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April 13, 2005

DAIM-BO-A-HA

Subject: Forwarding the draft final *Remedial Investigation Workplan; Skeet Range, Testing Range*; Hamilton Army Airfield; Novato, CA.

Ms. Naomi Feger
Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Dear Ms. Feger,

The Army is pleased to provide the draft final *Remedial Investigation Workplan; Skeet Range, Testing Range*; Hamilton Army Airfield; Novato, CA for your review.

This document is submitted in accordance with Board Order No. R2-2003-0076 Site Cleanup Requirements (SCR) – Hamilton Army Airfield. The areas included in this sampling effort were identified as requiring further investigation in the *Record of Decision Remedial Action Plan, Hamilton Army Airfield* (Army, RWQCB, DTSC, August 2003).

This document is being submitted to the RWQCB in accordance with SCR provision C8. It is also being distributed in accordance with SCR provision C9 for information.

I request your comments by May 11, 2005. If you have any questions, please contact me at (415) 883-6386.

Sincerely,

Edward Keller, P.E.
BRAC Environmental Coordinator
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Draft Final Work Plan Remedial Investigation Workplan; Skeet Range, Testing Range
Hamilton Army Airfield, Novato, CA 94949
April 2005

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**REMEDIAL INVESTIGATION
WORK PLAN
SKEET RANGE, TESTING RANGE
HAMILTON ARMY AIRFIELD
NOVATO, CALIFORNIA**



Testing Range

DRAFT FINAL

PREPARED BY:



**US Army Corps
of Engineers ®**

Sacramento District
Environmental Design Section

PREPARED FOR:



Department of the Army
Base Realignment and Closure

April 2005

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ACRONYMS AND ABBREVIATIONS

ASR	Archives Search Report
Bgs	below ground surface
BRAC	Base Realignment and Closure
CSM	Conceptual Site Model
COCs	Contaminants of Concern
DQO	Data Quality Objectives
DMA	Demonstration of Methods Applicability
EDS	Environmental Design Section
EPA	Environmental Protection Agency
FADL	Field Activity Daily Log
FSP	Field Sampling Plan
FWV	Field Work Variance
GC/MS	Gas Chromatography/Mass Spectrometry
HAFB	Hamilton Air Force Base
HAAF	Hamilton Army Airfield
IA	Immunoassay
ICP	Inductively Coupled Plasma Spectroscopy
IDW	Investigation Derived Waste
NELAC	National Environmental Laboratory Accreditation Committee
PAHs	Polynuclear Aromatic Hydrocarbons
PARCC	Precision, Accuracy, Representativeness, Completeness, Comparability
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation Limit
QSM	Quality Systems Manual
PPE	Personal Protective Equipment
RI	Remedial Investigation
ROD/RAP	Record of Decision/Remedial Action Plan
SAP	Sampling and Analysis Plan
SFBRWQCB	California Regional Water Quality Control Board-San Francisco District
SI	Site Inspection
SIM	Selective Ion Monitoring
SOP	Standard Operating Procedure
SSHSP	Site Specific Health & Safety Plan
RI	Remedial Investigation
USACE	U.S. Army Corps of Engineers
WET	Waste Extraction Test
WP	Work Plan
XRF	X-Ray Fluorescence

**REMEDIAL INVESTIGATION WORK PLAN
SKEET RANGE AND TESTING RANGE
HAMILTON ARMY AIRFIELD
NOVATO, CALIFORNIA**

1.0 INTRODUCTION

1.1 Scope of Plan

This Work Plan (WP) presents the project scope, regulatory authorities, site background, and project objectives for the Skeet Range and Testing Range at the Hamilton Army Airfield (HAAF) in Novato, California. Included in this Remedial Investigation (RI) WP are the Triad Investigation Approach, Field Sampling Plan (FSP), and the Quality Assurance Project Plan (QAPP). The investigation is designed to collect the data necessary to determine the vertical and horizontal extent of the contamination. The work is being accomplished under the Army's Base Realignment and Closure (BRAC) program.

The U.S. Army Corps of Engineers (USACE), Sacramento District will perform the work.

This Work Plan describes the planned activities, which involve collecting and analyzing soil samples for lead, copper, cadmium, and polynuclear aromatic hydrocarbons (PAHs), where applicable. The California Regional Water Quality Control Board – San Francisco Bay Region (SFBRWQCB) will provide regulatory oversight. A report of the findings of this investigation will be prepared by the USACE after execution of this WP.

The Triad approach to the investigation is described in Section 2.0 of this WP. The FSP (Section 3.0) presents the field sampling program for each site, including site-specific objectives, sampling strategy, sampling locations, sample collection methods, and sample handling procedures. The QAPP (Section 4.0) presents functions procedures, and specific quality assurance (QA) and quality control (QC) activities designed to achieve the project objectives.

1.2 Project Objectives

The project objective is to define the extent of contamination at the Skeet and Testing Ranges above the action goals identified in the *Final Main Airfield Parcel Record of Decision/ Remedial Action Plan (ROD/RAP), Hamilton Army Airfield, Novato, California, August 2003*. This information will be used to identify the areas of excavation, planned for July 2005. Data from samples collected at the extent of contamination and analyzed by standard fixed laboratory methods during this investigation will serve as pre-excavation confirmation samples.

1.3 Site History

The Army Air Corps constructed Hamilton Army Airfield between 1932 and 1935. Hamilton Army Airfield (HAAF) was first used as an airbase for bombers in 1935. At a later time it was used for transport and fighter aircraft. HAAF played a major role in World War II as a training field and staging area for Pacific operations. During the mid-1940s, the hospital served as an acute care and rehabilitation facility for thousands of war casualties per month. The airfield was renamed Hamilton Air Force Base (HAFB) in 1947 as a part of the newly created U.S. Air Force. The Army used portions of the Base on a permit basis until 1984 when approximately 712 acres of HAFB were transferred to the Army and renamed Hamilton Army Airfield.

HAAF is located 25 miles north of San Francisco in the City of Novato, Marin County, California (Figure 1-1). HAAF is bounded by U.S. Highway 101 to the west and San Pablo Bay to the east. The low-lying areas are seven to eight feet below mean sea level and are kept dry by a system of perimeter levees, storm drains, drainage ditches, and water pumps.

The project area is currently vegetated by grasses and occasional shrubs, and is subject to inundation during rainy periods.

1.4 Areas of Concern

The areas of concern that will be investigated are:

- 1) former site of a Skeet Range, and 2) former site of a Testing Range along the inboard side of the eastern levee. The site locations are illustrated in Figure 1-2.

1.4.1 Skeet Range

The Skeet Range was sampled in 2004 as part of the Miscellaneous Sites Investigation (USACE 2004). The sample locations were based upon estimated distance of the range of ammunition from shotguns. The samples were analyzed for metals (antimony, arsenic, cadmium, chromium, copper, lead, nickel, and zinc) and PAHs. Six of the nine samples from the Skeet Range (ASR #18) contained constituents that exceeded the action goal. Elevated lead (4 samples), cadmium (1 sample) and Total PAH (4 samples) concentrations within the Skeet Range appear to be restricted to the center and western portion of the range (refer to Figure 3-1).

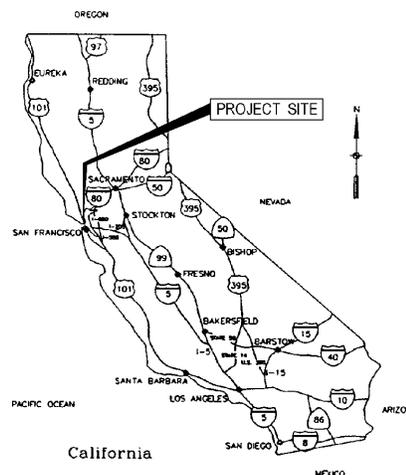
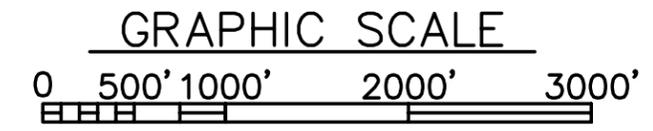
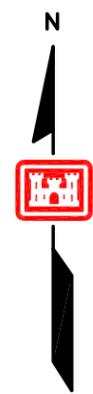
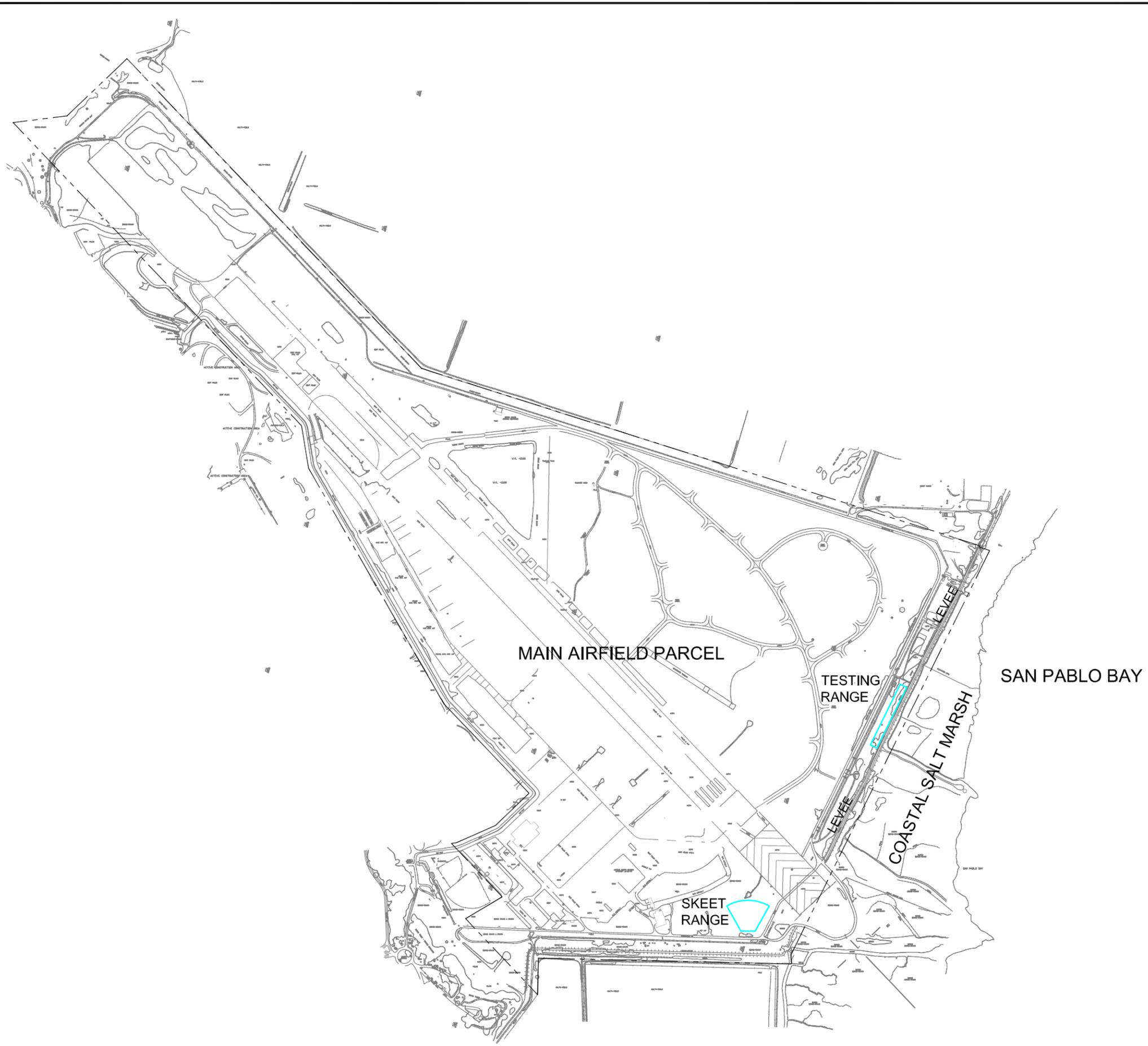


