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RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) FACILITY INVESTIGATION PROGRAM PLAN (U)

by

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This is a technical report

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**RCRA FACILITY INVESTIGATION
PROGRAM PLAN (U)**

**PREPARED FOR:
SAVANNAH RIVER SITE
AIKEN, SOUTH CAROLINA**

JUNE 30, 1989

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CHAPTER 1
OVERVIEW RFI PROGRAM PLAN

1.1 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation Program Plan has been developed to provide a framework for the completion of RCRA Facility Investigations (RFI) at identified units on the Savannah River Site (SRS) facility. As such, the RFI Program Plan provides:

- Technical guidance for all work to be performed
- Managerial control
- A practical, scientific approach

The purpose of this Overview is to demonstrate how the basic RFI Program Plan elements (technical, management, and approach) are interwoven to provide a practical and workable plan. The goal of the RFI Program Plan is to provide a systematic, uniform approach for performance and reporting. In addition, the RFI Program Plan has been developed to be specific to the SRS facility and to adhere to the Environmental Protection Agency (EPA) RFI guidance received as part of the SRS RCRA Part B Permit (Appendix W). The US EPA publication "Characterization of Hazardous Waste Sites" has been liberally adapted for use in this RFI Program Plan.

1.2 RFI PROCESS

1.2.1 RFI Program Defined

The Savannah River Site of the Department of Energy (DOE) manages certain waste materials which are regulated under the Resource Conservation and Recovery Act (RCRA). In particular, certain activities have required operating or post closure permits under RCRA. The RFI Program broadens the authority of EPA and SCDHEC to include the investigation of other potential waste sources at the facility. As such, the RFI Program is an extension of RCRA permitting and closure activities.

1.2.2 Regulatory Issues

RCRA regulated units are those surface impoundments, landfills, and waste piles (collectively termed "land disposal units") which have received hazardous waste since November 19, 1980. These "land disposal units" require a RCRA Operating or Post Closure Permit, unless hazardous constituents are removed to background levels during closure and no ground water impact has resulted.

The Resource Conservation and Recovery Act contains provisions in Section 3004(u) for:

- Investigation and corrective actions for releases of hazardous constituents from non-regulated units

Non-regulated units have been termed Solid Waste Management Units (SWMUs) and may represent:

- Any activity where hazardous constituents may remain uncontrolled and potentially released to the environment

SWMUs are subject to Section 3004(u) and include:

- All designated "land disposal units" which did not receive waste after July 26, 1982. This includes units that were inactive prior to November 19, 1980, with no further significant management activities
- Any non-regulated activity which could have potentially released hazardous constituents to the environment regardless of when such release occurred

1.3 SRS RFI PROGRAM PLAN

1.3.1 Introduction to the RFI Program Plan

A RCRA Facility Assessment (RFA) report of SRS inactive waste units was prepared by EPA Region IV. This report is contained in Appendix W as part of the SRS RCRA Part B Permit. The EPA identified SWMUs which are subject to the RFI process. Due to the number of RFI units identified, EPA and SCDHEC have required SRS to develop an RFI Program Plan, preliminary to generating unit-specific plans. The approval of the SRS RFI Program Plan by EPA and SCDHEC will allow subsequent unit-specific RFI plans, addressing all SWMUs, to be developed.

1.3.2 RFI Program Plan Function

The SRS RFI Program Plan has two basic functions:

1. The development of a generic plan to delineate standard investigative and management procedures.
2. The development of a prioritized schedule for the initiation and completion of the RFI process at all SWMUs.

1.3.3 RFI Program Plan Goals

The RFI Program Plan has been developed to accomplish the following SRS goals:

- Develop a uniform SRS-wide approach
- Ensure a quality product
- Ensure implementation of the uniform approach
- Ensure employee safety and health
- Provide a management framework for SRS
- Ensure practicality in RFI implementation
- Provide guidelines and oversight to implement the RFI at a reasonable cost while generating adequate information
- Utilize existing site information where possible

1.4 EPA RFI GUIDANCE

The RFI guidance, as provided by EPA, is contained in Appendix W.

In general, RFI plans will be developed to:

- Characterize the environmental setting
- Define the source of hazardous constituents
- Define the degree and extent of release of hazardous constituents
- Identify actual or potential receptors

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SRS has decided that RFI plans shall also contain the following:

- Identify hazardous substance receipt at unit
- Define the degree and extent of release of hazardous substances
- Health and Safety plan
- Quality Assurance/Quality Control plan
- Data Management plan

EPA has determined that all RFI plans will address the following impact media:

- Soils
- Ground Water
- Subsurface Gas
- Surface Water
- Ambient Air

The SRS RFI Program Plan contains specific guidelines thus providing a common approach for addressing all of the above.

1.5 RFI PROGRAM PLAN APPROACH

1.5.1 RFI Program Plan Outline

The SRS RFI Program Plan has been organized into the following chapters:

<u>Chapter</u>	<u>Content</u>
1	RFI Program Plan Overview
2	Safety, Health, and Emergency Response Plan
3	QA/QC Program Plan
4	Preliminary Unit Evaluation Requirements
5	Unit Screening Requirements
6	Soils Sampling Strategy Requirements
7	Ground Water Sampling Strategy Requirements
8	Surface Water/Sediment Sampling Strategy Requirements
9	Ambient Air Sampling Strategy Requirements
10	Data Management Requirements
11	Receptor Analysis Requirements
12	Schedule for Unit-Specific RFI Plans

1.5.2 RFI Program Plan Flowchart

Chapters 4 through 9 represent the chronological order in which the RFI plan will be developed and ultimately implemented. The Health and Safety, QA/QC, and Data Management Chapters (2, 3, and 10, respectively), are "stand alone" sections which will be uniformly adhered to for all units. The Receptor Analysis (Chapter 11) will be performed for all units, unless the Preliminary Unit Evaluation (Chapter 4) or the Unit Screening/Soil Confirmation Sampling (Chapters 5 and 6) has determined, and the regulatory agencies concur, that no further investigation will be required at a unit. The Unit-Specific Plans Flowchart (Figure 1-1) demonstrates the investigation chronology and decision tree flow

FIGURE 1-1

SRS RFI PROGRAM PLAN

UNIT-SPECIFIC PLANS FLOWCHART

path. Each sequential level of work effort is dependent on accumulated knowledge of the unit.

1.5.2.1 Preliminary Unit Evaluation

The Contractor shall assimilate and evaluate all existing information concerning an individual unit. For most units, some information exists regarding:

- Area geology/hydrogeology
- Historical unit use and material disposed
- Ground water quality
- Receptor identification

Chapter 4 of the RFI Program Plan details the type of information which will be evaluated and refers to checklists (Appendices B and C) which will assist in compiling the data.

As shown in the Figure 1-1 Flowchart, the output of the Preliminary Unit Evaluation will determine if a hazardous substance has been received at a site.

No further investigation will be required at a unit if:

- Sufficient evidence can be documented, as required by the Permit, that the unit never received a hazardous substance.

1.5.2.2 Unit Screening

The Preliminary Unit Evaluation will determine if a hazardous substance has been disposed of at a particular RFI unit or if there is a possibility of such activity. For units requiring investigation beyond the Preliminary Unit Evaluation, the Contractor will develop a Unit Screening plan. The Unit Screening investigative activity may include the following geophysical and geochemical methods:

- Geophysical Investigations including Ground Penetrating Radar (GPR) and Electromagnetics (EM)
- Soil Gas Analysis
- Confirmation Soils Analysis

The objectives of unit screening are:

- Hazardous substance source identification
- Hazardous substance material identification
- Determine general horizontal boundaries of impact

The Unit Screening Flowchart (Figure 1-2) demonstrates the decision tree process that the Contractor is to utilize. Should the Preliminary Unit Evaluation indicate a possibility of buried ~~containers~~, drums, etc., a Screening/Geophysical Investigation shall first be performed to locate such material. The methods and procedures for Screening/Geophysical Investigation are discussed in Appendix L. The use of other methods or procedures for Unit Screening Geophysical Investigations may be evaluated depending on the particular requirements of a given RFI unit.

FIGURE 1-2
SRS RFI PROGRAM PLAN
UNIT SCREENING FLOWCHART

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Proceeding beyond the geophysical investigation, the Contractor must consider the Preliminary Unit Evaluation results and choose the appropriate Unit Screening technique. If volatile organic compounds are known or suspected to have been disposed, a Screening/Soil Gas Analysis is required. The methods and procedures to perform a Screening/Soil Gas Analysis are discussed in Chapter 5 and Appendix K. If it can be thoroughly documented that no volatile organic compounds were disposed, the Contractor may proceed directly to Screening/Confirmation Soils Analysis. ~~This is (1) a screening for non-volatile organic compounds, metals, other inorganic compounds, and radioactive material, and (2) a verification of the absence of volatile organic compounds.~~ The methods and procedures for the Screening/Confirmation Soils Analysis are contained in Chapter 6.

The results from the RFI unit screening will provide the information necessary to justify continuing/discontinuing the unit investigation. For example, available data for the specific RFI unit may indicate a release of hazardous substances to the ground water. This information would have come to light during the Preliminary Unit Evaluation phase. Based on this information the RFI unit soils shall be deemed to have been potentially impacted. Knowledge of such information shall, in turn, trigger the iterative process herein. If the RFI unit screening process ascertains that the unit's soils have not been impacted, the investigation of the RFI unit shall be terminated. If the RFI Unit Screening results establish that the RFI unit's soils have been impacted, the investigation shall proceed to the Assessment phase.

As shown in the Unit Screening Flowchart, a Screening/Soil Gas Analysis which meets background conditions is always to be followed by Screening/Confirmation Soils Analysis. This step will ensure that quantitative analytical data verifies that hazardous substances are not present above background. Given this scenario, it is anticipated that no further investigation would be required. However, if chemicals are detected during the Screening/Confirmation Soils Analysis at above background concentrations, a complete Soil Assessment would be required. The background soil characterization methodology is discussed in Section 1.8.

1.5.2.3 Soils Assessment

A detailed Soils Assessment Sampling phase will be performed according to the methods and procedures outlined in Chapter 6 if the unit screening indicates the presence of hazardous substances above background.

If hazardous substances are detected in the soil profile during the Soils Assessment Sampling phase, the potential exists for impact to other media (as discussed below).

1.5.2.4 Ground Water, Surface Water, and Ambient Air Assessment

The positive identification of hazardous substances in the soil indicates potential impacts to ground water, surface water, and ambient air. Should the RFI unit be deemed to be a source of release of chemicals, all other media potentially impacted will be addressed. Chapters 7, 8, and 9 outline the methods and procedures to address these media. As in addressing the soil medium, minimal preliminary sampling of these three media will be used to indicate the order of magnitude of the potential impact. If no impact is determined for any particular medium during Preliminary Sampling, the more extensive Assessment Sampling will not be necessary. Once a source of hazardous material has been detected, the Contractor's responsibility is to:

- Determine the extent and magnitude of impact to the media, as required in the RFI Program Plan.

1.6 RFI MANAGEMENT PLAN

1.6.1 RFI Program Management Plan

SRS has developed a management framework plan for the RFI Program. This "RFI Program Management Plan" is sufficient to guide the development and implementation of the RFI work. It is incorporated by reference and attached as Appendix A.

1.6.2 Management Plan Flowchart

As illustrated in the previously discussed Unit-Specific Plans Flowchart (Figure 1-1), a decision tree framework has been developed for the RFI process. There are key points provided in the investigation of each unit where accumulated data will be reviewed and a flow path decision made.

A Unit-Specific Management Plan Flowchart (Figure 1-3) has been developed to establish reviews involving the SRS RFI Program Team (RFI PT). Flow path decisions will be obvious in some cases (i.e., where sufficient evidence is available to determine if a particular medium has been impacted).

1.6.3 Management Checkpoint System

In addition to providing a flow path decision, the periodic checkpoints allow a review of work performed. Also, the decision tree flow path must allow for iterations between the checkpoints. For instance, the initial Soils Assessment sampling phase at a unit may not fully characterize the horizontal extent of hazardous material. A second iterative effort may be needed to accomplish this. The checkpoint system will allow:

FIGURE 1-3
SRS RFI PROGRAM PLAN
UNIT-SPECIFIC MANAGEMENT PLAN FLOWCHART

- Review of accumulated data
- Flow path decisions to be made when adequate data exist
- Plans to be reviewed for iterative unit investigation

The purpose of the checkpoint system is to:

- Provide a mechanism to ensure SRS management of the RFI process
- Implement a uniform facility-wide approach
- Ensure unit-specific work plan practicality
- Control costs
- Provide for Contractor accountability
- Ensure that each of the five impact media have been adequately addressed and the extent of any hazardous material defined

1.7 CONTRACTOR WORK PLAN REQUIREMENTS

1.7.1 Work Plan Approach

The management plan flowchart/decision tree framework approach prohibits a Contractor from developing a total, comprehensive unit-specific RFI plan for any of the identified RFI units. For instance, hazardous substance impact to soils shall first be confirmed before any final plans are developed to address potential impact to ground water, surface water or ambient air.

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If no source is found, (i.e., in the soils assessment), then it is anticipated that ground water, surface water, and ambient air need not be assessed as part of the RFI. Sufficient information shall be developed to document that a release of hazardous substance is not possible. This information will be submitted to the regulatory agencies as required by the Permit.

1.7.1.1 Initial Unit-Specific Work Plan (Preliminary Unit Evaluation)

The Contractor will develop for RFI Team review initial unit-specific RFI plans which contain the following:

- Specific plans, methods and procedures to address the Preliminary Unit Evaluation including:
 - Reference to RFI Program Health and Safety, Data Management and QA/QC Plans

1.7.1.2 Unit-Specific Work Plan (Unit Screening Plan)

After completing the Preliminary Unit Evaluation, the Contractor will develop for RFI Team review (if necessary):

- A specific Unit Screening plan including:
 - Reference to RFI Program Health and Safety, Data Management and QA/QC Plans
 - Health and Safety plan revisions

1.7.1.3 Unit-Specific Work Plan (Soil Assessment Sampling Plan)

After completing the unit screening (see Management Plan Flowchart), the Contractor will develop for regulatory review (if necessary):

- A specific Soil Assessment Sampling plan based on information gathered in the Preliminary Unit Evaluation and Unit Screening efforts including:
 - RFI Program Health and Safety plan and revisions
 - RFI Program Data Management plan
 - RFI QA/QC plan
 - Receptor Analysis plan

Information gathered during the Preliminary Evaluation and/or Unit Screening may indicate the necessity of conducting concurrent investigations of other media (especially groundwater). In these cases, the soil assessment sampling plan shall be amended to include plans for assessing other media potentially impacted to expedite completion of the RFI.

1.7.1.4 Unit-Specific Work Plan (Media Specific Assessment)

After completing the soil assessment sampling or concurrently with the soil assessment phase depending on unit conditions, the Contractor will develop for regulatory review (if necessary):

- A specific ground water assessment plan and
- A specific surface water assessment plan and
- A specific ambient air assessment plan including:
 - Health and Safety plan revisions
 - QA/QC plan

- Data Management plan
- Receptor Analysis plan

1.7.2 Unit-Specific Management Plan Objectives

The Unit-Specific Management Plan shall be followed at all units in order to:

- Ensure uniformity of approach
- Adhere to the EPA RFI Guidance provided with the Part B permit
- Allow SRS to manage each unit in accordance with the Management Plan Flowchart
- Assure product quality
- Ensure that accepted investigative methods/procedures are used
- Ensure employee safety
- Ensure that accepted laboratory analytical methods are used
- Ensure satisfactory data management
- Provide a systematic approach
- Provide a framework for Contractor cost accountability

For certain RFI units, much investigative information is already available. In these cases, the SRS RFI Program Team may allow deviations from the Management Flowchart. Such

deviations will be allowed case-by-case but shall not, in any situation, contravene the intent and objectives of the RFI Program Plan.

1.7.3 Unit-Specific Plan Groupings

Chapter 12 of this RFI Program Plan, "Schedule For Unit-Specific RFI Plans", groups the identified RFI units by geography, similarity of wastes received, structural similarity, etc. Many of the plans will address multiple units which are grouped according to geographics, similarity of waste received, or common use.

