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DEPARTMENT OF THE AIR FORCE
27TH SPECIAL OPERATIONS MISSION SUPPORT GROUP (AFSOC)
CANNON AIR FORCE BASE NEW MEXICO

AUG 2012 NMED Hazardous Waste Bureau

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Dear Ms. Andress

Attached is the *Final Work Plan - Resource Conservation and Recovery Act Facility Assessment - Solid Waste Management Unit 73, Cannon Air Force Base, New Mexico.* My action officers for this submittal are Mr. Ronald Lancaster, Chief, Asset Management Flight at (575) 784-1146, or Mr. Matthew Higginbotham, Restoration Program Manager at (575) 784-6031. If you would like to contact me directly I can be reached at (575) 784-2770.

Sincerely

DAVID C. PIECH, Colonel, USAF
Commander

Attachment:
Final Work Plan - Resource Conservation and Recovery Act Facility Assessment - Solid Waste Management Unit 73, Cannon Air Force Base, New Mexico
cc:
Environmental Protection Agency, Region VI, Ms. Wendy Jacques w/o Attachment

WORK PLAN

Resource Conservation and Recovery Act Facility Assessment
Solid Waste Management Unit 73
Cannon Air Force Base, New Mexico

Contract No. FA8903-08-D-8781, Task Order 0154
Project No. CZQZ118900

Final
April 2012

27 SOCES/CEAN
Cannon Air Force Base
New Mexico

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Solid Waste Management Unit 73
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Final
April 2012

Prepared for:

27 SOCES/CEAN
Cannon Air Force Base, New Mexico

Air Force Center for Engineering and the Environment

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ACRONYMS AND ABBREVIATIONS

ºC	degrees Celsius
AFB	Air Force Base
AFCEE	Air Force Center for Engineering and the Environment
AFSOC	Air Force Special Operations Command
ASTM	American Society for Testing and Materials
bgs	below ground surface
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CO	Contracting Officer
C-O-C	chain-of-custody
COPC	contaminant of potential concern
COR	Contracting Officer's Representative
CPSMR	Contractor's Progress, Status, and Management Report
CSM	Conceptual Site Model
CSEM	Conceptual Site Exposure Model
DoD	Department of Defense
DOT	Department of Transportation
DQO	data quality objective
DRO	diesel range organic
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
ERPIMS	Environmental Restoration Program Information Management System
ESRI	Environmental Systems Research Institute
FCR	Field Change Request
ft	foot/feet
GC/MS	gas chromatography/mass spectrometry
GIS	Geographic Information System
GPS	global positioning system
GRO	gasoline range organic
GSI	Geomechanics Southwest, Inc.
HSP	Health and Safety Plan
HSWA	Hazardous and Solid Waste Amendments
ID	identification
IDQTF	Intergovernmental Data Quality Task Force

ACRONYMS AND ABBREVIATIONS (CONTINUED)

IDW	investigation-derived waste
in	inch/inches
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
NCR	nonconformance report
NELAC	National Environmental laboratory Accreditation Conference
NMED	New Mexico Environment Department
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, comparability, and completeness
PDF	Portable Document Format
PID	photoionization detector
PCB	polychlorinated biphenyl
PPE	personal protective equipment
QA	quality assurance
QC	quality control
QAPP	Quality Assurance Project Plan
QSM	Quality Systems Manual for Environmental Laboratories
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RPD	relative percent difference
RPM	Restoration Program Manager
RSL	regional screening level
SDSFIE	Spatial data Standard for Facilities, Infrastructure, and Environment
SIM	selective ion monitoring
SOP	Standard Operation Procedure
SOW	Statement of Work
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TAL	target analyte list
TestAmerica Denver	TestAmerica Laboratories, Inc.
Tetra Tech	Tetra Tech, Inc.
TPH	total petroleum hydrocarbon

ACRONYMS AND ABBREVIATIONS (CONTINUED)

UFP	Uniform Federal Policy
USCS	Unified Soil Classification Systems
USSOCOM	United States Special Operations Command
VOC	volatile organic compound
WGS84	World Geodetic System 1984
WP	Work Plan

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EXECUTIVE SUMMARY

ES.1 Introduction

A Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) will be conducted at Solid Waste Management Unit (SWMU) 73, the Stormwater Drainage and Retention Pond, to investigate potential soil and sediment contamination and assess potential threats to human health and the environment associated with stormwater flows. The project site, located on the grounds of the Whispering Winds Golf Course at Cannon Air Force Base (AFB), New Mexico, consists of a series of stormwater drains and culverts that discharge into a retention pond. The investigation will evaluate whether runoff captured at SWMU 73 has released contamination to surface soil, sediment, and subsurface soil at the site. The site has never been investigated and the nature and extent of contamination, if present, and potential risks to sensitive resources are unknown.

The site is administered under the Base's Environmental Restoration Program (ERP) and requires assessment to be considered for no further action status and removal from Cannon AFB's Hazardous and Solid Waste Amendments (HSWA) permit. The scope of work includes a literature search; development of conceptual site models; investigation of site media through advancement of soil borings; collection of sediment, surface soil, and subsurface soil samples; and chemical analysis. The RFA data will be used to characterize the site and develop, evaluate, and select appropriate response alternatives or provide recommendations for future action leading to site closure.

This Work Plan describes the overall strategy, technical approach, activities, standard operating procedures (SOPs), milestones, and technical requirements to conduct the RFA at SWMU 73. The plan ensures the integrity of the work to be performed for the project through upfront and focused planning and project team cooperation. The Work Plan format incorporates the Uniform Federal Policy (UFP) for Quality Assurance Project Plan (QAPP), which was developed by the Intergovernmental Data Quality Task Force (IDQTF 2005a,b,c,d) to provide a common organizational framework and approach to quality planning, implementation, and assessment and ensure that the data collected will be of the appropriate type and quality needed for their intended use. Tetra Tech, Inc. (Tetra Tech) prepared the Work Plan for the Air Force Center for Engineering and the Environment (AFCEE) under Contract FA8903-08-8781, Task Order 0154.

The overall project objective for the assessment is to obtain data to sufficiently identify and characterize potential contamination in site soils and sediment related to stormwater runoff. The data generated during the investigation will be used to:

- Define the project setting and subsurface conditions.
- Identify contaminated media.
- Characterize the nature and extent of contamination at the site.
- Compare contaminant concentrations to background concentrations and approved health-based soil screening levels (SSLs) to identify contaminants of potential concern.

- Support the development, evaluation, and selection of the appropriate response alternatives for the site based on the assessment findings.

ES.2 Work Plan Organization

The Work Plan, UFP-QAPP, Environmental Health and Safety Plan (HSP), and supporting information integrate the technical and quality aspects of environmental data collection and analysis as follows:

- *Work Plan*—The Work Plan summarizes the project scope, objectives, technical approach, field investigation and sampling protocols, submittal requirements, and project management. The plan provides an overview of Cannon AFB location and history and summarizes background information about SWMU 73 including site description, history, and environmental setting. The preliminary conceptual site model (CSM) and conceptual site exposure model (CSEM) developed to identify impacted media, potential exposure pathways, and human and ecological receptors are also presented.

  The field investigation and sampling methodologies presented in the Work Plan specify the procedures that will be followed to conduct the RFA in accordance with requirements and guidance established by the U.S. Environmental Protection Agency (EPA), AFCEE, Department of Defense (DoD), and the U.S. Air Force. The plan provides the sampling rationale, design, and protocol; outlines the project data quality objectives (DQOs); describes the analytical requirements; and establishes the procedures for sample collection, packaging, and shipment. The plan also specifies requirements for field documentation, such as chain-of-custody (C-O-C) forms, sample labels, boring logs, field logbooks, and calibration logs, and overall data management.

For additional reference, the Work Plan also includes appendices that were prepared to support the site assessment of SWMU 73:

- *Appendix A*—The UFP-QAPP Worksheets primarily address critical planning elements such as project organization and schedule; problem statement and DQO development; sampling and analysis program rationale and design; project action criteria and performance metrics; laboratory and field quality control; data review, verification, and validation; preventive and corrective actions; and quality system deliverables. Applicable laboratory and field SOPs are identified, and the procedures that will guide implementation of RFA field activities have been incorporated into the appendix for reference. All analytical tasks described in the UFP-QAPP will be conducted in compliance with the *Department of Defense Quality Systems Manual for Environmental Laboratories* (DoD QSM) version 4.2 (DoD 2010).

- *Appendix B*—The appendix provides examples of forms that will be used to support the field investigation. Forms include the boring log, C-O-C form, sample label, custody seal, field change request, and nonconformance report.

- *Appendix C*—The HSP outlines the procedures to ensure all work is performed in a safe manner and that appropriate precautions are established to protect site workers, visitors, and property.

1. INTRODUCTION

This Work Plan addresses the personnel, materials, equipment, and services necessary to perform a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) at Solid Waste Management Unit (SWMU) 73, the Stormwater Drainage and Retention Pond, located at Cannon Air Force Base (AFB), New Mexico. The project site consists of a series of stormwater drains and culverts that discharge to a retention pond on the grounds of the Whispering Winds Golf Course, located in the north-central portion of the Base. Figure 1, the facility map, depicts the location of the project site within Cannon AFB. The site map, Figure 2, shows site drainage features and the proposed sample locations.

SWMU 73 receives stormwater runoff from the surrounding course greens and fairways and residential and semi-industrial portions of Cannon AFB (see Figure 2). Stormwater runoff is recognized as a potential source of contamination in surface water, sediment, and soil. Depending on land uses within the source area, stormwater runoff can transport sediment, dissolved pollutants, and chemical pollutants attached to sediment. Potential contaminants include total petroleum hydrocarbons (TPH) (gasoline range organics [GRO] and diesel range organics [DRO]), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorinated pesticides, glycols, explosives, and target analyte list (TAL) metals. The release status of the site is currently unknown.

The RCRA corrective action program was established to investigate and require clean up of releases of hazardous wastes or constituents to the environment at facilities subject to RCRA permits. Pursuant to the requirements of their Hazardous and Solid Waste Amendments (HSWA) permit, Cannon AFB is actively conducting corrective action activities for SWMUs identified at the Base. The U.S. Environmental Protection Agency (EPA) has authorized the New Mexico Environment Department (NMED) to implement the federal RCRA program and oversee corrective action program activities conducted in accordance with the Base's HSWA permit. The RCRA Facility Assessment is the first step of the corrective action process.

The Work Plan provides the project scope, objectives, technical approach, quality, field investigation, and project management requirements to complete the proposed RFA. It provides the framework to document site conditions and environmental setting, construct preliminary site conceptual models for human and ecological receptors, and collect chemical data of sufficient quality and quantity to identify and characterize the nature and extent of contaminants released to site media from runoff. The field investigation and sampling methodologies presented in the Work Plan specify the procedures that will be followed to conduct the RFA in accordance with requirements and guidance established by the EPA, Air Force Center for Engineering and the Environment (AFCEE), Department of Defense (DoD), and the U.S. Air Force. The plan provides the sampling rationale, design, and protocol; outlines the project data quality objectives (DQOs); describes the analytical requirements; and establishes the procedures for sample collection, packaging, and shipment. The plan also specifies requirements for field documentation, such as chain-of-custody (C-O-C) forms, sample labels, boring logs, field logbooks, and calibration logs, and overall data management.

This Work Plan meets the requirements stipulated within the AFCEE under Contract FA8903-08-8781, Task Order 0154; the project Statement of Work (SOW) dated 3 August 2011; and NMED. All field activities will be performed in accordance with the Environmental Health and Safety Plan (HSP) (Appendix C).

1.1 Purpose

Specific site environmental conditions at SWMU 73 are largely unknown. The purpose of the assessment is to evaluate the project site for releases to site media related to stormwater management activities. The RFA focuses on data collection and evaluation to determine the likelihood of release, nature and extent of any release, and make recommendations concerning the site. The RFA is considered complete when sufficient information has been evaluated to make a determination regarding releases or likely releases at the site and the need for further investigation. Based on the findings of the RFA, preliminary determination regarding releases of concern will identify the need for future action and interim corrective measures, or the assessment will conclude that no release has occurred that poses a threat to human health or the environment and recommend no further action for SWMU 73 and site closure.

The overall project objective for the field investigation is to obtain data sufficient to identify and characterize contamination in site soils and sediment related to stormwater runoff. The data generated during the investigation will be used to:

- Document environmental conditions and potential for release to site media resulting from past and present stormwater management activities.
- Identify contaminated media.
- Characterize the nature and extent of contamination at the site.
- Compare contaminant concentrations to background concentrations and approved health-based soil screening levels (SSLs) to identify contaminants of potential concern (COPCs).
- Support the development, evaluation, and selection of the appropriate response alternatives for the site, including recommendations for future action leading to site closure and removal from the Base's HSWA permit.

1.2 Scope

This Work Plan describes the overall strategy, technical approach, activities, procedures, milestones, and technical requirements to complete the RFA in accordance with the SOW, contract, Base, and NMED requirements. The release potential to all environmental media at the site, including surface water, groundwater, air, sediment, and soil, will be considered during the preliminary review and construction of site conceptual models. As directed by AFCEE, however, the site inspection and field investigation phases of the project will focus on upland media: exposed sediment, surface soil, and subsurface soil. The scope of the assessment, therefore, is to identify and evaluate the nature and extent of potential contamination in surface soil, sediment, and subsurface soil at SWMU 73. Five borings will be advanced to a depth of 25 feet (ft) below ground surface (bgs) and sampled at five depths. Because the waste characteristics of the stormwater runoff are unknown, the samples will be analyzed for an extensive parameter list.

The sampling plan rationale and protocols; quality assurance/quality control (QA/QC) program; project implementation plan/scope of work; analytical requirements; and procedures are presented in this Work Plan; supporting information is provided in the Uniform Federal Policy (UFP)-Quality Assurance Project Plan (QAPP) Worksheets (Appendix A). Implementation of the Work Plan will ensure that DQOs specified for this project are met; field sampling protocols are documented and reviewed in a consistent manner; and data collected are of known quality, technically accurate, and scientifically valid and defensible. All project activities will be performed in compliance with state and federal regulations. The UFP-QAPP Worksheets primarily address critical planning elements such as project organization and schedule; problem statement and DQO development; sampling and analysis program rationale and design; project action criteria and performance metrics; laboratory and field QC; data review, verification, and validation; corrective action; and quality system deliverables. Applicable laboratory and field standard operating procedures (SOPs) are identified, and the procedures that will guide implementation of RFA field activities have been incorporated into the appendix for convenient reference. All analytical tasks described in the UFP-QAPP will be conducted in compliance with the *Department of Defense Quality Systems Manual for Environmental Laboratories* (DoD QSM) version 4.2 (DoD 2010).

1.3 Methodology

The RFA process will be conducted in three phases:

- *Step 1, Preliminary Review*—Available information about the project site that could provide evidence for release will be gathered as a first step. Sources of information include the Cannon AFB Administrative Record; facility maps; topographic, geological, and soil maps; aerial images; and interviews with Base representatives. The review documents the site environmental setting, site background, history, and design and operating characteristics of the site's drainage/retention pond system. This preliminary information provides a framework for understanding the site's release potential, including identifying contaminated media, pollutant migration pathways, and exposure points, and identifying data gaps. The human health conceptual site model (CSM) and ecological conceptual site exposure model (CSEM) are generated based on this preliminary information.

- *Step 2, Visual Site Inspection*—Visual evidence of potential releases is collected during the second step of the RFA, the site inspection. The visit will document current environmental condition, including land use; vegetation and ground cover; habitat; site grading characteristics; drainage patterns; configuration and condition of the culverts, runoff channels, and retention pond; and pond water levels and confirm likely pollutant migration pathways for runoff. AFCEE has directed that a sampling and analysis phase will be conducted. The initial visit will provide the opportunity to inspect the proposed sampling locations, delineate sensitive habitats, and define site access, existing institutional controls, and potential obstacles to performing the field investigation. The sampling locations may be modified based on the findings of the site visit and confirmation of likely pollutant pathways. Some data gaps may also be addressed during the field investigation to document the environmental setting and revise the preliminary CSM and CSEM.

- *Step 3, Field Investigation*—A field investigation will be conducted to fill data gaps identified during construction of the preliminary site conceptual models. Chemical data will be

collected and used to identify releases to exposed sediment, surface soil, and subsurface soil and characterize the nature and extent of any contamination. Soil borings will be logged to provide information about soil characteristics and subsurface conditions to aid in evaluating constituent fate and transport. The Work Plan describes the sample locations, depth of samples, sampling methods, analytical parameters, and logging requirements. SOPs are provided in Section 8.0 of this plan. Chemical analyses will be performed by a DoD Environmental Laboratory Accreditation Program (ELAP) certified laboratory in accordance with the UFP-QAPP and DoD QSM) version 4.2 (2010).

1.4 Overview of the Work Plan

This Work Plan has been developed to guide implementation of all aspects of the RFA. The Work Plan complements the plan appendices (UFP-QAPP, HSP, and forms) prepared to conduct the assessment. Cross-references are used throughout the planning documents to direct the reader to the appropriate section that addresses related requirements to a particular activity or aspect of work.

This Work Plan is organized as follows:

- *Section 1, Introduction*—summarizes the project purpose, scope, objectives, and methodology and describes the organization of the Work Plan.
- *Section 2, Installation Background*—summarizes background information about Cannon AFB including the site location, description, and history.
- *Section 3, Site Description, History, and Environmental Setting*—provides background information about SWMU 73, including the site description, history, and environmental setting.
- *Section 4, Conceptual Site Model*—describes the preliminary human health CSM and ecological CSEM, which identify release mechanisms, impacted media, potential transport mechanisms and pathways, potential receptors, and exposure routes in which receptors may potentially be exposed to chemical contamination at SWMU 73. Data gaps to be addressed during the RFA are also addressed.
- *Section 5, Project Organization*—summarizes the project organization including the key personnel, their roles and responsibilities in the field investigation phase of the project, and subcontractors.
- *Section 6, Project Implementation Plan/Scope of Work*—provides an overview of the general approach to implementing field and supporting investigation activities, including the field and evaluation scopes of work. The project planning, meetings, development of DQOs, and overview of proposed activities are presented.
- *Section 7, Design of Data Collection Operations*—presents plan elements involving data collection operations including sample design and rationale; analytical approach; description of the sample identification system; summary of the field sampling and analytical program; and requirements for sample volumes, container types, preservation, and holding times.

- *Section 8, Field Sampling Activities*—describes in detail the procedures that will be followed to implement the field investigation program, including drilling operations, logging requirements, soil and sediment sample collection, headspace analysis, decontamination of drilling and sampling equipment, management of investigation-derived waste (IDW), and borehole abandonment.

- *Section 9, Sample Handling*—presents the procedures that will be followed to ensure that the history of each sample and its handling are documented from sample collection through all transfers of custody. Sample custody, transfer of custody and shipment, and laboratory custody procedures are described.

- *Section 10, Field Operations Documentation*—discusses the appropriate field documentation that will be prepared and maintained for project investigation and sampling activities.

- *Section 11, Calibration Procedures*—presents proper calibration procedures and frequency applicable to measuring and test equipment used in the field and laboratory to ensure that equipment will be of the type, range, accuracy, and precision necessary to provide data meeting project DQOs.

- *Section 12, Internal Quality Control Checks*—addresses internal QC checks to ensure that field and laboratory analyses comply with the requirement of the project investigation.

- *Section 13, Data Validation, Reduction, and Reporting*—describes the procedures pertaining to data validation and reporting of field and analytical laboratory data.

- *Section 14, Performance and Systems Audits*—addresses performance and system audits to ensure that the RFA sampling and analysis activities are performed in accordance with the procedures established for the project.

- *Section 15, Preventive Maintenance*—describes the preventive maintenance program to ensure that field sampling and analytical equipment are maintained to the manufacturers' specifications and in operational conditions.

- *Section 16, Data Assessment*—presents data assessment formulas to evaluate precision, accuracy, and completeness of field and laboratory data generated in support of the RFA, and reviews the process that will be followed to assess data for precision, accuracy, representativeness, comparability, and completeness.

- *Section 17, Corrective Action*—presents the corrective action program that will be implemented for the investigation at SWMU 73. Procedures for identifying the need for corrective action, verifying corrective action, and completing related documentation are addressed.

- *Section 18, Reporting*—describes the reports, meetings, and notifications that will be prepared to execute the RFA.

- *Section 19, Data Management*—summarizes the requirements for data management, including project documentation and records, laboratory data package deliverables, and reporting formats.

- *Section 20, References*—provides a list of references used to prepare the Work Plan.

2. INSTALLATION BACKGROUND

2.1 Location and Facility Description

Cannon AFB is located in Curry County, New Mexico, approximately 7 miles west of the city of Clovis (Figure 1). Cannon AFB occupies approximately 3,782 acres. The Base rests on a nearly flat plain that slopes gently (10 to 15 ft per mile) to the east and southeast. Elevations in the vicinity of Cannon AFB range from 4,250 to 4,350 ft above mean sea level. Playas form the only features of relief evident at the Base.

Cannon AFB consists of an airfield and associated operations, maintenance, and support facilities that are located northwest of the airfield. Additional Base support facilities, such as the munitions storage area and current fire department training area, are located south and east of the airfield. Housing facilities are located in the northwestern portion of the Base and also occupy an area west of U.S. Highway 277 and north of U.S. Highway 60 that was at one time part of Cannon AFB. The remaining areas bordering the Base are utilized as farmland and the occasional residential home.

2.2 History

Prior to the existence of the Base, farming and ranching were the primary land uses. In 1929 Portair Field was established on the land as a transcontinental air terminal. In 1942, the DoD took control of Portair Field and re-named it as Clovis Army Air Base. Clovis Army Air Base was subsequently closed in 1947.

In 1951, the Air Base was reopened and assigned to the Tactical Air Command as Clovis Air Force Base. In 1957, the Base was renamed Cannon AFB. From the 1960s until 2007, Cannon AFB was part of the Tactical Air Command or Air Combat Command and home of the 27th Fighter Wing. In May 2005, the Base Realignment and Closure Commission recommended to the Secretary of Defense to close Cannon AFB. Subsequently, a final report (September 2005) from the Commission to the President recommended Cannon AFB remain open as an enclave until at least December 2009 and that the 27th Fighter Wing be disestablished. In the interim, the Secretary of Defense was to seek other missions for assignment to Cannon AFB.

As a result of this search, the Air Force Special Operations Command (AFSOC) was designated as the new mission for Cannon AFB in 2007. AFSOC is headquartered at Hurlburt Field, Florida. AFSOC is a Major Command and the Air Force component of United States Special Operations Command (USSOCOM), a unified command located at MacDill AFB, Florida. AFSOC is responsible to USSOCOM for the readiness of Air Force Special Operations Forces for worldwide deployment. AFSOC is composed of highly trained, rapidly deployable airmen who are equipped with highly specialized aircraft. These forces provide global ability to conduct special operations missions ranging from precision application of firepower, to infiltration, exfiltration, resupply, and refueling of operational elements. Cannon AFB will provide AFSOC dedicated installation, range facilities, and training airspace for special operations forces to achieve and maintain skills.

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3. SITE DESCRIPTION, HISTORY, AND ENVIRONMENTAL SETTING

3.1 Site Description

SWMU 73 is the stormwater drainage and retention pond at the Whispering Winds Golf Course facility located in the north-central portion of Cannon AFB (Figure 1). The *Preliminary Review/VSI Report, RCRA Facility Assessment* (A.T. Kearney 1987) describes the unit as a series of stormwater drains and culverts that discharge into a retention pond. As shown on Figure 2, the 2.6-acre site is located northwest of D.L. Ingram Boulevard near Green #5 and occupies a low area surrounded by short, elevated greens. The study area includes the retention pond, the pond banks/margins, and drainage channels and culverts that convey runoff to the pond.

The native vegetation of Cannon AFB is Plains-Mesa Grassland, which undisturbed is composed almost entirely of grasses, with forbs and shrubs comprising less than 10 percent. The vegetation at SWMU 73 is disturbed. Areas not inundated by surface water are sparsely vegetated with prairie grasses, low shrubs, and small trees. The golf course greens that surround the site are planted in bent grass, with Bermuda grass covering the fairways. The isolated riparian/aquatic communities on Cannon AFB are typically associated with drainage ditches/channels and playa lakes similar to conditions at SWMU 73.

The design and operating characteristics of a SWMU determine to a great extent its potential for release. The source area for runoff includes residential and semi-industrial portions of the Base and surrounding areas of the golf course. Culverts direct the runoff flows under the roads that border the golf course such as D.L. Ingram Boulevard (near the Base Civil Engineering Building) and Casablanca Avenue. The drainage areas have developed shallow channels that convey the stormwater around and through the golf course greens before discharging into the retention pond.

The pond and drainage channels are subjected to influxes of runoff during precipitation events. Surface water is intermittently present as runoff in the drainage channel, but the retention pond appears to have a permanent pool of water year-round. Stormwater contaminants can remain dissolved or suspended in the water column for some time. Generally, however, the permanent pool allows some pollutant particles to settle out, where they are subject to natural biological, chemical, and infiltration processes. Examples include nutrient uptake through biological activity and adsorption of pollutants contained in the infiltrated runoff by subsurface soil particles. Other contaminants such as trace metals and organic compounds bind with solids that settle to the bottom of the pond as contaminated sediment. Sediments may also be deposited within the runoff channel during precipitation events. The current thickness of sediments accumulated on the pond bottom and in other depositional upland areas is unknown.

Sediment is traditionally defined as the deposited material underlying a body of water. Sediment is formed as waterborne solids (particulates) settle out of the water column and build up as bottom deposits. This process occurs in the retention pond and to some extent in the runoff channels. During low-flow conditions the overlying water temporarily recedes, exposing sediments in the pond to the air. The runoff channel dries completely, also exposing sediments on the channel

bottom and margins. For this reason, sediment is considered as two separate media, submerged and exposed. Exposed sediment in the runoff channels, channel margins, and pond margins will be evaluated with soil. Soil is also evaluated as two separate media: surface soil from 0 to 2 ft bgs and subsurface soil from 2 ft bgs to the water table. Groundwater occurs at approximately 315 ft bgs in this area of the Base, and will not be encountered during the field investigation.

3.2 Site History

SWMU 73 provides stormwater runoff control for the southeastern portion of the Whispering Winds Golf Course on Cannon AFB and receives runoff through culverts from the Base. Retention ponds are commonly used in such settings to control runoff and associated pollution from overland flows. The golf course facility opened as a nine-hole course in 1954, and added an additional nine holes in 1994. The facility is bounded by D.L. Ingram Boulevard to the southeast, Casablanca Avenue and residences to the southwest, and U.S. Highway 84/60 to the north.

The SWMU 73 runoff channels and drainage areas cut through the course and discharge stormwater flows into the retention pond near Green #5. The retention pond was created by grading and redeveloping a natural playa. The details of construction are not known, but the pond contains water year-round because it has a liner that inhibits significant infiltration. The depth of water contained in the pond varies over time based on precipitation, inflow volumes, evaporation, and use by plants and animals.

Based on the operational history of SWMU 73 for stormwater runoff control, the potential for contamination of sediment, surface soil, and subsurface soils exists. Stormwater runoff is a primary source of contamination in surface water. Depending on land use and waste management practices of facilities in the source area, runoff can be highly polluted with particulate matter, pesticides, fertilizers, petroleum products, other organics, metals, and salts. Polluted stormwater flows may also result in deposition of contaminated sediments in the pond and upland drainage areas. These pollutants can then be leached and carried through the vadose zone by infiltrating stormwater.

The thickness of sediments deposited within the retention pond and elsewhere on upland areas of the SWMU, specific pollutant types, amount of runoff occurring over time, and concentrations of pollutants associated with historical and current stormwater flows directed to SWMU 73 are unknown.

3.3 Literature Search and Information Review

The site has not been previously investigated, and no record exists of any spills or releases. A literature search of the Cannon AFB Administrative Record was undertaken to determine whether sampling data are available to characterize the nature and extent of potential environmental impacts at SWMU 73. No records or documents describing site background or operational history were available for review.

In response, the site was evaluated based on facility maps that depict local conditions and results of studies performed at similar sites at the Base. Background information was obtained from examination of utility maps, planning and development maps, topographic maps, and aerial images. These sources were used to define the general project setting and identify existing site conditions, features, sensitive resources, and potential for hazards such as RCRA-listed wastes or unexploded

ordnance. This information was also used to develop the preliminary CSM and CSEM, identify data gaps, focus design of the sampling program, identify potentially impacted media, and select potential contaminants of concern for study.

3.4 Environmental Setting

3.4.1 Climate

Cannon AFB is located within a semi-arid climate zone. A weather station in nearby Clovis receives an average of about 17 inches (in) of precipitation a year; average minimum and maximum temperatures are 43 and 72 degrees Fahrenheit (Western Regional Climate Center, 2005a). Most precipitation falls during the summer months, and much of the annual precipitation likely is lost to evapotranspiration. Annual pan evaporation at the weather station in Clovis averages 86.64 in; evaporation is largest from May through August (Western Regional Climate Center, 2005b). The wettest months occur during the summer when seasonal monsoonal storms bring moisture to the area. The wettest month is August with an average rainfall of 3.43 in.

3.4.2 Site Geology and Hydrology

Cannon AFB is underlain by Ogallala Formation fluvial deposits consisting primarily of unconsolidated silty sand to clayey sand. These deposits include sporadic caliche layers and more extensive zones containing caliche-cemented nodules (Harza 1997). The caliche zones act as an aquitard and effectively isolate the aquifer from surface conditions (A.T. Kearny 1987). The total thickness of the Ogallala Formation beneath the site is not known. Based on available regional information, the Ogallala Formation may be as thick as 390 ft under Cannon AFB.

The Blackwater Draw Formation of Quaternary age generally overlies the Ogallala Formation at Cannon AFB. The formation is composed primarily of unconsolidated eolian sand deposits and ranges in thickness from 0 to 80 ft in eastern New Mexico (McLemore 2001). A caliche layer is typically present in the unsaturated zone of the Blackwater Formation in New Mexico (Hart and McAda, 1985). Drilling at Cannon AFB has indicated that caliche is discontinuous, typically found within 30 ft of the surface, and of variable thickness (USGS 2005).

Based on previous investigations at Cannon AFB, all drilling will be conducted through unconsolidated Quaternary sediments. The soils in the area of SWMU 73 are classified as Amarillo fine sandy loam, 0–2 percent slope phase, associated with limited occurrence of Clovis fine sandy loam, 0–2 slope phase (A.T. Kearny 1987). Amarillo soils cover over 90 percent of Cannon AFB and typically consist of loamy sand overlying a hard, calcareous caliche layer. Clovis soils generally occur in small areas associated with playa lakes. Clovis soils are similar to the Amarillo soils, but the chalky zone occurs at a somewhat shallower depth. Zones of caliche will likely be encountered during drilling of the five 25-ft-deep soil borings. Groundwater is located at an approximate depth of 315 ft bgs, and will not be encountered during this drilling program.

3.4.3 Topography and Drainage Patterns

Historically, drainage at Cannon AFB has been characterized as overland flow into four natural ephemeral playas. The northern two playas have been converted into intensely maintained, plastic-lined golf course ponds, including the pond at SWMU 73. When the golf course was constructed, grading created short elevated greens with low areas separating the greens and fairways. The runoff channels and retention pond at SWMU 73 are described by the golf course as water hazards.

Grading the natural playa and installing a liner has resulted in a permanent pond because stormwater flows are captured but no natural outlet is present.

