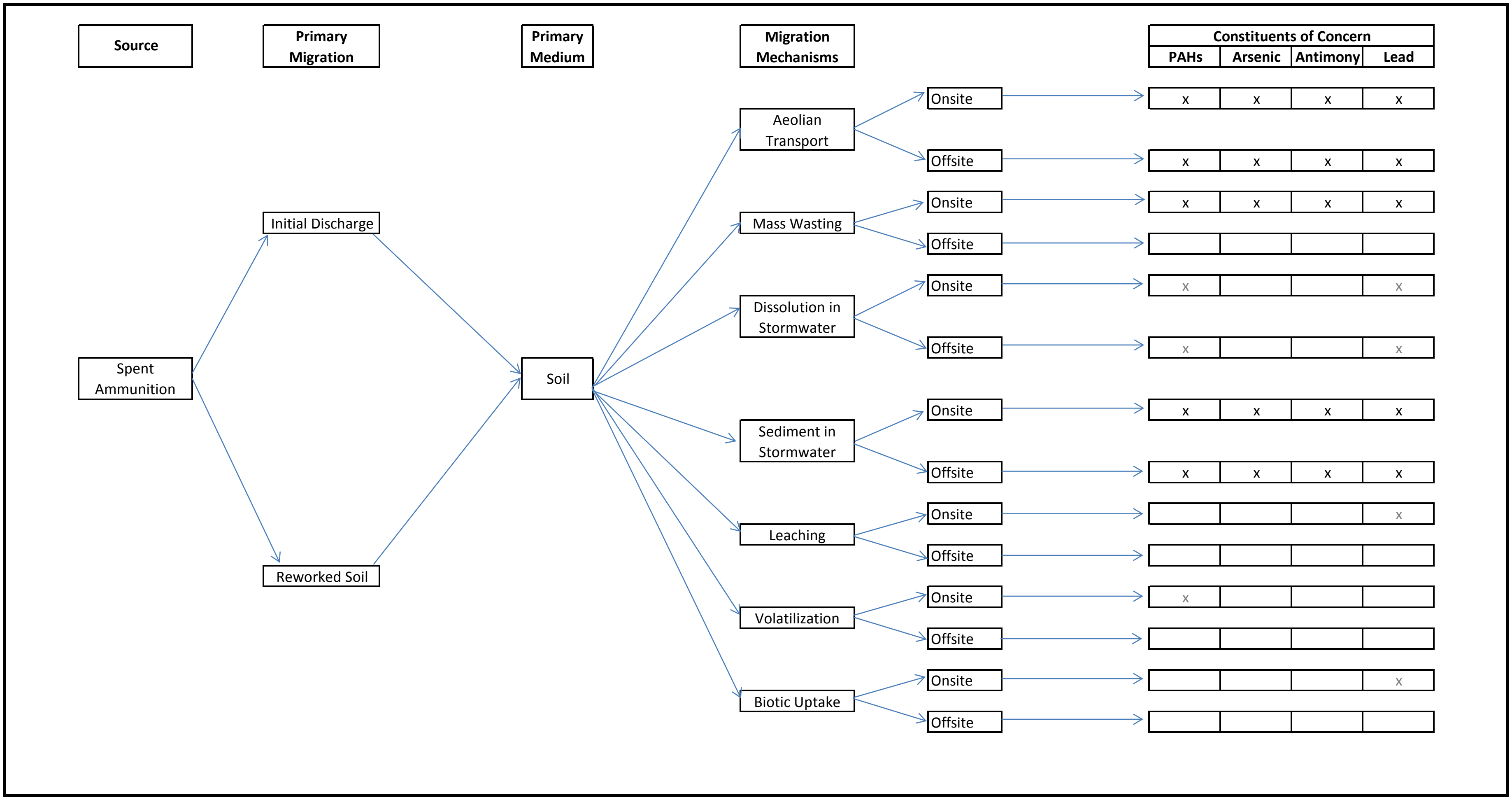
* Medium is surface soil for all receptors, and also subsurface soil for construction workers only.

● Potentially Complete Exposure Pathway

◒ Potentially complete but Insignificant Exposure Pathway

○ Incomplete Pathway

Figure 15
Conceptual Fate and Transport Model
U.S. Border Patrol Firing Range
Nogales, Arizona



Migration Mechanism	Location	PAHs	Arsenic	Antimony	Lead
Aeolian Transport	Onsite	x	x	x	x
Aeolian Transport	Offsite	x	x	x	x
Mass Wasting	Onsite	x	x	x	x
Mass Wasting	Offsite				
Dissolution in Stormwater	Onsite	x			x
Dissolution in Stormwater	Offsite	x			x
Sediment in Stormwater	Onsite	x	x	x	x
Sediment in Stormwater	Offsite	x	x	x	x
Leaching	Onsite				x
Leaching	Offsite				
Volatilization	Onsite	x			
Volatilization	Offsite				
Biotic Uptake	Onsite				x
Biotic Uptake	Offsite				

Notes:

x - Potentially Significant Transport Mechanisms for COC
x - Potential but Not Significant Transport Mechanisms for COC
Blank - Insignficant Transport Mechanism for COC

Table 1
Data Quality Objectives for Soil Sample Analysis:
Determination of Viability for Accutest Laboratory Detection Limits
in comparison to EPA and ADEQ Screening Levels
U.S. Border Patrol Firing Range
Nogales, Arizona

Soils		**Metals (ICP/MS)**				**6010 SW846**		
Analyte	**CAS No.**	**EPA Residential RSLs (mg/kg)**	**EPA Industrial RSLs (mg/kg)**	**ADEQ Residential SRLs (mg/kg)**	**ADEQ Non-residential SRLs (mg/kg)**	**Accutest Laboratories Detection Limits**		**Below ADEQ or EPA Screening Level?**
						DL (mg/kg)	**RL (mg/kg)**	
Antimony	7440-36-0	3.1E+01	4.1E+02	3.1E+01	4.1E+02	0.087	2	Yes
Arsenic	7440-38-2	3.9E-01	1.6E+00	1.0E+01	1.0E+01	0.07	2	Yes
Lead	7439-92-1	4.0E+02	8.0E+02	4.0E+02	8.0E+02	0.054	2	Yes

Soils			**Poly-aromatic Hydrocarbons (GC/MS)**			**8270D**		
Analyte	**CAS No.**	**EPA Residential RSLs (mg/kg)**	**EPA Industrial RSLs (mg/kg)**	**ADEQ Residential SRLs (mg/kg)**	**ADEQ Non-residential SRLs (mg/kg)**	**Accutest Laboratories Detection Limits**		**Below ADEQ or EPA Screening Level?**
						DL (mg/kg)	**RL (mg/kg)**	
Acenaphthene	83-32-9	3.4E+03	3.3E+04	3.7E+03	2.9E+04	0.17	0.33	Yes
Acenaphthylene	208-96-8	NSL	NSL	NSL	NSL	0.067	0.17	NA
Anthracene	120-12-7	1.7E+04	1.7E+05	2.2E+04	2.4E+05	0.033	0.17	Yes
Benzo[a] anthracene	56-55-3	1.5E-01	2.1E+00	6.9E-01	2.1E+01	0.023	0.17	Yes
Benzo (a) pyrene	50-32-8	1.5E-02	2.1E-01	6.9E-02	2.1E+00	0.017	0.30	Yes
Benzo[b]fluoranthene	205-99-2	1.5E-01	2.1E+00	6.9E-01	2.1E+01	0.020	0.17	Yes
Benzo (g, h, i) perylene	191-24-2	NSL	NSL	NSL	NSL	0.05	0.17	NA
Benzo[k]fluoranthene	207-08-9	1.5E+00	2.1E+01	6.9E+00	2.1E+02	0.04	0.17	Yes
Chrysene	218-01-9	1.5E+01	2.1E+02	6.8E+01	2.0E+03	0.033	0.17	Yes
Dibenzo (a, h) anthracene	53-70-3	1.5E-02	2.1E-01	6.9E-02	2.1E+00	0.043	0.17	Yes

Table 1
Data Quality Objectives for Soil Sample Analysis:
Determination of Viability for Accutest Laboratory Detection Limits
in comparison to EPA and ADEQ Screening Levels
U.S. Border Patrol Firing Range
Nogales, Arizona

Soils				Poly-aromatic Hydrocarbons (GC/MS)			8270D	
Analyte	CAS No.	EPA Residential RSLs (mg/kg)	EPA Industrial RSLs (mg/kg)	ADEQ Residential SRLs (mg/kg)	ADEQ Non-residential SRLs (mg/kg)	Accutest Laboratories Detection Limits		Below ADEQ or EPA Screening Level?
						DL (mg/kg)	RL (mg/kg)	
Fluoranthene	206-44-0	2.3E+03	2.2E+04	2.3E+03	2.2E+04	0.033	0.17	Yes
Fluorene	86-73-7	2.3E+03	2.2E+04	2.7E+03	2.6E+04	0.06	0.17	Yes
Indeno [1,2,3-cd] pyrene	193-39-5	1.5E-01	2.1E+00	6.9E-01	2.1E+01	0.047	0.17	Yes
1-Methylnaphthalene	90-12-0	2.2E+01	9.9E+01	NSL	NSL	0.053	0.17	Yes
2-Methylnaphthalene	91-57-6	3.1E+02	4.1E+03	NSL	NSL	0.053	0.17	Yes
Naphthalene	91-20-3	3.6E+00	1.8E+01	5.6E+01	1.9E+02	0.057	0.17	Yes
Phenanthrene	85-01-8	NSL	NSL	NSL	NSL	0.037	0.17	NA
Pyrene	129-00-0	1.7E+03	1.7E+04	2.3E+03	2.9E+04	0.23	0.33	Yes

Notes:

ADEQ Arizona Department of Environmental Quality
EPA U.S. Environmental Protection Agency
GS Gas Chromatography
mg/kg milligrams per kilogram
MS Mass Spectrometer
NA Not applicable
NSL No Screening Level
SRL soil remediation level

Table 2
Sample Analytical Result Detections and Human Health Risk Screening
Shallow Composite and Grab Soil Samples
Nogales Border Patrol Firing Range
Nogales, Arizona

Constituent	USEPA ESSLs	Units	Composite Soil Samples 0 to 6 Inches Below Ground Surface																
			BPN-4S	BPN7S	BPN8S	BPN-9S	BPN-10S	BPN-12S	BPN-13S	BPN142S	BPN-15S	BPN-16S	BPDN-16S (Dup)	BPN-17S	BPN-18S	BPN-59S	BPN-60S	BPN-61S	BP-78S
Inorganics																			
Antimony	0.27	mg/kg	<1.7	**4.6**	**84**	**27.5**	**5.9**	**198**	**454**	**125**	**11.2**	**417**	**471**	**48.2**	**19.7**	**27.9**	**7.1**	**25.8**	**399**
Arsenic	18	mg/kg	5	5.5	12.1	6.7	5.2	10.2	**22.8**	10.2	4.8	**20.7**	**22.1**	6.8	6.1	6.3	5.6	10.9	16.5
Lead	11	mg/kg	**198**	**920**	**10,200**	**3,540**	**952**	**22,800**	**35,200**	**15,100**	**1,840**	**36,400**	**37,300**	**6,310**	**6,940**	**8,480**	**2,890**	**2,680**	**46,800**
Polycyclic Aromatic Hydrocarbons																			
Benzo(a)anthracene	1.1	mg/kg	NA	NA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	NA	<LOD	<LOD	<LOD	NA	NA	NA	NA	0.191
Benzo(a)pyrene	1.1	mg/kg	NA	NA	<LOD	0.0349	<LOD	0.244	<LOD	<LOD	NA	<LOD	<LOD	<LOD	NA	NA	NA	NA	0.368
Benzo(b)fluoranthene	1.1	mg/kg	NA	NA	<LOD	0.0345	<LOD	<LOD	**1.570**	<LOD	NA	0.72	<LOD	<LOD	NA	NA	NA	NA	0.279
Benzo(g,h,i)perylene	1.1	mg/kg	NA	NA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	NA	<LOD	<LOD	<LOD	NA	NA	NA	NA	0.267
Benzo(k)fluoranthene	1.1	mg/kg	NA	NA	<LOD	<LOD	<LOD	<LOD	**1.240**	<LOD	NA	<LOD	<LOD	<LOD	NA	NA	NA	NA	<LOD
Chrysene	1.1	mg/kg	NA	NA	<LOD	0.0529	<LOD	0.226	**2.14**	<LOD	NA	**1.180**	**1.780**	<LOD	NA	NA	NA	NA	0.359
Fluoranthene	29	mg/kg	NA	NA	<LOD	<LOD	<LOD	<LOD	1.780	<LOD	NA	0.765	<LOD	<LOD	NA	NA	NA	NA	<LOD

Constituent	USEPA ESSLs	Units	Grab Soil Samples 0 to 6 Inches Below Ground Surface																								
			BPG-1S	BPG-2S	BPG-3S	BPDG-3S (Dup)	BPG-4S	BPG-5S	BPG-6S	BPG-7S	BPG-8S	BPG-9S	BPG-10S	BPG-11S	BPG-12S	BPG-13S	BPG-14S	BPG-15S	BPG-16S	BPG-17S	BPG-18S	BPG-19S	BPDG-19S (Dup)	BPG-20S	BPG-21S	BPG-22S
Inorganics																											
Antimony	0.27	mg/kg	**286**	**428**	**454**	**465**	**48**	**46.3**	**29.2**	**4.2**	**10**	**16**	**2**	**5.4**	**7.7**	**67.7**	**206**	**10.9**	**34.3**	**44.3**	**98.4**	**89.6**	**96.4**	**388**	**311**	**363**
Arsenic	18	mg/kg	13.9	17.2	17.1	**18.6**	7.1	14.3	8.6	5.8	6.6	7.1	5.2	5.3	5.3	9	16.5	7.5	6.8	10	8.6	8.1	8	16.4	12.4	11.8
Lead	11	mg/kg	**33,100**	**41,600**	**49,300**	**49,300**	**7,160**	**4,200**	**3,220**	**2,390**	**6,040**	**7,000**	**419**	**1,250**	**1,160**	**9,050**	**19,000**	**1,920**	**5,070**	**9,480**	**14,800**	**11,900**	**12,700**	**44,800**	**38,600**	**34,700**
Polycyclic Aromatic Hydrocarbons																											
Benzo(a)anthracene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.402	NA	NA
Benzo(a)pyrene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.883	NA	NA
Benzo(b)fluoranthene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.378	NA	NA
Benzo(g,h,i)perylene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.590	NA	NA
Chrysene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.844	NA	NA
Fluoranthene	29	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	NA	NA

Notes:
Bold - Exceeds ESSLs

USEPA	United States Environmental Protection Agency
ESSL	Ecological Soil Screening Level
NA	Not Analyzed
LOD	Limit of Detection
mg/kg	milligrams per kilogram
<	Less Than

Table 3
Sample Analytical Result Detections
Deep Composite and Grab Soil Samples
U.S. Border Patrol Firing Range
Nogales, Arizona

Constituent	Arizona SRLs		USEPA RSLs		Units	Composite Soil Samples 12 to 30 Inches Below Ground Surface																	
	Residential ASRL (1)	Non-Residential ASRL (1)	Residential RSL	Industrial RSL		BPN-4D18	BPDN-4D18 (Dup)	BPN-7D18	BPN-8D18	BPN-9D24	BPN-10D18	BPN-12D18	BPN-13D18	BPN-14D14	BPN-15D14	BPN-16D18	BPN-17D18	BPN-18D30	BPDN-18D30 (Dup)	BPN-59D30	BPN-60D18	BPN-61D14	BP-78D25
Antimony	31	410	31	410	mg/kg	<1.8	<1.8	<1.7	10.2	4.9	<1.8	45.8	71	2.9	<1.8	28.5	2.1	<1.9	<1.8	6.6	<1.8	3	38
Arsenic	10	10	0.39	1.6	mg/kg	4.9	4.8	5.2	6.1	5.5	5.1	7	14.8	4.4	5	6.3	4.5	5.5	5.7	5.9	5.2	5	8.7
Lead	400	800	400	800	mg/kg	20	20	70	1,910	771	347	6,370	6,550	438	197	2,750	378	315	301	4,120	345	445	7,850

Constituent	Arizona SRLs		USEPA RSLs		Units	Grab Soil Samples 12 to 42 Inches Below Ground Surface							
	Residential ASRL (1)	Non-Residential ASRL (1)	Residential RSL	Industrial RSL		BPG-1D18	BPG-3D30	BPG-13D30	BPG-16D30	BPDG-16D30 (Dup)	BPG-18D30	BPG-21D42	BPDG-21D42 (Dup)
Antimony	31	410	31	410	mg/kg	30.6	176	5.3	19.4	20.1	31.8	184	208
Arsenic	10	10	0.39	1.6	mg/kg	5.7	15.7	5.8	6	5.6	6.2	9.3	9.2
Lead	400	800	400	800	mg/kg	4,220	26,000	916	3,060	2,970	4,850	24,800	27,000

Notes: **Notes:**

USEPA	United States Environmental Protection Agency
RSL	USEPA Soil Regional Screening Level
ASRL	Arizona Soil Remediation Level
NA	Not Analyzed
ND	Not Detected
mg/kg	milligrams per kilogram
<	Less Than

Table 4
Sample Analytical Result Detections
Toxicity Characteristic Leaching Potential (TCLP) Samples
U. S. Border Patrol Firing Range
Nogales, Arizona

Constituent	USEPA Toxicity Characteristic Concentration	Units	BPN-13S	BPG-3S	BPG-7S	BPG-8S	BPG-17S
Arsenic	5	mg/L	<0.25	0.27	<0.25	<0.25	<0.25
Lead	5	mg/L	511	1930	3.4	9.2	158

Notes:

LOD	Limit of Detection	BPN	Composite Samples
mg/L	milligrams per Liter	BPG	Grab Samples
<	Less Than	USEPA	U.S. Environmental Protection Agency

Table 5
Spent Ammunition and Shooting Target Debris COC Source Material
Items Extracted from Soil Samples During Seiving
U.S. Border Patrol Firing Range
Nogales, Arizona

Constituents of Concern	Source Material Item	Composite Soil Samples																
		Shallow Soil Samples: 0 to 12 Inches Below Ground Surface																Subsurface Soil Samples containing COC Source Materials
		BPN-4S	BPN-7S	BPN-8S	BPN-9S	BPN-10S	BPN-12S	BPN-13S	BPN14S	BPN-15S	BPN-16S	BPN-17S	BPN-18S	BPN-59S	BPN-60S	BPN-61S	BP-78S	BP-78 (25" bgs)
Lead, Antimony, and Arsenic	SAA Debris: Bullets or bullet fragments	0	1	8	0	0	17	3	1	0	15	0	0	0	0	1	24	2
	Shotgun shell slug or buckshot pellet	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	4	0
Polynuclear Aromatic Hydrocarbons	Plastic Shotshell Wadding	0	1	2	2	3	0	6	31	1	14	18	5	0	0	0	4	1
	Clay Pigeon Target Fragment	0	0	0	0	1	0	12	0	0	0	1	0	0	0	0	1	0

Constituents of Concern	Source Material Item	Grab Soil Samples																							
		Shallow Soil Samples: 0 to 12 Inches Below Ground Surface																					Subsurface Soil Samples containing COC Source Materials		
		BPG-1S	BPG-2S	BPG-3S	BPG-4S	BPG-5S	BPG-6S	BPG-7S	BPG-8S	BPG-9S	BPG-10S	BPG-11S	BPG-12S	BPG-13S	BPG-14S	BPG-15S	BPG-16S	BPG-17S	BPG-18S	BPG-19S	BPG-20S	BPG-21S	BPG-22S	BPG-3 (30" bgs)	BPG-18 (30" bgs)	BPG-21 (42" bgs)
Lead, Antimony, and Arsenic	SAA Debris: Bullets or bullet fragments	2	3	14	0	0	0	0	0	0	0	0	0	2	2	0	2	1	2	14	43	28	8	70	1	15
	Shotgun shell slug or buckshot pellet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	9	0	0	1	0	1
Polynuclear Aromatic Hydrocarbons	Plastic Shotshell Wadding	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	2	0	0	1
	Clay Pigeon Target Fragment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Constituents of Concern	Total Constituent of Concern Source Material Items Extracted from Soil Samples, by Grid Cell															
	N-4	N-7	N-8	N-9	N-10	N-12	N-13	N-14	N-15	N-16	N-17	N-18	N-59	N-60	N-61	78
Lead, Antimony, and Arsenic	0	1	16	0	0	40	5	1	0	15	0	0	0	0	1	130
Polynuclear Aromatic Hydrocarbons	0	1	2	2	4	1	18	31	1	14	19	5	0	0	0	14

Notes:

"	Inches
bgs	below ground surface
COC	Constituent of Concern
SAA	Small Arms Ammunition

Table 6
Soil Sampling Equipment QA/QC
Rinse Water Samples
U.S. Border Patrol Firing Range
Nogales, Arizona

Constituent	USEPA Tap Water RSL	Accutest DL	Accutest RL	Units	Rinsate Samples		
					BPRS-001	BPRS-002	BPRS-003
Inorganics							
Antimony	15	0.51	6	µg/l	<6.0	<6.0	<6.0
Arsenic	0.045	0.65	10	µg/l	<10	<10	<10
Lead	0.24	0.85	10	µg/l	<10	<10	<10
Poly-Aromatic Hydrocarbons							
Benzo(a)anthracene	0.029	2	10	µg/l	NA	<LOD	NA
Benzo(a)pyrene	0.0029	2	10	µg/l	NA	<LOD	NA
Benzo(g,h,i)perylene	NS	2	10	µg/l	NA	<LOD	NA
Benzo(b)fluoranthene	0.029	2	10	µg/l	NA	<LOD	NA
Chrysene	2.9	2	10	µg/l	NA	<LOD	NA
Fluoranthene	0.0015	3	10	µg/l	NA	<LOD	NA
Benzo(k)fluoranthene	0.29	2	10	µg/l	NA	<LOD	NA

Notes:

DL	Detection Limit
NA	Not Analyzed
LOD	Limit of Detection
QA/QC	Quality Assurance/Quality Control
RL	Reporting Limit
RSL	Regional Screening Level
µg/l	micrograms per liter
USEPA	United States Environmental Protection Agency
<	Less Than

Table 7
Physical/Chemical Constants
U.S. Border Patrol Firing Range
Nogales Arizona

Constituent	Molecular Weight	Henry's Law Constant (atm-m3/mol)		Vapor Pressure (mm Hg)		log Koc		Kow (l/kg)		Kd (2) (l/kg)		Solubility in Water (mg/l)		Bioconcentration Factor (l/kg)	
Benzo(a)anthracene (3)	228.3	1.20E-05	a	2.20E-08	b	5.25	a	4.07E+05	b	3.54E+03		0.0094	a	NA	
Benzo(a)pyrene (3)	252.32	4.57E-07	a	5.60E-09	b	5.77	a	1.15E+06	b	1.17E+04		0.00162	a	NA	
Benzo(b)fluoranthene (3)	252.32	6.57E-07	a	5.00E-07	b	5.78	a	1.10E+06	b	1.20E+04		0.0015	a	NA	
Benzo(g,h,i)perylene (3)	276	1.44E-07	b	1.03E-10	b	6.20	b	3.16E+06	b	3.20E+04		0.00026	b	NA	
Benzo(k)fluoranthene (3)	252.32	5.84E-07	a	9.59E-11	b	5.77	a	1.15E+06	b	1.17E+04		0.0008	a	NA	
Chrysene (3)	228.3	5.23E-06	a	6.30E-07	b	5.26	a	4.07E+05	b	3.61E+03		0.002	a	NA	
Fluoranthene (4)	202.26	8.86E-06	a	5.00E-06	b	4.74	a	7.94E+04	b	1.11E+03		0.26	a	1,150	d
Antimony	121.75	0	c	ND		NA		NA		4.50E+01	c	CS		1	d
Arsenic	74.92	0	c	ND		NA		NA		3.10E+01	c	CS		44	d
Lead	207.2	0	c	ND		NA		NA		9.00E+02	c	CS		49	d

(1) - (l/kg) stands for (liters/kilogram)
(2) - Kd was calculated as Koc*foc (where foc is assumed to be 2%)
(3) - High Molecular Weight PAH
(4) - Low Molecular Weight PAH

NA- Not available
ND- No data

a - USEPA, 2011. Regional Screening Criteria Chemical Parameters.
b - ATSDR Toxicological Profile for Polycyclic Aromatic Hydrocarbons. August 1995
c - USEPA Screening Level Risk Asssessment Protocol for Hazardous Waste Combustion Facilities. August 1999.
d - USEPA, 1986. Superfund Public Health Evaluation Manual. EPA/540/1-86/060.

Table 8
Screening Criteria and Toxicological Endpoints
U.S. Border Patrol Firing Range
Nogales, Arizona

Parameter		Toxicity Endpoint	Critical Effect	Arizona SRLs		USEPA RSLs	
				Residential ASRL (1) (mg/kg)	Non-Residential ASRL (1) (mg/kg)	Residential RSL (mg/kg)	Industrial RSL (mg/kg)
Inorganics							
	Antimony	nc	Longevity, blood chemistry	31	410	31	410
	Arsenic	c		10	10	0.39	1.6
	Lead	nc	Neurotoxicity	400	800	400	800
Polynuclear Aromatic Hydrocarbons							
	Benzo(a)anthracene	c		0.69	21	0.15	2.1
	Benzo(a)pyrene	c		0.069	2.1	0.015	0.21
	Benzo(b)fluoranthene	c		0.69	21	0.15	2.1
	Benzo(g,h,i)perylene	nc		NA	NA	NA	NA
	Benzo(k)fluoranthene	c		6.9	210	1.5	21
	Chrysene	c		68	2,000	15	210
	Fluoranthene	nc	Nephropathy	2,300	22,000	2,300	22,000

Notes:
(1) Criteria for arsenic is based on regional background.