1.7.3.1 Plan Requirements For Multiple Unit Groups

For any of the groups involving multiple units, one "unit- specific" RFI plan will be developed and contain the following:

- A common Health and Safety Plan
- A common QA/QC Plan
- A common Data Management Plan
- A common Schedule
- Individual Preliminary Unit Evaluations, (unless the units are contiguous)
- Individual Unit Screening, Soils, Ground Water, Surface Water, and Ambient Air Plans, (unless the units are contiguous)
- Individual Receptor Analysis Plans, (unless the units are contiguous)

1.8 BACKGROUND SOILS CHARACTERIZATION

1.8.1 Background Soils Characterization Approach

Prior to development of the specific Unit Screening or Assessment Sampling plan (Soil Assessment Sampling Plan, Plan No. 3, Section 1.7.1.3), background soils analytical data for the RFI Program shall be developed by SRS and provided to the Contractor. Each RFI unit shall be placed into one of six major geophysical groupings based on common soil profiles. The grouping of the RFI units into these profiles for background soils analysis purposes will result in the following:

- A reduction in the number of background areas to be analyzed
- Completion of background soils characterization prior to actual constituent analysis of the soils at any RFI unit
- A uniformity in the sampling and analytical methods used

1.8.2 Background Soils Characterization Procedure

The background soils in each of the geographic areas will be characterized according to the following step-wise procedure. This procedure is described for the Contractor's information only, because all background data will be generated prior to RFI unit investigations.

Background soils samples will generally be taken in appropriate areas not affected by plant operations. Where background contamination is present, the source of this contamination will be identified.

1. A suitable background area, which has not been impacted by waste disposal units, will be located on elevated ground and upgradient to the surface water and ground water flow directions.

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2. One or more soil test borings will be advanced to a depth of 10 or 20 feet at each background soil test unit. Soil samples will be collected from each soil horizon and from the underlying parent material.
3. Samples will be analyzed for the following parameters:

Physical Parameters

Soil classification
Soil grain size analysis
Mineral content
Cation exchange capacity analysis
Soil pH
Exchangeable Acidity
Exchangeable Base/Metals

Chemical Parameters

Primary Metals/Inorganics

Arsenic
Barium
Cadmium
Chromium

Other Parameters

Chloride
Cyanide
Fluoride
Lithium

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Chemical Parameters (Continued)

Primary Metals/Inorganics

Lead
Mercury
Selenium
Silver
Aluminum
Copper
Iron
Manganese
Nickel
Potassium
Sodium
Thallium
Zinc

Other Parameters

Magnesium
Manganese
Nitrate
Phosphorus
Sulfate

Radionuclides

Gross Alpha
Gross Beta
Strontium
Uranium

Organics

Appendix VIII (RCRA)
Total Organic Carbon

1.8.3 Use of Background Analytical Data

Each Contractor conducting unit investigations will be provided the background soils analytical data prior to performing unit RFI investigations. Unit-specific, rather than geographically-common, background conditions will be established for ground water, surface water/sediment, and ambient air sampling, when required.

CHAPTER 2: CONTENTS

SAFETY, HEALTH AND EMERGENCY RESPONSE PLAN (SHERP)

- 2.1 Introduction
- 2.2 Coordination and Responsibility
- 2.3 Training of Personnel
- 2.4 Medical Surveillance and Bioassay
- 2.5 Recordkeeping
- 2.6 Required Personal Protection Equipment and Procedures
- 2.7 Standard Safety Procedures and Controls
- 2.8 Decontamination Control Measures
- 2.9 Emergency Procedures and Equipment
- 2.10 Emergency Spill Response
- 2.11 Emergency Services and Telephone Numbers

CHAPTER 2

SAFETY, HEALTH AND EMERGENCY RESPONSE PLAN (SHERP)

2.1 INTRODUCTION

DOE-SR historically has emphasized safety as an essential element in all activities. The following chapter summarizes the major sections to be addressed in a Safety, Health and Emergency Response Plan (SHERP). For each unit-specific RFI Plan, the Contractor shall develop a unit-specific SHERP. This plan shall establish in detail the protocols necessary for protecting on-site personnel, the public and the environment from any physical, chemical, radiological and/or biological hazards associated with the on-site activities.

Work within any radiation control zone or other areas which could endanger the health and safety of any on-site employees or personnel shall not commence until approved by SRS Health Protection (HP), and the Department of Energy Savannah River Waste Management and Safety Division (DOE-SR/WM and SD). The SHERP shall be submitted to the SRS RFI Program Team (RFI PT) for approval prior to the Notice to Proceed. The following documents along with those given in Appendix D, shall be consulted in the preparation of the SHERP.

- OSHA standards 29 CFR 1910, 1904 and 1926, specifically 29 CFR 1910.120 (the new Interim Final Rule dated 12-19-86) "Hazardous waste operations and emergency response"
- SRS Health Protection DPSOP 40 Series
- SRS DPSOP-254, Hydrogeologic Data Collection (This document has been provided separately to the regulatory agencies.)

- EPA "Standard Operating Safety Guides," November 1984
- NIOSH/OSHA/USCG/EPA "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985
- NIOSH "A Guide to Safety in Confined Spaces," July 1987
- SRP Safety Guidelines for Subcontractors, April 1, 1986
- Safety Information for Savannah River Plant Subcontract Personnel, May 1986
- DOE-SR Safety, Health and Fire Protection Orders, 5480 Series
- National Drilling Federations Drilling Safety Guide
- National Water Well Associations Manual of Recommended Safe Operating Procedures and Guidelines for Water Well Contractors and Pump Installers

2.2 COORDINATION AND RESPONSIBILITY

The SRS RFI Program Team shall not allow work to begin until a unit-specific SHERP has been provided to, reviewed, and signed by all field supervisory personnel. The Contractor will provide the unit control necessary to carry out the provisions of the SHERP. The overall responsibility for the health and safety of Contractor project personnel lies with the Contractor. The Contractor Unit Health and Safety Officer (HSO) will be responsible for ensuring that the SHERP is complied with during all unit operations. The HSO should be able to countermand the field manager and cease work should health and safety conditions warrant. The stop-work and/or evacuate authority of the SRS Program Coordinator (SRS RFI PC) and HSO shall also transcend contractor-subcontractor arrangements. See Figure 2-1 for RFI unit health and safety chain of command. Any subcontractors shall be provided with a copy of this SHERP and shall comply with all aspects of the SHERP.

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FIGURE 2-1
SRS RFI PROGRAM PLAN
RFI UNIT HEALTH & SAFETY
ORGANIZATION CHART

2.3 TRAINING OF PERSONNEL

Unit-specific training shall be carried out by the unit HSO before entry to the SWMU. This shall consist of a review of the specific chemicals of concern, risks, symptoms of exposure and an overview of the SHERP to include delineation of work zones, access, decontamination protocols, safety procedures and emergency contacts. SRS HP will provide instruction for Contractor personnel involved in unit operations at suspect radioactive units. HP Area Survey will review the Contractor's Work plan to develop monitoring requirements mandated by the specific unit and each work activity.

The Contractor shall identify the responsible individual to act as the unit Health and Safety Officer (HSO). A second person shall also be identified as an alternate should the primary HSO be absent from the field unit. The HSOs will ensure that additional field crew members also be trained, tested, qualified and knowledgeable of the SHERP and unit conditions. All unit personnel will be subject to review by the SRS RFI PT.

2.4 MEDICAL SURVEILLANCE AND BIOASSAY

The Contractor shall provide medical surveillance support for its unit employees. The Medical Surveillance Program is the core element of the Contractor Health and Safety Plan that provides maximum assurance of employee safety and liability protection. The intent of this program is to detect deleterious consequences of occupational exposure to hazardous substances and physical stresses, particularly those associated with the work environment at hazardous waste units. The Surveillance Program is designed to monitor specific physiological conditions and mechanisms that may be affected by non-episodic exposure as well as to provide acute or episodic medical care as needed. The SRS RFI PT reserves the right to initiate unannounced medical examinations and bioassays.

2.5 RECORDKEEPING

The Contractor shall maintain logs and reports sufficient to document the implementation and execution of the personnel protection program. This documentation shall consist of

medical surveillance files, training files, daily logs and accident reports as required by relevant DOE orders.

2.6 REQUIRED PERSONAL PROTECTION EQUIPMENT AND PROCEDURES

Personal protective equipment (PPE) and operational procedures will be determined based on professional decisions gathered from available analytical and toxicological data as shown in Appendices E, F, G, and H. The minimum PPE for any work activity on the RFI units is as follows:

- Blue disposable coveralls, Tyvek or equivalent
- Rubber boots
- Chemical resistant/rubber gloves
- Safety glasses
- Hard hats
- Hearing protection (if permissible noise exposure exceeded)
- Face Shield (if specific unit conditions warrant)

During work activities in areas with volatile organic compounds, respirator use according to airborne concentrations shall be as follows:

<u>Concentration</u>	<u>Equipment</u>
- Detectable to 1 ppm	half mask organic vapor
- >1 to 10 ppm	full mask organic vapor
- >10 to 100 ppm	supplied air or SCBA
- 100 ppm	supplied air with escape pack or SCBA
- above 200 ppm	Requires special work plan authorized by SRS HP and DOE-SR SD

For conditions requiring protection against inhalation of airborne radioactive species, or other special situations, SRS HP Area Survey will provide guidance for the selection of the most practical methods.

2.7 STANDARD SAFETY PROCEDURES AND CONTROLS

Standard safety procedures shall be followed during all RFI investigations. These precautionary measures are designed to reduce the risks of inadvertent or accidental chemical exposure or injury to personnel during on-unit operations. Personal precautions and operational requirements defined in each unit-specific SHERP shall be followed by all unit personnel. However, no field operation is without some degree of risk. For this reason, a minimum of two people shall be assigned at all work units; each shall stay within voice contact at all times.

Whole body counts and biological sampling may be conducted for certain work activity at units identified by the HP Area Survey and Industrial Hygiene Group. The need and frequency of this monitoring will be the responsibility of SRS HP and based upon the work plan submitted by the Contractor prior to work activities. SRS HP Industrial Hygiene Group will be consulted for guidance on personnel monitoring and bioassay requirements for potential nonradioactive chemical exposures.

2.8 DECONTAMINATION CONTROL MEASURES

When high concentrations of hazardous/radioactive substances are exposed, work zones shall be established within specific units to reduce the potential for the accidental spread of these substances by workers or equipment. The flow of personnel and equipment between zones shall be controlled through access and egress points designated by the Contractor HSO. Three general areas of operation shall be established to reduce the risk of personnel exposure to hazardous substances. The control scheme is graphically represented in Figures 2-2 and 2-3. The three areas are:

Figure 2-2
Generic Schematic for RFI Site Control
General

Figure 2-3
Generic Schematic for
Equipment/Personnel Decontamination
Control

- Exclusion Zone (Zone A)
- Contamination Reduction Zone (Zone B)
- Support Zone (Zone C)

The use of the three-area designation with access/egress control points coupled with established decontamination procedures provides reasonable assurance against the translocation of contaminants. This system of control is based on a "worst case" situation. Less stringent unit control and decontamination procedures may be utilized based upon field activities and results of Contractor monitoring data.

2.9 EMERGENCY PROCEDURES AND EQUIPMENT

Some risk of personal injury or chemical exposure is inherent in waste unit activities. These risks and the effects of unpredictable events such as accidental injury, chemical exposure, fire or explosion shall be minimized by adhering to good work practices, using personal protective equipment appropriate to the existing field conditions, performing adequate monitoring of individuals and ambient field conditions, and staying alert both for personal performance and for that of co-workers. In the event that an accident occurs, all on-site personnel are to follow the procedures developed in the unit-specific SHERP. Contact shall be made to the appropriate authorities depending on the extent and nature of the incident.

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2.10 EMERGENCY SPILL RESPONSE

In the event of any spill, the Contractor HSO shall notify the SRS Emergency Operations Center (EOC). The Contractor shall immediately initiate necessary containment measures. In the case of minor spills, the Contractor shall exhume the impacted soils and properly dispose of such. Should a larger spill occur (which the Contractor cannot adequately respond to or which may result in any off-site impact) the SRS EOC shall be asked to immediately mobilize the SRS Spill Response Team.

2.11 EMERGENCY SERVICES AND TELEPHONE NUMBERS

Good judgment shall always be used to avoid needlessly jeopardizing lives in attempts to respond to emergency situations. In extremely hazardous conditions await emergency service. The appropriate contact(s) from the following list shall be made for emergency situations.

	<u>Commercial No.</u>	<u>Site No.</u>
● SRS Emergency Operations Center (first priority contact - operator will contact ambulance and other emergency help as appropriate)	725-2117	5-2117
● Ambulance	557-4122	7-4122
● Fire Protection		7-4000
● Wackenhut Security		7-8420
● Area Emergency Coordinator	Varies	

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QA/QC PROGRAM PLAN

- 3.1 Introduction
- 3.2 Organization
 - 3.2.1 QA Requirements
 - 3.2.2 Control of Purchased Services
 - 3.2.3 Document Control
 - 3.2.4 Training Requirements
 - 3.2.5 Unit Inspections and Audits
 - 3.2.6 Control of Non-Conformances
- 3.3 General QC Requirements for Sampling and Field Measurements
 - 3.3.1 Sample Order
 - 3.3.2 Control of Measuring and Test Equipment
 - 3.3.2.1 Calibration Identification
 - 3.3.2.2 Calibration Standards
 - 3.3.2.3 Calibration Frequency
 - 3.3.3 Documentation Procedures for Preparation of Reagents or Supplies Which Become Part of the Sample
 - 3.3.4 Sample Container Preparation
 - 3.3.5 Sample Identification and Labeling
 - 3.3.6 Field Notes
 - 3.3.7 Photographs
 - 3.3.8 Sample Handling
 - 3.3.9 Sample Chain of Custody
 - 3.3.9.1 Chain of Custody Record Form
 - 3.3.9.2 Completed Chain of Custody Record Form
 - 3.3.10 Request for Analysis
 - 3.3.10.1 Completed Request for Analysis Form
 - 3.3.11 Sample Packing
- 3.4 Media Specific QC Considerations

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3.4.1 Soil Sampling QC Methodology

- 3.4.1.1 Predetermine Sampling Location
- 3.4.1.2 Container Type and Preservation Requirements
- 3.4.1.3 Soil Sampling Equipment Decontamination Procedures
- 3.4.1.4 Field Analytical Instruments
- 3.4.1.5 Surface and Shallow Soil Sampling Procedures
- 3.4.1.6 Intermediate Depth Soil Sampling
- 3.4.1.7 Deep Soil Sampling
- 3.4.1.8 Organic Vapor Screening
- 3.4.1.9 Field Quality Control Samples

3.4.2 Ground Water Sampling QC Methodology

- 3.4.2.1 Predetermine Sampling Locations
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- 3.4.2.4 Field Analytical Instrument Decontamination
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- 3.4.2.6 Submersible Pump QC Procedures
- 3.4.2.7 Field Quality Control Samples
 - 3.4.2.7.1 Quality Control Duplicate/Split Samples
 - 3.4.2.7.2 Sampler Rinsate Samples
 - 3.4.2.7.3 Trip Blank Samples

3.4.3 Surface Water/Sediment Sampling QC Methodology

- 3.4.3.1 Sampling Point Locations
- 3.4.3.2 Container Type and Preservation Requirements
- 3.4.3.3 Field Equipment Calibration
- 3.4.3.4 Decontamination Procedures
- 3.4.3.5 Surface and Deep Water Sample Collection
- 3.4.3.6 Sediment and Sludge Sample Collection
- 3.4.3.7 Field Quality Control Samples

3.4.4 Ambient Air Sampling QC Methodology

- 3.4.4.1 Sampling Point Locations
- 3.4.4.2 Sampling Equipment Calibration and Preparation
- 3.4.4.3 Container Type and Preservation Requirements
- 3.4.4.4 Decontamination Procedures
- 3.4.4.5 Equipment Operating Procedures
- 3.4.4.6 Sample Collection and Handling Procedures
- 3.4.4.7 Field Quality Control Samples

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- 3.5 Laboratory QA/QC
- 3.6 Required Documentation
 - 3.6.1 Contractor Deliverables and Record Requirements
- 3.7 Storage of Contractor Deliverables and Records
- 3.8 Training Requirements
- 3.9 Unit Inspections and Audits
- 3.10 Control of Nonconforming Items

CHAPTER 3

QA/QC PROGRAM PLAN

3.1 INTRODUCTION

This document describes the Quality Assurance (QA) and Quality Control (QC) requirements which shall provide general guidance for consultants, subcontractors or laboratories in preparing and implementing a QA/QC Plan which is necessary for RCRA Facility Investigations at the Savannah River Site. This guidance is prepared to complement, (but not supersede), the SRS QA Manual. It describes the methods and approaches for providing quality control of field activities which are consistent with the requirements of SRS and DOE QA programs. A unit-specific QA/QC Plan will be submitted as part of each RFI and will address the requirements outlined in this generic plan.