The intake is passive with stormwater runoff accumulating in the low-lying basin area. Based on aerial images, one runoff channel discharges into the pond at its extreme western point from a culvert that passes underneath Casablanca Avenue. Runoff also enters the site from a culvert that passes under D.L. Ingram Boulevard, across from the Base Civil Engineering Building. The areal extent of the retention pond varies with the water depth, which is constrained by the amount of runoff entering the site, precipitation duration and timing, evapotranspiration processes, and limited infiltration if the liner is not intact.

Based on the aerial image of the study area, the retention basin appears to have a wide, flat shelf located to the north of the pond that may be exposed sediment or sediment inundated by shallow water. Typical retention pond designs plan for such areas to lie no more than 1 ft below the permanent water level as a safety measure in case a person or animal falls into the water. There also appears to be an access drive around the basin above the permanent water level to allow maintenance vehicles access to the basin.

4. CONCEPTUAL SITE MODEL

The preliminary human health CSM and ecological CSEM for SWMU 73 at Cannon AFB are presented on Figures 3 and 4. The site conceptual models integrate information about the site to describe potential source areas, release mechanisms, transport pathways/mechanisms, exposure scenarios, and complete and incomplete exposure pathways. It also identifies potentially exposed receptors under the current and reasonably anticipated future land and water uses. The preliminary site conceptual models will be used to focus the sampling design for the RFA and identify chemical and nonchemical data gaps to be addressed during the field investigation. As more data are generated the preliminary CSM and CSEM will be refined to reflect the updated information for site setting, subsurface conditions, individual pathways, and potential receptors.

4.1 Human Health Conceptual Site Model

4.1.1 Potential Constituents, Media, and Exposure Pathways

4.1.1.1 Potential Constituents

The site consists of a series of drainage areas and culverts that discharge into a retention pond. The drainage area and retention pond have received stormwater runoff from surrounding areas of the golf course since its construction in 1954 and expansion in 1995. Culverts direct runoff from Cannon AFB into drainage channels that discharge into the pond as well. Progressive urbanization at the Base has increased runoff from storm events over time and decreased natural recharge processes. Stormwater runoff transports dissolved chemicals, sediment, and chemical pollutants bound to sediment, and is a primary source of contamination in surface water and deposited sediments. Depending on the land use and waste management practices of the residential and semi-industrial facilities in the source area, stormwater runoff can be highly polluted with sediments, pesticides, fertilizers, petroleum products, other organics, metals, and salts. As a result, chemical contamination from petroleum (GRO and DRO), VOCs, SVOCs, PAHs, PCBs, chlorinated pesticides, glycols, explosives, and metals may have impacted sediment and soil at the site. Although the preliminary CSM and CSEM do not exclude the potential occurrence of any constituent, site operational history indicates a very low probability for encountering RCRA-listed wastes or unexploded ordnance.

4.1.1.2 Potential Media of Concern

The exposure media contain the source or become contaminated through migration of contaminants from the source area. While the source area is not completely understood, it is assumed that the source of impacted media at the site is related to overland stormwater flows. The following media are considered directly impacted or serve as primary sources of potential contamination:

- Surface soil and exposed sediment on dry areas of the site (upland media)
- Subsurface soil
- Surface water
- Submerged sediment

Interactions between the primary sources of contamination and other media at the site have resulted in secondary sources of contamination. These secondary sources may re-contaminate environmental media at the site under certain conditions such as disturbance. The following media are considered secondary sources of contamination at SWMU 73:

- Air
- Airborne particulates
- Groundwater

Surface soil, exposed sediments, and subsurface soil are the upland media most likely to be directly impacted by a release associated with stormwater runoff. The drainage channels and retention pond capture runoff that may contain sediment, sediment-bound pollutants, and dissolved pollutants. The dissolved pollutants enter the waters of the retention pond, which can infiltrate through the submerged sediments deposited on the pond bottom and even leach contaminants into the vadose zone. The dissolved pollutants may also infiltrate into the surface soil, exposed sediment, and subsurface soils beneath the runoff channels and areas around the pond that are subject to periodic inundation caused by fluctuations in pond water level. Sediments and sediment-bound pollutants settle out and are deposited on the bottom of the retention pond, effectively concentrating them. Contaminated sediments may also be deposited on pond banks during high-water events when the pond is fuller, and along the sides and bottom of the runoff channel itself.

Contaminants in both exposed and submerged sediments can be re-released into surface waters during periods of high flow, transported, and redeposited with sediment within the runoff channels, pond margins/banks, or pond bottom. When exposed, these sediments may be subject to wind erosion and be distributed through fugitive dust. Infiltration of surface water can then leach sediment-bound contaminants into surface and subsurface soils. In addition, precipitation falling on exposed contaminated media can mobilize contamination.

Indirect releases to groundwater can potentially occur if contamination in sediment, surface soil, subsurface soil, and/or surface water migrates through the vadose zone to the water table. These releases may be continuous (as in the case of surface water and saturated bottom sediments) or recurrent or intermittent in nature, as in overland stormwater runoff. However, it is unlikely that impacts to groundwater will occur and the exposure pathway to groundwater is incomplete. As described in Section 4.1.2.4 for the future residential land use scenario, migration potential is limited by semi-arid climate conditions, impervious layers in the vadose zone, low percolation rates, installation of a plastic lining in the pond, and depth to the regional water table.

Volatiles may be released into the atmosphere from surface water, surface soil, and sediment, especially during hot dry periods typical of New Mexico's semi-arid climate. Releases to air can also occur from suspension of contaminated particulates derived from surface soil and exposed sediment. The nature of air releases suggests that the majority of the mass available for release will be released shortly after the constituent is placed in the media. For low concentrations of volatiles the potential risk to human health is likely insignificant. However, windborne particulates suspended and dispersed by wind represent a potential complete exposure pathway.

4.1.2 Potential Receptors and Exposure Scenarios

This section identifies potential receptors and potential exposure pathways for current and reasonably anticipated future use scenarios considered in the preliminary CSM. Based on current and potential land-use scenarios, receptors for completed exposure pathways can be exposed to varying depths of soil, or soil exposure intervals. According to NMED guidance (2012b), depth of samples should be considered and surface soils (0–1 ft bgs) should be evaluated separately from subsurface soils due to possible differences in exposure levels that would be encountered by different receptors. Exposure intervals for each receptor are based on the types of activities in which each receptor is likely to be involved. Potential receptors considered in the preliminary CSM include:

- Recreational User/Visitor
- Maintenance Worker
- Off-site Resident/Trespasser
- Residents

The Management Action Plan for Cannon AFB indicates that current land use at SWMU 73 is expected to remain industrial in the future. The first three populations represent use of the site as long as it operates as a golf course. As incidental users the exposure durations for these populations are considered limited. If the golf course is redeveloped for residential use then the future target population would consist of residents. This represents the most conservative exposure scenario considered for the evaluation.

Potential exposure routes for each pathway considered in the preliminary CSM include:

- Ingestion
- Dermal contact
- Inhalation

Considering current land uses, inhalation of volatiles released to the atmosphere from subsurface soil and groundwater are not considered complete pathways. Dermal contact and ingestion of groundwater and interactions between groundwater and surface water, exposed sediment/surface soil, subsurface soil, or submerged sediment are not expected to occur.

4.1.2.1 Recreational User/Visitor Land Use Scenario

The site is located on an active golf course. Access to the site is controlled but the golf course is a popular recreational facility. The surface water features are considered to be water hazards, and so it is reasonable to assume that people may be exposed to contamination in surface water and submerged sediment while wading in the water to collect golf balls and to be exposed to contamination in sediment/surface soil while walking across the site. Under current conditions, recreational users/visitors may be exposed to contamination in the surface soil/sediment from 0–1 ft bgs through the following potentially complete pathways:

- Surface soil outside of depositional areas via incidental ingestion and dermal contact

- Surface water via incidental ingestion and dermal contact with the water bodies (pond and channel when runoff is present)

- Exposed sediment along the pond banks, runoff channel margins, and in the runoff channels (when dry) via incidental ingestion and dermal contact
- Submerged sediment within the shallow retention pond via incidental ingestion and dermal contact
- Air through inhalation of windborne particulates

4.1.2.2 Maintenance Worker Land Use Scenario

Workers perform routine maintenance activities at the golf course including general grounds-keeping (lawn mowing, gardening, repairs to greens and fairways). It is reasonable to assume that maintenance workers may need to work at times within the study area. Under current conditions, maintenance workers may be exposed to contamination in sediment, surface soil, and subsurface soil from 0–10 ft bgs through the following potentially complete pathways:

- Surface soil outside of depositional areas via incidental ingestion and dermal contact
- Subsurface soil via incidental ingestion and dermal contact
- Exposed sediment along the pond margins/banks, runoff channel margins, and in the runoff channels (when dry) via incidental ingestion and dermal contact
- Surface water via incidental ingestion and dermal contact (pond and ditch when runoff is present)
- Submerged sediment within the shallow retention pond via incidental ingestion and dermal contact
- Air through inhalation of windborne particulates

4.1.2.3 Off-site Resident/Trespasser Land Use Scenario

The golf course is accessible to residents who live nearby and to other trespassers who may gain entry to the course and thereby access the site. It is reasonable to assume that people may wade in the surface water bodies or walk across the dry upland areas of the site. Under current conditions, off-site residents/trespassers may be exposed to contamination in sediment/surface soil from 0–1 ft bgs through the following potentially complete pathways:

- Surface soil outside of depositional areas via incidental ingestion and dermal contact
- Exposed sediment along the pond margins/banks, runoff channel margins, and in the runoff channels (when dry) via incidental ingestion and dermal contact
- Surface water via incidental ingestion and dermal contact (pond and ditch when runoff is present)
- Submerged sediment within the shallow retention pond via incidental ingestion and dermal contact

- Air through inhalation of windborne particulates

4.1.2.4 Residential Land Use Scenario

Cannon AFB intends to operate the golf course facility into the foreseeable future. However, it is possible that the site could be redeveloped in the future as residential property. It is likely that the low-lying basin would be preserved as this is a redeveloped natural playa, and the study area would continue to function as a drainage and runoff management feature. If maintained as open space, the site media would be accessible to residents. Under future conditions, residential users may be exposed to contamination in sediment, surface soil, and subsurface soil from 0–10 ft bgs through the following potentially complete pathways:

- Surface soil via incidental ingestion and dermal contact
- Subsurface soil via incidental ingestion and dermal contact
- Sediment via incidental ingestion and dermal contact
- Surface water via incidental ingestion and dermal contact
- Air through inhalation of particulates

Groundwater occurs approximately 315 ft bgs in this area of Cannon AFB. Caliche layers likely underlie the site and would act as an aquitard, isolating the regional aquifer from possible impacts caused by leaching and migration of contaminants from sediment and soil to the groundwater table. Fate and transfer modeling conducted at SWMU 101, the sewage lagoons, indicated that excessive amounts of infiltrating water are necessary to provide the transport mechanism required to greatly affect groundwater concentrations (Foster Wheeler Environmental Corporation 2001). Precipitation amounts over the upland areas of the site are not sufficient to provide a significant positive pressure head to enhance transport of constituents through the vadose zone. The positive pressure head created from the ponded water could create a driving transport mechanism. However, the pond is lined, which inhibits infiltration assuming the liner is in good condition. Based on the modeling results the exposure pathway to groundwater is incomplete, even for a future land use scenario.

If the site is redeveloped it is possible that water supply wells could be installed within or near the study area to provide water for irrigation, reservoir storage, or other domestic use. However, the groundwater is not expected to contain constituents related to any release at SWMU 73.

4.1.2.5 Nature and Extent of Contamination

There is no record of previous releases to the environment at SWMU 73 that would result in contaminants being present at this site. This site is identified as a SWMU on the Base's HSWA permit. Stormwater flows from the golf course and residential and semi-industrial portions of the Base discharge to this low-lying area. Review of the site history and background information indicates the horizontal extent of any potential release of contaminants to the environment is likely confined to those areas within the SWMU that have been inundated by stormwater flows. The site drainage features are expected to approximately delineate areas with a higher potential for release from those anticipated to show minor to minimal impacts. Based on inundation frequency and duration, the retention pond basin, pond banks and margins, and runoff channels and margins would most likely exhibit the highest concentrations of deposited contaminants. These same areas are anticipated to have the greatest potential for vertical impacts to sediment and soil.

However, the nature and extent of potential contamination has not been evaluated. Release characterization procedures should consider chemical and physical properties of both the soil and detected constituents to assist in determining the nature and extent of contamination. Other factors that should be considered include active environmental processes, climate, and subsurface geology and hydrology, in particular variability in vertical and horizontal stratigraphy.

4.1.2.6 Fate and Transport

Potential routes of pollutant transport have been identified and indicate that surface water, surface soil, subsurface soil, and deposited sediments within the drainage area and retention pond are the media most likely to have been impacted by pollutants transported in stormwater runoff. Release mechanisms include deposition, infiltration, percolation, and leaching. The tendencies for different constituents to be transported in runoff, deposited, and migrate through the unsaturated zone will depend on several factors: amount of contaminant, physical state, physical and chemical properties of the constituents, physical and chemical properties of the soil/geologic materials, and site geology and hydrology. The potential mobility, volatility, and biodegradability of constituents need to be considered. For example, chemicals released to soil may undergo transformation or degradation by chemical or biological mechanisms, may be adsorbed onto soil particles, may be resuspended as particulates and dispersed, or may volatilize into soil pore spaces or into the air. Contaminants may also transfer from one medium to other media.

If contamination is present in site media at SWMU 73, it could pose a threat to human health and the environment. Under current exposure scenarios, human and ecological receptors at the golf course could be exposed to contaminated surface water, sediment, surface soil, and subsurface soil through inhalation/respiration, incidental ingestion, dermal contact, bio-uptake/direct contact, and bioaccumulation. Although considered insignificant, exposure to contaminants in air through volatilization is also possible.

4.2 Conceptual Site Exposure Model

A CSEM shows the relationship between the contaminant source, the contaminant release and transport mechanisms, exposure media, and routes by which ecological receptors are potentially exposed. A CSEM of the ecological receptors expected to be present at the site was developed using information about the receptors' life cycle and habitats to determine whether complete exposure pathways exist.

A complete exposure pathway between a receptor and an impacted environmental medium is necessary for potential ecological risk to occur. A complete exposure pathway is a pathway that has:

- A source and mechanism for contaminant release to the environment
- An environmental transport medium for the contaminant
- A point of receptor contact (i.e., exposure point) with the contaminated medium or through the food web
- An exposure route to the receptor (ingestion, inhalation, and direct contact)

4.2.1 Potential Sources and Release Mechanisms

The CESM for ecological receptors at SWMU 73 is presented in Figure 4. The contaminant source is stormwater runoff discharged to the site from the surrounding golf course and residential and semi-industrial portions of the Base. The exposure setting is summarized in Section 3.0. The potential constituents and potential media of concern are described in Sections 4.1.1.1 and 4.1.1.2, respectively.

Both terrestrial and aquatic habitats are available at the site. Ponds and marginal areas around the ponds provide rare opportunities at Cannon AFB for riparian/aquatic communities to thrive. Conditions are not expected to change in the foreseeable future, so this CSEM represents current and future exposure pathways.

4.2.1.1 Contaminant Fate and Transport

Transport mechanisms for constituents from primary impacted media to secondary and tertiary impacted media are depicted in the CESM (Figure 4). Potential exposure media for the ecological model include the following:

- Volatiles in air
- Airborne particulates
- Surface soil and exposed sediment (0–2 ft bgs)
- Subsurface soil (2–10 ft bgs [maximum ecologically relevant depth])
- Submerged sediment
- Surface water
- Groundwater

4.2.1.2 Surface Soil/Exposed Sediment and Subsurface Soil

As shown in Figure 4, contamination present in surface soils/exposed sediment may be transported by wind, volatilization, surface water runoff, erosion, or infiltration and leaching to subsurface soil. The presence of vegetation may inhibit or reduce the transport of particles as wind-blown dust. Particulates or fugitive dust transported by wind might also be deposited on surface water in the pond or dispersed to other areas. Low precipitation rates in this semi-arid climate limit opportunities for surface water erosion, runoff, and leaching of constituents in soil as mechanisms for transport. Geochemical processes such as adsorption, precipitation, and attenuation may modify the concentration of chemicals in percolating leachate through the underlying vadose zone.

4.2.1.3 Surface Water

The pond is recharged by stormwater flows entering the site via overland flow from the golf course and through culverts from the Base. Precipitation may act to dilute chemical concentrations in the pond, but evaporation would have the effect of increasing chemical concentrations. Given the climatic conditions neither process is expected to contribute significantly to changing chemical concentrations in the pond.

4.2.1.4 Submerged Sediment

Sediments are substrate materials that are permanently or usually covered by surface water. Depending on the balance of groundwater recharge and evaporation, marginal sediments along the edge of the pond may become exposed and dry to become soils, or these soils may be inundated

over time and be considered sediments. Exposed sediments are treated like surface soil in this evaluation. As noted in Figure 4, chemicals within the surface waters and sediments of the pond may partition between these two media. Contaminants in the sediments of the pond may also leach into the vadose zone and impact subsurface soil.

4.2.1.5 Groundwater and Air

Groundwater occurs at approximately 315 ft bgs beneath the site, well below the ecologically relevant depths of 0–5 ft bgs for non-burrowing receptors and 0–10 ft bgs for burrowing receptors and plants determined by NMED risk assessment guidance (NMED 2012b). Exposures from direct contact and ingestion of chemicals that have leached from subsurface soil to groundwater and from volatilization of groundwater are not complete pathways at SWMU 73. In addition, groundwater does not discharge to surface water or to the ground surface where plants and animals could be exposed.

Concentrations of volatile chemicals in surface water or exposed sediment/surface soil are not anticipated to be present in meaningful concentrations for risk. For this reason, inhalation of vapors is considered an incomplete pathway, and inhalation of chemicals associated with airborne particulates is a potentially complete but insignificant exposure route for ecological receptors at SWMU 73.

4.2.2 Potentially Complete Exposure Routes

This section describes in general terms the potential routes of exposure of plants and animals to contaminants at the site:

- Respiration/inhalation
- Dermal contact/uptake
- Ingestion
- Trophic transfer

Exposures of various tropic levels to contaminants in site media and resulting exposures through the food chain may lead to multiple groups of receptors. As shown in Figure 4, complete exposure routes at SWMU 73 may impact both terrestrial and aquatic receptors.

4.2.2.1 Respiration/Inhalation

Respiration is a potentially complete pathway for terrestrial invertebrates by passive exchange of air and for vertebrates by inhaling airborne particulates or volatilized chemicals. However, inhalation of volatiles in air is not considered a complete exposure pathway. Inhalation of chemicals associated with airborne particulates is a potentially complete but insignificant exposure route for ecological receptors in SWMU 73.

4.2.2.2 Dermal Contact/Uptake

Plants can accumulate chemicals through direct deposition of airborne particulates on their absorptive surfaces (e.g., leaves) and through uptake from the soil via their roots. However, the majority of chemical uptake by a plant is through its root system. The potential for chemicals to accumulate in plants is influenced by the specific properties of the chemical, the soil physical/chemical properties, and biophysical properties of the plant. Dermal exposure is considered

complete for terrestrial plants in surface soil/exposed sediment and subsurface soil, and for aquatic plants in surface water and submerged sediments.

Many animals are equipped with protective outer coverings that reduce or prevent the absorption of chemicals, and so dermal exposure is usually a less important pathway than oral ingestion in accounting for exposure to contaminants. Species that have little natural protection and spend long periods in soil (such as earthworms) are likely to be more exposed. The dermal exposure route is potentially complete for ground-dwelling animals such as earthworms and burrowing animals that live mostly within the soil. However, the significance of the dermal exposure route for most terrestrial receptors depends on whether concentrations of chemicals that have a high potential for dermal uptake or dermal toxicity are present at elevated levels. Dermal exposure to airborne particulates is not a complete pathway for either terrestrial or aquatic animals. Dermal contact with formerly airborne particulates is expected to occur primarily via contact with surface soil or surface water onto which particulates have settled and is addressed in exposure routes associated with those media. Dermal exposure to surface water (and submerged sediment) is expected to be limited to those receptors that are aquatic and live within the pond waters for at least part of their life cycle, such as benthic invertebrates and amphibians, and those that spend a significant amount of time on or in the surface water of the pond, such as ducks and other water fowl. Dermal exposure for receptors visiting the pond to drink, such as various species of mammals, is not expected to be a significant pathway of exposure.

4.2.2.3 Direct Ingestion

Direct ingestion of chemicals and absorption via the alimentary canal is an important route of exposure for biota. Invertebrates can ingest soil and sediment directly while burrowing or foraging; benthic invertebrates may also be exposed to contaminants in surface water through ingestion. Mammals and birds can ingest soil and sediment directly while foraging and cleaning their fur or feathers. While some terrestrial receptors (e.g., jackrabbits and shrews) derive much of their water through their diet, others, such as deer and coyotes, may regularly seek out surface water to drink and therefore may be exposed to chemicals in the surface water medium. The surface water of the pond provides a potentially complete pathway of exposure via ingestion to receptors that seek out surface water for drinking.

4.2.2.4 Trophic Transfer

Trophic transfer refers to chemical exposure via consumption of other plants or animals. Any animal that eats another plant or animal that contains chemicals of concern in turn may be exposed to those chemicals of concern. For example, contaminants in surface soil/exposed sediments at SWMU 73 could be released to subsurface soil through leaching and have potential to move through the food chain. An earthworm is exposed to the contaminants in the soil (biotic uptake). A deer mouse is exposed to the contaminants by eating the earthworm (biotic uptake). Finally, a burrowing owl is exposed to the contaminants by eating the deer mouse (biotic uptake). The extent to which trophic transfer occurs depends on exposure of lower trophic level plants or prey to chemicals of concern, their ability to bioaccumulate those chemicals, the extent to which those chemicals are partitioned in their tissues, and which parts are eaten by the higher trophic level consumer. Trophic transfer may be of particular importance for bioaccumulative chemicals like PCBs or DDT that are not readily metabolized or eliminated and may biomagnify in higher trophic level consumers.

The receptors of interest in the CSEM (Figure 4) are from a variety of trophic guilds and trophic levels. Exposure to airborne particulates via trophic transfer is considered a potentially complete but insignificant pathway for all receptors, because direct contact of airborne particulates with vegetation and inhalation exposure routes from airborne particulates to potential prey for this medium are considered insignificant pathways.

4.2.2.5 Potential Ecological Receptors

This section identifies potential receptors and potential exposure pathways for current and reasonably anticipated future use scenarios considered in the preliminary model. Potential receptors considered in the preliminary CSEM include:

- Plants (terrestrial and aquatic)
- Invertebrates (benthic and terrestrial)
- Amphibians
- Mammals
- Waterfowl

The CSEM (Figure 4) uses known or expected ecological relationships of flora and fauna at the site to present a suite of potential receptors that represent the various trophic guilds within the biological communities and that have the potential to be exposed to chemicals of concern at the site by the described pathways. The information about potential receptors that may occur in the vicinity of SWMU 73 was taken from the Screening Level Ecological Risk Assessment performed for SWMU 101, the sewage lagoons (Foster Wheeler Environmental Corporation 2001).

This section discusses the receptors chosen to represent trophic guilds of the biological communities of SWMU 73 and the exposure pathways relevant to each guild. Terrestrial animal receptors are expected to be concentrated around habitats and media that provide forage and cover, including surface water and the vegetation of the pond's marginal areas. Aquatic receptors, including aquatic plants, benthic invertebrates, and a variety of waterfowl, have been documented at playa lakes in New Mexico and may be expected to be primarily associated with surface waters of the pond.

4.2.2.6 Plants

The climate of the Base area is semi-arid. The thin layer of topsoil in the vicinity of Cannon AFB is sandy loam, which is highly susceptible to wind erosion, and in many locations supports only sparse vegetation. The undisturbed natural vegetation is mostly shortgrass prairie. Dominant native grasses of the Plains-Mesa Grassland include blue grama and buffalo grass. Other terrestrial grasses may include three-awn, black grama, bluestem, six-weeks grama, and windmill grass. Forbs and small shrubs may include red globemallow, curly cup gumweed, spiny goldenweed, coneflowers, rabbitbrush, broom snakeweed, and honey mesquite. Aquatic plants include rooted (e.g., cattails around the pond margins) and floating (e.g., green algae) vegetation. Forbs and grasses have relatively shallow root systems and are consumed by many animals of the plains. Woody plants such as sagebrush and rabbitbrush tend to have deeper root systems and are not as palatable to ecological consumers.

Under current conditions, aquatic plants may be exposed to contamination through the following potentially complete pathways:

- Dermal contact with airborne particulates, submerged sediment, and surface water

Terrestrial forbs at the site are potentially exposed to contamination through the following potentially complete pathways:

- Dermal contact with airborne particulates
- Dermal contact with and uptake from surface soil/exposed sediment

Because of their deeper root systems, woody plants may be exposed to contamination through the following potentially complete pathways:

- Dermal contact with airborne particulates
- Dermal contact with and uptake from surface soil/exposed sediment and subsurface soil

4.2.2.7 Invertebrates

Benthic invertebrates spend part or all of their life cycle in an aquatic environment, and include true bugs, beetles, dragonflies, mayflies, midges, and mosquitoes. Complete exposure pathways for benthic invertebrates include the following at SWMU 73:

- Direct contact with sediment and surface water
- Ingestion of sediment and surface water
- Trophic transfer by consuming vegetation or prey that may have been exposed via sediment and surface water

Terrestrial invertebrates are considered as two categories characterized by their life cycle patterns. Epifauna include grasshoppers, many spiders, and true flies that spend their life cycle aboveground. Infauna, by contrast, live part or all of their life cycle underground. Examples include some spiders and ants.

Epifaunal invertebrates may be exposed to contamination at SWMU 73 via the following potentially complete exposure pathways:

- Inhalation of airborne particulates
- Direct contact with surface soil/exposed sediment
- Incidental ingestion of surface soil/exposed sediment while consuming food
- Trophic transfers by consuming vegetation or prey that may have been exposed via airborne particulates, surface soil/exposed sediment, and subsurface soil. Trophic transfer from subsurface soil is considered a potentially complete but insignificant pathway because these pathways would be restricted to ingestion of woody plant material.

In faunal invertebrates may be exposed to contamination at the site through the following potentially complete exposure pathways:

- Inhalation of airborne particulates
- Direct contact with surface soil/exposed sediment and subsurface soil
- Incidental ingestion of surface soil/exposed sediment and subsurface soil while consuming food
- Trophic transfers by consuming vegetation or prey that may have been exposed via airborne particulates, surface soil/exposed sediment, and subsurface soil.

4.2.2.8 Vertebrates

A wide variety of animals inhabit the Plains-Mesa Grasslands community. Amphibians, waterfowl, and mammals were selected as potential vertebrate receptors. Amphibian's species are typically associated with riparian habitats and playa lakes. Species that may occur at SWMU 73 include plains leopard frog, Great Plains toad, green toad, red-spotted toad, and spade foot toads. Common reptiles include yellow-mud turtle, Texas horned lizard, round-tailed horned lizard, Great Plains skink, Texas blind snake, and plains black-headed snake.

Birds of the Plains-Mesa Grasslands include raptors, which are relatively abundant in all habitats, and a variety of seed-eating sparrows and other ground-dwelling birds as residents and migrants. Insectivorous and tree-nesting species are most abundant in riparian areas. Shorebirds and water birds and migratory waterfowl use the rivers, playa lakes, and reservoirs of the region.

Trophic relationships among species can provide insight into many ecological processes; typical small mammals include desert shrew, desert cottontail, black-tailed prairie dog, pocket gopher, pocket mouse, and wood rats. Larger mammals include American pronghorn, badger, coyote, and swift fox.

Waterfowl may be exposed to contamination at the site through the following potentially complete exposure pathways:

- Inhalation of airborne particulates
- Direct contact with surface soil/exposed sediment, surface water, and submerged sediment
- Incidental ingestion of surface soil/exposed sediment, surface water, and submerged sediment while consuming food
- Trophic transfers by consumption of vegetation or prey that may have been exposed via airborne particulates, surface soil/exposed sediment, and submerged sediment.

The jackrabbit was chosen as a representative of primary consumer/browser. The jackrabbit may be exposed to contamination at the site through the following potentially complete exposure pathways

- Inhalation of airborne particulates
- Direct contact with surface water and surface soil/exposed sediment

- Incidental ingestion of surface soil/exposed sediment and surface water while consuming food
- Trophic transfers by consuming vegetation or prey that may have been exposed via airborne particulates, surface soil/exposed sediment, subsurface soil, and surface water.

Amphibians such as toads and frogs may be exposed to contamination at the site through the following potentially complete exposure pathways:

- Inhalation of airborne particulates
- Direct contact with surface water, submerged sediment, and surface soil
- Incidental ingestion of surface soil/exposed sediment, surface water, and submerged sediment while consuming food
- Trophic transfers by consuming vegetation or prey that may have been exposed via airborne particulates, surface soil/exposed sediment, submerged sediments, and surface water.

4.2.3 Data Gaps

The preliminary CSM and CSEM for SWMU 73 were prepared with minimal specific input because the project site has not been investigated. However, no known wastes or contaminants have been released to site media at SWMU 73. To address the chemical data gap, potential releases will be evaluated by assessing the horizontal and vertical extent of contamination in exposed sediment, surface soil, and subsurface soil. The presence of sediment and soil contamination at SWMU 73 will be evaluated by collecting samples from hollow-stem auger borings to delineate the horizontal and vertical extent of contaminants in site media. To be considered a release, the assessment must demonstrate that detected constituents are related to operations at the SWMU based on knowledge of the pollutant migration pathways. The preliminary human health CSM and ecological CSEM will be updated based on the findings from the RFA.

In addition to the field investigation, other nonchemical data gaps have been identified for the project site. The following data gaps will be addressed to complete the site characterization and refine the CSM and CSEM.

- *Historical Features*—Gather information about surrounding land use and potential off-site historic source areas, including upgradient areas of the Base identified as residential/semi-industrial. This data will help determine what constituents might be present in stormwater runoff controlled at the site.
- *Physical Characteristics*—Document past and current boundaries of potential release areas and identify site features associated with stormwater management. Several factors must be known to characterize a release to sediment or soil. Soil characteristics and other environmental factors include 1) surface features such as topography, erosion potential, land-use capability, and vegetation type and density; 2) stratigraphic/hydrologic features such as soil profile, particle size distribution, hydraulic conductivity, pH, porosity, and action exchange capacity; and 3) meteorological factors such as temperature, precipitation, runoff,

and evapotranspiration. Relevant soil physical and chemical properties should be measured and related to waste properties to determine the potential mobility of the contaminants in the soil.

- *Current Site Use*—Confirm the current site use and describe the site features including ground cover, underground utilities, and grading structures that could affect potential pathways. The description should include surrounding land use, groundwater use, and discussion of off-site source areas. Institutional controls (fencing, access restrictions), current zoning, and reasonably anticipated future zoning should be considered.

- *Ecological Habitat Evaluation*—Perform a preliminary site reconnaissance to assess the presence and condition of potential terrestrial and aquatic ecological habitats. Determine whether any part of the study area is used for habitat, forging areas, or refuge for a protected species. For soil, two soil intervals should be evaluated: for non-burrowing receptors, the soil interval to be considered is between 0 and 5 ft bgs, and for all burrowing receptors and plants, the soil interval to be evaluated is 0–10 ft bgs. NMED has developed a checklist that can be used to collect data for the CSEM (NMED 2012b). This assessment will be used to refine the ecological receptors and evaluate exposure pathways.

- *Topographic and Surface Water Features*—Obtain the most current topographic map and aerial images to document surface water-related features such as low areas and drainage pathways and areas where stormwater runoff may at times be uncontrolled.