Figure 1-1: Project Location Map



U.S. ARMY
 CORPS OF ENGINEERS
 SACRAMENTO, CALIFORNIA

FIGURE 1-2
**Skeet Range and Testing
 Range Location Map**

BRAC PROPERTY
 HAMILTON ARMY AIRFIELD

The project objective is to define the extent of contamination at the Skeet Range above the action goals identified in the *Final Main Airfield Parcel Record of Decision/ Remedial Action Plan (ROD/RAP)*, Hamilton Army Airfield, Novato, California, August 2003. This information will be used to identify any required area of excavation.

1.4.2 Testing Range

The Testing Range was sampled in 2004 as part of the Miscellaneous Sites Investigation (USACE 2004). The samples were analyzed for metals (antimony, arsenic, cadmium, chromium, copper, lead, nickel, and zinc). All five samples from the Testing Range (ASR #4) contained constituents that exceeded the action goal. These were limited to lead and copper (refer to Figure 3-2). Sampling and analysis will be limited to lead and copper at the site previously identified during the Site Inspection stage. The remedial action will immediately follow the RI.

The project objective is to define the extent of contamination at the Testing Range above the action goals identified in the *Final Main Airfield Parcel Record of Decision/ Remedial Action Plan (ROD/RAP)*, Hamilton Army Airfield, Novato, California, August 2003. This information will be used to identify any required area of excavation.

1.5 Geology

HAAF lies within the San Francisco-Marine structural block of the northern Coast Range geomorphic province of California. The Coast Range province is characterized by a series of nearly parallel mountain ranges and intermountain alluvial valleys that trend obliquely to the coastline in a northwesterly direction. The geologic units are composed of a heterogeneous mixture of metamorphosed igneous and sedimentary rock types and exhibit varying degrees of tectonic deformation. These rocks are grouped together as the Franciscan Complex, are of Jurassic to Cretaceous age, and form the bedrock beneath HAAF. Tertiary alluvium and colluvium deposits locally overlie the bedrock. Overlying these units are Quaternary Bay Mud and man-made fill.

The higher relief areas to the west and south of the BRAC property are underlain primarily by serpentinite and sandstone of the Franciscan Complex. A clayey, weathered horizon typically overlies the bedrock beneath the Bay Mud deposits. Alluvial/colluvial deposits composed of sands and silts are present along the hill slopes and are interbedded with Bay Mud in some areas.

The Bay Mud, which underlies most of the Bay plain and the airfield parcel, is of Quaternary age and typically consists of semi-consolidated to unconsolidated, highly plastic, clayey silt to silty clay, with microscopic organic matter throughout, as well as discrete lenses and beds of peat and occasional shell fragments. The Bay Mud is soft and plastic when moist but shrinks, hardens, and becomes brittle when dried. The Bay Mud is stiff and cracked from about 3 feet below ground surface (bgs) to a maximum depth of 12 feet bgs. The cracked Bay

Mud is underlain by saturated Bay Mud (soft Bay Mud). The total thickness of Bay Mud increases towards San Pablo Bay and is estimated to be more than 60 feet thick at the eastern edge of the BRAC property (IT, 1997c). Differential ground settlement is occurring in various areas of the airfield due to poor bearing strength and low shear strength of the Bay Mud. Resultant settlement features as deep as 3 feet are evident within aircraft taxiways.

Soil collected during the March 2003 sampling event was classified in accordance with ASTM D2488-00 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)." Most of the soils within two feet of the surface are clayey silt to silty clay, and fit the profile of the Bay Mud. Three locations along the southern and western edges of the BRAC parcel have bedrock less than 2 feet bgs (SO-88, SO-89, SO-90). Several locations close to taxiways have fill composed of gravel and asphalt within 2 feet of ground surface.

1.6 Conceptual Site Models

Conceptual site models (CSMs) were developed for each area of concern (Figures 1-3 and 1-4). Some of the basic assumptions used in developing the CSMs are described here.

- 1) The future use of both the Skeet and Testing Ranges is as a wetland.
- 2) Action Goals are based upon future wetland use.
- 3) Soil lead contamination has not migrated to groundwater.

1.7 Project Staffing

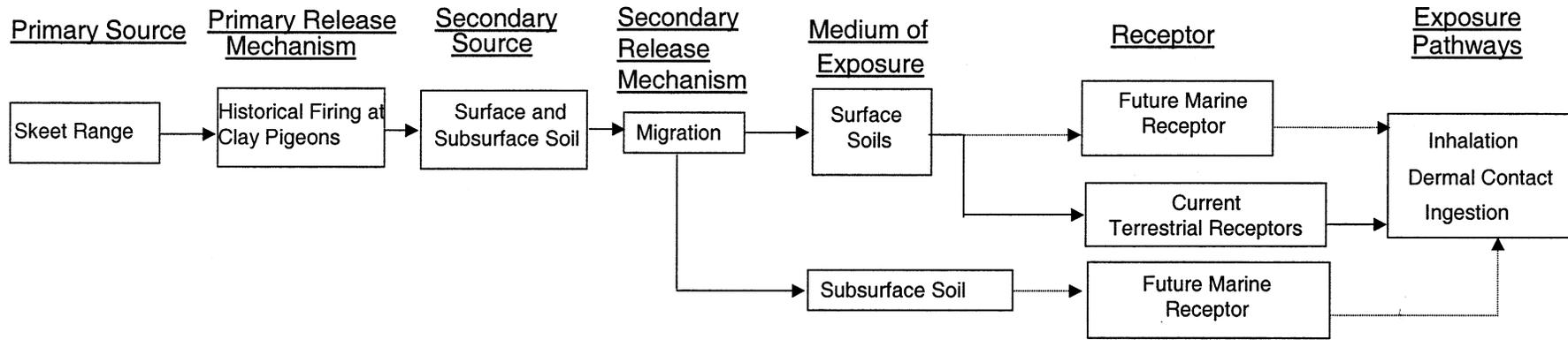
The Environmental Design Section (EDS), Sacramento District, USACE, under the supervision of Richard Meagher, Professional Engineer (P.E.), California License Number 44858, prepared this WP. The following personnel are responsible for the preparation of this WP and will perform the site characterization.

<u>Name</u>	<u>Title</u>
Project Manager	Ray Zimny
Technical Team Leader	Kathy Siebenmann
Project Geologist	Fred Hart
Project Chemist	Carleton Fong
Industrial Hygienist	Dave Elskamp
Geographic Information System Technician	Mike O'Neill

USACE chemists will perform all field analyses for lead, cadmium, copper, and PAHs. A laboratory compliant with the National Environmental Laboratory Accreditation Committee (NELAC) standards will be under contract to USACE to perform fixed laboratory analyses.

Figure 1-3 – Skeet Range Conceptual Site Model

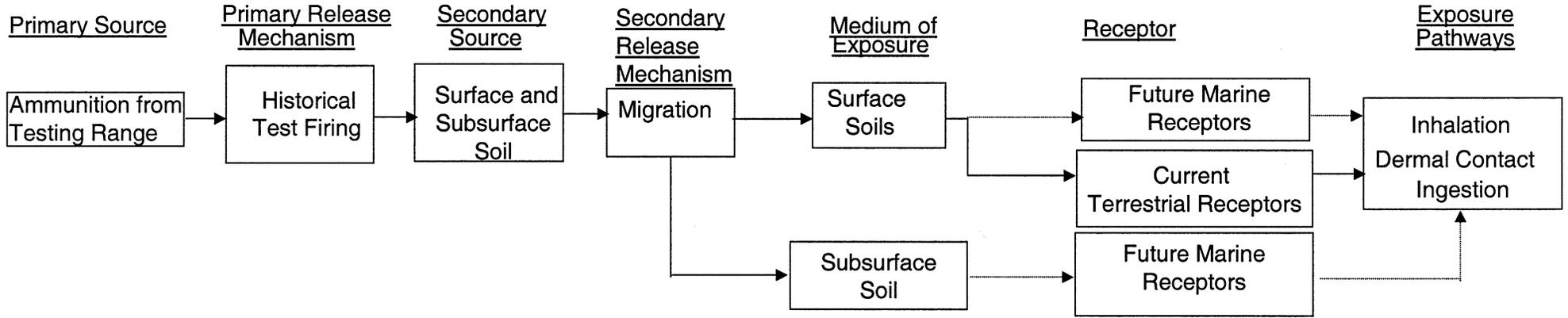
(Complete Pathways shown here, other pathways are signified with a dashed line)



Constituents of Concern:
Lead, Cadmium, and PAHs

Figure 1-4 – Testing Range Conceptual Site Model

(Complete Pathways shown here, other pathways are signified with a dashed line)



Constituents of Concern:

Lead, Copper

2.0 TRIAD APPROACH TO INVESTIGATION

The Triad approach was developed by U.S. Environmental Protection Agency (EPA) to expedite investigation and ensure that the data collected support the intended remedial action alternatives. The Triad approach includes three elements: a) Systematic Project Planning, b) Dynamic Work Strategies, and c) Real-time Measurement Technologies. To the extent possible considering the constraints of this project, this investigation will incorporate the Triad approach.