The emphasis of this QA Program is on all activities which generate analytical data. Specific requirements are provided for the sampling and analysis of soils, ground water, surface water, subsurface gas, and ambient air. The general procedures described herein are applicable to most field exercises. The primary purpose of this plan is to ensure that samples and measurements taken for the purpose of monitoring and assessment are representative of the environmental conditions at the site.

In implementing a QA/QC Plan, it is important to understand the difference between QA and QC. QA refers to the system whereby an organization provides assurance that monitoring of quality-related activities has occurred. The QA is the recordkeeping and management system which ensures proper documentation of all activities including traceability, completeness and security.

The key QA elements applicable to the RFI process and addressed in this chapter are:

- Organization
- Control of Purchased Services
- Document control
- Training Requirements
- Unit Inspections and Audits
- Control of nonconforming items

QC refers to those activities which provide for the control and measurement of the characteristics of an item or process in accordance with established requirements. The key QC elements applicable to RFIs and addressed in this chapter are:

- Specific sampling methodology
- Quality control samples
- Decontamination
- Sample handling and packaging

As appropriate, applicable QC elements for a specific RFI shall also be incorporated into operating procedures to ensure that samples are representative of a unit environment, and that field measurements and sample analyses are sufficiently precise and accurate.

The QC requirements of appropriate laboratory analyses performed during RFI projects will be the applied protocols of the EPA Contract Laboratory Program (CLP). Key laboratory QC elements include:

- Method blanks
- Laboratory control samples
- Calibration check samples
- Replicate samples
- Matrix-spiked samples
- Control charts
- Surrogate samples
- Zero and span gases
- Reagent quality control checks
- Preservative
- Container

3.2 ORGANIZATION

3.2.1 QA Requirements

Each unit-specific QA/QC plan shall describe the organizational structure of the department or Contractor organization involved in the RFI project.

The Plan shall describe the functional and administrative responsibilities and interfaces of the Contractor organization. In addition, job descriptions shall be developed and documented for key functional positions. The descriptions shall include the responsibilities and activities performed by key individuals in specific assignments and include the minimum experience and physical qualification requirements.

The Contractor shall become thoroughly familiar with the QA/QC requirements outlined in the SRS QA Manual for the Petrochemicals Department of E.I. DuPont de Nemours Co.

The SRS and projected Contractor QA organizational structure and interface associated with the RFI project are shown in Figure 3-1. It shall be the responsibility of the Contractor to become thoroughly familiar with SRS and the SRS Quality Assurance Organization, which are described in the SRS QA Manual Procedure QAP 1.1.

3.2.2 Control of Purchased Services

The SRS RFI Program Team will be responsible for ensuring that all required documents are obtained/stored in accordance with SRS QA Procedure 17.1. All documents so identified shall become the exclusive property of SRS and shall not be released by Consultants or Contractors without the express written permission of SRS & DOE.

The Contractor shall, at a minimum, deliver the following documents to the RFI Program Team:

- Unit-Specific RFI Work Plan
- Unit-Specific RFI Report

FIGURE 3-1

SRS RFI PROGRAM PLAN

QA ORGANIZATION AND INTERFACES

- Any and all progress/interim reports required by Part V of the SRS Hazardous Waste Permit
- Any other applicable documents requested

3.2.3 Document Control

All operational procedures associated with sampling and field measurement shall be controlled to ensure that the latest revisions of approved procedures are used. A procedure index shall be readily available to appropriate personnel for reference to confirm the latest revision of procedures. A procedure for handling temporary changes shall be documented. All procedures shall be retained as records in accordance with the requirements of this chapter and the SRS QA Manual.

3.2.4 Training Requirements

Personnel involved in RFI activity at the SRS shall be trained such that they fulfill the qualifications/requirements for their respective assignments. The training shall be documented to the satisfaction of the SRS RFI Program Team. The documentation shall demonstrate adequate preplanning and successful completion of necessary training elements. Records shall be maintained for each individual by his parent organization while that person is on a particular RFI assignment. Contractors shall submit resumes of all key employees who will be involved in RFI activity at the SRS. These resumes will outline the qualifications of key Contractor personnel. The resumes will be submitted as an Appendix to the RFI Work Plan. The SRS RFI Program Team will review and approve all key Contractor personnel selected for involvement in RFI activity at the SRS.

3.2.5 Unit Inspections and Audits

The SRS RFI Program Team shall have the authority to conduct unit investigations and audits, (or to authorize same), of both RFI field work and laboratory analytical work. These inspections/ audits shall be conducted in accordance with SRS QA Procedure 18-1.

Should a non-conformance be identified, the RFI Program Team shall have the authority to stop the Contractor's work until the situation is corrected.

3.2.6 Control of Non-Conformances

Non-conformances shall be identified, corrected, and documented. After identification/detection; tagging, segregation, or stop work order action, (as appropriate), shall be taken to preclude further use until proper disposition is determined and completed. The effect of the non-conformance upon the RFI activity shall be brought to the attention of the RFI Program Team for review, evaluation and corrective action. Control of non-conformances shall be in accordance with SRS QA Procedure 15-1.

3.3 GENERAL QC REQUIREMENTS FOR SAMPLING AND FIELD MEASUREMENTS

This section describes the methods and approaches for providing Quality Control procedures for field sampling and measurement. The information discussed within this section is applicable to all media (i.e., soils, ground water, subsurface gas, surface water and ambient air) under investigation as part of the RFI. The specific objectives are to:

- Establish standard field sampling and measurement practices and methods for all RFIs
- Establish procedures for demonstrating the consistency of sampling and measurement methods
- Assist in recognition of deficiencies which may affect the quality of data obtained by the sampling efforts
- Develop the methodology to verify the quality of the data submitted to SCDHEC and EPA

3.3.1 Sample Order

To minimize cross-contamination, the sampling order at all units shall begin with background or ambient samples and end with samples where contamination is expected to be the highest. The sample order shall be determined prior to the actual sampling event. A site map showing physical features of the specific unit shall be considered in determining sampling order.

3.3.2 Control of Measuring and Test Equipment

This section describes procedures to ensure that field instruments used throughout the RFI Program are properly calibrated and that the calibrations are adequately documented. For RFI investigations, proper calibration is required of all measuring and test equipment. Improperly calibrated field instruments will have serious negative impact on the precision and accuracy and thus the validity of the field measurements.

The calibration policies and procedures set forth will apply to all measuring and test equipment. This includes tools, gauges, instruments, standards and other devices/systems used to make measurements or used to monitor the safety of personnel and the environment. All measuring and test instruments fall into three general categories: those which are calibrated prior to each use, those which are calibrated on a scheduled or periodic basis, and those used for references.

All equipment which requires calibration will have an assigned identification number permanently affixed to the instrument. For measuring and test equipment requiring periodic calibration, a label will be affixed to each instrument showing:

- Description
- Manufacturer
- Model number

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- Serial number
- Date of last calibration or maintenance
- By whom calibrated/maintained
- Due date of next scheduled calibration

A master list of all equipment used for a specific RFI shall be prepared and maintained with the above information.

Calibration reports and compensation or correction figures will be maintained with the instrument. Thermometers are exempted from the labeling requirement, but not from the calibration requirement.

A written stepwise calibration procedure must be available for all measuring and test equipment prior to field work. Any instrument which is not calibrated to within the required specifications must display a warning tag to prevent the use of the equipment. Equipment unable to meet approved calibration specifications shall not be used. The required calibration ranges and uncertainties for each measuring and test device shall be documented.

3.3.2.1 Calibration Identification

Instruments past due for calibration or maintenance must be immediately removed from service, either physically or, if this is impractical, by tagging, sealing, labeling, or other means. It shall be the responsibility of the Contractor to provide all calibration and maintenance of equipment based on manufacturer specifications or documented requirements prior to use. Likewise, the Contractor shall be responsible for maintaining the required record-keeping system pertaining to calibration and maintenance of equipment including the tagging of equipment not meeting the required standards.

3.3.2.2 Calibration Standards

All physical, electronic, or chemical measurements or calibrations performed must be traceable, directly or indirectly, through an unbroken chain of properly conducted calibrations (supported by reports or data sheets). All measurements and calibrations shall be referenced to National Bureau of Standards (NBS) recognized standards or physical constants, or to standards prepared by nationally recognized procedures. Reports must be up-to-date for each reference standard and each subordinate standard used for calibration of measuring and test equipment. All standards shall have an uncertainty rating of no more than one-fourth of the specified uncertainty for the measuring or test equipment under calibration.

3.3.2.3 Calibration Frequency

At a minimum, calibration and maintenance intervals for field instruments must be those recommended by the respective manufacturers, unless experience dictates a shorter interval. When the manufacturer has not specified a calibration interval for the equipment, the interval will be established in writing by the user of such equipment and approved by the SRS RFI Program Team. Adherence to the calibration schedule is mandatory. The fact that these calibrations may be performed by an outside source does not exempt the user from the responsibility for identifying, monitoring, and controlling calibration intervals and ensuring that maintenance checks are made on time.

Documentation of field instrument calibrations shall be the responsibility of the Contractor. All calibration records shall be maintained in a Field Instrument Calibration Note Book. This note book shall contain the instrument operation manual including the specific calibration procedure for that instrument. In addition, the following information shall be recorded in the note book on a log sheet similar to Figure 3-2:

- Equipment Type (e.g., pH meter)
- Manufacturer and Model Number

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- Serial Number
- Recommended Calibration Frequency
- Date of Latest Calibration
- Dates of Field Measurement (use)
- Name of Person Who Calibrated Instrument
- Calibration Standards Used
- Source of Calibration Standards

Entries in the log book shall be made at the beginning of each sampling or measuring effort and when each instrument is calibrated. All documentation in the log book shall be made in ink. If an error is made, corrections shall be made by crossing a line through the error and entering the correct information. Changes shall be dated and initialed. No entries shall be obliterated or rendered unreadable. Records shall be kept for all instruments requiring calibration including, but not limited to:

- pH Meters
- Specific Conductance Meters
- HNu Photoionization Detectors
- Organic Vapor Analyzers (OVA)
- Explosimeters
- Ground Penetrating Radars

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- Radioactive Decay Counters
- Non-contact Terrain Conductivity Meters
- Oxygen Meters
- Flow Meters
- Digital Thermometers
- Portable Gas Chromatographs
- Survey Equipment

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Figure 3-2

Sample Instrument Calibration

Make

Model #

Serial #

1. **Recommended Calibration Frequency:** _____
2. **Last Calibration Date:** _____
3. **Calibrated By:** _____
4. **Calibration Standards Used:** _____
5. **Source of Calibration Standard:** _____
6. **Calibration Procedure Used** if more than one method in manual _____
7.

Usage Date	<u>Sample ID Number</u>	<u>Location</u>
_____	_____	_____
_____	_____	_____

3.3.3 Documentation Procedures for Preparation of Reagents or Supplies Which Become Part of the Sample

All reagents or supplies which become an integral part of the sample must be properly prepared and documented. A bound log book shall be maintained concerning the use and preparation of chemicals, reagents or other materials (i.e., filter media) which are used on a specific RFI project. This record will include:

- Preparation Date
- Preparer's Name
- Expiration Date
- Measurements Made During Reagent Preparation (e.g., individual chemical weights or volumes)
- Reference Chemicals or Materials Used
 - Date of Receipt
 - Source
 - Purity
 - Chemical Composition
 - Expiration Date

This log book shall be maintained by the Laboratory Project Manager or his designee.

3.3.4 Sample Container Preparation

The preparation procedures are designed to provide maximum confidence that containers used to ensure sample integrity from the time of collection to the time of analysis do not introduce foreign substances (contamination) to such samples. Because of the possibility of contamination existing in even new containers, all containers (regardless of age) used in the sampling event shall be cleaned according to the procedures listed below. These procedures will not apply to manufacturer prepared sample containers or cartridges used to collect air and subsurface gas samples. Any containers that are provided for sampling use, in any media, that are certified clean from the manufacturer or Contractor laboratory will be exempted from these cleaning requirements. All containers shall be cleaned in accordance with the procedures listed in Test Methods for Evaluating Solid Waste, EPA SW-846, November, 1986. One percent of the cleaned containers supplied by the laboratory contractor for an RFI project shall be retained as container blanks subject to the requirements of the CLP program guide. The cleanliness of the containers shall also be verified through the use of trip blanks.

3.3.5 Sample Identification and Labeling

Proper sample identification is an essential part of any field sampling project. Because of its importance to accurate data acquisition, documentation and labeling of samples in the field is necessary. Each sample shall be identified in the field log book and on the sample container label. The sample label shall include the following information:

- Date and Time
- Sample ID number
- Project Number
- Sampler (name)

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- Sample location
- Preservative (if any)
- Matrix Type

Sample identification number as referenced above as part of the sample label will identify the following information in sequence as listed:

- Sample Identification Code
- Sample Matrix Type

All RFI units are identified by the unit facility code which shall be used as part of the sample identification number.

The matrix type will be identified according to the following codes:

S - Soil

A - Air

G - Subsurface Gas

W - Surface Water

X - Ground Water

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The sequence of the samples taken during a sampling date will be included in the sample identification number. This sequence number shall be identified through the chronological sampling order. This number will be important in determining the number of invalid samples if cross-contamination between samples, due to equipment or personnel, occurs or is suspected.

For example, the second soil sample collected from the second coring at 643-7G on May 9, 1988 would have a sample identification number as follows:

RBG7G0202/S

The date would be entered under the heading sample date.

When existing ground water monitoring wells are sampled, the sample identification system currently in use by SRS shall also be used by the Contractor. It shall be the responsibility of the Contractor to ensure that the monitoring well identification number used by SRS is maintained in all documents and reports generated. Similarly, surface water samples taken from NPDES outfalls shall be identified by the established SRS identification.

3.3.6 Field Notes

Field notes provide evidence attesting to the quality of the RFI, and shall be designated as records and must comply with all requirements outlined in the SRS QA Manual, QA Procedure 17-1, for nonpermanent records. Contractors must relinquish log book entries in accordance with the schedule established by the SRS RFI Program Team.

A bound field log book shall be maintained by the field sampling team manager to provide a daily record of events. At the beginning of each entry, the following shall be recorded:

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- Date
- Time
- Meteorological conditions
- Field personnel present
- Level of personal protection
- Signature of the person making the entry

Field log books shall provide the means of recording all data regarding sample collection. As such, entries shall be described in as much detail as possible so that essential information is properly documented. All documentation in field books shall be in ink. If an error is made, corrections shall be made by crossing a line through the error and entering the correct information. Changes shall be dated and initialed. No entries shall be obliterated or rendered unreadable.

A simple drawing of the unit (not to scale) shall be included in the log book to provide an illustration of all sampling points.

The cover of each log book used shall contain:

- Person or organization to whom the book is assigned
- Book number
- Project name, number

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- Start date
- End date

Entries in the log book shall include at a minimum the following for each sample date:

- Unit identification
- Location of sampling points
- Description of sampling points
- References to photographs of the RFI unit and brief sketch of sampling points
- Sample Identification Number
- Number of samples taken
- Time of sample collection
- Reference to sample location map
- Number of QA samples taken (e.g. duplicates)
- Collectors' names
- Field observations
- Sample distribution (e.g., QA laboratory, agency split)
- All field measurements made (e.g. pH, temperature, specific conductance)

3.3.7 Photographs

The Contractor field manager and the RFI Program Team shall determine the need for photographs for documentation purposes. The RFI Program Team shall arrange for a SRS photographer to take all photographs. Photographs shall be considered non-permanent records and shall meet the requirements of SRS QA Manual, QA Procedure 17-1.

Photographs shall be taken to document unusual sampling locations or conditions and all other pertinent information such as unit topography and current unit conditions. The name of the photographer, date, time, unit location and unit description shall be entered sequentially in the field log book as photos are taken. All film and photographs taken within SRS will be approved by the SRS RFI Program Team and shall become the property of SRS. The Contractor shall be responsible for documentation of photographs taken by the SRS photographer for a specific RFI unit.

Special lenses, films, filters, or other image enhancement techniques must be noted in the field log book. However, aperture settings and shutter speeds for photographs taken within the normal automatic exposure range need not be recorded. The following table summarizes pertinent notes in regard to accurate photography:

- 35 mm color slides shall be used unless specified otherwise
- Photos shall show surrounding area and reference objects for scale
- Picture number, roll number (if more than one roll of film is used), and description of picture shall be logged in the field note book
- Film roll number, type film (ASA-100), date, building number describing location of pictures, shall be identified by taking a photograph of an informational sign on the first frame of the roll

3.3.8 Sample Handling

Personnel collecting soil, ground water, and air samples shall take the following precautions to minimize sample contamination or cross-contamination between samples:

- At a minimum, latex surgical gloves will be used while taking all samples, disposed of after equipment has been decontaminated, and a clean pair used for the next sample
- Sampling personnel shall not touch the inside of the sampling container
- Sampling personnel shall not walk over any areas where samples will be taken

Immediately following the collection of the sample, the container shall be sealed and the sample shall be labeled and entered in the field sampling log book as described in Section 3.3.5 and 3.3.6. At this time, the chain of custody form record shall be completed to note the acquisition of the sample (see Section 3.3.9.2).