- *Geological conditions*—Determine the range and variability of values for soil properties and parameters to more accurately predict the mobility of contaminants in soil. The number of cores necessary to characterize site soils depends on the site's geological complexity and size, the potential areal extent of the release, and the importance of defining small-scale discontinuities in surficial materials. Five borings are planned for the field investigation. U.S. Department of Agriculture county soil surveys may be obtained for most areas, but existing information on regional soil types is suitable for initial planning purposes only. The Unified Soil Classification System (USCS) procedure that will be used to identify material in the soil boring logs is adequate for descriptive purposes and for qualitative estimates of the fluid transport properties of soil layers.

  Chemical and physical measurements should be made for each distinct soil layer, or boundary between layers, that may be affected by a release. During drilling, the Field Geologist should note on the drilling log the depths of soil horizons, soil types and textures, and the presence of joints, channels, and zones containing plant roots or animal burrows. Soil variability, if apparent, should generally be accounted for by increasing the number of sample points for measurement of soil chemical and physical properties.

5. PROJECT ORGANIZATION

A team consisting of Tetra Tech, AFCEE, and Cannon AFB will manage implementation of the task order. NMED will provide regulatory support and oversight. The Tetra Tech project team includes corporate, managerial, and technical positions to ensure compliance with the applicable quality requirements, overall project safety, the safety and health of workers under its direction, and performance of field activities according to the work plan, regulatory requirements, and this contract.

This section identifies key personnel and their roles in the field investigation phase of the project. The project organization is further detailed in the site-specific UFP-QAPP (Appendix A). The project organizational chart is provided in Figure 5 and Worksheet #5. Worksheet #7 summarizes the roles, responsibilities, and authorities of key organizations and personnel on this project. Worksheet #6 of the UFP-QAPP summarizes communication pathways.

5.1 Project Manager

Ms. Carol Rieger, PMP, is the Tetra Tech Project Manager for this project. The Project Manager is responsible for ensuring the investigation is performed in a safe, efficient, and cost-effective manner, and is compliant with applicable regulatory and contract requirements. Ms. Rieger serves as the technical point of contact with the Cannon AFB Restoration Program Manager (RPM) and AFCEE Contracting Officer (CO) and Contracting Officer's Representative (COR).

5.2 Field Operations Leader/Field Geologist

Mr. Richard Buckmaster is the Field Operations Leader responsible for daily execution of work at the site. He will oversee the field work and coordinate and supervise the on-site drilling and sampling activities. He will also act as the Field Geologist and Environmental Safety Supervisor. The Field Operations Leader reports to the Tetra Tech Project Manager and will directly supervise subcontractors performing field work at all times. Tetra Tech is responsible for the work performed by all subcontractors under its supervision.

5.3 Field Investigation Support

Tetra Tech will execute the field program at SWMU 73 under the direction of the Field Operations Leader. This individual will coordinate, mobilize, and demobilize equipment and personnel and ensure that all soil borings are advanced, logged, sampled, and abandoned in accordance with field SOPs (Section 8.0). Samples will be collected, packaged, documented, and shipped to the off-site analytical laboratory by qualified personnel in accordance with Section 9.0 and field SOPs. The Field Operations Leader will ensure that field documentation is complete and accurate, decontamination procedures are implemented in accordance with the SOPs, and the site is restored to its original condition.

All field activities will be carried out in accordance with the HSP (Appendix C). Tetra Tech personnel and subcontractors are required to have current hazardous waste training as defined by Title 29, Code of Federal Regulations (CFR), Section 1910.120.

Other project staff, including the Project QA Officer, Project Chemist/Database Manager, and Data Validator, will ensure that work is implemented in accordance with the contract, DoD QSM version 4.2 (2010), SOPs, and UFP-QAPP requirements. Detailed descriptions of these positions, including responsibilities and authorities, are provided in the UFP-QAPP Worksheet #7 (Appendix A).

5.4 Subcontractors

5.4.1 Subcontract Laboratory

TestAmerica Laboratories, Inc., Arvada, Colorado (TestAmerica Denver) will provide all analytical services (including labor, equipment, and materials) required to complete the investigation. TestAmerica Denver is compliant with DoD QSM version 4.2 (2010) and holds a current DoD ELAP accreditation for all appropriate analytical methods.

The TestAmerica Denver Laboratory Project Manager will review all data packages prior to reporting. In addition, the Laboratory QA Officer performs periodic reviews of all QC procedures to ensure compliance with EPA, National Environmental Laboratory Accreditation Conference (NELAC), and DoD QSM requirements.

5.4.2 Subcontract Drilling Services

Geomechanics Southwest, Inc. (GSI), Albuquerque, New Mexico, will provide drilling services for the project. GSI has extensive experience in environmental and geotechnical site investigations and is licensed with the New Mexico Office of the State Engineer. The drilling subcontractor will mobilize one hollow-stem auger rig to the site with a two-man crew and all necessary materials, tools, and equipment to complete five borings. The hollow-stem auger drilling rig will be capable of continuous core collection required for sampling. The subcontractor technical contact will coordinate drilling activities with the Tetra Tech Field Operations Leader.

6. PROJECT IMPLEMENTATION PLAN/SCOPE OF WORK

The Project Implementation Plan outlines the DQOs, site access and coordination of work, and scope of activities to conduct the RFA at SWMU 73. Field investigations will be conducted to obtain data to sufficiently identify and characterize potential contamination in site soils and sediment related to stormwater management. The Project Implementation Plan was prepared to ensure the following:

- DQOs specified for this project are met.
- Field sampling protocols are documented and reviewed in a consistent manner.
- Data collected are of known quality, technically accurate, and scientifically valid and defensible.
- All project activities will be performed in compliance with state and federal regulations. Detailed SOPs for all tasks necessary to complete field investigations are provided in Section 8.0 and referenced in the UFP-QAPP Worksheet #21 (Appendix A).

6.1 Data Quality Objectives

Implementation of the RFA will require successful completion of the field investigation scope of work. This plan will address the sampling approach and protocol, sample locations, depth of samples, sampling methods, analytical parameters, logging requirements, field procedures, and field and sample documentation that will be implemented to ensure that results meet the DQOs. The DQOs are designed to ensure data of adequate quality and quantity are collected to support project decisions. The DQOs described in this section are documented in UFP-QAPP Worksheet #11 (Appendix A) and comply with the UFP-QAPP and EPA QA/G4, Guidance on Systematic Planning Using the Data Quality Objective Process (2006). Minimum QA/QC requirements identified by the current version of the DoD QSM version 4.2 (2010) are incorporated in the UFP-QAPP.

6.1.1 Problem Statement

Cannon AFB is interested in investigating whether stormwater flows have released contamination to surface soil, sediment, and subsurface soil at SWMU 73. The site is administered under the Base's Environmental Restoration Program (ERP) and requires assessment to be considered for no further action status and removal from Cannon AFB's HSWA permit. The site has never been investigated and the nature, extent, and magnitude of contamination in sediment, surface soil, and subsurface soil, if present, and potential risks to sensitive resources are unknown. Soil and sediment sampled from 0 to 25 ft bgs will be analyzed for VOCs, SVOCs, PAHs, TPH-GRO, TPH-DRO, chlorinated pesticides, PCBs, glycols, explosives, anions, and TAL metals. The problem definition statement for the investigation is presented in UFP-QAPP Worksheet #10 (Appendix A).

6.1.2 Decision Statement

The RFA will involve collecting environmental data to characterize the site and develop, evaluate, and select appropriate response alternatives or provide recommendations for future action leading to

site closure. Tetra Tech will evaluate site data to make decisions based on the following decision statements:

- Is sediment and soil chemical data adequate to characterize the nature and extent of potential contamination at the site?
- Are chemical constituents present in sediment, surface soil, and subsurface soil at concentrations above the method detection limits (MDLs)?
- Can COPCs potentially related to site activities be identified (detected anthropogenic [organic] compounds, inorganic constituents exceeding established background levels, and inorganic constituents for which background levels have not been established)?
- Do COPC concentrations in sediment, surface soil, and subsurface soil exceed NMED SSLs or EPA regional screening levels (RSLs), thereby requiring further action?

6.1.3 Decision Inputs

Data required to address the decision statements may include the site environmental setting and physical and chemical characteristics of sediment, surface soil, and subsurface soil. The following data and information will be used as the basis for making the decisions identified in Section 6.1.2: sediment, surface soil, and subsurface soil chemical data; photoionization detector (PID) screening data, bore log description; CSM and CSEM; and maps/aerial imagery.

All chemical data collected and evaluated during the assessment will be compared to MDLs, background concentrations established for Cannon AFB, and applicable state and federal screening levels. Metals concentrations established for Cannon AFB are presented in *Naturally Occurring Concentrations of Inorganics and Background Concentrations of Pesticides at Cannon Air Force Base, New Mexico* (Cannon AFB 1997). The 95 percent upper tolerance limits (UTLs) from the background study will be used for the comparison. Screening levels are based on NMED residential and industrial SSLs (NMED 2012a,b). Analytes that have no established NMED SSL will be compared to EPA residential and industrial residential RSLs (EPA 2011). Specific decision inputs for this RFA are included in Table 1. Table 2 (presented at the end of this section) provides the list of individual constituents that will be analyzed in sediment, surface soil, and subsurface soil, along with MDLs, NMED SSLs, and EPA RSLs.

6.1.4 Study Boundary

The SWMU 73 boundary defines the horizontal study boundary for the site. The primary area of investigation will be downgradient, upland media most likely to be impacted from exposure to pollutants in stormwater runoff. The area upgradient of the SWMU will also be investigated to document upgradient soil conditions. The vertical boundary for the RFA is subsurface soil to a depth of 25 ft bgs. Hollow-stem auger drilling methods will be used to advance and sample soil borings. The project will be conducted according to the timeline defined in the project schedule (Section 6.2). Field activities are anticipated to begin in late spring/summer and last 3 days.

Table 1. Decision Inputs: Data Collection, Data Parameters, and Data Uses

Resource Materials	Data Parameters	Data Uses
Sediment and Soil Samples	Definitive chemical data: VOCs, SVOCs, PAHs, TPH-GRO, TPH-DRO, chlorinated pesticides, PCBs, glycols, explosives, anions, and TAL metals	• Identify nature and extent (lateral and vertical) of contamination in sediment, surface soil, and subsurface soil. • Compare contaminant concentrations to detection limits, background concentrations, and risk-based SSLs to determine whether contaminant concentrations exceed MDLs, NMED SSLs, EPA RSLs, and/or background levels established for the Base and require further action. • Support the development, evaluation, and selection of the appropriate response alternatives for the site, including recommendations for future action leading to site closure and removal from the Base's HSWA permit. • Update preliminary CSM and CSEM.
Soil cuttings	Screening data: PID	• Select potential sample intervals based on PID readings/headspace analysis.
Borelog	Soil/lithology	• Describe subsurface lithology at five locations to a depth of 25 ft bgs according to USCS, color, consistency, soil moisture, grain size, and size distribution.
Conceptual Site Models	Human health and ecological site models	• Document environmental conditions and potential for release to site media resulting from past and present stormwater management activities. • Define possible contaminated media, potential routes of contamination migration, exposure pathways, receptors, and potential impacts to receptors.
Environmental Setting	Non-chemical data: maps, aerial imagery, GPS	• Optimize location of the borings based on soil type, site drainage patterns, visual indication of previous stormwater flows, surface water features, topography, utilities/possible obstructions, and man-made features associated with the golf course. • Document locations of soil borings/samples.

6.1.5 Decision Rule

If the chemical data generated as a result of the RFA field investigation are not adequate to characterize the nature and extent of contamination at the site, then further action will be considered (e.g., additional sampling).

If the dataset is adequate to characterize the nature and extent of contamination at the site then sediment/soil results will be compared to MDLs, background concentrations, NMED SSLs, and EPA RSLs. The first step is to identify preliminary COPCs, or those constituents detected at concentrations above the MDLs. The second step is to identify detected COPCs in soil and sediment potentially related to site activities (i.e., organic compounds, naturally occurring inorganic constituents exceeding background levels, and inorganic constituents for which no background concentrations have been established). If no constituents are detected above the MDLs or detected constituents are metals at concentrations below established background levels, then no further action is required and the site will be recommended for closure.

Organic compounds, naturally occurring inorganic constituents that exceed background, and inorganic constituents with no established background level will be carried through the process to identify COPCs that exceed NMED residential and industrial SSLs or EPA RSLs. If COPCs in

sediment, surface soil, or subsurface soil exceed background and soil screening criteria, then further action will be considered for the site. If detected COPC concentrations are less than the soil screening criteria then no further action is required and the site will be recommended for closure.

6.2 Project Planning Chart—Project Schedule

Field work and project implementation for the RFA at SWMU 73 will follow the Project Planning Chart (project schedule) presented in Figure 6. The schedule will be updated monthly in the Contractor's Progress, Status, and Management Report (CPSMR).

6.3 Site Access and Coordination of Work

Cannon AFB maintains responsibility for all Base access and security measures required to gain access to the Base. The Cannon AFB RPM or designee will coordinate work site activities with Golf Course Facility Management, Base Security, and the Tetra Tech Field Team Leader. Access must be arranged to enter and work at the site because the study area is on an active golf course. Work will be planned and performed to minimize disruption to golf course operations and ensure the health and safety of the field team, golf course maintenance workers and groundskeepers, security personnel, and members of the public. Care will be taken to prevent damage to the environment, property, utilities, materials, supplies, and equipment.

6.4 Scope of Field Activities

Field activities will be implemented as outlined in the project schedule (Figure 6). Detailed descriptions and field procedures to be followed during each activity are presented in subsequent sections of this Work Plan.

Field activities for the RFA at SWMU 73 consist of the following:

- Project Kick-off Meeting
- Site Preparation/Dig Permit
- Mobilization
- Drilling
- Logging
- Soil and sediment sample collection
- Headspace analysis using a PID
- Decontamination
- Laboratory analysis
- IDW management
- Borehole abandonment
- Demobilization
- Site restoration

6.4.1 Field Kick-off Meeting

Before the start of field work, a field implementation kickoff meeting will be held at Cannon AFB. Invitees will include representatives from Cannon AFB, AFCEE, and Tetra Tech. The meeting will outline roles and responsibilities of all participants; review scope, schedule, access, planned field activities, and procedures; review handling of IDW and health and safety requirements; discuss contract issues and communication; and outline Cannon AFB rules and security requirements.

During the field implementation kickoff meeting, a list of critical contacts within the field team, Cannon AFB, AFCEE, and NMED will be compiled. This contact list will be used should immediate input be needed to resolve issues critically impacting field work. With concurrence from the Cannon AFB RPM, the Tetra Tech Project Manager will arrange to contact Golf Course Facility Managers, Base Security, and other affected departments to notify them of planned work and the anticipated schedule. Tetra Tech will prepare presentation materials, agendas, and minutes for meetings, if requested.

6.4.2 Site Preparation/Dig Permit

Site preparation activities include preparing plans, obtaining necessary Base permits and approvals, gaining access permissions, and procuring materials and equipment. Cannon AFB will coordinate work site activities with Golf Course Facility Management, Base Security, and the Tetra Tech Field Operations Leader to arrange for access to the site, ensure protection of human health and the environment, and prevent damage to property, utilities, materials, supplies, and equipment. The project will minimize disruption to golf course operations and avoid disruptions to the field schedule. Tetra Tech will ensure physical security of the work area with security equipment and personnel. The field crew will prepare a secure area for temporary storage and a field work support area based on locations selected during the pre-work meeting. A temporary decontamination pad/area will be set up by the drilling company at a location designated by Cannon AFB with a water supply.

Before intrusive work begins a dig permit needs to be completed and approved by the Chief of Operations or Chief of Engineering and Environmental Planning at the Base in accordance with Cannon AFB requirements. The work clearance request is processed just prior to the start of work and is valid for 30 days. The type of information that must accompany this permit includes location, contract number, type of facility, location of utilities, whether the area has been staked, proposed boring locations, and clearance and termination dates. The proposed borehole locations and vicinity will be reviewed with Base representatives to expedite the permit process. The borehole locations, surface obstructions, location of utilities, access controls, drainage and grading features, surface water extent, configuration of golf course greens and fairways, and location of adjacent footpaths and roads will be considered to support issue of the permit and staking of borehole locations. The TtEC Field Operations Leader will contact a Base-approved utility locating service to mark the site in the presence of the subcontractor driller so that all field personnel are aware of underground utilities.

6.4.3 Mobilization

The field investigation will be conducted entirely within the SWMU 73 study area delineated on Figure 2. Given the brief duration of the required field activities, mobilization efforts and logistics for the field team and equipment will be limited. The Tetra Tech Field Operations Leader will coordinate site setup and mobilize equipment and the drilling subcontractor after the project area has been marked for utilities and boring locations are staked. Boreholes will be located a minimum of 10 ft from areas of standing water and access to each drilling site will be planned to minimize ground disturbance during placement of the truck-mounted drill rig.

The Field Operations Leader will review spill containment and prevention procedures with the drilling subcontractor and ensure appropriate controls and cleanup materials are in place before

drilling operations begin. The carrier truck, rig, and drilling equipment will be inspected to ensure no diesel fuel or hydraulic fluid leaks are present. Equipment to be mobilized includes a truck-mounted CME-75 rig equipped with 3-1/4 in by 6-5/8 in continuous flight hollow stem auger with a CME Continuous Sampling system; 55-gallon, 1A2 drums; self-contained decontamination trailer; split spoons and other sampling equipment; PID for field screening; global positioning system (GPS) unit; and support vehicles such as pickup trucks. An on-site field office is not required for the investigation. Work will not conducted during heavy rains to minimize the potential for impacts from runon and runoff. Based on conditions at the time, however, sandbags or hay bales may be used as temporary stormwater control measures.

Tetra Tech will ensure physical security of the work area with security equipment and personnel as required. The field crew will prepare a secure area for temporary storage and a field work support area based on locations selected during the pre-work meeting. A temporary decontamination pad will be set up by the drilling company in an area designated by Cannon AFB with a water supply. The site will be restored to its original condition following completion of the fieldwork.

6.4.4 Investigation Activities

6.4.4.1 Drilling

Five soil borings (SB-01 through SB-05) will be advanced to a depth of 25 ft bgs at the locations shown in Figure 2. The five soil borings will be advanced by a two-man team, furnished by the drilling subcontractor, using a hollow-stem auger drilling rig with continuous core collection required for sampling. This method supports sample collection, as well as observation and description of the soil column at each location to allow visual identification of soil staining, lithology changes, etc., and collection of field measurements with a PID. Drilling operations are described in Section 8.1. Soil will be logged by the Tetra Tech Field Geologist from the core collected during drilling as described in Section 8.2.

6.4.4.2 Logging

Soil at the site will be classified according to the USCS procedure described in Section 8.2. This procedure classifies material based on field determination of the percentages of gravel, sand, and fines in the soil, and on the plasticity and compressibility of fine-grained soils. Each boring will be fully described on a boring log similar or equivalent to that shown in Figure B-1 (Appendix B) and in accordance with American Society for Testing and Materials (ASTM) D5434. These data will be used to document subsurface conditions and identify site soils and lithology from 0 to 25 ft bgs. The Field Geologist will log the boring as it is being drilled by recording relevant data on the appropriate boring log and in a bound field logbook. Boring log forms may be transcribed from a field logbook.

6.4.4.3 Soil and Sediment Sample Collection

Samples will be collected and analyzed to characterize the horizontal and vertical nature and extent of environmental impacts to sediment/surface soil and subsurface soil at SWMU 73. Five soil samples (plus the required number of QA/QC samples) will be collected from each soil boring for chemical analyses as described in Section 8.3.

6.4.4.4 Headspace Screening

As described in Section 8.3.5, soil samples will be field screened for VOCs at the time of sample collection. Field screening will utilize a PID. Use, calibration, and maintenance of the PID are addressed in Section 11.0.

6.4.4.5 Decontamination

All drilling and sampling equipment that may directly or indirectly contact samples will be thoroughly decontaminated as described in Section 8.4. Drilling and sampling equipment will be decontaminated prior to and between borings and samples, respectively. Rinsate generated during decontamination procedures will be collected and contained in Department of Transportation (DOT)-approved 55-gallon 1A2 drums.

6.4.4.6 Sample Analysis

The proposed sampling and analysis program consists of 25 environmental soil samples plus 2 field duplicate and 2 matrix spike/matric spike duplicate (MS/MSD) samples. Two rinse blanks and two trip blanks (VOCs only) will also be collected. TestAmerica Denver will prepare and analyze the samples in compliance with DoD QSM version 4.2 (2010). Samples will be analyzed for VOCs (EPA 8260B), SVOCs (EPA 8270C), PAHs (EPA 8270C selective ion monitoring [SIM]), TAL metals (EPA 6010C/6020A), mercury (EPA 7471B), PCBs (EPA 8082A), pesticides (EPA 8081B), explosives (EPA 8330B), TPH-GRO (EPA 8015C), TPH-DRO (EPA 8015C), major anions (EPA 9056A), and glycols (EPA 8015C).

The sampling locations, associated analytical methods, and QC samples for the field investigation are summarized in Sections 7.0 and 8.0 and UFP-QAPP Worksheets #18 and #20 (Appendix A). The specific analytical parameters for the methods are summarized in UFP-QAPP Worksheet #15. Sample identification (ID), handling, custody, and recordkeeping will follow the requirements presented in Sections 7.0, 9.0, and 10.0 of the Work Plan and UFP-QAPP Worksheets #26 and #27. The chemical data will be reviewed, verified, and validated to ensure data meet DQOs as specified in Worksheets #34 through #37 and Sections 12.0 and 13.0.

6.4.4.7 Investigation-Derived Waste Management

Tetra Tech shall containerize, stage, characterize, and properly dispose of all IDW generated during the RFA according to the procedures described in Section 8.5. Based on site history and land use, Tetra Tech assumes that the IDW will not be RCRA hazardous or explosive and will not contain contamination greater than NMED SSLs, thus allowing the soil to be disposed on the ground. No off-site disposal of IDW will be required.

6.4.4.8 Borehole Abandonment

All drilled borings will be abandoned in accordance with applicable state regulations. Cement-bentonite grout is preferred. Procedures for borehole abandonment are presented in Section 8.6.

6.4.5 Demobilization and Site Restoration

After completion of the work, all drilling equipment, vehicles, personnel, tools, and miscellaneous materials will be demobilized from the site. The work areas of the site, including each boring location, will be restored to original conditions. Efforts will be made to minimize impacts to work

sites and sampling locations, particularly those in or near sensitive environments. Following the completion of work at a site, all drums, trash, and other waste will be removed. Decontamination water will be transported to the designated locations specified by the Base.

6.4.6 Field Quality Control

Field QC will be performed under the direction of the Field Operations Leader. In accordance with the UFP-QAPP, limited-scope QC surveillances or desk audits will be conducted, and Field Change Requests (FCRs) and nonconformance notices (Appendix B) will be completed when discrepancies occur. In addition, a memorandum documenting each day's field activities will be completed and emailed to the Cannon AFB RPM and AFCEE COR.

6.4.7 Health and Safety

Health and safety activities will be conducted in accordance with the HSP and attached Activity Hazard Analyses (Appendix C). The Environmental Safety Supervisor will ensure implementation of these health and program and procedures, and all employees will be responsible for complying with these documents.

6.5 Scope of Characterization Activities

Some activities required to meet project objectives will be performed before the field operations begin or are part of the post-field operations evaluation and interpretation of results as follows:

- The first step of the RFA process involves gathering information that will be used to document the environmental conditions at the site. The preliminary review includes researching and summarizing the project setting background and history. This information forms the basis for developing the preliminary CSM and CSEM.

- Chemical results for exposed sediment and soil will be compared to human health-based SSLs as part of the evaluation process. Inorganic constituents exceeding established background concentrations, organic constituents, and inorganic constituents for which no background concentration exists will be compared to the constituent-specific NMED SSLs (NMED 2012a, b) or EPA RSLs (EPA 2011) listed in Table 2. Constituents exceeding the SSLs will be identified as COPCs.

- The dataset of validated chemical results will be used to characterize any releases to site sediment or soil and determine the nature and extent of contamination.

- The findings of the RFA will be used to develop, evaluate, and select appropriate responses for the site based on investigation findings.

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Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
VOCs (EPA 8260B)							
Toluene-d8 (Surr)	0.5	02	0.1	NA	NA	NA	NA
1,2-Dichloroethane-d4 (Surr)	0.5	0.25	0.5	NA	NA	NA	NA
4-Bromofluorobenzene (Surr)	0.5	0.25	0.5	NA	NA	NA	NA
Dibromofluoromethane (Surr)	0.5	0.25	0.5	NA	NA	NA	NA
1,1,1,2-Tetrachloroethane	5	1	0.56	2.91E+04	1.61E+05	c/c	NMED SSL
1,1,1-Trichloroethane	5	1	0.52	1.56E+07	7.89E+07	ns/ns	NMED SSL
1,2,3-Trichloropropane	5	1	0.81	4.97E+01	3.76E+04	c/c	NMED SSL
1,2,3-Trichlorobenzene	5	1	0.75	4.9E+04	4.9E+05	n/ns	EPA RSL
1,1-Dichloroethane	5	1	0.21	6.45E+04	3.59E+05	c/c	NMED SSL
1,2,4-Trichlorobenzene	5	1	0.73	7.30E+04	3.67E+05	n/ns	NMED SSL
1,2-Dibromo-3-Chloropropane	10	1	0.6	1.86E+03	1.08E+03	c/c	NMED SSL
1,1-Dichloropropene	5	1	0.54	--	--	--	--
1,1-Dichloroethene	5	1	0.59	4.49E+05	2.29E+06	n/ns	NMED SSL
1,1,2-Trichloroethane	5	1	0.88	2.81E+03	1.33E+04	n/c	NMED SSL
1,1,2,2-Tetrachloroethane	5	1	0.61	8.02E+03	4.35E+04	c/c	NMED SSL
1,2,4-Trimethylbenzene	5	1	0.58	6.2E+04	2.6E+05	n/ns	EPA RSL
1,2-Dichlorobenzene	5	1	0.45	2.31E+06	1.40E+07	ns/ns	NMED SSL
1,2-Dichloroethane	5	1	0.7	7.89E+03	4.35E+04	c/c	NMED SSL
1,3-Dichlorobenzene	5	1	0.48	--	--	--	--
1,3-Dichloropropane	5	1	0.51	1.6E+06	2.0E+07	ns/ns	EPA RSL
1,3,5-Trimethylbenzene	5	1	0.57	7.8E+05	1.0E+07	ns/ns	EPA RSL
2-Butanone (MEK)	20	10	1.83	3.71E+07	3.75E+08	n/nls	NMED SSL
1,4-Dichlorobenzene	5	1	0.78	3.17E+04	1.77E+05	c/c	NMED SSL
1,2-Dichloropropane	5	1	0.55	1.52E+04	8.44E+04	c/c	NMED SSL
2,2-Dichloropropane	5	1	0.44	--	--	--	--
2-Hexanone	20	10	4.89	2.1E+05	1.4E+06	n/n	EPA RSL
4-Methyl-2-pentanone (MIBK)	20	10	4.36	5.82E+06	7.38E+07	ns/ns	NMED SSL
4-Isopropyltoluene	5	1	0.49	--	--	--	--

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Continued)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
Benzene	5	1	0.47	1.54E+04	8.47E+04	c/c	NMED SSL
Acetone	20	10	5.38	6.66E+07	8.68E+08	n/nls	NMED SSL
Bromobenzene	5	1	0.49	3.0E+05	1.8E+06	n/ns	EPA RSL
Bromoform	5	1	0.23	6.16E+05	2.42E+06	c/c	NMED SSL
Bromomethane	10	1	0.5	1.65E+04	8.65E+04	n/n	NMED SSL
Carbon tetrachloride	5	1	0.63	1.08E+04	5.98E+04	c/c	NMED SSL
Carbon disulfide	5	1	0.42	1.53E+06	8.33E+06	ns/ns	NMED SSL
2-Chlorotoluene	5	1	0.51	1.56E+06	2.27E+07	ns/ns	NMED SSL
4-Chlorotoluene	5	1	0.78	1.6E+06	2.0E+07	ns/ns	EPA RSL
Chlorobenzene	5	1	0.54	3.76E+05	2.12E+06	ns/ns	NMED SSL
Chlorobromomethane	5	1	0.3	1.6E+05	6.8E+05	n/n	EPA RSL
Chlorodibromomethane	5	1	0.57	--	--	--	--
Chloroform	10	1	0.29	5.86E+03	3.27E+04	c/c	NMED SSL
Chloroethane	10	1	0.89	--	--	--	--
Chloromethane	10	1	0.77	2.75E+05	1.29E+06	n/cs	NMED SSL
cis-1,2-Dichloroethene	5	1	0.56	1.56E+05	2.27E+06	n/ns	NMED SSL
cis-1,3-Dichloropropene	5	2	1.29	--	--	--	--
Dibromomethane	5	1	0.84	5.16E+04	2.54+05	n/n	NMED SSL
Dichlorobromomethane	5	1	0.22	5.41E+03	3.01E+04	c/c	NMED SSL
Dichlorodifluoromethane	10	1	0.52	1.68E+05	7.98E+05	n/ns	NMED SSL
Ethylbenzene	5	1	0.67	6.84E+04	3.78E+05	c/cs	NMED SSL
Hexachlorobutadiene	5	1	0.55	6.11E+04	2.46E+05	n/c	NMED SSL
Isopropylbenzene	5	1	0.59	2.43E+06	1.45E+07	ns/ns	EPA RSL
Ethylene Dibromide	5	1	0.52	5.88E+02	3.22E+03	c/c	NMED SSL
Methylene Chloride	5	1	0.75	4.09E+05	4.70E+06	n/c	NMED SSL
Methyl tert-butyl ether	20	1	0.34	9.01E+05	4.89E+06	c/c	NMED SSL
m-Xylene & p-Xylene[3]	3.2	2	1.04	8.14E+05	3.98E+06	ns/ns	NMED SSL
Naphthalene	5	1	0.63	4.30E+04	2.41E+05	c/c	NMED SSL
n-Butylbenzene	5	1	0.56	3.9E+06	5.1E+07	ns/ns	EPA RSL

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Continued)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
N-Propylbenzene	5	1	0.58	3.4E+06	2.1E+07	ns/ns	EPA RSL
o-Xylene	5	1	0.61	8.98E+05	4.41E+06	ns/ns	NMED SSL
Styrene	5	1	0.63	7.28E+06	5.00E+07	ns/ns	NMED SSL
sec-Butylbenzene	5	1	0.77	--	--	--	--
tert-Butylbenzene	5	1	0.5	--	--	--	--
trans-1,2-Dichloroethene	5	1	0.39	2.70E+05	1.44E+06	n/ns	NMED SSL
trans-1,3-Dichloropropene	5	1	0.67	--	--	--	--
Tetrachloroethene	5	1	0.59	7.02E+03	3.66E+04	c/c	NMED SSL
Toluene	5	1	0.69	5.27E+06	5.77E+07	ns/ns	NMED SSL
1,2-Dichloroethene, Total	5	1	0.39	--	--	--	--
Trichloroethene	5	1	0.23	8.77E+03	4.13E+04	n/c	NMED SSL
Trichlorofluoromethane	10	2	1.04	1.41E+06	6.94E+06	ns/ns	NMED SSL
Vinyl chloride	5	2	1.34	7.28E+02	2.61E+04	c/c	NMED SSL
TAL Metals (EPA 6020A)							
Antimony	200	40	14	3.13E+04	4.54E+05	n/n	NMED SSL
Arsenic	500	150	50.6	3.90E+03	1.77E+04	c/c	NMED SSL
Barium	250	200	70.5	1.56E+07	2.24E+08	n/nl	NMED SSL
Beryllium	100	65	22.5	1.56E+05	2.26E+06	n/n	NMED SSL
Cadmium	100	25	9.38	7.03E+04	8.97E+05	n/n	NMED SSL
Chromium	200	175	76	2.97E+03	6.31E+04	c/n	NMED SSL
Cobalt	100	18	6.63	2.3E+04	3.0E+05	n/n	EPA RSL
Copper	2500	200	71.1	3.13E+06	4.54E+07	n/n	NMED SSL
Lead	150	50	18.2	4.0E+05	8.0E+05	IEUBK/IEUBK	NMED SSL
Manganese	250	90	33	1.86E+06	2.67E+07	n/nl	NMED SSL
Nickel	350	75	25.3	1.56E+06	2.25E+07	n/n	NMED SSL
Selenium	500	250	133	3.91E+05	5.68E+06	n/n	NMED SSL
Silver	100	60	20.3	3.91E+05	5.68E+06	n/n	NMED SSL
Thallium	100	10	3.51	7.82E+02	1.14E+04	n/n	NMED SSL