2.1 Systematic Project Planning

Systematic Project Planning includes the development of a Conceptual Site Model (described in Section 1), Data Quality Objectives (DQOs), and a Demonstration of Methods Applicability (DMA) for each site. This work plan discusses these elements of the planning process. The CSM identifies the sources, pathways, and receptors of the current concentrations of contaminants based upon the known information. The CSM is not stagnant; it can be updated with each piece of new information regarding the site, including analytical data, physical data, and reuse alternatives. The DQO process identifies the overall objective of data needs and follows a documented process through to the sampling strategy. The purpose of using the data quality objectives process is to ensure that any sampling meets the needs of the project and the usability of the data is directly linked to the objectives. To generate data that will meet the project objectives, it is necessary to define the types of decisions that will be made, identify the intended use of the data, and design a data collection program. The DQOs include any type of information, such as previous site studies, utilized to form a sampling strategy or achieve the objective, not just analytical data. The DQO process assists in determining the appropriate sampling design, quantitation limits, analytical methods, and sample handling procedures. The DQO process was developed by the EPA from the document, *Guidance on the Data Quality Objectives Process* (EPA, 2000).

Step 1: State the Problem: Contaminant concentrations greater than the ROD/RAP action goals remain in soil at the Skeet and Testing Ranges at HAAF.

Step 2: Identify the Decision: Determine the boundaries of contaminated soil (above action goals) so that any required remediation can occur during the summer of 2005. All data is being collected to delineate the extent of the previously identified Contaminants of Concern (COCs) and applicable data will be considered pre-excavation confirmation samples.

Step 3: Identify the Inputs to the Decision: 1) Action Goals from the *Main Airfield Parcel Record of Decision/Remedial Action Plan, Hamilton Army Airfield*, Public Comment Final, May 2003; 2) Skeet and Testing Range historical contaminant concentrations documented in *Source Investigation Report for the Archives Search Report Sites 4,18, and 19, Hamilton Army Airfield*, April 2004; and 3) Skeet and Testing Range contaminant concentrations to determine extent.

Step 4: Define the Boundaries: The runway and the roads will bound the Skeet Range. Sampling will not occur any closer than 20 feet from these asphalted areas for Total PAH. The Army is not responsible for removing PAHs due to the construction and use of asphalt roadways at HAAF. The currently excavated area near the bottom of the levee will bound the Testing Range in that direction. The levee road will bound the Testing Range at the top of the levee.

Step 5: Develop Decision Rules:

Skeet Range - If the contaminant concentration from the initial sampling locations exceeds the action goals, sampling will continue laterally approximately 100 feet and vertically 0.5 feet until concentrations are all less than the applicable action goal, up to the boundaries described above. Once the concentrations from these samples (at approximately 100 foot intervals) are below the action goals, samples will be collected approximately 50 feet laterally back towards the previous sample with at least one COC concentration above the action goal at the same depth. Step-outs, step-downs, and step-ins will continue to the square grid size of 25 feet for the Skeet Range. When contaminant concentrations are all less than the associated action goal down to the 25-foot grid size, the sampling will cease, the extent of contamination will be considered defined, and the excavation boundaries will be equivalent to this extent of contamination. No further samples will be collected to determine the excavation boundaries or confirm removal of soil with COCs above action goals.

Testing Range: If the contaminant concentration from the initial sampling locations exceeds the action goals, sampling will continue laterally approximately 100 feet to the north and south and 15 feet to the east and west (up and down the levee) and vertically 0.5 feet until concentrations are all less than the applicable action goal, up to the boundaries described above. Once the concentrations from these samples (at approximately 100-foot and 15-foot intervals) are below the action goals, samples will be collected laterally approximately 50 feet north and south back towards the previous sample with at least one COC concentration above the action goal at the same depth. Step-outs, step-downs, and step-ins will continue to the square grid size of 15 feet for the Testing Range. When contaminant concentrations are all less than the associated action goal down to the 15-foot grid size, the sampling will cease, the extent of contamination will be considered defined, and the excavation boundaries will be equivalent to this extent of contamination. No further samples will be collected to determine the excavation boundaries or confirm removal of soil with COCs above action goals.

Step 6: Specify the Consequences of Decision Errors: High bias or false positives of analytical results will result in excavation of soil that does not pose a risk to future wetland species. Low bias or false negatives of analytical results would allow soil contaminated with COCs to remain on site, potentially impacting future wetland species.

Step 7: Optimize the Sampling Design: The COCs are as follows:

Skeet Range – lead (action goal of 46.7 mg/Kg), cadmium (action goal of 1.2 mg/Kg), and Total PAHs (action goal of 4.022 mg/Kg)

Testing Range - lead (46.7 mg/Kg) and copper (action goal of 68.1 mg/Kg)

Results will be used to determine the lateral and vertical boundaries of excavation, based upon comparison of COC concentrations to action goals documented in the ROD/RAP. Sampling locations and depths have been proposed based upon historical information. The initial proposed sample locations are illustrated in Figures 3-1 and 3-2. Step-out, step-down, and step-in samples will be collected based upon the results of the initial samples down to a 25-foot and 15-foot grid size for the Skeet Range and Testing Range, respectively. The final grid size for each site was determined based upon the estimated total cost of sampling vs. the estimated total cost of excavation and disposal.

Field analytical methods are most efficient for collecting the data necessary for this determination; however, it is currently unknown if the field methods proposed in this work plan for the analysis of lead, copper, and cadmium will meet the project objectives. Therefore, following the Triad approach, a DMA will be performed using the initial samples in the sampling scheme (illustrated on Figures 3-1 and 3-2). The results of the DMA will determine how step-out, step-down, and step-in samples (described in Step 5: Develop Decision Rules) will be analyzed. The DMA will compare the results from the various field procedures to fixed laboratory data of known quality. These field methods are discussed in more detail in Section 2.3.

2.2 Dynamic Work Strategies

Using Dynamic Work Strategies allows the assessment of the data to determine the next step of data collection. Not all situations that may arise in the field can be considered during the planning stage. The decision rules identified in Step 5 of the DQO process (Section 2.1) are the rules that will be used based upon current knowledge. However, if the sampling strategy or specific decision rules must be altered, SFBRWQCB will be notified for approval.

2.3 Real-time Measurement Technologies

X-ray Fluorescence (XRF) and immunoassay (IA) test kits will be used for field analysis of metals and PAHs, respectively. Although the IA kits for PAH analysis has been used successfully at HAAF in the past, XRF has recently provided detection limits that do not meet the action goals. The DMA will include the following methods for lead, copper, and cadmium in soil.

In situ XRF analysis – multiple measurements are taken directly on the ground surface, after removing surface debris (assuming the soil is not saturated)

Ex-situ XRF analysis – multiple samples in close proximity to one another in the immediate area of *in-situ* soil sample measurement are collected in a plastic baggie, homogenized by hand, and analyzed directly through the plastic (for unsaturated soil)

Fixed laboratory inductively-coupled plasma (ICP) spectrometry – a portion of the sample in the plastic baggie will be transferred to a 4 ounce jar, shipped to a laboratory for analysis.

Results of the three methods will be compared and the most efficient way of producing data of adequate quality to define the extent to the ROD/RAP action goals will be determined. Step-outs, step-ins, and step-downs from the initial sampling locations will be analyzed by one of the following scenarios.

1) All samples for metals analysis will be analyzed *in-situ* by XRF. The mean of the 8 measurements will be used for decision-making. The reporting limit for all three elements will be at least as low as the associated action goal. When the extent has been reached based upon XRF results, all extent samples will be sent to a fixed laboratory for ICP analysis.

2) All samples for metals analysis will be analyzed *in-situ* by XRF. The mean of the 8 measurements will be used for decision-making. The reporting limit for at least one element will be greater than the associated action goal. When non-detect has been reported for the element(s) with the higher reporting limit(s) and XRF results with reporting limits at or below the action goal are below the action goal, all extent samples will be sent to a fixed laboratory for ICP analysis. Further step-outs may be required based upon the fixed laboratory analysis.

3) All samples for metals analysis will be analyzed *ex-situ* by XRF. The reporting limit for all three elements will be at least as low as the associated action goal. When the extent has been reached based upon XRF results, all extent samples will be sent to a fixed laboratory for ICP analysis.

4) All samples for metals analysis will be analyzed *ex-situ* by XRF. The reporting limit for at least one element will be greater than the associated action goal. When non-detect has been reported for the element(s) with the higher reporting limit(s) and XRF results with reporting limits at or below the action goal are below the action goal, all extent samples will be sent to a fixed laboratory for ICP analysis. Further step-outs may be required based upon the fixed laboratory analysis.

5) Reporting limits for most or all of the three elements for both XRF methods are greater than the action goals, or are significantly greater than the action goals and all samples will be sent for ICP analysis.

The comparison of metals concentrations to one another may also affect the choice of field analytical methods and analytes. If all samples with metal exceedences include exceedences for lead and there is difficulty using the XRF to detect down to the action goal for cadmium, analyzing the samples for lead only may suffice, as long as the extent samples are analyzed by ICP. A technical memorandum will include a discussion of the data and the proposed plan of action for all step-outs.

IA test kits will be used for PAH analysis. Samples with IA data that have determined extent of contamination to the action goal will be shipped to a fixed laboratory for analysis to PAHs by gas chromatography/mass spectrometry (GC/MS) by selective ion monitoring (SIM).

3.0 FIELD SAMPLING PLAN

3.1 Sampling Procedures

The site-specific field activities will include:

Surveying: The northing and easting coordinates for six locations at the Skeet Range and three locations at the Testing Range will be surveyed and the rest will be measured off from the surveyed points.

Surface soil samples: Surface soil samples will be collected after scraping vegetation and debris off the soil surface and using a decontaminated shovel or scoop.

Subsurface soil samples: the maximum depth will be assumed to be 3 feet bgs. A backhoe may be used, particularly in the Testing Range, if there is difficulty in achieving maximum depth.