NA Not Available
c Carcinogenic Endpoint
nc Noncarcinogenic Endpoint

Sources:
State of Arizona Title 18, Chapter 7, Article 2. Soil Remediation Standards, 2007 Regulatory Levels
USEPA Regional Screening Level (RSL) Summary Table November 2011

Table 9
Ecological Screening Criteria
U.S. Border Patrol Firing Range
Nogales, Arizona

Constituent	PAH Molecular Weight	USEPA ESSLs	Receptor	Source
Inorganics				
Antimony		0.27	Mammalian	a
Arsenic		18	Plants	b
Lead		11	Avian	c
Polynuclear Aromatic Hydrocarbons				
Benzo(a)anthracene	HMW	1.1	Mammalian	d
Benzo(a)pyrene	HMW	1.1	Mammalian	d
Benzo(b)fluoranthene	HMW	1.1	Mammalian	d
Benzo(g,h,i)perylene	HMW	1.1	Mammalian	d
Benzo(k)fluoranthene	HMW	1.1	Mammalian	d
Chrysene	HMW	1.1	Mammalian	d
Fluoranthene	LMW	29	Soil Invertebrate	d

LMW - Low molecular weight
HMW - High molecular weight
ESSL - Ecological Soil Sceening Levels
Sources:

a - USEPA 2005. Ecological Soil Screening Levels for Antimony Interim Final. OSWER Directive 9285.7-61

b - USEPA 2005. Ecological Soil Screening Levels for Arsenic Interim Final. OSWER Directive 9285.7-62

c - USEPA 2005. Ecological Soil Screening Levels for Lead Interim Final. OSWER Directive 9285.7-70

d - USEPA 2007. Ecological Soil Screening Levels for Polynuclear Aromatic Hydrocarbons (PAHs) Interim Final. OSWER Directive 9285.7-78

Table 9
Ecological Screening Criteria
U.S. Border Patrol Firing Range
Nogales, Arizona

Constituent	PAH Molecular Weight	USEPA ESSLs	Receptor	Source
Inorganics				
Antimony		0.27	Mammalian	a
Arsenic		18	Plants	b
Lead		11	Avian	c
Polynuclear Aromatic Hydrocarbons				
Benzo(a)anthracene	HMW	1.1	Mammalian	d
Benzo(a)pyrene	HMW	1.1	Mammalian	d
Benzo(b)fluoranthene	HMW	1.1	Mammalian	d
Benzo(g,h,i)perylene	HMW	1.1	Mammalian	d
Benzo(k)fluoranthene	HMW	1.1	Mammalian	d
Chrysene	HMW	1.1	Mammalian	d
Fluoranthene	LMW	29	Soil Invertebrate	d

LMW - Low molecular weight
HMW - High molecular weight
ESSL - Ecological Soil Sceening Levels
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c - USEPA 2005. Ecological Soil Screening Levels for Lead Interim Final. OSWER Directive 9285.7-70

d - USEPA 2007. Ecological Soil Screening Levels for Polynuclear Aromatic Hydrocarbons (PAHs) Interim Final. OSWER Directive 9285.7-78

Table 10
Ecological Risk Screening
Shallow Composite and Grab Soil Samples
U.S. Border Patrol Firing Range
Nogales, Arizona

Constituent	USEPA ESSLs	Units	Composite Soil Samples 0 to 12 Inches Below Ground Surface																
			BPN-4S	BPN7S	BPN8S	BPN-9S	BPN-10S	BPN-12S	BPN-13S	BPN142S	BPN-15S	BPN-16S	BPDN-16S (Dup)	BPN-17S	BPN-18S	BPN-59S	BPN-60S	BPN-61S	BP-78S
Inorganics																			
Antimony	0.27	mg/kg	<1.7	4.6	84	27.5	5.9	198	454	125	11.2	417	471	48.2	19.7	27.9	7.1	25.8	399
Arsenic	18	mg/kg	5	5.5	12.1	6.7	5.2	10.2	22.8	10.2	4.8	20.7	22.1	6.8	6.1	6.3	5.6	10.9	16.5
Lead	11	mg/kg	198	920	10,200	3,540	952	22,800	35,200	15,100	1,840	36,400	37,300	6,310	6,940	8,480	2,890	2,680	46,800
Polynuclear Aromatic Hydrocarbons																			
Benzo(a)anthracene	1.1	mg/kg	NA	NA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	NA	<LOD	<LOD	<LOD	NA	NA	NA	NA	0.191
Benzo(a)pyrene	1.1	mg/kg	NA	NA	<LOD	0.0349	<LOD	0.244	<LOD	<LOD	NA	<LOD	<LOD	<LOD	NA	NA	NA	NA	0.368
Benzo(b)fluoranthene	1.1	mg/kg	NA	NA	<LOD	0.0345	<LOD	<LOD	1.570	<LOD	NA	0.72	<LOD	<LOD	NA	NA	NA	NA	0.279
Benzo(g,h,i)perylene	1.1	mg/kg	NA	NA	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	NA	ND	<LOD	<LOD	NA	NA	NA	NA	0.267
Benzo(k)fluoranthene	1.1	mg/kg	NA	NA	<LOD	<LOD	<LOD	<LOD	1.240	<LOD	NA	ND	<LOD	<LOD	NA	NA	NA	NA	<LOD
Chrysene	1.1	mg/kg	NA	NA	<LOD	0.0529	<LOD	0.226	2.14	<LOD	NA	1.180	1.780	<LOD	NA	NA	NA	NA	0.359
Fluoranthene	29	mg/kg	NA	NA	<LOD	<LOD	<LOD	<LOD	1.780	<LOD	NA	0.765	<LOD	<LOD	NA	NA	NA	NA	<LOD

Constituent	USEPA ESSLs	Units	Grab Soil Samples 0 to126 Inches Below Ground Surface																							
			BPG-1S	BPG-2S	BPG-3S	BPDG-3S (Dup)	BPG-4S	BPG-5S	BPG-6S	BPG-7S	BPG-8S	BPG-9S	BPG-10S	BPG-11S	BPG-12S	BPG-13S	BPG-14S	BPG-15S	BPG-16S	BPG-17S	BPG-18S	BPG-19S	BPDG-19S (Dup)	BPG-20S	BPG-21S	BPG-22S
Inorganics																										
Antimony	0.27	mg/kg	286	428	454	465	48	46.3	29.2	4.2	10	16	2	5.4	7.7	67.7	206	10.9	34.3	44.3	98.4	89.6	96.4	388	311	363
Arsenic	18	mg/kg	13.9	17.2	17.1	18.6	7.1	14.3	8.6	5.8	6.6	7.1	5.2	5.3	5.3	9	16.5	7.5	6.8	10	8.6	8.1	8	16.4	12.4	11.8
Lead	11	mg/kg	33,100	41,600	49,300	49,300	7,160	4,200	3,220	2,390	6,040	7,000	419	1,250	1,160	9,050	19,000	1,920	5,070	9,480	14,800	11,900	12,700	44,800	38,600	34,700
Polynuclear Aromatic Hydrocarbons																										
Benzo(a)anthracene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.402	NA	NA
Benzo(a)pyrene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.883	NA	NA
Benzo(b)fluoranthene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.378	NA	NA
Benzo(g,h,i)perylene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.590	NA	NA
Chrysene	1.1	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.844	NA	NA
Fluoranthene	29	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	NA	NA

Notes:

USEPA	United States Environmental Protection Agency
ESSL	Ecological Soil Screening Level
NA	Not Analyzed
LOD	Limit of Detection
mg/kg	milligrams per kilogram
<	Less Than

Data Validation Report: Nogales C18284 Report

January 31, 2012

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Table of Contents

List of Acronyms and Abbreviations

CCV	Continuing Calibration Verification
ICV	Initial Calibration Verification
LCS/LCSD	Laboratory Control Sample / Laboratory Control Sample Duplicate
MS/MSD	Matrix Spike / Matrix Spike Duplicate
mg/L	Milligrams per Liter
ND	Not Detected
NFG	National Functional Guidelines
PAH	Polyaromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Comparability, Completeness
PQL	Practical Quantification Limit
QA/QC	Quality Assurance / Quality Control
RL	Reporting Limit
RPD	Relative Percent Difference
SDG	Sample Delivery Group
SVOC	Semivolatile Organic Compound
µg/L	Micrograms per Liter
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
%D	Percent Difference
%R	Percent Recovery
%RSD	Percent Relative Standard Deviation

1. INTRODUCTION

This Data Validation Report has been prepared by Neptune and Company, Inc. to assess the validity of laboratory analytical data reported by Accutest Laboratories, San Jose California, Accutest Job Number C18284, report dated 12/12/2011. The laboratory report from Accutest contained the results for samples analyzed for Poly aromatic hydrocarbons (PAHs) and three metals (antimony, arsenic, lead). The PAHs were extracted using EPA method SW846 3550B and analyzed via EPA method 8270C. Two preparation batches OP4694 (aqueous) and OP4693 (soils) were required for the PAH analyses. For the metals analyses, the samples were extracted via EPA method 3050B and analyzed using EPA method 6010B under four preparation batches: MP4058 (aqueous), MP4056 (soil), MP4059 (soil), and MP4064 (soils) plus one Leachate batch (MP4283). However, none of the samples reported were leachates.

Analysis	Number of Samples*	Matrix
PAHs	11 (OP4693)	Soil
PAHs	1 (OP4694)	Aqueous
Metals	22 (four separate WOs/SDGs)	Soil
Metals	22 (four separate WOs/SDGs)	Aqueous

* Sample count does not include QC samples such as Laboratory Blanks, LCS, Matrix Spikes, or similar.

The laboratory reports included summary results for both the samples and quality control samples analyzed with the sample batches. This summary information included analyte results, Continuing Calibration Verification (CCV), MS/MSD results, and LCS results for the PAH analytical suite. PAH data also included surrogate recoveries and internal standard information. For the metals, internal standard information, ICP Interference Check Sample, ICP Serial Dilution initial was provided. The metals data were reported along with a reporting limit (RL) and an instrument detection limit (IDL) for the blank results. PAH results were also provided with an associated RL. Using the language from the EPA *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*, data in this project were validated to Stage 2B. Internal standard areas were also provided with the PAH data and were validated. However, raw calibration and sample information was not reported by the laboratory, therefore validation to Stage 4 was not performed.

The laboratory reports were evaluated based on the following documents: Applicable analytical method (e.g. SW-846 Method 8270C, 6010B), and the general validation steps outlined in the *Contract Laboratory Program National Functional Guidelines for Superfund Organic Data Review*, June 2008, and the *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, October 2004. Acceptance criteria for the QC samples were based upon the associated analytical method, or laboratory specific limits where they have been derived. In cases where the analytical method did not fully describe the quality assurance criteria or corrective action the *DoD Quality Systems Manual for Environmental Laboratories*, Version 4.1 was followed. Professional judgment also may have been used in some cases to qualify the results.

This report summarizes the quality assurance evaluation of the data according to precision, accuracy, representativeness, completeness, and comparability (PARCC) relative to the National Functional Guidelines. This report provides an assessment of the data and identifies potential sources of error, uncertainty, and bias that may affect the overall usability. Included with this report are two Excel spreadsheets that document the validation process, one for the metals analysis and a second for the PAH analysis. These files are named TPMC Nogales C18284 Metals Validation.xlsx and TPMC Nogales C18284 PAH Validation.xlsx.

Qualifiers	
J-	Estimated: The associated numerical value is an estimated quantity with a potentially negative bias. The analyte was detected but the reported value may not be accurate or precise. The "J-" qualification indicates the data fell outside the QC limits, but the exceedance was not sufficient to cause rejection of the data.
J+	Estimated: The associated numerical value is an estimated quantity with a potentially positive bias. The analyte was detected but the reported value may not be accurate or precise. The "J+" qualification indicates the data fell outside the QC limits, but the exceedance was not sufficient to cause rejection of the data.
J	Estimated: The associated numerical value is an estimated quantity. It is not possible to assess the direction of the potential bias. The analyte was detected but the reported value may not be accurate or precise. The "J" qualification indicates the data fell outside the QC limits, but the exceedance was not sufficient to cause rejection of the data.
B	The result is associated with blank contamination. The sample result should be evaluated with respect to the level of contamination and usability assessed within the decision context.
R	Rejected: The datum is unusable (the compound or analyte may or may not be present). Use of the "R" qualifier indicates a significant variance from functional guideline acceptance criteria.
UJ	Estimated/Nondetected: Analyses were performed for the compound or analyte, but it was not detected. This qualification is used to flag possible false negative results in the case where low bias in the analytical system is indicated by low calibration response, surrogate, or other spike recovery.
E	The analyte exceeded the calibration range of the instrument. There is greater uncertainty associated with the reported value.

PARCC Criteria

Precision is a measure of the agreement or reproducibility of analytical results under a given set of conditions. It is a quantity that cannot be measured directly but is calculated from percent recovery data. Precision is expressed as the relative percent difference (RPD):

RPD = Absolute Value of (D1-D2)/{1/2(D1+D2)} X 100

Where D1 and D2 are the reported concentrations for sample and duplicate analyses.

An RPD outside the numerical QC limit in either MS/MSD samples or LCS/LCSD indicates imprecision but does not imply accuracy or allow for directional qualification (e.g. J+ or J-). For this data set, duplicate results were only reviewed for replicate LCS and MS data. No replicate native sample results were evaluated.

Accuracy is a measure of the agreement of an experimental determination and the true value of the parameter being measured. It is used to identify bias in a given measurement system Recoveries outside acceptable QC limits may be caused by factors such as instrumentation, analyst error, or matrix interference. Accuracy is assessed through the analysis of spiked matrix samples and laboratory control samples containing analytes of interest and surrogate compounds. Surrogate spikes were added to every environmental sample, blank, LCS, MS/MSD, and standard, for the organic analyses. The soil samples analyzed in this report also included LCS and MS results. Accuracy of inorganic analyses is determined using the percent recoveries of MS and LCS analyses.

Percent recovery (%R) is calculated using the following equation:

$$\%R = (A-B)/C \times 100$$

where:
A = measured concentration in the spiked sample
B = measured concentration of the spike compound in the unspiked sample
C = concentration of the spike

Spike recoveries outside the acceptable QC accuracy limits provide an indication of bias, where the reported data may overestimate or underestimate the actual concentration of compounds detected. This directional bias information can be used to provide J- or J+ qualification, when no other qualifiers complicate the datum.

Representativeness is a qualitative parameter that expresses the degree to which the sample data are characteristic of a population. It is evaluated herein by reviewing the QC results of blanks, samples and holding times. Positive detects of compounds in the blank samples identify compounds that may have been introduced into the samples during sample collection, transport, preparation, or analysis. The QA/QC blanks collected and analyzed are method blanks, trip blanks, and field blanks.

Contamination found in both the environmental sample and a laboratory blank sample are usually assumed to be laboratory artifact if the concentration in the environmental sample is less than 10 times the blank value for common laboratory contaminants or 5 times the blank value for other laboratory contaminants.

Holding times are evaluated to assure that the sample integrity is intact for accurate sample preparation and analysis. Holding times will be specific for each method and matrix analyzed. Holding time exceedances can cause loss of sample constituents due to biodegradation, precipitation, volatization, and chemical degradation. Sample results for analyses that were performed after the method holding time but less than two times the method holding time were qualified as estimated (J- or UJ). In cases where sample results for analyses were performed after two times the method holding time, the associated non-detected analytes were qualified as rejected (R).

Comparability is a qualitative expression of the confidence with which one data set may be compared to another. In the data validation context it provides an assessment of the equivalence of the analytical results to data obtained from other analyses. Comparability is also dependent upon other PARCC criteria, because only when precision, accuracy, and representativeness are known can data sets be compared with confidence.

Completeness is defined as the percentage of acceptable sample results compared to the total number of sample results. Completeness equals the total number of sample results for each fraction minus the total number of rejected sample results divided by the total number of sample results multiplied by 100. Percent completeness is calculated using the following equation:

$$\%C = (T - R)/T \times 100$$

where:
%C = percent completeness
T = total number of sample results
R = total number of rejected sample results

Basis for qualifying data**:**

Surrogates: Reviewed as part of this validation for EPA method 8270C (PAHs). Recovery limits were based upon the laboratory limits provided in the report associated with each sample.

ICV/CCV: ICV/CCV samples were qualified with a J- / J+ for all detected analytes in which the recovery was below/above the QC limit. Limits are discussed in each section below. These qualifiers apply to all samples within the associated batch. Samples were qualified with a UJ if the analytes were ND and the recovery was below limit. Samples that were ND, and the recovery exceeded the QC limit were not qualified.

LCS: LCS samples were provided for EPA method 8270C (PAHs). The data were qualified with a J- / J+ for all detected analytes in which the recovery was below/above the QC limit. Limits are discussed in each section below. These qualifiers apply to all samples within the associated batch. Samples were qualified with a UJ if the analytes were ND and the recovery was below limit. Samples that were ND, and the recovery exceeded the QC limit were not qualified.

MS/MSD: MS/MSD samples were qualified with a J- / J+ for all detected analytes in which the recovery was below/above the QC limit. Limits are discussed in each section below. These qualifiers only apply to the samples that were spiked. Samples were qualified with a UJ if the analytes were ND and the recovery was below limit. Samples that were ND, and the recovery exceeded the QC limit were not qualified.

Blanks: Samples were compared with blank values. None of the data were associated with blanks that had concentrations that required qualification or censoring. For the metals results, all method and continuing calibration check blanks were below the reporting limit. None of the PAH blanks had any detected concentrations of the analytes.

Method specific checks were included for the metals data, including a serial dilution and interference check sample. The results are criteria are provided in Section 3.0.

The following sections present a review of QC data for each analytical method.

2. Extractables by GCMS via EPA Method SW846 8270C: PAHs

A total of 1 aqueous sample and 11 soils samples were analyzed for extractable PAHs. The samples were extracted using EPA SW846 Method 3550B under two preparation batches and analyzed in three analytical batches (EY477, EY479, and EY481). Sample preparation and analytical batch information is provided in the associated data validation workbook (Excel spreadsheet with individual worksheets). Soil samples were selected at a nominal mass of 30 grams and extracted to a final volume of 1.0 mL. Approximately one liter of the single aqueous sample was extracting and concentrated to 1.0 mL using EPA SW846 Method 3510C prior to analysis. Eighteen PAH compounds were reported, alog with recoveries for three surrogates. Dilution factors were provided and RL data were adjusted if samples were diluted. All samples that had reportable values for the PAH compounds were qualified with a J by the laboratory because the values were less than the reporting limit (RL), but greater than the method detection limit (MDL).

None of the sample results were rejected based on holding time or other quality assurance/control issues. Quality issues for each check are discussed below.

2.1. Quality Control Results

2.1.1. Initial and Continuing Calibration

Initial calibration and initial tuning results were provided for each analytical batch with only summary results (RSD values for each analyte) provided for the September 7, 2011 initial calibration. All PAH analytes had RSD values within the limit of 20%.

Continuing calibration data was also provided with each of the three analytical batches. The response factor for the PAH analytes was compared to the average response factor from the initial calibration. All values were found to be within 20% deviation of the ICAL.

No data required qualification based upon the calibration data reported.

2.1.2. Laboratory Control Samples (LCS)

A blank spike and blank spike duplicate (equivalent to a LCS and LCS duplicate) were analyzed and these are associated with both preparation batches. The recovery limits are specific to each analyte and were reported with the data. In all cases the recovery of the analyte was within the laboratory limits, and all RPD values were also in control. No data were qualified based upon the blank spike results.

2.1.3. Blank Samples

A method blank was prepared and analyzed with both preparation batches. No analytes were detected. No data were qualified based upon the blank results.

2.1.4. Matrix Spike and Matrix Spike Duplicate

A matrix spike and MS duplicate was prepared and analyzed with each preparation batch. For batch OP4694, sample C18302-9 was spiked. Note, this sample is a batch-associated sample but is not a project-associated sample. The recovery was in the laboratory limits for all analytes.

For batch OP4693, sample C18284-27 was spiked. This sample had recoveries above the acceptance limits for Benzo(a)pyrene, Benzo(b)fluoranthene, and Benzo(k)fluoranthene. Benzo(a)pyrene, Benzo(b)fluoranthene were identified in the native sample and are qualified as J+. Benzo(k)fluoranthene was not reported for the native sample, since the spike recover was above the limit, the results do not indicate a potential for false negative or false positive and no qualification is applied.

Table 2.1.4-1

Data Qualified due to Matrix Spike Recoveries

Sample	Recovery (limits)	Associated analytes and Qualifiers
C18284-27 (BP78S6)	Benzo(a)pyrene 115%/107% (39-112%) Benzo(b)fluoranthene 119%/106% (40-117%) Benzo(k)fluoranthene 131%/122% (41-117%)	J+ for Benzo(a)pyrene, Benzo(b)fluoranthene, and Benzo(k)fluoranthene

2.1.5. Surrogate and Internal Standard Recoveries

All samples were spiked with three surrogate compounds prior to extraction. Surrogate recovery limits are laboratory specific and reported with the summary information. The recovery of the spiked surrogate compounds were within the limits with the following exceptions:

Samples C18284-39 and C18284-40 has low Nitrobenzene-d5 recovery (15% and 18%). The laboratory attributed these low recoveries to matrix interference- viscous matrix. Samples C18284-28 and C18284-29 also had low recoveries for Terphenyl-d14 (47% and 54%) again due to viscous sample matrix. The laboratory was contacted to verify the association between surrogates and analytes. These analytes have been qualified in the EDD provided with this report.

Table 2.1.5-1

Data Qualified based on Surrogate Recovery

Sample	Surrogate and Recovery (limits)	Associated analytes and Qualifiers
C18284-39 (BPN10S6)	Nitrobenzene-d5: 15% (20-100%)	Associated analytes qualified with a UJ- (all non detects)
C18284-40 (BPN9S6)	Nitrobenzene-d5: 18% (20-100%)	Associated analytes qualified with a J- or UJ- (all non detects)
C18284-28 (BPN16S6)	Terphenyl-d14: 47% (55-130%)	Associated analytes qualified with a J- or UJ- (all non detects)
C18284-29 (BPDN16S6)	Terphenyl-d14: 54% (55-130%)	Associated analytes qualified with a J- or UJ- (all non detects)

The laboratory also spiked the sample extracts with six internal standards, these data are provided on page 112 of 293 in the laboratory report. All internal standards were recovered within the laboratory limits. This indicates the analysis of the sample was in control, and that the low surrogate recovery was isolated to the extraction step.

2.2. Summary

Data were qualified for one matrix spike sample (C18284-27) for two analytes. Four samples were qualified due to low surrogate recoveries. No other PAH data required qualification, all data are considered usable.

3. Metals via EPA Method SW846 6010B: Antimony, Arsenic, Lead

A total of 68 soil and three aqueous samples were analyzed for metals (antimony, arsenic and lead) using EPA Method 6010B. The samples were first extracted using EPA Method 3050B. Six instrument QC and five preparation QC batches were required for all samples and matrices.

None of the sample results were rejected based on holding time or other quality assurance/control issues. Reporting limits were provided with the samples with nominal values of 1.7 -1.8 mg/kg when no dilution was required. Lead was found at fairly high concentrations in several samples, this required dilution of the samples.

3.1. Quality Control Results

3.1.1. Initial and Continuing Calibration

An initial calibration check was performed and the QC limits of 90-110% were met for all initial calibration check standards.

Continuing calibration checks were analyzed to bracket the samples with recovery limits 90-110%. All continuing calibration checks met these requirements.

No data required qualification due to the calibration data provided.

3.1.2. Laboratory Control Samples (LCS)

A spike blank sample was analyzed with each of the five batches. The blank spike limits are 80-120%. All three analytes were within limits, no data were qualified based on spike blank and laboratory control sample results..

3.1.3. Blank Samples

A method blank was analyzed with each batch. All method blanks were below the RL and the MDL with the following exceptions. In batch MP4064, antimony and lead had results above the MDL. Arsenic and lead had method blank concentrations above the MDL in batch MP4283. However, since the values were below the RL, no qualification of the samples was required.

3.1.4. Matrix Spike Samples

A matrix spike and matrix spike duplicate was analyzed with each batch. The recovery limits of 75-125% were met with the following exceptions. Qualifiers due to matrix spike samples are summarized in Table 3.1.4-1.

In batch MP4056 sample 18284-8 had low antimony recovery (35% and 33%); and negative lead (-22.2% and -153%) recovery. The low antimony is likely due to matrix interferences. This sample is qualified as J- for antimony. The low lead recoveries are associated with the very high ratio of native lead to the spiked amount of lead. When this ratio is very large, poor recovery is not uncommon; as such no data are qualified for lead.

In batch MP4059 sample 18284-27 high antimony recovery (136% and 181%); and very high lead (5184% and 11880%) recovery. The high antimony is likely due to matrix interferences. This sample is qualified as J+ for antimony. The very high lead recoveries are associated with the very high ratio of native lead to the spiked amount of lead. When this ratio is very large, poor recovery is not uncommon; as such no data are qualified for lead.

In batch MP4064 sample C18284-49 showed low antimony MS recoveries (18% and 40%) possibly due to matrix interference. Again in this sample lead had high recovery (222% and 444%) due to the high native to spike concentrations. This sample is qualified J- for antimony only.

Table 3.1.4-1

Data Qualified due to Matrix Spike Samples

Spike Sample	Analyte	Samples	Qualifier
MS, MP4056	Antimony	C18284-8	J-
MS, MP4059	Antimony	C18284-27	J+
MS, MP4064	Antimony	C18284-49	J-

3.1.5 Serial Dilutions

The laboratory prepared and analyzed serial dilutions for each batch. The QC limits for serial dilutions are generally calculated as the percentage difference between the original and diluted result, where the original has a concentration greater than 50 times the detection limit. Different acceptance criteria are used depending upon the project requirement. The analytical method uses a criterion where the diluted value should be within 90-110% of the original value. Using the acceptance range of 90-110% of the original (undiluted) value, the following dilutions were slightly outside of this range:

Arsenic in batch MP4056 was above the QC limit at 11.5 % difference calculated by the laboratory or 12.7 RPD using the equation above. The value is outside the 90-110% range specified by the method. This difference indicates possible matrix interference. Sample C18284-8 is qualified due to this difference.

Lead in batch MP4058 and Arsenic in batch MP4283 were above the QC limit at 100% and 294.7%. However, this percent difference is acceptable due to low initial sample concentrations that were less than 50 times the IDL.

For the lead in batch MP4059, the original value was 456000 and the diluted value 412000. The laboratory reported a % difference of 20.8%. However, using the method limits of 90-110% or the original, the diluted value is within this range.

The serial dilution in batch MP4064 was above the 110% upper limit for antimony, arsenic, and lead, which indicates possible matrix interference. Sample C18284-29 is qualified due to this difference. Qualifiers due to serial dilutions are summarized in Table 3.1.4-2.

Table 3.1.5-1
Data Qualified due to Serial Dilutions

Serial Dilution	Sample	Analyte	% Difference	Qualifier
SDL, MP4056	C18284-8	Arsenic	11.5	J
SDL, MP4064	C18284-29	Antimony	17.1	J
		Arsenic	16	J
		Lead	18.2	J

3.1.6 Post digestion spike

A post digestion spike is required as part of the analytical method when matrix spike recoveries are not within the QC limits. Matrix spike results were discussed in Section 3.1.4 above. QC limits were not specified for the post digestion spike by the laboratory. The analytical method specifies an acceptance range of 75-125% of the known value (spike amount).

For this data set, the percent recoveries ranged between 88 and 108% with the following exceptions. In batch MP4059 (sample C18284-27), lead had a percent recovery of 1000.3% and was noted as having a spike amount that was low relative to the sample amount. This anomalous recovery is again very likely due to the very large difference between the spike amount and native concentration (circa 100:1). Therefore, the data are not qualified.

3.2. Summary

The following samples were qualified due to QC exceedances, no data are rejected and all results are considered usable.

Sample 18284-4 is qualified as J- for antimony due to the matrix spike results.

Sample 18284-27 is qualified as J+ for antimony due to the matrix spike results.

Sample C18284-49 is qualified J- for antimony due to the matrix spike results.

Sample C18284-8 is qualified J for arsenic due to the serial dilution results.

Sample C18284-29 is qualified J for antimony, arsenic, and lead, due to the serial dilution results.

4. PARCC

Precision and accuracy assessments were included in each individual section above. The precision and accuracy of the data are considered acceptable with the qualifiers included.

Representativeness: All holding times were met as described at the beginning of each section. No significant blank contamination was found. The representativeness of the project data is considered acceptable.

Comparability: The laboratory used standard analytical methods for all of the analyses. No method detection limit information was provided to compare with the reporting limits but in all cases a reporting limit was provided with each datum. The PAH data was all qualified by the laboratory as a result of data below the reporting limit. There is no information provided that would question the comparability of the results. The overall comparability is considered acceptable.

Completeness: No results were rejected based on this data validation. The completeness level attained for the samples was 100 percent.