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Continued)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
TAL Metals (EPA 6010C)							
Aluminum	50000	3000	1550	7.80E+07	1.13E+09	n/nl	NMED SSL
Calcium	100000	20000	14100	--	--	--	--
Iron	80000	5000	3800	5.48E+07	7.95E+08	n/nl	NMED SSL
Magnesium	30000	5000	3700	--	--	--	--
Potassium	300000	50000	41000	--	--	--	--
Sodium	500000	100000	59000	--	--	--	--
Mercury (EPA 7471B)							
Mercury	17	8.33	5.53	1.56E+04	7.36E+04	ns/ns	NMED SSL
TPH-GRO (EPA 8015C)							
a,a,a-Trifluorotoluene (Surr)	0.005	0.002	--	NA	NA	NA	NA
Gasoline Range Organics (GRO)-C6-C10	1.2	0.55	0.325	1.0E+03	3.0E+03	NA	NMED SSL
TPH-DRO (EPA 8015C)							
Diesel Range Organics [C10-C28]	4	2	0.678	1000	3.0D+03	--	NMED SSL
o-Terphenyl (Surr)	0.016	0.2	0.04	NA	NA	--	NA
SVOCs (EPA 8270C)							
Acenaphthene	330	17	10.3	3.44E+06	3.67E+07	n/n	NMED SSL
Acenaphthylene	330	33	17	--	--	--	--
Anthracene	330	33	17	1.72E+07	1.83E+08	n/nl	NMED SSL
Benzidine	4000	3960	990	5.01E+00	8.33E+01	c/c	NMED SSL
Benzo[a]anthracene	330	33	20	1.48E+03	2.34E+04	c/c	NMED SSL
Benzoic acid	1600	660	330	2.4E+08	2.5E+09	nl/nl	EPA RSL
Benzo[b]fluoranthene	330	33	26.2	1.48E+03	2.34E+04	c/c	NMED SSL
Benzo[k]fluoranthene	330	66	40	1.48E+04	2.34E+05	c/c	NMED SSL
Benzyl alcohol	330	33	10	6.1E+06	6.2E+07	n/n	EPA RSL
Bis(2-chloroethoxy)methane	330	66	23	1.8E+05	1.8E+06	n/n	EPA RSL
Bis(2-chloroethyl)ether	330	33	16.6	2.68E+03	1.42E+04	c/c	NMED SSL
4-Bromophenyl phenyl ether	330	33	19	--	--	--	--
Butyl benzyl phthalate	330	66	43	2.6E+05	9.1E+05	c/c	EPA RSL

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Continued)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
2,4-Dimethylphenol	330	130	66	1.22E+06	1.37E+07	n/n	NMED SSL
Dimethyl phthalate	330	33	23	6.11E+08	6.84E+09	nl/nl	NMED SSL
4,6-Dinitro-2-methylphenol	1600	660	330	4.9E+03	4.9E+04	n/n	EPA RSL
2,4-Dinitrophenol	1600	670	333	1.22E+05	1.37E+06	n/n	NMED SSL
2,4-Dinitrotoluene	330	130	66	1.57E+04	6.18E+04	c/c	NMED SSL
2,6-Dinitrotoluene	330	66	28	6.11E+04	6.84E+05	n/n	NMED SSL
Fluoranthene	330	66	36	2.29E+06	2.44E+07	n/n	NMED SSL
Fluorene	330	33	18	2.29E+06	2.44E+07	n/ns	NMED SSL
1,2-Diphenylhydrazine	330	33	22	6.08E+03	2.39E+04	c/c	NMED SSL
2-Fluorobiphenyl (Surr)	66	33	NA	NA	NA	NA	NA
2-Fluorophenol (Surr)	66	33	NA	NA	NA	NA	NA
Hexachlorobenzene	330	66	29	3.04E+03	1.2E+04	c/c	NMED SSL
Hexachlorobutadiene	330	66	10	6.11E+04	2.46E+05	n/c	NMED SSL
Hexachloroethane	330	33	21.3	4.28E+04	4.79E+05	n/n	NMED SSL
N-Nitrosodiphenylamine	330	33	21	9.93E+05	3.91E+06	c/c	NMED SSL
N-Nitrosodi-n-propylamine	330	66	31	6.9E+01	2.5E+02	c/c	EPA RSL
1,4-Dichlorobenzene	330	33	13.6	3.17E+04	1.77E+05	c/c	NMED SSL
2-Chloronaphthalene	330	33	10	6.26E+06	9.08E+07	ns/ns	NMED SSL
2-Chlorophenol	330	33	21	3.91E+05	5.68E+06	n/n	NMED SSL
4-Chlorophenyl phenyl ether	330	66	21	--	--	--	--
Chrysene	330	33	27	1.48E+05	2.34E+06	c/c	NMED SSL
Dibenz(a,h)anthracene	330	33	19	1.48E+02	2.34E+03	c/c	NMED SSL
Dibenzofuran	330	33	20	7.8E+04	1.0E+06	n/ns	EPA RSL
Benzo[g,h,i]perylene	330	33	16	--	--	--	--
Benzo[a]pyrene	330	33	20	1.48E+02	2.34E+03	c/c	NMED SSL
Di-n-butyl phthalate	330	33	29	6.11E+06	6.84E+07	n/n	NMED SSL
1,2-Dichlorobenzene	330	33	22	2.31E+06	1.40E+07	ns/ns	NMED SSL
1,3-Dichlorobenzene	330	33	12	--	--	--	--
3,3'-Dichlorobenzidine	1600	330	90	1.08E+04	4.26E+04	c/c	NMED SSL

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Continued)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
2,4-Dichlorophenol	330	66	10	1.83E+05	2.05E+06	n/n	NMED SSL
Diethyl phthalate	660	33	26	4.89E+07	5.47E+08	n/nl	NMED SSL
Indeno[1,2,3-cd]pyrene	330	33	22	1.48E+03	2.34E+04	c/c	NMED SSL
Isophorone	330	33	17	5.12E+06	1.37E+08	c/cs	NMED SSL
2-Methylnaphthalene	330	33	19	3.1E+05	4.1E+06	n/ns	EPA RSL
2-Methylphenol	330	33	13	3.1E+06	3.1E+07	n/n	EPA RSL
Naphthalene	330	66	31	4.30E+04	2.41E+05	c/c	NMED SSL
2-Nitroaniline	1600	66	50	6.1E+05	6.03+06	n/n	EPA RSL
3-Nitroaniline	1600	133	73	--	--	--	--
4-Nitroaniline	1600	130	72.5	2.4E+04	8.6E+04	c/c	EPA RSL
Nitrobenzene	330	33	22	5.35E+04	3.00E+05	c/c	NMED SSL
2-Nitrophenol	330	66	10	--	--	--	EPA RSL
4-Nitrophenol	1600	330	97	--	--	--	EPA RSL
Nitrobenzene-d5 (Surr)	66	33	--	NA	NA	NA	NA
Pyrene	400	33	12.1	1.72E+06	1.83E+07	n/n	NMED SSL
Pentachlorophenol	1600	670	330	8.94E+03	3.00E+04	c/c	NMED SSL
Phenanthrene	330	33	17	1.83E+06	2.05E+07	ns/n	NMED RSL
Terphenyl-d14 (Surr)	66	33	--	NA	NA	NA	NA
2,4,6-Tribromophenol (Surr)	66	33	--	NA	NA	NA	NA
1,2,4-Trichlorobenzene	330	33	28	7.30E+04	3.67E+05	n/ns	NMED SSL
2,4,5-Trichlorophenol	330	130	10	6.11E+06	6.84E+07	n/n	NMED SSL
2,4,6-Trichlorophenol	330	66	10	6.11E+04	6.84E+05	n/n	NMED SSL
Phenol	330	33	18	1.83E+07	2.05E+08	n/nl	NMED SSL
Carbazole	330	67	36	--	--	--	--
N-Nitrosodimethylamine	520	66	37	2.26E+01	3.76E+02	c/c	NMED SSL
Bis(2-ethylhexyl) phthalate	330	66	46	3.47E+05	1.37E+06	cs/cs	NMED SSL
Di-n-octyl phthalate	330	66	14.4	--	--	--	--
3 & 4 Methylphenol	330	66	33	--	--	--	--
4-Chloro-3-methylphenol	330	130	66	6.1E+06	6.2E+07	n/n	EPA RSL

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Continued)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
4-Chloroaniline	330	130	81.9	2.4E+03	8.6E+03	c/c	EPA RSL
2,2'-oxybis[1-chloropropane]	330	33	23	4.6E+03	2.2E+04	c/c	EPA RSL
Phenol-d5 (Surr)	66	33	--	NA	NA	NA	NA
2,6-Dichlorophenol	330	130	69	--	--	--	--
N-Nitrosopyrrolidine	330	130	64	2.32E+03	9.12E+03	c/c	NMED SSL
SVOCs (EPA 8270 SIM)							
Anthracene	5.00	2.50	0.720	1.72E+07	1.83E+08	n/nl	NMED SSL
Acenaphthene	5.00	2.50	0.160	3.44E+06	3.67E+07	n/n	NMED SSL
Acenaphthylene	5.00	2.50	0.170	--	--	--	--
Benzo[a]anthracene	5.00	2.50	0.900	1.48E+03	2.34E+04	c/c	NMED SSL
Benzo[b]fluoranthene	5.00	2.50	1.200	1.48E+03	2.34E+04	c/c	NMED SSL
Benzo[k]fluoranthene	5.00	2.50	1.000	1.48E+04	2.34E+05	c/c	NMED SSL
Benzo[a]pyrene	5.00	2.50	0.740	1.48E+02	2.34E+03	c/c	NMED SSL
Benzo[g,h,i]perylene	5.00	2.50	1.100	--	--	--	--
Chrysene	5.00	2.50	1.000	1.48E+05	2.34E+06	c/c	NMED SSL
Dibenz(a,h)anthracene	5.00	2.50	1.300	1.48E+02	2.34E+03	c/c	NMED SSL
Fluoranthene	5.00	2.50	1.000	2.29E+06	2.44E+07	n/n	NMED SSL
Fluorene	5.00	2.50	0.470	2.29E+06	2.44E+07	n/ns	NMED SSL
Indeno[1,2,3-cd]pyrene	5.00	2.50	1.100	1.48E+03	2.34E+04	c/c	NMED SSL
Naphthalene	5.00	2.50	0.326	4.30E+04	2.41E+05	c/c	NMED SSL
Phenanthrene	5.00	2.50	1.100	1.83E+06	2.05E+07	ns/n	NMED SSL
Pyrene	5.00	2.50	1.100	1.72E+06	1.83E+07	n/n	NMED SSL
1-Methylnaphthalene	5.00	2.50	0.260	2.2E+04	9.9E+04	c/c	EPA RSL
2-Methylnaphthalene	5.00	2.50	0.309	3.1E+05	4.1E+05	n/ns	EPA RSL
2-Fluorobiphenyl (Surr)	1.00	2.50	NA	NA	NA	NA	NA
Nitrobenzene-d5 (Surr)	1.00	2.50	NA	NA	NA	NA	NA
Terphenyl-d14 (Surr)	1.00	2.50	NA	NA	NA	NA	NA

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Continued)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
Organochlorine Pesticides (EPA 8081B)							
Endosulfan I[4]	1.7	0.46	0.176	3.67E+05	4.10E+06	n/n	NMED SSL
Endosulfan II[4]	1.7	0.46	0.287	3.67E+05	4.10E+06	n/n	NMED SSL
Endosulfan sulfate	1.7	0.46	0.276	--	--	--	--
Endrin	1.7	0.46	0.306	1.83E+04	2.05E+05	n/n	NMED SSL
Endrin aldehyde	1.7	0.46	0.171	--	--	--	--
Endrin ketone	1.7	0.69	0.489	--	--	--	--
beta-BHC	1.7	0.69	0.664	2.70E+03	1.06E+04	c/c	NMED SSL
alpha-BHC	1.7	0.46	0.214	7.72E+02	3.04E+03	c/c	NMED SSL
delta-BHC	1.7	0.69	0.401	--	--	--	--
gamma-BHC (Lindane)	1.7	0.69	0.464	5.17E+03	2.29E+04	c/c	NMED SSL
gamma-Chlordane[5]	1.7	0.69	0.266	1.62E+04	7.19E+04	c/c	--
4,4'-DDD	1.7	0.69	0.546	2.03E+04	7.98E+04	c/c	NMED SSL
4,4'-DDE	1.7	0.46	0.238	1.43E+04	5.63E+04	c/c	NMED SSL
4,4'-DDT	2	0.69	0.59	1.72E+04	7.81E+04	c/c	NMED SSL
Heptachlor	1.7	0.46	0.214	1.08E+03	4.26E+03	c/c	NMED SSL
Heptachlor epoxide	1.7	0.69	0.426	5.3E+01	1.93E+02	c/c	EPA RSL
Dieldrin	1.7	0.46	0.21	3.04E+02	1.20E+03	c/c	NMED SSL
Aldrin	1.7	0.46	0.251	2.84E+02	1.12E+03	c/c	NMED SSL
Methoxychlor	3.3	0.69	0.45	3.1E+05	3.1E+06	n/n	EPA RSL
Toxaphene	170	27	15.8	4.42E+03	1.74E+04	c/c	NMED SSL
Toxaphene Peak 1	67	27	15.8	NA	NA	NA	NA
Toxaphene Peak 2	67	27	15.8	NA	NA	NA	NA
Toxaphene Peak 3	67	27	15.8	NA	NA	NA	NA
Toxaphene Peak 4	67	27	15.8	NA	NA	NA	NA
Toxaphene Peak 5	67	27	15.8	NA	NA	NA	NA
alpha-Chlordane[5]	1.7	0.46	0.323	1.62E+04	7.19E+04	c/c	NMED SSL
DCB Decachlorobiphenyl (Surr)	0.5	0.23	0.05	NA	NA	NA	NA
Tetrachloro-m-xylene (Surr)	0.5	0.23	0.05	NA	NA	NA	NA

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Continued)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
PCBs (8082A)							
PCB-1221	33	20	15.6	1.49E+03	6.24E+03	c/c	NMED SSL
PCB-1221 Peak 1	47	20	15.6	NA	NA		NA
PCB-1221 Peak 2	47	20	15.6	NA	NA		NA
PCB-1221 Peak 3	47	20	15.6	NA	NA		NA
DCB Decachlorobiphenyl (Surr)	10	5	--	NA	NA		NA
PCB-1016	33	10	5.09	3.93E+03	4.13E+04	n/n	NMED SSL
PCB-1016 Peak 1	33	10	5.09	NA	NA		NA
PCB-1016 Peak 2	33	10	5.09	NA	NA		NA
PCB-1016 Peak 3	33	10	5.09	NA	NA		NA
PCB-1016 Peak 4	33	10	5.09	NA	NA		NA
PCB-1016 Peak 5	33	10	5.09	NA	NA		NA
PCB-1232	33	10	5.12	1.49E+03	6.24E+03	c/c	NMED SSL
PCB-1232 Peak 1	33	10	5.12	NA	NA		NA
PCB-1232 Peak 2	33	10	5.12	NA	NA		NA
PCB-1232 Peak 3	33	10	5.12	NA	NA		NA
PCB-1232 Peak 4	33	10	5.12	NA	NA		NA
PCB-1232 Peak 5	33	10	5.12	NA	NA		NA
PCB-1242 Peak 1	33	10	9.12	NA	NA		NA
PCB-1242	33	10	9.12	2.22E+03	8.26E+03	c/c	NMED SSL
PCB-1242 Peak 2	33	10	9.12	NA	NA		NA
PCB-1242 Peak 3	33	10	9.12	NA	NA		NA
PCB-1242 Peak 4	33	10	9.12	NA	NA		NA
PCB-1242 Peak 5	33	10	9.12	NA	NA		NA
PCB-1248	33	10	5.61	2.22E+03	8.26E+03	c/c	NMED SSL
PCB-1248 Peak 1	33	10	5.61	NA	NA		NA
PCB-1248 Peak 2	33	10	5.61	NA	NA		NA
PCB-1248 Peak 3	33	10	5.61	NA	NA		NA
PCB-1248 Peak 4	33	10	5.61	NA	NA		NA

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Continued)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
PCB-1248 Peak 5	33	10	5.61	NA	NA		NA
PCB-1254	33	10	5.52	1.12E+03	8.26E+03	n/c	NMED SSL
PCB-1254 Peak 1	33	10	5.52	NA	NA		NA
PCB-1254 Peak 2	33	10	5.52	NA	NA		NA
PCB-1254 Peak 3	33	10	5.52	NA	NA		NA
PCB-1254 Peak 4	33	10	5.52	NA	NA		NA
PCB-1254 Peak 5	33	10	5.52	NA	NA		NA
PCB-1260	33	10	2.65	2.22E+03	8.26E+03	c/c	NMED SSL
PCB-1260 Peak 1	33	10	2.65	NA	NA		NA
PCB-1260 Peak 2	33	10	2.65	NA	NA		NA
PCB-1260 Peak 3	33	10	2.65	NA	NA		NA
PCB-1260 Peak 4	33	10	2.65	NA	NA		NA
PCB-1260 Peak 5	33	10	2.65	NA	NA		NA
Explosives (EPA 8330B)							
2-Amino-4,6-dinitrotoluene	0.1	0.04	0.0329	1.5E+02	2.0E+03	n/n	EPA RSL
4-Amino-2,6-dinitrotoluene	0.1	0.04	0.0299	1.5E+02	1.9E+03	n/n	EPA RSL
2,4-Dinitrotoluene	0.1	0.04	0.0147	1.57E+01	6.18E+01	c/c	NMED SSL
2,6-Dinitrotoluene	0.1	0.04	0.0191	6.11E+01	6.84E+02	n/n	NMED SSL
2,4,6-Trinitrotoluene	0.1	0.04	0.0307	3.91E+01	5.68E+02	n/n	NMED SSL
3-Nitrotoluene	0.2	0.08	0.064	6.1E+00	6.2E+01	n/n	EPA RSL
2-Nitrotoluene	0.2	0.08	0.0472	2.9E+00	1.3E+01	c/c	EPA RSL
4-Nitrotoluene	0.2	0.1	0.0365	3.0E+01	1.1E+02	c/c	EPA RSL
Nitrobenzene	0.3	0.1	0.085	5.35E+01	3.00E+02	c/c	NMED SSL
1,3,5-Trinitrobenzene	0.1	0.04	0.0138	2.2E+03	2.7E+04	n/n	EPA RSL
1,3-Dinitrobenzene	0.1	0.04	0.0166	6.1E+00	6.2E+01	n/n	EPA RSL
HMX	0.1	0.04	0.0227	3.91E+03	5.68E+04	n/n	NMED SSL
RDX	0.2	0.08	0.043	5.82E+01	3.41E+03	c/c	NMED SSL
Tetryl	0.2	0.08	0.0439	2.44E+02	2.74E+03	n/n	NMED SSL
1,2-Dinitrobenzene (Surr)	0.1	0.04	0.019	NA	NA	NA	NA

Table 2. Analyte List for Soil Samples and Associated Detection Limits and Screening Levels for Human Health (Concluded)

	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)	Residential SSL (µg/kg)	Industrial SSL (µg/kg)	Endpoint (µg/kg)	Source[1,2] (µg/kg)
Anions (Nitrate, Nitrite) (EPA 9056A)							
Nitrate as N	5	1	0.314	1.25E+05	1.82E+06	nl/nl	NMED SSL
Nitrite as N	5	1	0.336	7.82E+03	1.14E+05	n/nl	NMED SSL
Anions (Chloride, Sulfate) (EPA 9056A)							
Chloride	30	5	1.97	--	--	--	--
Sulfate	50	5	1.73	--	--	--	--
Glycols (EPA 8015C)							
2,2'-Oxybisethanol	10	--	0.55	--	--	--	--
Ethylene glycol	10	--	1.7	1.2E+05	1.2E+06	nm/nm	EPA RSL
Propylene glycol	10	--	1.2	1.2E+06	1.2E+07	nm/nm	EPA RSL
1,4-Butanediol (Surr)	--	--	--	NA	NA	NA	NA

Definitions(s):

-- – SSL not established
c – carcinogenic
DL – detection limit
EPA – U.S. Environmental Protection Agency
LOD – limit of detection
LOQ – limit of quantitation
MS – mass spectrometry
µg/kg – milligrams per kilogram
n – noncarcinogenic
nl – noncarciongenic; SSL may exceed ceiling limit
nm – noncarcinogenic; concentration may exceed ceiling
ns – noncarcinogenic; SSL may exceed saturation
NA – not applicable
NMED – New Mexico Environment Department
RSL – regional screening level
SSL – soil screening level
SVOC – semivolatile organic compound

Note(s):

1 NMED Table A-1, NMED Soil Screening Levels (February 2012)
2 EPA Regional Screening Levels (November 2011)
3 SSL shown for total xylenes.
4 SSL shown for endosulfan
5 SSL shown for chlordane.

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7. DESIGN OF DATA COLLECTION OPERATIONS

7.1 Sample Design and Rationale

Cannon AFB has directed Tetra Tech to conduct a field investigation at SWMU 73 to fill data gaps identified during construction of the preliminary CSM and CSEM described in Section 4.0. Chemical data will be collected and used to identify releases to exposed sediment, surface soil, and subsurface soil and characterize the nature and extent of any contamination. Five borings will be advanced and sampled at five depths. Because the pollutant characteristics of stormwater runoff are unknown, the samples will be analyzed for an extensive parameter list. The soil borings will be logged to provide information about soil characteristics and subsurface conditions to aid in evaluating constituent fate and transport. No borings will be advanced in areas covered with surface water.

Review of the site history, background information, environmental conditions, site conceptual models, and aerial images indicates that horizontal and vertical impacts to site media from any potential release of contaminants to the environment at SWMU 73 are likely confined to areas that have been inundated by stormwater runoff. The site drainage features are therefore expected to approximately delineate those upland areas with the highest release potential. Surface evidence of previous stormwater flows (sediment deposition) indicates that contaminated sediment, surface soil, and subsurface soil may be present at the site. Based on inundation frequency and duration, the pond banks/margins, runoff channels, and associated channel marginal areas would most likely contain the highest concentrations of deposited contaminants and impacts from inter-media transport. For this reason, these same areas are anticipated to also have the greatest potential for vertical impacts to sediment and soil.

Sample collection is intended to supplement known data to the greatest extent possible to reduce spatial data gaps and uncertainties. A stratified random sampling strategy has been selected to sample sediment and soil at locations most likely to be contaminated. This method allows smaller sub-groups to be investigated requiring fewer samples while controlling sources of sampling error due to lateral and horizontal nonhomogeneity of site sediment and soil. To collect data to characterize the horizontal and vertical extent of contamination, soil borings will be advanced at the five locations shown in Figure 2. The proposed boring distribution will provide upgradient and downgradient coverage of the depositional areas to characterize immediate and cumulative impacts to site sediment and soil.

The soil borings will be advanced using a hollow-stem auger rig with the capability of producing continuous core. This method will allow for sample collection as well as observation and description of the soil column at each location; visual identification of soil staining, lithology changes, etc.; and collection of field measurements with a PID. Each boring will be logged to classify soil and identify subsurface conditions.

The soil borings on the figure are designated SB-01 through SB-05. Boring SB-01 will be advanced immediately northwest of D.L. Ingram Boulevard at the intake point to the runoff channel to assess conditions upgradient of the SWMU. Borings SB-02, SB-03, and SB-04 will be placed at downgradient locations within the runoff channel approximately 100 ft, 150 ft, and 180 ft from Boring SB-01 to assess the nature and extent of potential sediment and soil contamination within

and beneath the channel. Boring SB-05 will be advanced at the western intake point of the pond where a runoff channel discharges stormwater from a culvert that passes underneath Casablanca Avenue. This location is across the pond approximately 320 ft west-northwest from Boring SB-04, and will test for potential contamination in sediment and soil at the pond's western margin.

Each soil boring will be drilled to a maximum depth of 25 ft bgs using the hollow-stem auger drilling method. Five environmental samples will be collected from each boring. Surface soil samples will be collected from 0 to 1 ft bgs and subsurface soil samples will be collected from 5 to 6 ft bgs, 11 to 12 ft bgs, 17 to 18 ft bgs, and 24 to 25 ft bgs to assess the vertical extent of any contamination present below the runoff channel and downgradient of the retention pond. A PID will collect screening data for headspace analysis to focus sample collection if evidence of contamination is detected.

The sampling design and rationale are summarized on UFP-QAPP Worksheet #17 (Appendix A). The sampling program for SWMU 73 is summarized on UFP-QAPP Worksheets #18, #19, and #20.

7.2 Analytical Approach

The analytical parameters for the RFA were selected to identify releases to exposed sediment/ surface soil and subsurface soil within the drainage channels, channel margins, and pond banks/margins. The site captures runoff originating from the golf course and receives stormwater flows from residential and semi-industrial portions of Cannon AFB through culverts. The diverse land uses of the source area prevent identification of specific target analytes appropriate for preliminary assessment of stormwater pollutant characteristics. Contamination detected in a pollutant pathway at the site will indicate constituents potentially transported by stormwater runoff. This information will be used to evaluate fate and transport processes and focus any additional data collection.

Table 3 summarizes the sampling and analysis program for the field investigation, including list of analytical parameters, corresponding methods, and estimated number of samples that will be collected. As part of the field QA/QC, two field duplicates, two rinse blanks, and two MS/MSD samples will be collected and analyzed for the project parameter list. Two trip blanks will be analyzed for VOCs only. Requirements for the project analytical program are also provided in the UFP-QAPP (Appendix A). Sample analysis, laboratory SOPs, and QA/QC program will comply with DoD QSM version 4.2 (2010).

7.3 Sample Identification

A unique identifier will be assigned to each environmental and QC sample collected during the field investigation. Data management procedures will be consistent with the project's sample ID system to ensure that all investigation data are documented, accessible, retrievable, accurate, and properly maintained. All sample identifiers and their corresponding locations will be carefully recorded on the borehole log and entered in the field logbook in narrative form and/or on hand-drawn maps. These sample designations will also be utilized on the subsequent data tables, figures, and drawings. Procedures for completing the boring log form are provided in Section 8.2. Requirements for documenting field activities in the field logbook are presented in Section 10.1.2.

7.3.1 Identifiers for Environmental Samples

All environmental samples will be identified based on an alpha-numeric code that will document the SWMU designation, media, boring number, and depth of sample collection. Samples will be numbered sequentially using the following nomenclature:

SWMU73	AA	NN	XX
Sampling Site Code	Media Type	Boring number/Sequential sample number	Sample Depth or Other Identifier

Symbol Definition:

A = Alphabetic
N = Numeric
X = Alphabetic or Numeric

Example Scenario: The following presents example codes that will be used on the project.

Sampling Site Code: This code defines the site within Cannon AFB as:

SWMU73 = SWMU 73

Media Type Code: This code identifies the source/media of the sample.

SS = Surface Soil (0–1 ft bgs)

SB = Subsurface Soil (5–6, 11–12, 17–18, and 24–25 ft bgs)

TB = Trip blank

RB = Rinse blank

Boring Number: This code identifies the boring number or sequence number for trip and rinse blanks.

01 = Boring SB-01

05 = Boring SB-05

Sampling depth: This code determines the depth to a particular sample.

00 = 0–1 ft depth interval

05 = 5–6 ft depth interval (for soil)

For example, the subsurface soil sample obtained from Boring SB-03 at a depth of 5–6 ft bgs will be identified as SWMU73SB0305. If a particular code in the numbering system is not used or not applicable, then it will be replaced with a zero. For duplicate samples, an additional pair of numbers will be added onto the end of the sample ID signifying the number sample obtained from that location. For example, adding "02" at the end of the sample ID above would indicate that it was a duplicate sample. QC samples will include the sampling site code (SWMU73) followed by the type of sample (TB or RB) and then a sequential number.

Analytical laboratories normally assign another identification number for each of the samples for their internal tracking and control of the samples. It is recommended that the laboratory be requested to provide a table that lists the actual sample number cross-referencing the sample number used to report the results. This procedure will insure proper tracking and accurate accounting for all the samples.

7.4 Sample Volumes, Container Types, and Preservation Requirements

Sample volumes, container types, and preservation requirements for the analytical methods to be performed on the samples are listed in Table 4 and in UFP-QAPP Worksheet #19 (Appendix A). The subcontracted laboratory, TestAmerica Denver, will provide pre-cleaned and preserved (if

applicable) sample containers according to EPA specifications for the methods. Sampling containers that are reused are decontaminated between uses by the EPA-recommended procedures (i.e., EPA 540/R-93/051). Containers are stored in clean areas to prevent exposure to fuels, solvents, and other contaminants.

Tracking of sample holding time begins with the collection of samples and continues until the analysis is complete. Holding time requirements are specified on Table 4 and in UFP-QAPP Worksheet #19 (Appendix A).

7.5 Field QC Samples

Field QC samples will be collected and analyzed during the investigation to assess the representativeness of the sampling activities. Field QC samples for this project will include:

- Rinse (equipment) blank
- Trip blank (VOCs only)
- Temperature blank
- Field duplicate

The data quality indicators, collection frequency, estimated number of samples, and measurement performance criteria for the field QC sample analyses are summarized in Table 5 and UFP-QAPP Worksheet #12 (Appendix A). Table 3 and Worksheet #20 (Appendix A) summarize the field QC sampling program for the investigation at SWMU 73. The following subsections describe each type of QC sample.

7.5.1 Rinse Blank

A rinse blank is a sample of the decontamination water (distilled water from the final rinse) poured into or over or pumped through the sampling device, collected in a pre-cleaned sample container provided by the laboratory, and transported to the laboratory for analysis. Equipment rinse blanks will be collected immediately after the equipment has been decontaminated. The rinse blank will be analyzed for all laboratory analyses requested for the environmental samples collected at the site.

Rinse blanks are used to assess the effectiveness of equipment decontamination procedures and to identify potential cross-contamination during sampling events. The frequency of collection for rinse blanks is after every decontamination event (not to exceed one per day).

7.5.2 Trip Blank

The trip blank consists of a VOC sample vial filled in the laboratory with analyte-free water (ASTM Type II reagent-grade water), transported to the sampling site, handled like the aqueous rinse blank sample, and returned to the laboratory for analysis. Each cooler containing aqueous samples for VOC analysis will contain a trip blank. Trip blanks are not opened in the field. Trip blanks are prepared only when aqueous VOC samples are collected and are analyzed only for VOC analytes.

Trip blanks are used to assess the potential introduction of volatile contaminants from sample containers or during the transportation and storage procedures. One trip blank will accompany each cooler of samples sent to the laboratory for analysis of VOCs.