The sample shall then be placed in the shipping container and preserved according to Table 3-1.

3.3.9 Sample Chain of Custody

It is imperative that an accurate record of sample collection, transport, analysis, and disposal be maintained and documented. Therefore, chain of custody procedures will be instituted and followed throughout the RFI.

Chain of custody procedures include field custody, laboratory custody and evidence files. The National Enforcement Investigation Center (NEIC) of the EPA defines custody of evidence in the following ways:

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- In actual physical possession
- In view after being in physical possession
- In a locked repository
- In a secure, restricted area

It is necessary to establish documentation to trace sample possession from the time of collection until disposal. The following list outlines field custody requirements:

- As few people as possible shall handle sample(s).
- Sampler shall be responsible for the care and custody of the samples until they are transferred or dispatched properly.

Samples shall be stored by those individuals or facilities designated on the chain of custody form. The following methodologies will be used to ensure proper transfer documentation:

- Samples shall be accompanied by a chain of custody record at all times.
- Samples shall be packed properly for shipment so that bottles will not dislodge and/or break during shipment.
- Shipped samples shall contain separate custody records (one for field laboratory, one for samples hand delivered to off-site laboratory, and one for samples shipped off-site).
- Samples shall be shipped via a 24-hour delivery service, when required, to ensure holding times are not exceeded.

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- Methodology of shipment, courier name(s), and other pertinent information shall be recorded on chain-of-custody form, with all measures ensuring special handling procedures as available by the delivery service utilized during shipment of the samples.
- When samples are split with an outside source or government agency, the split shall be noted.
- If either party refuses a split sample, the refusal shall be noted and signed by both parties.
- All records pertaining to the shipment of a sample shall be retained (freight bills, post office receipts, and bills of lading).

3.3.9.1 Chain of Custody Record Form

Figure 3-3 is the Chain of Custody Form to be used by personnel responsible for ensuring the integrity of samples from the time of collection to shipment to the laboratory. The Contractor laboratory shall not accept samples for analysis without a correctly prepared Chain of Custody Form. The Contractor laboratory shall be responsible for maintaining chain of custody of the sample(s) from time of receipt to disposal. The Contractor laboratory shall use all forms and techniques specified by the EPA-CLP to ensure the integrity of all samples.

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FIGURE 3-3
CHAIN OF CUSTODY FORM

[illegible]

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The Chain of Custody Form shall be signed by each individual who has the samples in their possession. Preparation of the Chain of Custody Form shall be as follows:

- The chain of custody record shall be initiated in the field by the person collecting the sample, for every sample. Every sample shall be assigned a unique identification number as described in Section 3.3.5 that is entered on the chain of custody form. Samples can be grouped for shipment using a single form. The chain of custody form allows for 12 samples.
- The record shall be completed in the field to indicate project, sampling team, etc.
- If the person collecting the sample does not transport the samples to the laboratory or deliver the sample containers for shipment, the first block for "Relinquished By ____," "Received By ____" shall be completed in the field.
- The person transporting the samples to the laboratory or delivering them for shipment shall sign the record form as "Relinquished By ____."
- If the samples are shipped to the laboratory by commercial carrier, the chain of custody form shall be sealed in a watertight container, placed in the shipping container, and the shipping container sealed prior to being given to the carrier.
- If the samples are directly transported to the laboratory, the chain of custody shall be kept in the possession of the person delivering the samples.
- For samples shipped by commercial carrier, the waybill shall serve as an extension of the chain of custody record between the final field custodian and receipt in the laboratory.
- Upon receipt in the laboratory, the Sample Receiving Supervisor shall open the shipping containers, compare the contents with the chain of custody record, ensure that

document control information is accurate and complete, and sign and date the record. Any discrepancies shall be noted on the chain of custody form.

- If the discrepancies occur, the samples in questions shall be segregated from normal sample storage and the field personnel immediately notified.
- The chain of custody (Figure 3-3) is completed upon receipt of the samples by the analytical service. The completed Chain of Custody Form will be returned to the field manager.
- The analytical service shall track, internally, sample integrity utilizing a procedure defined by the Contract Laboratory Program (CLP).

3.3.9.2 Completed Chain of Custody Record Form

Figure 3-4 presents a sample of a completed Chain of Custody Form.

3.3.10 Request for Analysis Form

The Request for Analysis Form shall be used to supplement the information on the Chain of Custody Form. The Request for Analysis Form shall be completed by the Field Manager and included with the chain of custody record. It is important that the Report for Analysis Form be provided to ensure the specific analytical requirements are defined and sample holding times are not exceeded.

3.3.10.1 Completed Request for Analysis Form

Figure 3-5 presents a completed sample form showing proper entry of the required information. This form shall be used during all sampling events.

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SHIP TO: RFI Contractor Laboratory

CUSTODY TRANSFER RECORD
RFI Contractor

[illegible]

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FIGURE 3.5 COMPLETED REQUEST FOR ANALYSIS FORM
*U.S. GOVERNMENT PRINTING OFFICE: 1984-750-932

ANALYSIS REQUEST - SAVANNAH RIVER PLANT

OSH 14-31 (Rev. 11-83)

DISTRIBUTION: WHITE - LABORATORY-RETURN TO ORIGINATOR; SPINK - LABORATORY; YELLOW - ORIGINATOR

LABORATORY		SUBMITTED BY		LOCATION	
Laboratory X Inc.		Contractor X Inc.		RFI Site	
DATE SUBMITTED		STUDY NO. OR ACCOUNT CODE			
March 30, 1989		RFI Contract No.			
SAMPLE DESCRIPTION AND IDENTIFICATION					
Soil sample, 1 liter glass, I.P. No. 631-176/5/03 3089/02					
SPECIAL SAFETY PRECAUTIONS					
Glass, Fragile					
ACTIVITY		LAB. SERIAL NO.			
Soil Sample		1234567890			
ANALYSES REQUESTED		ESTIMATED		FOUND BY LABORATORY	
Hg		0-15 mg/kg		13 mg/kg	
Fe		50-100 mg/kg		70 mg/kg	
SO ₄ ⁻		150-300 mg/kg		325 mg/kg	
REQUEST APPROVED		ANALYSIS APPROVED		DATE COMPLETED	
Laboratory QA Manager		Laboratory Project Manager		April 10, 1989	

3.3.11 Sample Packaging

The transportation of environmental samples from the time they are collected to their arrival at the laboratory is an integral part of the QC process. The mode of travel must be such that the sample is not altered physically, chemically or biologically. The travel time to the laboratory must not exceed the sample holding time. The chain of custody must also be maintained during the transportation process.

Samples collected at the unit will be immediately placed in the sample cooler. Once the cooler is filled with samples, it shall be locked and securely positioned in a sampling vehicle or other secure storage facility until the completion of the day's sampling activities. The following protocol will be followed for packaging of samples:

- Only waterproof metal or equivalent strength plastic ice chests and coolers will be used.
- The volume level will be marked on each bottle with a grease pencil.
- Strapping tape will be placed around the lid of all sample containers except for volatile organic samples.
- Approximately three inches of inert cushioning material will be placed in the bottom of the cooler.
- The sample containers will be placed upright in the cooler in such a way that they do not touch and will not touch during shipment. In addition, all sample containers will be placed in clear plastic leak proof bags. Care will then be taken to ensure that sample labels are legible through the bag.
- Additional inert packing material will be placed in the cooler to partially cover the sample containers. Ice or freeze packs will be placed around, among, and on top of the sample containers.

- Each cooler will be filled with additional cushioning materials to prevent movement of samples during shipment.
- The Chain of Custody Form will be placed in a waterproof plastic bag and placed just under the lid of the cooler.
- If the cooler is equipped with a drain plug, it will be taped shut.
- The lid will be secured with strapping tape at a minimum of two locations. No labels will be covered.
- The completed shipping label will be attached to the top of the cooler.
- "This Side Up" labels will be placed on two sides of the cooler, and "Fragile" labels will be placed on all four sides.
- Numbered and signed custody seals will be placed on the front right and back left of each cooler. These seals will be covered with clear tape.
- The weight limit of the shipper will be maintained.
- The packaged samples will meet all applicable DOT requirements prior to shipment.

3.4 MEDIA SPECIFIC QC CONSIDERATIONS

Sections 3.4.1 (Soil Sampling QC Methodology) through 3.4.5 (Ambient Air Sampling QC Methodology) below discuss general procedures related to the sampling QC of each specific medium. These sections outline the QC procedures to be followed during field sampling activities to ensure quality and reliability of data generated during the RFI.

3.4.1 Soil Sampling QC Methodology

Chapter 6 (Soils Sampling Program Requirements) discusses the general procedures for the sampling of soils during the RFI. Chapter 6 should be used in conjunction with Chapter 3 (SRS QA/QC Program Plan) and specific sections below to ensure quality field sampling as well as the generation of accurate and reliable data. Appendix I summarizes the soils classification system detailed in DPSOP 254 which will be used for all RFI projects.

3.4.1.1 Predetermine Sampling Locations

The selection of sampling points will be based on existing data for each RFI site as described in Section 6.6.2.2 and 6.6.2.3 (Confirmation Sampling Phase) and 6.6.3.2 and 6.6.3.3 (Assessment Sampling Phase) and any previous reconnaissance trips. The sampling points will be predetermined and clearly marked on a unit map prior to the sampling event. The Contractor shall prepare a written sampling plan which will address the following:

- Sampling numbers
- Sample location and depths
- Analytical parameters
- Container requirements
- Health and Safety requirements
- Unit-specific sampling QC procedures

3.4.1.2 Container Type and Preservation Requirements

Prior to the field sampling event, sample container and preservation requirements will be predetermined. The parameters to be analyzed at the laboratory will determine the container material, volume and preservative, if any. Table 3-1 (Sample Containers, Preservation, Storage, and Holding Times) identifies container material and preservative requirements. Table 3-2 identifies recommended analytical methods and detection limits for specific

parameters commonly analyzed. The analytical method or methods will determine the required sample volume and will be determined prior to sampling in site-specific plans.

3.4.1.3 Soil Sampling Equipment Decontamination Procedures

This section describes procedures to be used in decontaminating equipment used in the RFI sampling effort. Equipment decontamination is essential to prevent or minimize cross-contamination of chemical constituents between soil samples. All equipment shall be decontaminated prior to the collection of each soil sample. Decontamination procedures for soil sampling devices shall be uniform to provide consistency for all RFI sampling efforts. The procedure that will be used to decontaminate sampling devices such as hand trowels, hand spades, hand augers and etc., will be performed in accordance with the following:

1. Clean with tap water and laboratory detergent (Liquonox or equivalent) using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with deionized or distilled water.
4. Rinse two times with high grade isopropanol solvent and allow to air dry.
5. Rinse thoroughly with deionized or distilled water and allow to air dry.
6. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is to be stored or transported.

The decontamination procedure that will be used for equipment such as truck mounted drill rigs, trailer mounted drill rigs, non-portable boring equipment and other equipment shall be in accordance with the following:

1. The drill rig and equipment shall be free from excess grease, oils and caked-on soils from previous work prior to arrival at the site. Equipment which leaks fuel, coolant, crankcase oil, transmission fluids, hydraulic fluids and lubricants shall be removed from the site and repaired prior to use.
2. All equipment that has a potential to leak (i.e., grease, oil, etc.) will be placed on plastic sheeting (6 mil or thicker), including drill rigs.
3. Prior to use, all equipment that will enter the borehole must be cleaned by a pressure washer (water at 200 degrees F and 1500 psi) at the well site. If the equipment will not be used immediately, it must be placed on a plastic sheet in a clean area. All other equipment that has a potential to induce contamination into the borehole (mud pumps, flow lines, etc.), will be flushed clean with potable water prior to use.
4. All well casings, screens, centralizers, tremie pipe, measuring lines, etc., will be steam cleaned immediately prior to starting a well.
5. Clean, new disposable rubber gloves shall be worn when handling well screens or casings. Personnel handling these items shall not handle tools or equipment while installing the well.

3.4.1.4 Field Analytical Instruments

All portable analytical instrument probes to be used in the field (pH, specific conductance), will be rinsed with deionized or distilled water prior to such use. During soil sampling any monitoring for organic vapors using equipment such as an OVA will require proper cleaning prior to use based on manufacturer specifications.

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Table 3-1

CONTAINERS, PRESERVATION, STORAGE, AND HOLDING TIMES

Parameter	Container ^b		Preservative-c,d		Maximum Holding Time for all Matrices	Sample Volume (ml)
	Water	Soil	Water	Soil		
INORGANIC TESTS						
Acidity	P	G	Cool, 4°C	Cool, 4°C	14 days	
Alkalinity	P	G	Cool, 4°C	Cool, 4°C	14 days	100
Ammonia	P	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days	400
Asbestos	P	G	Cool, 4°C	Cool, 4°C	48 hours ^f	1000
Bicarbonate	P	G	None Required	None Required	Analyze Immediately	100
Biological Oxygen Demand (BOD) and Carbonaceous BOD	G Bottle and Top	G	Cool, 4°C	Cool, 4°C	48 hours	1000
Bromide	P	G	None Required	None Required	28 days	100
Carbonate	P	G	None Required	None Required	Analyze Immediately	100
Chemical Oxygen Demand (COD)	P	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days	
Chloride	P	G	None Required	None Required	28 days	50
Chlorine, Total Residual	P	N/A	None Required	N/A	Analyze Immediately	200
Color	P	N/A	Cool, 4°C	N/A	48 hours	50

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Table 3-1 (Continued)

Parameter	Container ^b Water	Soil	Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e	Sample Volume (ml)
			Water	Soil		
Cyanide, Total and Amenable to Chlorination	P	G	Cool, 4°C NaOH to pH >12 0.6 g Ascorbic Acid/g	Cool, 4°C	14 days ^h	500
	G Bottle and Top	N/A	None Required	N/A	Analyze Immediately	100
Dissolved Oxygen Probe						
Winkler	G Bottle and Top	N/A	Fix On Site Store in Dark	N/A	8 hours	
Fluoride	P	G	None Required	None Required	28 days	300
Hardness	P	N/A	HNO ₃ or H ₂ SO ₄ to pH<2	NA	6 months	100
Hydrazine	P	G	If not analyzed immediately, collect under acid. Add 90 ml of sample to 10 ml HCl.	Cool, 4°C	7 days	100
Iodide	P	G	Cool, 4°C	Cool, 4°C	24 hours	100
Iodine	P	G	None Required	None Required	Analyze Immediately	500

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Table 3-1 (Continued)

Parameter	Container ^b		Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e	Sample Volume (ml)
	Water	Soil	Water	Soil		
Kjeldahl and Organic Nitrogen	P	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days	500
Metals ⁱ						
Chromium VI	P	G	Cool, 4°C	Cool, 4°C	24 hours	100
Mercury	P	G	HNO ₃ to pH <2	Cool, 4°C	28 days	100
Others	P	G	HNO ₃ to pH <2	Cool, 4°C	6 months	200
Nitrate	P	G	Cool, 4°C	Cool, 4°C	48 hours	100
Nitrate plus Nitrite	P	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days	100
Nitrite	P	G	Cool, 4°C	Cool, 4°C	48 hours	50
Oil and Grease	P	G	Cool, 4°C H ₂ SO ₄ to pH <2	Cool, 4°C	28 days	1000
Orthophosphate	P	G	Filter Immediately Cool, 4°C	Cool, 4°C	48 hours	50
pH	P	G	None Required	None Required	Analyze Immediately	

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Table 3-1 (Continued)

Parameter	Container ^b Water	Preservative ^{c,d} Water	Soil	Maximum Holding Time for all Matrices ^e	Sample Volume (ml)
Sulfide	P	G	Cool, 4°C Add Zinc Acetate plus NaOH to pH >9	28 days	500
Sulfite	P	G	None Required	Analyze Immediately	50
Surfactants	P	G	Cool, 4°C	48 hours	250
Temperature	P	G	None Required	Analyze Immediately	100
Turbidity	P	N/A	Cool, 4°C	48 hours	100
ORGANIC TESTS^f					
Acrolein and Acrylonitrile	S	S	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ g Adjust pH to 4-5 ^k	14 days ^k	40
Benzidines ^l	G	G	Cool, 4°C ^m 0.008% Na ₂ S ₂ O ₃ g pH 2-7	7 days until extraction ⁿ	40
Chlorinated Hydrocarbons ^l	G	G	Cool, 4°C	7 days until extraction 40 days after extraction	40
Haloethers ^l	G	G	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ g	7 days until extraction 40 days after extraction	40

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Table 3-1 (Continued)

Parameter	Container ^b		Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e	Sample Volume (ml)
	Water	Soil	Water	Soil		
Nitroaromatics and Isophorone ¹	G	G	Cool, 4°C Store in Dark	Cool, 4°C Store in Dark	7 days until extraction 40 days after extraction	
Nitrosamines ^{1,0}	G	G	Cool, 4°C Store in Dark 0.008% Na ₂ S ₂ O ₃ g	Cool, 4°C Store in Dark	7 days until extraction 40 days after extraction	
PCBs	G	G	Cool, 4°C	Cool, 4°C	7 days until extraction 40 days after extraction	
Pesticides ¹	G	G	Cool, 4°C pH 5-9p	Cool, 4°C	7 days until extraction 40 days after extraction	
Phenols ¹	G	G	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ g	Cool, 4°C	7 days until extraction 40 days after extraction	
Phthalate Esters ¹	G	G	Cool, 4°C	Cool, 4°C	7 days until extraction 40 days after extraction	
Polynuclear Aromatic Hydrocarbons	G	G	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ g Store in Dark	Cool, 4°C Store in Dark	7 days until extraction 40 days after extraction	
Purgeable Aromatic Hydrocarbons	S	S	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ g HCl to pH <2g	Cool, 4°C	14 days ^d	
Purgeable Halocarbons	S	S	Cool, 4°C 0.008% Na ₂ S ₂ O ₃ g	Cool, 4°C	14 days	

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Table 3-1 (Continued)

Parameter	Container ^b Water Soil	Preservative ^{c,d}		Maximum Holding Time for all Matrices ^e	Sample Volume (ml)
		Water	Soil		
TOD ¹	G G	Cool, 4°C 0.008% Na ₂ S ₂ O ₃	Cool, 4°C	7 days until extraction 40 days after extraction	100
Total Organic Carbon	G G	Cool, 4°C HCl or H ₂ SO ₄ to pH < 2	Cool, 4°C	28 days	100
Total Organic Halogen	G G	Cool, 4°C 1 ml of 0.1 M sodium sulfite	Cool, 4°C	7 days	100

Analytes not listed should be preserved at 4°C and held not longer than 7 days.