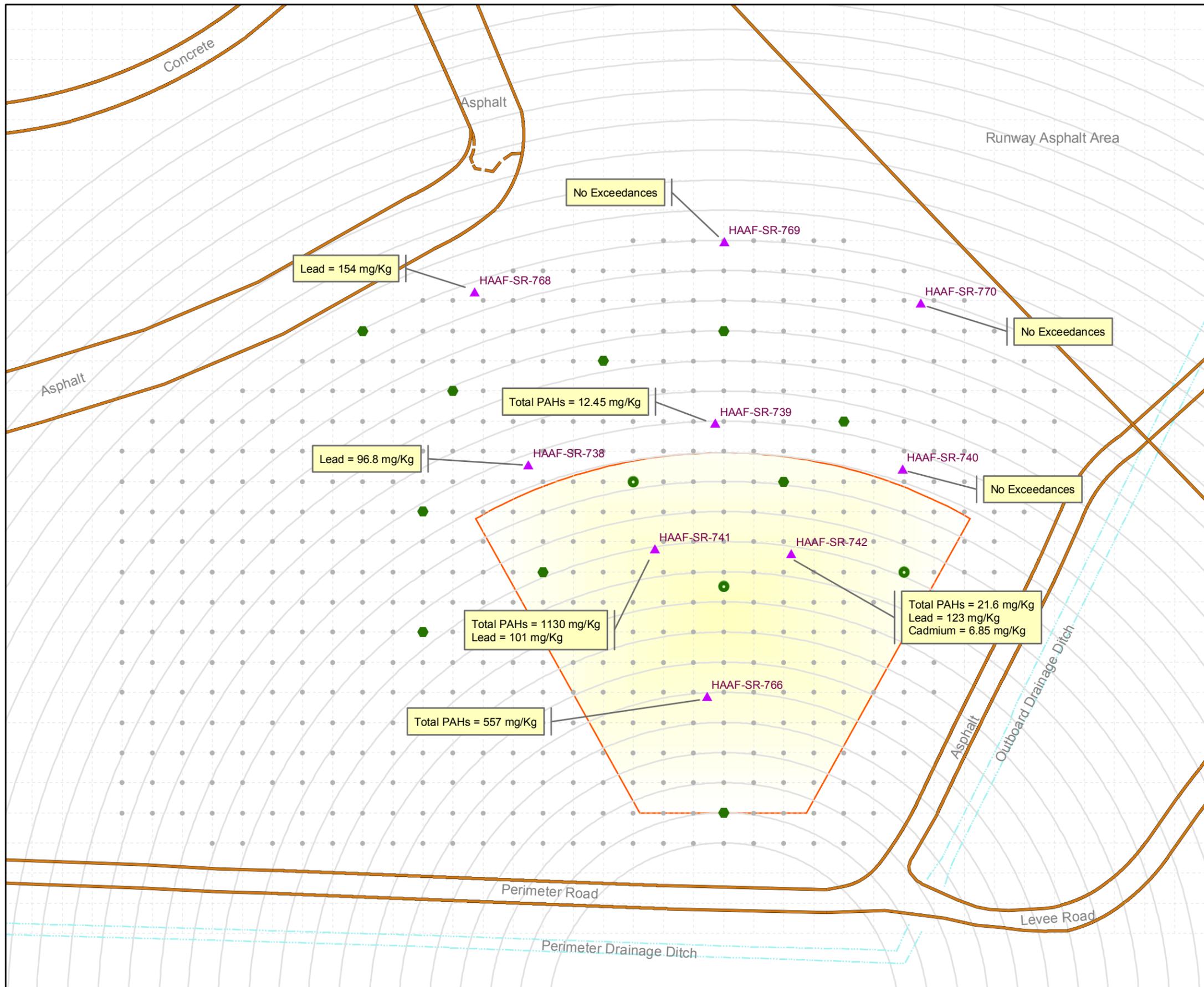
Specific sampling plans for each sample site are detailed later in this section, and analytical procedures for each site are discussed further in Section 4.0.

3.2 Site Specific Sampling Plans

3.2.1 Skeet Range Sampling Strategy

At the beginning of fieldwork a field portable XRF unit will be used to determine the concentration of lead and cadmium and an IA kit will be used to determine Total PAH concentrations. Approximately 16 samples from 13 initial sampling locations will be collected from the site, as illustrated in Figure 3-1. Samples will be collected from the surface and 0.5 feet bgs for three locations near previous samples with high contaminant concentrations. The samples will be analyzed in three ways: 1) the XRF will analyze for lead and cadmium *in-situ* (as described in Section 2.3), 2) an intrusive sample will be collected from that location and homogenized in a plastic bag then analyzed by the XRF, and 3) the sample will be sent to an off-site laboratory for analysis by ICP. The results from the various analyses will be reviewed to determine the feasibility of using data from the XRF to define the lateral and vertical extent of lead and copper. Section 2.3 describes the DMA process in more detail.

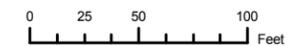
Samples will be collected from the site and analyzed for lead, cadmium, and PAHs until the extent of contamination above the action goals has been determined. If the contaminant concentration from the initial sampling locations exceeds the action goal, sampling will continue laterally (north, south, and away from the center) approximately 100 feet and vertically 0.5 feet until concentrations are all less than the applicable action goal. Once the concentrations from these samples (at approximately 100-foot intervals) are below the action goals, samples will be collected approximately 50 feet laterally back towards the previous sample with at least one COC concentration above the action goal at the same depth. Step-outs and step-ins will continue to the square grid size of 25 feet for the Skeet Range. When contaminant concentrations are all



Legend

- Historical Sample Location (Jan. 2004)
- Proposed Initial Surface Soil Location
- Proposed Initial Depth Soil Locations
- 25 ft. Grid for Sample Spacing
- 25 ft. Arcs for Sample Spacing
- Water Feature Edge
- Hardscape Surface Edge
- Historical Skeet Range Site Boundary

Note: Historical results displayed are limited to those exceeding the action goals.



U.S. Army Corps of Engineers
Sacramento District, CA



Designed by: K. SIEBENMANN	Date: 4/13/2005	Rev. 2	Sheet: 1 of 1
Drawn by: M. O'NEILL	File Name: skeet_WP_v2.mxd		
Project: BRAC REMEDIAL INVESTIGATION WORK PLAN			

Novato California

**Skeet Range Workplan
Proposed Sample Locations**

DRAFT Final

BRAC PROPERTY
HAMILTON ARMY AIRFIELD

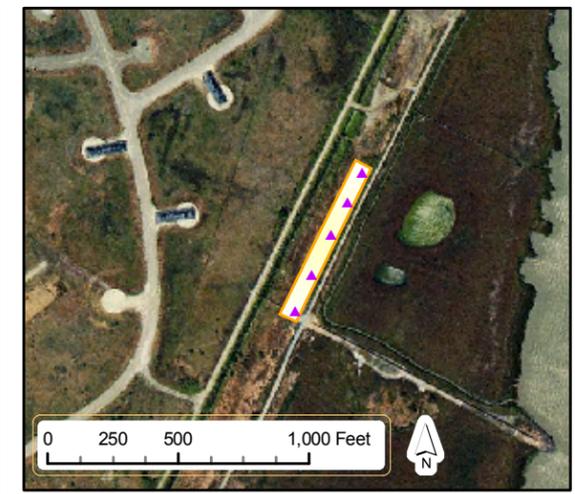
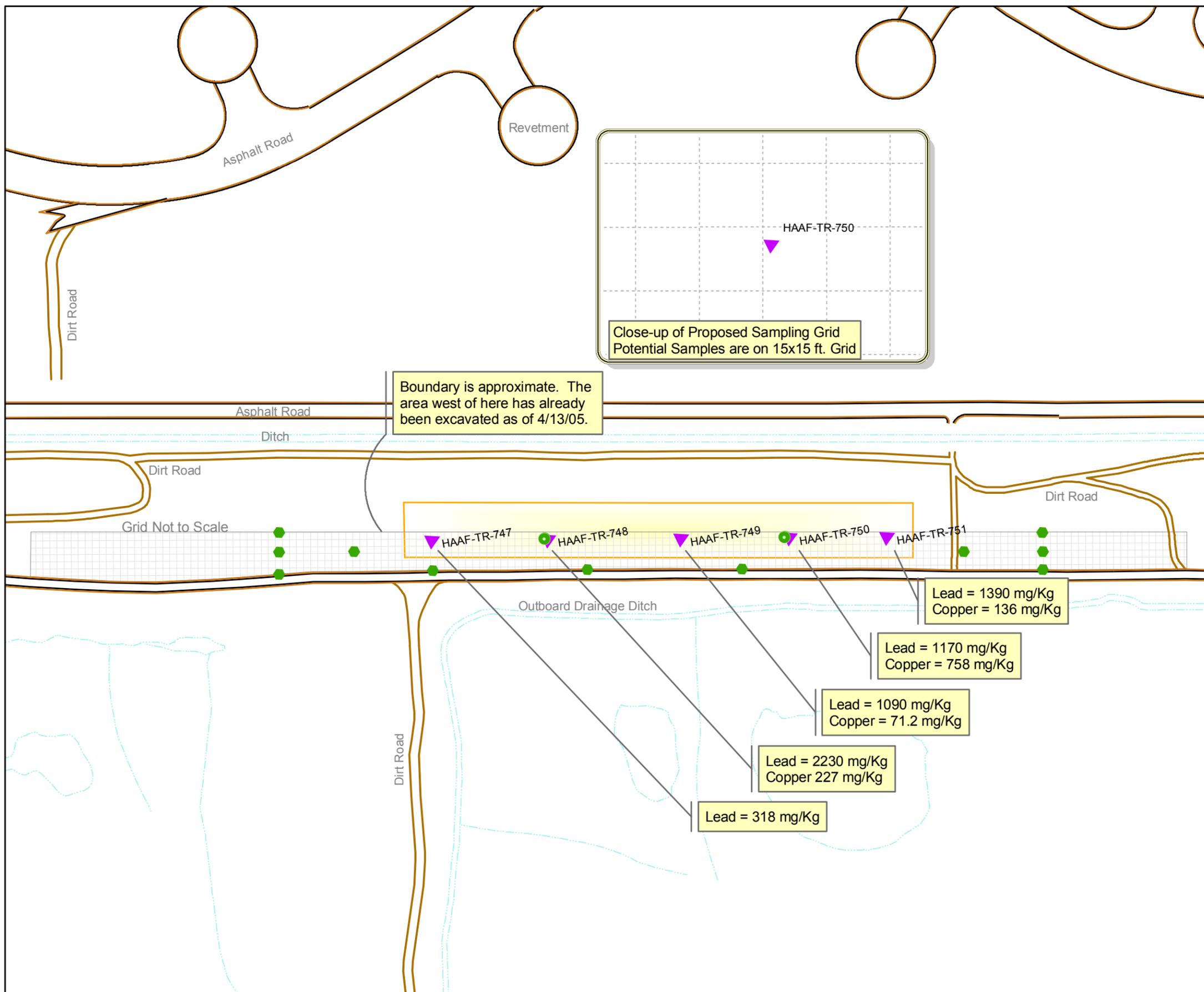
Figure 3-1

less than the associated action goal down to the 25-foot grid size, pre-excavation confirmation samples will be sent to a fixed laboratory for lead and cadmium analysis by ICP and Total PAH analysis by GC/MS. Analytical methods are described in more detail in Section 4.