7.5.3 Temperature Blank

Each cooler containing soil and aqueous samples will be shipped with a temperature blank. A temperature blank is a sample container filled with tap water and stored in the middle of the cooler during sample collection and transportation. The laboratory will record the temperature of the temperature blank immediately upon receipt of the samples. The temperature blank is used to measure the actual temperature of the samples in the cooler as received by the laboratory. The temperature is measured by placing a thermometer directly into the vial.

7.5.4 Field Duplicates

Field duplicates will be collected at a frequency of 1 in 20 samples per matrix (5 percent). Field duplicate pairs consist of two samples of the same matrix (a primary and a duplicate) collected at the same time, location, and depth to the extent possible, using the same sampling techniques. The duplicate samples are treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Duplicate sample results are used to assess precision of the sample collection process. Precision of soil and sediment samples to be analyzed for VOCs is assessed from collocated samples using EnCore® samplers because the compositing process required to obtain uniform samples could result in loss of the compounds of interest.

Table 3. Summary of RFA Soil Samples

Analyses		Estimated Number of Samples						
Analytical Parameter	**EPA Method**	**Surface Soil/ Sediment Samples (0–1 ft bgs)**	**Subsurface Soil Samples (5–6 ft bgs)**	**Subsurface Soil Samples (11–12 ft bgs)**	**Subsurface Soil Samples (17–18 ft bgs)**	**Subsurface Soil Samples (24–25 ft bgs)**	**QA/QC Samples (Soil and Water)[1,2]**	**Total Samples**
VOCs	8260B	5	5	5	5	5	4 Soil 4 Water	29 Soil 4 Water
SVOCs	8270C	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
PAHs	8270C SIM	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
Pesticides	8081B	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
PCBs	8082A	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
Explosives	8330B	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
TAL Metals	6010C/6020A	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
Mercury	7471B	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
TPH-DRO	8015C	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
TPH-GRO	8015C	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
Anions (Chloride, nitrate, nitrite, sulfate)	9056A	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water
Glycols (Antifreeze)	8015C	5	5	5	5	5	4 Soil 2 Water	29 Soil 2 Water

Note(s):
[1] Analytical scope for soil QC samples includes two field duplicate and two matrix spike/matrix spike duplicates.
[2] Analytical scope for aqueous QC samples includes two rinse blanks (one per day) and two trip blanks (VOCs only; one sample per cooler).

Definitions(s):
bgs – below ground surface
DRO – diesel range organics
EPA – U.S. Environmental Protection Agency
ft – foot/feet
GRO – gasoline range organics
PAHs – polynuclear aromatic hydrocarbons
PCB – polychlorinated biphenyls
QA – quality assurance
QC – quality control
SIM – selective ion monitoring
SVOC –semivolatile organic compound
TAL – target analyte list
TPH – total petroleum hydrocarbons
VOC –volatile organic compounds

Table 4. Soil Sample Analytical Method Requirements

Analytical Group	EPA Method	Sample Volume	Containers (number, size, and type)	Preservation Requirements	Maximum Holding Time (preparation/ analysis)
VOCs	8260B	5 grams	(3) 5-gram EnCore sampler	Cool, 0-6°C	48 hours for analysis 14 days for analysis if kept frozen
SVOCs	8270C	30 grams	(1) 4-oz glass jar	Cool, 0-6°C, not frozen	14 days to extract / 40 days to analyze
TAL Metals	6010C/6020A	Minimum 3 grams	(1) 8-oz glass jar	Cool, 0-6°C	180 days
Mercury	7471B	Minimum 3 grams	(1) 8-oz glass jar	Cool, 0-6°C	28 days
PAHs	8270C SIM	30 grams	(1) 8-oz glass jar with Teflon-lined lid	Cool, 0-6°C	14 days to extract / 40 days to analyze
Explosives	8330B	Minimum 10 grams	(1) 4-oz wide-mouth glass jar w/Teflon- lined cap	Cool, at 0-6°C	14 days until extraction and 40 days until analysis
Organochlorine Pesticides	8081B	30 grams	(1) 8-oz wide-mouth glass jar with Teflon-lined cap	Cool, 0-6°C, not frozen	14 days to extract / 40 days to analyze
PCBs	8082A	30 grams	(2) 8-oz wide-mouth glass jar with Teflon-lined cap	Cool, 0-6 °C	NA
TPH-GRO	8015C	EnCore® samplers 5 grams; additional 2-oz sample	(3) 5-gram EnCore® samplers; (1) 2-oz glass jar	Cool, 0-6°C	48 hours for analysis 14 days for analysis if kept frozen
TPH-DRO	8015C	30 grams	(1) 8-oz glass jar with Teflon-lined cap	Cool, 0-6°C	14 days to extract / 40 days to analyze
Anions (Nitrate, Nitrite as N)	9056A_48HR	50 grams	(1) 8-oz HDPE	Cool, 0-6°C	48 hours
Anions (Chloride and Sulfate)	9056A_28D	50 grams	(1) 8-0z HDPE	Cool, 0-6°C	28 days
Glycols	8015C	4 oz	(2) 4-oz glass jar	Cool, 0-6°C	14 days

Definitions(s):
°C – degree Celsius
DRO – diesel range organics
EPA – U.S. Environmental Protection Agency
GRO – gasoline range organics
HDPE – high density polyethylene
NA – not applicable
oz - ounce
PAHs – polynuclear aromatic hydrocarbons
PCB – polychlorinated biphenyls
SOP – standard operating procedure
SVOC –semivolatile organic compound
TAL – target analyte list
TPH – total petroleum hydrocarbons
VOC –volatile organic compounds

Note(s):
The number in parentheses in the "Sample Container" column denotes the number of containers needed.
Additional volume is required for laboratory quality control (e.g., MS/MSD) sample analyses at a frequency of 1 per 20 samples.

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

Table 5. Field QA/QC Sample Objectives

QC Sample	Data Quality Indicator	Frequency/Estimated Number	Measurement Performance Criteria[1]
Field Duplicate	Measure analytical precision	1 in 20 samples (5%)/2 samples	RPD ≤ specified control limit
MS/MSD	Measure of accuracy, bias, and analytical precision.	1 in 20 samples (5%)/2 samples	Meets % Recovery and RPD control limits
Equipment Rinse Blanks	Measure of accuracy and representativeness. Quantify artifacts introduced during sampling, decontamination, transport from ambient air, and in decontamination water supply, or analysis of sample.	1 per day/2 samples	Target analytes not detected.
Trip Blank	Measure accuracy and representativeness. Quantify artifacts introduced during sampling, transport, or analysis of samples and in laboratory water supply for volatile organic constituents (i.e., VOCs).	1 per cooler/2 samples	Target analytes not detected.
Temperature Blank	Document the temperature of samples in each cooler upon arrival at the laboratory.	1 per cooler/2 samples	4 ± 2°C

Notes:
[1] Acceptance criteria as specified in DoD QSM version 4.2 (2010) and UFP-QAPP Worksheet #28 (Appendix A).

°C – degrees Celsius
DoD – Department of Defense
MS – matrix spike
MSD – matrix spike duplicate
QAPP – Quality Assurance Project Plan
RPD – relative percent difference
UFP – Uniform Federal Policy
VOC – volatile organic compound

8. FIELD INVESTIGATION ACTIVITIES

This section describes the field investigation approach for this project by matrix. Drilling operations, logging, sample collection, decontamination, and IDW management will be implemented as described in the following sections.

The following SOPs for the field activities are provided for reference in UFP-QAPP Worksheet #21 (Appendix A):

- SOP 1 Borehole and Sample Logging
- SOP 2 Subsurface Soil Sampling
- SOP 3 Surface Soil Sampling
- SOP 4 Photoionization Detectors and Organic Vapor Analyzers
- SOP 5 Headspace Screening
- SOP 6 Borehole Abandonment
- SOP 7 Equipment Decontamination

8.1 Drilling Operations

The drilling subcontractor, GSI, will mobilize one CME-75 HD truck-mounted drill rig with Cummins 6B diesel rig engines to the site with a two-man crew and all necessary materials, tools, and equipment to complete the borings at the staked locations. The drill will come equipped with 3-1/4 in by 6-5/8 in continuous flight hollow-stem auger with a 2-1/2 in inner-diameter CME Continuous Sampling System. No fluids will be used to advance the soil borings. Samples will be collected continuously at 5-ft intervals in each of the boreholes. The CME Continuous Sampling System uses a 5-ft-long split barrel sampler that is attached to a string of rod, and is advanced ahead of the auger as the drill string is advanced into the formation. The sample tube does not rotate with the auger, resulting in collection of representative, oriented core samples. Sampling will be performed in general accordance with ASTM D1586 specifications.

Subcontractor workers will be experienced, competent drillers with current Occupational Safety and Health Administration (OSHA) HAZWOPER training and appropriate personal protective equipment (PPE) (Level D).The Tetra Tech Field Operations Leader/Field Geologist will coordinate activities with the designated subcontractor technical contact. The subcontractor will provide the Field Geologist with daily reports of the materials used and the labor incurred. The Field Operations Leader/Field Geologist will approve all daily reports in the field after discussion with lead driller.

Five borings will be drilled to a depth of 25 ft bgs. All borings will conform to New Mexico and local regulations, and all permits, applications, and other documents required by state and local authorities will be obtained. The location of all borings will be approved in writing by the Base before drilling commences, and Cannon AFB representatives will mark the locations before the field team mobilizes to the site. Borings will be sited in approximately level areas a minimum of 10 ft from standing water; no drilling will take place in areas inundated by surface water. Access to each boring location by the truck-mounted drill rig will be planned to minimize ground disturbance. The

geographic coordinates for all sampling locations will be collected using a GPS unit and recorded on the boring log and in the field logbook. All field activities will be photo-documented.

The Field Operations Leader will inspect the drilling equipment and review spill containment, control, and prevention procedures with the drilling crew prior to placement of the rig at the first boring location. Hollow-stem rigs are relatively simple, with few lubricated parts at positions likely to contaminate the boring. The drill rig will leak no any fluids that may enter the hole or contaminate equipment that is placed in the hole. Rags will not be used to absorb leaking fluids; all leaking fluids will be caught in a proper container until the leak is repaired. If sample integrity could be comprised by leaking drill rig fluids, then sample operation will be shut down until the lead is repaired.

Temporary measures will be implemented during drilling activities to minimize erosion and sedimentation. As part of site preparation activities, the site will be inspected to observe soil conditions and identify potential access problems for a drilling rig, secure a water supply for decontamination, and to check for hazards to personnel and equipment (such as utilities on and near the site). Boreholes will be located at approximately level sites capable of accommodating the truck-mounted drill rig and equipment; all drilling sites will be a minimum of 10 ft from areas of standing water. Access routes to the drilling locations will be planned to minimize ground disturbance. The hollow-stem auger drilling method generates no drilling fluids and all cuttings will be containerized in drums. Drilling operations will not be conducted during heavy precipitation events. Based on site conditions at the time, hay bales and sandbags may be used as temporary erosion and sedimentation control measures.

All down-hole drilling equipment, sample tools, and drill rig will be decontaminated prior to arrival at the site and following drilling at each location in accordance with the procedures described in Section 8.4. Decontamination operations for the rig and split spoon samplers will be conducted in the portable, self-contained decontamination trailer provided by the drilling subcontractor for that purpose. Decontamination of small sampling equipment will be performed on a temporary pad constructed by the drilling team at a location that prevents impacts to the golf course pond. Liquid and solid wastes from the decontamination equipment and tools will be properly containerized in DOT-approved 55-gallon drums.

8.2 Logging Operations

8.2.1 Boring Logs and Documentation

Soil classification will follow the USCS as provided in ASTM D2487. Soil will be classified by the Field Geologist from the core collected during drilling. The USCS procedure will be applied to identify materials in soil boring logs based on field determination of the percentages of gravel, sands, and fines in the soil and on plasticity and compressibility of fine-grained soils.

The Field Geologist will log the boring as it is being drilled by recording relevant data in the field logbook, including the method of deriving the classification. In addition, each boring will be fully described on the boring log shown in Figure B-1 or equivalent (Appendix B) and as specified in ASTM D5434. The attachment to Figure B-1 displays the decision matrix used in classifying soils by this system. If necessary, the entries in the bound field logbook may be used for transcription to the log. The soil boring log and logbook will identify the subcontractor, driller, and Field Geologist and include the number and location of each boring and a general description of the drilling equipment

used to advance the boring. This description, including information such as size and length of augers, rig manufacturer, and model, may be provided in a general legend.

Handling of samples during soil classification will be coordinated with chemical sampling activities. Note that measurements should be accurate to one-tenth of a ft and drill logs should be drawn at an appropriate scale. The log will also document the depth limits, type, and number of each sample taken. Sample identifiers will follow the nomenclature presented in Section 7.3 and all samples will be numbered consecutively. The number of blows required for each 6-in penetration of split-spoon sampler and for each 12-in penetration of casing will be recorded; the hammer weight and length of fall for split-spoon samplers also will be documented.

As the boring is advanced, the Field Geologist will evaluate adjacent recovered samples with observations of cuttings to determine stratigraphic definitions or distinctions within the soil column. These contacts or breaks will be indicated on the boring log. After the stratigraphic breaks have been identified on the log, the Field Geologist will develop and record an appropriate description for each defined stratigraphic unit. Each description should contain information about the color, grain size distribution, consistency, and moisture, and the appropriate two-letter USCS classification category symbol.

8.2.2 Classification of Soils

For intact media such as split-spoon samples the classification will include, but not be limited to, the USCS two-letter classification, plus a more complete verbal description of color, consistency, soil moisture, grain size, and size distribution. Field instrument readings (PID) and observations of visible contamination for each sample or from cuttings that appear contaminated will be recorded.

8.2.2.1 USCS Classification

Soils will be classified according to ASTM D2487; Figure B-1 illustrates the method of classification. This method identifies soil types on the basis of grain size and liquid limits, and categorizes them by two-letter symbols. Fine grained soils (pass through No. 200 U.S. standard sieve) are silts (M) or clay (C). Organic material (O) is a common component of soil. Gravelly soils are identified as G and sandy soils are denoted as S. Rock fragments will be noted followed by a size designation.

The second letter in the two-letter USCS symbol provides information about the grain size distribution of granular soils, or the plasticity characteristics of fine-grained soils. These second letter modifiers are “P” for well sorted, “W” for well graded/poorly sorted, “C” for clayey, “M” for silty, “L” for low plasticity, or “H” for high plasticity.

8.2.2.2 Color

Soil colors should be described using a single color descriptor modified to denote variation in shade or color mixtures. Color is useful in correlating units between sampling locations, and so it is important that color descriptions be kept consistent throughout the field operations. Colors are described while the sample is still moist and based on a fresh surface; therefore, samples should be split vertically to describe the color. ASTM D1535, Munsell Color Charts or equivalent, may be used to describe soil color.

8.2.2.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the Field Geologist must first identify the soil type. Granular soils are generally noncohesive, while finer grained soils are cohesive. The density/consistency of noncohesive, granular soils is classified according to standard penetration resistances in blows per ft (blows/ft) obtained from split-spoon sampling methods (Section 8.3) that are in accordance with ASTM D1586. Those designations are:

Noncohesive Soils Consistency Designation	Resistance (blows/ft)
Very loose	0 to 4
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-in outside diameter 12 in into the material using a 140-pound (lb) hammer falling freely through 30 in. The sampler is driven through an 18- or 24-in sample interval and number of blows is recorded for each 6-in increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the second and third 6 in of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This should be noted on the log and referenced to the sample number.

The density/consistency of cohesive soils can be determined by blow counts according to the following designations:

Cohesive Soils Consistency Designation	Resistance (blows/ft)
Very soft	<2
Soft	2–4
Medium soft	4–8
Stiff	8–15
Hard	>30

If the sample is decomposed rock, it is classified as a soft, decomposed rock fragment rather than a hard soil.

8.2.2.4 Soil Component

Soils are comprised of particles of varying size and shape and are combinations of the various soil types. Grain size classifications are used in describing soils. The following terms are useful in the description of soil components:

Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0%–10%
Little	11%–20%
Some	21%–35%
"and"	36%–50%

8.2.2.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. Dry soil appears to contain little or no water while saturated soils hold all the water they can. Determination of moisture can be subjective so it is important for the Field Geologist to remain consistent throughout the entire job.

8.2.2.6 Stratification

Stratification can be evaluated after the spilt-spoon sampler is opened. The stratification or bedding thickness for soil is dependent on grain size and composition. As shown below, classifications range from micro-laminated for thicknesses less than 1/32 in to very thick for thicknesses greater than 3.3 ft.

Metric Thickness	English Equivalent	Classification
>1 meter (m)	> 3.3 ft	Very thick
30 cm–1 m	1.0–3.3 ft	Thick-bedded
10–30 cm	4.0 in–1.0 ft	Medium-bedded
3–10 cm	1.0–4.0 in	Thin-bedded
1–3 cm	2/5–1 in	Very thinly-bedded
3–1 cm	1/8–2/5 in	Laminated
1–3 mm	1/32–1/8 in	Thinly-laminated
<1 mm	<1/32 in	Micro-laminated

8.3 Soil and Sediment Sample Collection

Five soil samples (plus the required number of QC samples) will be collected from each soil boring for chemical analyses based on a combination of pre-specified intervals and/or visual observations. Each soil boring will extend to a total depth of 25 ft bgs. No drilling will take place within the golf course pond. A description of the sample location, depth, and time of collection will be noted in the field logbook and on the boring log. Each sample will be assigned a unique sample ID number. A photograph will be taken of the sample location.

All personnel involved in sampling activities must wear appropriated PPE (Level D) as outlined in the HSP (Appendix C). The minimum PPE required will conform to Level D protection consisting of a shirt, long pants, steel-toed boots, hard hat, clean, chemical-resistant gloves, splash goggles, and hearing protection (when personnel work in close proximity to equipment that produces high noise levels). The level of PPE will be based on site conditions and the level of contamination present or suspected at the site.

Soil sample containers, required volume, and preservation requirements are listed for each analytical method on Table 4 in Section 7.4. Containers will be properly sealed, assigned, and labeled with the sample identification number, tagged with a custody seal, and placed in a chilled cooler. C-O-C forms, sample labels, field forms, and field logbook entries will be completed during the field event. Geographic coordinates for all sampling locations will be collected using geographic information system (GIS) for each sampling location.

The following types of samples are proposed for collection during the RFA:

- Biased upgradient surface soil/sediment sample—to determine whether contamination is present within the 0–1 ft depth interval at an upgradient location and establish concentrations near the site to be used for comparison with the site investigation data.
- Biased upgradient subsurface soil samples—to determine whether contamination is present in soils at depth intervals between 1–25 ft bgs at an upgradient location and establish concentrations near the site to be used for comparison with the site investigation data.
- Biased downgradient surface soil/sediment—to determine whether contamination is present within the 0–1 ft depth interval at four downgradient locations. Comparison of downgradient concentrations with the upgradient sampling data will be used to assess potential impacts to sediment and surface soil related to stormwater runoff and characterize the nature and extent of contamination.
- Biased downgradient subsurface soil samples—to determine whether contamination is present in soils at depth intervals between 1–25 ft bgs at four downgradient locations. Comparison of downgradient concentrations with the upgradient sampling data from the same depth intervals will be used to assess potential impacts to subsurface soil related to stormwater runoff and characterize the nature and extent of vertical and horizontal contamination.
- Field QC samples—to assess the representativeness of the sampling activities.

8.3.1 Surface Soil/Sediment Sample Collection

Surface soil/sediment samples (0–1 ft bgs) will be collected for off-site laboratory analysis according to the following procedure:

- Scrape away any surficial organic material.
- Obtain soil sample using disposable sampling equipment or a stainless-steel scoop or trowel by scooping soil from the surface to a maximum depth of 1 ft bgs.
- Record appropriate air monitoring results.
- Empty remaining contents of the split-spoon sampler into a disposable sample tray/pan or decontaminated stainless-steel pan. Homogenize sample using disposable sampling equipment or a decontaminated stainless-steel scoop or trowel. Scrape the soil from the sides, corners, and bottom of the tray or pan. Roll the soil to the middle of the tray or pan,

and initially mix. Quarter the sample and move the quarters to the four corners of the tray or pan. Each quarter of the sample should then be mixed individually. Roll the quarters to the center or the tray or pan and mix the quarters together.

- Fill sampling jars/containers with soil using decontaminated stainless-steel spatulas or spoons. Sample volume, container, and preservation requirements are described in Section 7.4.

- Place analytical samples in cooler and chill to 0-6 degrees Celsius (ºC). Samples will be shipped to the laboratory within 24 hours.

- Samplers will don new sampling gloves at each location. Sample equipment should be disposed between borings in accordance with Section 8.5 or decontaminated as specified in Section 8.4.

- The Field Geologist will out field logbook, boring log, custody seals, labels, and C-O-C forms. Example copies of these forms are included in Appendix B. Soil classification information should be recorded in the field logbook and on the boring log. Classify soils in accordance with the requirements of Section 8.2.

8.3.2 Subsurface Soil Sample Collection

Subsurface soil samples will be collected for off-site laboratory analyses using a split-spoon sampler. Samples will be collected from four intervals: 5–6 ft bgs, 11–12 ft bgs, 17 –18 ft bgs, and 24–25 ft bgs. The following procedure will be used for split-spoon sampling:

- Drill boring to the desired sampling depth. Drive the split-spoon into the undisturbed soil to collect sample.

- Drive a stainless-steel 2-in or 3-in outside diameter split-spoon sampler into the undisturbed soil using the standard penetration test (ASTM D1586-74). In this process blows from a 140-pound hammer falling 30 in will be counted until either approximately 2 ft has been penetrated or 100 blows within a 6-in interval have been applied. A decontaminated split-spoon will be used for each sample collected for chemical analyses.

- Record the number of blows required for each 6 in of penetration or fraction thereof. The first 6 inches are considered to be a seating drive. The sum of the number of blows required for the second and third 6 in of penetration in termed the penetration resistance. If the sampler is driven less than 2 ft, the penetration resistance is still the blows encountered for the second and third 6-in intervals. If more than 50 blows have been counted for a particular 6-in interval then refusal shall be entered on the log.

- Bring the sampler to the surface and remove both ends and one-half of the split-spoon so that the recovered soil rests in the remaining half of the barrel. Place split-spoon sampler on clean polyethylene sheeting and describe recovery length, USCS classification, composition, color, moisture, etc. in the field logbook and on the boring log. Record appropriate PID results.

- Empty remaining contents of the split-spoon into a disposable sample tray/pan or decontaminated stainless-steel pan. Homogenize sample using disposable or decontaminated sample equipment. Scrape the soil from the sides, corners, and bottom of the tray or pan. Roll the soil to the middle of the tray or pan, and initially mix. Quarter the sample and move the quarters to the four corners of the tray or pan. Each quarter of the sample should then be mixed individually. Roll the quarters to the center or the tray or pan and mix the quarters together.

- Fill remaining jars with soil using decontaminated stainless-steel spatulas or spoons. Sample volume, container, and preservation requirements are described in Section 7.4.

- Place analytical samples in cooler and chill to 0-6 ºC. Samples will be shipped to the laboratory within 24 hours.

- Samplers will don new sampling gloves at each location. Sample equipment should be disposed of between borings in accordance with Section 8.5 or decontaminated as specified in Section 8.4.

- The Field Geologist will fill out the field logbook, soil boring log, custody seals, labels, and C-O-C forms. Soil classification should be completed and recorded in the field logbook and on the boring log as specified in Section 8.2.

8.3.3 EnCore® Sample Collection

Surface and subsurface sample collection for VOC and/or TPH-GRO analyses will be in accordance with EPA SW-846 Method 5035 and NMED requirements. Samples will be collected using EnCore® (or similar) samplers. Samples should be collected from the sampler prior to lithologic logging and homogenization to avoid any disturbance to the sample core.

8.3.4 Sample Handling

Samples will be labeled, packaged, and shipped to the off-site laboratory for analysis as described in Section 9.0. In accordance with the DoD QSM version 4.2 (2010) requirements, the most current version of the EPA methods will be selected for analysis. Place analytical samples in a cooler and chill to 0–6°C. Samples will be shipped within 24 hours to the off-site laboratory. Fill out field logbook, boring log, custody seals, labels, and C-O-C forms. Copies of these forms are included in Appendix B.

8.3.5 Headspace Screening

Soil samples will be field screened for VOCs in the field at the time of sample collection using a PID in accordance with the following procedure. The ionization potential of the lamp for the PID will be optimum for the contaminants of concern. Use, calibration, and maintenance of the PID are described in Section 11.0.

- Immediately upon opening the split-spoon sampling device and after collecting the volatile organic sample, collect a representative portion of the sample and place in a clean, contaminant-free jar. The sample may also be placed in a new, clean, plastic sandwich bag inside a jar to minimize the number of new jars required. If the plastic bag method is

utilized, readings will be taken inside empty bags to ensure no external contamination is being introduced.

- If the volume of sample recovered is insufficient for all analytical requirements, then the material used in the headspace readings could be utilized for any non-volatile sampling requirements (i.e., the headspace material could be used to fulfill geotechnical testing requirements). If due to insufficient sample volume an additional sample was retrieved immediately below the initial attempt, an additional headspace reading is not required.
- Seal each jar with at least one continuous sheet of aluminum foil, using the jar lid to secure the foil.
- Vigorously agitate the sample jar for at least 15 seconds and then allow a minimum of 10 minutes (or as the environmental conditions dictate) for the sample to adequately volatilize.
- During cold weather the samples will be warmed to room temperature prior to taking the headspace measurement.
- Re-shake the jar and then remove the jar lid. Quickly insert the vapor sampling probe through the aluminum foil and record the maximum meter response (which should be within the first 2 to 5 seconds). Erratic responses should be evaluated in terms of high organic vapor concentrations or conditions of elevated headspace moisture.
- Record headspace screening data on the boring log and any other appropriate documentation (e.g., sample transmittals, field logbooks, etc.), as appropriate.
- The screening instrument will be calibrated according to the appropriate standard span gas and will be calibrated a minimum of twice daily and before use after a long shut-down period (i.e., lunch breaks, equipment breakdowns, weather-related breaks, etc.).
- If sample jars are to be re-used in the field, jars must be cleaned according to the field decontamination procedures for cleaning of sampling equipment. In addition, headspace readings must be taken to ensure no residual organic vapors exist in the cleaned sample jars.
- Any deviation(s) from the approved procedures must be noted on the drill logs and the field logbook and a basis stated for the deviation(s).

8.4 Decontamination

All drilling and nondisposable sampling equipment that may directly or indirectly contact samples will be thoroughly decontaminated prior to arrival at the site and following drilling/sampling activities at each location to prevent cross-contamination and introduction of foreign material into the samples. The following decontamination procedures will be used.

All non-dedicated sampling equipment, such as sample trays, spatulas, and spoons, that come in direct contact with the sample media will be decontaminated by washing with a non-phosphate detergent such as Liquinox™ or equivalent and double rinsed with deionized water. Gross contamination may be removed from sampling equipment using soap and water from an approved

source. After decontamination, the sampling equipment will be placed on clean plastic sheeting and allowed to completely air dry. If not immediately used, the equipment will be wrapped in aluminum foil.

A portable decontamination pad constructed at a location near the site with an operational water source will be used to decontaminate and collect liquid and solid wastes from the equipment and tools. The temporary pad will be constructed of a seamless material impermeable to water in an area away from the work zone and free of surface contamination. Solutions used for decontamination operations must be stored in the proper container to ensure integrity. Soap should be stored in clean containers and poured directly from the container into the wash bucket or tub. Water should be kept in clean tanks, hand-pressure sprayers, or squeeze bottles. Deionized water should be stored in clean containers that can be closed when not in use; squeeze bottles may be used to apply the rinse water. Decontamination water will be collected in 55-gallon, DOT-approved drums as described in Section 8.4.

Large pieces of drilling equipment, such as auger flights and split spoons, will be decontaminated in the fully self-contained decontamination trailer provided by the drilling subcontractor. Decontamination of is generally performed by means of a combination of high-pressure, hot water washing and triple rinse or by triple rinse alone. Triple rinse generally consists of an initial wash in potable water containing a phosphate-free laboratory detergent followed by two rinses in potable water. This process allows for the collection of decontamination fluids in the trailer-mounted containment basins and facilitates transfer into drums.

8.5 Investigation-Derived Waste Management

Tetra Tech shall containerize, stage, characterize, and properly dispose of all IDW generated during the RFA according to applicable procedures and regulations. Up to seven DOT-approved 55-gallon Type 1A2 open-top steel drums will be provided for soil and decontamination residues. Drums containing soil IDW will be staged at the sample boring locations within the exclusion zone during drilling operations. Contaminated soil IDW, if encountered based on visual or olfactory observations, will be segregated in a separate drum from "clean" soil core. Decontaminated or disposable PPE will be managed as solid waste.

Upon completion of sampling, Tetra Tech will require the Base to provide a secure location to store the IDW until it is characterized based on analytical results. Characterization of the IDW is required and shall determine the eventual disposal method(s). Based on site history and land use, Tetra Tech assumes that the IDW will not be RCRA hazardous or explosive and will not contain contamination greater than NMED soil screening levels, thus allowing the soil to be disposed on the ground. No off-site disposal of IDW will be required.

8.6 Borehole Abandonment

Borehole abandonment procedures will be performed in accordance with all state regulations. Borehole abandonment will be supervised by the Field Geologist and the details recorded in the field notebook and noted on the Bore Log Form, depicted in Figure B-1 (Appendix B). Unless otherwise specified, boreholes will be abandoned as described below:

- Wear appropriate PPE (Level D) as specified in the HSP (Appendix C).

- Prior to abandonment, the borehole will be probed to determine the total open depth of the hole.

- A plugging material consisting of one or a combination of the following materials will be used:

  - Pelletized medium grade or crushed bentonite
  - Bentonite slurry (which can include polymers designed to retard swelling)
  - Neat cement with not more than 5 percent by weight of bentonite
  - High solids grout

  A plugging material consisting of bentonite-cement is preferred. The Project Manager shall approve the plugging material in consultation with the drilling subcontractor before abandoning the borings.

- Cement and bentonite slurries will be pumped into place in a continuous operation with a grout pipe introducing the plugging material at the bottom of the well and moving the pipe progressively upward as the well is filled. This method will be repeated to within 1 to 2 ft bgs unless otherwise specified.

- For shallower boreholes, where water is not encountered, pelletized or crushed bentonite can be used. Bentonite must be poured down the borehole in 3- to 5-ft lifts and hydrated using clean potable water between lifts. This method will be repeated to within 1–2 ft bgs to allow for swelling. After full hydration and swelling has occurred, and if necessary to bring to surface grade, a small amount bentonite should be added to the borehole followed by appropriate hydration with clean water.

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9. SAMPLE HANDLING

The history of each sample and its handling is documented from its collection through all transfers of custody until it has reached the analytical laboratory. Internal laboratory records then document the custody of the sample through its final disposition. The objective of the sample packaging and shipping requirements is to maintain sample integrity from the time a sample is collected until it is received at the analytical laboratory. C-O-C forms, sample labels, custody seals, and other sample documents will be completed.

9.1 Sample Custody

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

The contractor will maintain C-O-C records for all environmental and field QC samples. A sample is defined as being under a person's custody if any of the following conditions exist:

- It is in his/her possession.
- It is in his/her view, after being in their possession.
- It was in his/her possession when it was locked it up.
- It is in a designated secure area.

Information on custody, transfer, handling, and shipping of samples will be recorded on a C-O-C form. The following minimum information concerning the sample will be documented on the laboratory-supplied C-O-C form:

- Unique sample ID
- Project number
- Date and time of sample collection
- Source of sample (including name, location, and sample type/matrix)
- Designation of MS/MSD
- Preservative used (ice)
- Analyses requested
- Number of containers
- Name of collector(s)
- Method of shipment

- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory. TestAmerica Denver documents transfer from the sample custodian to the laboratory electronically.