ACCUTEST LABORATORIES
2105 Lundy Ave, San Jose, CA 95131
(408) 588-0200 FAX: (408) 588-0201

CHAIN OF CUSTODY

"TPMCNMA3937"

FED-EX Tracking #: 8746 30310470
Bottle Order Control #:
Accutest Quote #: VV 8/2011-6
Accutest NC Job #: C C18284

Client / Reporting Information

Company Name: TERRANEAR PMC
Address: 1100 RHODE ISLAND NE
City / State / Zip: ALBUQUERQUE NM 87110
Project Contact: RICK KLINGEL
Phone #: 505-938-3133
Samplers's Name: CARL PIDGE TPMC

Project Information

Project Name: BORDER PATROL FIRING RANGE
Street: NOGALES, ARIZONA
City / State:
Project #: 33239
EMAIL: EKLINGEL@TERRANEARPMC.COM
Client Purchase Order #: ACCUTEST 33239

Requested Analysis: 6010B Pb As Sb; 8270 PAH

Matrix Codes: WW- Wastewater; GW- Ground Water; SW- Surface Water; SO- Soil; OI-Oil; WP-Wipe; LIQ - Non-aqueous Liquid; AIR; DW- Drinking Water (Perchlorate Only)

Accutest Sample ID	Sample ID / Field Point / Point of Collection	Date (2011)	Time (HRS)	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	NaHSO4	MEOH	ENCORE	6010B Pb As Sb	8270 PAH	LAB USE ONLY
1	BPG1S	9/28	1010	CARL	SO	1									X		1X WP
2	BPG2S	9/28	1110	CARL	SO	1									X		
3	BPG3S	9/28	1140	CARL	SO	1									X		↓
4	BPDG3S	9/28	1140	CARL	SO	1									X		
5	BPG4S	9/28	1148	CARL	SO	1									X		
6	BPG5S	9/28	1149	CARL	SO	1									X		
7	BPG6S	9/28	1154	CARL	SO	1									X		
8	BPG7S MS/MSD	9/28	1200	CARL	SO	3									X		3X WP
9	BPG8S	9/28	1202	CARL	SO	1									X		1X WP
10	BPG9S	9/28	1207	CARL	SO	1									X		↓

Turnaround Time (Business days)

PER CONTRACT / CALL ERIC KLINGEL

Approved By:/ Date:

- [X] Standard TAT
- [ ] 3 Day (applicable markup)
- [ ] 2 Day (applicable markup)
- [ ] 1 Day (applicable markup)

Emergency T/A data available VIA Lablink

Data Deliverable Information

CALL ERIC KLINGEL

- [ ] Commercial "B" - Results with QC summaries
- [X] REDT1- Level 3 data package
- [ ] FULT1 - Level 4 data package
- [ ] EDF for Geotracker
- [ ] EDD Format

Provide EDF Global ID
Provide EDF Logcode:

Comments / Remarks

Cooler #1 → 4.1 - 0.1 = 4°C (8oz + Liters ON ICE)
#2 → 18.8 - 0.1 = 18.7°C (whirl PAX Bags) * no Ice.
Custody seals → INTACT EK 10/5/11

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler:	Date Time:	Received By:	Relinquished By:	Date Time:	Received By:
1 [signature]	2011 10/4 1100	1 [signature] 08:55 10-05-11	2		2
Relinquished by: 3	Date Time:	Received By: 3	Relinquished By: 4	Date Time:	Received By: 4
Relinquished by: 5	Date Time:	Received By: 5	Custody Seal #	On Ice (Y) N	Number of coolers 2 / Cooler Temp. ___ oC

CHAIN OF CUSTODY

2 of 6

ACCUTEST LABORATORIES
2105 Lundy Ave, San Jose, CA 95131
(408) 588-0200 FAX: (408) 588-0201

FED-EX Tracking #: 8746 30310470
Bottle Order Control #:
Accutest Quote #: VV8/2011-6
Accutest NC Job #: C C18284

Client / Reporting Information

Company Name: TERRANEAR PMC
Address: 1100 RHODE ISLAND NE
City / State / Zip: ALBUQUERQUE NM 87110
Project Contact: RICK KLINGEL
Phone #: 505-938-3133
Samplers's Name: CARL PIDAL TPMC

Project Information

Project Name: USACE BORDER PATROL FIRING RANGE
Street:
City: NOGALES State: AZ
Project #: 33239
EMAIL: EKLINGEL@TERRANEARPMC.COM
Client Purchase Order #: ACCUTEST 33239

Requested Analysis: 6010B Pb As Sb; 8270 PAH

Matrix Codes: WW- Wastewater; GW- Ground Water; SW- Surface Water; SO- Soil; OI-Oil; WP-Wipe; LIQ - Non-aqueous Liquid; AIR; DW- Drinking Water (Perchlorate Only)

Accutest Sample ID	Sample ID / Field Point / Point of Collection	Date (2011)	Time	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	NaHSO4	MEOH	ENCORE	6010B Pb As Sb	8270 PAH	LAB USE ONLY
11	BPG10S	9/28	1211	CARL	SO	1									X		1xWP
12	BPG11S	9/28	1705		SO	1									X		↓
13	BPG12S	9/28	1705		SO	1									X		↓
14	BPG13S	9/28	1711		SO	1									X		↓
15	BPG14S	9/28	1711		SO	1									X		↓
16	BPRS001	9/28	1530		GW	1					X				X		1-Liter Amber N/P
17	BPG15S	9/29	0933		SO	1									X		1xWP.
18	BPG16S	9/29	0941		SO	1									X		↓
19	BPG17S	9/29	0948		SO	1									X		↓
20	BPG18S	9/29	0957	CARL	SO	1									X		↓

Turnaround Time (Business days)

PER CONTRACT
Approved By:/ Date: CONTACT RICK KLINGEL

- [X] Standard TAT
- [ ] 3 Day (applicable markup)
- [ ] 2 Day (applicable markup)
- [ ] 1 Day (applicable markup)

Emergency T/A data available VIA Lablink

Data Deliverable Information

CONTACT ERIC KLINGEL

- [ ] Commercial "B" - Results with QC summaries
- [X] REDT1- Level 3 data package
- [ ] FULT1 - Level 4 data package
- [ ] EDF for Geotracker
- [ ] EDD Format

Provide EDF Global ID
Provide EDF Logcode:

Comments / Remarks

LAB SENT 1L AMBER GLASS NEAT FOR RINSATE SAMPLES

(-15) → preserved (w/HNO3) in a 250ml HDPE for metals

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler:	Date Time:	Received By:	Relinquished By:	Date Time:	Received By:
1 [signature]	2011 10/4 1100	1 [signature] 08:55 10-05-11	2		2
Relinquished by: 3	Date Time:	Received By: 3	Relinquished By: 4	Date Time:	Received By: 4
Relinquished by: 5	Date Time:	Received By: 5	Custody Seal #	On Ice Y / N; Number of coolers	Cooler Temp. °C

CHAIN OF CUSTODY

ACCUTEST LABORATORIES
2105 Lundy Ave, San Jose, CA 95131
(408) 588-0200 FAX: (408) 588-0201

FED-EX Tracking #: 8746 3031 0470
Bottle Order Control #:
Accutest Quote #: VV 8/2011-6
Accutest NC Job #: C C18284

Client / Reporting Information

Company Name: TERRANEAR PMC
Address: 1100 RHODE ISLAND NE
City: ALBUQUERQUE State: NM Zip: 87110
Project Contact: RICK KLINGEL
Phone #: 505-938-3133
Samplers's Name: CARL ADAE TPMC

Project Information

Project Name: USACE BORDER PATROL FIRING RANGE
Street:
City: NOGALES State: AZ
Project #: 33239
EMAIL: EKLINGEL@TERRANEARPMC.COM
Client Purchase Order #: ACCUTEST 33239

Requested Analysis: 6010B Pb, As, Sb; 8270 PAH

Accutest Sample ID	Sample ID / Field Point / Point of Collection	Date (2011)	Time	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	NaHSO4	MEOH	ENCORE	6010B Pb, As, Sb	8270 PAH	LAB USE ONLY
21	BPG19S	9/29	1009	CARL	SO	1									X		1x WP
22	BPDG19S	9/29	1009		SO	1									X		↓
23	BPG20S	9/29	1019		SO	1+1									X	X	1x WP 1x 8oz
-24	BPRS002	9/29	1520		GW	2					X	X	2		X	X	2x 1Lits N/P
25	BPG21S	9/29	1031		SO	1									X		1x WP
26	BPG22S	9/29	1041		SO	1									X		↓
27	BP78S6 MS/MSD	9/30	0745		SO	6									X	X	3x WP 3x 8oz
28	BPN16S6	9/30	0805		SO	2									X	X	1x WP 1x 8oz
29	BPDN16S6	9/30	0805		SO	2									X	X	
30	BPN17S6	9/30	0821	CARL	SO	2									X	X	↓

Matrix Codes: WW- Wastewater; GW- Ground Water; SW- Surface Water; SO- Soil; OI-Oil; WP-Wipe; LIQ - Non-aqueous Liquid; AIR; DW- Drinking Water (Perchlorate Only)

Turnaround Time (Business days)

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- [X] Standard TAT
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Emergency T/A data available VIA Lablink

Data Deliverable Information

CONTACT RICK KLINGEL

- [ ] Commercial "B" - Results with QC summaries
- [X] REDT1- Level 3 data package
- [ ] FULT1 - Level 4 data package
- [ ] EDF for Geotracker
- [ ] EDD Format ____

Provide EDF Global ID ____
Provide EDF Logcode: ____

Comments / Remarks

(-24) preserved (w/HNO3) in a 250ml HDPE for metals.

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler	Date Time	Received By	Relinquished By	Date Time	Received By
1 [signature]	2011 10/4 1100	1 [signature] 08:55 10-05-11	2		2
3		3	4		4
5		5	Custody Seal #	On Ice Y / N; Number of coolers ____	Cooler Temp. ____ °C

CHAIN OF CUSTODY

ACCUTEST LABORATORIES

2105 Lundy Ave, San Jose, CA 95131
(408) 588-0200 FAX: (408) 588-0201

FED-EX Tracking #: 8746 30310470
Bottle Order Control #:
Accutest Quote #: VV 8/2011-6
Accutest NC Job #: C C18284

Client / Reporting Information | **Project Information**

Company Name: TERRANEAR PMC
Project Name: USACE BORDER PATROL FIRING RANGE
Address: 1100 RHODE ISLAND NE
Street:
City / State / Zip: ALBUQUERQUE NM 87110
City: NOGALES State: AZ
Project Contact: RICK KLINGEL
Project #: 33239
Phone #: 505-938-3133
EMAIL: EKLINGEL@TERRANEARPMC.COM
Samplers's Name: CARL ADLE TPMC
Client Purchase Order #: ACCUTEST 33239

Requested Analysis: 6010B Pb, As & Sb; 8270 PAH

Accutest Sample ID	Sample ID / Field Point / Point of Collection	Date (2011)	Time	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	NaHSO4	MEOH	ENCORE	6010B Pb, As & Sb	8270 PAH	LAB USE ONLY
31	BPN18S6	9/30	0835	Carl	SO	1									X		1X WP
32	BPN13S6	9/30	0852		SO	2									X	X	1X WP 1X B02
33	BPN15S6	9/30	0900		SO	1									X		1X WP
34	BPN12S6	9/30	0908		SO	2									X	X	1X WP 1X B02
35	BPN14S6	9/30	0935		SO	2									X	X	↓
36	BPN59S6	9/30	1007		SO	1									X		1X WP
37	BPN60S6	9/30	1023		SO	1									X		↓
38	BPN61S6	9/30	1040		SO	1									X		↓
39	BPN10S6	9/30	1332		SO	2									X	X	1X WP 1X B02
40	BPN9S6	9/30	1355	Carl	SO	2									X	X	↓

Matrix Codes: WW- Wastewater; GW- Ground Water; SW- Surface Water; SO- Soil; OI-Oil; WP-Wipe; LIQ - Non-aqueous Liquid; AIR; DW- Drinking Water (Perchlorate Only)

Turnaround Time (Business days)

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Approved By:/ Date: CONTACT RICK KLINGEL

- [x] Standard TAT
- [ ] 3 Day (applicable markup)
- [ ] 2 Day (applicable markup)
- [ ] 1 Day (applicable markup)

Emergency T/A data available VIA Lablink

Data Deliverable Information

CONTACT RICK KLINGEL

- [ ] Commercial "B" - Results with QC summaries
- [x] REDT1- Level 3 data package
- [ ] FULT1 - Level 4 data package
- [ ] EDF for Geotracker
- [ ] EDD Format____

Provide EDF Global ID ____
Provide EDF Logcode: ____

Comments / Remarks

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler:	Date Time:	Received By:	Relinquished By:	Date Time:	Received By:
1 [signature]	2011 10/4 1100	1 [signature] 10-05-11 08:55	2		2
Relinquished by: 3	Date Time:	Received By: 3	Relinquished By: 4	Date Time:	Received By: 4
Relinquished by: 5	Date Time:	Received By: 5	Custody Seal #	On Ice Y / N	Number of coolers ____ Cooler Temp. ____ °C

CHAIN OF CUSTODY

ACCUTEST LABORATORIES
2105 Lundy Ave, San Jose, CA 95131
(408) 588-0200 FAX: (408) 588-0201

FED-EX Tracking #: 8746 3031 0470
Bottle Order Control #:
Accutest Quote #: VV 8/2011 - 6
Accutest NC Job #: C C18284

Client / Reporting Information

Company Name: TERRANEAR PMC
Address: 1100 RHODE ISLAND NE
City: ALBUQUERQUE State: NM Zip: 87110
Project Contact: RICK KLINGEL
Phone #: 505-938-3133
Samplers's Name: CARL PIDGE TPMC

Project Information

Project Name: USACE BORDER PATROL FIRING RANGE
Street:
City: NOGALES State: AZ
Project #: 33239
EMAIL: RKLINGEL@TERRANEARPMC.COM
Client Purchase Order #: ACCUTEST 33239

Requested Analysis: 6010B Pb As Sb; 8270 PAH

Accutest Sample ID	Sample ID / Field Point / Point of Collection	Date (2011)	Time	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	NaHSO4	MEOH	ENCORE	6010B Pb As Sb	8270 PAH	LAB USE ONLY
41	BPN8S6	9/30	1438	Carl	SO	2									X	X	1X WP 1X 8oz
42	BPN7S6	9/30	1516	〃	SO	1									X		1X WP
43	BPN4S6	9/30	1533	〃	SO	1									X		↓
44	BPG13D30	10/1	0855	〃	SO	1									X		↓
45	BPG16D30	10/1	1055	〃	SO	1									X		↓
46	BPG1D18	10/1	1140	〃	SO	1									X		↓
47	BPG18D30	10/1	1312	〃	SO	1									X		↓
48	BPDG16D30	10/1	1055	〃	SO	1									X		↓
49	BPG3D30 MS/MSD	10/2	1021	〃	SO	3									X		3 X WP
50	BPRS003	10/2	1340	Carl	GW	1					X				X		1-liter AG N/P

Matrix Codes: WW- Wastewater; GW- Ground Water; SW- Surface Water; SO- Soil; OI-Oil; WP-Wipe; LIQ - Non-aqueous Liquid; AIR; DW- Drinking Water (Perchlorate Only)

Turnaround Time (Business days)

PER CONTRACT — Approved By:/ Date: CONTACT RICK KLINGEL

- [x] Standard TAT
- [ ] 3 Day (applicable markup)
- [ ] 2 Day (applicable markup)
- [ ] 1 Day (applicable markup)

Emergency T/A data available VIA Lablink

Data Deliverable Information

CONTACT RICK KLINGEL

- [ ] Commercial "B" - Results with QC summaries
- [x] REDT1- Level 3 data package
- [ ] FULT1 - Level 4 data package
- [ ] EDF for Geotracker
- [ ] EDD Format ____

Provide EDF Global ID ____
Provide EDF Logcode: ____

Comments / Remarks

-50 preserved (10/HNO3) in a 250ml HDPE for metals.

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler:	Date Time:	Received By:	Relinquished By:	Date Time:	Received By:
1 [signature]	2011 10/4 1100	1 [signature] 08:55 10-05-11	2		2
Relinquished by: 3	Date Time:	Received By: 3	Relinquished By: 4	Date Time:	Received By: 4
Relinquished by: 5	Date Time:	Received By: 5	Custody Seal #	On Ice Y / N	Number of coolers ____ Cooler Temp. ____ oC

CHAIN OF CUSTODY

ACCUTEST LABORATORIES
2105 Lundy Ave, San Jose, CA 95131
(408) 588-0200 FAX: (408) 588-0201

FED-EX Tracking #: 8746 3031 0470
Bottle Order Control #:
Accutest Quote #: VV 8/2011-6
Accutest NC Job #: C C18284

Client / Reporting Information
Company Name: TERRANEAR PMC
Address: 1100 Rhode Island NE
City / State / Zip: ALBUQUERQUE, NM 87110
Project Contact: RICK KLINKEL
Phone #: 505-938-3133
Samplers's Name: CARL ADAMS TPMC

Project Information
Project Name: USACE BORDER PATROL FIRING RANGE
Street:
City / State: NOGALES AZ
Project #: 33239
EMAIL: EKLINKEL@TERRANEARPMC.COM
Client Purchase Order #: ACCUTEST 33239

Requested Analysis: 6010B Pb As Sb; 8270 PAH

Matrix Codes: WW- Wastewater; GW- Ground Water; SW- Surface Water; SO- Soil; OI-Oil; WP-Wipe; LIQ - Non-aqueous Liquid; AIR; DW- Drinking Water (Perchlorate Only)

Accutest Sample ID	Sample ID / Field Point / Point of Collection	Date (2011)	Time	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	NaHSO4	MEOH	ENCORE	6010B Pb As Sb	8270 PAH	LAB USE ONLY
51	BPN15D14	10/2	1445	Carl	SO	1									X		1X WP
52	BPG21D42	10/2	1357		SO	1									X		
53	BPDG21D42	10/2	1357		SO	1									X		
54	BPN18D30	10/3	0826		SO	1									X		
55	BPDN18D30	10/3	0826		SO	1									X		
56	BPN14D14	10/3	0928		SO	1									X		
57	BPN17D18	10/3	1041		SO	1									X		
58	BPN16D18	10/3	1205		SO	1									X		
59	BPN13D18	10/3	1400		SO	1									X		
60	BPN12D18	10/3	1515	Carl	SO	1									X		

Turnaround Time (Business days)
PER CONTRACT
Approved By:/ Date: CONTACT RICK KLINKEL
[X] Standard TAT
[ ] 3 Day (applicable markup)
[ ] 2 Day (applicable markup)
[ ] 1 Day (applicable markup)

Emergency T/A data available VIA Lablink

Data Deliverable Information
CONTACT RICK KLINKEL
[ ] Commercial "B" - Results with QC summaries
[X] REDT1- Level 3 data package
[ ] FULT1 - Level 4 data package
[ ] EDF for Geotracker [ ] EDD Format
Provide EDF Global ID
Provide EDF Logcode:

Comments / Remarks

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler:	Date Time:	Received By:	Relinquished By:	Date Time:	Received By:
1 [signature]	2011 10/4 1100	1 [signature] 08:55 10-05-11	2		2
Relinquished by: 3	Date Time:	Received By: 3	Relinquished By: 4	Date Time:	Received By: 4
Relinquished by: 5	Date Time:	Received By: 5	Custody Seal #	On Ice Y / N	Number of coolers ____ Cooler Temp. ____ oC

Accutest Laboratories Northern California Sample Receiving Check List Job#: C18284 Initial: EK

Review Chain of Custody — Chain of Custody is to be complete and legible.

- ☑ Are these regulatory (~~NPDES~~) samples? ~~CWA~~ DOD — (Yes) / No
- ☑ Is pH requested? — Yes / (No)
  - ☐ Was Client informed that hold time is 15 min? Yes / No — Continue Yes / No
  - ☐ Was ortho-Phosphate filtered with in 15 min? Yes / No — Continue Yes / No
- ☑ Are sample within hold time? — (Yes) / No
  - Are sample in danger of exceeding hold-time — Yes / (No)
- ☑ Existing Client? New Client Yes / (No) — Existing Project? New Project Yes / (No)
  - If No: Is Report to info complete and legible, including;
    - ☑ deliverable ☑ Name ☑ Address ☑ phone ☑ e-mail
  - Is Bill to info complete and legible, including;
    - ☐ PO# ☐ Credit card ☐ Contact ☐ address ☐ phone ☐ e-mail
  - Is Contact and/or Project Manager identified, including;
    - ☑ phone ☑ e-mail
    - ☑ Project name / number
- ☑ Special requirements? — Yes / (No)
- ☑ Sample IDs / date & time of collection provided? — (Yes) / No
- ☑ Is Matrix listed and correct? — (Yes) / No
- ☑ Analyses listed, we do, or client has authorized a subcontract? — (Yes) / No
- ☑ Chain is signed and dated by both client and sample custodian? — (Yes) / No
- ☑ TAT requested available? (Yes) / No — Approved by PM

Review Coolers:

- ☑ Were all Coolers temperatures measured at ≤6°C? — (Yes) / No
  - If cooler is outside the ≤6°C; note down the affected bottles in that cooler on the left
- ☑ Are samples on Ice? — (Yes) / No

Note that ANC does NOT accept evidentiary samples. (We do not lock refrigerators)

- ☑ Shipment Received Method FedEx
- ☑ Custody Seals: Intact EK 10/05/11 Present: (Yes) No — If Yes; Unbroken: (Yes) No

Review of Sample Bottles: If you answer no, explain to the side

- ☑ Chain matches bottle labels? (Yes) / No — ☑ Sample bottle intact? (Yes) / No
- ☑ Is there enough sample volume in proper bottle for requested analyses? — (Yes) / No
- ☐ Proper Preservatives? Yes / No
  - Check pH on preserved samples except 1664, 625, 8270 and VOAs; make notes on left.
- ☐ Headspace-VOAs? **Greater than 6mm in diameter** — Yes / No
  - **List sample ID and affected container**

Client Sample ID	pH Check	Other Comments/Issues
-15		preserved (w/HNO3) for ulter for 6010B
-24		↓ ↓
-50		↓ ↓

Non-Compliance issues and discrepancies on the COC are forwarded to Project Management

CHAIN OF CUSTODY

ACCUTEST LABORATORIES

2105 Lundy Ave, San Jose, CA 95131
(408) 588-0200 FAX: (408) 588-0201

"TPMCNMA3937"

1 of 1

FED-EX Tracking #: 8746 30310480
Bottle Order Control #:
Accutest Quote #: VV 8/2011-6
Accutest NC Job #: C C18298

Client / Reporting Information

- Company Name: TERRANEAR AMC
- Address: 1100 RHODE ISLAND NE
- City / State / Zip: ALBUQUERQUE, NM 87110
- Project Contact: RICK KLINKEL
- Phone #: 505-938-3133
- Samplers's Name: CARL RIDGE TPMC

Project Information

- Project Name: USACE BORDER PATROL FIRING RANGE
- Street:
- City / State: NOGALES AZ
- Project #: 33239
- EMAIL: RKLINKEL@TERRANEAR PMC.COM
- Client Purchase Order #: ACCUTEST 33239

Requested Analysis: 6010B Pb, As, Sb; 8270 PAH

Accutest Sample ID	Sample ID / Field Point / Point of Collection	Date (2011)	Time	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	NaHSO4	MEOH	ENCORE	6010B Pb, As, Sb	8270 PAH	LAB USE ONLY
-1	BP78D25	10/4	0850	Carl	SO	1									X		Whirl PAK Bag
-2	BPN7D18		0925		SO	1									X		
-3	BPN4D18		0952		SO	1									X		
-4	BPDN4D18		0952		SO	1									X		
-5	BPN8D18		1037		SO	1									X		
-6	BPN9D24		1145		SO	1									X		
-7	BPN10D18		1240		SO	1									X		
-8	BPN59D30		1420		SO	1									X		
-9	BPN60D18		1503		SO	1									X		
-10	BPN61D14	10/4	1540	Carl	SO	1									X		

Matrix Codes: WW-Wastewater; GW-Ground Water; SW-Surface Water; SO-Soil; OI-Oil; WP-Wipe; LIQ-Non-aqueous Liquid; AIR; DW-Drinking Water (Perchlorate Only)

Turnaround Time (Business days)

PER CONTRACT

Approved By:/Date: CONTACT RICK KLINKEL

- [X] Standard TAT
- [ ] 3 Day (applicable markup)
- [ ] 2 Day (applicable markup)
- [ ] 1 Day (applicable markup)

Emergency T/A data available VIA Lablink

Data Deliverable Information

CONTACT RICK KLINKEL

- [ ] Commercial "B" - Results with QC summaries
- [X] REDT1- Level 3 data package
- [ ] FULT1 - Level 4 data package
- [ ] EDF for Geotracker
- [ ] EDD Format
- Provide EDF Global ID
- Provide EDF Logcode:

Comments / Remarks

SAMPLING EVENT COMPLETE
FINAL COOLER

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by	Date Time	Received By	Relinquished By	Date Time	Received By
1 [signature]	2011 10/5 1130	1 [signature] 08:40 10-06-11	2		2
3		3	4		4
5		5	Custody Seal #		

On Ice Y / N (N circled)
Number of coolers 1
Cooler Temp. 18.3-0.1=18.2 °C

Accutest Laboratories Northern California **Sample Receiving Check List** **Job#: C18298** **Initial: EK**

Review Chain of Custody — Chain of Custody is to be complete and legible.

- ☑ Are these regulatory (~~NPDES~~) samples? ~~CWA~~ (DOD) — (Yes) / No
- ☑ Is pH requested? — Yes / (No)
  - ☐ Was Client informed that hold time is 15 min? Yes / No — Continue Yes / No
  - ☐ Was ortho-Phosphate filtered with in 15 min? Yes / No — Continue Yes / No
- ☑ Are sample within hold time? — (Yes) / No
  - Are sample in danger of exceeding hold-time — Yes / (No)
- ☑ Existing Client? (Yes) / No — Existing Project? (Yes) / No
  - If No: Is Report to info complete and legible, including;
    - ☐ deliverable ☐ Name ☐ Address ☐ phone ☐ e-mail
  - Is Bill to info complete and legible, including;
    - ☐ PO# ☐ Credit card ☐ Contact ☐ address ☐ phone ☐ e-mail
  - Is Contact and/or Project Manager identified, including;
    - ☐ phone ☐ e-mail
    - ☐ Project name / number
- ☑ Special requirements? — (Yes) / No
- ☑ Sample IDs / date & time of collection provided? — (Yes) / No
- ☑ Is Matrix listed and correct? — (Yes) / No
- ☑ Analyses listed, we do, or client has authorized a subcontract? — (Yes) / No
- ☑ Chain is signed and dated by both client and sample custodian? — (Yes) / No
- ☑ TAT requested available? (Yes) / No — Approved by PM

Review Coolers: Whirl PAK Bags recv'd in a cooler

- ☑ Were all Coolers temperatures measured at ≤6°C? — Yes / (No)
  - If cooler is outside the ≤6°C; note down the affected bottles in that cooler on the left
- ☑ Are samples on Ice? — Yes / (No)

Note that ANC does NOT accept evidentiary samples. (We do not lock refrigerators)

- ☑ Shipment Received Method FedEx
- ☑ Custody Seals: Present: (Yes) / No — If Yes; Unbroken: (Yes) / No

Review of Sample Bottles: If you answer no, explain to the side

- ☑ Chain matches bottle labels? (Yes) / No — ☑ Sample bottle intact? (Yes) / No
- ☑ Is there enough sample volume in proper bottle for requested analyses? — (Yes) / No
- ☐ Proper Preservatives? Yes / No
  - Check pH on preserved samples except 1664, 625, 8270 and VOAs; make notes on left.
- ☐ Headspace-VOAs? **Greater than 6mm in diameter** **List sample ID and affected container** — Yes / No

Client Sample ID	pH Check	Other Comments/Issues

Non-Compliance issues and discrepancies on the COC are forwarded to Project Management

SITE CHARACTERIZATION
NOGALES BORDER
PATROL FIRING RANGE

"Rite in the Rain"®
ALL-WEATHER
FIELD
No. 351

NOGALES, ARIZONA
USACE SACRAMENTO
CONTRACT NO.:
W9126G-06-D-0016

KEVIN BEYER

TERRANEAR PMC, LLC

BOOK # 1 OF 2

"Rite in the Rain®"
ALL-WEATHER WRITING PAPER

Name Kevin Beyer
Terranear PMC, LLC
Address 222 Valley Creek Blvd.
Suite 210, Exton, PA 19341
Phone 610-717-2271

Project Nogales Border
Patrol Firing Range

Clear Vinyl Protective Slipcovers (Item No. 30) are available for this style of notebook.
Helps protect your notebook from wear & tear. Contact your dealer or the J. L. Darling Corporation.

CONTENTS

PAGE	REFERENCE	DATE
	Acronyms	
	CBP - Customs and Border	
	Protection	
	EPA - Environmental Protection	
	Agency	
	PAH - Polycyclic Aromatic	
	Hydrocarbons	
	XRF - X-Ray Fluorescence	
	BP - Border Patrol	
	NBPFR - Nogales Border	
	Patrol Firing Range	
	TPMC - Terranear PMC, LLC	
	PLS - Polaris Land Surveying, LLC	
	USE - U.S. Environmental, Inc.	
	CP - Carl Ridge	
	NIST - National	
	Institute of Standards and	
	Technology	
	ND - Non-Detect	

9-26-11 / KAB

820 Arrive at meeting with Steve Martin of USACE, Shawn Palmer of the Border Patrol, and Paul Enriquez with CBP.

825 Paul Enriquez with CBP raises concerns about TPMC SAP and SSHP. Items discussed: sampling consistency, grid layout, notification of Mr. Garcia with property entry, hotspots and further delineation / taking photos and documentation of borders of study area.

835 Steve Martin of USACE asks for insight of eventual result of the project from Rick Klingel of TPMC.

843 List of guns and ammunition used
shotgun plugs, shell casings
.357 Magnum
"hollow-body" casings
gas canisters
smoke grenades
(Shawn Palmer of Border Patrol)

845 CBP allowed to fire into washes. Main wash on site feeds into Mariposa wash. (Shawn Palmer)

846 Concerns of property owners over the moving of the shooting berm. (Shawn

848 Mr. Arbo has a "boneyard" of old equipment sitting at the corner of the range map. (Shawn Palmer)

849 Paul Enriquez of CBP notes concerns of remedial levels for Mr. Garcia being at very stringent levels.

852 Steve Martin makes a note of involving EPA and State of Arizona in terms of scope of project and resolution.

856 Scorpions under rocks and potential for rattlesnakes. (Shawn Palmer)

903 Further issues brought by Paul Enriquez about SAP.

9-26-11 / KAB

905 10 PAH samples at range because of concern are composite samples as per Rick Klingel.

908 Clarifications of XRF use and "old" versus "new" sample grids as per Rick Klingel. Confirmatory samples also discussed.

912 Rick Klingel makes note of greater concern of horizontal transport ~~and~~ [KAB] rather than vertical transport.

917 Shawn Palmer says this range has been in use since late 1800's.

921 Barr brothers may also visit the project site as per Shawn Palmer.

930 Shawn Palmer hours of work. 6 AM - 5 PM Field Operations Supervisor

932 End of meeting with CBP and USACE.

940 Leave CBP building for Nogales BP firing range.

9-26-11 / KAB

952 Out with Steve Martin, Paul Enriquez, Shawn Palmer, and Carl Pidge taking a site walk of the Nogales BP firing range. Discussion arises about hiring surveyor due to steep slopes and elevation changes. (Also with Rick Klingel).

1003 Discussion of previous stakes / markings to reference for grid construction with Paul Enriquez.

1027 Leave NBPFR with Rick Klingel and Carl Pidge ~~in~~ [KAB] and go back to the hotel in order to regroup.

1050 Contacted Don Taylor of TPMC in order to integrate additional information into NBPFR ~~into~~ [KAB] grid map. ← KAB

1115 Set up Top Con GPS for field use.

1315 Discussion of additional reconnaissance due to prior Allwyn ESA methodology.

9-26-11 / KAB

1330 Break for lunch.
1500 Mobilize to Home Depot to pick up stakes and a hammer.
1545 Mobilize to site and walk with GPS.
1730 Found artillery round on surface. Location: N: 3467947.55, E: 502761.137.
1735 Found artillery round on surface. Location: N: 3467956.224, E: 502776.400.
1737 Found artillery round on surface. Location: N: 3467975.708, E: 502784.372 (Picture of object in place.)
1815 Leave site for the day.