^aPreservatives and holding times are from Federal register, Vol. 49, No. 209, Friday, October 26, 1984, Page 43260 and Characterization of Hazardous Waste Sites: A Methods Manual — Volume II. Sampling Methods Second Edition, EPA-600/4-84-076. Container requirements are consistent with these references.

^bp = Polyethylene

G = Amber Glass with Teflon-lined cap

S = Glass Vial with Teflon-lined septum cap

^cSample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When use of an Automatic sampler makes it impossible to preserve each aliquot, samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

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d When any sample is to be shipped by common carrier or sent through the U.S. Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements in this table, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation, has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO₃) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H₂SO₄) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.3 or less).

e Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Some samples may not be stable for the maximum time period given in the table. A laboratory is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample integrity.

f If samples cannot be filtered within 48 hours, add 1 ml of a 2.71% solution of mercuric chloride to inhibit bacterial growth.

g Should only be used in the presence of residual chlorine.

h Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustment in order to determine if sulfide is present. If sulfide is present, it can be removed by addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

i For dissolved metals, filter immediately on site before adding preservative.

j Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

k The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within three days of sampling.

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When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times must be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and 40 days after extraction. Exceptions to this optimal preservation and holding times procedure are noted in footnotes g, m, and n.

If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.

Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

For the analysis of diphenylnitrosamine, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$.

Sample receiving no pH adjustment must be analyzed within 7 days of sampling.

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TABLE 3-2

RECOMMENDED ANALYTICAL METHODS AND DETECTION LIMITS
FOR COMMONLY ANALYZED PARAMETERS

PART 1

RADIOLOGICAL COMPOUNDS

Parameters	Recommended Methods ^a		Recommended Detection Limit ^b	
	Water	Soil/Sludge	Water	Soil/Sludge
Gross Alpha	GPC EPA 900.0 SM 703	GPC	3 pCi/L	100 pCi/kg
Gross Beta	GPC EPA 900.0 SM 703	GPC	4 pCi/L	1000 pCi/kg
Gamma Isotopic	GS EPA 901.1	GS	(b)	100 pCi/kg
Tritium	LSC EPA 906.0 SM 708	LSC	1000 pCi/L	100 pCi/kg
Strontium-89	GPC	-	10 pCi/L	-
Strontium-90	EPA 905.0 SM 704	GPC	2 pCi/L	500 pCi/kg
Iodine-129	GS	-	1 pCi/L	-
Misc Beta	GPC	-	1 pCi/L	-
Total Uranium	UF EPA 908.1 SM 711B	UF	1 mg/L	0.5 mg/kg
Isotopic Uranium	AS EPA 908.0	GS	1 pCi/L	500 pCi/kg
Actinides	AS EPA 907.0	AS	1 pCi/L	1 pCi/kg

- (a) GPC = gas proportional counter
GS = gamma spectrometry
LSC = liquid scintillation counting
AS = alpha spectrometry
UF = uranium fluorimetric
SM = Standard Methods for the Examination of Water and Wastewater

- (b) The MDC is taken as 1/10 of the EPA drinking water standard and therefore depends on the radionuclide. MDCs for gamma emitting radionuclides likely to be encountered at SRP are 20 pCi/L for Co-60, 20 pCi/L for Cs-137, and 10 pCi/L for Cs-134.

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TABLE 3-2
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PART 2

VOLATILE ORGANIC COMPOUNDS

<u>Parameters</u>	<u>Recommended Methods</u>	
	<u>Water^c</u>	<u>Solids^d</u>
Halogenated Volatile Organics	601,624 or 524	5030/8010 or 8240
Volatile Aromatic Hydrocarbons	602,624 or 524	5030/8020 or 8240
	<u>Recommended Detection Limits</u>	
	<u>Water POL^e (ug/L)</u>	<u>Solids POL (ug/g)</u>
Benzene	2.0	0.02 - 0.20
Bromodichloromethane	1.0	0.01 - 0.10
Bromoform	2.0	0.02 - 0.20
Bromomethane	—	—
Carbon Tetrachloride	1.2	0.01 - 0.12
Chlorobenzene	2.0	0.02 - 0.20
Chloroethane	5.2	0.02 - 0.52
2-Chloroethylvinyl Ether	1.3	0.01 - 0.13
Chloroform	0.5	0.01 - 0.05
Chloromethane	0.8	0.01 - 0.08
Dibromochloromethane	0.9	0.01 - 0.09
1,2-Dichlorobenzene	1.5	0.02 - 0.15
1,3-Dichlorobenzene	3.2	0.03 - 0.32
1,4-Dichlorobenzene	2.4	0.02 - 0.24
Dichlorodifluoromethane	—	—
1,1-Dichloroethane	0.7	0.01 - 0.07
1,2-Dichloroethane	0.3	0.01 - 0.03
1,1-Dichloroethylene	1.3	0.01 - 0.13
trans-1,2-Dichloroethylene	1.0	0.01 - 0.10
Dichloromethane	—	—
1,2-Dichloropropane	0.4	0.01 - 0.04
trans-1,3-Dichloropropene	3.4	0.03 - 0.34
Ethylbenzene	4.0	0.04 - 0.40

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<u>Recommended Detection Limits</u>		
	<u>Water POL^e (ug/L)</u>	<u>Solids POL (ug/g)</u>
Toluene	2.0	0.02 - 0.20
1,1,2,2-Tetrachloroethane	0.3	0.01 - 0.03
Tetrachloroethene	0.3	0.01 - 0.03
1,1,1-Trichloroethane	0.3	0.01 - 0.03
1,1,2-Trichloroethane	0.2	0.01 - 0.02
Trichloroethylene	1.2	0.01 - 0.12
Trichlorofluoromethane	—	—
Vinyl Chloride	1.8	0.02 - 0.18

^cMethods can be found in 40 CFR Part 136.

^dMethod numbers refer to EPA SW-846, Test Methods for Evaluating Solid Waste; Physical/Chemical Methods, Third Edition.

^ePractical Quantification Limit

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TABLE 3-2
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PART 3

SEMI-VOLATILE ORGANIC COMPOUNDS

Method	Water ^f	Solids ^g
GC/MS Method for Semi-Volatile Organics	625	8250/8270
Parameter	MDL ^h (ug/L)	
Acenaphthene	1.9	1.9
Acenaphthylene	3.5	3.5
Anthracene	1.9	1.9
Alrin	1.9	1.9
Benzidine	44	44
Benzo(a)anthracene	7.8	7.8
Benzo(b)fluoranthene	4.8	4.8
Benzo(k)fluoranthene	2.5	2.5
Benzo(a)pyrene	2.5	2.5
Benzo(ghi)perylene	4.1	4.1
Benzyl butyl phthalate	2.5	2.5
Alpha-BHC	—	—
Beta-BHC	4.2	4.2
Delta-BHC	3.1	3.1
Gamma-BHC	—	—
Bis(2-chloroethyl)ether	5.7	5.7
Bis(2-chloroethoxy)methane	5.3	5.3
Bis(2-ethylhexyl)phthalate	2.5	2.5
Bis(2-chloroisopropyl)ether	5.7	5.7
4-Bromophenyl phenyl ether	1.9	1.9
Chlordane	—	—
4-Chloro-3-methylphenol	3.0	3.0
2-Chloronaphthalene	1.9	1.9
2-Chlorophenol	3.3	3.3
4-Chlorophenyl phenyl ether	4.2	4.2
Chrysene	2.5	2.5
4,4'-DDD	2.8	2.8
4,4'-DDE	5.6	5.6
4,4'-DDT	4.7	4.7
Dibenzo(a,h)anthracene	2.5	2.5
Di-n-butylphthalate	2.5	2.5
1,3-Dichlorobenzene	1.9	1.9
1,2-Dichlorobenzene	1.9	1.9
1,4-Dichlorobenzene	4.4	4.4
3,3'-Dichlorobenzidine	16.5	16.5
2,4-Dichlorophenol	2.7	2.7
Dieldrin	2.5	2.5
2,4-Dimethylphenol	2.7	2.7
Diethyl phthalate	22	22
Dimethyl phthalate	1.6	1.6

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2,4-Dinitrophenol	42	42
2,4-Dinitrotoluene	5.7	5.7
2,6-Dinitrotoluene	1.9	1.9
Di-n-octylphthalate	2.5	2.5
Endosulfan I	—	—
Endosulfan II	—	—
Endosulfan sulfate	5.6	5.6
Endrin	—	—
Endrin aldehyde	—	—
Fluoranthene	2.2	2.2
Fluorene	1.9	1.9
Heptachlor	1.9	1.9
Heptachlor epoxide	2.2	2.2
Hexachlorobenzene	1.9	1.9
Hexachlorobutadiene	0.9	0.9
Hexachlorocyclopentadiene	—	—
Hexachloroethane	1.6	1.6
Ideno(1,2,3-cd)pyrene	3.7	3.7
Isophorone	2.2	2.2
2-Methyl-4,6-dinitrophenol	24	24
Naphthalene	1.6	1.6
Nitrobenzene	1.9	1.9
2-Nitrophenol	3.6	3.6
4-Nitrophenol	2.4	2.4
N-Nitrosodimethylamine	—	—
N-Nitrosodi-n-propylamine	—	—
N-Nitrosodiphenylamine	1.9	1.9
PCB-1016	—	—
PCB-1221	—	—
PCB-1232	—	—
PCB-1242	—	—
PCB-1248	—	—
PCB-1254	—	—
PCB-1260	—	—
Pentachlorophenol	3.6	3.6
Phenanthrene	5.4	5.4
Phenol	1.5	1.5
Pyrene	1.9	1.9
Toxaphene	—	—
1,2,4-Trichlorobenzene	1.9	1.9
2,4,6-Trichlorophenol	2.7	2.7

^fMethods can be found in 40 CFR Part 136.

^gMethod numbers refer to EPA SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition.

^hMDL = Method Detection Limit

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TABLE 3-2
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PART 4

METALSⁱ

Parameter	Recommended Methods			
	AA ^j	Water ICP ^k	AA ^l	Solids EP/TCLP ^m
Aluminum	202.1,202.2	200.7		
Antimony	204.1,204.2	200.7	7040,7041	
Arsenic	206.2,206.3	200.7	7060,7061	40 CFR 261 App II
Barium	208.1,208.2	200.7	7080,7081	40 CFR 261 App II
Beryllium	210.1,210.2	200.7	7090,7091	
Cadmium	213.1,213.2	200.7	7130,7131	40 CFR 261 App II
Calcium	215.1,215.2	200.7		
Chromium	218.1,218.2	200.7	7190,7191	40 CFR 261 App II
Cobalt	219.1,219.2	200.7		
Copper	220.1,220.2	200.7	7210,7211	
Iron	236.1,236.2	200.7		
Lead	239.1,239.2	200.7	7420,7421	40 CFR 261 App II
Magnesium	242.1	200.7		
Manganese	243.1,243.2	200.7	7470,7471	40 CFR 261 App II
Mercury (cold vapor)	245.1,245.2			
Molybdenum	246.1,246.2	200.7	7520,7521	
Nickel	249.1,249.2	200.7		
Potassium	258.1	200.7	7740,7741	40 CFR 261 App II
Selenium	270.2,270.3	200.7	7760,7761	40 CFR 261 App II
Silver	272.1,272.2	200.7		
Sodium	273.1	200.7	7840,7841	
Thallium	279.1,279.2	200.7		
Tin	282.1,282.2			
Titanium	283.1,283.2			
Vanadium	286.1,286.2	200.7	7910,7911	
Zinc	289.1,289.2	200.7	7950,7951	

ⁱThis table represents selected methods from 40 CFR Part 136, 40 CFR Part 261, and EPA SW 846. The selection of method will vary according to the sample matrix, additional contaminants which could cause interferences, and the program under which the sample is being evaluated. In certain cases, additional methods beyond those listed here will be required.

^jMethod numbers refer to EPA Methods for Chemical Analysis of Waters and Wastes, PB84-128677, Revised March 1983.

^kMethod can be found in 40 CFR Part 136, Appendix C.

^lMethod numbers refer to EPA SW 846 Test Methods for Evaluating Solid Wastes; Physical/Chemical Methods, Third Edition, or EPA Methods for Chemical Analysis of Waters and Wastes.

^mEP = Extraction Procedure Toxicity, TCLP = Toxicity Characteristic Listing Procedure (proposed 51 Federal Register 21648, June 13, 1986).

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TABLE 3-2
(continued)

PART 5

WET CHEMISTRY

Parameter	Method ⁿ	Water MDL(ppb)	Solids	
			Method ^o	MDL(ppb)
Ammonia nitrogen	350.1	10	350.1	1000
Biochemical oxygen demand	405.1			
Cation exchange capacity			9080	
Chemical oxygen demand	410.1/.2/.3/.4			
Chloride	325.1/.2/.3			
Chlorine, residual	330.1/.2/.3/.4/.5			
Cyanide	335.1	10	9010	2000
Fluoride	340.2	100	340.2	100
Nitrate + nitrite	353.1	10	353.1	1000
Nitrate nitrogen	352.1	10	352.1	1000
Oil and grease	413.1			
Percent solids	160.3	0.1%	160.3	0.1%
pH	150.1	0.1 unit	9040	1 unit
pH (soil)			9045	
Specific conductance	120.1	10umhos/cm	9050	1000 umhos/cm
Sulfate	375.1/.3/.4			
Sulfide	376.1/.2			
Surfactants	425.1			
Total kjeldahl nitrogen	351.2	100	351.2	10000
Total organic carbon	415.1	1000	9060	100000
Total organic halides	450.1	10	9020	1000
Total phosphorus	365.4	10	365.4	1000
Total suspended solids	209 C	1000		

ⁿMethod numbers refer to EPA Methods for Chemical Analysis of Waters and Wastes, PB84-128677, Revised March 1983 except for TSS which is found in Standard Methods for the Examination of Water and Wastewater.

^oMethod numbers refer to EPA SW 846 Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods, Third Edition, or EPA Methods for Chemical Analysis of Waters and Wastes.

3.4.1.5 Surface and Shallow Soil Sampling Procedures

Equipment to be utilized for collection of near surface soils include: stainless steel trowel, stainless steel mixing bowl, tile spade, and stainless steel hand auger. Surface and shallow soil sampling (1-15 cm depth) shall be in accordance with Method II-1 from Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods, 2nd Edition (EPA-600/4-84-076).