All samples will be uniquely identified, labeled, and documented in the field at the time of collection as described in this section. Examples of custody seals, labels, and C-O-C forms are provided in Appendix B.

In order to maintain and document sample possession, the following C-O-C procedure should be implemented:

- Samples will be collected as described in Section 8.3 and applicable field SOPs. The field sampler will be personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- A sample label is attached to the sample container. The information recorded on the sample label includes the sample ID, sampling location, date and time, type of analysis required, and preservation notes. The sample label also contains an appropriate place for designating the sample collection method and the type of sample (water, soil, etc.) collected for analyses. Sample labels will be completed with indelible ink unless prohibited by weather conditions.

9.2 Transfer of Custody and Shipment

The following procedures will be implemented when transferring and shipping samples:

- Samples will be packaged properly for shipment and dispatched to the laboratory for analysis. It is recommended that sample containers be placed in resealable plastic storage bags and wrapped in protective packing material for shipment.

- A plastic cooler (such as a Coleman® or other sturdy cooler) is typically used as a shipping container. All samples for chemical analysis must be shipped cooled to 4°C with ice. All samples will require icing prior to shipping. Ice will be double-bagged using a plastic trash bag and placed on top of the samples in the cooler.

- Tape the drain of the cooler shut so that no fluids, such as melted ice, will drain out during shipment. A large plastic bag may be used as a liner for the cooler and packing material, such as bubble wrap, or Styrofoam beads, should be placed in the bottom of the liner. The containers are placed in the lined cooler. Cardboard or foam separators may be placed between the containers at the discretion of the shipper. The liner should be taped closed, if used, and sufficient packing material should be used to prevent sample containers from making contact or rolling around during shipment.

- Wrap the coolers with strapping tape at two locations to secure the lid.

- Two or more signed custody seals are to be placed on the outside of each cooler, with at least one at the front and one at the back, located in a manner that would indicate if the container was opened during transit. It is recommended that "Fragile" and "This Side Up" labels be placed on the outside of each cooler that contains glass bottles.

- Wide, clear tape may be placed over the seals to ensure that seals are not accidentally broken during shipment. Nylon packing tape may be used providing that it does not completely cover the custody seal. Alternatively, evidence tape may be substituted for custody seals.

- The cooler should be shipped via an overnight carrier. All shipments must be in possession of contractor personnel until released to the carrier, and a receipt is obtained. A standard air bill is necessary for shipping environmental samples.

- The person responsible for delivery of the samples to the air carrier will sign the C-O-C form. The method of shipment, shipper's name(s), air bill number, and other pertinent information will be entered in a comment section on the custody record. The original C-O-C record will accompany the shipment and a copy should be placed in a Ziploc bag and taped to the inside the cooler. A copy will also be retained in the project files.

- It is not necessary for the shipper to sign C-O-Cs; however, the air bill will be retained by the sample handler for tracking.

- When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the C-O-C record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory.

- Upon receipt at the laboratory the person receiving the samples will sign and return the C-O-C copy to the Project Manager. Copies of the C-O-C forms and all custody documentation will be maintained in the project files. The original C-O-C forms will remain with the samples until final disposition of the samples by the laboratory. After disposal of the samples according to laboratory procedure, the original C-O-C form will be sent to the Project Manager by the analytical laboratory for the project files.

9.3 Laboratory Custody Procedures

The laboratory will be responsible for custody and tracking of samples upon receipt at the facility. The laboratory will have a written QA program for all analytical activities. The following custody procedures provide the basic requirements to be implemented by the laboratory:

- A designated sample custodian accepts custody of the shipped samples and verifies that the information on the sample labels matches that on the C-O-C records. If discrepancies are observed, they are entered under a comment section and the field sampling team and/or project management must be notified immediately for resolution. The custodian then enters the sample label data into a bound logbook that is arranged by project code and station number.

- The laboratory custodian will use the sample label number and/or assign a unique laboratory number to each sample label and will assure that all samples are transferred to the proper analyst or stored in the appropriate secure area.

- The laboratory custodian will store the samples in a designated area. Appropriate analysts sign for and take samples from the storage area under controlled conditions. Laboratory

personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian.

- When sample analyses and necessary QA checks have been completed in the laboratory, the unused portion of the sample and the sample container must be disposed of as required.
- The laboratory will maintain records of all identifying sample labels and other QA documentation. Samples received by the laboratory will be retained until analyses and QA checks are completed.

10. FIELD OPERATIONS DOCUMENTATION

Appropriate field documentation for all activities will be maintained as part of the formal project documentation. Field documentation includes Daily Field Operations Reports, field logbooks, soil boring logs, photographs, and FCR forms. Sample documentation includes of C-O-C forms, sample numbering system, and air bill/shipping records. Information recorded on sample labels and custody seals is prepared as part of the sample documentation process. Data management procedures established in Section 19.0 will be followed to ensure that all investigation data are documented, accessible, retrievable, accurate, and properly maintained.

10.1 Field Documentation

Field documentation includes the field logbook(s), photographs, documentation of reagent sources (i.e., decontamination water, preservatives), soil boring logs, and FCRs. Unless restricted by weather conditions, all original data recorded in field logbooks and on sample labels, C-O-C records, and receipt-for-samples forms are written in waterproof black ink. For all photographs taken, a photographic log will be maintained to record the date, time, subject, frame and roll number (if applicable), and name of the photographer.

Accountable, serialized records will not be destroyed or discarded, even if they are illegible or contain inaccuracies that require a replacement record. If an incorrect entry is made, the data will be crossed out with a single strike mark, and initialed and dated. No erasures will be permitted and the erroneous information will not be obliterated.

10.1.1 Daily Field Operations Reports

On days that field operations occur, Daily Field Operations Reports will be prepared by the Field Operations Leader in memo format and emailed to the Project Manager, Cannon AFB RPM, and AFCEE COR. The report will include weather information of each sampling day, personnel, field instrument measurements, calibrations, boreholes advanced and logged, description of all environmental and field QC samples collected, the matrix of each sample, GPS locations, list of major equipment and location, any departures from the approved plans, any problems encountered, stand-by time, and any on-site verbal or written instructions authorized by the client.

10.1.2 Field Logbook

A permanently bound logbook with sequentially numbered pages will be maintained by the Field Operations Leader to provide daily records of significant events, observations, and measurements during the field investigation. Field logbooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the field investigation. The field logbook entries will be chronological, factual, detailed, and objective. At the completion of all entries for a given task or at the end of the day, the logbook will be signed and dated.

A numbering system will be assigned to field notebooks for ease of reference and reconstruction of field events. A record of the numbering system and the individuals assigned field logbooks will also be maintained. Logbooks will be kept as permanent records in the project file.

The following is a partial list of the types of information that may be recorded in the logbook:

- Name and title of author; date and time of entry; and physical/environmental conditions (weather included) during the daily field activities
- Name and title of all personnel on site
- Sampling activity purpose and plan
- Location of the sampling point (including GPS coordinates)
- Number of boreholes advanced and logged
- Soil classification information
- Type of sampled media (e.g., sediment, surface soil, subsurface soil)
- Sampling sequence and collection method
- Description of all sampling equipment used, including trade names, model numbers, diameters, material composition, etc.
- Sample identification for each sampled point
- Date and time sample was collected
- Analyses, type and number of containers, and preservation required
- Visual description of sample collection activities and samples (e.g., color, odor, etc.)
- Results of field instrument (PID) measurements: readings, units, location
- Calibration results for field instrument
- Decontamination information
- Remarks describing conditions that might affect the representativeness of a sample
- Field Documentation

10.1.3 Boring Log

Each boring will be fully described on the boring log presented in Appendix B. Procedures and protocol for completing the boring log are described in Section 8.2. The Field Geologist will log the boring as it is being drilled by recording relevant data in the field logbook and on the boring log. The entries in the bound field logbook may be used for transcription to the log.

10.1.4 Photographs

Field activities, such as sampling or drilling, will be photo-documented. The specific field activity, the name of the photographer, date, time, site location, and site description should be entered sequentially in the logbook as photos are taken. Once developed by a laboratory or downloaded

from a digital camera, the photographic prints will be serially numbered corresponding to the logbook descriptions.

10.1.5 Field Change Requests

In compliance with the project-specific UFP-QAPP (Appendix A) and Section 17.2, FCRs will be filled out if there are any significant changes from the scope of work. If the FCR represents a major change the AFCEE and Cannon AFB will be notified and the change will be approved prior to commencement. If the FCR is minor and the resolution is clearly outlined in the data quality objectives, the FCR will be filed; the change will be made in the field; and Cannon AFB, AFCEE, and the Tetra Tech Project Manager will be notified of the change.

10.2 Sample Documentation

Sample documentation, including sample IDs, labels, custody seals, receipt for samples, airbills/shipping papers, and C-O-C records, will follow the procedures specified in Section 9.0. All original data recorded on sample documentation will be written in waterproof black ink. Records will not be destroyed or discarded. If an incorrect entry is made, the data will be crossed out with a single strike mark, and initialed and dated. No erasures will be permitted and the erroneous information will not be obliterated.

Forms that must be completed to document field activities are included in Appendix B. Sample documentation will be entered in the field logbook and shown on the borehole log.

10.2.1 Sample Labels

Sample labels will be affixed to each sample container. Complete collection information, sample type, matrix, time, date, field number, analysis requested, and the sampler's name will be recorded with indelible ink.

10.2.2 Custody Seals

Custody seals are placed on the cooler. Custody seals must include the signature of the person shipping the samples and the date the shipping container was sealed.

10.2.3 Chain-of-Custody Forms

C-O-C forms will be completed and will accompany each sample at all times. Data on the forms will include the sample ID number, date sampled, time sampled, project name, project number, and signatures of those in possession of the sample. The method of shipment, shipper's name(s), air bill number, and other pertinent information will be entered in a comment section on the custody record. Forms will accompany those samples shipped to the designated laboratory so that sample possession information can be maintained. The field team will retain a separate copy of the C-O-C reports at the field office. Additionally, the sample numbers; date and time collected; collection location; tracking number; and analysis will be documented in the field logbook.

10.2.4 Shipping Forms

Air bills and any shipping forms or receipts for samples will be completed fully and signed and dated. Copies of the completed forms are maintained in the project files.

10.2.5 Sample Numbering System

A unique identifier will be assigned to each environmental and QC sample collected during the field investigation. The sample numbering system used for samples collected will follow the nomenclature outlined in Section 7.3. Data management will be consistent with the project's sample ID system. All sample identifiers and their corresponding locations will be carefully recorded on the borehole log and entered in the field logbook in narrative form and/or on hand-drawn maps. These sample designations will also be utilized on the subsequent data tables, figures, and drawings.

11. CALIBRATION PROCEDURES AND FREQUENCY

11.1 General

Measuring and test equipment used in the field and the laboratory will be controlled by formally prescribed calibration requirements. Equipment will be of the type, range, accuracy, and precision necessary to provide data compatible with the data quality requirements. When available, accepted procedures published by the ASTM, the EPA, the National Institute of Standards and Technology (NIST), or manufacturer equipment manuals will be used. Variances from these procedures will be justified and documented in the project-specific plans. Each calibration procedure will also include the acceptance criteria and the conditions that will require recalibration or repair.

The frequency of calibration will be determined based on the following:

- Type of equipment
- Inherent stability
- Manufacturer recommendations
- Values given in published sources
- Intended use
- Instrument response to spot checks with standards
- Instrument performance and response time
- Experience

Field equipment calibration, maintenance, testing, and inspection requirements are summarized in UFP-QAPP Worksheet #22 (Appendix A). The requirements for analytical instrument calibration are presented in UFP-QAPP Worksheet #24. Analytical instrument and equipment maintenance, testing, and inspection requirements are summarized in UFP-QAPP Worksheet #25.

11.2 Responsibilities

11.2.1 Analytical Laboratory Equipment and Instrumentation

The Laboratory Manager is ultimately responsible for ensuring that calibration requirements are met. The laboratory will maintain documentation of calibration as required by the method and according to contract requirements. The frequency of calibration will be as specified by the analytical method.

11.2.2 Field Equipment and Instrumentation

The Field Operations Leader, or designee, at the site will be responsible to ensure the following procedure is implemented:

- Establish a protocol that will include the field measuring and testing devices requiring calibration and the frequency of calibration for each device based on manufacturer's suggestions and procedures.

- Assure that the field measuring and testing devices used are of the proper range, type, and accuracy for the tests being performed.

- Implement a system for issuing, collecting, and returning all field measuring and testing devices and assure that methods are employed to for proper handling, storage, and care of the test equipment in order to maintain its required accuracy.

11.3 Out-of-Calibration Equipment

The following procedures will be implemented for out-of-calibration equipment:

- Any test equipment determined to be out of calibration will be recalibrated as often as necessary to maintain accuracy. When test equipment is found to be out of calibration, damaged, lost, or stolen, an evaluation will be made to ascertain the validity of previous test results since the last calibration check. If it is necessary to assure the acceptability of suspect items, the originally required tests will be repeated using properly calibrated equipment.

- Any test equipment consistently found to be out of calibration will be repaired or replaced.

11.4 Calibration Procedures for Laboratory Equipment

Calibration procedures and frequency specified in the contract analytical laboratory's procedures will be followed.

11.5 Calibration Procedures for Field Instruments

The MiniRAE 2000 (or equivalent PID) will be used for field screening during the RFA. The field instrument will be calibrated according to the appropriate standard span gas and calibrations will be performed a minimum of twice daily and before use after a long shut-down period (i.e., lunch breaks, equipment breakdowns, weather-related breaks, etc.). Calibration information will be documented in the field logbook.

The specifications for the MiniRAE 2000 (first 11 pages of the 94-page Operation and Maintenance Manual [RAE Systems 2005]) are provided as an attachment to SOP 4 (UFP-QAPP Worksheet #21, Appendix A). The entire manual will be maintained in the field during investigation activities and will be followed for set-up, inspection, calibration, and operation of the PID.

12. INTERNAL QUALITY CONTROL CHECKS

This section describes internal QC checks to be addressed for both field and laboratory analysis in order to comply with the requirements of the project investigation.

12.1 Field Quality Control Checks

QC procedures for field measurements will include:

- Calibrating the instruments as described in Section 11.0
- Measuring duplicate samples
- Checking the reproducibility of measurements by taking multiple readings on a single sample or reference standard
- Comparing field measurements with NIST or other approved and traceable standards

QC samples will be collected as described in Section 7.0. The field QC samples will include the following at the recommended frequencies:

- ***Trip blank***—High-grade laboratory water sample that accompanies each cooler of samples for VOC analysis to the laboratory. This sample is to be analyzed for volatile compounds only.
- ***Rinse (Equipment) blank***—Collected during sampling to ensure thorough equipment decontamination activity. Equipment blanks will be collected immediately after the equipment has been decontaminated. This blank will be analyzed for all laboratory analyses requested for environmental samples collected at the site.
- ***Field Duplicates***—Field duplicates will be collected at a frequency of 20 percent. Both the sample and its associated duplicate will be analyzed for the same parameters in the laboratory.
- ***Temperature Blank***—Sample container filled with tap water and stored in the middle of the cooler during sample collection and transportation to measure actual temperature of the samples. The laboratory will record the temperature upon receipt of the samples. Each cooler containing soil and aqueous samples will be shipped with a temperature blank.

12.2 Laboratory Quality Control Checks

Laboratory QC checks include several procedures to ensure laboratory accuracy and precision during sample analysis. Types of laboratory quality control samples used during laboratory analyses include the following:

- ***Method Blanks***—Method blanks consist of an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. A method blank is analyzed with each sample batch. The method blank sample is carried through the complete

sample preparation and analytical procedure. The method blank is used to document contamination resulting from the analytical process.

- ***Calibration Blanks***—Calibration blanks are prepared with standards to create a calibration curve. They differ from the other standards only by the absence of analyte and provide the "zero-point" for the curve. A linear regression is established with a point at the origin. This is associated with an initial calibration.

- ***Internal Standards***—Internal standards are measured amounts of certain compounds added after sample preparation or extraction. They are used in an internal standard calibration method to correct sample results suffering from capillary column injection losses, purging losses, or viscosity effects. Internal standard calibration is currently used for volatile and semivolatile organic extractables by gas chromatograph/mass spectrometer (GC/MS).

- ***Surrogates***—Surrogates are measured amounts of certain compounds added before sample preparation or extraction for organic analyses. The amount spiked is dependent on the method of analysis. The recovery of a surrogate is measured to determine systematic extraction problems. Surrogates are added to all samples analyzed for chlorinated pesticides, GC/MS extractables, herbicides, explosives, petroleum hydrocarbons, and VOCs.

- ***Matrix Spikes***—MS samples are aliquots of samples to which known amounts of analyte have been added. They are subjected to the same sample preparation or extraction procedure and analyzed as samples. The amount of spike added will be as specified in the analytical method. Spikes are prepared and analyzed at a frequency of at least 1 per 20 project samples. MS/MSD samples will be collected at 1 per 20 soil/sediment environmental project samples. Field personnel will collect extra soil sample volumes for MS/MSD analysis and designate the MS/MSD sample on the C-O-C form.

  The percent spike recovery measures sample matrix interference effects, and reflects the accuracy of the determination. Percent spike recoveries are calculated as follows:

$$\%REC = \frac{SR - USR}{SA} \times 100$$

where,

SR	=	the observed analyte concentration in the spiked sample
USR	=	the analyte concentration in the original sample
SA	=	the analyte concentration added to the spiked sample

- ***Duplicates and Matrix Spike Duplicates***—Duplicates are additional aliquots of samples subjected to the same preparation and analytical scheme as the original sample. In cases where a stable, reproducible standard is available, matrix spike duplicates are substituted for duplicates. Duplicates (or MSDs) are prepared and analyzed on a daily basis and at a frequency of at least 1 per every 20 samples. The relative percent difference (RPD) between duplicates or matrix spike duplicates measures the precision of a given analysis. RPDs are calculated as follows:

$$\%RPD = \frac{R_1 - R_2}{R_{av}} x\,100$$

or

$$\%RPD = \frac{S_1 - S_2}{S_{av}} x\,100$$

where,

R1 and R2	=	duplicate determinations of the analyte in the sample
S1 and S2	=	the observed concentrations of analyte in the spike and its duplicate
Rav	=	(R1+R2)/2
Sav	=	(S1+S2)/2

- ***Laboratory Control Sample/Laboratory Control Sample Duplicate***—Laboratory control standards are aliquots of analyte-free water or solid phase sample that are spiked with the target analytes at a known concentration. They are subjected to the sample preparation or extraction procedure and analyzed as samples. The stock solutions used for laboratory control samples (LCSs) are purchased or prepared independently of calibration standards. The LCS recovery tests the function of analytical methods and equipment. LCS/Laboratory Control Sample Duplicates (LCSDs) are prepared and analyzed on a daily basis or at a frequency of 1 per 20 samples.

In addition to the aforementioned QC samples, the QC parameters established in the UFP-QAPP (Appendix A) will be followed by the laboratory. The project-specific analytical instrument requirements are summarized in UFP-QAPP Worksheet #24 and the QC sample requirements are summarized in UFP-QAPP Worksheet #28.

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13. DATA VALIDATION, REDUCTION, AND REPORTING

13.1 Data Validation

The following section describes the procedures pertaining to data validation of both the field and the analytical laboratory data.

13.1.1 Laboratory Data

Laboratory data will be validated according to procedures outlined in the following documents:

- The project-specific UFP-QAPP (Appendix A)
- DoD QSM version 4.2 (2010)
- Test Methods for Evaluating Solids Waste, SW846 Physical/Chemical Methods (EPA 2007 and updates)
- EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2008)
- EPA Contract Laboratory Program National Functional Guidelines for Superfund Inorganic Methods Data Review (EPA 2010)

Criteria to be evaluated for organic analyses include, but are not limited to:

- C-O-C quality
- Holding times
- Instrument calibration
- Blanks (including method, trip, ambient air, and equipment)
- Method reporting limits
- Laboratory corrective actions
- Surrogate monitoring compound recovery
- MS/MSD recovery
- Internal standard performance
- Data completeness

Results, which do not meet acceptance criteria as provided in the Functional Guidelines, or project requirements will be qualified with the appropriate data flags.

Criteria to be evaluated for inorganic analyses include:

- C-O-C quality
- Holding times
- Instrument calibration
- Blanks (including method, calibration, and equipment)
- Method reporting limits
- Laboratory corrective actions
- Inductively coupled plasma interference check

- MS/MSD recovery
- LCS/LCSD recovery
- Serial dilution analyses
- Data completeness

Results which do not meet acceptable criteria as provided in the Functional Guidelines or SOPs will be qualified with the appropriate qualifier code.

Following the validation procedure, a summary report will be prepared which briefly outlines the rationale for and the significance of all qualifier codes applied to the analytical data. The following data validation qualifiers may be added to the data based upon the merit of the QC results associated with the data:

U Value is a non-detect as reported by the laboratory, or has been qualified as a false positive based on contamination found in associated blanks.

R Value is considered to be unreliable and is unusable due to significant noncompliance with associated QC criteria.

J Positive value is considered to be an estimate based on associated QC parameter exceedances.

UJ Detection limit is considered to be estimated based on associated QC parameter exceedances.

13.1.2 Field Records

Field documentation will ensure sample integrity and provide sufficient technical information to recreate each field event. All field data will be reviewed to ensure that:

- Proper field procedures are implemented
- Appropriate documentation is available for each activity
- Field instruments are calibrated as required
- Required number and type of field QC samples are collected
- Numerical value and units of each field measurement are documented
- Field equipment is decontaminated as specified

Any deficient condition that may potentially affect the sample integrity and/or data quality will be discussed with the field personnel immediately upon discovery. Field corrective measures will be implemented as discussed in this plan. A report identifying all deficient conditions will be prepared and submitted.

13.2 Data Reduction

Data reduction frequently includes computation of analytical results from raw instrument data and summary statistics, including standard errors, confidence intervals, test of hypothesis relative to the parameters, and model validation. Procedures address the reliability of computations and the overall correctness of the data reduction. The numerical transformation algorithms used for data reduction

will be verified against a known problem set to ensure that the reduction methods are correct. Standard analytical procedures will be used for analytical and data reduction.

The data generated will be used to satisfy individual project requirements. The equations and the typical calculation sequence that should be followed to reduce the data to the acceptable format are instrument-and method-specific.

Auxiliary data produced for internal records and not reported as part of the analytical data include the following: laboratory worksheets, laboratory notebooks, sample tracking system forms, instrument logs, standard records, maintenance records, calibration records, and associated QC. These sources will document data reduction and will be available for inspection during audits and to determine the validity of data.

A multidisciplinary team (e.g., chemists, QA Officer) will review field records and laboratory data to determine if any environmental data are not representative of environmental conditions due to deviations from acceptable field or laboratory practices. Such data will not be used.

13.3 Reporting

Following validation, a data-validation report summary will be prepared. This report will document the reason for all qualifiers applied to the analytical data during the data validation process. All laboratory problems or results not meeting QC criteria will also be identified and the impact to data usability discussed. All investigation reports will include a summary of data quality and data validation.

As required, analytical data will be provided by the laboratory in electronic format. The format may include the laboratory standard format or the Environmental Restoration Program Information Management System (ERPIMS) electronic format as required for specific projects.

For consistent reporting of analytical data in tabular format within reports and deliverables, the following information must be presented to meet the requirements of the NMED:

- Sample location ID
- Sample date
- Sample depth (as appropriate for soil)
- Analytes by individual name
- Method reporting limits
- Nondetections reported as less-than value relative to reporting limit
- Background values (as appropriate for metals and radionuclides)
- Risk evaluation information (screening levels, risk results as appropriate)

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14. PERFORMANCE AND SYSTEMS AUDITS

14.1 General

The purpose of performance and system audits is to assure that the sampling and analysis activities are performed in accordance with the procedures established in this plan and the UFP-QAPP (Appendix A). The field and laboratory audits include two independent parts: internal and external audits. The QA Officer will coordinate internal audits of field activities with the Field Operations Leader using a graded approach based on the complexity of the field program. External audits of field activities may be conducted by Cannon AFB, AFCEE, or other government agencies, as needed. Internal audits of laboratory activities will be conducted by the analytical laboratory's QA Manager or his/her designee. External audits of laboratory activities may be conducted by the Project Chemist, Cannon AFB, or other government agencies.

Planned project assessments are presented in UFP-QAPP Worksheet #31 and QA Reports to Management are listed in UFP-QAPP Worksheet #33 (Appendix A).

14.1.1 Field System Audit

At the beginning of field activities, the QA Officer will coordinate a limited scope desk audit with the Field Operations Leader covering, as an example, the following on-site activities:

- ***Organization and Responsibility***—To determine whether the QA organization is operational
- ***Collection of Samples***—To assure that written procedures are available and are being followed
- ***C-O-C Procedures***—To assure that the appropriate steps have been followed in the traceability of sample origin
- ***Operational Procedures***—To assure that the appropriate QC checks are being made in the field and records of these checks are maintained
- ***Equipment and Instruments***—To determine that specified equipment and instrument is available and in working order
- ***Training***—To assure that sampling crews are adequately trained
- ***Records***—To assure that record-keeping procedures are operational
- ***Corrective Action***—To verify that the appropriate chain of command is followed in responding to out-of-control situations and that they are properly reported

14.1.2 Resolution of Discrepancies

If there are any discrepancies, deficiencies, or indeterminate results, the individual performing the audit will take the necessary action to ensure appropriate corrective actions are taken and completed prior to documenting acceptance of the activities performed. If resolution cannot be reached, work

will be stopped by the QA Officer and the problems will be brought to the attention of the Project Manager or delegated representative to attain resolution.

The Project Manager or delegated representative will evaluate the problems, provide solutions, and verify implementation of solutions prior to allowing the activity to resume.

14.1.3 Nonconformance/Stop-Work

Nonconformance/Stop-Work will be implemented as described in Section 17.0 of this plan.

14.2 Laboratory Performance and System Audits

14.2.1 Performance Audits

Performance audits, if performed, will be conducted by using performance evaluation samples and blind QC samples to assess the laboratory precision and accuracy of the total measurement system or portions thereof. The frequency of these audits will depend on the nature of the site being investigated and the end use of the analytical data.

14.2.2 System Audits

System audits, if performed, will include examination of laboratory documentation on sample receiving, sample log-in, sample storage, C-O-C procedures, sample preparation and analysis, calibration and instrument operating records, personnel training and qualification, and nonconformance reporting and resolution.

Any discrepancies identified during the audit will be resolved and corrected as discussed in Section 17.0 of this plan.

14.3 Audit Reports

Field and laboratory audits will be documented in audit reports if performed. Each audit report will identify the auditor and the activities audited at the site or in the laboratory. Individuals contacted and their functional roles will be identified in the report.

The audit report will identify conformance and non-conformance with SOPs and technical requirements. If resolution to non-conformances is obtained during the audit, the audit report will identify the resolution. Other discrepancies will be addressed as discussed in Section 17.0 of this plan.

15. PREVENTIVE MAINTENANCE

15.1 General

The objective of the preventive maintenance program for sampling and analytical equipment is to avoid generating spurious environmental measurements that could endanger site personnel, lead to inappropriate remedial responses, or impede an enforcement action. An adequate preventive maintenance program increases reliability of a measurement system and prevents instruments and equipment from failing during use. The following factors will be addressed in each project-specific preventive maintenance program:

- Instruments and equipment that are subject to wear, deterioration, or other changes in operational characteristics
- Spare parts necessary to minimize down time
- Optimum frequency of maintenance as depicted in equipment maintenance schedules

15.2 Field Sampling and Analytical Equipment

All sampling and analytical equipment will be maintained to the manufacturers' specifications and in operational condition. Routine preventive maintenance as well as per-use inspections and checkout will be conducted to assure proper operation of the various pieces of equipment. Preventive maintenance procedures for field analytical equipment should be implemented as required by the equipment manufacturer. Field maintenance activities will be documented in dedicated logbooks.

UFP-QAPP Worksheet #22 (Appendix A) summarizes the requirements for instrument and equipment maintenance, testing, and inspection

15.3 Laboratory Analytical Equipment

As part of their QA/QC program, analytical laboratories will have SOPs for preventive maintenance of each measurement system and necessary support equipment. The laboratory will implement routine preventive maintenance procedures to minimize the occurrence of instrument failure and other system malfunctions. Designated laboratory personnel will regularly perform routine scheduled maintenance and repair of all instruments. All laboratory instruments will be maintained in accordance with manufacturers' specifications. Laboratory maintenance activities will be documented in logbooks.

UFP-QAPP Worksheet #25 (Appendix A) summarizes the requirements for instrument and equipment maintenance, testing, and inspection.

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16. DATA ASSESSMENT

The goal of the program is to provide analytical data of consistent and known quality for determining the nature and extent of contamination, assessing risks, instituting corrective actions, and/or identifying and mitigating threats to public health and the environment. Protocols and methodologies are therefore designed to provide data of known quality in strict accordance with QA procedures and C-O-C requirements.

Data assessment requirements are presented in the UFP-QAPP Worksheet #37 (Appendix A).

16.1 Formulas

16.1.1 Precision

Multiple aliquots of the samples are spiked and each aliquot is treated exactly the same throughout the analytical method. Spikes are added at approximately 10 times the method detection limit. The percent difference between the values of the duplicates, as calculated below, is taken as a measure of the precision of the analytical method.

$$\%RPD = \frac{2 \times (D1 - D2)}{(D1 + D2)} x\,100$$

where: RPD = Relative percent difference
D1 = First sample value
D2 = Second sample value (duplicate)

16.1.2 Accuracy

A control standard is prepared by adding a known amount of pure compound to a blank matrix (before any extraction is performed). A standard reference material may also be used as both the matrix (i.e., reagent grade silica sand) and as the added compound. These samples measure the accuracy of analytical operations in a standard matrix.

Accuracy as percent recovery (P) is calculated as:

$$P = \frac{Experimental\,Value}{True\,Value} x\,100\%$$

A sample spike is prepared by adding a known amount of a pure compound to the environmental sample before any extraction is performed. The compound is the same or similar (as in isotopically labeled compounds) as that being assayed in the environmental sample. These spikes simulate the background and interferences found in the actual samples, and calculated percent recovery of the spike is taken as a measure of the accuracy of the total analytical method. It is calculated as follows:

$$P = \frac{100(OH - X)}{T}$$

where: P = Percent recovery
OH = Measured analyte concentration

X = Measured analyte concentration in the sample before the spike is added
T = Concentration of spike

16.1.3 Completeness

Assessment of data completeness includes the review of the following:

- Required samples and analyses have been processed (both field measurements and laboratory data)
- Complete records and documentation exist for each parameter analyzed and for associated QC samples
- Specified procedures have been implemented
- Electronic data packages are completed as required

Completeness will be measured as:

$$C = \frac{V}{T} x 100$$

where: C = Completeness of data in percent
V = Number of required measurements judged valid
T = Total number of required measurements

16.2 Field Measurements

Field data will be reviewed by the Project QA Officer for accuracy, precision, and completeness, taking into account overall objectives, background data points, and field QC samples as defined in Section 13.0 of this plan. The field results will be reviewed for compliance with established QC criteria specified in the UFP-QAPP (Appendix A) and this section. Accuracy of field measurements will be assessed using daily instrument calibration, calibration check, and analysis of blanks. Precision will be assessed on the basis of reproducibility by multiple readings of a single sample and on the basis of duplicate sample readings. Data completeness will also be assessed. The equations for calculating precision, accuracy, and completeness are presented in Section 16.1.

16.3 Laboratory Data

Assessment of data in terms of the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters is an integral part of laboratory verification process. Laboratory data are reviewed in two stages; the first stage is at the laboratory and the second stage by independent data validator(s).