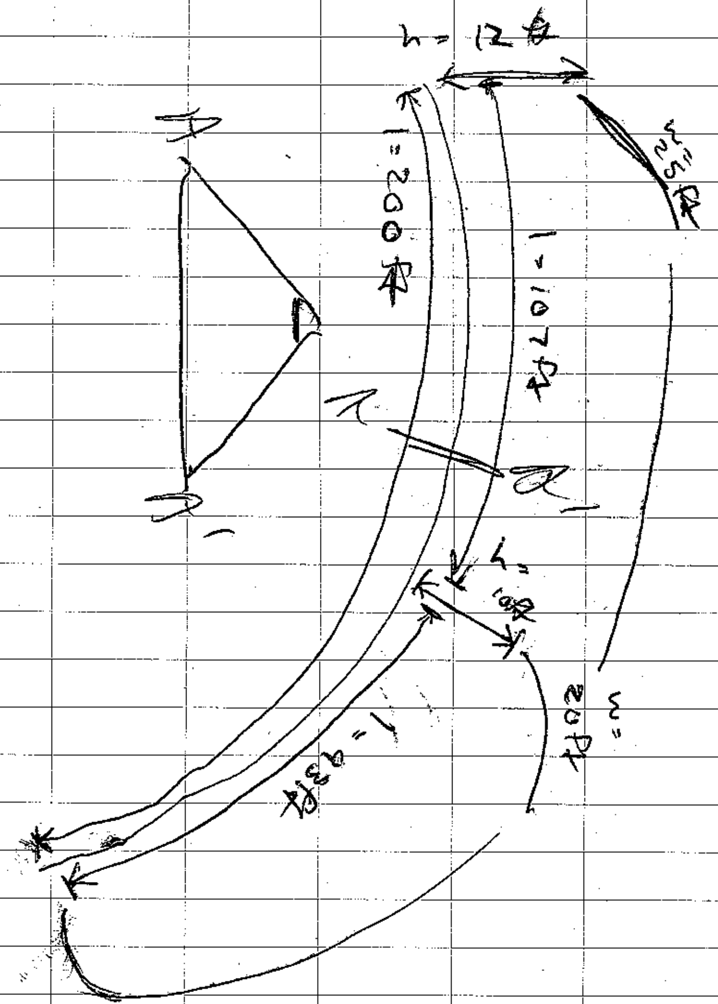
9-26-11 / KAB

9-27-11 / KAB

825 Arrive on site. Discussions arise about nature of MEC and ordnance on site and changes in scope. These are had by Steve Martin, Paul Enriquez, and Rick Klingel.
930 H + S tailgate meeting.
940 Begin to stake out small arms firing range.
1235 ~~Break for lunch.~~ KAB
Count number of squares in the grid layout for the shooting range.
1320 Break for lunch.
1430 Return from lunch.
1440 Arrive at site. Continue staking grid at shooting range.
1725 Volume parameters of shooting berm. (Diagram shown on next page).

9-27-11 / KAB

1725 Sketch of berm



9-27-11 / KAB

1745 Leave site for day

9-27-11 / KAB

9-28-11 / KAB

755 Leave hotel and go to Wal-Mart to pick up soap for decon of sieves, ~~and~~ KAB hand auger, and shovel. Rick Klingel at hotel writing e-mails.

805 Arrive on site. unload equipment and supplies from truck.

815 Set up GPS Unit.

820 Continue stake out of sample grid for taking GPS points and samples. while staking, Rick Klingel, Carl Pidge, and Kevin Beyer meet Mr. Garcia at the ~~end~~ ~~of~~ KAB edge of his property. He tells us he did not recieve the liability waiver.

1015 Take GPS points of grid corners.

1110 Complete taking of GPS points for grid corners. Take GPS locations of samples

9-28-11 / KAB

1110	that Carl Pidge has worked on.
1116	Take GPS point N-12-G-1.
1119	Take GPS point N-12_G-2.
1157	Take GPS point 78_G-3.
1202	Take GPS point 78-G-4.
1205	Take GPS point N-16_G-5.
1207	Take GPS point N-16_G-6.
1209	Take GPS point N-18_G-7.
1211	Take GPS point N-60_G-8.
1214	Take GPS point G-9.
1216	Take GPS point N-10_G-10
1230	Break for lunch.
1344	Return. Proceed to site.
1417	Take GPS point N-9_G-11.
1419	Take GPS point N-9_G-12.
1422	Take GPS point N-8-G-13.
1424	Take GPS point N-12_G-14.
1439	Take GPS point N-9.G-15.
1441	Take GPS point N-8_G-16.
1444	Take GPS point G-17.
1447	Take GPS point G-18.
1450	Take GPS point G-19.
1452	Take GPS point G-20.
1454	Take GPS point G-21.
1456	Take GPS point G-22.

9-28-11 / KAB

1505 Stake out N-10 discrete locations.
1510 Stake out N-9 discrete locations.
1513 Stake out N-8 discrete locations.
1517 Stake out 92 discrete locations.
1521 Stake out N-7 discrete locations.
1526 Stake out N-12 discrete locations.
1531 Stake out N-13 discrete locations.
1543 Stake out N-14 discrete locations.
1553 Stake out N-15 discrete locations.
1611 Stake out N-18 discrete locations.
~~1624 Stake out~~ KAB
1632 Stake out N-17 discrete locations.
1647 Stake out N-16 discrete locations.
1653 Stake out 78 discrete locations.
1715 Clean up site
1745 Leave site for day.

9-28-11 / KAB

9-29-11 / KAB

657 Leave hotel and proceed to ~~Walmart~~ KAB Safeway to get Ziploc bags.
~~710~~ KAB
711 Leave Safeway and head to site.
719 Arrive at site.
726 Carl Pidge leaves for hotel to pick up additional plastic scoops. Kevin Beyer stays to continue set-up and decon hand auger.
749 Carl Pidge returns.
811 Verify N-7 and 92 grid locations are correct.
907 N-7 grid and sample locations corrected. Grid 92 stakeout should actually be ~~N-4~~ KAB Grid N-4. Sample locations adjusted accordingly.
917 Take GPS point for Grid corner N-7-NE.

9-29-11 / KAB

930	Continue to retrieve grab sample locations.
1052	Finish collecting shallow grab samples.
1117	Stake out N-59 discrete locations.
1128	Stake out N-60 discrete locations.
1135	Stake out N-61 discrete locations
1156	Demarcate PAH locations (splits of discrete locations).
1233	Leave site to pick up XRF gun at hotel.
1317	Pick up XRF at front desk of Best Western Nogales with Authorization by Carl Pidge.
1320	Read and study XRF manual to understand function and use. Open up XRF case (note: case is zip tied).
1323	Kapton window in XRF has some dents and creases.
1350	Call Environmental Rental with regards to charging iPAQ.

9-29-11 / KAB

1353	Spoke to Customer Service and forwarded to appropriate person. Greg Gazza out of Waltham, MA. Was informed that base station for iPAQ has the connection for ~~p~~ [KAB] power adapter.
1400	Continue to read manual.
1420	Mobilize to Wal-Mart to get bottles of water for sampling.
1500	Arrive back at site. Assist Carl Pidge with sampling.
1540	Take GPS points of corners of Arbo property to correlate with PLS.
1610	Continue to read XRF manual (Manufacturer: Innov-X; Model: α-4000 XRF; Serial No.: 8988).
	~~No~~ KAB

9-29-11 / KAB

1645 Leave site for the day.
1700 Back at hotel. Continue reading XRF manual.
1720 Put battery in XRF, along with iPAQ. Boot up IPAQ and open Innov-X software. Go into "Soil Mode." Turn on XRF unit.
1740 Standardization performed with metal clip.
1745 Standardization successful.
1750 Perform calibrations with Blank (SiO_2), NIST Medium (2711), and NIST High (2710). Performed calibrations but calibration sheet sent with ~~unit~~ KAB ~~is~~ KAB instrument is in wrong units. Attempt to search internet for NIST standards in ppm.
1800 Look up standards tomorrow.

9-29-11 /KAB

9-30-11 / KAB

655 Leave hotel for site. Pick up ice at fiesta market.
700 Head to the site. Gate was open at front of site.
705 Arrive at site.
730 Take GPS points for 78 discrete locations.
738 ~~Take discrete locations for~~ KAB Collect discrete locations for grid 78.
750 Take GPS points for N-16 and N-17 discrete locations
825 Take GPS points for N-18 and N-15 discrete locations.
840 Take GPS points for N-13 discrete locations.
856 Take GPS points for N-12 discrete locations
903 Take GPS points for N-14 discrete Locations.
907 Collect discrete locations for grid N-14.

9-30-11 / KAB

944 Take GPS points for N-59, N-60, and N-61 discrete locations.

954 Collect discrete locations for grid N-59.

1009 Collect discrete locations for grid N-60.

1024 Collect discrete locations for grid N-61.

1050 Take GPS points for N-10 and N-9 discrete locations.

1100 Talked to Rick Klingel about troubleshooting XRF.

*Note: U.S. Environmental, NJ: 609-570-~~88~~ KAB 8555 Pat Feitch

1110 Head back to hotel to call U.S. Environmental about Standards (NIST).

1118 Stop by FedEx on way to hotel to get hours of operation and shipping forms.

9-30-11 / KAB

1118 FedEx hours:
M-F: 11:00 AM - 4:30 PM
Sat, Sun: Closed.

1130 Arrive at hotel. Call U.S. Environmentall about NIST Standards. Transferred from Pat Feitch to Leonard Orr. 1% = 10000 ppm according to Leonard.
mg/g ≟ mg/Kg ≟ ppm
NIST.org gives more complete information.
Configuring XRF in order to show certain elements. Soil mode ⇒ options ⇒. Leonard will do research on conversion factor for $\frac{mg}{g}$ and $\frac{mg}{kg}$ to ppm, in addition to configuring XRF to show certain elements, and call back.

1214 Leonard Orr of USE calls back. Soil Mode ⇒ Options ⇒ Display Elements.

9-30-11 / KAB

1214 If unit freezes up, on the bottom there is recessed ~~hole~~ KAB button that can be pressed with stylus that will allow a soft reset. 1 minute test time is recommended for samples. Shoot three times on standards if need be.

1250 Head back to site.

1308 Collect discrete locations for grid N-10.

1335 Collect discrete locations for grid N-9.

1358 Take GPS points for N-8 and N-7 discrete locations.

1411 Take GPS points for N-4 discrete locations.

1419 Collect discrete locations for grid N-8.

1441 Collect discrete locations for grid N-7.

9-30-11 / KAB

1521 Collect discrete locations for grid N-4.

1530 Mr. Garcia approaches the edge of his property and takes a picture of Kevin Beyer and some pin flags.

1546 Spoke to Mr. Garcia again. He asked about live ordnance and I referred him to talk to USACE as I do not know about any information.

1550 Collect random samples with hand auger for test run of XRF.

1632 Leave site for the day. Gate locked behind us.

1645 Retrieve TPMC laptop from Carl Ridge to install Top Con Software and upload GPS data.

1655 Install Top Con Software.

1730 Upload GPS data to Laptop.

9-30-11

1915 Convert certified values from NIST Tables to ppm
1923 Perform trial run of standardization and reading standards. Read 2 different samples after changing elements in program to Sb, As, and Pb.
1934 Unable to change elements. Proceed with NIST Standards and soil samples.
1937 Blank standard = ND
NIST Medium:
Sb = ND < 73 (19.4 ± 1.8 ppm)
As = 94 ± 11 (105 ± 8 ppm)
Pb = 1130 ± 20 (1162 ± 31 ppm)
NIST High:
Sb = ND < 80 (38.4 ± 3 ppm)
As = 613 ± 28 (626 ± 38 ppm)
Pb = 5525 ± 77 (5532 ± 80 ppm)
1946 Attempt to read soil samples. ~~Soil~~ KAB
Soil Sample #1:
Sb = 144 ± 26 ppm
As = 443 ± 32 ppm

9-30-11 / KAB

1946 Pb = 9507 ± 113 ppm
1950 Soil Sample #2:
Sb = 165 ± 26 ppm
As = 336 ± 30 ppm
Pb = 8289 ± 101 ppm
2000 Conclude tests and pack up XFR.

9-30-11 / KAB

10-1-11 / KAB

710 Leave hotel for the site.
725 Arrive at site
733 Put together XRF. ~~St~~ KAB
Standardize with metal clip, SiO_2, and NIST Medium and High Standards.
743 Standardization successful. Resolution = 229.
746 SiO_2 = ND
NIST Medium:
Sb = ND<79 ppm
As = 96 ± 11 ppm
Pb = 1051 ± 21 ppm
NIST Medium (2nd run):
Sb = ND <77 ppm
As = 105 ± 11 ppm
Pb = 996 ± 20 ppm
NIST Medium (3rd run):
Sb = ND < 81 ppm
As = 92 ± 12 ppm
Pb = 1051 ± 21 ppm
** Note: All readings for XRF are in parts per million unless otherwise noted.

10-1-11 / KAB

800 NIST High:
Sb = ND<82
As = 644 ± 29
Pb = 5255 ± 76
805 Standards check successful.
810 Set up on deep sample G-13D and auger to 12". Auger to 12"-18" and take small sample for XRF reading.
819 XRF reading:
Sb = ND<71
As = 102 ± 15
Pb = 2431 ± 33
821 Continue augering to 18"-24" interval. Take small sample for XRF reading.
829 XRF reading:
Sb = ND< 68
As = 65 ± 10
Pb = 1109 ± 18
832 Continue augering to 24"-30" interval. Take small sample for XRF reading.

10-1-11 / KAB

841 XRF reading:
Sb = ND < 69
As = 13 ± 3
Pb = 99 ± 5

852 Use soil in auger. Maximum depth 30". Take sample G-13 D.

900 Decon hand auger and shovel.

907 Set up on G-16 D and remove up to 12" with shovel.

915 Auger down on 12"-18" interval. Take small soil sample for XRF.

921 XRF reading:
Sb = ND < 72
As = ND < 39
Pb = 1871 ± 28

926 Auger down on 18"-24" interval. Take small soil sample for XRF.

932 XRF reading:
Sb = ND < 70
As = 67 ± 10
Pb = 1041 ± 18

936 Auger down on 24"-30" interval. Take small soil sample for XRF.

10-1-11 / KAB

~~953 XRF reading:~~ KAB
~~Sb =~~ KAB
~~As =~~ KAB
~~Pb =~~ KAB

958 Battery running low on unit. Replace battery and restart unit.

1000 Restandardize unit with metal clip. Standardization successful.

1003 Rerun NIST Medium and High Standards, and SiO_2.

1005 SiO_2 = ND
NIST Medium:
Sb = ND < 77
As = 110 ± 11
Pb = 1022 ± 20
NIST High:
Sb = ND < 87
As = 664 ± 29
Pb = 5066 ± 76
NIST High (2nd Run):
Sb = ND < 84
As = 663 ± 29
Pb = 5237 ± 76

10-1-11 / KAB

1012 XRF reading (24"-30"):
Sb = ND < 69
As = ND < 26
Pb = 970 ± 17

1017 Auger down on 30"-36" interval. Take small ~~sample~~ KAB ~~for X~~ KAB soil sample for XRF.

1033 XRF reading:
Sb = ND < 68
As = ND < 19
Pb = 440 ± 11

1037 Auger down on 36"-42" interval. Take sample for XRF.

1043 Unable to auger to 36"-42" interval. Resample 30"-36" interval. Take small soil sample for XRF.

1045 XRF reading:
Sb = ND < 70
As = 31 ± 7
Pb = 559 ± 12

1047 Take sample G-16 D at depth of 36".

10-1-11 / KAB

1058 Set up on G-1 D and remove up to 12" with shovel.
* Note: around 12" deep soil contains moisture. May interfere with XRF readings.

1108 Auger down on 12"-18" interval. Take small sample for XRF.

1115 XRF reading:
Sb = ND < 69
As = ND < 9
Pb = 74 ± 5

1120 Take sample G-1D at depth of 18".

1148 Set up on G-18 D and remove up to 12" with shovel.

1157 Auger down on 12"-18" interval. Take small sample for XRF.

1205 XRF Reading:
Sb = ND < 71
As = 116 ± 15
Pb = 2586 ± 35

1208 Auger down on 18"-24" interval. Take small sample for XRF.

10-1-11 / KAB

1223 XRF Reading:
Sb = ND < 72
As = 76 ± 17
Pb = 3162 ± 42
1226 Auger down on 24" - 30" interval. Take small sample for XRF.
1243 Refusal at 25" due to tire. Move location 2' then try again.
1244 Hand dig with shovel to 12". Continue augering on 12"-18" interval. Take small sample for XRF.
1255 XRF Reading:
Sb = ND < 67
As = 21 ± 7
Pb = 576 ± 12
1258 Auger down on 18" - 24" interval. Take small sample for XRF.
1308 XRF Reading
Sb = ND < 70
As = 39 ± 8
Pb = 645 ± 14
1310 Auger down on 24" - 30" interval. Take small sample for XRF.

10-1-11 / KAB

1315 XRF Reading:
Sb = ND < 70
As = 30 ± 8
Pb = 642 ± 13
1317 Unable to go any farther down hole. Hit refusal from rock in 2 separate areas in hole. Take sample at depth of 30".
1327 Set up on G-3D and remove up to 12" with shovel.
1340 Auger down on 12" - 18" interval. Take small sample for XRF.
1348 XRF Reading:
Sb = 186 ± 27
As = 358 ± 37
Pb = 12451 ± 151
1350 Auger down on 18" - 24" interval. Take small sample for XRF.
1406 Refusal around 19". Move location to the side 1' and try again. Remove up to 12" with shovel and auger down on 12"-18" interval.

10-1-11 /KAB

1410 Unable to auger down due to rock content in hole. Move location 1' down the slope and try again. Remove up to 12" with shovel. Auger down ~~on~~ 12" - 18" interval. Take sample for XRF.

1423 XRF reading:
Sb = ND <69
As = 65 ± 9
Pb = 897 ± 16

1426 Restandardize XRF. Standardization successful.

1428 Shoot SiO_2, NIST Medium, and NIST High Standards.

1429 SiO_2 = ND
~~NIST Medium:~~ KAB
~~Sb =~~ KAB
~~As =~~ KAB
~~Pb =~~ KAB

1434 Battery power too low to analyze. Need to recharge batteries. Head to Home Depot to obtain power inverter. Locked gate on the way out.

10-1-11 /KAB

1521 Arrive back at site. Open gate and lock behind.

1544 Hooked power inverter up to truck, unit did not turn on, leave site for the day to return inverter. ~~and~~ KAB 18"-24" interval sample retained for XRF for tomorrow.

1604 Lock gate on the way out.

1628 Purchase power inverter at Radio Shack.

1639 Return power ~~int~~ KAB inverter to Home Depot.

1642 Go to Walmart to pick up water.

1700 Arrive back at hotel.

10-1-11 /KAB

10-2-11 / KAB

830 Leave Hotel for site.
834 Open gate and lock behind us.
837 Arrive on site.
840 Put together XRF. Go through standardization process.
843 Screen for iPAQ is very dark even though charged overnight.
847 Screen brightness adjusted!
848 Continue putting together XRF.
850 Standardization successful
852 Test SiO_2, NIST Medium, and NIST High standards.
854 SiO_2 = ND
NIST Medium:
Sb = ND < 77
As = 99 ± 12
Pb = 1130 ± 22
NIST High:
Sb = ND < 83
As = 688 ± 29
Pb = 5176 ± 76
NIST High (2nd run):
Sb = ND < 84
As = 643 ± 29
Pb = 5145 ± 75

10-2-11 / KAB

906 Standards check successful.
908 Take XRF reading of G-3D 18"-24" interval (3rd location):
Sb = 176 ± 27
As = 224 ± 37
Pb = 12297 ± 152
925 Auger down on 24"-30" interval. Take small sample for XRF.
931 XRF Reading:
Sb = 117 ± 25
As = 499 ± 32
Pb = 9645 ± 115
934 Auger down on 30"-36" interval. ~~Take small sample for XRF.~~ KAB Retain 24"-30" interval for possible use. ~~Collect MS/MSD~~ KAB
1005 Unable to get past 30" for G-3D location. Collect additional soil from G-3D 24"-30" for matrix spike/matrix spike duplicate. Maximum depth is 30".
1027 Recon hand auger and shovel.

10-2-11 / KAB

1037 Set up on G-21D. Removal of top 12" already performed by Carl Ridge on 10-1-11. Proceed to auger down 12"-18". Take small sample for XRF.

1043 XRF Reading:
Sb = 181 ± 26
As = 149 ± 30
Pb = 8959 ± 109

1046 Auger down on 18"-24" interval. ~~Take small~~ KAB Take small sample for XRF.

1059 XRF Reading:
Sb = 126 ± 26
As = 350 ± 29
Pb = 7778 ± 95

1102 Auger down on 24"-30" interval. Take small sample for XRF.

1114 XRF Reading:
Sb = 113 ± 25
As = 264 ± 28
Pb = 7714 ± 93

1116 Auger down on 30"-36" interval. Take small sample for XRF.

10-2-11 / KAB

1136 XRF Reading:
Sb = 124 ± 27
As = 375 ± 28
Pb = 6742 ± 87

1141 Auger down on 36"-42" interval. Take small sample for XRF.

1316 Restandardize XRF. Standardization successful.

1318 Test SiO_2, NIST Medium and NIST High standards

1319 SiO_2 = ND
NIST Medium:
Sb = ND < 73
As = 104 ± 11
Pb = 1077 ± 20
NIST High:
Sb = ND < 80
As = 643 ± 27
Pb = 4930 ± 70
NIST High (2nd run):
Sb = ND < 92
As = 645 ± 32
Pb = 4853 ± 81

10-2-11 /KAB

1327 Replace battery on XRF.
1333 XRF Reading:
Sb = 182 ± 25
As = 138 ± 32
Pb = 9507 ± 116
~~1337 Auger down on 42" - 48". Take small sample for XRF. Retain ~~ KAB ~~interval for use.~~ KAB
1337 Take sample from 36" - 42" as to not take additional time on project.
1413 Auger down on N-15 D-1 12"-18" interval.
1428 Got down to 14" maximum depth. Take small sample for XRF.
1430 XRF Reading:
Sb = ND<74
As = 11 ± 3
Pb = 79 ± 5
1433 ~~Take s.~~ KAB Collect N-15 D-1 at 14" maximum depth.
** Note: Soil is moist.
1437 Auger down on N-15 D-3

10-2-11 /KAB

1437 12"-18" interval. Take small sample for XRF.
1440 XRF Reading:
Sb = ND<80
As = ND<12
Pb = 114 ± 6
** Note: Soil is moist.
1445 Collect N-15 D-3 at 14" maximum depth.
1448 Decon auger and trowel.
1455 Auger down on N-18 D-3 12"-18" interval. Take small sample for XRF
1510 XRF Reading:
Sb = ND<69
As = 22 ± 4
Pb = 141 ± 6
~~1316~~ KAB 1516 Collect N-18 D-3 at 14" maximum depth.
1532 Auger down on N-18 D-4 12"-18" interval after clearing up to 12" with shovel. Take small sample for XRF.

10-2-11 / KAB

1540 XRF Reading:
Sb = ND <72
As = 166 ± 15
Pb = 2296 ± 32
1544 Collect N-18 D-4 at
18" maximum depth.
1551 Decon all tools. Put away
XRF.
1626 Leave site for the day.
Open gate and lock behind
us.
1645 Back at hotel

10-2-11 / KAB

10-3-11 / KAB

700 Leave hotel for the site.
710 Arrive on site. Gate open
when we arrived.
715 Put together XRF. Touch
screen on iPAQ not as
responsive as usual. Allow
additional time to warmup.
721 Reset iPAQ and turn
on again. Seemed to
fix the issue.
725 Standardization performed.
726 XRF standardization successful.
728 Test SiO_2, NIST Medium
and NIST High Standards.
730 SiO_2 = ND
NIST Medium:
Sb = ND < 75
As = 97 ± 11
Pb = 1137 ± 21
NIST High:
Sb = ND < 83
As = 671 ± 28
Pb = 5183 ± 74

10-3-11 / KAB

737 Standards check successful.

743 Field team realized that sample N-18 D-4 should go down to Pb reading of 400 ppm or 48" depth.

745 Auger down on N-18 D-4 18" - 24". Take small sample for XRF.

757 XRF Reading:
Sb = ND<70
As = 119 ± 12
Pb = 1491 ± 23

806 Auger down on 24" - 30". Take small sample for XRF.

816 XRF Reading:
Sb = ND<71
As = 16 ± 4
Pb = 164 ± 7

820 Collect N-18 D-4 24" - 30". Maximum depth 30".

835 Auger down on N-14 D-3 12"-18". Hole predug by CP. Collect small sample for XRF.

10-3-11 / KAB

850 Only able to get down to 14" due to interlocked rocks in hole.

852 XRF Reading:
Sb = ND<67
As = 15 ± 4
Pb = 186 ± 7

** Note: Soil is moist

854 Collect N-14 D-3 at 14" maximum depth.

912 Auger down on N-14 D-4 12"-18" interval. Hole predug by CP. Collect small sample for XRF.

921 Only able to get down to 13" due to interlocked rocks in hole.

923 XRF Reading
Sb = ND<68
As = 17 ± 4
Pb = 181 ± 7

** Note: Soil is moist

925 Collect N-14 D-4 at 13" maximum depth.

10-3-11 / KAB

928 Decon hand auger and shovel.

941 Open up N-17 D-2 down to 12" with digging bar.

952 Auger down on N-17 D-2 12"-18" interval. Take small sample for XRF.

1000 Only able to get down to 13" due to interlocked rocks in hole.

~~1002 XRF Reading:~~ KAB

~~Sb=~~ KAB

~~As=~~ KAB

~~Pb=~~ KAB

~~** Note: Soil is moist.~~ KAB

1003 Replace battery in XRF.

1004 XRF Reading:

Sb= ND<69

As= 14±4

Pb= 141±7

** Note: Soil is moist.

1011 Collect N-17 D-2 at 13" maximum depth.

1027 Auger down on N-17 D-3 12"-18" interval. Hole pre dug by CP. Take small

10-3-11 / KAB

1027 sample for XRF.