3.2.2 Testing Range Sampling Strategy

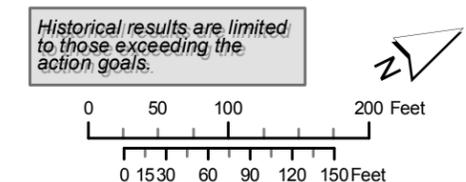
At the beginning of fieldwork a field portable XRF unit will be used to determine the concentration of lead and copper. Approximately 17 samples from 13 initial sampling locations will be collected from the site as illustrated in Figure 3-2. Samples will be collected from the surface, 0.5 feet bgs, and 1.0 feet bgs for two locations near previous samples with high concentrations. The samples will be analyzed in three ways: 1) the XRF will analyze for lead and copper *in-situ* (as described in Section 2.3), 2) an intrusive sample will be collected from that location and homogenized in a plastic bag then analyzed by the XRF, and 3) the sample will be sent to an off-site laboratory for analysis by ICP. The results from the various analyses will be reviewed to determine the feasibility of using data from the XRF to define the lateral and vertical extent of lead and copper. Section 2.3 describes the DMA process in more detail.

Samples will be collected from the site and analyzed for lead and copper until the extent of contamination above the action goals has been determined. If the contaminant concentration from the initial sampling locations exceeds the action goal, sampling will continue laterally north and south along the side of the levee at 100 foot intervals and vertically 0.5 feet to a maximum of 3 feet bgs until concentrations are all less than the applicable action goal. Samples will also be collected at 15-foot intervals to the east and west up and down the side of the levee. Once the concentrations from these samples (at approximately the 100-foot north-south intervals) are below the action goals, samples will be collected approximately 50 feet laterally back towards the previous sample with at least one COC concentration above the action goal at the same depth. Step-outs and step-ins will continue to the square grid size of 15 feet for the Testing Range. When contaminant concentrations are all less than the associated action goal down to the 15-foot grid size, pre-excavation confirmation samples will be sent to a fixed laboratory for lead and copper analysis by ICP and Total PAH analysis by GC/MS. Analytical methods are described in more detail in Section 4.



Legend

- ▼ Historical Soil Sample Location
- Proposed Initial Surface Sample Location
- Proposed Initial Depth Sample Location
- 15x15 ft. Grid for Sample Spacing
- Paved Surface
- Dirt Road
- Water Feature
- Historical Range Site Boundary
- Proposed Range Investigation Area (Grid not to scale)



U.S. Army Corps of Engineers
Sacramento District, CA

Designed by: K. SIEBENMANN	Date: 4/13/2005	Rev. 2	Sheet: 1 of 1
Drawn by: M. O'NEILL	File Name: TestingRng_WP_v2.mxd		
Project: BRAC REMEDIAL INVESTIGATION WORK PLAN			

Novato California

**Testing Range Workplan
Proposed Sample Locations**

DRAFT Final

BRAC PROPERTY
HAMILTON ARMY AIRFIELD
Figure 3-2

Sampling Summary

A summary of the sampling plan is presented in Table 3-1.

Table 3-1: Summary of Proposed Sampling and Analysis

Site Name	Sample ID (primary and field duplicate [FD] sample quantity)	Sample Depth	Type of Sample	Number and Type of Container/ Preservation	Analytes	EPA Method
Skeet Range – DMA	13 + 1 FD 3 + 1 FD	Surface 0.5 feet	In-situ soil	None	Pb, Cd	SW6200 (XRF)
	13 + 1 FD 3 + 1 FD	Surface 0.5 feet	Ex-situ soil	Plastic bag, jar	Pb, Cd	SW6200 (XRF) SW6010B (ICP)
	13 + 1 FD 3 + 1 FD	Surface 0.5 feet	Ex-situ soil	Jar, 4°C	Total PAHs	SW4035 (IA) SW8270C (GC/MS SIM)
Skeet Range – Full Sampling Effort	Unknown Unknown Unknown	Surface 0.5 feet 1.0 feet	Unknown soil	Unknown, may be in-situ	Pb, Cd	Unknown
	Unknown Unknown Unknown	Surface 0.5 feet 1.0 feet	Ex-situ soil	Jar, 4°C	Total PAHs	SW4035 (IA)
Skeet Range – Pre- Excavation Confirmation Samples	Unknown	Unknown	Ex-situ soil	Plastic bag, jar	Pb, Cd	SW6010B (ICP)
	Unknown	Unknown	Ex-situ soil	Jar, 4°C	Total PAHs	SW8270C (GC/MS SIM)
Testing Range – DMA	13 + 1 FD 2 2 + 1 FD	Surface 0.5 feet 1.0 feet	In-situ soil	None	Pb, Cu	SW6200 (XRF)
	13 + 1 FD 2 2 + 1 FD	Surface 0.5 feet 1.0 feet	Ex-situ soil	Plastic bag, jar	Pb, Cu	SW6200 (XRF) SW6010B (ICP)
	13 + 1 FD 2 2 + 1 FD	Surface 0.5 feet 1.0 feet	Ex-situ soil	Jar, 4°C	Total PAHs	SW4035 (IA) SW8270C (GC/MS SIM)
Testing Range – Full Sampling Effort	Unknown Unknown Unknown	Surface 0.5 feet 1.0 feet	Unknown soil	Unknown, may be in-situ	Pb, Cu	Unknown
	Unknown Unknown Unknown	Surface 0.5 feet 1.0 feet	Ex-situ soil	Jar, 4°C	Total PAHs	SW4035 (IA)
Testing Range – Pre- Excavation Confirmation Samples	Unknown	Unknown	Ex-situ soil	Plastic bag, jar	Pb, Cu	SW6010B (ICP)
	Unknown	Unknown	Ex-situ soil	Jar, 4°C	Total PAHs	SW8270C (GC/MS SIM)

Notes: This table will be completed following the assessment of results from the DMA.

3.4 Quality Control Samples

The following field quality control (QC) samples will be collected to assess precision and accuracy.

3.4.1 Field Duplicates

Duplicate field samples provide information regarding precision for the entire measurement system including sample acquisition, homogeneity, handling, shipping, storage, preparation, and analysis. For this project, two field duplicates will be collected and analyzed during the DMA. The field duplicate for the *in-situ* XRF analysis will consist of one set of 8 measurements within an area, move to another sampling location for testing and come back to the same sample locations later the same day.

3.4.2 Temperature Blanks

Temperature blanks consist of tap water in a VOA vial that is shipped in the same cooler with the environmental samples to the fixed laboratory. When received at the laboratory, the temperature in the blank is measured to determine if temperature preservation requirement has been met. One temperature blank will be included in each cooler sent to the laboratory.

3.5 Sampling Equipment and Procedures

3.5.1 General Information

The fieldwork for this inspection is anticipated to begin in June 2005. All fieldwork will be performed in accordance with the Work Plan and the Site Safety and Health Plan (SSHP).

3.5.2 Soil Sampling Equipment and Procedures

All soil samples will be collected using a stainless steel spoon, trowel, or shovel. However, samples may be unearthed using a backhoe and the sample collected from the backhoe bucket. Soil will be logged in the field in accordance with American Society of Testing and Materials (ASTM) D2488-93, Description and Identification of Soils (Visual Manual Procedure) (ASTM, 1993). All sampling equipment will be decontaminated according to the procedures detailed in Section 3.5. After collection, each soil sample will be sealed in Ziploc™ bags or 4-ounce glass jars and labelled. Upon completion of soil sampling, all holes will be backfilled with borehole cuttings and native soil. Samples will be placed in coolers or other protective containers and taken to the analysis location. This may be Building 82, within the site itself, or sent to the laboratory via Federal Express or hand delivered to the analytical laboratory representative under chain-of-custody protocol.

3.6 Equipment Decontamination Procedures

During sampling activities, appropriate decontamination measures will be taken to minimize sample contamination from sampling equipment. All hand soil sampling equipment will be decontaminated using a non-phosphate detergent wash, tap water rinse, and deionized water rinse applied from squirt bottles. Decontamination will be executed immediately prior to equipment use. Clean disposable gloves will be worn while sampling and decontaminating sampling equipment and tools.

3.7 Sample Documentation and Handling

3.7.1 Sample Numbering and Labels System

A unique identification number is assigned to each sample. A complete set of labels will be prepared for each anticipated sample in advance of the sampling event. Each sample will be numbered and include the following information:

- Project name (HAAF-SR or HAAF-TR);
- Sample number (e.g., 2100, 2101, etc.); and
- Depth, in feet;

An example: Skeet Range sample location number 2110, sample depth 0.5 feet, the sample label will be HAAF-SR-2110-0.5. A surface sample collected from the Testing Range, sample location number 2151 will have a label such as: HAAF-TR-2151-0.

All information pertaining to a particular sample will be referenced by its identification number. Samples will be recorded on the sample container, in the field logbook, and on the sample chain-of-custody form.

Each sample collected at the site will be labelled with the following information:

- Project Name;
- Sample identification number;
- Sample location;
- Date and time of collection;
- Name of person(s) collecting the sample;
- Analysis requested;
- Preservation; and
- Any other information pertinent to the sample.