After data have been generated by the analyst or instrument, they will be submitted to a qualified peer (another analyst, QA Manager, group supervisor, or equivalent) for review. The initial review performed at the laboratory is for transcription errors, calculation errors, holding times, a check for completeness, contractual requirements, and to ensure that data meet the QC criteria established by the analytical method. If data exceeds QC criteria, appropriate corrective actions will be implemented, if applicable. If not, the data will be reported as such with a detailed description of the QC exceedance noted in the case narrative.

An independent data validator (independent of the laboratory and the data user) will perform the second stage data review. Detailed description of data validation procedures are presented in Section 13.0 of this plan.

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17. CORRECTIVE ACTION

17.1 Nonconformance Report

Review and implementation of systems and procedures may result in recommendations for corrective action (see also QAPP Worksheets #31 and #32). Any deviations from the specified procedures within approved project plans due to unexpected site-specific conditions also will warrant corrective action. A nonconformance report (NCR) will be issued for each deficient/nonconforming condition identified (i.e., when unacceptable procedural practices or conditions are identified). The person identifying the deficient/nonconforming condition will prepare the NCR. The NCR will fully describe the conditions requiring corrective action, will indicate the nature of the corrections required, and will specify a schedule for compliance. The final authority for issuance of an NCR rests with the QA Officer through the Project Manager.

A typical NCR is included in Appendix B. Nonconforming conditions will be documented, and all deficiencies will be resolved prior to completion of the project and in the timeliest manner possible. Analysis of potential solutions (corrective actions) will determine which remedy is most effective in correcting the problem. The process will include all appropriate personnel and will be documented via meeting notes and information listed in the proper sections of both the NCR form and the Corrective Action Request form. The Project QA Officer will track the NCRs, analyze the corrective actions required, and take the necessary steps to resolve the causes of the nonconforming conditions in order to prevent recurrence.

17.2 Field Change Request

During the RFA field investigation, any changes to the approved sampling program as outlined in the plans must be documented. An example FCR form is shown in Appendix B. FCRs will be numbered serially, starting with the number "01." In general, the field team, Project Manager, and QA Officer may identify the need for corrective action. The field staff, in consultation with the Field Operations Leader, will recommend a corrective action. The Project Manager will approve the corrective action, which will be implemented by the field team. A copy of the FCR will be provided to applicable project team members, as well as be maintained at the site and in the project management files. Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods.

17.3 Stop-Work Order

If corrective actions are insufficient, resolution cannot be reached, or results of prior work are indeterminate, work may be stopped by a Stop-Work Order. The Stop-Work Order can only be authorized by the Project Manager or QA Officer in writing. If there is a disagreement between these personnel, the differences will be brought to the attention of succeeding levels of management until resolution is achieved.

The conditions for which the Stop-Work Order was issued will be described in sufficient detail to allow proper evaluation of the problems and to affect proper corrective action. Documentation of discussions, telephone conference notes, or correspondence which describe the actions taken to

evaluate the problems, provide solutions, and verify implementation of solutions will be attached to the Stop-Work Order and fully referenced in the appropriate spaces. Work will not continue until the Stop-Work Order has been rescinded by the individual that authorized the order.

17.4 Data Validation and Data Assessment Corrective Action

Corrective actions may be required for field activities and analytical work based on the outcome of data validation and data assessment activities as well as site audits. Corrective actions may include resampling and reanalysis, especially when critical sample results are rejected during the data validation process.

The following situations require corrective action based on data validation and data assessment:

- Critical sample results are rejected
- Background sample data are rejected
- Excessive blank contamination, rendering data to be questionable
- QC criteria exceeding allowable limits
- Results with extremely high detection limits
- Data completeness not meeting project requirements (95 percent for analytical data)
- Proper procedures not implemented in the field or in the laboratory
- Data are not legally defensible

All corrective actions of this type will be documented by the Data Validator(s) and Project Chemist/Database Manager or designee and approved by the Project Manager.

17.5 Laboratory Corrective Action

Corrective action in the laboratory may occur prior to, during, and/or after analyses. The laboratory must perform corrective actions on all out-of-control events (e.g., initial calibration, continuing calibration, verification, blanks, spikes, etc.) immediately and must bring analytical processes into control prior to proceeding with the analyses. Corrective action reports must be prepared for each out-of-control event, and must document the actions taken, the resolution of the problem, and the return to analytical control. If corrective action does not rectify the situation, the laboratory will contact the Project Manager for resolution.

17.5.1 Sample Control Nonconformance

The following conditions constitute a sample control nonconformance, which typically occurs prior to analyses:

- Incorrect/incomplete or missing C-O-C
- Custody seal not intact
- Broken sample container
- Insufficient sample volume
- Incompatible sample container or cap
- Incorrect sample pH (aqueous samples)
- Incorrect temperature preservation
- Headspace in volatile organic analysis vials
- Missed hold time upon sample receipt

- Insufficient information available to log in samples
- Multiple phases

When a sample control nonconformance occurs, the person identifying the nonconformance will complete a laboratory NCR and forward it to the laboratory project manager for the job. The laboratory project manager then reviews the NCR and contacts the client. If there is a question in regard to resampling, the contractor will contact their client to discuss the situation in detail. The laboratory project manager initiates any corrective actions. All communications require documentation.

17.5.2 Sample Analyses Nonconformance

The following conditions constitute a sample analysis nonconformance, which normally occurs during or after analysis:

- Failure to perform the required QC checks
- Failure to meet calibration criteria
- QC criteria exceedance
- Error in data reduction or reporting
- Blanks contain target analytes above acceptable levels
- There are unusual changes in detection limits
- Unusual sample response during analysis that is likely to adversely affect the results or precludes completion of analysis

When a sample analysis nonconformance occurs, the person identifying the nonconformance prepares a NCR and forwards it to the group leader who will take the corrective action, and places a copy in the project files. The group leader (or designee) reviews the corrective action and concurs or requests further action. He/she ensures that the action is implemented.

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18. REPORTING

Tetra Tech is responsible for planning and executing project activities, including the development, implementation, and maintenance of project report(s) and deliverables. Various reports may be required, such as progress/status reports, plans, data validation reports, QA reports to management, and the RFA report.

18.1 Contractor's Progress, Status, and Management Report

Tetra Tech will prepare and submit a quarterly CPSMR. The CPSMR shall be used to review and evaluate the overall progress of the project, along with any existing or potential problem areas. The CPSMR will include a summary of the events that occurred during the reporting period, discussion of performance, identification of problems, proposed solutions, corrective actions taken, and outstanding issues. Cost information and summary of any quality-related issues will be included in this report.

In addition, a QC Summary Report may be prepared as directed by the Project Manager that discusses of all data points that may have been influenced or compromised and their effect on achieving the DQOs for the project. Some additional elements that may be summarized in the report include:

- Project description
- Sampling and analysis scope
- Laboratory quality control activities
- Field quality control activities
- Data evaluation
- Analytical data results
- Discussion of qualified data
- Internal quality control reporting
- Lessons learned
- Conclusions and recommendations

18.2 Daily Field Operations Reports

The field program is anticipated to last approximately 3 days. Daily Field Operations Reports will be used to document daily field activities. This daily report will be transmitted as a memo sent via email to the Cannon AFB RPM and AFCEE COR that reports daily field activities. Completion of the Daily Field Operations Report is discussed in Section 10.1.

18.3 Notification Requirements

Tetra Tech will promptly notify the COR and Cannon AFB RPM of critical issues that may affect the contract performance and/or human health and the environment. The types of issues that require notification include, but are not limited to, health risks, spills, unexpected utility crossings, unusual weather conditions, unacceptable materials, changes in critical personnel, and encountering unexploded ordnance. On critical issues, oral notification should be made immediately, followed by written notification as soon as practical.

Conference calls will be held on an as-needed basis, among the Tetra Tech Project Manager, field team, and AFCEE and Cannon AFB representatives to discuss progress of the field effort, upcoming field work, and consider any problems or issues that require resolution. Minutes of the meeting will be kept by the Field Operations Leader as requested and distributed to the participants. Tetra Tech will comply with OSHA safety and health regulations and local safety office requirements and coordinate work site activities with applicable base agencies, offices, or departments. Tetra Tech will provide the COR copies of any OSHA report(s) submitted during the period of performance of the work.

18.4 Project Deliverables

18.4.1 Work Plan

The Work Plan will summarize the overall strategy, technical approach, milestones, and technical documents to execute the work required for this project. Three versions of the Work Plan are required for work conducted under the Base Environmental Restoration Program for sites under the Base's HSWA permit. The draft Work Plan will be prepared and submitted for review and comments to Cannon AFB and AFCEE to ensure that it meets objectives and the level of quality expected by the Base. The final Work Plan will provide a revision of the draft deliverable based on comments from Cannon AFB and AFCEE. NMED will not review any documents that are not "Final" versions; therefore, the final Work Plan will be submitted to NMED for review and approval. The revised final Work Plan will incorporate any comments received from NMED. Once NMED approves the Work Plan, field work can commence. Responses to reviewers' comments will be issued with the final and revised final work plan documents.

18.4.2 RFA Report

The RFA report will summarize the investigation activities and results and provide conclusions and recommendations for the site. The report will be comprehensive and sufficiently detailed to allow decisions to be made by NMED as to the nature and extent of any releases to site media, potential exceedances of human health-based SSLs, and need for corrective action, if any. The RFA report will integrate the findings from the three assessment phases (preliminary investigation, site inspection, and sampling and analysis) and include background information; site environmental setting, detailed descriptions of the field activities, GIS-based maps of all sampling locations; and presentation of results including summary tables, figures, graphical representations, and photographs; and conclusions. The findings of the assessment will be incorporated into an updated CSM and CSEM. In addition, the RFA report will show the comparison of constituent concentrations against established background concentrations and NMED SSLs or EPA RSLs and summarize COPCs for the site. The report will clearly indicate what areas of the site require further investigation and present information to focus the investigation.

Three versions of the RFA report will be prepared: draft, final, and revised final. AFCEE and Cannon AFB will review the draft RFA report and the final RFA report will incorporate reviewers' comments. NMED will review the final RFA report and the revised final RFA report will be issued based on the state's comments. Responses to reviewers' comments will be issued with the final and revised final report documents.

18.4.3 Conceptual Site Model/Conceptual Site Exposure Model Update

The preliminary CMS and CSEM developed for the RFA are presented in Section 4.0. The conceptual models will be updated using validated data of sufficient quality and quantity supported by acceptable QA/QC results and site characterization information gathered during the RFA. The primary purpose of the CSM and CSEM is to aid in identifying exposure pathways by which populations may be exposed to contaminants. The sampling results and supporting information including geologic and chemical data will be used to update the conceptual models. The updated CSM and CSEM will be presented in the RFA report.

18.5 Quality Assurance Reports

Deliverables associated with the tasks identified in the Work Plan and monthly Project, Status, and Management reports will contain separate QA sections that summarize data quality information. QA reporting will address both field and laboratory efforts. Quality reports to management are further described in the UFP-QAPP Worksheet #33 (Appendix A).

18.5.1 Frequency of Quality Assurance Reports

The Project QA Officer or designee will prepare and provide a QA report to the Project Manager and other appropriate project personnel on the performance of the QA Program on a regular basis throughout the duration of data-generating projects as required by the contract.

18.5.2 Contents of Quality Assurance Reports

Typical reports to management contain:

- Results of all system and performance audits conducted during the period
- Data validation memoranda and data assessment reports
- Listing of the nonconformances issued during the period, related corrective actions undertaken, and an assessment of the results of these actions
- Identification of significant QA problems and recommended solutions
- Information reflecting on the achievement of specific data quality objectives
- Updates on training provided and changes in key personnel

18.5.2.1 Daily Field Operations Report

During field investigation activities, Daily Field Operations Reports will be compiled and sent out to the Cannon AFB RPM and AFCEE COR on a daily basis. For this project the report will be prepared in memo format and emailed. However, should problems arise during project related activities, the client will be notified immediately. Daily reports will include, but not be limited to, the following list of topics as appropriate:

- Date (and corresponding sequential report number)
- Location of the work (including installation, site, boring, etc.)

- Weather information (including temperature, wind speed and direction, humidity, precipitation, etc.)
- Work performed and personnel performing the work
- Sampling performed (including specifics such as location, type of samples, log number, etc.)
- Field analysis performed (including results, instrument checks and calibration, problems, etc.)
- Problems encountered and corrective actions taken (including specifics regarding sampling problems and alternate sampling methods utilized.)
- Quality control activities
- Verbal or written instructions from government personnel
- Calibration procedures and recording
- Names of all personnel on-site (including their corporate, government, or other affiliations, their job titles, and their job functions and/or reasons for being on-site)
- Equipment used
- Health and Safety considerations (including site control measures, levels of personal protection required, on-site monitoring activities and results, accidents, etc.)
- Deviations from approved work plan
- General and specific remarks
- Expected activities for the next working day
- Distribution list for the daily reports
- Signature and job title of the daily reports preparer
- Drill logs completed as outlined in Section 8.2.

19. DATA MANAGEMENT

The RFA is expected to generate significant amounts of data, including chemical results for surface soil/sediment and subsurface soil analyses, laboratory data packages, data validation reports, physical data (soil boring logs), field documentation, and sample documentation. Data management procedures will be established to ensure that all investigation data are documented, accessible, retrievable, accurate, and properly maintained. Data and report processing procedures will be followed, including production of status reports and data summary reports.

19.1 Field Data

The field program involves analysis of an extensive parameter list, in different media (depth intervals), with different sample types, and at various sample locations. Soil borings will be logged, generating data describing lithology and soil characteristics. Data deliverables may include electronic and hard copy formats. Data management procedures already established for AFCEE projects will be applied to process these data such that relevant data descriptors (e.g., sample id, locations, depths, type, procedures, methods, and analysts/validators) are accessible, retrievable, tracked, and maintained.

Field documentation will consist of soil boring logs, field logbooks, and FCRs. Samples will be labeled, packaged, tracked, and shipped to the off-site laboratory for analysis under documentation that includes assignment of unique sample identifiers, labels, and C-O-C records. Soil classification data obtained from borehole logging and information associated with sample documentation will be entered in the field logbook and on the soil boring log. Appropriate field documentation, including photographs, for all activities will be maintained as part of the project files. The organization and procedures of the RFA project files will follow protocols established for previous AFCEE projects.

The sample identification system to ensure assignment of unique sample IDs is outlined in Section 7.3. Specific requirements for field logbooks, soil boring logs, photographs, FCRs, and sample documentation will follow the procedures specified in Sections 9.0 and 10.0. Additional information describing use of the soil boring log to document logging activities, including an example boring log form, is provided in Section 8.2. Examples of other forms that must be completed to document field activities are included in Appendix B.

19.2 Field Data Review

Field documentation will ensure sample integrity and provide sufficient technical information to re-create each field event. All field data will be reviewed to ensure that:

- Proper field procedures are implemented
- Appropriate documentation is available for each activity
- Field instruments are calibrated as required
- Required number and type of field QC samples are collected
- Numerical value and units of each field measurement are documented
- Field equipment is decontaminated as specified

Any deficient condition that may potentially affect the sample integrity and/or data quality will be discussed with the field personnel immediately upon discovery. Field corrective measures will be implemented as discussed in Section 17.0. A report identifying all deficient conditions will be prepared and submitted.

19.3 Laboratory Data Package

Definitive data deliverables for the off-site laboratory analyses are required for this project. Tetra Tech will ensure that all hard copy and electronic data deliverables supplied by the laboratory are complete and adequate to support the quality and usability of the data. Raw data packages will be submitted to Cannon AFB/AFCEE upon request. Data packages will include all information required to re-create the analysis, including correspondence with the laboratory regarding QA/QC exceedances and documentation of corrective actions.

Tetra Tech will adhere to the data deliverable requirements for the ERPIMS. ERPIMS is the Air Force system for validation and management of data from environmental projects at all Air Force bases. ERPTools X is the latest generation of ERPIMS software developed for distribution to contractors, including prime contractors and laboratories. The ERPIMS Web Service provides synchronization between the ERPIMS submission and production databases with the client-side database contained within the ERPTools X application. Guidance to be followed includes program specifications for ERPTools X version 5.0.8.0, and the ERPIMS Data Loading Handbook version 5.0. In addition to ERPIMS, Tetra Tech will submit all data in accordance with the contract, SOW, Base, and NMED requirements.

The laboratory will submit all sample results and QC information as required by their contract and project-specific requirements. The deliverables will include a hardcopy data package including instrument data and electronic data files. Electronic data formats include ERPIMS data deliverables or laboratory standard electronic data files. The laboratory will also comply with data archiving as required by the contract.

For data verification/validation needs, all data provided by the subcontract laboratory in a hard copy format will be evaluated to ensure that the results meet comprehensive data package requirements and are equivalent to an EPA Contract Laboratory Program (CLP) data deliverable package. This will allow validation of the data in accordance with EPA requirements (current EPA Organic/Inorganic National Functional Guidelines for Data Review – EPA 540/R-08-01 and EPA 540/R-04-004). Worksheets #34 through #36 of the QAPP have additional information on data verification and validation reviews.

Analytical data will be provided by the laboratory within 15 days of the receipt of samples in hard-copy and electronic formats. Submitted laboratory reports will be in compliance with all applicable EPA CLP reporting requirements. These reports will include, but not be limited to, the following:

- Cover page–laboratory identification (name, address, and telephone number), project name, client, official signature.
- The signature of an authorized laboratory employee indicating the acceptability of the data.
- Unique laboratory sample delivery group identification.

- Field sample identifications as written on the C-O-C form and corresponding laboratory sample ID number.
- Sample date; sample preparation and analysis date.
- Method numbers for all preparation, cleanup, and analysis procedures employed.
- Preparation, analysis, and other batch numbers utilized.
- A copy of the signed C-O-C records indicating the condition of the samples at the time of receipt at the laboratory.
- Reporting limits adjusted for sample-specific factors (e.g., aliquot size, dilution/ concentration factors, moisture content, etc.).
- Sample results reported with the correct number of significant figures and any data qualifiers assigned by the laboratory in units of milligrams per kilogram dry weight for soils, and micrograms per liter for aqueous equipment blanks. For sample results greater than the method detection limit but less than the sample-specific quantitation limit, values shall be reported and qualified as estimated.
- Instrument data if required, data qualifiers, confirmation data, concentration units.
- Sample results from all runs recorded and reported, along with dilution/concentration factors, if applicable.
- A summary of pertinent C-O-C and tracking information (i.e., dates of preparation and analysis, analytical instrumentation, associated QC samples, etc.).
- QA/QC information such as QC sample and spike recoveries and control limits, calibration data, explanation of data qualifiers, factors affecting sample results, nonconformance reports, and corrective action reports.
- Copies of raw data including instrument outputs (such as chromatograms, quantitation reports, etc.), relevant logbooks, instrument injection logs and standard preparation logs.

19.4 Laboratory Data Management/Presentation

All laboratory analytical records will be maintained by the subcontract laboratory, Test America Denver, in accordance with their internal SOPs. UFP-QAPP Worksheet #30 (Appendix A) contains information on data delivery requirements.

The analytical results will be presented in its entirety as an appendix (i.e., full hard-copy data packages in Portable Document Format (PDF) format and electronic files, both updated as appropriate with additional qualifiers. All data will be reported.

Results of the verification/validation reviews (see UFP-QAPP Worksheets #34 through #36 [Appendix A]) will be documented in a data validation report, which will be incorporated as an appendix to the RFA report.

19.5 Reports/Data Presentation

RFA data will be reported according to established procedures to ensure consistent, technically accurate, and concise presentation. The data should be presented in a logical format using tabular, graphical, and other visual displays. The tables and figures are important decision-making tools that can display large quantities of data and show relationships between data elements in an understandable format. For example, analytical results are often presented in tabular formats; sample locations on topographic maps and aerial images; and stratigraphy and log results in graphical formats.

The project Work Plan and RFA report will be prepared in accordance with the document template established for all Cannon AFB deliverables. All project deliverables, including text, tables and figures, will undergo an independent QC review by a competent individual as per corporate internal QC review procedures.

19.6 Spatial Data (Map) Presentations

All maps and associated data must comply with the latest version of Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE). These data will be organized using the current version of the standard approved by the Headquarters Air Force Geo Integration Office as the functional lead for installation mapping and visualization. The SDSFIE will determine file and feature class identification and definition, attribution, and valid domain values. The GIS dataset will be accompanied by metadata conforming to the Federal Geographic Data Committee's Content Standard for Digital Geospatial Metadata.

Geospatial data must be delivered in a geo-referenced GIS format (feature-based file structures with one-to-one cardinality between spatial records and attribute records) which would include Environmental Systems Research Institute's (ESRI) shapefile and geodatabase formats. All attribute data as specifically outlined in the task order contract must be included either in the GIS data file or as a separate table with a SDSFIE key variable that may be used to relationally join the separate table with the GIS data file. All geospatial data must be delivered in the World Geodetic System 1984 (WGS84) projection, State Plane Coordinate System, using feet or metric coordinate units.

19.7 Project Files

Tetra Tech will create and maintain in one location, written and electronic records sufficient to recreate each sampling, analytical, testing and monitoring event, and will make these records available to AFCEE and Cannon AFB representatives upon request. Tetra Tech will also retain written calculations using information obtained from sampling, analysis, monitoring and testing activities, to include all raw data. All project-related data will be archived and retained in the project files for the duration of the project. Hard-copy data packages (field- and/or laboratory-related) will also be kept in these files unless undergoing processing, verification/validation, or evaluation/review.

Electronic data and documents will be stored on the project's Lakewood, Colorado, "Projects" computer drive in a location designated by the Project Manager. The most current version of electronic data/documents will be made available for use. Outdated versions of electronic data/documents will be archived and moved to a location separate from the current versions or

deleted. All project records will be maintained according to internal corporate procedures and established procedures for AFCEE projects.

At the end of the project, final disposition of all documents, including analytical data, will be determined in conjunction with Cannon AFB and AFCEE.

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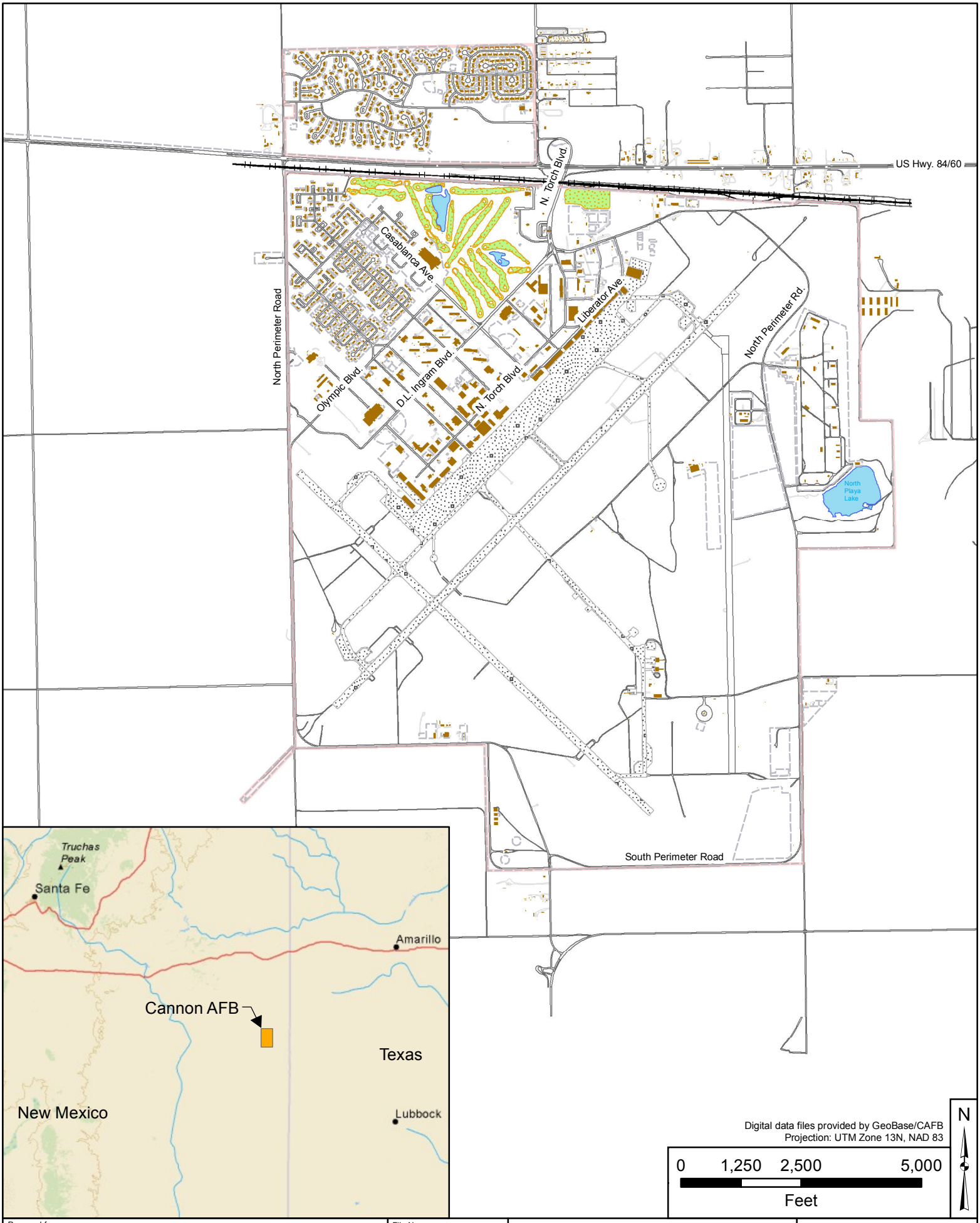
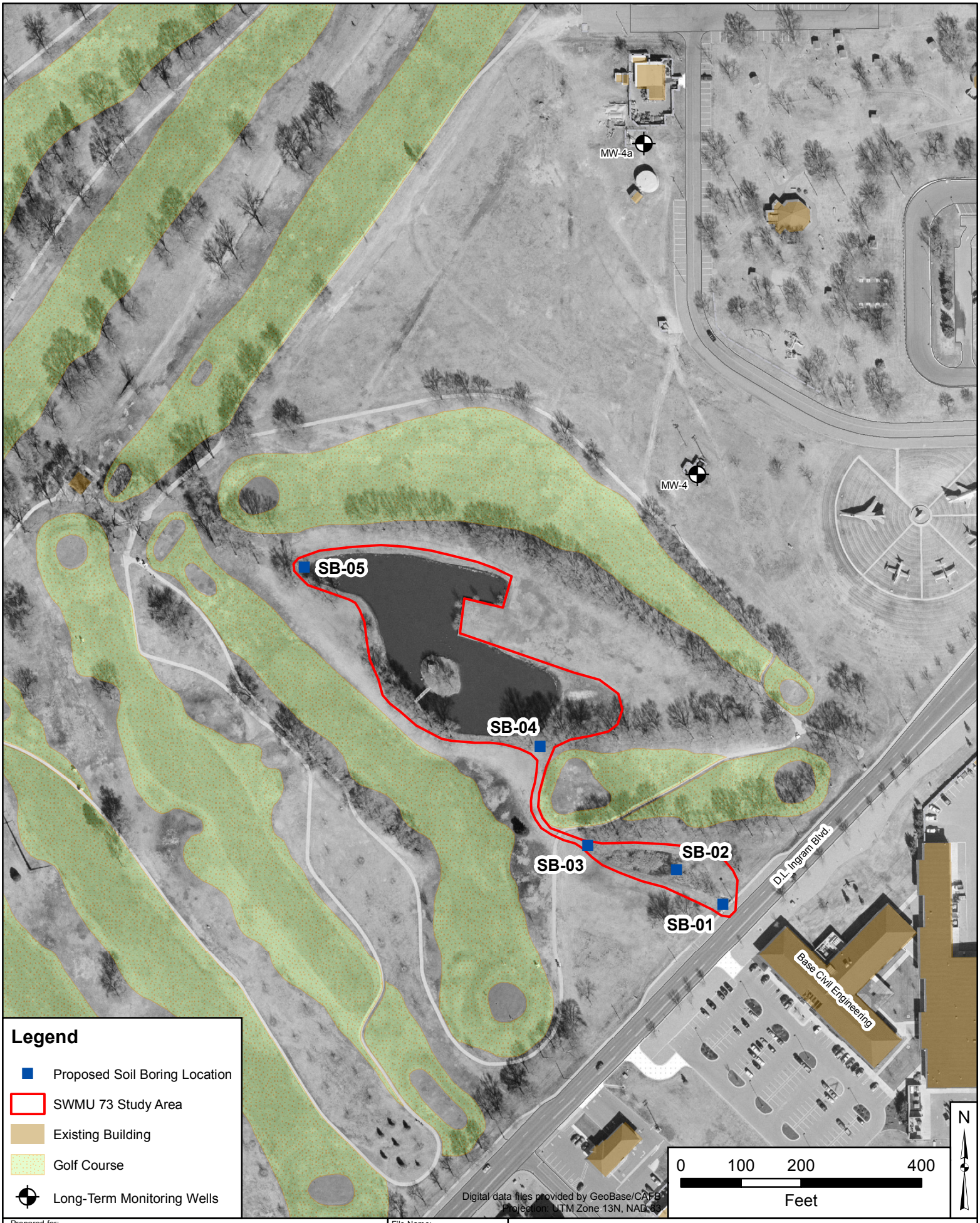
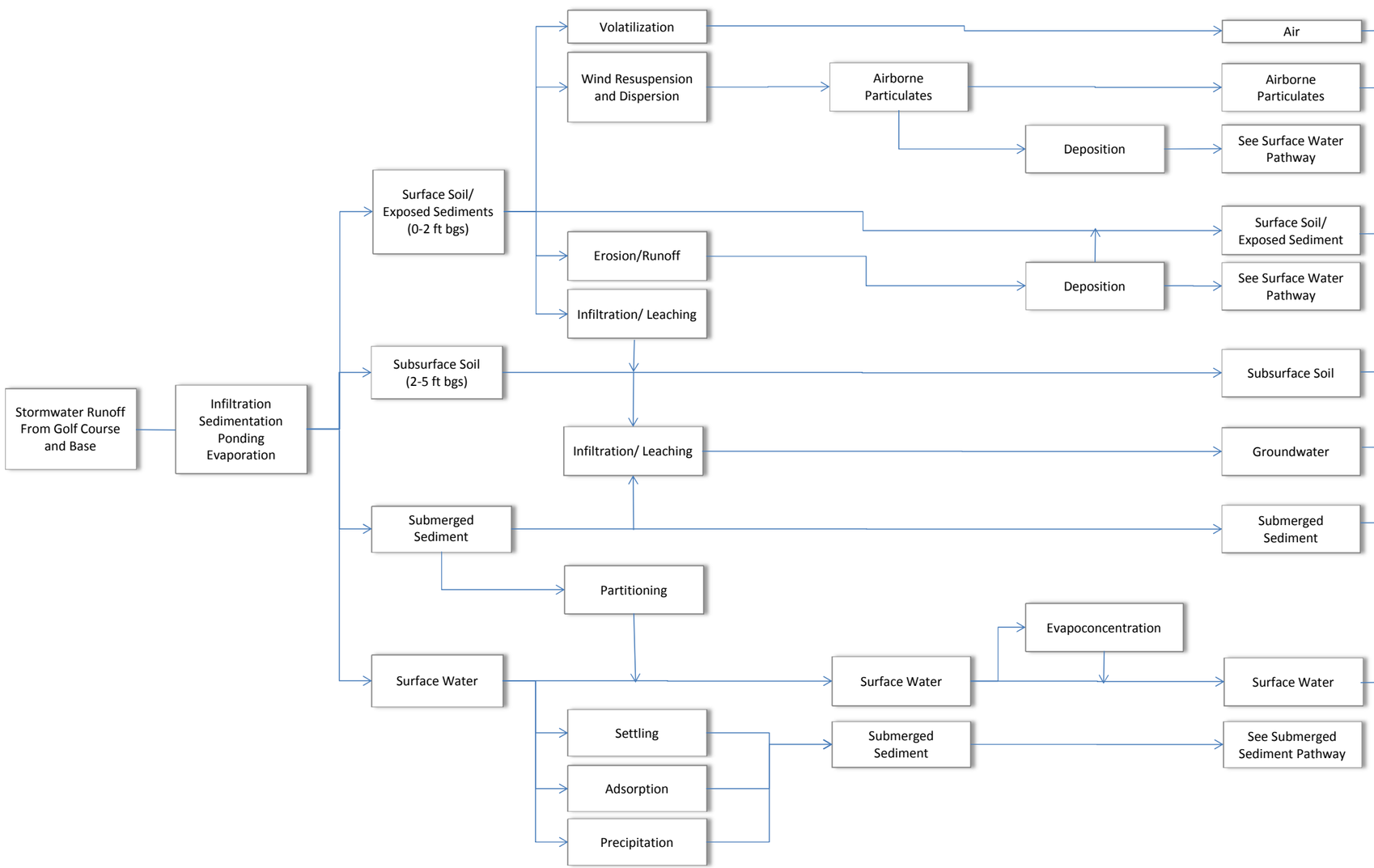