1030 XRF Reading:

Sb = ND<72

As = ND<7

Pb = 37±4

** Note: Soil is moist.

1037 Collect N-17 D-3 at 18" maximum depth.

1041 Decon hand auger and shovel.

1046 Restandardize XRF.

1048 Standardization successful.

1050 Shoot SiO_2, NIST Medium and NIST High Standards.

1051 SiO_2 = ND

NIST Medium:

Sb = ND<75

As = 101±11

Pb = 1118±21

NIST High:

Sb = ND<80

As = 622±28

Pb = 5249±75

1055 Standards check successful.

1058 Dig down 12" on N-16 D-3. Auger down to 12"-18" interval. Take small sample for XRF.

10-3-11 / KAB

KAB ~~to 58~~

1136 XRF Reading:
Sb = ND < 83
As = 45 ± 9
Pb = 573 ± 15

1138 Unable to go past 14" on N-16 D-3. Attempt another location.

1140 Auger down on N-16 D-2 12"-18" interval. Hole pre dug by CP. Take small sample for XRF reading.

1148 XRF Reading:
Sb = ND < 67
As = 22 ± 5
Pb = 286 ± 8

** Note: Soil is moist

1152 Unable to get past 14" due to interlocked rocks in hole.

1154 Collect N-16 D-2 at 14" maximum depth.

1207 Auger down on N-16 D-1 12"-18" interval. Hole pre dug by CP. Take small sample for XRF.

10-3-11 / KAB

1217 XRF Reading:
Sb = ND < 68
As = ND < 11
Pb = 134 ± 6

1220 Collect N-16 D-1 at 18" maximum depth.

1232 Pecon all tools.

1245 Dig down to 12" on N-13 D-3 with digging bar.

1254 Stop digging on N-13 D-3. 2 holes already dug to 12" on N-13 grid. Proceed to N-13 D-2.

1257 Auger down on N-13 D-2 12"-18" interval. Take small sample for XRF.

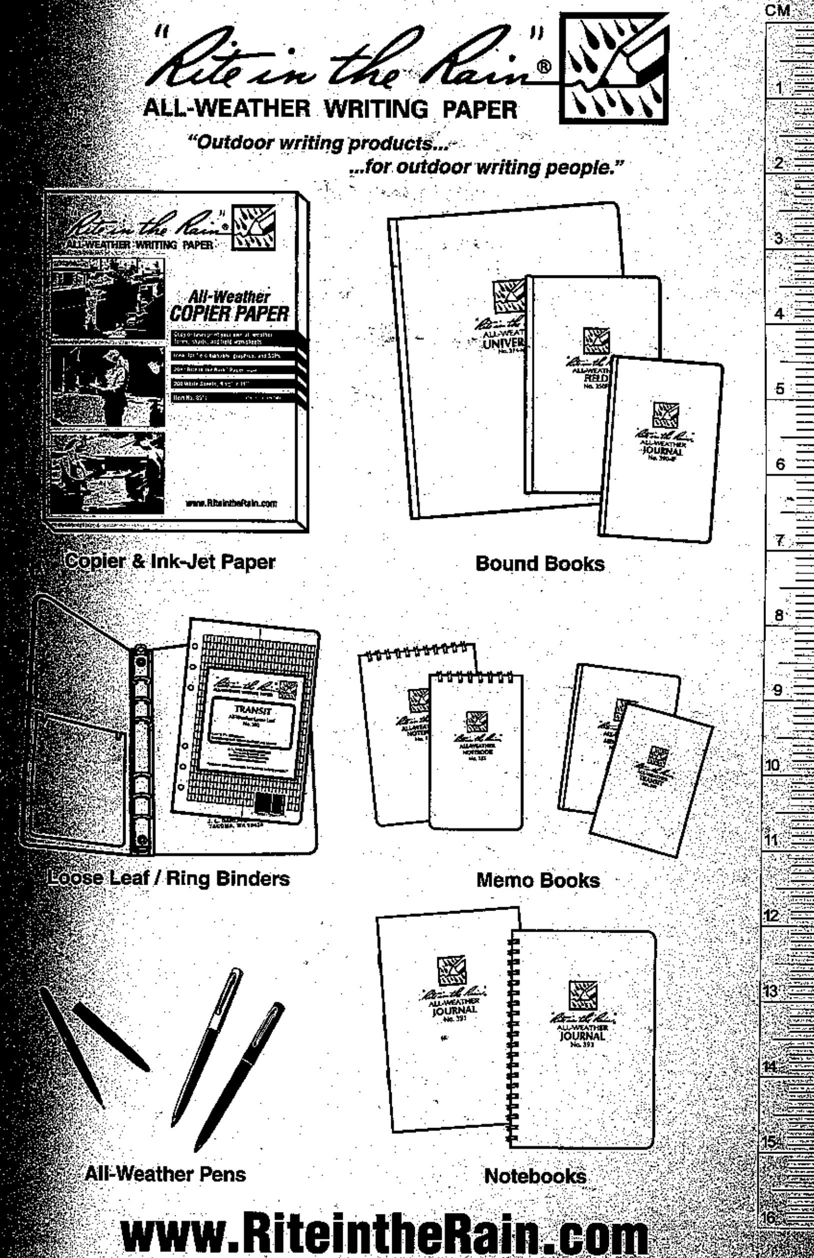
1306 XRF Reading:
Sb = ND < 69
As = 35 ± 7
Pb = 600 ± 13

1311 Sample for XRF taken at 13". An attempt will be made to get to 16".

1323 Unable to get past 13" due to rocks in hole. (Cont. in Book #2)

Note:

Polaris Land Surveying, LLC
POC: J.D. Reyes, RLS
3528 N. Flowing Wells Rd.
Tuscon, AZ 85705
Tele: (520)-322-6900



SITE CHARACTERIZATION

NOGALES BORDER PATROL FIRING RANGE

"Rite in the Rain"®
ALL-WEATHER
FIELD
No. 351

NOGALES, ARIZONA

USACE SACRAMENTO

CONTRACT NO.:
W 9126G-06-D-0016

KEVIN BEYER

TERRANEAR PMC, LLC

BOOK #2 OF 2

"Rite in the Rain"®
ALL-WEATHER WRITING PAPER

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Project Nogales Border Patrol
Firing Range

CONTENTS

PAGE	REFERENCE	DATE
	** - designates note	
	Acronyms	
	NIST - National Institute	
	of Standards and Technology	
	XRF - X-Ray Fluorescence	
	CP - Carl Ridge	
	ND - Non-Detect	

10-3-11 /KAB

1327 Collect N-13 D-2 at maximum depth of 13".

1340 Auger down on N-13 D-1 12"-18" interval. Hole predug by CP. Collect small sample for XRF.

1351 XRF Reading:
Sb = ND < 68
As = 17 ± 5
Pb = 257 ± 8 ; ** Note: Soil is moist.

1353 Collect N-13 D-1 ~~12"-18"~~ KAB at maximum depth of 18".

1404 Decon all tools.

1413 Auger down on N-12 D-3 12"-18" interval. Hole predug by CP. Take small sample for XRF. Take sample from 13".

1433 XRF Reading:
Sb = ND < 69
As = 47 ± 8
Pb = 789 ± 15
** Note: soil is moist.

1437 Make an attempt to get to 18". Get down to 18". Take small sample for XRF.

10-3-11 /KAB

~~1449 XRF Reading:~~ KAB
~~Sb =~~ KAB
~~As =~~ KAB
~~Pb =~~ KAB

1451 Restandardize XRF and replace battery.

1457 Standardization successful.

1500 Test SiO_2, NIST Medium, and NIST High.

1502 SiO_2 = ND
NIST Medium:
Sb = ND < 75
As = 86 ± 11
Pb = 1116 ± 21
NIST High:
Sb = ND < 80
As = 656 ± 28
Pb = 5303 ± 75

1507 XRF Reading:
Sb = ND < 67
As = 41 ± 8
Pb = 808 ± 15 ; ** Note: Soil is moist.

1510 Collect N-12 D-3 at maximum depth of 18".

10-3-11 /KAB

1520 Auger down on N-12 ~~P-14~~ KAB D-4 12"-18" interval. Hole predug by CP. Take small sample for XRF (from 15").

1531 XRF Reading:
Sb = ND < 73
As = ~~As~~ KAB 146 ± 18
Pb = 3371 ± 44; *Note: Soil is moist.

1535 Continue augering to 18". Take small sample for XRF.
XRF Reading:
Sb = ND < 69
As = 77 ± 11
Pb = 1414 ± 22
** Note: Soil is moist.

1543 Collect N-12 P-4 at maximum depth of 18".

1555 Decon all tools. *KAB

1600 Turn off XRF and put away.

1630 Leave site for the day.

1645 Arrive at hotel.

10-3-11 /KAB

10-4-11 /KAB

715 Leave hotel for the site.

720 Stop at Fiesta market for ice for coolers.

730 Gate is open when we arrive.

732 Arrive on site.

734 Put together XRF.

736 Standardize XRF.

739 Standardization successful.

740 Shoot SiO_2, NIST Medium, and NIST High Standards.

741 SiO_2 = ND
** Note: SiO_2 is blank standard
NIST Medium:
Sb = ND < 73
As = 115 ± 14
Pb = 1124 ± 21
NIST High:
Sb = ND < 80
As = 612 ± 28
Pb = 5381 ± 75

749 Standards check successful.

752 Dig down to 12" on 78 D-1.
~~Auger down on 12"-18" interval.~~ KAB

10-4-11 /KAB

806 Unable to get past 5" on 78 D-1. Move to 78 D-2
812 Dig down to 12" on 78 D-2.
815 Auger down on 12"-18" interval. Take small sample for XRF.
820 XRF Reading:
Sb = ND<69
As = 98 ± 15
Pb = 2644 ± 35; **Note: soil is moist.
823 Auger down on 18"-24" interval. Take small sample for XRF.
832 XRF Reading:
Sb = ND<70
As = 132 ± 14
Pb = 1999 ± 29
** Note: Soil is moist.
834 Auger down on 24"-30" interval. Take small sample for XRF.
839 XRF Reading:
Sb = ND <71
As = 274 ± 19
Pb = 3769 ± 47

10-4-11 /KAB

841 Unable to get past 25" due to rocks in hole. Collect 78 D-2 at a maximum depth of 25".
843 CP augers on 78 ~~D-4~~ D-3 down to 12"-18" interval. Take small sample for XRF.
846 XRF Reading:
Sb = ND <72
As = 133 ± 14
Pb = 2001 ± 29
852 Collect 78 D-3 at maximum depth of 18".
859 Go to N-7 D-1. Dig down to 12". Auger down on 12"-18" interval. Take small sample for XRF.
908 XRF Reading:
Sb = ND < 67
As = ND<9
Pb = 70 ± 5
910 Collect N-7 D-1 at 18" maximum depth.
915 Dig down on N-7 D-4 to 12". Auger down on 12"-18" interval. Take small sample for XRF.

10-4-11 /KAB

920 XRF Reading:
Sb = ND < 69
As = 7 ± 2
Pb = 29 ± 4

923 Collect N-7 D-4 at 18" maximum depth. Decon all tools.

** N-7 locations on the side walls of arroyo.

927 Dig down to 12" on N-4 D-1. Auger down on 12"-18" interval. Take small sample for XRF.

938 XRF Reading:
Sb = ND < 68
As = 8 ± 2
Pb = 25 ± 3

943 Collect N-4 D-1 at 18" maximum depth.

946 Dig down to 12" on N-4 D-2. Auger down on 12"-18" interval. Take small sample for XRF.

~~948~~ 946 KAB XRF Reading:
Sb = ND < 68
As = 9 ± 2
Pb = 30 ± 4

10-4-11 /KAB

950 Collect N-4 D-2 at 18" maximum depth.

** N-4 locations on side walls of the arroyo.

954 Dig down 12" on N-8 D-2. Auger down on 12"-18" interval. Take small sample for XRF.

1005 ~~XRF Reading:~~ KAB
~~Sb =~~ KAB
~~As =~~ KAB
~~Pb =~~ KAB

1006 ~~uni~~ KAB iPAQ freezes up. ~~Do a~~ KAB Perform a soft reset as instructed by Leonard Orr of USE.

1009 Restandardize XRF.

1011 Standardization successful.

1012 Shoot SiO_2, NIST Medium and NIST High Standards.

1013 SiO_2 = ND
NIST Medium:
Sb = ND < 73
As = 102 ± 11
Pb = 1128 ± 21

10-4-11 / KAB

1013 NIST High:
Sb = ND<79
As = 696 ± 28
Pb = 5285 ± 74

1017 XRF Reading:
Sb = ND<69
As = 28 ± 6
Pb = 365 ± 10

1019 Collect N-8 D-2 at
18" maximum depth.

1024 Dig down 12" on N-8 D-1.
Auger down on 12"-18" interval.
Take small sample for XRF.

1033 XRF Reading:
Sb = ND<68
As = 16 ± 4
Pb = 205 ± 7

1035 Collect N-8 D-2 at 18"
maximum depth.

1047 Decon auger and shovel.

1058 Dig down 12" on N-9 D-2.
Auger down on 12"-18" interval.
Take small sample for XRF
reading.

10-4-11 / KAB

1110 XRF Reading:
~~Pb~~ Sb = ND<68
As = 38 ± 7
Pb = 506 ± 11

1115 Auger down on 18"-24"
interval. Take small sample
for XRF.

1125 XRF Reading:
Sb = ND<67
As = 23 ± 5
Pb = 322 ± 9

1127 Collect N-9 D-2 at 24"
maximum depth.

1130 Dig down 12" on N-9 D-1.
Auger down on 12"-18" interval.
Take small sample for XRF.

1141 XRF Reading:
Sb = ND<67
As = 16 ± 5
Pb = 241 ± 8

1143 Collect N-9 D-1 at ~~a~~ KAB 18"
maximum depth.

1148 Decon auger and shovel.
Replace battery in XRF.

10-4-11 /KAB

1157 Dig down 12" on N-10 D-2. Auger down on 12"-18" interval. Take small sample for XRF.

1217 XRF Reading:
Sb = ND < 66
As = 10 ± 2
Pb = 22 ± 3

** Note: Soil is moist.

1220 Collect N-10 D-2 at 18" maximum depth.

1227 Dig down 12" on N-10 D-1. Auger down on 12"-18" interval. Take small sample for XRF.

1235 XRF Reading:
Sb = ND<68
As = 15 ± 4
Pb = 209 ± 7; ** Note: soil is moist.

1238 Collect N-10 D-1 at 18" maximum depth.

1243 Decon auger and shovel.

1253 Dig down 12" on N-59 D-2 with trowel. Auger down on 12"-18" interval. Take small sample for XRF.

10-4-11 /KAB

1302 XRF Reading:
Sb = ND < 77
As = 730 ± 37
Pb = 11631 ± 140

1310 Auger down on 18"-24" interval. Take small sample for XRF.

1324 XRF Reading:
Sb = ND < 70
As = 246 ± 18
Pb = 3613 ± 45

1327 Auger down on 24"-30" interval. Take small sample for XRF.

1339 +KAB XRF Reading:
Sb = ND<71
As = 331 ± 21
Pb = 4642 ± 57

1342 Unable to proceed farther down hole due to roots and several large rocks. Collect N-59 D-2 at 30" maximum depth.

10-4-11 /KAB

1348	Dig down to 12" on N-59 D-4.
	Auger down on 12"-18" interval.
	Take small sample for XRF.
1358	~~XRF Reading:~~ KAB
	~~Sb =~~ KAB
	~~As =~~ KAB
	~~Pb =~~ KAB
1400	Replace battery in XRF.
	Restandardize.
1405	Standardization successful.
1408	Shoot SiO_2, NIST Medium, and
	NIST High Standards.
1410	SiO_2 = ND
	NIST Medium:
	Sb = ND<73
	As = 76 ± 4
	Pb = 1109 ± 20
	NIST High:
	Sb = ND<81
	As = 677 ± 28
	Pb = 5352 ± 75
1415	XRF Reading:
	Sb = ND<67
	As = ND<14
	Pb = 226 ± 7

10-4-11 /KAB

1418	Collect N-59 D-4 at
	18" maximum depth.
1421	Decon all tools.
1433	~~N~~ KAB Auger down on N-60
	D-3 12"-18" interval. Hole
	predug by CP. Take small sample for XRF.
1441	XRF Reading:
	Sb = ND<68
	As = 14 ± 4
	Pb = 130 ± 6
1443	Collect N-60 D-4 at 18"
	maximum depth.
1447	Auger down on N-60
	D-1 12"-18" interval. Hole
	predug by CP. Take small
	sample for XRF.
1455	Unable to get ~~to~~ KAB past
	13" due to rocks in hole.
1457	XRF Reading:
	Sb = ND<67
	As = 9 ± 3
	Pb = 50 ± 4
1500	Collect N-60 D-1 at 13"
	maximum depth.

10-4-11/KAB

1505 Decon all tools.
1513 Auger down on N-61 D-1
12" - 18" interval. Hole pre-dug
by CP. Take small sample for XRF.
1520 Unable to get past 14" due
to rocks in hole.
1523 XRF Reading:
Sb = ND < 69
As = 26 ± 6
Pb = 327 ± 9
1526 Collect N-61 D-1 at 14"
maximum depth.
1529 Auger down on N-61 D-2
12"-18" interval. Hole pre-dug
by CP. Take small sample for XRF.
1533 Unable to go beyond 14" due
to rocks in hole
1535 XRF Reading:
Sb = ND < 69
As = ND < 13
Pb = 189 ± 7
1538 Collect N-61 D-2 at 14"
maximum depth.
1542 Decon all tools.

10-4-11 /KAB

1557 Take apart and put away
XRF.
1605 Put tools in shed.
1607 Site cleanup.
1635 Leave site for the day.
1640 Gate was locked. Locked
gate upon exit.
1650 Back at hotel.

10-4-11 /KAB

10-5-11 / KAR

915 Leave hotel for the site.
920 Arrive on site.
922 Pull up pin flags and stakes and fill in holes.
1020 Demobilize from site.
1025 Leave site. Gate is open as we leave. Head to CBP building to drop off gate key.
1040 Met with Shawn Palmer and dropped off gate key. Proceed to Fed Ex for shipment of XRF, hand auger, GPS unit, sample cooler, sampling supplies, and personal materials.
1103 Obtain address for USE by calling Pat Feitch 609-570-8555. Address 5 C South Gold Dr. Hamilton, NJ 08691.
1110 Relinquish control of XRF to FedEx Nogales.
1115 Head to Tuscon to stay at

10-5-11 / KAB

1115 Holiday Inn Express.
1230 Arrive at Holiday Inn Express Tuscon. Fly out tomorrow around 7AM.

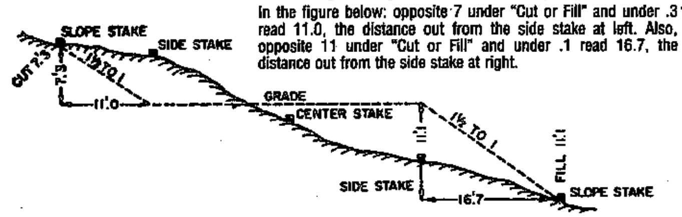
10-5-11 / KAB

[redacted]

DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING

Roadway of any Width. Side Slopes 1½ to 1.

In the figure below: opposite 7 under "Cut or Fill" and under .3 read 11.0, the distance out from the side stake at left. Also, opposite 11 under "Cut or Fill" and under .1 read 16.7, the distance out from the side stake at right.



Cut or Fill	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	Cut or Fill
	Distance out from Side or Shoulder Stake										
0	0.0	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	0
1	1.5	1.7	1.8	2.0	2.1	2.3	2.4	2.6	2.7	2.9	1
2	3.0	3.2	3.3	3.5	3.6	3.8	3.9	4.1	4.2	4.4	2
3	4.5	4.7	4.8	5.0	5.1	5.3	5.4	5.6	5.7	5.9	3
4	6.0	6.2	6.3	6.5	6.6	6.8	6.9	7.1	7.2	7.4	4
5	7.5	7.7	7.8	8.0	8.1	8.3	8.4	8.6	8.7	8.9	5
6	9.0	9.2	9.3	9.5	9.6	9.8	9.9	10.1	10.2	10.4	6
7	10.5	10.7	10.8	11.0	11.1	11.3	11.4	11.6	11.7	11.9	7
8	12.0	12.2	12.3	12.5	12.6	12.8	12.9	13.1	13.2	13.4	8
9	13.5	13.7	13.8	14.0	14.1	14.3	14.4	14.6	14.7	14.9	9
10	15.0	15.2	15.3	15.5	15.6	15.8	15.9	16.1	16.2	16.4	10
11	16.5	16.7	16.8	17.0	17.1	17.3	17.4	17.6	17.7	17.9	11
12	18.0	18.2	18.3	18.5	18.6	18.8	18.9	19.1	19.2	19.4	12
13	19.5	19.7	19.8	20.0	20.1	20.3	20.4	20.6	20.7	20.9	13
14	21.0	21.2	21.3	21.5	21.6	21.8	21.9	22.1	22.2	22.4	14
15	22.5	22.7	22.8	23.0	23.1	23.3	23.4	23.6	23.7	23.9	15
16	24.0	24.2	24.3	24.5	24.6	24.8	24.9	25.1	25.2	25.4	16
17	25.5	25.7	25.8	26.0	26.1	26.3	26.4	26.6	26.7	26.9	17
18	27.0	27.2	27.3	27.5	27.6	27.8	27.9	28.1	28.2	28.4	18
19	28.5	28.7	28.8	29.0	29.1	29.3	29.4	29.6	29.7	29.9	19
20	30.0	30.2	30.3	30.5	30.6	30.8	30.9	31.1	31.2	31.4	20
21	31.5	31.7	31.8	32.0	32.1	32.3	32.4	32.6	32.7	32.9	21
22	33.0	33.2	33.3	33.5	33.6	33.8	33.9	34.1	34.2	34.4	22
23	34.5	34.7	34.8	35.0	35.1	35.3	35.4	35.6	35.7	35.9	23
24	36.0	36.2	36.3	36.5	36.6	36.8	36.9	37.1	37.2	37.4	24
25	37.5	37.7	37.8	38.0	38.1	38.3	38.4	38.6	38.7	38.9	25
26	39.0	39.2	39.3	39.5	39.6	39.8	39.9	40.1	40.2	40.4	26
27	40.5	40.7	40.8	41.0	41.1	41.3	41.4	41.6	41.7	41.9	27
28	42.0	42.2	42.3	42.5	42.6	42.8	42.9	43.1	43.2	43.4	28
29	43.5	43.7	43.8	44.0	44.1	44.3	44.4	44.6	44.7	44.9	29
30	45.0	45.2	45.3	45.5	45.6	45.8	45.9	46.1	46.2	46.4	30
31	46.5	46.7	46.8	47.0	47.1	47.3	47.4	47.6	47.7	47.9	31
32	48.0	48.2	48.3	48.5	48.6	48.8	48.9	49.1	49.2	49.4	32
33	49.5	49.7	49.8	50.0	50.1	50.3	50.4	50.6	50.7	50.9	33
34	51.0	51.2	51.3	51.5	51.6	51.8	51.9	52.1	52.2	52.4	34
35	52.5	52.7	52.8	53.0	53.1	53.3	53.4	53.6	53.7	53.9	35
36	54.0	54.2	54.3	54.5	54.6	54.8	54.9	55.1	55.2	55.4	36
37	55.5	55.7	55.8	56.0	56.1	56.3	56.4	56.6	56.7	56.9	37
38	57.0	57.2	57.3	57.5	57.6	57.8	57.9	58.1	58.2	58.4	38
39	58.5	58.7	58.8	59.0	59.1	59.3	59.4	59.6	59.7	59.9	39
40	60.0	60.2	60.3	60.5	60.6	60.8	60.9	61.1	61.2	61.4	40

PROPERTY OF TPMC
222 VALLEY CREEK BLVD
SUITE 210
EXTON, PA. 19341
610·862·5000

IF FOUND PLEASE
CALL THE ABOVE
PHONE NUMBER
THANK YOU

SITE:
US BORDER PATROL
1651 W. TARGET RANGE RD.
NOGALES, ARIZONA

The paper in this book is made of 50% high grade rag stock with a WATER RESISTING surface sizing.

CONTENTS

PAGE NO.	REFERENCE	DATE
TAMC	505-573-8761 CELL RICK KLINGEL	
TAMC	484-653-8131 CELL CARL PIDGE	
USACE	814-694-9026 STEVE MARTIN	
BPFR	BORDER PATROL FIRING RANGE	
NAP	NO AMMUNITION PRESENT	
SCPB	SMALL CALIBER PISTOL BULLET	
FBJ	FRAGMENT OF BULLET JACKET	
CSW	CARDBOARD SHOTSHELL WAD	
PSW	PLASTIC SHOTSHELL WAD	
SCPC	SMALL CAL PISTOL CASE	
SBP	SHOTSHELL BUCKSHOT PELLET	
SSS	SHOTGUN SHELL SLUGS	
CPF	CLAY PIGEON FRAGS	
SCRB	SMALL CALIBER RIFLE BULLET	

CARL
PIDGE PG.
26 SEPT 11

USACE NOGALES FIRING RANGE
INITIAL MEET + WALKDOWN
33239

SUNNY
LT WIND
LOW 90s

0700 MEET TAMC ERIC (RICK) KLINGEL FOR
BREAKFAST, CARL PIDGE + KEVIN BEYER
0805 AT US BORDER PATROL FOR MEETING
w/
- USBP SHAWN PALMER US BORDER PATROL
- USACE STEVE MARTIN
- USBP PAUL ENRIQUEZ
- TAMC RICK KLINGEL, CARL PIDGE, KEVIN BEYER
0945 AT FIRE RANGE FOR WALK DOWN
1030 WALK DOWN COMPLETE.
1045 BACK AT HOTEL w/ TAMC RICK TO
DISCUSS PROJECT TASKS AND EQUIPMENT
1100 RICK KLINGEL CONTACT WITH LOCAL
SURVEYOR TO GET GRID WORK FOR
SAMPLING AREA, COORDINATE PROCESS
NOTE: US ARMY CORPS OF ENGINEERS (USACE)
CONTRACT # W912G-06-D-0016
SAFETY BRIEFING = 1015 HRS, INITIAL SITE
HAZARD TRAINING
1145 LUNCH BREAK AND GATHER EQUIPMENT
1610 BACK AT FIRE RANGE (BPFR) TO LOCATE
POINTS, STAKE AND FLAG LOCATIONS.

CP

(1)

CARL FOGE | BPFR NOGALES
SOIL SAMPLING

26 SEPT 2011 33239

1745 BACK FROM STAKING LOCATIONS
AND WALKING AREA. FOUND SEVERAL
LARGE CALIBER, WHAT LOOK LIKE
ARTILLERY SHELLS FRAGMENTS (FRAGS)
≈ 2 INCH DIAMETER, ONE FRAG COULD
BE 6 INCH DIAMETER
1815 OFF RANGE, GATE LOCKED

BPFR NOGALES

27 SEPT 2011 33239

0630 MEET TPUC KEVIN BEYER & RICK KLINGEL
FOR BREAKFAST. DISCUSS TASK FOR TODAY
AND SAFETY BRIEF
0710 KEVIN & RICK PREP TO DECON GAS UNIT
WHILE I DRIVE TO HOME DEPOT
0820 BACK AT BPFR
0800 H&S BRIEFING
NOTE: SCOPE CHANGE DUE TO LARGE FRAGMENTS
(FRAGS) WHICH COULD BE MUNITIONS
SCRAP AND/OR ~~ARTILLERY SHELLS~~ CS 27 SEPT 11
PAUL ENRIQUEZ AND STEVE WEAVER AND
RICK KLINGEL DISCUSSING WORK SCOPE
CHANGE OF SCOPE FROM BPFR AND ADJOINING
PROPERTY TO JUST BPFR. PER PAUL & STEVE
0940 SET UP TO GRID THEN SAMPLE
BPFR ONLY. KEVIN & RICK WILL BEGIN
GRID ON BPFR WHILE CARL MAKES RUN
TO HOME DEPOT
1130 MR ARBO AND MR JOE BARR STOPPED
BY BPFR TO DISCUSS WHAT WAS BEING
ACCOMPLISHED. MR BARR SHOWED ME SOME
PROPERTY MARKERS TO THE ARBO PROPERTY
FOR SURVEYOR TO TIE IN TO

CARL PIDER | BPFR NOGALES SOIL SAMPLING | 33239

27 SEPT 11

1330 LUNCH BREAK

1430 BACK FROM LUNCH TO CONTINUE GRID LAYOUT ON BPFR ONLY

1500 MR JOE BARR STOPPED BY TO TALK W/ PAUL (USAF) AND MR BARR DROPPED OF A COMPUTER DISC AND AERIAL PHOTO W/ SURVEYOR'S PLOTS

1745 BPFR GRID COMPLETE, STAKES AND PIN FLAGS

- PINK 25 FOOT GRID SPACING
- ORANGE CENTER SAMPLING POINT

1750 OFF BPFR GATE LOCKED

(signature)

CARL PIDER PG | BPFR NOGALES SOIL SAMPLING | SUNNY LOW 60S HIGH 80S

28 SEPT 11 | 33239

0630 BREAKFAST AND DISCUSSION W/ TPWR RICK KUNCEL, KEVIN BEYER AND CARL PIDER SAMPLE ALLOCATION, NOMENCLATURE, AND RECORDING INFORMATION, TAILGATE MEETING

0800 ON ROAD TO BORDER PATROL FIRING RANGE (BPFR)

0810 AT BPFR, STAGE AND PREP EQUIPMENT ALSO DESIGNATE CENTER GRID POINTS W/ GRID LOCATION

1010 GRAB SAMPLE G-1 SURFACE SOIL 0-0.5 FT BERM / WHIRLPAK = 8 OZ
2x SMALL CALIBER PISTOL BULLETS (SCPB) AND 4x FRAGS OF BULLET JACKETS (FBJ)

BPG1S

1110 G-2 SS 0-0.5 FT BERM = 8 OZ
3x SCPB + 6x FBJ **BPG2S**

1140 G-3 SS 0.5 FT **BPG3S**
14x SCPB + 13x FBJ + 1x CARDBOARD SHOTSHELL WAD (CSW) + 1x PLASTIC SHOTSHELL WAD (PSW) **DUPLICATE**

BPDG3S

1230 LUNCH BREAK

NOTE: GRAB ALIQUOTS TAKEN BEFORE LUNCH WILL BE PREPARED AFTER LUNCH SAMPLES KEPT IN MY CUSTODY

(signature)

CARL RIDGE PG — BPFR NOGALES SOIL SAMPLING — SUNNY HIGH 80s LIGHT BREEZE

28 SEPT 11 — 33239

1340 BACK FROM LUNCH, ERIC KRUEGER
HEADED TO AIRPORT DEMOBE
KEVIN WILL CONTINUE GPS TOPCON
MODEL GRS-1 ANTENNA PG-A5
OF LOCATIONS, CARL WILL CONTINUE
TO PREP SAMPLES COLLECTED BEFORE
LUNCH THEN COLLECT OTHER GRAB (G)
SAMPLES
NOTE: RICK SAID THE 22 GRAB (G)
SAMPLES 22 SHALLOWS WITH 6
CORRESPONDING DEEP SPATIAL
DISTRIBUTION 6 DEEP AT 3 FRONT
OF BERM AND 3 BACK OF BERM
1415 SIEVED BPG4S SEE PAGE 7
NOTE. ALL SAMPLE ALIQUOTS SIEVED
THRU USA STANDARD TEST SIEVE
WWW ADVANTECH MFG. COM
800.511.2096 STAINLESS STEEL SIEVES
- NO. 8 2.36mm/0.0937 INCH
- NO. 50 300 μm/0.0117 INCH
DISPOSABLE STERILEWARE 800 4BEL-ART
SCOOPS, NEW SCOOP FOR EACH LOCATION
DECONTAMINATION OF SS SIEVES w/ SOAP
AND DISTILLED WATER, RINSE w/ DEIONIZED
WATER, AIR DRY ON PLASTIC SHEET

[signature]

BPFR NOGALES

28 SEPT 11 — 33239

SURFACE SOIL GRAB (G)
- BPG4S 0-0.5FT @ 1148HRS. (RICK)
1x FBG + 1x PSW
- BPG5S 0-0.5FT @ 1149HRS (KEVIN)
~~AP~~ 2x FBJ
- BPG6S 0-0.5FT @ 1154HRS (RICK)
1x FBJ
- BPG7S 0-0.5FT @ 1200HRS (KEVIN)
NO DISCERNABLE BULLET MATERIAL
MS/MSD 3x 4oz WHIRL PAKS
1x FBJ
~~1430 THUNDERSTORM ROLLING IN FROM~~
- BPG8S 0-0.5FT @ 1202HRS (RICK)
1x FBJ 1x 4oz
- BPG9S 0-0.5FT @ 1207HRS (KEVIN)
1x FBJ 1x 4oz 6010B, Pb, As, Sb

[initials]