3.7.2 Field Logbook

A permanently bound field logbook will be maintained during all field activities. The logbook will be used to record sample identification numbers, sample locations, sampling date

and time, chain-of-custody numbers, personnel on site, and any significant observations or events during field activities. The project name, project number, site location, sampling event, project manager, telephone number and address of contact office (should the logbook be misplaced or lost) will be listed in ink. The field logbook is intended to record events during sampling in sufficient detail to allow field personnel to reconstruct events that transpired during the project. Any soil logging will be recorded on dedicated field forms. When data is recorded on such forms, a reference to the forms will be included in the field logbook.

The project leader will maintain the field logbook and will sign and date the logbook prior to initiation of fieldwork. If it is necessary to transfer the logbook to alternative personnel during the course of fieldwork, the person relinquishing the logbook will sign and date the logbook at the time the logbook is transferred and the person receiving the logbook will do likewise. Corrections to erroneous data will be made by crossing a single line through the entry and entering the correct information. The correction will be initialled and dated by the person making the entry. Unused portions of logbook pages will be crossed out, initialled, and dated at the end of each workday. Logbook entries must be dated, legible, in ink, and contain accurate documentation. Language used will be objective, factual, and free of personal opinions. Hypotheses for observed phenomena may be recorded, however, they must be clearly indicated as such and only relate to the subject observation.

The specific sampling location of each sample is recorded with each sample identification number in the field logbook. The type of sample media and type and number of containers are recorded with the sample identification number in the field logbook and on the chain-of-custody form. Laboratory analyses to be conducted on the sample are recorded with the sample identification number in the field logbook and on the chain-of-custody form. The date and time of sampling preparation and collection, and personnel who conducted sampling are recorded with the sample identification number in the field logbook and on the chain-of-custody form. The names of visitors and any other persons on site are also recorded in the field logbook. Sampling personnel will also record the ambient weather conditions and other conditions at the sampling location that may affect sample collection, the apparent representativeness of the sample, or sample analysis in the field logbook.

3.7.3 Sample Packaging and Shipping

Samples will be transported as soon as possible after sample collection and preparation to the on-site analysis area, where applicable, or to the fixed laboratory for analysis. The following procedures are to be used when packing and transporting samples to the off-site laboratory:

- Use metal or equivalent strength plastic coolers or sturdy shipping containers,
- Package samples in individual plastic bags and place in container with ice sealed in plastic bags;

- Put paperwork (chain-of-custody record, etc.) in a waterproof plastic bag and tape it to the inside of the container,
- Tape the container lid and any drain shut with fiber-reinforced tape,
- Place at least two numbered and signed custody seals on container, one at the front right and one at the back left of cooler,
- Attach completed shipping label to the top of container and ship following the carrier's instructions.

Sample containers will be shipped via Federal Express for overnight delivery to the laboratory or the samples will be hand delivered to the laboratory. If shipped, a copy of the bill of lading (air bill) is to be retained and becomes part of the sample custody documentation. The laboratory will be notified in advance of all shipments by telephone on the day of shipment and by advanced scheduling.

3.7.4 Chain-of-Custody Procedures

All samples will be accompanied to the laboratory by a chain-of-custody form. The chain-of-custody form contains the following information:

- Project name;
- Laboratory information
- Sample numbers;
- Sample collection point;
- Sampling date;
- Time of collection of samples;
- Sample matrix description;
- Analyses requested for each sample;
- Preservation method;
- Number and type of containers used;
- Any special handling or analysis requirements.
- Signature of person collecting the samples;
- Signature of persons involved in the chain of possession.

The form will be filled out with ink. All information shall match the information found on the label. When the samples are transferred from one party to another, the individuals

will sign, date, and note the time on the form. A separate form will accompany each delivery of samples to the laboratory. The form will be included in the container used for transport to the laboratory. The sampling personnel will retain a copy of the form.

3.8 Data Processing

Field analytical results will be manually entered into a pre-developed Excel™ spreadsheet. Preliminary results from the laboratory will also be hand-entered when results are received. Personnel from HAAF will provide sample locations and coordinates for step-out, step-down, and step-in samples. All information will be plotted daily on a figure similar to Figures 3-1 and 3-2.

3.9 Investigation Derived Waste

Investigation derived waste (IDW) consisting of decontamination water, personal protective equipment (PPE), and empty containers will be generated during the course of the fieldwork. Due to the low volume of decontamination water that will be generated, all decontamination water will be stored in a 50-gallon metal drum, which will be appropriately disposed of at a later time. All other wastes will be disposed of in a trash receptacle.

4.0 QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan (QAPP) presents functions, procedures, and specific quality assurance (QA) and quality control (QC) activities to ensure that all analytical data are consistently produced and of known quality to achieve the data quality objectives defined in Section 2.0. The QAPP provides data specifications for all anticipated analyses and establishes procedures for data review and assessment.

The QAPP format was derived following EPA QA/G-5, *Guidance for the Preparation of Quality Assurance Project Plans* (EPA, 2002b) and the QAPP elements were developed following EPA QA/R-5, *Requirements for Quality Assurance Project Plans* (EPA, 2001).

The purpose of this QAPP is to ensure that the data collected are of known and documented quality and useful for the purposes for which they are intended. The procedures described are designed to obtain data quality indicators for each field procedure and analytical method. Data quality indicators include the PARCC parameters (Precision, Accuracy, Representativeness, Comparability, and Completeness). To ensure that quality data continues to be produced, systematic checks must show that test results and field procedures remain reproducible and that the analytical methodology is actually measuring the quantity of analytes in each sample.

The reliability and credibility of analytical laboratory results can be corroborated by the inclusion of a program of scheduled replicate analyses, analyses of standard or spiked samples, and analysis of split samples with QA laboratories for some projects. Regularly scheduled analyses of known duplicates, standards, and spiked samples are a routine aspect of data reduction, validation, and reporting procedures. The laboratory requirements include those specified in *Department of Defense Quality Systems Manual (QSM) for Environmental Laboratories*, June 2002.

4.1 Analytical Methods Requirements

Table 4-1 provides a summary of the required analytical methods, parameters, and associated holding times required for this project.

Table 4-1: Summary of Analytical Methods

Analytical Method	Preparation Method	Parameters	Holding Time	Preservation
SW6200 <i>in-situ</i>	None	Lead, Cadmium, Copper	None	None
SW6200	SW6200	Lead, Cadmium, Copper	6 months	None
SW6010B/SW7000	SW3050B	Lead, Cadmium, Copper	6 months to analysis	None
SW4035	SW4035	Polynuclear Aromatic Hydrocarbons (PAHs)	14 days	4°C
Modified SW8270C, Selective Ion Monitoring	SW3550B	Polynuclear Aromatic Hydrocarbons (PAHs)	14 days until extraction, 40 days from extraction to analysis	4°C

4.1.1 Sample Preparation Methods

The following section briefly summarizes the sample extraction and cleanup methods that will be performed for the determination of organic analyte. Cleanup methods must be used where applicable to meet the quantitation limits (QLs).

Method SW3550B: Ultrasonic Extraction for PAHs in soil

This method is used to extract non-volatile and semivolatile organic compounds from solids such as soils and sludges. The sonication process ensures intimate contact between the sample matrix and the extraction solvent. Extraction is accomplished by mixing the weighed, ground sample with the appropriate solvent. The sample is dispersed into the solvent using the sonication technique. The extraction solvent is specified in the analytical method. The extract is dried, concentrated, and then treated using a cleanup method, or analyzed directly by the appropriate method.

4.1.2 Organic Analytical Methods

The following section briefly summarizes the analytical methods listed in Table 4-1 that will be performed for the determination of organic constituents at the Skeet and Testing Ranges.

4.1.2.1 Modified Method SW8270C: Polynuclear Aromatic Hydrocarbons (PAHs) by Gas Chromatography/Mass Spectrometry, Selective Ion Monitoring (SIM)

Method SW8270C is used to quantify most neutral, acidic, and basic organic compounds that are soluble in methylene chloride. Such compounds include PAHs. The concentrated extract is injected into a gas chromatograph for separation and detected by mass spectrometry. Mass spectrometry provides a characteristic ion pattern for fragmented target analytes, providing

a high level of confidence in compound identification. Compounds are quantitated by comparing the response of a characteristic ion to the average response from a 5-point calibration. The internal standard technique is used for calibration. The instrument will be modified for selective ion monitoring (SIM) to reduce interferences and lower the quantitation and detection limits of PAHs for this project. Aliquot of the extract is injected into a GC/MS that is set up to detect only specific ions found in the PAH analytes.

4.1.2.2 Method SW4035: Soil Screening for Polynuclear Aromatic Hydrocarbons by Immunoassay

A weighed sample is extracted and filtered using a purchased test kit. The extract and an enzyme conjugate reagent are added to immobilized antibodies. The enzyme conjugate “competes” with the PAHs present in the sample for binding to the immobilized anti-PAH antibody. The test is interpreted by comparing the response produced by testing a sample to the response produced by testing standards simultaneously.

4.1.3 Inorganic Analytical Methods

The following section briefly summarizes the analytical methods listed in Table 4-1 that will be performed for the determination of inorganic constituents at the Skeet and Testing Ranges.