1. Upon reaching the approximate sample depth based on procedures listed in Chapter 6 (Soils Sampling Program Requirements), using a decontaminated stainless steel scoop or spatula, remove and discard a thin layer of soil from the area which comes in contact with the sampling equipment.
2. Thoroughly mix samples as necessary.
3. Transfer sample into an appropriate sample bottle using the same stainless steel scoop or spatula listed above. The sampler will ensure that an adequate volume of sample is collected based on the chosen analytical technique.
4. Check that a Teflon liner is present in the cap if required. Secure the cap tightly. The chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach supplemented by a minimal holding time. Table 3-1 should be consulted for containerization and preservation requirements.
5. Immediately after the sample is collected the following documentation is required:
 - Label as specified in Section 3.3.5
 - Enter sample in field log book as specified in Section 3.3.6

- Photograph as specified in Section 3.3.7
 - Sample Chain of Custody Form as specified in Section 3.3.9.
5. Decontaminate equipment after each sample (as described in Section 3.4.1.3).
 6. Discard contaminated personal protective clothing (see Section 3.3.8).
 7. Place sample in cooler and prepare for packaging as specified in Section 3.3.11.

3.4.1.6 Intermediate Depth Soil Sampling

For deeper samples collected at 1-3 meter depths, the following procedure (Method II-2) from Volume II of Characterization of Hazardous Waste Sites, using a hand or power auger and thin-wall tube coring apparatus, will be followed:

1. After reaching desired sample depth based on procedures listed in Chapter 6, slowly and carefully remove auger from boring. (Note: When sampling directly from auger, collect sample after auger is removed from boring and proceed to Step 7.)
2. Remove auger tip from drill rods and replace with a precleaned thin-wall tube sampler. Install proper cutting tip.
3. Carefully lower corer down borehole and gradually force corer into soil. Care should be taken to avoid scraping the borehole sides. Hammering of the drill rods to facilitate coring should be avoided as the vibrations may cause the boring walls to collapse.
4. Remove corer and unscrew drill rods.
5. Remove cutting tip and remove core from device.

6. Discard top of core (approximately 2.5 cm), which represents any material collected by the corer before penetration of the layer in question. Thoroughly mix sample as necessary. Place remaining core into sample container.
7. Check that a Teflon liner is present in the cap if required. Secure the cap tightly. The chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach supplemented by a minimal holding time. Table 3-1 should be consulted for specific containerization and preservation requirements.
8. Immediately after the sample is collected the following documentation is required:
 - Label the container as specified in Section 3.3.5
 - Field log book entry as specified in Section 3.3.6
 - Photograph as specified in Section 3.3.7
 - Complete Chain of Custody Form as specified in Section 3.3.9.
9. Decontaminate equipment after each sample as specified in Section 3.4.1.3.
10. Discard personal protective clothing, if contaminated, as specified in Section 3.3.8.
11. Place sample in cooler and prepare for packaging as specified in Section 3.3.11.

Samples shall not be removed directly from the auger, because a disturbed sample may be produced which could be contaminated by overlying soils. In rocky soil, where it is impossible to insert a thin tube sampler, sampling directly from the auger may be the only viable method. In loose soil where the borehole will not remain open when the auger is removed, a temporary casing can be used until the desired sampling depth is reached. In some cases it may be necessary to use a hollow stem auger to prevent the borehole from collapsing.

3.4.1.7 Deep Soil Sampling

For deep soil sampling (depths greater than 3 m) boring advancement or installation procedures shall utilize the information presented in Chapter 7, Ground Water Sampling Program Requirements.

For most cases a split spoon sampler shall be used to collect the necessary soil sample. It may be necessary to substitute other sample devices in place of the split spoon samples in certain situations. In this case, specific sample collection procedures shall be developed prior to sampling using the information presented in Chapters 6 and 7. In all cases, Steps 4 through 7 below shall be followed. If a split spoon sampler shall be used to obtain deep soil samples, the samples shall be collected as specified in ASTM D1586-84. Each split spoon sample will be taken according to the following procedures:

1. Decontaminate sampler as specified in Section 3.4.1.3.
2. Drive sampler 24 inches with a 140-pound hammer falling 30 inches recording the number of blows required.
3. Sample aliquots will be removed from the split spoon sampler using a decontaminated stainless steel spatula, scoop or spoon thoroughly mixed as necessary, and placed in the appropriate containers.
4. Immediately after the sample is taken the following documentation is required:
 - Label as specified in Section 3.3.5
 - Enter sample identification in field log book as specified in Section 3.3.6
 - Photograph as specified in Section 3.3.7
 - Complete Chain of Custody Form as specified in Section 3.3.9.

5. Decontaminate split spoon by steam cleaning between samples in the same borehole, as specified in Section 3.4.1.3.
6. Discard personal protective clothing, if contaminated, as specified in Section 3.3.8.
7. Place sample in cooler at 4°C and prepare for packaging as specified in Section 3.3.11.

3.4.1.8 Organic Vapor Screening

For soils in which contamination is suspected, a small portion of each sample will be screened using OVA and HNu analyzers depending on the suspected contaminants. The following procedure shall be followed for screening of organic vapor concentration:

1. Place a small portion of the sample in an air-tight plastic bag. Seal and label the bag. Place the bag in a warm location such as inside a field sampling vehicle.
2. After approximately twenty minutes, the headspace of the bag sample will be screened using the HNu and OVA. This value will be recorded in the Field Sampling Log Book (See Section 3.3.6). The OVA and HNu analyzer shall be used primarily to monitor for air safety for field personnel.

3.4.1.9 Field Quality Control Samples

In order to verify the quality of the sample collection, transportation and analysis of samples collected during the SRS RFI, several types of quality control samples shall be collected during soils sampling. These samples will include duplicates, sampler rinsates, trip blanks, and field blanks.

For the purposes of this plan, QA/QC samples will be defined as follows:

- Duplicate/Split Samples - these are blind quality control samples which are duplicates of field samples, and which are submitted to the Contractor laboratory. All duplicate

samples for volatile organic analyses will be grab samples as opposed to composite samples for other compounds of interest. Internal quality assurance duplicate samples will be collected at a frequency of one per sampling site or one for each 10 samples sent to the Contractor laboratory, whichever is greater. These sample results will be compared to those of the original samples for final data validation.

- **Trip Blank Samples** - these samples, prepared by the Contractor laboratory, are used for volatile organic samples and other compounds of interest. The samples are submitted blind to the Contractor laboratory with each cooler containing volatile organic field samples.

Trip blanks for soils are defined as containers filled with native soils previously collected and analyzed. These blanks shall accompany the field samples during sampling, storage and transportation to the laboratory. These samples will be analyzed to determine if the storage or handling of the field samples has jeopardized their integrity. The results of the trip blanks will be used for final data validation purposes. Trip blanks will be submitted at a frequency of one per sample shipment or as specified by the RFI Program Team. Trip blanks will be used for volatile organic samples and other compounds of interest.

- **Rinsate Samples** - these samples will consist of a portion of the rinse waters which have been used to decontaminate sampling instruments such as hand spades, trowels, augers and etc. These samples are identified as such and submitted to the contractor laboratory and, optionally to the SRS Quality Assurance laboratory.

Sampler rinsate samples will be collected periodically during sampling. Rinsate samples will be collected at a minimum frequency at least one per sample shipment for each specific cleaning procedure or as specified by the SRS RFI Program Team. These samples will be collected following the cleaning of a bailer, trowel, or hand auger by pouring deionized or distilled water over and inside the sampler after decontamination. A portion of this water will be collected and tested to verify the adequacy of the field

cleaning procedures. The results of these samples will be used for final data validation purposes.

- **Field Blanks** - these samples will consist of soils previously collected and analyzed. These soils will be stored in a secured container such as a 55-gallon drum and will be used to supply all field blanks for the RFI Program. Prior to the sampling event, a portion of these soils shall be transferred to another clean container. This container shall be transported to the field during the sampling period and using proper handling techniques, the soils will be transferred to an appropriate analytical container using methods and equipment (i.e., stainless steel spoons, mixing bowls, etc.) identical to the actual field samples. The purpose of the field blank is to identify any introduction of contamination by sample handling techniques.

Field blank samples are quality control samples provided to the SRS Quality Assurance Laboratory or its designated laboratory at SRS's option. The results of these samples will be used for final data validation purposes. Field blanks will be taken as appropriate or as requested by authorized SRS personnel.

3.4.2 Ground Water Sampling QC Methodology

The primary QC consideration for collecting ground water samples for chemical analyses is to ensure the sample has not been altered or contaminated during withdrawal from the monitoring well or introduction into the sample container. Special procedures are required for ground water sampling based on the yield of a particular well. High and moderate yield wells will generally be pumped by submersible pump to obtain a representative sample. Low yield wells will be evacuated and sampled with a bailer. To ensure uniformity in ground water sampling procedures, DPSOP 254 Chapter XI (duPont, 1987) will be used. Specific procedures for submersible pump and bail sampling are discussed in this DPSOP.

Containment of evacuated ground water from monitoring wells will be evaluated on a unit and well specific basis. Where existing data indicate the need, containment of all evacuated water will be required.

3.4.2.1 Predetermine Sampling Locations

The selection of sampling locations will be based on any existing monitoring well data for each RFI unit and other monitoring wells installed to characterize the RFI unit. The Contractor will prepare a written ground water sampling plan which will address the following:

- Existing monitoring wells to be sampled
- Installation of additional monitoring wells required for sampling
- Analytical parameters
- Container requirements
- Health and Safety requirements
- Sampling QC procedures (in accordance with DPSOP 254)

The sampling plan will be submitted to the RFI Program Team for review and approval prior to commencement of sampling.

3.4.2.2 Container Type and Preservation Requirements

Prior to the ground water sampling event, sample containers will be prepared in accordance with DPSOP 254-XI Attachment 4. The container type and preservation requirements will also be predetermined based on the analytical parameters to be tested. Table 3-1 identifies container material and preservation requirements for selected analytical parameters.

3.4.2.3 Ground Water Sampling Equipment Decontamination Procedures

This section describes procedures to be used to decontaminate equipment used to obtain ground water samples. Due to the high variability of ground water quality at SRS, dedicated stainless steel bailers and submersible pumps shall be required for all existing and new monitoring wells. Care shall be exercised by sampling personnel to avoid contacting the bailers or pumps with the surrounding soils or unprotected hands. All bailers and pumps which have contacted any soil, unprotected hands or anything which may contaminate the equipment shall be decontaminated according to the following procedures:

Bailers

1. Clean with tap water and laboratory detergent (Liquonox or equivalent) using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with deionized or distilled water.
4. Rinse two times with high grade isopropanol solvent and allow to air dry.
5. Rinse thoroughly with deionized or distilled water and allow to air dry.
6. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is to be stored or transported.

Submersible Pump

1. Rinse or pump a mixture of tap water and laboratory detergent (Liquonox or equivalent) thoroughly through pump using a brush if necessary to remove particulate matter or surface film.

2. Rinse and pump deionized or distilled water (minimum of 30 gallons) and allow to air dry.
3. Wrap with aluminum foil to prevent contamination if equipment is to be stored or transported.

Bailer and submersible pumps which are taken out of the well casing shall be placed on aluminum foil or other appropriate material to prevent contamination.

3.4.2.4 Field Analytical Instrument Decontamination

All analytical instrument probes (pH, specific conductance, temperature) will be rinsed with deionized or distilled water prior to and between measurements.

3.4.2.5 Bailer Sampling QC Procedures

This section describes the step by step procedure for sampling ground water from a monitoring well using a bailer. The field sampling team shall become familiar with DPSOP 254-XI.7.

1. Predetermine sampling locations as described in Section 3.4.2.1.
2. Predetermine analytical parameters, container type and preservation requirements (see Tables 3-1 and 3-2).
3. Assemble all necessary sampling equipment.
4. Follow bailer sampling procedure per DPSOP 254-XI.7. Note: Latex surgical gloves will be used during well evacuation and sampling.
5. Immediately after sample is obtained the following documentation is required.

- Label as specified in Section 3.3.5.
 - Enter sample identification in field log book as specified in Section 3.3.6.
 - Photograph as specified in Section 3.3.7.
 - Complete Chain of Custody Form as specified in Section 3.3.9.
6. Discard personnel protective clothing, if contaminated, as specified in Section 3.3.8.
 7. Place sample containers in cooler and prepare for packaging as specified in Section 3.3.11.

3.4.2.6 Submersible Pump QC Procedures

This section describes the step by step procedure for sampling ground water from a monitoring well using a submersible pump. The field sampling team shall become thoroughly familiar with DPSOP 254-XI.8.

1. Predetermine sampling location as described in Section 3.4.2.1.
2. Predetermine analytical parameters, container type and preservation requirements (see Tables 3-1 and 3-2).
3. Assemble all necessary sampling equipment.
4. Follow pump sampling procedures as described in DPSOP 254-XI.8. Note: Latex surgical gloves will be used during well evacuation and sampling.
5. Immediately after sample is obtained the following documentation is required.

- Label as specified in Section 3.3.5.
 - Enter sample identification in field log book as specified in Section 3.3.6.
 - Photograph as specified in Section 3.3.7.
 - Complete Chain of Custody Form as specified in Section 3.3.9.
6. Discard personnel protective clothing, if contaminated, as specified in Section 3.3.8.
7. Place sample containers in cooler and prepare for packaging as specified in Section 3.3.11.

3.4.2.7 Field Quality Control Samples

In order to verify the quality of the sample collection, transportation and analysis of samples collected during the SRS RFI, several types of quality control samples will be collected for each matrix type. These samples will include: duplicates, sampler rinsates, trip blanks, and field blanks.

For the purposes of this plan, QA/QC samples will be defined as follows:

- Duplicate/Split Samples - these are blind quality control samples which are duplicates of field samples, and which are submitted to the contractor laboratory. All duplicate samples for volatile organic analyses will be grab samples as opposed to composite samples for other compounds of interest.
- Trip Blank Samples - these samples, prepared by the contractor laboratory, are used for volatile organic samples and other compounds of interest. The samples are submitted blind to the contractor laboratory with each cooler.

- Rinsate Samples - these samples will consist of distilled rinse water which has been poured over decontaminated sampling equipment such as a bailer or submersible pump. The samples are submitted blind to the contractor laboratory and, optionally to the SRS Quality Assurance laboratory.
- Field Blanks - these samples will consist of deionized water.

3.4.2.7.1 Quality Control Duplicate/Split Samples

Internal quality assurance duplicate samples will be collected at a frequency of one per matrix type or one for each ten samples of each matrix type sent to the contractor laboratory, whichever is greater. These sample results will be compared to those of the original samples for final data validation.

3.4.2.7.2 Sampler Rinsate Samples

Sampler rinsate samples will be collected periodically during each sampling effort. Rinsate samples will be taken at a minimum frequency of one per sample shipment or as specified by the RFI Program Team. These samples will be collected following the cleaning of a bailer or submersible pump by pouring deionized or distilled water over and inside the equipment after decontamination. A portion of this water will be collected and tested to verify the adequacy of the field cleaning procedures. The results of these samples will be used for final data validation purposes. Sample rinsates will be collected only after decontamination.

3.4.2.7.3 Trip Blank Samples

Trip blanks are defined as containers filled with deionized or distilled water which accompany the field samples during sampling, storage and transportation to the laboratory. These samples will be analyzed to determine if the storage or handling of the field samples has jeopardized their integrity. The results of these samples will be used for final data

validation purposes. Trip blanks will be submitted at a frequency of one per sample shipment or as specified by the RFI Program Team.

Trip blanks will be used for volatile organic samples and other compounds of interest.

3.4.3 Surface Water/Sediment Sampling QC Methodology

Chapter 8 (Surface Water/Sediment Sampling Strategy) outlines the general procedures for surface water and sediment sampling at RFI sites. This section discusses the required QC procedures prior to and during sampling and will be used in conjunction with Chapter 8.

3.4.3.1 *Sampling Point Locations*

Sampling point locations will be predetermined according to the criteria specified in Sections 8.6.1.2 and 8.6.1.3 (Preliminary Sampling Phase) and 8.6.2.3 and 8.6.2.4 (Assessment Sampling Phase). Sampling strategies are dependent on the type of surface water body being sampled (e.g., impoundments, streams, drainage ditches, wetlands). The locations will be clearly marked on a unit map prior to actual sampling. The Contractor will prepare a written sampling plan which will address the following:

- Sample Numbers
- Sampling Locations and Depths
- Analytical Parameters
- Container Requirements
- Health and Safety Requirements
- Unit-Specific Sampling QC Procedures

3.4.3.2 Container Type and Preservation Requirements

Prior to all field sampling activities, sampling container type and volume, sample preservation methods and holding times will be predetermined. Table 3-1 (Section 3.4.1.2) identifies container and storage requirements for parameters to be analyzed. Sediment and sludge samples shall be collected in containers specified for soil samples. Table 3-2 (Section 3.4.1.2) lists analytical methods and detection limits for commonly analyzed surface water and sediment parameters. General sample container preparation requirements are listed in Section 3.3.4.