CARL RIDGE PL. BPFR NOGALES SOIL SAMPLING THUNDERSTORM LIGHT RAIN

28 SEPT 11 33239

1445 PREP/SIEVE BPG5S SEE PAGE 7

1505 PREP/SIEVE BPG6S SEE PAGE 7

1530 RINSATE BLANK BPRS001

Pb, As, Sb 6010B METHOD

POUR DEIONIZED WATER OVER DECONNED

STAINLESS STEEL SIEVES, POUR INTO

1 LITER AMBER, NEAT, 6010B

1545 PREP/SIEVE BPG7S SEE PAGE 7

MS/MSD TRIPLE VOLUME 6010B

1630 THUNDERSTORM ROLLING INTO AREA

FROM SOUTHEAST

1640 BPG8S PREPED/SIEVED SEE PAGE 7

6010B Pb, As, Sb

1650 STORM/LIGHT RAIN PASSED BY

1700 BPG9S PREP/SIEVE SEE PAGE 7

6010B Pb, As, Sb

NOTE: CLOUD COVER SLOWING AIR DRY

OF SIEVES, WHILE WAITING FOR SIEVE

TO DRY, KEVIN & I COLLECTED SURFACE

SOIL LOCATIONS BPG11S (1705 HRS),

BPG12S (1705 HRS), BPG13S (1711 HRS)

AND BPG14S (1711 HRS)

1725 BPG9S PREP/SIEVE SEE PAGE 7

1745 ALL PICKED UP, SAMPLE IN OUR

CUSTODY, OFF SITE

(8)

CARL RIDGE BPFR NOGALES SOIL SAMPLING SUNNY LT BREEZE HIGH 60S TO LOW 90S

29 SEPT 11 33239

0630 BREAKFAST & TAILGATE MEETING

0700 TO WALMART FOR SUPPLIES

0720 ON SITE TO CONTINUE GRAB (C)

SAMPLING SOIL FOR 6010B LEAD (Pb)

ARSENIC (As) AND ANTIMONY (Sb)

SET UP DECON

- DISTILLED WATER & SOAP

- DEIONIZED WATER RINSE

- AIR DRY

SOIL SAMPLES WILL BE SIEVED AS

YESTERDAY AND PLACED INTO 8 OZ

WHIRLPAK BAGS ≈ 4 OZ / SAMPLE OF

THE FINES THAT PASS THE NO. 50 SIEVE

SOIL COLLECTED W/ DISPOSABLE SCOOP

0815 SIEVE BPG10S SEE PAGE 10

0830 SIEVE BPG11S SEE PAGE 10

0915 SIEVE BPG12S SEE PAGE 10

0920 KEVIN TO COLLECT MORE GRAB (C)

SURFACE SOIL SAMPLES FROM G-15 ON

0940 JD FROM SURVEYOR CREW CALLED TO

SAY THEY WILL ARRIVE IN ≈ 1 HOUR

0945 SIEVE BPG13S SEE PAGE 10

1005 SIEVE BPG14S SEE PAGE 10

1040 SIEVE BPG15S SEE PAGE 10

(9)

CARL PIKE PG

BPFR NOGALES
SOIL SAMPLING
29 SEPT 11 33239

SAMPLE INFORMATION (Pb, As, Sb)

- BPG10S 0-0.5FT 28SEPT11 @ 1211 HRS
NO AMMUNITION PRESENT (NAP)
- BPG11S 0-0.5FT 28SEPT11 1705 HRS
NAP
- BPG12S 0-0.5FT 28SEPT11 1705 HRS
2x SMALL CALIBER PISTOL CASES (SCPC)
- BPG13S 0-0.5FT 28SEPT11 1711 HRS
2x SCPB + 1x FBJ
- BPG14S 0-0.5FT 28SEPT11 1711 HRS
2x SCPB + 11x FBJ + 1x SCPC
- BPG15S 0-0.5FT 29SEPT11 0933 HRS
NAP
- BPG16S 0-0.5FT 29SEPT11 0941 HRS
2x SCPB + 5x FBJ + 2x SHOTGUN BUCKSHOT PELLETS (SBP)
- BPG17S 0-0.5FT 29SEPT11 0948 HRS
1x SCPB + 3x FBJ
- BPG18S 0-0.5FT 29SEPT11 0957 HRS
2x SCPB + 1x FBJ + 1x SBP
- BPG19S 0-0.5FT 29SEPT11 1009 HRS
14x SCPB + 1x PSW + 5x FBJ +
4x SCPC + 1x SMALL CALIBER RIFLE CASE (SCRC)

[signature]

(10)

BPFR

29 SEPT 11 33239

1110 SIEVE BPG16S 29SEPT11 0941 HRS
SEE PAGE 10
1138 SIEVE BPG17S SEE PAGE 10
1140 POLARIS LAND SURVEYING LLC
REP J.D. REYES (RLS) ON SITE
3528 NORTH FLOWING WELLS ROAD
TUCSON, AZ 85705 520.322.6400
READING SITE SSHP, SIGN AND RECEIVE
TAILGATE MEETING
1210 I SHOWED JD THE PROPERTY MARKS
THAT MR BARR HAD POINTED OUT TO
ME
1225 KEVIN SHOWING JD OTHER POSSIBLE
BOUNDARY MARKERS
1230 SIEVE BPG18S SEE PAGE 10
1311 SIEVE BPG19S SEE PAGE 10
NOTE: KEVIN TO HOTEL TO PICKUP XRF
DEVICE
NOTE: SHOULD DUPLICATE BPDG19S, SPLIT
ALIQUOT FROM BPG19S
1348 SIEVE BPG20S SEE PAGE 12
DUE TO PLASTIC SHOTSHELL WADS (PSW) AND
CLAY PIGEON FRAGS (CPF) ANALYZE FOR
6010B (Pb As Sb) PLUS JAR FOR
PAH (METHOD 8270) RINSATE 2 LITERS

[signature]

(11)

CARL ALDER | BPFR NOGALES SOIL SAMPLING 33239 | LOW 90S LT BREEZE

29 SEPT 11

SAMPLE INFORMATION

-BPG 20S 0-0.5FT 29SEPT 11 1019 HRS.
NOTE DUE TO HIGH QUANTITY OF MATERIAL
FROM AMMO, TOOK PAH 8oz JAR AND
6010B Pb, As, Sb 2 LITERS, AMBER, NEAT
68 x FBJ, 2 x SHOTGUN SHELLS, 7 x SBP,
4 x PSW, 43 x SCPB
-BPG 21S 0-0.5FT 29 SEPT 11 1031 HRS.
23 x FBJ, 28 x SCPB, 1 x PSW, 1 x CSW
-BPG 22S 0-0.5FT 29SEPT 11 1041 HRS.
10x FBJ, 8x SCPB, 2x PSW, 1x CSW,
1x SCPC

BPFR

29 SEPT 11
1520 RINSATE SAMPLE BPRS002
2 x 1L AMBER GLASS NEAT
1540 SIEVE BPG21S SEE PAGE 12
1612 SIEVE BPG22S SEE PAGE 12
1630 ALL TWENTY TWO (22) SHALLOW
GRAB SAMPLES COMPLETE AT THIS TIME
PICK UP FOR TODAY
1645 OFFSITE, GATE LOCKED BY TRUCK
LEAVING BEHIND US

CARL PIDWE | BPFR NOGALES SOIL SAMPLING 33239 | SUNNY LT BREEZE HIGH 60S

30 SEPT 11

0640 ON ROAD, PICK UP ICE FOR PAH SAMPLES

0700 AT ARBO PROPERTY GATE, ALREADY OPEN

0705 HAS TAILGATE

0715 SET UP DECON AREA W/ LIQUINOX SOAP/WATER AND WATER RINSE

0910 KEVIN AND I HAVE COLLECT SURFACE SOIL (0-0.5 FT) SAMPLES FROM 78 PAH MS/MSD, N16 PAH, N17 PAH, N18, N13 PAH, N15, N12 PAH, ALL OF ABOVE ALSO Pb, AS, Sb

0915 CARL WILL START ARGO/SIEVE WHILE KEVIN CONTINUES TO SAMPLE

NOTE: NOMENCLATURE

BP78S6

BP - BORDER PATROL

78 - SAMPLE GRID

S - SHALLOW

D - DEEP

6 - 6 INCHES (BOTTOM SAMPLE DEPTH

0925 SIEVE BP78S6 SEE PAGE 15

1035 SIEVE BPN16S6 LOCATION N-16 SEE PAGE 15

(14)

BPFR

30 SEPT 11 33239

SAMPLE INFORMATION

- BP78S6 30 SEPT 11 0745 HRS

PAH/Pb, As, Sb MS/MSD TRIPLE VOLUME

3x 4oz BAGS + 3x 4oz JAR PAH

45x FBT, 2x SBP, 4x PSW, 8x CSW

2x SHOTGUN SHELL SLUGS (SSS), 1x CLAY PIGEON FRAG (CPF), 1x SINGLE CALIBER RIFLE BULLET (SCRB) STEEL CORE,

23x SCPB

- BPN16S6 30 SEPT 11 0805 HRS

6010B/8270

DUPLICATE ~~BPN16S6~~ 6010B/8270

BPDN16S6 24x SCPC, 15x SCPB

5x SCRC, 14x PSW, 28x CSW, 24x FBT

- BPN17S6, PAH/Pb, As, Sb 30 SEPT 11 0821 HRS

1x CPF, 8x SCPC, 4x FBT, 8x CSW, 18x PSW

- BPN18S6 30 SEPT 11 0835 HRS

5x PSW, 13x CSW, 6x SCPC, 2x SCRC

- BPN13S6 30 SEPT 11 0850 HRS 6010B/8270

8x SCPC, 6x PSW, 1x CSW, 3x SCPB

12x CPF, SEVERAL WOOD FRAGS FROM RAILROAD TIES

(15)

CAMP PARKS PG — BPFR SOIL SAMPLING 33239 — SUNNY MID 80s STRONG WIND

30 SEPT 11

1055 TALK RICK KLINKEE CALLED FOR UPDATE, RICK SUGGEST KEVIN CONTACT SUPPLIER TO DISCUSS XRF

1120 SIEVE BPN1756 SEE PAGE 15

1215 SIEVE BPN1856 SEE PAGE 15

1240 SIEVE BPN1356 SEE PAGE 15

1320 SIEVE BPN1556 SEE PAGE 17

1345 SIEVE BPN1256 SEE PAGE 17

1411 SIEVE BPN1456 SEE PAGE 17

1435 SIEVE BPN5956 SEE PAGE 17

1457 SIEVE BPN6056 SEE PAGE 17

1513 SIEVE BPN6056 SEE PAGE 17

1535 SIEVE BPN1056 SEE PAGE 17

1533 KEVIN TOOK FINAL SURFACE SOIL SAMPLE LOCATION

1600 SIEVE BPN956 SEE PAGE 17

1616 FINAL DECON FOR TODAY

REMAINING SAMPLES TO SIEVE N-8, N-7 & N-4

PICK UP AND SECURE FOR TODAY

1630 LEAVE SITE

1645 LOCKED ARBO'S GATE

[signature]

BPFR

30 SEPT 11 33239

SAMPLE INFORMATION

+BPN1556 30 SEPT 11 0900 HRS
6010B Pb, As, Sb 2x CSW, 1x PSW
5x SCRC, 15x SCPC

- BPN1256 30 SEPT 11 @ 0908 HRS
6010B/8270, 17x SCPB, 1x SCPC,
3x FBJ, 1x SSS

- BPN1456 30 SEPT 11 @ 0935 HRS
6010B/8270 31x PSW, 20x CSW, 11x
SCPC, 3x FBJ, 1x SCPB.

- BPN5956 30 SEPT 11 1007 HRS 6010B
2x FBJ

- BPN6056 30 SEPT 11 1023 HRS 6010B
3x FBJ

- BPN6156 30 SEPT 11 1040 HRS 6010B
2x FBJ, 1x SCPB

- BPN1056 30 SEPT 11 1332 HRS 6010B/
8270 4x SCRC, 6x SCPC, 3x PSW
1x CPF

BPN956 30 SEPT 11 1355 HRS 6010B/
8270 23x SCPC, 1x SHOT SHELL BRASS
2x PSW, 1x CSW, 1x FBJ

[signature]

CARL RIDGE AL | BPFR NOGALES SOIL SAMPLING 33239 | SUNNY LT BREEZE MID 60s

1 OCT 11

0630 BREAKFAST ON TAILGATE

MEETING w/ KEVIN BEYER

0715 HEAD TO SITE

0725 AT LOCKED ARMCO GATE, ACCESS

THRU RE-LOCK

0730 SETTING UP WORK AREA, KEVIN

WILL OPERATE INNOV-X XRF ~~X~~-4000

SN 8988

0740 I WILL SIEVE REMAINING

SURFACE SOIL SAMPLES FROM 30 SEPT 11

- N-8 30 SEPT 11 1438 HRS

8270 (PAH) + 6010B (Pb, As, Sb)

- N-7 30 SEPT 11 1516 HRS 6010B

- N-4 30 SEPT 11 1533 HRS 6010B

0808 SIEVE BPN8S6 SEE PAGE 19

NOTE: KEVIN WILL BEGIN COLLECTING

THE SIX (6) DEEP SOIL SAMPLES

FROM GRAB SAMPLE LOCATIONS

FIRST XRF READING 12-18 INCHES

PER TELECON RICK KLINGEL

0845 SIEVE BPN7S6 6010B

0925 ~~0915~~ SIEVE BPN4S6 6010B

0950 SIEVE BPG13D30 6010B

NOTE: D30 DENOTES DEEP SAMPLE AT

MAX DEPTH 30-INCHES

BPFR

1 OCT 11 33239

SAMPLE INFORMATION

- BPN8S6 30 SEPT 11 @ 1438 HRS

6010B (Pb, As, Sb) + 8270 (PAH)

SEE CONTENTS PAGE FOR ABBREVIATIONS

1x SBP, 2x PSW, 3x CSW, 1x SCPC, 8x

SCAB, 6x FBT

- BPN7S6 30 SEPT 11 @ 1516 HRS 6010B

1x PSW, 1x SCPB 0-0.5FT

- BPN4S6 30 SEPT 11 @ 1533 HRS 6010B

1x FBT

- BPG13D30 1 OCT 11 @ 0855 HRS 6010B

XRF Pb = 99 PPM +/- 15 NAP

- BPG16D30 1 OCT 11 @ 1055 HRS 6010B

XRF Pb = 559 PPM +/- 12 PPM NAP

- BPG1D18 1 OCT 11 @ 1140 HRS 6010B

XRF Pb = 74 ppm +/- 5 ppm ~~MS/MSD~~

LOW FINES/HIGH MOISTURE COULD NOT USE

AS MS/MSD

- BPG18D30 1 OCT 11 @ 1312 HRS 6010B

XRF Pb = 643 ppm +/- 13, HAND AUGER

REFUSAL AFTER 2 SPOTS, 1 ON TIRES &

1 ON ROCKS AND CONTINUOUS SLOUGH

2x FBT + 1x SCAB

CARL PIDGE RG | BORDER PATROL NOGALES AZ 33239 | FUTURE RANGE SOIL SAMPLING | SUNNY LT BREEZE MID 80S

1 OCT 11

NOTE FOR PESA SAMPLES, SOIL IS EXTREMELY DRY, NO COHESIVENESS, SLOUGH IS INEVITABLE, MUST DIG LARGE HOLE AT TOP TO TRY AND ALLEVIATE SLOUGH

1100 SIEVE BPG16D30 6010B SEE PAGE 19

DUPLICATE BPDG16D30 6010B SEE PAGE 19

1150 SIEVE BPG1D18 6010B ~~MS/MSD~~ SEE PAGE 19

NOTE: DUE TO HIGH SAND CONTENT/LOW FINES AND MOISTURE, COULD NOT USE BPG1D18 AS MS/MSD

1228 THUNDER IN DISTANCE CLOUDS MOVING IN

NOTE: BPG1D18 TOOK 6 FULL LARGE WHIRLPAKS TO YIELD 4OZ OF FINES. I HAD TO DRY THE SOIL ON PLASTIC SHEET TO ALLOW FINES STUCK TO SAND PARTICLES TO RELEASE ON THE SIEVE

1300 LIGHT RAIN STORM W/ THUNDER TAKE COVER UNTIL STORM BLOWS BY

1330 SIEVE BPG18D30 6010B SEE PAGE 19

(20)

BPFR 33239 | OVERCAST WINDY HIGH 80S

1 OCT 11

1435 XRF BOTH BATTERIES AT POWER LEVEL BELOW ALLOWING INSTRUMENT TO FUNCTION KEVIN WILL GO BACK AND PLUG IN AT HOTEL; RUN TO WAL-MART TO PURCHASE A POWER INVERTER TO CHARGE OFF TRUCK. I WILL REMAIN ON LOCATION AND PRE-DIG SOME "N" DESIGNATED LOCATIONS TO 12-INCHES

1530 KEVIN BACK W/ POWER INVERTER WILL NOT WORK, DONE FOR TODAY PICK UP AND SECURE AREA

NOTE: TREMENDOUS DIFFICULTY TO DIG AND AUGER BECAUSE LARGE & SMALL INTERLOCKING ROCKS. AS WELL WHEN SOIL IS DRY THE HOLE WILL CONTINUE TO SLOUGH

1600 TO HOME DEPOT TO RETURN THE POWER INVERTER.

(21)

CARL PIDLEY PG. 2 OCT 11 | BPFR NO CHURS SOIL SAMPLING 33239 | GUSTY LOW 40-50s SUNNY

0800 MEET KEVIN FOR BREAKFAST
TAILGATE MEETING
0830 ON BORDER PATROL FIRING RANGE (BPFR), SET UP TO ATTEMPT HAND AUGER SOIL SAMPLING
0900 SPOKE TO TPMC RICK KLINGER
EXTREME DIFFICULTY TO HAND DIG AND HAND AUGER THROUGH INTERLOCKED COBBLES AND BIG ROCK FRAGMENTS UP TO 8-INCH IN SIZE, WE DO NOT HAVE NECESSARY EQUIPMENT TO DO SUBSURFACE SAMPLING, RICK SUGGESTS A DIGGING BAR TO ACCESS MATERIAL 12-18 INCHES BELOW GROUND SURFACE (BGS). I TOLD RICK WE WILL DO OUR BEST. RICK SAID EVEN IF WE CAN GET 1 SAMPLE LOCATION IN EACH OF THE 15 GRIDS THAT WILL GIVE US GOOD INFORMATION.
0925 KEVIN WILL CONTINUE TO AUGER INTO THE BERM WHILE I DRIVE TO HOME DEPOT FOR DIGGING BAR.

BPFR
2 OCT 11 33239

1000 JD REYES ONSITE FROM POLARIS SURVEYING. HE IS GOING TO SHOOT SOME DISTANT LOCATIONS UP TO 1 MILE AWAY. I TOLD JD HE CANNOT GO ON PROPERTY OUTSIDE THE FIRING RANGE BERM WE DO NOT HAVE ACCESS.
1040 CAME BACK ON BPFR, I WILL BEGIN ATTEMPTS TO PRE-DIG N# LOCATIONS W/ DIGGING BAR TO 12-INCHES.
1145 I HAVE FOUR (4) LOCATIONS DUG 10-12 INCHES DEEP W/ DIGGING BAR. THE 4 LOCATIONS ARE A 4 DIFFERENT N# GRIDS TO ASSURE WE GET AT LEAST ONE DEEP SAMPLE AT EACH GRID.
1200 JD MARKING BOUNDARY LOCATIONS
1210 SIEVE BPG3D30 SEE PAGE 25
MS/MSD
1320 JD FROM POLARIS SURVEYING IS HEADED OFF SITE TO FIND AND SHOOT CONTROL POINTS
1340 RINSATE BLANK BPRS003, POST-BPG3D30, PRE-BPG

SAME PAGE PG — BPFR NOGALES SOIL SAMPLING 33239 — WINDY HIGH 80S SUNNY

2 OCT 11

1345 CAME BACK TO PRE-DIG DEEP SAMPLE LOCATIONS W/ DIGGING BAR

NOTE: AT N-15 I WAS ABLE TO DIG TO ≈12 INCHES AT N-15/D-1 AND N-15/D-3

TAKE DEEP SAMPLE COMPOSITE FROM THESE TWO NODES WITHIN N-15 GRID

1453 SIEVE BPG21D42 SEE PAGE 25

DUPLICATE BPDG21D42 6010B

1535 SIEVE ~~BPGN15D~~ BPN15D14

SEE PAGE 25

1630 PICKED UP HEAD OUT

1635 ARB GATE LOCKED AFTER WE LEAVE

BPFR

2 OCT 11 33239

SAMPLE INFORMATION

-BPG3D30 2OCT11 1021 HRS 6010B, XRF 9,645 PPM +/-115 PPM FOR Pb

MS/MSD 70x SCAB, 1x SSS, 46x FBJ

-BPRS003 RINSATE SAMPLE, DEIONIZED WATER POURED THROUGH DECONTAMINATED SIEVE SET. 6010B Pb, As, Sb

1x 1L AMBER GLASS, NEAT 1340 HRS

-BPN15D14 2OCT11 @ ~~1435~~ 1445 HRS 6010B

-D-1 XRF = 79 PPM +/- 5 PPM Pb

-D-3 XRF = 114 PPM +/- 6 PPM Pb

NAP

-BPG21D42 2OCT11 1357 HRS 6010B

XRF Pb = 4507 PPM DUPLICATE

SAMPLE BPDG21D42 6010B, 1x SSS, 1x PSW, 15x SCAB, 20x FBJ

CALL PIDL PL.
BPFR NOGALES SON. SAN...
SUNNY MID 60S LT BREEZE

3 OCT 11 33239

0630 TPMC KEVIN BEECE & I MEET FOR BREAKFAST @ TAILGATE MEETING

0711 AT ARBO PROPERTY GATE ALREADY OPEN BY OTHERS

NOTE: KEVIN WILL SET UP XRF THEN RE-VISIT N18D D-4 SPOT TO DIG DEEPER AS IT IS IN THE BERM AND XRF PB = 2,296 ppm AT 18-INCHES. D-3 ALMOST ON FLAT PORTION OF BPFR WAS XRF PB = 141 ppm +/- 6 ppm AT 18-INCHES

I WILL START DIGGING

0900 BARR BROTHERS STOPPED BY TO SEE PROGRESS AND ASK QUESTIONS. I REFERRED QUESTIONS BE DIRECTED TO PAUL @ USBP

NOTE: KEVIN DUG N-18 D4 TO 30 INCH XRF PB = 164 ppm +/- 4 ppm, I WILL USE DATE & TIME FOR TODAY SEE PAGE 28

0945 SIEVE BPN18D30 SEE PAGE 28

1030 SIEVE BPN14D14 SEE PAGE 28

1128 SIEVE BPN17D18 SEE PAGE 28

BPFR
PARTLY SUNNY GUSTY WIND HIGH 80S

3 OCT 11 33239

NOTE: N16 ATTEMPT TO DIG INTO BERM AT D3 COULD NOT GET DOWN NO DEEPER THAN 14-INCHES, ATTEMPT TO GET DEEP (D) SAMPLE AT TWO (2) OTHER SPOTS WITHIN THE N16 GRID

1255 SIEVE BPN16D18 SEE PAGE 28

NOTE: DUE TO MOISTURE CONTENT SOME SAMPLES WERE AIR DRIED ON PLASTIC SHEETING PRIOR TO SIEVE OTHERWISE FINES WILL NOT PASS; FINE SIEVE, NEW PLASTIC SHEET USED FOR EACH SAMPLE

NOTE: MULTIPLE TRIES WITHIN N13 GRID SPOT D2 GOT TO 13-INCHES

1410 SIEVE BPN13D18 SEE PAGE 28

1445 CALL FROM TPMC RICK KILLINGER FOR PROGRESS UP DATE, I REITERATED TO HIM THE DIFFICULTY IN GETTING DEEP SAMPLES RICK SAID EVEN IF WE CAN GET ONE LOCATION WITHIN THE GRID.

1610 SIEVE BPN12D18 SEE PAGE 29

AIR DRY MOIST SAMPLE PRE-SIEVE

CARL AIDE PG. BPFR NO CALCS SOIL SAMPLING
3 OCT 11 33239

SAMPLE INFORMATION
- BPN18D30 3 OCT 11 @ 0826 HRS 6010B
ALIQUOT D3 3 OCT 11 XRF Pb = 141 ppm
+/- 6 ppm FLAT 14 INCH
ALIQUOT D4 3 OCT 11 0826 HRS BEEN
XRF Pb = 164 ppm +/- 7 ppm 30 IN
NAP, DUPLICATE BPDN18D30
- BPN14D14 3 OCT 11 0828 HRS 6010B
ALIQUOT D3 XRF Pb = 186 ppm +/- 7 ppm
ALIQUOT D4 XRF Pb = 181 ppm +/- 7 ppm
1 x FBJ AIR DRY DUE TO MOISTURE
- BPN17D18 3 OCT 11 @ 1041 HRS 6010B
ALIQUOT D2 XRF Pb = 195 ppm +/- 7 ppm
ALIQUOT D3 XRF Pb = 33 ppm +/- 4 ppm
NAP, AIR DRY DUE TO MOISTURE
- BPN16D18 3 OCT 11 @ 1205 HRS 6010B
- D2 XRF Pb = 286 ppm +/- 8 ppm
- D1 XRF Pb = 134 ppm +/- 6 ppm
NAP, AIR DRY DUE TO MOISTURE
SEE NOTE PAGE 27 REGARDING AIR DRY
- BPN13D18 3 OCT 11 1400 HRS 6010B
NAP ALIQUOT D2 13 INCHES XRF Pb = 600 ppm
+/- 13 ppm,
ALIQUOT D1 18 INCHES XRF Pb = 257 ppm
+/- 8 ppm

BPFR
3 OCT 11 33239

SAMPLE INFORMATION
- BPN12D18 3 OCT 11 @ 1515 HRS 6010B
- D3 ALIQUOT XRF Pb = 808 ppm +/- 15 ppm
- D4 ALIQUOT XRF Pb = 1414 ppm +/- 22 ppm
NAP
1630 ALL PICKED UP, SAMPLES IN OUR
CUSTODY HEADING OFFSITE
NOTE: MR ARBO'S GATE WAS OPEN WHEN WE
ARRIVED THIS MORNING AND IS STILL OPEN
AS WE LEAVE.