4.1.3.1 EPA Method 6010B: Inductively Coupled Plasma-Atomic Emission Spectrometry

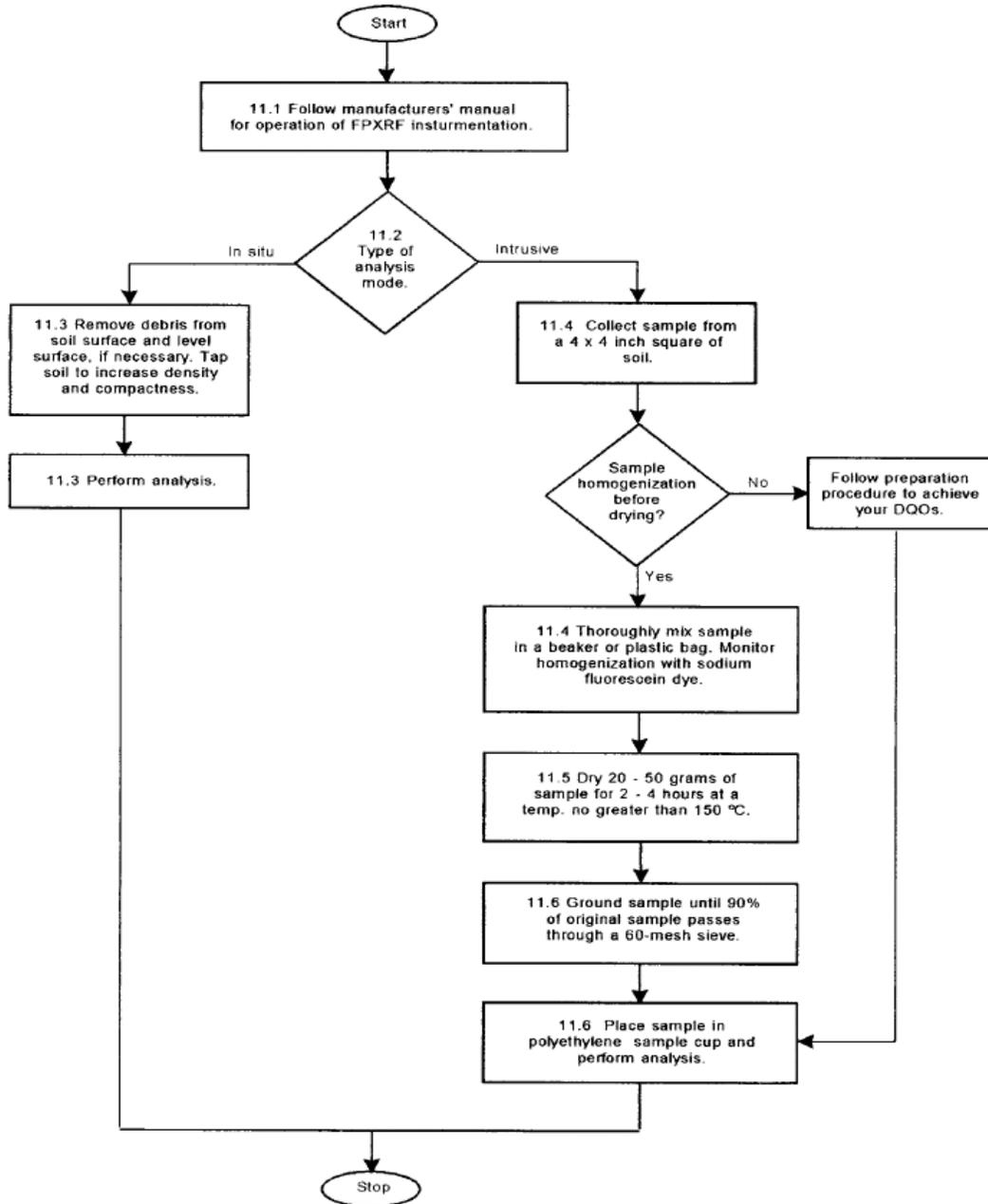
Inductively coupled plasma/atomic emission spectroscopy (ICP) determines elements in solution. The sample requires digestion by Method 3005 for water and 3050 for soil prior to analysis. The method provides a simultaneous or sequential multi-element determination of elements by ICP. Element-emitted light is measured by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific atomic line emission spectra are produced by radio frequency inductively coupled plasma. The spectra are dispersed and photo-multiplier tubes monitor the intensities of the lines. The spectra are physical property of the element. And the intensity is proportion to the concentration of the element in solution.

4.1.3.2 EPA Method 6200: X-Ray Fluorescence

Sample preparation for x-ray fluorescence spectroscopy can vary. The attached flow chart illustrates the options available.

METHOD 6200

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT



**Figure 4-1
XRF Analysis Options Flowchart**

The XRF analysis for the DMA for the Ranges RI will consist of *in-situ* and *ex-situ* analyses. *In-situ* analysis consists of clearing the ground surface of debris and placing the instrument directly on the ground for analysis. The length of time the sample is held to the ground as well as the homogeneity of the soil can affect the detection limit. This method allows multiple readings and, potentially, a more representative sample by averaging the readings. *Ex-situ* analysis will consist of eliminating the debris and scooping a sample into a baggie. The sample will be homogenized manually before measurement through the plastic by the XRF. Drying, sieving, and grinding will be performed for this project, due to the time-consuming nature of these activities. The soil must not be saturated for either XRF techniques to provide adequate quality data. The principle of XRF analysis is based on atomic excitation. An atom is in an excited state when an electron is added or removed. Elements in a soil sample are irradiated with a beam of X-rays. As each X-ray source bombards the elements in a soil sample, the inner-orbital electrons in the atom are photo-ejected and leave the atom in an excited state as a result of electron vacancy. To return to a more relaxed state, an outer orbital electron will fill the vacancy and in the process emit X-rays possessing energy that is unique to each element. The X-ray energy emitted is measured and undergoes mathematical regression analysis to determine a calculated value. Dual detectors will be necessary for analysis for lead, cadmium, and copper. There is no sample destruction during the XRF analysis and therefore, the sample can be re-analyzed multiple times or can be submitted to a fixed laboratory for ICP analysis.

4.2 Analytical Data Reduction and Review

The selected laboratories will be responsible for providing complete documentation of all analytical test results and QC sample results in a comprehensive certificate of analysis in addition to an electronic file of data in a particular format appropriate for automated data review by the USACE, Sacramento District Chemistry Section.

4.3 Quality Assurance And Quality Control Procedures

Different types of replicate and blank samples are collected as part of the QA/QC program. Several QC samples will be analyzed for this project to provide a means to assess both field and analytical performance. The following sections describe the different types of QC samples and how they are assessed to evaluate data quality.

4.3.1 Field QA/QC Checks

Field QC samples are discussed in Section 3.3 and consist of field duplicates and temperature blanks. Each type of field QC sample undergoes the same preservation, analysis, and reporting procedures as the related environmental samples.

The following table summarizes the field QC sample collection frequencies and acceptance limits.

Table 4-2: Field QC Sample Collection Frequencies And Acceptance Limits

QC Sample Type	Minimum Collection Frequency	Acceptance Limits
Field Duplicate	2 per site during the DMA. Additional field duplicates may be collected for additional information regarding variability of constituents within the soil	Relative Percent Difference (RPD) \leq 50 RPD
Temperature Blank	1 per cooler containing samples for PAH analysis	4° C \pm 2° C

4.3.2 Analytical QA/QC Checks

The laboratory will have a QA/QC program that monitors data quality with internal QC checks. Those specific internal QC checks and frequency of checks are provided in Appendix A and in the method-specific laboratory QA/QC procedures. These laboratory QC checks include blank samples, laboratory control samples (LCSs), duplicate analyses, and matrix spikes/matrix spike duplicates (MS/MSDs). The control limits for LCSs, MS/MSDs, and surrogates will be statistically-derived and specific to the laboratory. Any control limits specified in this QAPP for these QC samples are comparison limits only. USACE will compare the laboratory-derived control limits to these to determine the quality of the laboratory. The comparison limits are representative of acceptable limits from numerous laboratories and are also statistically derived.

4.4 Data Quality Indicators (PARCC Parameters)

The PARCC parameters are qualitative and quantitative statements regarding the quality characteristics of the data used to support project objectives and ultimately, environmental decisions. These parameters are presented in the remainder of this section.

4.4.1 Precision

Precision is a measure of the degree to which two or more measurements are in agreement, and describes the reproducibility of measurements of the same parameter for samples analyzed under similar conditions. A fundamental tenet of using precision measurements for QC is that precision will be bounded by known limits. Results outside these predetermined limits trigger corrective actions or indicate heterogeneity of contaminants within the environmental matrix. Precision will be evaluated from field duplicate data, laboratory duplicate data, and

MS/MSD data. Acceptable precision is achieved when RPD values are within the acceptance criterion.

4.4.1.1 Field Precision

Field precision objectives are met by collecting and measuring field duplicates at a rate of 1 duplicate per 10 environmental samples. The acceptance limit for field duplicate precision is ≤ 50 RPD for soil results. This precision estimate encompasses the combined uncertainty associated with sample collection, homogenization, splitting, handling, laboratory and field storage (if applicable), sub-sampling and preparation for analysis, and analysis.

4.4.1.2 Laboratory Precision Objectives

Laboratory precision QC samples (i.e., MS/MSD) will be analyzed with a minimum frequency of five percent. Acceptance limits for laboratory precision is ≤ 35 RPD.

4.4.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. This parameter is assessed by measuring spiked samples or well-characterized samples of certified analyte concentrations (e.g., laboratory control sample [LCS]). Accuracy measurements are designed to detect biases resulting from the sample handling and analysis processes.

4.4.2.1 Field Accuracy Objectives

Field accuracy is maintained by monitoring adherence to procedures that prevent sample contamination or degradation. Accuracy also shall be improved qualitatively through adherence to all sample handling, preservation, and holding-time requirements.

4.4.2.2 Analytical Accuracy Objectives

Analytical accuracy is measured through the comparison of a spiked sample or LCS result to a known or calculated value and is expressed as a percent recovery (%R). MS/MSD analyses measure the combined accuracy effects of the sample matrix, sample preparation, and sample measurement. LCSs are used to assess the accuracy of laboratory operations. Each sample is spiked with target analytes for the analysis being performed to ensure that accuracy measures are obtained for each target analyte. Spiking concentrations shall equal or approximate the mid-level calibration standard. Laboratory accuracy is assessed via comparison of calculated percent recovery values to accuracy control limits.

4.4.3 Representativeness

Representativeness is an expression of the degree to which the data accurately and precisely represents a characteristic of a population or environmental condition existing at the site. Adherence to this work plan and use of standardized sampling, handling, preparation, analysis, and reporting procedures ensure that the final data accurately represent the desired populations. Representativeness will be evaluated during data assessment to evaluate whether each datum belongs to the observed data distribution through outlier testing. Any anomalies will be investigated to assess their impact on statistical computations as part of the report.

4.4.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected under normal conditions. Completeness is expressed as a percentage. Technical completeness is a measure of the amount of usable, valid laboratory measurements per matrix obtained for each target analyte. Usable, valid results are those that are judged, after data assessment, to represent the sampling populations and to have not been rejected for use through data validation or data assessment. Analytical completeness objectives are 90 percent for each critical target analyte. Qualifications on the use of data caused by incomplete data sets will be documented in the report.