3.4.3.3 Field Equipment Calibration

All field equipment used for surface water and sediment sampling shall be calibrated in accordance with the generic calibration procedures listed in Section 3.3.2. Sampling and field measurements shall not be conducted until equipment is properly calibrated.

The pH, specific conductance, and dissolved oxygen meter(s) shall be calibrated any time the equipment is moved to another RFI unit. The pH meter will be calibrated as specified in SW-846. The SW-846 procedure specifies standard buffer solutions (pH 4, 7, and 10) to bracket the expected pH values of the samples. If sample pH values are encountered greater than 10 or less than 4, special buffer solutions will be made. The specific conductance meter shall be calibrated using a KCl (Potassium Chloride) standard. The oxygen meter and flowmeter, if utilized, shall be calibrated according to procedures listed in the specific equipment operating manual. All thermometers shall be calibrated at least monthly, using a National Bureau of Standards certified thermometer.

3.4.3.4 Decontamination Procedures

Equipment decontamination is essential for preventing or minimizing cross-contamination between samples. All equipment shall be decontaminated between sampling points. Decontamination procedures shall be uniform to provide consistency for all RFI sampling efforts and will be conducted in accordance with the following procedure:

1. Clean with on-site water supply well water and phosphate-free laboratory detergent (Iiquonox or equivalent) using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with on-site water supply well water.
3. Rinse thoroughly with deionized or distilled water.
4. Rinse two times with high grade isopropanol solvent and allow to air dry.
5. Rinse thoroughly with deionized or distilled water and allow to air dry.
6. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is to be stored or transported.

All rinse waters shall be contained in a manner to prevent the introduction of contamination. All rinsate will be collected in a compatible container and properly disposed of to prevent cross contamination to adjacent areas.

3.4.3.5 Surface and Deep Water Sample Collection

All water sampling shall be conducted in accordance with SRS DPSOP 254 and Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods, Second Edition (EPA-600/4-84-076).

3.4.3.5a Shallow Surface Water Sampling

For sampling shallow surface waters, the following procedures shall be followed:

1. Remove the sample bottles to be used at the unit from the coolers. Fill in all information indicated on the bottle label with an indelible ink marker or ball point pen.

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2. Care shall be exercised when opening and filling the bottles since some of the bottles contain carefully measured amounts of chemical preservatives. The preservatives vary, but some are small amounts of concentrated sulfuric and nitric acid which are extremely corrosive.
3. Do not mix the caps or rinse the sample containers.
4. Surface grab samples may be collected directly in the sampling container. Reduce risk of sample contamination by sampling against the stream flow.
5. Fill the sample containers with the proper volume of water or sediment, according to specifications in Table 3-1, Section 3.4.1.2. **DO NOT OVERFLOW** (except in case of VOCs -refer to special VOCs sampling instructions) to prevent loss of preservative.
6. Cap the containers tightly. Place the sample container in a plastic bag and seal.
7. Place sample in cooler, add ice or blue ice (preferred).
8. Fill out field data form and/or chain of custody form. Observe and note in the field log book, any visible contamination on-site, (e.g., sheen on water, floating debris, odors, fish kills, etc.).
9. Measure designated in-situ field parameters and record data in field log book.

Disposable gloves will be used during all sampling events. The inside of the sampling container must never be touched or contaminated with repellents, perfumes, or other organic liquids and vapors.

3.4.3.5b Deep (Stratified) Water Sampling

Sampling of stratified waters or waters too deep to sample using the procedure in 3.4.3.5a above, will be sampled using a brass or plastic Kemmerer bottle or equivalent method as indicated below:

1. Inspect sampler bottle for thorough cleaning and ensure that sample drain valve is closed (if bottle is so equipped).
2. Measure and then mark sample line at desired sampling depth.
3. Open bottle by lifting top stopper-trip head assembly.
4. Gradually lower bottle until desired level is reached (predesignated mark from Step 2).
5. Place messenger on sample line and release.
6. Retrieve sampler; hold sampler by center stem to prevent accidental opening of bottom stopper.
7. Rinse or wipe off exterior of sampler body (wear proper gloves and protective clothing).
8. Recover sample by grasping lower stopper and sampler body with one hand (gloved), and transfer sample by either (a) lifting top stopper with other hand and carefully pouring contents into sample bottles, or (b) holding drain valve (if present) over sample bottle and opening valve.
9. Allow sample to flow slowly down side of sample bottle with minimal disturbance.
10. Select sample bottles and preserve the sample if necessary as per guidelines in Sections 3.3.4 and 3.4.1.2.

11. Check that a Teflon liner is present in the cap if required. Secure the cap tightly.
12. Label the sample bottle with an appropriate tag. Be sure to complete the tag with all necessary information. Record the information in the field log book and complete all chain-of-custody records.
13. Decontaminate sampler and messenger following procedures outlined in Section 3.4.3.4 after use and between sampling locations.

3.4.3.6 Sediment and Sludge Sample Collection

All sediment and sludge sampling shall be conducted in accordance with SRS DPSOP 254 and Characterization of Hazardous Waste Sites -A Methods Manual: Volume II. Available Sampling Methods, Second Edition (EPA-600/4-84-076).

3.4.3.6a Sludge or Sediment Sampling With A Ponar Grab

The dredge or grab will be capable of sampling most of the aquatic sediment types encountered at SRS. The procedures outlined below are for the Ponar grab, but will be applicable to other clamshell-type scoops commercially available. The procedures are:

1. Attach a precleaned Ponar to the necessary length of sample line. Solid braided 5 mm (3/16 inch) nylon line is usually of sufficient strength; however, 20 mm (3/4 inch) or greater nylon line allows for easier hand hoisting.
2. Measure and mark the distance to bottom on the sample line. A secondary mark, 1 meter shallower, will indicate proximity so that lowering rate can be reduced, thus preventing unnecessary bottom disturbance.
3. Open sampler jaws until latched. From this point on, support sampler by its lift line or the sampler will be tripped and the jaws will close.

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4. Tie free end of sample line to fixed support to prevent accidental loss of sampler.
5. Begin lowering the sampler until the proximity mark is reached.
6. Slow rate of descent through last meter until contact is felt.
7. Allow sample line to slack several centimeters. In strong currents more slack may be necessary to release mechanism.
8. Slowly raise dredge clear of water surface.
9. Place Ponar into a stainless steel or Teflon tray and open. Lift Ponar clear of the tray.
10. Collect a suitable mixed aliquot with a precleaned stainless steel lab spoon or equivalent and place sample into appropriate container, as specified in Table 3-1.
11. Check for a Teflon liner in cap if required and secure cap tightly. The chemical preservation of solids is generally not recommended. (Refer to Guidelines in Table 3-1.) Refrigeration is usually the best approach. Maximum holding times specified in SW-846 must not be exceeded.
12. Label the sample bottle per Section 3.3.5. Label carefully and clearly, addressing all the categories or parameters. Complete all chain-of-custody documents and record in the field log book.
13. Consult Section 3.4.3.4 for appropriate decontamination procedures to be used on sampling equipment after use and between sampling locations.

3.4.3.6b *Sludge or Sediment Sampling With A Hand Corer*

Sediment sampling through vegetated soils likely to be encountered in wetlands or floodplains will be conducted with the use of a hand corer. The corer can be strategically placed to sample in small clearings and is capable of cutting through underlying root mats to obtain a discrete sample. A number of core types may be utilized effectively, but all will essentially follow the procedure presented below:

1. Inspect the corer for proper precleaning, and select sample location.
2. Force corer in with smooth continuous motion.
3. Twist corer, then withdraw in a single smooth motion.
4. Withdraw sample into a stainless steel or Teflon tray.
5. Transfer mixed sample into an appropriate sample bottle with a stainless steel lab spoon or equivalent.
6. Check that a Teflon liner is present in cap if required. Secure the cap tightly. Chemical preservation of solids is generally not recommended. (Refer to Guidelines in Table 3-1.) Refrigeration is usually the best approach. Maximum holding times specified in SW-846 must not be exceeded.
7. Label the sample bottle with the appropriate information. Be sure to label carefully and clearly, addressing all the categories or parameters. Complete all chain-of-custody documents and record in the field log book.
8. Decontaminate sampling equipment after use and between sample locations as required.

3.4.3.7 Field Quality Control Samples

In order to assure sample quality during collection, transportation, and analysis, several types of quality control samples will be collected for each matrix type. These samples, for both water and sediment media, will include duplicates, sampler rinsates, trip blanks, and field blanks. Quality control requirements for water samples are identical to those listed in the Ground Water QC Section 3.4.2.7. QC requirements for sediment and sludge samples are similar to those listed in the Soil QC Section 3.4.1.9.

3.4.4 Ambient Air Sampling QC Methodology

This section outlines the required QC procedures prior to and during ambient air sampling. The general air sampling strategies and methodologies are listed in Sections 9.4.2 and 9.4.3, rather than in this section.

3.4.4.1 Sampling Point Locations

Sampling point locations will be selected according to the criteria discussed in Sections 9.6.2.2 and 9.6.3.2. The locations will be predetermined and clearly marked on a unit map prior to actual sampling. The contractor will prepare a written sampling plan which will address the following:

- Sampling numbers
- Sample location and depths
- Analytical parameters
- Container requirements

- Health and Safety requirements
- Sampling QC procedures

3.4.4.2 Sampling Equipment Calibration and Preparation

All ambient air sampling equipment will be properly calibrated and prepared before field use according to the guidelines listed in Section 3.3.2. This section lists general calibration and standard preparation procedures for ambient air sampling equipment specified in Section 9.6.

3.4.4.2a Calibration of Flame Ionization and Photoionization Detectors

Calibration of flame ionization and photoionization detectors shall be in accordance with manufacturing specifications and shall be documented as described in Section 3.3.2.

Each time the organic vapor and gas measurement equipment is moved to a different RFI site, a re-calibration check will be performed, according to the procedures specified for the equipment.

3.4.4.2b Calibration of High Volume Particulate Samplers

A general procedure (from Method IV-9 in Characterization of Hazardous Waste, Vol. II, 2nd edition) for the calibration of high-volume particulate samplers appears below. The operating manual for the specific equipment used must be consulted prior to calibration, in order to note variations from the procedure listed below.

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1. Remove filter retaining plate from the sampler to be calibrated and place a clean filter in the filter holder.
2. Attach the variable resistance orifice (VRO) to the sampler and position the orifice setting to full open. Secure the VRO fall plate to ensure an air tight seal with the orifice gasket. Attach a slack tube manometer to the sampler unit.
3. Plug sampler into 120-volt source, while checking manometer to ensure that the orifice pressure drop does not exceed the range of the manometer. Let the sampler run for about 5 minutes.
4. Turn motor off and place a fresh chart on the unit. The chart should include the following information: high-volume sampler identification, date, time, and location of calibration, ambient temperature and barometric pressure, and operator's name. The chart should be labeled "Calibration Data."
5. Check the recorder for proper operation, and zero the pen if necessary.
6. Determine five approximately equally spaced intermediate points which provide pressure drops between the desired maximum and minimum operating point and record the following data on the calibration sheet:
 - pressure drop from the manometer (in. H₂O)
 - flow rate indicated on the recorder, liters/min (ft³/min).

Repeat three points centralized in the vicinity of the expected sampler flow rate to ensure accuracy in the field.

(The recorder should be tapped gently prior to reading, to ensure that the recorder pen is in its final position.)

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7. Record the airflow rate from the VRO high-volume calibration curve for each flow recorder reading.

$$\text{ACCEPTABILITY} = 100 \frac{|(Q_o - Q_c)|}{|Q_c|} \text{ within } 5\%$$

where: Q_o = observed flow rate
 Q_c = flow rate from calibrated curve

8. If the air flow rate exceeds the acceptable limits, rerun points for which percent deviation exceeds 5 percent until acceptance limits are attained.
9. Correct the sample flow rate to standard conditions using the following formula:

$$Q_2 = Q_1 \frac{T_2 P_1}{T_1 P_2}$$

where: Q_2 = corrected flow rate std., liters/min (std. ft³/min)

Q_1 = recorded flow rate from chart, liters/min (ft³/min)

T_1 = temperature during calibration, °K (°R)

T_2 = standard temperature, 298°K (537°R)

P_1 = atmospheric pressure during calibration,
mm Hg (in. Hg)

P_2 = standard absolute pressure, 760 mm Hg
(29.92 in. Hg)

Samplers must be calibrated when first purchased, after major maintenance on the sampler (e.g., replacement of motor or brushes), any time the flow measuring device

Samplers must be calibrated when first purchased, after major maintenance on the sampler (e.g., replacement of motor or brushes), any time the flow measuring device (rotameter or recorder) has been replaced or repaired, or any time a one-point calibration check deviates from the calibration curve by more than ± 6 percent.

3.4.4.2c Calibration of Sampling Pumps (for Volatile Organics Sampling)

For measurement of specific organic constituents or constituent groups, using more complex volatile organic sampling trains (such as those listed in Appendix P), the following general cautions must be considered:

1. Sampling pumps should be initially calibrated before use in the field, as specified below according to Method IV-7 of Characterization of Hazardous Waste Sites, Volume II, Second edition:

Procedure for Calibration of Sampling Pumps Equipped with Rotameter, Needle Valve Combination.

- a. Select a set of sampling pumps and assemble necessary equipment (see Figure 4-1 in above reference). Calibrate each pump as follows:
- b. Measure ambient air temperature, barometric pressure and relative humidity. Determine water vapor pressure from tables.
- c. If battery test is available, check battery.
- d. Place "calibrator" sorbent cartridge in line and start pump. Allow pump to stabilize. Do not use this "calibrator" cartridge for actual sampling, however, it can be reused for additional calibration runs.

- e. Determine actual flow rate, f , with bubble tube flowmeter.

$$f = \frac{\text{Distance traveled (ml)}}{\text{Travel time (min)}}$$

- f. Adjust flow rate of the sampler to the desired rate by adjusting the needle valve. Verify that the flow rate has been achieved by checking against bubble tube three times. Calculate a mean value by summing the values of the three individual readings and dividing by three. The deviation of the individual flow rates from the mean flow rate should not exceed ± 5 percent.

- g. Calculate flow rate at standard conditions as follows:

$$F = f \frac{T_{\text{std}} P_c - P_{\text{H}_2\text{O}}}{T_c P_{\text{std}}}$$

Nomenclature --

- F = flow rate at standard conditions, liters/min (ft^3/min)
 f = actual flow rate at calibration conditions, liters/min (ft^3/min)
 T_c = temperature of air during calibration $^{\circ}\text{K}$ ($^{\circ}\text{R}$)
 P_c = pressure of air during calibration, mm Hg (in. Hg)
 T_{std} = standard absolute temperature, 298°K (537°R)
 P_{std} = standard absolute pressure, 760 mm Hg (29.92 in. Hg)
 $P_{\text{H}_2\text{O}}$ = vapor pressure of water at T_c , mm Hg (in. Hg)

- h. Mark level achieved during flow rate setting on rotameter and record on sampling data sheets for reference. To ensure acceptable flow rate precision, this reference setting on the rotameter should be maintained during sampling. The rotameter can either be integral with the pump (as in the MSA Monitaire Model S) or separate.

- i. Note that, in this case, the rotameter is used only as a visual reference. To ensure correctness of the reference point, calibration conditions should not deviate from sampling conditions by more than the following:

Temperature $\pm 15^{\circ}\text{C}$

Barometric pressure ± 10 mm Hg.

Procedure for Calibration of Constant Flow Pump Systems

- a. Select a set of sample pumps and assemble necessary equipment. Figure 4-2 (in the above reference) depicts a calibration set-up developed by E.I. DuPont de Nemours & Company for use with their constant flow sampling pumps. This configuration or equivalent is acceptable.
- b. Calibrate each pump according to the following basic steps. In addition, consult the manufacturer's instructions for specific details unique to the model in use.
- c. Measure ambient air temperature, relative humidity, and barometric pressure. Determine water vapor pressure from tables.
- d. If battery test is available, check battery.
- e. Connect pump inlet to bubble tube flowmeter* and start pump. Allow pump to stabilize before taking readings.
- f. Adjust to desired flow rate. With the calibration configuration depicted in Figure 4-2 (in the above reference), the flow rate can be adjusted to the target range with the magnehelic flow rate meter.
- g. If a flow rate meter is not available, determine the initial flow rate using the bubble tube flow meter and record the time required for the bubble to travel between the appropriate volume markings on the tube.