CARL ADKE PG | BPFR NOGALES SOIL SAMPLING 33239 | SUNNY UPPER 60S LT BREEZE

4 OCT 11

0630 BREAKFAST AND TAILGATE SAFETY MEETING W/ TPMC KEVIN BEYER.

0710 HEAD TO SITE, PICK UP ICE FOR PAH SAMPLES

NOTE: LAST EVENING I COMPLETED CHAIN OF CUSTODY, PACKED ONE COOLER W/ ALL PAH AND RINSATE (AQUEOUS) SAMPLES AND ONE COOLER WITH ALL SMALL WHIRL PAKS WITH 6010B Pb As Sb SOIL SAMPLES; PER INSTRUCTION PAH ON ICE AND 6010B DO NOT REQUIRE ICE

AT SOME POINT THIS MORNING WE WILL BREAK TO TAKE TWO (2) COOLERS TO FEDEX AIRBILL # 8746 3031 0470

ACCUTEST LABS
2105 LUNDY AVENUE
SAN JOSE CA 95131
408-588-0200
LAB FEDEX ACCT # 4133-97081
PRIORITY OVERNIGHT

0735 AT ARCO GAS, ALREADY OPEN

0740 ARRIVE AT BORDER PATROL FIRING RANGE (BPFR), KEVIN WILL PREP

(30)

BPFR 33239

4 OCT 11

XRF UNIT TO SCAN SOIL FOR Pb, As, AND Sb, I WILL PREP TO PROCESS SOIL FOR SHIPMENT TO LAB

0957 SIEVE ~~PA~~ BP78D25 SEE PAGE 32

1028 SIEVE BPN7D18 SEE PAGE 32

1055 SIEVE BPN4D18 SEE PAGE 32

DUPLICATE BPDN4D18

1136 SHIP TWO (2) COOLERS TO ACCUTEST LAB SEE PAGE 30, CONTENTS ALL SAMPLES UP TO AND INCLUDING 3 OCT 11.

1200 ME BACK AT BPFR

1220 SIEVE BPN8D18 SEE PAGE 32

1242 SIEVE BPN9D24 SEE PAGE 32

1325 SIEVE BPN10D18 SEE PAGE 32

NOTE: WIND HIGH GUSTS SINCE AROUND NOON, NO VISIBLE DUST BLOWING AROUND

NOTE: LOCATIONS N-59, N-60 + N-61 ARE IN THE PARKING LOT EAST OF BPFR

1450 SIEVE BPN59D30 SEE PAGE 33

SCATTERED SHOWERS BLOWING THROUGH INTERMITTENT SHOWERS, STRONG WIND GUSTS

(31)

CALL PIKE 4 OCT 11 | BPFR NOGALES SOIL SAMPLING 33239

SAMPLE INFORMATION

- BP78 D25 4 OCT 11 @ 0850 HRS 6010B
  ALIQUOT D2 XRF Pb = 3,769 ppm +/- 47 ppm
  ALIQUOT D3 XRF Pb = 2,001 ppm +/- 29
  1x FBJ, 2x SCPB, 1x PSW PIECE
- BPN7 D18 4 OCT 11 @ 0925 HRS 6010B
  ALIQUOT D1 XRF Pb = 70 ppm +/- 5 ppm
  ALIQUOT D4 XRF Pb = 29 ppm +/- 4 ppm
  NAP
- BPN4 D18 4 OCT 11 @ 0952 HRS 6010B
  ALIQUOT D1 XRF Pb = 25 ppm +/- 3 ppm
  ALIQUOT D2 XRF Pb = 30 ppm +/- 4 ppm
  BPDN4 D18 DUPLICATE NAP
- BPN8 D18 4 OCT 11 @ 1037 HRS 6010B
  ALIQUOT D1 XRF Pb = 205 ppm +/- 7 ppm
  ALIQUOT D2 XRF Pb = 365 ppm +/- 10 ppm
  NAP
- BPN9 D24 4 OCT 11 @ 1145 HRS 6010B
  ALIQUOT D1 XRF Pb = 241 ppm +/- 8 ppm
  ALIQUOT D2 XRF Pb = 322 ppm +/- 9 ppm
  NAP
- BPN10 D18 4 OCT 11 @ 1240 HRS 6010B
  ALIQUOT D1 XRF Pb = 209 ppm +/- 7 ppm
  ALIQUOT D2 XRF Pb = 22 ppm +/- 3 ppm
  NAP AIR DRY D2 ALIQUOT, MOIST

BPFR

4 OCT 11 33239

SAMPLE INFORMATION

- BPN59 D30 4 OCT 11 @ 1420 HRS 6010B
  ALIQUOT D2 XRF Pb = 4,642 ppm +/- 57 ppm
  FROM BERM ALONG PARKING LOT
  ALIQUOT D4 XRF Pb = 276 ppm +/- 7 ppm
  FLAT PART OF PARKING LOT NAP
- BPN60 D18 4 OCT 11 @ 1503 HRS 6010B
  ALIQUOT D1 XRF Pb = 50 ppm +/- 4 ppm
  ALIQUOT D3 XRF Pb = 130 ppm +/- 6 ppm
  BOTH IN FLAT PART OF PARKING LOT NAP
- BPN61 D14 4 OCT 11 @ 1540 HRS 6010B
  ALIQUOT D1 XRF Pb = 327 ppm +/- 9 ppm
  ALIQUOT D XRF Pb = 189 ppm +/- 7 ppm
  NAP

SOIL SAMPLING COMPLETE AS TASKED BY TAMC RICK KLINKEL

CARL PIPER PG 4 OCT 11 | BPFR NOGALES SOIL SAMPLING 33239 | LOWBOYS STAGING AREA

1525 SIEVE BPN60D18 SEE PAGE 33
1545 SIEVE BPN61D14 SEE PAGE 33
1557 FINAL SOIL SAMPLE IN COOLER AT THIS TIME AS TASKED BY TPMC PM RICK KLINGEL
1638 ALL DIGGING HAND TOOLS IN BPFR SHED, ALL EQUIPMENT PICKED UP AT THIS TIME, SAMPLES FROM TODAY IN MY CUSTODY TO FEDEX OUT TOMORROW
1642 ARBO GATE LOCKED BY US
1800 CALL TO TPMC RICK KLINGEL TO SAY WE FINISHED SAMPLING. RICK WANTS US TO BACKFILL ALL HOLES AND PULL ALL PIN FLAGS

CARL PIPER 5 OCT 11 | BPFR NOGALES SOIL SAMPLING 33239

0900 H&S TAILGATE
0910 GALLOWAY, ARBO GATE ALREADY UNLOCKED. TASK PER TPMC RICK KLINGEL TO PULL ALL PIN FLAGS AND STAKES THEN BACKFILL ALL HOLES WE DUG FOR SOIL SAMPLES
1030 ALL PIN FLAGS & WOODEN STAKES, OTHER THAN THOSE PLACED BY THE SURVEYOR, HAVE BEEN PICKED UP. STAKES AND UNUSED PINK FLAGS PLACED IN BPFR SHED. ALL OTHER PIN FLAGS WILL BE THROWN AWAY
1030 OFF SITE TO US BORDER PATROL TO RETURN ARBO GATE KEY TO USBP REP SHAWN PALMER
1040 DROPPED OFF KEY TO SHAWN PALMER. HEAD TO FED EX
1100 AT FEDEX TO SHIP COOLER (1) TO ACCUTEST LAB SAN JOSE CA AIRBILL # 8746 3031 0480 PRIORITY OVERNIGHT
SHIP BACK XRF UNIT TO US ENVIRONMENTAL AIRBILL #87463030 8697 STD OVERNIGHT
1120 ON ROAD TO TUCSON AZ

Photo 1
View of U.S. Border Patrol Firing Range
Photo taken facing East

Photo 2
View of U.S. Border Patrol Firing Range
Photo taken facing Southeast

Photo 3
View of West End of U.S. Border Patrol Firing Range, Including Back Stop Berm
Photo taken facing Southwest

Photo 4
Interior of Covered Firing Area
Photo taken facing South

Photo 5
View of Surrounding Undeveloped Land
Photo taken facing Northeast

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TPMC Technician Acquiring Survey Point

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Surveyed Sampling Grid
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TPMC Technician Collecting Soil Sample

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#8-Size Sieves used to segregate Fine Soils from Coarse Material and Bullet Fragments

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TPMC Technician Sieving Soil Samples

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Soil Sample Packaging

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Bullet Fragments from Coarse Portion of Soil Sample BPG21S

Photo 14
Shotgun Wadding on Ground Surface at the U.S. Border Patrol Firing Range

U.S. Army
Corps of Engineers

Fort Worth District

Final

June 2014

Volume II-Feasibility Study

U.S. Border Patrol Firing Range
Nogales, Arizona

Contract Number: W9126G-06-D-0016
Task Order 0039

Prepared for:

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LIST OF ACRONYMS

%	Percent
ARAR	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation, Recovery, and Liability Act
CFR	Code of Federal Regulations
COC	Constituents of Concern
CBP	Customs and Border Protection
DD	Decision Document
FS	Feasibility Study
mg/kg	milligrams per kilogram
mg/l	milligrams per Liter
NCP	National Contingency Plan
PAH	Polynuclear Aromatic Hydrocarbons
RA	Remedial Action
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RSL	Regional Screening Level
SRL	Soil Remediation Level
TCLP	Toxicity Characteristic Leaching Potential
TM	Trade Mark
TPMC	TerranearPMC, LLC
USACE	U.S. Army Corps of Engineers
USBP	U.S. Border Patrol
USEPA	U.S. Environmental Protection Agency
XRF	X-Ray Fluorescence

1.0 INTRODUCTION

This Feasibility Study (FS) describes alternatives to address Constituents of Concern (COC) hazards at the U.S. Border Patrol (USBP) firing range in Nogales, Arizona. This document was prepared by TerranearPMC, LLC (TPMC) of Albuquerque, New Mexico, in partial fulfillment of the requirements of Task Order No. 0039 under Contract W9126G-06-D-0016. Contracting Officer's Representative and technical oversight responsibilities for the tasks described in this document were provided by the U.S. Army Corps of Engineers (USACE), Fort Worth District.

The one-half acre Site is located on the west side of Nogales Arizona (Figures 1 and 2), and consists of the USBP firing range. The USBP firing range contains structural improvements and buildings related to small-arms shooting and target practice activities (Figure 3). The buildings and structures at the site consist of:

- An open-sided covered firing deck on concrete slab, located at the eastern end of the range, approximately sixty feet by fifteen feet,

- Two wooden storage sheds, one adjoining the southern end of the covered firing deck (approximately ten feet by fifteen feet), and the other located east of the firing deck (approximately eight feet by five feet),

- Three concrete slab target staging pads, each oriented parallel to and west of the covered firing deck; each approximately sixty feet by ten feet,

- An approximately twelve foot-high earthen backstop berm at the western edge of the site.

The site has been formally identified by the USBP in the RI, and is referred to as the USBP firing range in the FS.

The USBP Firing Range Remedial Investigation/Feasibility Study (RI/FS) report is divided into two parts: the Remedial Investigation (RI) is Volume 1 and the FS is Volume II. The RI phase of work has been completed for the USBP firing range. This FS report only addresses the one-half acre USBP firing range proper and not the adjoining properties. This RI/FS meets the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

1.1 SCOPE OF FEASIBILITY STUDY

The purpose of this FS is to identify Remedial Action Objectives (RAOs), identify and screen potential response actions that may meet the RAOs, assemble the response actions into remedial alternatives to address any potential COC hazards at the USBP firing range, and evaluate the remedial alternatives using established criteria. The objective of the FS is the development, screening and detailed analysis of remedial action alternatives to remediate the USBP firing range in Nogales, Arizona. The remediation of the COCs will be the final remedial action to be taken by the USBP. This FS is designed to provide a screening of a focused list of possible remedial technologies followed by a detailed evaluation of selected alternatives. The detailed evaluation of alternatives involves the analysis of a wide variety of factors using the best professional judgment.

This FS was prepared based upon data presented in the RI. This FS uses the following U. S. Environmental Protection Agency (USEPA) publications: *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, dated October 1988 as amended by the 1986 Superfund Amendments and Reauthorization Act, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*, dated July 1999, and the *National Oil and Hazardous Substance National Contingency Plan (NCP)* (USEPA 1994a) as a guideline. The Government requires that the FS prepare detailed analyses of remedial alternatives using nine criteria. The analyses include:

Threshold Criteria

1. Overall protection of human health and the environment;
2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs);

Primary Balancing Criteria

3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume;
5. Short-term effectiveness;
6. Implementability;
7. Cost;

Modifying Considerations

8. Government acceptance; and
9. Community acceptance.

The analyses of the alternatives individually against each criterion compared against one another will be used to determine the respective strengths and weaknesses and to identify key trade-offs that must be balanced for the site. The results of the detailed analyses are summarized so that an appropriate remedy consistent with CERCLA can be selected. The purpose of the FS process is not the unobtainable goal of removing all uncertainty, but rather to gather and present information to support an informed risk management decision for the most appropriate remedial action for the site. The FS approach described in the guidance documents will be tailored to site-specific circumstances and modified to consider the inherently unique aspects of conducting remedial activities at the USBP firing range. The FS consists of two general steps as listed and described briefly below:

1. Identification and screening of a focused list of possible remedial technologies; and
2. Detailed evaluation of remedial alternatives using process options within viable technology types.

In the first step, technology types are identified, screened, and selected or eliminated from further consideration on the basis of effectiveness, implementability and cost. The identification and screening of technology types is presented in Section 2.1. In the second step, viable process options are assembled into the site-specific remedial alternatives that are described and evaluated; this step is presented in Section 2.3. Process options are techniques for implementing each remedial technology. A Proposed Plan will be prepared to identify the preferred remedial alternative.

1.2 *REPORT ORGANIZATION*

This FS report is organized into eight sections as follows:

1.0 **Introduction:** This section describes the purpose and objectives of the FS and presents background information on the RI/FS process.

2.0 **Remedial Approach:** This section summarizes USBP firing range RI results, defines the areas for which remedial alternatives are developed, and presents the RAOs and potential ARARs.

3.0 **Development and Screening of Alternatives:** This section identifies the range of applicable general response actions for COCs hazard management at the USBP firing range and a screening of general response actions and process options.

4.0 **Identification and Analysis of Remedial Alternatives**: This section presents identified remedial alternatives for the USBP firing range.

5.0 **Comparative Analysis of Remedial Alternatives:** This section evaluates and compares remedial alternatives based on nine evaluation criteria for the USBP firing range.

6.0 **Process to Identify and Select a Remedial Alternative:** This section summarizes the CERCLA process for identifying and selecting a remedial alternative for implementation.

7.0 **Approval Process:** This section describes the approval process for documenting the preferred alternative(s) for implementation at the USBP firing range.

8.0 **References:** This section provides a list of references cited in this report.

2.0 REMEDIAL APPROACH

2.1 SUMMARY OF RI RESULTS

The general premise of the RI process for USBP firing range is that soil contamination exists throughout the site (Figure 1) for which an investigation is required to define the nature and extent of the COCs. The following describes the conclusions of the USBP firing range RI.

2.2 REMEDIAL ACTION OBJECTIVES

RAOs drive the formulation and development of response actions. The primary RAOs for the USBP firing range are based upon the hazard assessment results presented in the RI Report and USEPA's threshold criteria of "Overall Protection of Human Health and the Environment" and "Compliance with ARARs".

Soil COCs related to historical USBP operations within the site were detected during the RI and the RAOs address these COCs in terms of human health and the environment. The exposure pathways for potential receptors to USBP firing range COCs are:

- Direct contact with soil COCs and COC source materials remaining at USBP firing range.
- Ingestion the soil COCs at the USBP firing range.
- Inhalation the soil COCs at the USBP firing range.

Based upon the hazard assessment and the RI/FS Guidance, the following RAOs were developed for the protection of human health and environment:

- Prevent or reduce the potential for receptors to come in direct contact with soil COCs and COC source materials remaining at USBP firing range.
- Prevent the potential for receptors to ingest the soil COCs at the USBP firing range.
- Prevent the potential for receptors to inhale the soil COCs at the USBP firing range.

As stated previously, these objectives are considered to be the basic requirement for the selected remedial action (RA) alternative for the USBP firing range.

2.3 CONSTITUENTS OF CONCERN

As noted in the RI, soil COCs related to historical USBP operations within the firing range site were detected in soil samples collected during the RI. The specific COCs are summarized as follows:

- Lead, antimony and arsenic originated from spent munitions from small arms firing at the USBP firing range. Lead, antimony and arsenic are constituents used in the manufacture of bullets and shotgun pellets.
- Polynuclear Aromatic Hydrocarbons (PAH) originated from spent munitions from small arms firing and targets at the USBP firing range. The PAHs are components used in the manufacture of plastic shotgun shell wadding and clay pigeon targets.

The lead, antimony, arsenic and PAH components from spent munitions were released to the environment through physical abrasion and chemical weathering of the spent small arms munitions and clay pigeon targets. Relevant information is presented in the FS sections that follow for each COC to allow evaluation of the remedial alternatives.

2.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d)(I) of CERCLA states that remedial actions on CERCLA sites must attain (or the decision document must justify the waiver of) any ARARs, which include environmental regulations, standards, criteria, or limitations promulgated under federal or more stringent state laws. An ARAR may be either applicable or relevant and appropriate, but not both.

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be: 1) a standard, requirement, criterion, or limitation under a state environmental or facility siting law; 2) promulgated (of general applicability and legally enforceable); 3) substantive (not procedural or administrative); 4) more stringent than the federal requirement; 5) identified by the state in a timely manner; and 6) consistently applied. ARAR identification considers a number of site-specific factors including potential remedial actions, compounds at the site, site physical characteristics, and site location. ARARs are usually divided into three categories: chemical-specific, location-specific, and action-specific.

2.4.1 Potential Chemical-Specific ARARs

Chemical-specific ARARs are health- or risk-based numerical values or methodologies. These values are protective of human health and the environment, and establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment. For the USBP firing range site, the potential media of concern is soil. Lead, antimony, arsenic and PAH COCs were detected above Arizona residential soil remediation levels (SRL) and USEPA residential regional screening levels (RSL) for soil, indicating a chemical hazard to human health or the environment exists at the USBP firing range. The preliminary site cleanup levels for COCs at the site are shown in the following table:

Preliminary Site Cleanup Levels

Constituent	Arizona SRLs		USEPA RSLs		Units
	Residential SRL	Non-Residential SRL	Residential RSL	Industrial RSL	
Inorganic					
Antimony	31	410	31	410	mg/kg
Arsenic	10	10	0.39	1.6	mg/kg
Lead	400	800	400	800	mg/kg
Polynuclear Aromatic Hydrocarbons					
Benzo(a)anthracene	0.69	21	0.15	2.1	mg/kg
Benzo(a)pyrene	0.069	2.1	0.015	0.21	mg/kg
Benzo(b)fluoranthene	0.69	21	0.15	0.21	mg/kg
Benzo(g,h,i)perylene	NA	NA	NA	NA	mg/kg
Benzo(k)fluoranthene	6.9	210	1.5	21	mg/kg
Chrysene	68	2,000	15	210	mg/kg
Fluoranthene	2,300	22,000	2,300	22,000	mg/kg

SRL = Arizona soil remediation levels
RSL = USEPA regional screening levels

Groundwater and surface water were removed from consideration in the RI planning phase as potential chemical exposure pathways because there was no indication of lead, arsenic, antimony or PAH contamination of these media resulting from USBP activities.

2.4.2 Potential Location-Specific ARARs

Location-specific ARARs govern activities in certain environmentally sensitive areas. These requirements are triggered by the particular location and the proposed remedial activity at a site. No potential location-specific ARARs have been indentified for the USBP firing range.

2.4.3 Potential Action-Specific ARARs

Action-specific ARARs are restrictions that define acceptable treatment and disposal procedures for hazardous substances. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on remedial measures. The following potential action-specific ARAR has been identified for the USBP firing range:

- Code of Federal Regulations (CFR) - 40 CFR 262, Standards Applicable to Generators of Hazardous Waste, 40 CFR 266, Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities and 40 CFR 268.7 and 268.9 RCRA Land Ban Disposal requirements.

- 40 CFR 262 and 266 specify requirements for waste generators to consider if any contaminated soils are generated during remediation that require disposal.

For each of the remedial alternatives developed in Section 4, their compliance with ARARs are evaluated and compared in Section 5.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 SCREENING OF ALTERNATIVES

A screening evaluation was conducted to determine remedial technologies that may be effective components for the RA alternatives. Technologies selected for inclusion in this FS were identified through experience with similar projects and information available in published literature, particularly the Remediation Technologies Screening Matrix and Reference Guide (USEPA 1994b). A number of technologies were screened using the following criteria (USEPA 1988):

- Effectiveness - Short-term and long-term protection of human health and the environment, the degree of protection as it relates to the treatment objectives, the degree of destruction or immobility achieved as it relates to the treatment objectives, and reliability of the considered technology;

- Implementability - The degree of difficulty in implementing the technology due to site-specific circumstances, the associated risks and limitations of the technology, feasibility, and limitations of the available technology or process options considered; and

- Cost – Implementation costs, including capital, operations and maintenance, and monitoring costs.

A description of each technology and a general evaluation of the technology based on the three screening criteria above (effectiveness, implementability, and cost) will be presented in the table, Possible Remedial Technology Screening (Table 1). The following summarizes the potential remediation technologies screened using the above criteria while Table 1 identified technologies that meet threshold and primary balancing criteria:

1. No Action

The NCP and the USEPA guidance require inclusion of the No Action alternative for an FS. According to the NCP, the level of treatment achieved by the other alternatives must be compared to the required expenditures of time and materials as an integral part of the remedy selection process. To achieve this comparison, the NCP requires the inclusion of the No Action alternative to serve as a baseline by which to compare the other potential alternatives.

2. Grade and Cap

The site will be graded utilizing the existing on site soils from the berm and other soil components of the firing range. An impervious cap is added and final grading to maintain the surface runoff away from the capped area. If necessary clean fill is added and graded to direct surface runoff away from the area. The final step is to add top soil and seed with native vegetation.

3. Soil Stabilization

Stabilization, or chemical treatment as it is often referred to, adds reagents to the contaminated soils to form less soluble compounds while controlling pH to produce a range of minimum solubility. Because stable an insoluble to less soluble compounds are formed, stabilized waste is considered protective of groundwater.

If Apatite II or other proven stabilization reagents are used no treatability test will be required.

4. Off-Site Landfill

The baseline approach on closure of firing ranges is to excavate the soil, load the soil onto over-the-road trucks with end dumps, and transport the soil to an appropriate landfill. Before that approach is selected, the contractor/owner will need to confirm whether the soil meets the criteria to be classified as Resource Conservation and Recovery Act (RCRA) hazardous waste or not. This determination is made by testing appropriate constituents using the Toxicity Characteristic Leaching Procedure (TCLP) method is required to select the appropriate landfill.

5. Soil Solidification

Solidification generally refers to adding pozzolanic material to a waste to reduce permeability and surface area. These pozzolans are usually alkaline materials, which can often increase the solubility of metals in many disposal environments. The most common form of solidification is a cement process. This technology involves the addition of COC soil to cement or a cement-based mixture, which thereby may limit the solubility and does limit the mobility of the waste based agent into the contaminated materials. Solidification may be implemented *in situ* (in place mixing) or *ex situ* by excavating the materials, machine-mixing them with a cement-based agent, and depositing the solidified mass in a designated area. The goal of this process is to limit the spread of contaminated material via leaching. The end product resulting from the solidification process is a monolithic block of waste with high structural integrity. Types of solidifying/stabilizing agents include Portland cement, gypsum, modified sulfur cement, consisting of elemental sulfur and hydrocarbon polymers, and grout, consisting of cement and other dry materials such as acceptable fly ash or blast furnace slag. Processes utilizing modified sulfur cement are typically performed ex situ.

If Portland cement is used as the solidification material no treatability test will be required.

6. Sieve, Sort and Removal

Sieve, Sort and Removal consolidates waste materials for recycling and reduces the COC mass in the soil. The physical-sizing process uses sequential wet-screening steps, the first of which is deagglomeration (breaking up soil clumps by mechanical means). Wet screening provides dust-free operation and sharp particle-size fraction cuts. For each screening step, “plus” and “minus” fractions are generated, with actual cut points based on the treatability study data. The goal of wet screening is to partition the particulate metal contamination into narrow-size fractions to facilitate effective gravity separation and to partition soil particles containing organic COCs into the smallest size fraction for subsequent classification.

For free-flowing sandy soils with little oversize material, other than spent projectiles, simple dry screening may be sufficient to recover the bullets in a condition suitable for recycling. The practical lower limit for screen size is ¼-inch. For soils containing measurable clay content:

- Significant volumes of soil in the screen reject pile
- Plus-size soil fraction, or
- Soils requiring particulate removal below ¼- inch

dry screening is generally not feasible.

7. Bioremediation/Phytoremediation

Phytoremediation is the only bioremediation method applicable to soils at sites such as the USBP firing range. Phytoextraction is the removal of inorganic COCs from above-ground portions of the plant (Anderson and Coats, 1994). When the shoots and leaves are harvested, the inorganic COCs are reclaimed or concentrated from the plant biomass. The advantages of phytoremediation are the low input costs, soil stabilization, pleasing aesthetics (no excavation), and reduced potential leaching of inorganic COCs from the soil. The limitations of phytoremediation are: the annual operation and maintenance efforts are extended over many years; the plant must be able to grow in the contaminated soil or material; and the soil diffusion/transport of metals to the rhizosphere must be sufficiently fast and complete to allow uptake of most metals from the soil relative to leaching to groundwater. When this technology is effective, the plant biomass should be contaminated above hazardous criteria and, thus, would necessitate proper handling and disposal, which leads to increased costs. Phytoremediation is passive and will take up to 20 years or more for COCs concentrations to reach regulatory levels at most range sites and is expected to take longer in an arid environment. Therefore, phytoremediation is not appropriate for sites that pose an immediate threat or risk to human health, or for clients who require rapid cleanup. No actual lead contaminated range site has been successfully amended with phytoremediation.

3.2 POTENTIAL REMEDIAL TECHNOLOGIES (RETAINED FOR FURTHER EVALUATION)

The following remedial technologies have been retained after screening for effectiveness, implementability, and cost:

- Off-Site Landfill
- Soil Stabilization
- Soil Solidification
- Cap and Grade
- Sieve and Sort

3.3 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The retained remedial technologies identified in Section 3.2 were selected based on the overall effectiveness, implementability and cost. However, a combination of various technologies has provided improved results based on the synergism between technologies. Therefore, various combinations of the selected technologies to develop the potential remedial alternatives were used. Those alternatives are presented and described below in Section 3.4.

3.4 SUMMARY OF REMEDIAL ALTERNATIVES

The following remedial alternatives were evaluated for the site Remedial Action:

- Alternative 1: Limited Off -Site Landfilling, Soil Stabilization and Cap and Grade
- Alternative 2: Sieving, Soil Stabilization and Cap and Grade
- Alternative 3: Off-Site Landfilling, Soil Solidification and Cap and Grade
- Alternative 4: Off-Site Landfilling

Each one of these remedial alternatives is a complete alternative, a selection of which will allow the Government to meet the proposed remedial objective. Each alternative may contain common and optional components.

4.0 IDENTIFICATION AND ANALYSIS OF REMEDIAL ALTERNATIVES

A description of each of the developed remedial alternatives and an evaluation of the alternatives, individually, using the nine USEPA FS evaluation criteria (USEPA 1999) is presented below. This section is designed to provide sufficient and relevant information to decision makers so that they can make an adequate comparison of the alternatives, select the appropriate site remedy, and determine the likelihood of achievement of the remedial objectives.

4.1 EVALUATION CRITERIA

The criteria used in evaluating the remedial alternatives are listed in Section 1.1. The first two criteria, categorized as "Threshold Criteria," are criteria that each alternative must meet to be eligible for further comparative analysis. The third through seventh criteria represent the primary criteria upon which the analysis is based. The last two criteria are discussed herein with respect to each individual alternative; however, comparative analysis will be further addressed following comments on the FS by the commenting public agencies. The evaluation and comparative analysis of alternatives is intended to provide the rationale for the selection of the preferred remedial alternative to be implemented at the site.

4.2 DETAILED ANALYSIS OF ALTERNATIVES

This section provides a detailed analysis of each alternative on the basis of the nine USEPA FS evaluation criteria listed in Section 1.1. A comparative analysis of the retained alternatives is provided in Section 5. Lead, arsenic and antimony will be referred to as COC metals.

4.2.1 Alternative 1: Limited Off-Site Landfilling, Soil Stabilization and Cap and Grade

Description of Limited off-Site Landfilling, Soil Stabilization and Cap and Grade

The first step of alternative 1 is to remove the highest concentrations of COC metals and PAH soils that are above site remediation levels. Soil will be stockpiled using X-Ray Fluorescence (XRF) as a screening tool to separate the soil piles by concentrations of lead above 400 milligrams per liter (mg/L) and less than 400 mg/L. Lead levels are used as an indicator by association for the presence of antimony, arsenic and PAHs. The areas of excavation will be confirmed to meet soil remediation levels with post excavation soil sampling and laboratory analysis. The stockpiled soils, after confirmatory laboratory sampling and analysis, will be transported to an appropriate landfill. The removal areas comprise select areas of the backstop berm firing range and parking lot. The second step will be to treat any remaining stockpiles that were below site remediation limits and in-place soils to a depth of 12 inches with a soil stabilization amendment. This method stabilizes lead and arsenic using a natural and benign additive, Apatite II, derived from processed fish bones, which chemically binds lead and arsenic into stable, insoluble minerals. Apatite II is suitable for most types of soil and groundwater and for contamination concentrations from parts per billion to weight percent levels. The third step involves installation of an impervious cap and soil layer over the site and subsequent grading of the cap and soil to direct infiltration and runoff away from the capped area.

Evaluation of Alternative

4.2.1.1 Overall Protection of Human Health and the Environment

The combined technologies should protect human health and the environment by removal of soil exceeding the remediation goals off-site, isolation and stabilization of COCs. When soil removal is completed, any remaining lead and arsenic should be stabilized. Cap and grading of the remaining soil areas will prevent infiltration of runoff waters contacting and mobilizing any remaining lead and arsenic and other COC metals and PAHs.

The effect on human heath for landfilling off-site, grading and soil stabilization would be short-term exposure by contact, inhalation or ingestion of dust in ambient air created on the site during Apatite II emplacement, grading and capping. Any health effects for on-site workers can be mitigated by engineering controls and personnel protection gear. As long as the cap is maintained, no human or environment exposure is expected.

4.2.1.2 Compliance with Site Remediation Levels

Landfilling off-site of the metals and PAHs will meet the site remediation levels for lead, arsenic, antimony and PAHs. For any lead and arsenic that has not been removed, the Apatite II will stabilize the lead to average leaching levels of 0.0065 mg/l and arsenic to average leaching levels of 0.04 mg/l. Apatite II also reduces the bioaccessibility on average by 27 percent (%) (ESTCP, 2006). If the PAHs and antimony are not removed to an off-site landfill, the cap and grade procedure will isolate the PAHs and antimony from human and ecological activities as long as the cap is maintained.

4.2.1.3 Long-Term Effectiveness and Permanence

The removal of the highest metal and PAH concentrations to an off-site landfill is a permanent site solution. The grading and capping of the site is permanent as long as it is not open to disturbance and deteriation over time. Apatite II provides long-term non-reversible metal sequestration. Apatite II can hold up to 20% of its weight in lead, or other metals, which are stable under a wide range of environmental conditions for geologically long time periods.

If the cap is disturbed or removed the effectiveness of isolating the remaining antimony and PAHs will be removed and these constituents can enter migratory pathways to human or ecological targets.

4.2.1.4 Reduction of Toxicity, Mobility, or Volume

By removing the metals and PAHs, landfilling off-site permanently reduces toxicity, mobility and volume of these constituents on site. Apatite II works to sequester metals by four general, non-mutually exclusive processes depending on the metal, the concentration of the metal, and the aqueous chemistry of the system: by heterogeneous precipitation on the surface of the Apatite II, by buffering the pH, by surface chemi-adsorption, and by biological stimulation, which remediates metals as well as PAHs. The cap and grading of the site prevents infiltration of waters into the non-stabilized metal and PAH areas and thus halts the mobility, but does not reduce the toxicity or volume of these constituents.

4.2.1.5 Short-term Effectiveness

Landfilling off-site and grading and capping the site will immediately reduce metals and PAHs concentrations in surface soils to below the site remediation levels. The soil stabilization with Apatite II will, over time, remove the remaining lead and arsenic from human availability and will reduce bioavailability. The capping and grading will immediately reduce the availability and mobility of any remaining metals and PAHs by moving runoff and infiltrating water away from these constituents.