4.4.5 Comparability

Comparability is defined as the confidence with which one data set can be compared to another (e.g., between sampling points; between sampling events). Comparability is achieved by using standardized sampling and analysis methods and data reporting formats (including use of consistent units of measurement), and by ensuring that reporting and detection limits are sufficiently low to satisfy project detection and quantitation criteria for the duration of the project. The QLs anticipated for this project are presented in Table 4-3.

Table 4-3: Target Analytes, Quantitation Limits and Comparison Criteria

Analyte	Method	Soil QL (mg/Kg)	Action Goals (mg/Kg)
Lead	SW6200 SW6010B	unknown (20) 10	46.7
Cadmium	SW6200 SW6010B	unknown 0.5	1.2
Copper	SW6200 SW6010B	unknown (30) 5	68.1
Total PAHs	SW4035 Modified SW8270C	1 individual PAHs range from 0.01 to 0.04, Total QLs equal 0.46	4.022

Note: Concentration in parentheses is claimed by manufacturer with full sample preparation and no matrix interferences.

4.5 Data Validation

The project team will review all the data generated for the project. Laboratory data will be reviewed electronically using the Automated Data Review software, and verified by the project chemist, where possible. Data qualifiers will be assigned for the following QC outliers: contaminated blanks, LCS outliers, and MS/MSD outliers. Additionally, approximately 10 percent of the data will be validated at the raw data level to verify analyte detection and quantitation. Any effect on data quality determined during the raw data validation will initiate further review to determine the extent of the data quality issues on the dataset.

5.0 REFERENCES

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APPENDIX

Quality Control Tables

Calibration and Internal Quality Control Procedures for Method SW6010B

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a
SW6010B	Metals	Linear Range Study (minimum of 3 standards and blank)	Once per quarter	$r \geq 0.995$	1) Correct problem 2) Repeat calibration
		Daily 2-point calibration - high std. and blank (high std. at top of linear range)	Daily, prior to sample analysis	High level standard analyzed as a sample, true value $\pm 5\%$	1) Correct problem according to instrument manufacturer's recommendations 2) Repeat calibration
		ICV- mid-level std. (prepared with second source standard)	Daily, prior to sample analysis	Within $\pm 10\%$ of expected value	1) Repeat ICV 2) If still out, identify and correct problem and repeat ICV 3) If still out, repeat initial calibration
		CCV- mid-level std. (prepared with second source standard)	After every 10 samples and at the end of each batch	Within $\pm 10\%$ of expected value	1) Reanalyze CCV 2) If still out, identify and correct problem 3) Recalibrate and reanalyze all samples since last valid CCV
		ICB / CCB (undigested)	Prior to sample analyses, after every 10 samples, and at the end of each batch	Measured concentrations must be $< \frac{1}{2}$ QL	1) Reanalyze calibration blank 2) If still out, identify and correct problem 3) Reanalyze samples back to last clean blank 4) Recalibrate, if necessary
		Method Blank	Generated with each leachate or digestion batch of 20 or fewer samples	Measured concentrations must be $< \frac{1}{2}$ QL	1) Reanalyze method blank 2) If still out, identify and correct problem 3) Reanalyze samples back to last clean method blank 4) Re-digest entire batch, if necessary
		LCS	1 LCS pair per preparation batch	Response for all analytes within project limits. (80-120%)	1) Reanalyze LCS 2) Identify and correct problem 3) If still out, redigest and reanalyze affected samples
		MS/MSD (sample spiked prior to digestion)	1 MS/MSD per every preparation batch	Response for all analytes within project limits. (80-120%)	1) Reanalyze MS; if still out: 2) Reextract and reanalyze MS only 3) If still out report both sets of data
		ICS	Beginning and end of each analytical run	Within $\pm 20\%$ of expected value for all metals	Reanalyze all samples not bracketed by passing ICS

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a
SW6010B (cont.)	Metals (cont.)	Serial dilution	1 per 20 samples per matrix if conc. >10 times the MDL	Analysis of a 1:4 dilution should be within $\pm 10\%$ of original concentration	1) Evaluate data for interference 2) Flag data as matrix interference
		QL	Not applicable	QLs established shall not exceed those in the accompanying table.	QLs that exceed established criteria shall be submitted to USACE for approval prior to any sample analysis

^aAll corrective actions associated with USACE project work shall be documented and the records maintained by the laboratory.

CCV = Continuing Calibration Verification
MS = Matrix Spike
ICV = Initial Calibration Verification
ICB = Initial Calibration Blank
CCB = Continuing Calibration Blank
r = Correlation Coefficient

MSD = Matrix Spike Duplicate
ICS = Interference Check Standard
LCS = Laboratory Control Sample
MDL = Method Detection Limit
MB = Method Blank
QL = Quantitation Limit

Summary of Calibration and Internal Quality Control Procedures for Method SW6200

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a
SW6200	Metals	Energy Calibration Check	Beginning of each working day, after every 10 samples and at the end of the day.	See instrument manufacturer's instructions.	See instrument manufacturer's instructions.
		ICV	Daily, prior to sample analysis	Within $\pm 20\%$ of expected value	1) Repeat ICV 2) If still out, identify and correct problem and repeat ICV 3) If still out, rerun energy calibration check.
		CCV	After every 10 samples and at the end of each batch	Within $\pm 20\%$ of expected value	1) Reanalyze CCV 2) If still out, identify and correct problem 3) Recalibrate and reanalyze all samples since last valid CCV
		ICB / CCB	Prior to sample analyses, after every 10 samples, and at the end of each batch	Measured concentrations must be $< \frac{1}{2}$ QL	1) Reanalyze calibration blank 2) If still out, identify and correct problem 3) Reanalyze samples back to last clean blank 4) Recalibrate, if necessary
		LCS	1 LCS per preparation batch	Response for all analytes within project limits. (80-120%)	1) Reanalyze LCS 2) Identify and correct problem
		Laboratory Duplicate	1 per preparation batch	Maximum RPD ≤ 35	1) Reanalyze duplicate pair 2) If still out reextract and reanalyze duplicate pair, report both sets of data
		QL	Not applicable	QLs established shall not exceed those in the accompanying table.	QLs that exceed established criteria shall be submitted to USACE for approval prior to any sample analysis

CCV = Continuing Calibration Verification

LCS = Laboratory Control Sample

CCB = Continuing Calibration Blank

ICV = Initial Calibration Verification

ICB = Initial Calibration Blank

QL = Quantitation Limit

Summary of Calibration and Internal Quality Control Procedures for Method 4035

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW4042	Total PAHs	Two-point calibration standards at 1.0 and 10 mg/kg	Prepare and analyze during sample preparation and analysis for each batch	Response of the standards should be inversely relational to concentration	Reanalyze batch
		Method Blank	1 per batch	Response greater than the 0.1 mg/kg standard response	Investigate possible source of problem. Take appropriate corrective action. Reanalyze batch.
		Duplicate preparation and analysis	1 per batch	Equivalent result (< 0.2 mg/kg; >0.2 <1 mg/kg; or >1 mg/kg)	Identify potential source of problem and correct. If source is not apparent, reanalyze same sample and duplicate in following batch to verify heterogeneity.

Summary of Calibration and Internal Quality Control Procedures for Method SW8270C, modified

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8270 SIM	Polynuclear Aromatic Hydrocarbons	Instrument tune (decafluorotriphenylphosphine)	Prior to initial calibration and every 12 hours of analysis time	Ion abundance criteria as described in SW8270C	Retune instrument and verify. Rerun affected samples.
		Five-point calibration	When daily calibration verification fails or following major instrument maintenance or repair	1. <u>Average RRF for SPCCs</u> : ≥ 0.050 . 2. <u>%RSD for RRFs for CCCs</u> : $\leq 30\%$ 3. <u>One option below for ALL analytes</u> ; Option 1: RSD for each analyte $\leq 15\%$ Option 2: Grand mean $\leq 15\%$ with no individual analyte RSD $> 30\%$ Option 3: linear regression, $r \geq 0.995$ Option 4: non-linear regression – COD $r^2 \geq 0.990$ (6 points 2 nd order, 7 points 3 rd order)	Correct problem then repeat initial calibration.
		Second source calibration verification	Once after each initial calibration	% Difference from expected value $\leq 25\%$ for all analytes.	Correct problem and verify second source standard. If that fails, then repeat initial calibration.

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8270 SIM	Polynuclear Aromatic Hydrocarbons	Calibration verification	Daily, prior to sample analysis and every 12 hours of analysis time	1. Average RRF for SPCCs: ≥ 0.050 2. %Difference/drift for CCCs: $\leq 20\%D$ 3. Grand mean of concentration for all analytes within $\pm 20\%D$ of expected value, with no individual analytes (except CCCs) $> 25\%$.	Correct problem, rerun CV. If that fails, then repeat initial calibration.
		Calibration verification internal standards	With every CV	Retention time ± 30 seconds from retention time of midpoint standard in the initial calibration. Quantitation ion peak area within 2 times area of initial calibration midpoint standard	Inspect mass spectrometer and GC for malfunctions. Take appropriate corrective actions. Reanalyze samples analyzed while system was malfunctioning.
		Method Blank	1 per preparation batch	All analytes $< \frac{1}{2}$ QL. For common laboratory contaminants, all analytes $< QL$.	Investigate possible contamination source. Take appropriate corrective action. Reprepare and reanalyze all samples processed with a contaminated blank, unless analyte is not detected in associated samples or present at greater than 10x blank concentration.
		Laboratory Control Sample	1 per preparation batch	Comparison recovery limits - 50-120%	Correct problem, then reprepare and reanalyze LCS and all samples in the associated preparatory batch for failed analytes.
		Matrix Spike and Matrix Spike Duplicate	1 MS/MSD per 20 project samples when identified on the Chain-of-Custody	Comparison recovery limits 50-120% and RPD $< 20\%$	Evaluate for supportable matrix effect. If no interference is evident reprepare and reanalyze MS/MSD and all affected samples once within the holding time. If still out report both sets of data.

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8270 SIM	Polynuclear Aromatic Hydrocarbons	Surrogate spike	All field and quality control samples	Comparison recovery limits 50-120%	Evaluate for supportable matrix effect. If no interference is evident reprepare and reanalyze affected sample(s).
		Quantitation limit standard (lowest concentration on initial calibration curve)	Verify at least once for every matrix and field effort	QLs established shall not exceed those in the Appendix B tables.	QLs that exceed established criteria shall be submitted to USACE Project Chemist for approval prior to analysis of any project samples.