Prepared for: ***Cannon Air Force Base, New Mexico***	File Name: Figure1.mxd	Existing Building; Airfield Surface; Golf Course	Figure 1 Site Location Map
Project: SWMU 73	Date of Issue: 12/07/2011		



Prepared for: **Cannon Air Force Base, New Mexico**	File Name: Figure2.mxd	Figure 2 Proposed Drilling Locations at Solid Waste Management Unit 73
Project: **SWMU 73 RCRA Facility Assessment**	Date of Issue: 02/08/2012	



Exposure Route	Potential Human Receptors			
	Recreational User/Visitor	Maintenance Worker	Resident/ Trespasser	Resident
	Current			Future
Inhalation	○	○	○	○
Inhalation	●	●	●	●
Ingestion	●	●	●	●
Direct Contact	●	●	●	●
Ingestion	—	●	—	●
Direct Contact	—	●	—	●
Ingestion	—	—	—	—
Direct Contact	—	—	—	—
Ingestion	●	●	●	●
Direct Contact	●	●	●	●
Ingestion	●	●	●	●
Direct Contact	●	●	●	●

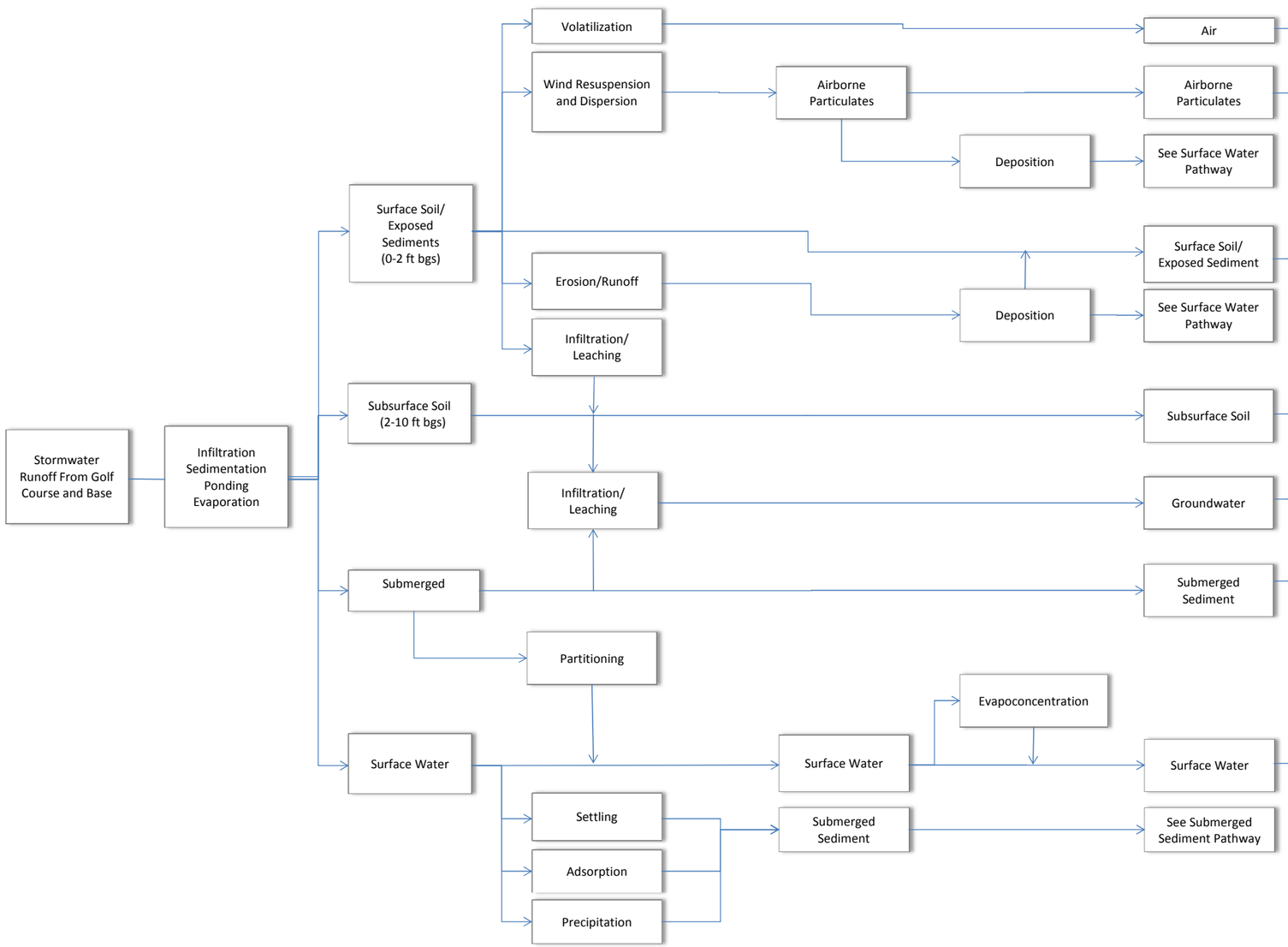
LEGEND

● Pathway potentially complete

○ Pathway potentially complete but considered insignificant

SWMU 73 RCRA Facility Assessment
Cannon Air Force Base, New Mexico
Air Force Center for Engineering and the Environment

Figure 3
Human Health Conceptual Site Model for Solid Waste Managment Unit 73



Exposure Route	Potential Ecological Receptors					
	Water Fowl	Mammal	Amphibian	Benthic Inverte-brate	Terrestrial Inverte-brate	Plants
Inhalation/Respiration	—	—	—	—	—	—
Inhalation/Respiration	○	○	○	—	○	—
Dermal Contact/Uptake	—	—	—	—	—	○
Trophic Transfer	○	○	○	—	○	—
Dermal Contact/Uptake	○	○	●	—	●	●
Ingestion	●	●	●	—	●	—
Trophic Transfer	●	●	●	—	●	—
Dermal Contact/Uptake	—	○	—	—	○	●
Ingestion	—	—	—	—	●	—
Trophic Transfer	●	●	●	—	●	—
Dermal Contact/Uptake	—	—	—	—	—	—
Ingestion	—	—	—	—	—	—
Trophic Transfer	—	—	—	—	—	—
Dermal Contact/Uptake	●	—	●	●	—	●
ingestion	●	—	●	●	—	—
Trophic Transfer	●	—	○	●	—	—
Dermal Contact/Uptake	●	○	●	●	—	●
Ingestion	●	●	●	●	—	—
Trophic Transfer	—	—	○	●	—	—

LEGEND

● Pathway potentially complete

○ Pathway potentially complete but considered insignificant

SWMU 73 RCRA Facility Assessment
Cannon Air Force Base, New Mexico

Figure 4
Ecological Conceptual Site Exposure Model for Solid Waste Managment Unit 73

Figure 5. Project Organization Chart

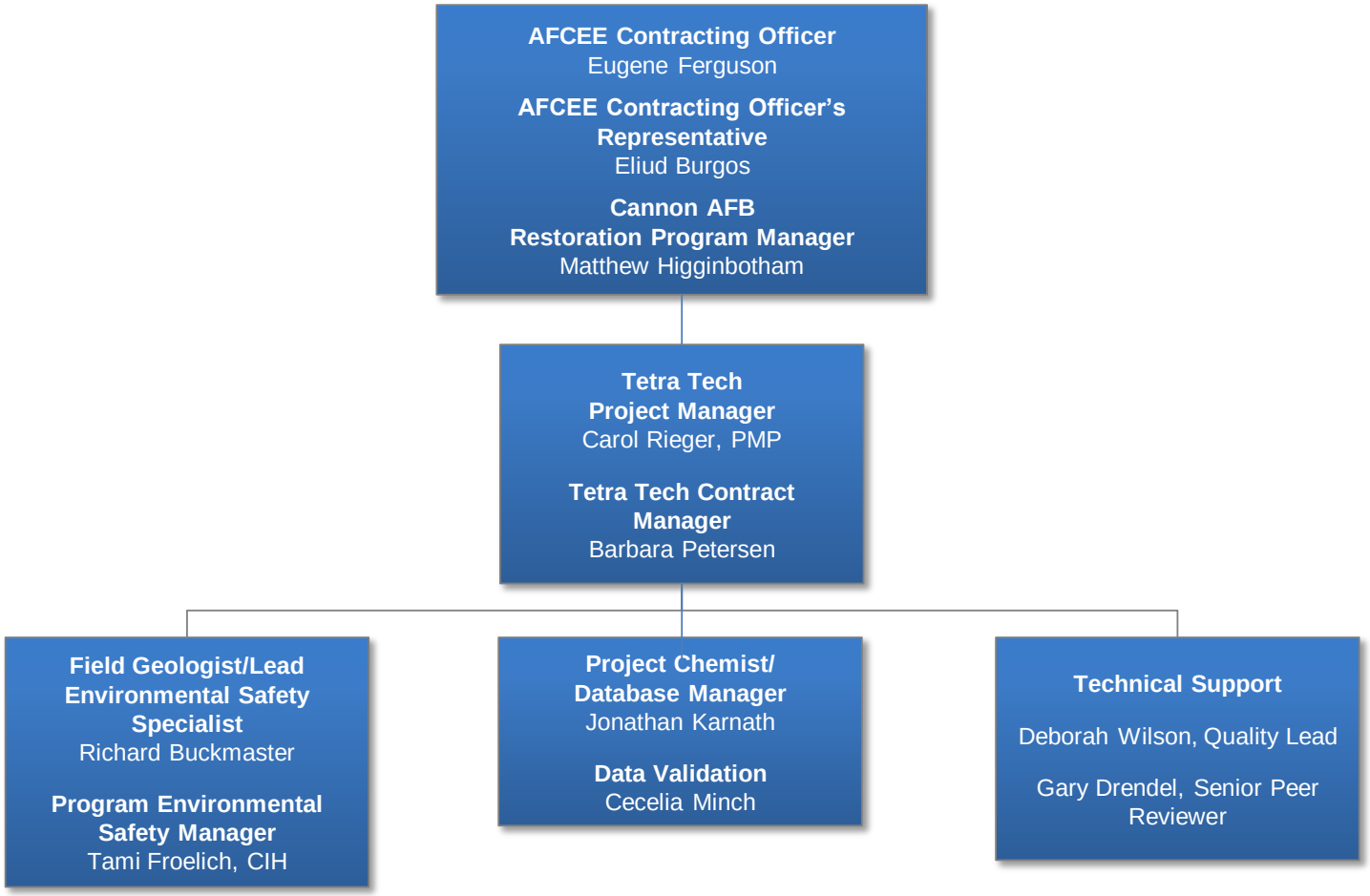
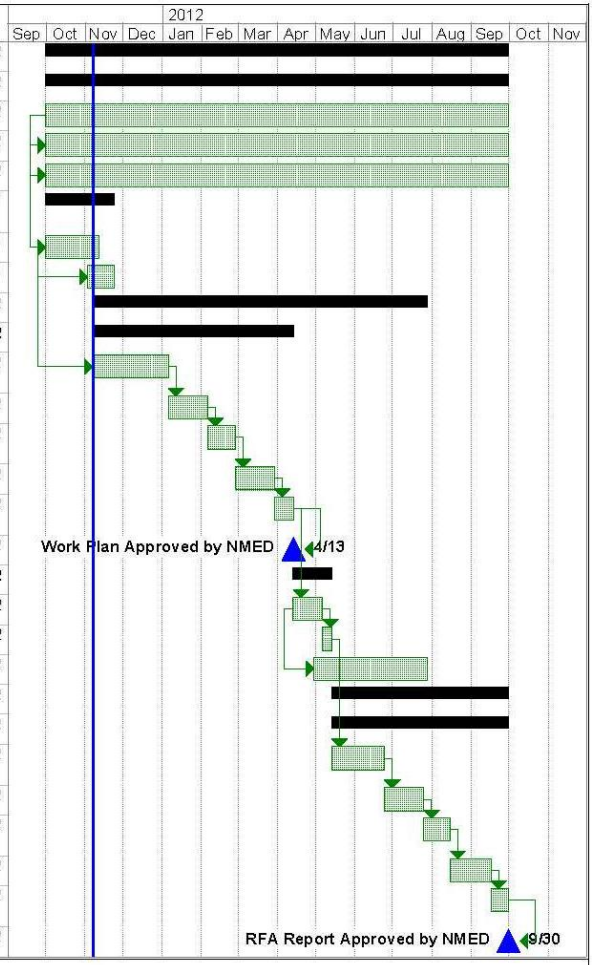


Figure 6. Project Schedule

ID	WBS	Task Name	Duration	Start	Finish
1	**1.00**	**RCRA Facility Assessment at SWMU 73**	**366 d**	**Oct 1 '11**	**Sep 30 '12**
2	**1.01**	**Project Planning / Management**	**366 d**	**Oct 1 '11**	**Sep 30 '12**
3	1.01.01	Project Planning & Proposal	366 d	Oct 1 '11	Sep 30 '12
4	1.01.02	Project Management / Meetings	366 d	Oct 1 '11	Sep 30 '12
5	1.01.03	Quarterly Progress / Financial Reports	366 d	Oct 1 '11	Sep 30 '12
6	**1.02**	**Literature Research & Site Conceptual Model**	**54 d**	**Oct 1 '11**	**Nov 23 '11**
7	1.02.01	Literature Research	42 d	Oct 1 '11	Nov 11 '11
8	1.02.02	Conceptual Model	21 d	Nov 3 '11	Nov 23 '11
9	**1.03**	**RFA Work Plan / Field Activities**	**265 d**	**Nov 7 '11**	**Jul 28 '12**
10	**1.03.01**	**Work Plan Documents**	**159 d**	**Nov 7 '11**	**Apr 13 '12**
11	1.03.01.01	Preparation of Draft Work Plan Documents	60 d	Nov 7 '11	Jan 5 '12
12	1.03.01.02	USAF Review	31 d	Jan 6 '12	Feb 5 '12
13	1.03.01.03	Preparation of Final Work Plan Documents	22 d	Feb 6 '12	Feb 27 '12
14	1.03.01.04	NMED Regulatory Review	31 d	Feb 28 '12	Mar 29 '12
15	1.03.01.05	Revision of Final Work Plan Documents Based on NMED Comments	15 d	Mar 30 '12	Apr 13 '12
16	1.03.01.06	**Work Plan Approved by NMED**	0 d	Apr 13 '12	Apr 13 '12
17	**1.03.02**	**Field Activities**	**31 d**	**Apr 13 '12**	**May 13 '12**
18	1.03.02.01	Procurement	24 d	Apr 13 '12	May 6 '12
19	1.03.02.02	Field Sampling	7 d	May 7 '12	May 13 '12
20	1.03.02.03	**Data Management / ERPIMS**	90 d	Apr 30 '12	Jul 28 '12
21	**1.04**	**RFA Report**	**140 d**	**May 14 '12**	**Sep 30 '12**
22	**1.04.01**	**Report Preparation**	**140 d**	**May 14 '12**	**Sep 30 '12**
23	1.04.01.01	Prparation of Draft RFA Report Document	42 d	May 14 '12	Jun 24 '12
24	1.04.01.02	USAF Review RFA Report	31 d	Jun 25 '12	Jul 25 '12
25	1.04.01.03	Preparation of Final RFA Report Documents	21 d	Jul 26 '12	Aug 15 '12
26	1.04.01.04	NMED Regulatory Review RFA Report	32 d	Aug 16 '12	Sep 16 '12
27	1.04.01.05	Revision of Final RFA Report Based on NMED Comments	14 d	Sep 17 '12	Sep 30 '12
28	1.04.01.06	**RFA Report Approved by NMED**	0 d	Sep 30 '12	Sep 30 '12



Task Milestone Summary

Printed: Nov 7 '11
Data Date:Nov 7 '11
Page 1 of 1

RCRA Facility Assesment at SWMU 73
Cannon Air Force Base, New Mexico

AF Project No. CZQZ118900 Contract No. FA8903-08-D-8781 Task Order 0154

TETRA TECH

Comment/Resolution Form

Quality Program Plan for Resource Conservation and Recovery Act Facility Assessment at Solid Waste Management Unit (SWMU) 73 Cannon Air Force Base, New Mexico

April 2012

Item No.	Section	Page No.	Reviewer's Comment	Comment Resolution
General Comments				
General			The UFP-QAPP is well developed and thorough. The UFP-QAPP is a series of forms and two text sections that describes the project control and the actual collection, preservation, and laboratory standard operating procedures (SOPs) for the laboratory data. According to prior NMED guidance, "references to the SOPs shall be removed from the Work Plan." The writers are "reminded that NMED does not review SOPs". NMED also has stated, "In all future work plans the Permittee must provide descriptions of proposed procedures, specific field methods and specific equipment to be used in the execution of the work plan, in the appropriate section(s) of the text of the work plans. The Permittee must also fully describe all site specific procedures, specific field methods and specific field equipment actually used in field in the appropriate sections of all future facility reports." NMED has made similar comments regarding the HSP. NMED has stated, "The Permittee is reminded that while a Site Safety and Health Plan is required NMED does not review or approve health and safety plans. In all future submittals to NMED the Permittee must not include, nor reference previously submitted, health and safety plans." Therefore, the text section of Appendix B should be promoted to stand behind the Executive Summary, and include any important information from the removed appendixes, such as SOPs converted to site specific procedures. Other missing information, as noted in the comments should be included in the text portion. SOP's and a HSP must exist and be available for government review, but NMED does not wish to have them submitted as part of the work plan.	The original Quality Project Plan (QPP) has been reorganized as requested, and is now referred to as the Work Plan of Final Work Plan. The text portions of Draft Work Plan Appendices B (Work Plan) and C (Field Sampling Plan) have been combined and promoted to stand behind the Executive Summary. Important information from the Standard Operating Procedures (SOPs) (Draft Work Plan Appendix D) has been incorporated into the main portion of the Final Work Plan to create a comprehensive document. The Final Work Plan now has three appendices included for reference by Tetra Tech, AFCEE, and Cannon AFB staff: • Appendix A, UFP-QAPP Worksheets • Appendix B, Forms • Appendix C, Environmental Health and Safety Plan (HASP) The figures have been moved from Appendix G into the main portion of the Final Work Plan. The text of the SOPs has been incorporated into Final Work Plan and Worksheet #21 of the UFP-QAPP for reference. No appendices will be submitted to NMED for review as part of this Final Work Plan document.

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Item No.	Section	Page No.	Reviewer's Comment	Comment Resolution
Specific Comments				
1	Quality Program Plan	Table of Contents (TOC), p. i	Appendix D and Appendix G will need to be removed from the submittals, and must be removed from the TOC.	Appendix D (Standard Operating Procedures) has been removed from the Work Plan. The details of these procedures are now included in appropriate sections of Section 8. The original text from the SOPs is still included in the document as part of Appendix A (UFP-QAPP, Worksheet #21). The Table of Contents will show that we have three appendices: Appendix A (UFP-QAPP), Appendix B (Forms); and Appendix C (HASP). The appendices are required for reference by Tetra Tech, AFCEE, and Cannon AFB staff and will not be included in the copies submitted to NMED.
2	Quality Program Plan	TOC, p. 1-2	Appendix D and Appendix G are not submitted to NMED, and must be removed from the list.	Appendix D has been incorporated into Section 8 of the Work Plan and Worksheet #21 of the UFP-QAPP (Appendix A). Appendix G (now included for reference as Appendix C) will appear in the Table of Contents, but will not be submitted to NMED for review.
3	Uniform Federal Policy-Quality Assurance Project Plan (QAPP)	Appendix A	NMED requires that all laboratories performing analyses to be accredited laboratories that can demonstrate that their work is legally defensible. NMED does not require the submittal of laboratory SOPs to determine the qualifications of laboratories performing analyses. Laboratory SOPs have been included in the Work Plan in the Appendix A of the UFP-QAPP Worksheets. NMED does not review or approve SOPs (see general comments). Approval of this Work Plan does not constitute approval of the QAPP or laboratory SOP's included therein.	Laboratory SOPs are listed, including title, date and version number, in accordance with UFP-QAPP requirements. The laboratory maintains these SOPs and the procedures will not be submitted as part of the Final Work Plan.
4	QAPP Worksheet #4		Several personnel are listed as "TBA." All personnel must be nominated and approved.	The worksheet is complete with the exception of telephone and fax contact information for Eugene Ferguson and Eliud Burgos. This information has been requested and, once received, will be included as a replacement page for Worksheet #3 in the UFP-QAPP (Appendix A).
5	QAPP Worksheet #7		Several personnel are listed as "TBA." All personnel must be nominated and approved.	All required information has been provided in Worksheet #7, UFP-QAPP (Appendix A).

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6	QAPP Worksheet #7		Under "Education and Experience Qualifications" only résumé available upon request or qualifications available on request is included. A résumé is not required, but the education and general experience qualifications must be included to satisfy the requirements of the form.	All required information has been provided in Worksheet #7, UFP-QAPP (Appendix A).
7	QAPP Worksheet #8		No special personnel training requirements are listed. HAZWOPPER training is for the response to a hazardous material spill response and hazardous waste handling. For instance, drill rig operators must have special training, and field sampling personnel are typically trained in collection, labeling, packaging and transport of samples. Need to document training and licenses for heavy equipment operators, as necessary. Hazardous waste transporters must have appropriate training and licenses.	Required information concerning training has been added to Worksheet #8, UFP-QAPP (Appendix A). Actual certificates for the drillers, etc. are not included, however, and can be requested from the driller and provided upon request.
8	QAPP Worksheet #10		The problem statement worksheet lacks clarity and includes descriptions of the project background, history, and current conditions, which should be placed elsewhere in the document to provide substantiation for the problem statement. It also includes descriptions of certain field activities which are part of the project scope and which will contribute to the final resolution, but are not necessarily part of the problem. This worksheet should be reduced to become a more concise discussion of the problem definition. The problem definition is limited to a single paragraph, paragraph two, and should be expanded to include the location of the RFA.	The problem statement in Worksheet #10, UFP-QAPP (Appendix A) has been rewritten for clarity and conciseness.
9	QAPP Worksheet #11		The first paragraph of this worksheet is the first time the project needs are succinctly stated. This paragraph should be included in the Executive Summary and in the text portion.	The information in the first paragraph of Worksheet #11, UFP-QAPP (Appendix A) has been incorporated into the Executive Summary of the Final Work Plan and is also included in Section 1 of the document.
10	QAPP Worksheet #14		Unfortunately, the data on this worksheet should be duplicated in the text portion of Appendix B.	The information presented in Worksheet #14 (UFP-QAPP [Appendix A]) and is duplicated in appropriate sections of the main text of the Final Work Plan in the following sections: • Section 3.3, Literature Search and Information Review

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Item No.	Section	Page No.	Reviewer's Comment	Comment Resolution
				• Section 4, Conceptual Site Model • Sections 6.2 and 6.4, Project Planning Chart and Scope of Field Activities • Section 8.5, Investigation-Derived Waste Management • Section 7.5, Field QC Samples • Section 13, Data Validation, Reduction and Reporting • Section 14, Performance Systems and Audits • Section 18, Reporting • Section 19, Data Management
11	QAPP Worksheet #14	p. 3 of 5, 1st paragraph	The current license of TestAmerica to do business with NMED must be given.	The NMED license from TestAmerica is included in Appendix A, at the end of Worksheet #7, UFP-QAPP (Appendix A).
12	QAPP Worksheet #15		This worksheet series describe laboratory SOPs. NMED will not review these SOPs and approval of the plan will not constitute approval of the SOPs. Licensed laboratories must have these SOPs on file along with a laboratory quality control plan that are reviewed by another agency.	The laboratory SOPs are noted by title, date, and revision in accordance with UFP-QPP requirements. These procedures are maintained by the laboratory and have not submitted as part of the Work Plan. These SOPs can be provided by the laboratory upon request.
13	QAPP Worksheet #16		Recommend including the project schedule with the figures. It is very difficult to find in this location, even with the crosswalk.	The project schedule is included in the Final Work Plan as Figure 6, Project Schedule.
14	QAPP Worksheet #17		Recommend stating that during sample collection activities personal protective equipment will include wearing clean, chemical resistant gloves and splash goggles. Any temporary erosion and sediment control during operation of the drill rig should be described in the text portion, and should cite reference in the field plan.	PPE requirements and use for sampling are included in Worksheet #17 (UFP-QAPP [Appendix A]) and Section 8.3 of the Final Work Plan. The temporary erosion and sediment control during operation of the drill rig has been added and described in Worksheet #17 (UFP-QAPP [Appendix A]) and in Section 8.1 of the Final Work Plan.
15	QAPP Worksheet #22		The make, model number, and response of the PID should be included. The person maintaining the PID should be shown as having the special training to calibrate and operate the device.	The make, model number, and manufacturer's specifications of the PID (MiniRAE® 2000) have been provided in Appendix A, UFP-QPP, as part of Worksheet #21 (UFP-QAPP [Appendix A]). The make and model number are also specified in Section 11 of the Final Work Plan. The reference for the Operation and Maintenance Manual for the PID is given, as well as the requirement for this

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				manual to be kept with field documentation and followed during the field investigation.
16	QAPP Worksheet #22		"Manufacturer's instructions" is too generic of a reference. PID is not very sensitive to long chain alkanes, which constitute most of TPH-DRO. Even though the particular manufacturer and model number may not be known, a typical should be given, along with any specific filters for the PID lamp that are used for TPH-DRO. These devices require training and experience to use reliably, and the training should be noted in Worksheet #8.	The specifications for the PID (MiniRAE® 2000) are included in Appendix A. Required on-the-job training are required for this field program is noted in Worksheet #8 of the UFP-QAPP (Appendix A).
17	QAPP Worksheets #23 – #25		This information must be available in the laboratory licensing documentation but should be removed from the QAPP submittal to NMED.	The laboratory licensing information has been included in the UFP-QAPP, Worksheet #7 (UFP-QAPP [Appendix A]).
18	Work Plan Introduction	p. 1-1, 4th paragraph	Last line. Appendix G has been removed.	The Environmental Health and Safety Plan (former Appendix G) has been removed from the document to be submitted to NMED. The contents of former Appendix G are now included as Appendix C in the Final Work Plan for reference by Tetra Tech and Cannon AFB.
19	Work Plan 6.4.3, Mobilization	p. 6-2	NMED has stated that plan writers must provide descriptions of proposed procedures, specific field methods and specific equipment to be used in the execution of the work plan, in the appropriate section(s) of the text of the work plans. The report states that "The equipment to be mobilized includes an HSA rig, CME 75 or equivalent; necessary tools; steam cleaner; sampling equipment; PID for field screening; global positioning system (GPS) unit; and support vehicles such as pickup trucks or vans. " Please supply details on how the equipment will be set up, oriented in the field, fueled, operated, and what measures will be taken to protect the environment immediately surrounding the drilling rig and associated equipment.	The SOPs, previously presented in Appendix C of the Draft Work Plan, have been incorporated into Section 8 of the Final Work Plan. Drilling methods and information on field equipment set-up are now included in Section 8.1.
20	Work Plan 6.4.3, Mobilization	p. 6-2	Since the drilling subcontractor is known and the make and model of drilling equipment is known, how the area will be protected during rig use should be discussed. Will the rig be delivered by pickup truck? Is the equipment diesel powered?	Information related to the drill rig and equipment to be used during the field program are presented in Section 8.1 of the Final Work Plan. Positioning of the rig and minimization of ground disturbance are also described in Section 8.1.

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			Will it require fuelling by hand? Will digging be required to level the rig? What is meant by "minimizing ground disturbance?"	
21	Work Plan Investigation Activities 6.4.4 and 6.4.4.1, Drilling	p. 6-2	"Drilling operations are described in Section 4.1 of the FSP (QPP Appendix C). Drilling will follow the procedures outlined in SOP D-1, Subsurface Soil Sampling (QPP Appendix D)." NMED has stated that plans must provide "descriptions of proposed procedures, specific field methods and specific equipment to be used in the execution of the work plan, in the appropriate section(s) of the text of the work plans" and the plan must also "fully describe all site specific procedures, specific field methods and specific field equipment actually used in field in the appropriate sections of the work plan." Appendix D has been removed, and therefore the important information in the removed SOPs must be included in the text.	Drilling operations are now specified in Section 8.1 of the Final Work Plan. Soil logging procedures are now presented in Section 8.2, while sampling procedures are described in Sedition 8.3.
22	FSP	General	The FSP contains several references to Appendix D, which will need to be removed. The activities must be described in text.	The activities described in the Draft Work Plan FSP have been incorporated into Section 8 of the Final Work Plan as requested.
23	FSP 4.3.2, Subsurface Soil Samples 4.3.2.1, Sample Collection	p. 4-2	This section is appropriately developed. However, in the past NMED has commented that "The Work Plan references surface and subsurface soil but does not specifically address the soil exposure intervals to be included in the risk assessments. The Permittee must identify the soil exposure intervals proposed for each receptor (human health and ecological) in the revised Work Plan." In order to satisfy the needs of NMED the appropriate data from the FSP should be set aside in clearly labeled tables.	Soil exposure criteria have been included in Section 4 of the Final Work Plan as part of the discussion of the human health and ecological conceptual site models.
24	FSP, Sample Custody	pp. 5-1, 5-2	Samples will be collected as described in this FSP and applicable field SOPs (QPP Appendix D). The field sampler will be personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched. Appendix D will need to be removed. This activity must be described in text.	Information from Appendix D has been moved to the work plan portion of the document. The field sampling activities are now described in Section 8.3 of the Final Work Plan. Sample custody procedures are now described in Section 9.

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Item No.	Section	Page No.	Reviewer's Comment	Comment Resolution
25	Appendix F, Forms	General	The compilation of forms in Appendix F is complete. However, since Appendix F is submitted as a stand alone appendix at least a list of forms should be included behind the cover page of the Appendix.	The forms are now included in Appendix B of the Final Work Plan as a reference intended for Tetra Tech, AFCEE, and Cannon AFB. A list of specific forms is included within the appendix. Appendix B and other appendices will not be included in the Final Work Plan submittal to NMED.
26	Appendix E Figures	General	Add a list of figures. To each figure place a note referencing the worksheet or page; i.e., see Worksheet #16.	The figures previously included in Appendix E of the Draft Work Plan have been moved to the main portion of the Final Work Plan. The list of figures is presented in the Table of Contents of the Final Work Plan.