4.2.1.6 Implementability

Landfilling off-site and cap and grade can be implemented with locally available earthmoving equipment and over the highway trucking. Soil stabilization can be implemented with similar earthmoving equipment and is completed in place. The soil stabilization amendment can be mixed directly with the contaminated soil, used as a liner, or mixed with grout, clay, and other reactive media.

4.2.1.7 Cost

Landfilling for off-site disposal ranges from $380 to $400/cubic yard and grade and cap ranges from $25 to $27/cubic yard. Apatite II costs ranges from $30 to $40 per cubic yard of treated soil. The final cost depends on the total cubic yardage when combining the three remediation technologies: cubic yardage estimate for limited landfilling is 3,000, the cubic yardage estimate for cap and grade is 2,000; and the cubic yardage estimate of the remaining soils for soil stabilization is 4,000. By combining the three remediation technologies, the cubic yardage for landfilling is reduced, the cubic yardage for cap and grade remain constant and the amount of Apatite II is reduced to 2,000 cubic yards.

4.2.1.8 Regulatory Acceptance

To be addressed in the Decision Document.

4.2.1.9 Community Acceptance

To be addressed in the Decision Document.

4.2.2 Alternative 2: Sieving, Soil Stabilization, and Cap and Grade

Description of Sieving, Soil Stabilization, and Cap and Grade

The first step of this alternative is to remove the metals fraction that is greater than ¼ inches in diameter using sieving and recycling the metals. For free-flowing sandy soils with little oversize material other than spent projectiles, simple dry screening may be sufficient to recover the bullets in a condition suitable for recycling. The practical lower limit for screen size is ¼- inch. The second step will be to treat the remaining metals in place and loose soils with a soil stabilization amendment Apatite II. This method stabilizes metals using a natural and benign additive. Apatite II derived from processed fish bones which chemically bind metals into stable, insoluble minerals. Apatite II is suitable for most types of soil and groundwater and for contamination concentrations from parts per billion to weight percent levels. The third step involves installation of an impervious cap over the site and subsequent grading of the cap to isolate the remaining COC metals and PAHs by directing surface waters and runoff away from the capped area.

Evaluation of Alternative

4.2.2.1 Overall Protection of Human Health and the Environment

The combined technologies of alternative 2 will protect human health and the environment by removal of bullet fragments. When completed, any remaining lead and arsenic should be stabilized and the antimony and PAH isolated from migratory pathways by the graded cap. If the cap is disturbed or removed PAHs and antimony will be able to enter migratory pathways and create limited exposure to humans and the environment.

4.2.2.2 Compliance with Site Remediation Levels

The sieving process will remove lead particles greater than ¼ inch in diameter thus reducing the small arms munitions derived lead, arsenic and antimony at the site. For any lead that has not been removed through sieving the Apatite II will stabilize the lead to average leaching levels of 0.007 mg/L and the arsenic to average leaching levels of 0.04 mg/L. The Apatite II also will produce an average reduction of bioaccessibility by 27% (ESTCP, 2006). If the PAHs and antimony are not removed by sieving, the cap and grade procedure will isolate the PAHs and antimony from human and ecological activities as long as the cap is maintained.

4.2.2.3 Long-term Effectiveness and Permanence

The removal and subsequent recycling of metals by sieving is a permanent site solution for a portion of the lead, arsenic, and antimony and PAHs. The grading and cap of the site, as long as it is left undisturbed, is also permanent. Apatite II is effective in long-term sequestration of metals. It reduces the bioavailability of the metals if the treated soils are ingested, particularly important for public health concerns and wildlife. Apatite II can hold up to 20% of its weight in lead and other metals, which are stable under a wide range of environmental conditions for geologically long time periods.

If the cap is disturbed or removed the effectiveness of isolating the remaining antimony and PAHs will be removed and these constituents can enter migratory pathways to human or ecological targets.

4.2.2.4 Reduction of Toxicity, Mobility or Volume

Apatite II works to sequester metals by four general, non-mutually exclusive processes depending on the metal, the concentration of the metal, and the aqueous chemistry of the system: by heterogeneous precipitation on the surface of the Apatite II, by buffering the pH, by surface chemi-adsorption, and by biological stimulation, which remediates metals as well as PAHs.

The sieving and recycling process, of the greater than ¼-inch portion of the small arms munitions constituents, removes the toxicity, mobility, and volume of sorted metal constituents completely. The cap and grading of the site prevents infiltration of waters into the non-stabilized metal and PAH areas and thus halts the mobility, but does not reduce the toxicity or volume.

4.2.2.5 Short-term Effectiveness

Sieving and removing a portion of the COCs from the soil on the site will immediately reduce lead, arsenic and antimony of the portion sieved to levels below USEPA SRLs and Arizona RSLs. The soil stabilization with Apatite II will, over time, remove the remaining lead and arsenic from human availability and will reduces bioavailability. Cap and grade will isolate both the larger fraction of the spent projectiles remaining, the finer portion of the spent projectiles, the antimony and the PAHs immediately after the cap is put into place.

4.2.2.6 Implementability

Grade and cap can be implemented with locally available earthmoving equipment and over the highway trucking. Soil stabilization can be implemented with similar earthmoving equipment and is completed in place. The stabilization amendment can be mixed directly with the contaminated soil, used as a liner, or mixed with grout, clay, and other reactive media.

For free-flowing sandy soils with little oversize material other than spent projectiles, simple dry screening may be sufficient to recover the bullets in a condition suitable for recycling. The practical lower limit for screen size is ¼ inch. Sieving soils containing a measurable clay content, significant volume of soil in the screen reject pile or soils requiring substantial COC removal below ¼-inch screen dry screening are generally not feasible.

4.2.2.7 Cost

Sieving and disposal ranges from $25 to $27/cubic yard and cap and grade ranges from $27 to $29/cubic yard. Apatite II costs are from $30 to $40 per cubic yard of treated soil. The final cost depends on the cubic yardage of each of the treatment methods: cubic yardage estimate for sieving is 5,800; the cubic yardage estimate for cap and grade is 2,000 and the cubic yardage estimate for soil stabilization is 7,000.

4.2.2.8 Regulatory acceptance

To be addressed in the Decision Document.

4.2.2.9 Community acceptance

To be addressed in the Decision Document.

4.2.3 Alternative 3: Limited Off-Site Landfilling, Soil Solidification and Cap and Grade

Description of Limited Off-Site landfilling, Soil Solidification and Cap and Grade

The first step of this alternative is to remove the metal and PAH-contaminated soils in the backstop berm that are above the site remediation levels, with confirmatory sampling, to an appropriate landfill. The second step will be to treat the remaining soils with a soil solidification amendment such as Portland cement. Solidification refers to the physical changes in the contaminated material when Portland cement is added as a binding agent. These changes include an increase in compressive strength, a decrease in permeability, and condensing of hazardous materials. The third step involves installation of an impervious cap over the site and subsequent grading of the cap to direct surface waters and runoff away from the capped area.

Evaluation of Alternative

4.2.3.1 Overall Protection of Human Health and the Environment

The combined technologies will protect the human health and environment by removal, isolation and solidification. After the landfilling, the remaining soils potentially containing metals and PAHs will be solidified by mixing with Portland cement. When this solidification process is completed, any remaining metals and PAHs should be encased in a solid, low permeability unit. Infiltration and runoff of waters will be isolated from contact with the remaining metals and PAHs when the cap and grading is completed. No destructive process concerning the COCs will be initiated by these steps, only removal and isolation.

If the cap is disturbed or removed, minor leaching and/or aeolian transport of remaining PAHs and metals may occur. This would allow them to enter migratory pathways and create limited exposure to humans and the environment.

4.2.3.2 Compliance with Site Remediation Levels

Landfilling off-site of metals and PAHs will meet the site remediation levels for lead, arsenic, antimony and PAHs. For any metals and PAHs that have not been removed, Portland cement will be used to solidify the metals, to isolate the metals and PAHs from the environment and reduce leachability of these constituents. Soil solidification also reduces the bioaccessibility. The cap and grade procedure will also further isolate the PAHs and metals from human and ecological activities as long as the cap is maintained.

Compliance with environmental screening levels will be met by removal and isolation as no destructive processes will implemented at the site. Disturbance of the cap and/or the solidified soils may allow remaining metals and PAHs to enter migratory pathway and thus exceed environmental screening levels in some instances.

4.2.3.3 Long-term Effectiveness and Permanence

The removal of metals and PAHs to an off-site landfill is a permanent site solution. The grading and capping of the site is not permanent as it is open to disturbance and deteriation over time if not maintained. Soil solidification, if not exposed to weathering conditions, is stable for geologically long time periods.

4.2.3.4 Reduction of Toxicity, Mobility, or Volume

By removing the metals and PAHs, landfilling off-site permanently reduces toxicity, mobility and volume of these constituents on site. Site soil solidification works to reduce mobility by isolation. Soil solidification does not reduce volume nor does it reduce toxicity. But, if the metal and PAHs are isolated from migratory pathways, the toxicity effects of the constituents cannot impact humans or the environment. The cap and grading of the site prevents infiltration of waters into the non-stabilized metal and PAH areas and thus halts the mobility, but does not reduce the toxicity or volume of these constituents. Because the major components of this alternative, cap and grade and the solidification, do not reduce the toxicity of the COCs, it will not be retained for further consideration.

4.2.3.5 Short-term Effectiveness

Off-site landfilling and grading and capping the site will immediately reduce concentration of metals and PAHs in surface soil and a portion of the subsurface soil levels to below site remediation levels. The soil solidification with Portland cement will immediately remove the remaining metals and PAHs in terms of bioavailability and reduce mobility beneath the cap. The capping and grading will immediately reduce the availability and mobility of any remaining metals and PAHs not solidified by moving runoff and infiltrating waters away from these constituents.

4.2.3.6 Implementability

Off-site landfilling and grade and cap can be implemented with locally available earthmoving equipment and over the highway trucking. Solidification also requires locally available soil handling equipment and stabilizing agents such as Portland cement. More innovative agents may require importation. A treatability study may be required to determine proper mix of soil and solidification amendment if Portland cement is not used as the solidification amendment.

4.2.3.7 Cost

Landfilling cost for off-site disposal ranges from $380 to $400 per cubic yard and grade and cap ranges from $27 to $29 per cubic yard. Solidification costs range from $100 to $110 per cubic yard of treated soil. The final cost depends on the cubic yardage of each of the treatment methods: cubic yardage estimate for off-site landfilling is 3,000, the cubic yardage estimate for cap and grade is 2,000 and the cubic yardage estimate for soil solidification is 4,000.

4.2.3.8 Regulatory Acceptance

To be addressed in the Decision Document.

4.2.3.9 Community Acceptance

To be addressed in the Decision Document.

4.2.4 Alternative 4: Off-Site Landfilling

Description of Off-Site Landfilling

This alternative removes the COC metals and PAHs from all contaminated soils that are above site remediation levels with confirmatory soil sampling to an appropriate landfill. The removal areas compromise the backstop berm, firing range proper and parking lot.

Evaluation of Alternatives

4.2.4.1 Overall Protection of Human Health and the Environment

This technology will protect human health and the environment by removal of all COC metals and PAHs. The effect on human health of off-site landfilling would be short term exposure to dust on site during excavation, stockpiling and loading for transport in ambient air by inhalation.

4.2.4.2 Compliance with Site Remediation Levels

Landfilling off-site of all soils containing COC metals and PAHs will meet the site remediation levels for lead, arsenic, antimony and PAHs.

4.2.4.3 Long-term Effectiveness and Permanence

The removal of COC metals and PAHs to an off-site landfill is a permanent site solution.

4.2.4.4 Reduction of Toxicity, Mobility, or Volume

By removing the COC metals and PAHs, landfilling off-site permanently reduces toxicity, mobility and volume of these constituents on site.

4.2.4.5 Short-term Effectiveness

Landfilling off-site will immediately reduce metals and PAHs surface levels to below site remediation levels. Short term exposure to air borne dust for construction workers during excavation, stockpiling and loading operations will occur. Any health effect on site workers can be mitigated by engineering controls and personnel protection gear.

4.2.4.6 Implementability

Landfilling off-site and grade and cap can be implemented with locally available earthmoving equipment and over the highway trucking.

4.2.4.7 Cost

The cost of landfilling for off-site disposal ranges from $380 to $400/cubic yard. The final cost depends on the cubic yardage to be landfilled. Cubic yardage estimate for landfilling is 7,000.

4.2.4.8 Regulatory Acceptance

To be addressed in the Decision Document.

4.2.4.9 Community Acceptance

To be addressed in the Decision Document.

4.3 ALTERNATIVES RETAINED FOR COMPARATIVE ANALYSIS

Each of the developed alternatives has been described and evaluated on the basis of the nine USEPA FS evaluation criteria. Alternatives 1, 2 and 4 are considered acceptable for further evaluation on a comparative basis in Section 5, whereas alternative 3 is not retained for further analysis.

5.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

In Section 4.2, the various remedial alternatives were described and evaluated individually for suitability for the USBP site remedial action. In this section, the retained alternatives are compared with each other using the five primary balancing USEPA evaluation criteria.

The retained alternatives are compared to evaluate the relative merits and deficiencies of each alternative relative to one another so that the better alternatives can be identified and ranked in terms of the various evaluation criteria.

The retained alternatives evaluated comparatively are referred to as follows:

- Alternative 1: Limited Off-Site Landfilling, Soil Stabilization, and Cap and Grade
- Alternative 2: Sieving, Soil Stabilization, and Cap and Grade
- Alternative 4: Landfilling Off-site

The retained alternatives 1, 2 and 4 meet the threshold criteria. Consistent with USEPA (1988) guidance, further comparative assessment of the alternatives is reserved for the more detailed analyses covered under the primary balancing criteria: long-term effectiveness and permanence, reduction of toxicity, mobility or volume, short-term effectiveness, implementability and cost.

5.1 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 1 - The limited off-site landfilling of selected areas of the USBP firing range COC metals and PAHs is a permanent site solution for the cubic yardage landfilled (3,000). Stabilization and cap and grade provide isolation from migratory pathways for the remaining COC metals and PAHs cubic yardage (4,000).

Alternative 2 - Sieving, sorting and recycling is a permanent site solution of the greater than ¼-inch portion of the COC metals from the cubic yardage sieved (7,000). Stabilization and cap and grade provide isolation from migratory pathways for the remaining COC metals and PAHs.

Alternative 4 - The removal of all COC metals and PAHs to an off-site landfill is a permanent site solution for the site (estimated cubic yardage 7,000).

5.2 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

Alternative 1 - The limited off-site landfilling of COC impacted soils from the USBP firing range will permanently remove the COC metals and PAHs for 3,000 cubic yards of soil. The sieving and recycling process, of the greater than ¼-inch portion of the small arms munitions from the remaining 4,000 cubic yards of soil, removes the toxicity, mobility and volume of these constituents permanently from the site. For the remaining lead and arsenic in the 4,000 cubic yards of soil, stabilization will effectively remove the toxicity and mobility of these constituents, and the remaining antimony and PAHs, the cap and grade will isolate these constituents and reduce the mobility to zero.

Alternative 2 - The sieving and recycling process, of the greater than ¼-inch portion of the small arms munitions from 7,000 cubic yards of soil removes the toxicity, mobility and volume of these constituents permanently from the site. For the remaining lead and arsenic in the 7,000 cubic yards of soil, stabilization will effectively remove the toxicity and mobility of these constituents, and the remaining antimony and PAHs will be isolated by the cap and grade that will reduce the mobility to zero.

Alternative 4 - By removing all the soils (estimated 7,000 cubic yards), containing lead, antimony, arsenic and PAHs that exceed USEPA SRLs to off-site landfills the toxicity, mobility and volume of all these constituents is permanently removed from the site.

5.3 SHORT-TERM EFFECTIVENESS

Alternative 1 and 2- Comparatively, the sieving and stabilization remediation techniques will also create short term exposure during excavation, grading and sieving. The short-term exposure risk can be mitigated by engineering controls. When the stabilization, capping and grading and/or sieving is complete the short-term effectiveness will be effective immediately by isolation and/or stabilization.

Alternative 4 - Landfilling all soils impacted with COC metals and PAHs off-site will create short-term exposure during excavation, grading and loading. The short-term exposure risk can be mitigated by engineering controls. When the soils have been removed from the site, this remediation will be immediately effective by removal of the COCs.

5.4 IMPLEMENTABILITY

Alternative 1- Stabilization of lead and arsenic will require a specialized amendment such as Apatite II. Landfilling off-site and capping and grading can be implemented with locally available earthmoving equipment and over the highway trucking.

Alternative 2 - Sieving requires specialized sieve and sort screens that are typically not locally available. Sieving for free-flowing sandy soils with little oversize material, other than spent projectiles, simple dry screening may be sufficient to recover the bullets in a condition suitable for recycling. The practical lower limit for screen size is ¼- inch. Stabilization of lead and arsenic will require a specialized amendment such as Apatite II. Capping and grading can be implemented with locally available earthmoving equipment

Alternative 4- Landfilling off-site can be implemented with locally available earthmoving equipment and over the highway trucking.

5.5 COST

Alternative 1- Limited landfilling, stabilization, and cap and grade costs per cubic yard are estimated to be $380 to $400, $30 to $40 and $27 to $29, respectively. The estimated cubic yardage for landfilling, stabilization and cap and grade are 3,000, 4,000 and 2,000, respectively. With a final cost estimated to range from $1,380,000 to $1,418,000.

Alternative 2 - Sieving, stabilization and cap and grade costs per cubic yard are estimated to be $25 to $27, $30 to $40 and $27 to $29, respectively. The estimated cubic yardage for sieving, stabilization and cap and grade are 5,800, 7,000 and 2,000, respectively. With a final cost estimated to range from $409,000 to $584,360.

Alternative 4- Landfilling for off-site disposal for soils containing COCs ranges from $380 to $400 per/cubic yard. The removal yardage to a landfill for all soils containing COCs off-site is estimated to be 8,917 cubic yards. With a final cost estimated to range from $3,583,708to $3,762,048.

5.6 REGULATORY BODY ACCEPTANCE

USEPA and Arizona acceptance will be addressed in the Decision Document following comments on the FS report.

5.7 COMMUNITY ACCEPTANCE

Community acceptance will be addressed in the Decision Document following comments on the FS report.

6.0 PROCESS TO IDENTIFY AND SELECT A REMEDIAL ALTERNATIVE

The U.S. Customs and Border Protection will identify a preferred remedial alternative based upon comments received from the regulatory agencies and project stakeholders during the review period of the Draft Final RI/FS Report. The Proposed Plan will be prepared after the FS is finalized. The preferred remediation alternative will be presented along with other alternatives in the Proposed Plan, and will be available for public review. The preferred alternative will be presented in a public meeting and the public will be allowed to comment on the Proposed Plan during a 30-day public comment period. Section 7 further discusses the process for identifying the preferred remedial alternative.

7.0 APPROVAL PROCESS

The approval process for the USBP firing range RI/FS and the process for selecting the remedial alternative include the following components:

- Prepare the Final RI/FS report for regulatory agencies and project stakeholder review.

- Prepare a Proposed Plan to solicit public input on the remedial alternatives and preferred remedial alternative. The Proposed Plan will present alternatives evaluated in the FS.

- Solicit public comments on the Proposed Plan during a 30-day review period.

- Arrange a public meeting on the Proposed Plan during a 30-day review period where written and verbal comments can be submitted. This meeting is announced in a local paper.

- Prepare a Decision Document (DD) that (1) summarizes the results of the RI/FS, (2) includes a responsiveness summary that summarizes any public comments received on the Proposed Plan and includes responses to comments, and (3) specifies the details of the selected remedy(s), including plans for development and submittal of a RD/RA Work Plan.

- Announce the decision regarding the remedy selection in a major local newspaper and place copies of the RI/FS, Proposed Plan, and DD in the Administrative Record and local information repositories.

8.0 *REFERENCES*

Anderson, T.A. and T.R. Coats, 1994. Innovative Site Remediation Technology Stabilization/Solidification. Water Environment Federation, Alexandria, Virginia.

Environmental Security Technology Certification Program (ESTCP), 2006, PIMS^{TM}: Remediation of Soil and Groundwater Contaminated with Metals, Cost and Performance Report (ER-0020), U.S. Department of Defense.

Tardy, B.A., T.R. Bricka, S.L., Larson, 2003. Chemical Stabilization of lead in Small Arms Firing Range Soils. DRDC/EL TR-03-20, U.S. Army Corps of Engineers Engineer Research and Development Center.

U.S. Environmental Protection Agency (USEPA), 40 CFR 262.

U.S. Environmental Protection Agency (USEPA), 40 CFR 266.

U.S. Environmental Protection Agency (USEPA), RCRA Land Ban Disposal Requirements (40 CFR 268.7 and 268.9).

U.S. Environmental Protection Agency (USEPA), *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*, dated July 1999.

U.S. Environmental Protection Agency (USEPA) 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, 540/G-89/004 OSWER Directive 9355.3-01, Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 1994a, *Nation Oil and Hazardous Substance Pollution Contingency Plan*, Sections 300.120 (d) 300.400(d) and 300.430 (e) (2) (i). Office of Emergency and Remedial Response. Washington, D.C. 20460.

U.S. Environmental Protection Agency (USEPA), 1994b. *Remediation Technologies Screening Matrix and Reference Guide* (USEPA 1994). October 1994.

U.S Environmental Protection Agency (USEPA), 2011. Regional Screening Level Table. Office of Emergency and Remedial Response. Washington, D.C. 20460. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm November.

Table 1 Remedial Technology Screening for COC metals and PAHs in Soils
U.S. Border Patrol Firing Range
Nogales, Arizona

Remedial Technology		Remedial Description	In Situ or Ex Situ	Treatability Test	Effectiveness	Implementability	Estimated Costs (Site Specific)	Screening Status
1	**No Action**	na	na	none	Not destructive, does not reduce mobility, does not reduce toxicity of contaminants and does not protect human health or the ecology	May require long term monitoring, extensive site characterization and risk assessment modeling, no power consumption, easy to implement.	**$6,000/ year**	**Do not retain for further evaluation.**
2	**Cap and Grade**	Involves installation of an impervious cover on the site and subsequent back fill and grading of clean fill to direct surface runoff away from the area.	Ex Situ	none	Effective method if cap is maintained over the long term. Cap will require maintenance.	Easy to implement. Requires either synthetic cover or source of low permeability material and heavy equipment for grading and backfill.	**$27 to $25/ cubic yard**	**Retain for further evaluation**
3	**In Situ Solidification**	Solidification refers to the physical changes in the COC material when Portland cement is added as a binding agent. These changes include an increase in compressive strength, a decrease in permeability, and condensing of hazardous materials	Ex Situ / In Situ	yes	Continuous monitoring of the site is required in order to ensure the contaminants have not re-assembled. Environmental factors such as freezing–thawing and wetting–drying were the focus of many studies dealing with the strength of Solidification. It was found that freezing and thawing had the most adverse effects on the durability of the treated materials	Requires locally available soil handling equipment and solidifying agents. More innovative agents may require importation. Treatability study required to determine proper mix.	**$90 to $110/ cubic yard**	**Retain for further evaluation**
4	**In Situ Stabilization**	Contaminants are physically bound or enclosed within a stabilized mass or a chemical reaction is induced between the stabilizing agent and contaminants to reduce their mobility.	Ex Situ /In Situ	yes	Particularly effective for metals. Long-term effectiveness has not been proven for all metals, thus there is a potential long-term liability as some metals remain on site in an immobilized state.	Requires locally available soil handling equipment and stabilizing agents. More innovative agents may require importation. Treatability study required to determine proper mix.	**$30 to $40/ cubic yd.**	**Retain for further evaluation**
5	**Off-Site Landfill**	Transport COC materials to a permitted off-site treatment and disposal facility	Ex Situ	none	Permanent Remedy, though it does not include destruction and material must be placed in a specialized landfill designed for zero leachate production.	Easy to implement. Shipping lead/antimony/arsenic wastes can be done within the state of Nevada within a distance of 800 miles.	**$380 to $400/ cubic yard**	**Retain for further evaluation**
6	**Sieve and Sort**	Using various size sieves the lead bullets, shot gun pellets, shotgun wadding and brass casings are separated from the excavated soils and then sorted for recycling or disposal.	Ex Situ	none	Permanent Remedy for small arms munitions debris, but does not remove the fine weathered material which contain a large portion of the COCs	Moderately level of Implementability as it entails mobilization of specialized equipment and local earthmoving equipment.	**$25 to $27/ cubic yard**	**Retain for further evaluation**
7	**Bioremediation/ Phytoremediation**	Phytoextraction is the removal of inorganic contaminants from above-ground portions of the plant. When the shoots and leaves are harvested, the inorganic COCs are reclaimed or concentrated from the plant biomass.	In Situ or Ex Situ	yes	Phytoremediation is passive and will take up to 20 years or more for contaminant concentrations to reach regulatory levels at most range sites. Therefore, phytoremediation is not appropriate for sites that pose an immediate threat or risk to human health, or for clients who require rapid cleanup.	While phytoextraction is proven to remove lead from soils, the relatively high levels of lead at small arms firing ranges the time required for effective phytoextraction render this technique impractical as a range remediation tool.	**$175/ cubic yard per growing season**	**Do not retain for further evaluation.**

	Table 2 Final Alternative Remedial Technology Comparative Screening for COC metals and PAHs in Soils U.S. Border Patrol Firing Range Nogales, Arizona								
Alt.	**Remedial Technology**	**Remedial Description**	**In Situ or ExSitu**	**Treatability Test**	**Reduction of Toxicity, Mobility or Volume**	**Long and Short Term Effectiveness**	**Implementability**	**Estimated Costs (Site Specific)**	**Screening Status**
1	**Limited Off-site Landfilling, Soil Stabilization and Cap and Grade**	Transport COC materials to a permitted off-site treatment and disposal facility. Contaminants are physically bound or enclosed within a stabilized mass or a chemical reaction is induced between the stabilizing agent and contaminants to reduce their mobility. Involves installation of an impervious cover on the site and subsequent back fill and grading of clean fill to direct surface runoff away from the area.	Ex Situ/In Situ	yes	Limited landfilling off-site will permanently reduce the toxicity, mobility and volume of a select amount of the COCs. Soil stabilization creating mineral transformation will effectively remove the toxicity and mobility of the remaining lead and arsenic but not the PAHs or antimony. Cap and grade will isolate all COCs and thus reduce the mobility and potential toxicity to zero.	Short and long term permanent remedy, though it does not include destruction, and material must be placed in a specialized landfill designed for zero leachate production. Particularly effective for metals. Long-term effectiveness has not been proven for antimony and PAHs, thus there is a potential for long-term liability if antimony and PAHs are found in high amounts exceeding government standards. Antimony and PAHs will remain on site in an isolated state. Effective method if cap and drainage is maintained over the long term. Cap and grade may require maintenance.	Moderate to difficult to implement. Shipping small to moderate amounts of lead, antimony,arsenic and PAH wastes can be done by transporting to the state of Nevada approved landfill which is a distance of 800 miles. Easy to moderate level of implementability as it requires locally available soil handling equipment and stabilizing agents. More innovative agents may require importation. Treatability study required to determine proper mix. Easy to implement. Requires either synthetic cover or source of low permeability material and heavy equipment for grading and backfill.	**$1,380,000 to $1,418,000**	**Retain for further evaluation**
2	**Sieving, Soil Stabilization and Cap And Grade**	Using various size sieves the lead bullets, shot gun pellets, shotgun wadding and brass casings are separated from the excavated soils and then sorted for recycling or disposal. Contaminants are physically bound or enclosed within a stabilized mass or a chemical reaction is induced between the stabilizing agent and contaminants to reduce their mobility. Involves installation of an impervious cover on the site and subsequent back fill and grading of clean fill to direct surface runoff away from the area.	Ex Situ /In Situ	yes	Sieving will remove will remove the large masses of spent bullets, pellets, and shot gun wadding permanently removing large particle (>1/4 inch) portions of all COCs. Soil Stabilization will be mineral transformation will effectively remove the toxicity and mobility of the remaining lead and arsenic but not the PAHs or antimony. Cap and grade will isolate all COCs and thus reduce the mobility and potential toxicity to zero.	Sieving and disposal is a short and long term permanent remedy for small arms munitions debris, but does not remove the fine weathered material which contains a portion of the COCs. Stabilization is particularly effective for metals. Long-term effectiveness has not been proven for antimony, or PAHs thus there is a potential long-term liability. Antimony and PAHs will remain on site in an isolated state. Effective method if cap and drainage is maintained over the long term. Grade may require maintenance.	Moderate level of implementability as it entails mobilization of specialized equipment and local earthmoving equipment. Easy to moderate level of implementability as it requires locally available soil handling equipment and stabilizing agents. More innovative agents may require importation. Treatability study required to determine proper mix. Easy to implement. Requires either synthetic cover or source of low permeability material and heavy equipment for grading and backfill.	**$409,000 to $584,360**	**Retain for further evaluation**
4	**Landfilling Off-Site**	Transport COC materials to a permitted off-site treatment and disposal facility	Ex Situ	none	Landfilling off-site of the COCs impacted soils will permanently reduce their toxicity, mobility and volume	Permanent Remedy, though it does not include destruction, and material must be placed in a specialized landfill designed for zero leachate production.	Difficult to implement. Shipping large amounts of lead, antimony, arsenic and PAH wastes can be done by transporting to the state of Nevada approved landfill which is a distance of 800 miles. .	**$3,583,708 to $3,762,048**	**Retain for further evaluation**