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h. Calculate the actual flow rate as follows:

$$f = \frac{\text{Distance traveled (ml)}}{\text{Travel time (min)}}$$

i. Once the flow rate of each sampler has been adjusted to the appropriate setting, verify three times with the bubble tube and record the results. Calculate the mean flow rate by summing the values of the three individual readings and dividing by three. The deviation of the individual flow rates from the mean flow rate should not exceed ± 5 percent.

j. Calculate flow rate and total sample value at standard conditions as follows:

$$F = f \frac{T_{\text{std}} P_c - P_{\text{H}_2\text{O}}}{T_c P_{\text{std}}}$$

*Constant flow type pumps have the ability to maintain the flow rate with ± 5 percent at pressure drops as high as 25 inches of water. For this reason, it is unnecessary to place a "calibrator" sorbent cartridge in line as long as the expected pressure drop does not exceed that specified by the manufacturer.

Nomenclature --

F = flow rate at standard conditions, liters/min (ft³/min)
f = actual flow rate at calibration conditions, liters/min (ft³/min)
T_c = temperature of air during calibration °K (°R)
P_c = pressure of air during calibration, mm Hg (in. Hg)
T_{std} = standard absolute temperature, 298°K (537°R)
P_{std} = standard absolute pressure, 760 mm Hg (29.92 in. Hg)
P_{H₂O} = vapor pressure of water at T_c, mm Hg (in. Hg)

k. When using the calibration configuration depicted in Figure 4-2, the flow maintenance feature of the pump can be checked by inducing a pressure drop across the system using the pressure drop valve and determining the subsequent flow rate with the bubble tube. The maximum difference between the flow rate determined in step i and the flow rate measured at the maximum expected pressure drop should not exceed ± 5 percent.

2. Sampling pumps should be periodically checked for leaks, according to the equipment operating procedure.
3. Collection and/or sorbent tubes should be compatible with the sampling pump used (check manufacturer specifications).
4. The collection tube expiration date (if applicable) should always be checked.

3.4.4.2d Calibration and Standards Preparation for Portable, Field-Operable Gas Chromatographs (GC)

Listed below are general procedures for GC standards preparation and instrument calibration, in accordance with Method IV-5 in Characterization of Hazardous Waste Sites, Volume II, Second Edition. Detailed calibration instructions must be obtained from the operating manual of the specific GC unit to be used.

1. Standard Preparation

GC standards in air are prepared by using quantities of pure solvent which are small enough to vaporize completely in a 40 ml VOA vial. The resultant concentration is calculated by:

$$C = \frac{A \times D}{V + A}$$

where: C = compound concentration (in $\mu\text{g/cc}$)
A = amount injected (in μl)
D = density of the standard (in g/ml)
V = volume of the vial and the air in it (in liters)

For example, 1 μl of toluene is injected into a clean 40 ml. VOA vial and allowed to vaporize. The resultant concentration is then calculated as:

$$\frac{(1 \mu\text{l}) \times (0.866 \text{ g/ml})}{(0.4 \text{ l})} = 2.2 \mu\text{g/cc}$$

This standard can then be used to prepare standards of lesser concentration by further dilution with air on a volume/volume basis.

Several standards can be injected into one vial to make a multi-component standard to save calibration time. Care shall be taken in component selection to prevent the resultant chromatograms from being too complex to determine individual compound responses. To extract a portion of the vapor, penetrate the septum with a clean syringe and fill to the desired volume. Remove the syringe and the standard is ready for injection into the chromatograph. Total volume removed shall not exceed 1 ml. Volumes in excess of 1 ml will detrimentally affect reproducibility of standards.

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2. Instrument Calibration

- a. Check battery charger level indicator; if in doubt, recharge battery as described in the manual.
- b. Turn instrument on and allow adequate warmup time.
- c. Follow operating procedures for lighting FID flame (if used), lighting PID lamp (if used), establishing carrier gas flow, zeroing recorder response, etc.
- d. Using the procedure described below, inject an appropriate amount of the standard described in Section 1. Hold the syringe in two hands, using one to guide the needle into the septum and the other to provide force to pierce the septum and to prevent the plunger from being forced out by the pressure from the GC. Insert the needle through the septum as far into the injection port as possible, swiftly and smoothly depress the plunger, hesitate one second, and withdraw the needle.
- e. Mark injection time and sample I.D. on output recorder strip chart, and start timer for monitoring retention times. Record pertinent parameters in analytical log book for documentation of analytical conditions.
- f. Record retention times and peak heights (or integrated peak areas if an integrator is available) of each eluting peak.
- g. Chromatograms of blank injections shall be made at frequent intervals, especially after running a sample with a high contaminant loading, to guard against syringe contamination.
- h. At least one standard run should be made on each day of analysis, or when conditions change sufficiently to warrant re-calibration.

Injection of standard mixtures of compounds will allow determination of retention time for each of the compounds. The elution order of the compounds in these mixtures will remain constant for a given GC column and shall be determined prior to field use. Tables 4-2 through 4-4, listed in Characterization of Hazardous Waste Sites, Volume II, give elution orders and approximate retention times for several compounds on several columns.

After both standards and samples have been run, comparison of the samples to standards shall be made. If retention time matches are noted, another column is installed in the GC and standards and samples re-run, with subsequent comparisons made. A retention-time match on two different columns provides a fairly reliable identification. However, given the purpose of this screening, the data shall be labeled "tentative" or "preliminary."

To save analytical time, the following strategy has been used. Since shorter GC columns result in shorter retention times at the cost of lower resolution between peaks, a short column is used to do the first set of analyses, and longer columns are used to verify compound identify and quantitation.

Following tentative identification of compounds in the sample, a determination of quantitation can be made. This can be based either on peak height or on the integrated area under the peak if an integrator is used.

First, using the response to the standard, calculate a response factor as:

$$RF = \frac{R}{V \times C}$$

where:

RF = response factor
C = concentration of the standard (µg/ml)
V = volume of standard injected (ml)
R = response to the standard (in integrated counts
or measured linear dimensions)

Sample concentrations can then be estimated by:

$$C' = \frac{R'}{RF \times V'}$$

where:

C'	=	sample concentration (µg/ml)
R'	=	response of sample peak (in the same units as used for the standard)
V'	=	volume of sample injected (ml)
RF	=	calculated response factor.

3.4.4.2e Preparations for Sampling Gaseous Compounds with Stain Detector (Colorimetric) Tube

Perform necessary pump leak check procedures. This is usually accomplished by plugging pump inlet, drawing a vacuum on the pump, holding it for at least 1 minute and determining visually if leak allows bellows to inflate or piston fails to return completely into pump. The pump can be plugged using a sealed detector tube. The detector tubes require no further preparation or calibration at this time.

3.4.4.2f Preparations for Sampling Volatile Organics Using Solid Sorbents (Tenax/Charcoal)

These preparation steps for sampling using solid sorbents (tenax or charcoal) are in accordance with Method IV-7 in Characterization of Hazardous Waste Sites, Volume II:

1. Assemble sampling train (Figure 4-4 in above reference). The general procedure requires four trains operated within the flow rate ranges listed in the preceding discussion be set up at each location. Duplicate samplers operating at the same flow rate as one or more of the listed ranges can be set up to collect duplicate samples for backup or quality assurance purposes. Set trains up at desired location and hang samplers on a tripod, music stand, or similar device. To ensure stability in wind gusts, weighing of these devices or some method of anchoring is advisable. Nonsparking

wooden stakes or fence post can be used but are more work, more difficult to move (which is often necessary), and may incur more risk where buried hazards exist.

2. Record all initial information (time, counter reading, cartridge number, pump number, sampler, blank number, barometric pressure, ambient temperature, relative humidity, etc.).
3. Start pump and observe system to determine if appropriate flow rate is being maintained. For systems utilizing rotameters, the calibrated rotameter setting shall be maintained during the entire run and shall be monitored regularly. Any adjustments to the rotameter are made by opening or closing the needle valve and are noted in the field log. Most constant flow sampling pumps have low flow indicators and/or an automatic shut-off feature at low flow conditions. These shall be initially observed and periodically monitored during the course of sampling.

3.4.4.2g Preparations for Sampling Semi-Volatile Organic Compounds Using Polyurethane Foam (PUF), Method IV-8, Characterization of Hazardous Waste Sites, Volume II.

1. Assemble sampling train (see Figure 4-5 in above reference). Set train up at desired location and hang sampler on a tripod, music stand, or similar device. To ensure stability in wind gusts, weighing of these devices or some method of anchoring is advisable. The use of wooden or other nonsparking stakes can be used, but experience has shown these to be less convenient and often more work than weighted stands.
2. Record all initial information (time, counter reading, cartridge number, pump number, sampler, blank number, barometric pressure, ambient temperature, relative humidity, etc.)
3. Start pump and observe system to determine if appropriate flow rate is being maintained. For systems utilizing rotameters the calibrated rotameter setting shall be maintained during the entire run and shall be monitored regularly. Any adjustments to

the rotameter are made by opening or closing the needle valve and shall be noted in the field log. Most constant flow sampling pumps have low-flow indicators and/or an automatic shut-off feature at low-flow conditions. These shall be initially observed and periodically monitored during the course of sampling.

3.4.4.3 Container Type and Preservation Requirements

Prior to the field sampling event, sample container and preservation requirements will be predetermined, based on the specific sampling methodology used. For field procedures such as organic vapor measurements using an OVA or calorimetric stain detector tubes, no special container type and preservation are required. Other sampling methodologies, container and preservative requirements are listed in Table 3-3.

3.4.4.4 Decontamination Procedures

Equipment decontamination is essential for preventing cross-contamination between samples. All equipment will be decontaminated prior to the collection of each air sample. Decontamination procedures will be uniform to provide consistency for all RFI sampling efforts.

The decontamination procedure for electronic equipment such as the OVA is as follows:

1. Wipe off exterior surface with damp or dry cloth.
2. Clean organic vapor probe as specified in operating manual.
3. Clean or change filters if needed as specified in operating manual.

High background readings after prolonged use may indicate sample probe and/or in-line filters (in front of detector) need to be cleaned. Use of pipe cleaners or clean air blown backwards through filters is adequate. Do not use organic solvents as detector will respond to solvent as well.

TABLE 3-3

AMBIENT AIR SAMPLING CONTAINER AND PRESERVATION REQUIREMENTS

<u>Sampling Methodology</u>	<u>Container</u>	<u>Preservative</u>	<u>Maximum Holding Time</u>
Field OVA or HNu	Organic-Free	---	30 - 60 Minutes Plastic Bag
Stain Detector (Calorimetric) Tubes	---	---	Analyze Immediately
Whole Volume Samples via Test Hole or Ground Probe	10 μ l - 1 liter Gas-Tight Syringe	Cool, 4°C Store in Dark	Analyze Immediately
Field-Operable Gas Chromatograph	10 μ l to 1 ml Gas-Tight Syringe	Cool, 4°C Store in Dark	Analyze Immediately
Tenax or Charcoal Adsorbent Tubes	Aluminum Foil and Glass Culture Tube	Cool, 4°C Store in Dark	48 Hours Recommended
Polyurethane Foam Cartridge	Aluminum Foil and Glass Culture Tube	Cool, 4°C Store in Dark	48 Hours Recommended
Petrex Cartridges	Aluminum Foil	Cool, 4°C Store in Dark	48 Hours Recommended

^a Container, preservative, and maximum holding time requirements are consistent with Characterization of Hazardous Waste Sites = A Methods Manual -- Volume II. Available Sampling Methods. Second Edition, EPA-600/4-84-076.

Syringes used to collect GC samples may become contaminated if high concentrations of organics are encountered. If a gas-tight syringe becomes contaminated, the easiest method of cleaning is to bake it in the oven at 105°C overnight. It may be possible to clean the syringe by removing the plunger, inserting the needle into the GC injection port, and allowing carrier gas to flow through it for several minutes.

3.4.4.5 Equipment Operating Procedures

3.4.4.5a Operation of Flame Ionization Detector (FID)

For ambient air organic vapor measurements, conducted by a flame ionization detector (FID), the following procedure (Method IV-3) taken from Characterization of Hazardous Wastes - A Methods Manual: Volume II. Available Sampling Methods, 2nd Edition (EPA - 600/4-84-076) will be followed:

1. Check battery charge level indicator; if in doubt, recharge battery as described in manual.
2. Turn instrument on and allow adequate warmup time.
3. If equipped with internal calibration capability, perform instrument calibration. Perform zero and other calibration procedures as described in operating manual.
4. If equipped with an alarm mode, set alarm at desired concentration.
5. Turn on pump and check for leaks by covering sampling inlet and observing rotameter. Indicator ball should drop to zero level.
6. With pump operating, open hydrogen gas storage tank valve and open supply regulator to allow fuel gas flow to detector chamber.

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7. Depress igniter switch, observe indicator needle for positive response and listen for a "pop." If flame fails to light, depress igniter switch again.
8. Once detector flame is lit, unit is ready for use.
9. If calibration to a specific hydrocarbon species is desired, complete this procedure according to the manufacturers instructions.
10. Hold sample probe within several inches of the area in question as low sample rate allows for only very localized readings.
11. Slow sweeping motion will help prevent the bypassing of problem areas. Make sure batteries are recharged within time frame specified in operator manual. Usual length of operating time between charges is 8-12 hours.
12. Some units have alarms that signal operator if detector flame goes out. If this alarm sounds, evacuate all personnel and relight flame in known safe area; then reenter unit.
13. Monitor fuel and/or combustion air supply gauges regularly to ensure sufficient gas supplies.
14. Representative readings will also depend on performance of routine maintenance as described in detail in operating manual. Also, since unit contains pressurized gas supplies, perform leak check procedures regularly, as leaking hydrogen gas is explosive.
15. As with any field instrument, accurate results depend on the operator being completely familiar with the operator's manual for the particular unit.
16. Concentrations beyond the greatest scale factor of the instrument or in excess of 30 percent (0.3) LEL of the sample component require system modification. Similar modification may be necessary for sampling in oxygen-deficient atmospheres. This

usually entails increasing the combustion air to the detector by sample dilution or by an independent air supply. A dilution system is simply the apparatus required to supply a filtered, controlled air supply for analyzers that use the sample gas stream as the source of combustion air. A dilution system can, by selection of various critical orifices, dilute a gas stream by ratios up to 100:1.

17. Always be sure that carrier gas flow (usually sample gas) is initiated prior to lighting the detector flame.

The above procedures are applicable for any portable FID. Detailed operating instructions for the specific FID unit must be obtained from the unit operating manual.

3.4.4.5b Operation of the Photoionization Detector (PID)

The photoionization detector has a broader capability than the FID, in that it can detect certain inorganic vapors. However, the PID is unable to detect low molecular weight hydrocarbons (e.g., methane and ethane) and certain toxic gases (e.g., carbon tetrachloride) which have high ionization potentials.

The following photoionization operating procedure, Method IV-3, (from Characterization of Hazardous Waste Sites: Volume II) will be followed when utilizing a PID.

1. Check battery charge level. If in doubt, charge battery as described in manual.
2. Turn unit on. Verification of UV lamp operation can be made by looking into sensor for purple glow of the lamp.
3. Perform zero and calibration procedure as described in operating manual. Calibration for specific compounds can be performed so that instrument response is proportional to the calibration gas concentration.

4. If so equipped, set alarm at desired level.
5. Once calibrated, unit is ready for use.
6. Position intake assembly within several inches of the sampling area, as the low sampling rate allows for only very localized readings.
7. A slow sweeping motion of the intake assembly will help prevent the bypassing of problem areas.
8. Static voltage sources such as AC power lines, radio transmissions, or transformers may interfere with measurements. See operating manual for discussion of necessary considerations.

The procedural steps listed above are intentionally general. The operating manual for the unit being used must be consulted for specific instructions.

3.4.4.5c Operation of High Volume Particulate Sampler

At sites where significant particulate release is suspected, some type of particulate measurement screening device must be incorporated. The following procedure for particulate sampling, as outlined in Method IV-9 in Characterization of Hazardous Waste Sites, Vol. II, 2nd edition, and 40 CFR, Part 50, Appendix B (July 1, 1986), shall be followed:

1. Installation of Clean Filter
 - a. Remove faceplate by loosening the four wing nuts and rotating the bolts outward.
 - b. Obtain a clean, weighed filter and record the filter number, high-volume sampler serial number, flowmeter serial number, location, run date, and start time on the data sheet.

- c. Carefully place the clean filter rough side up, on the wire screen, and center the filter so that when the faceplate is in position, the gasket will form a tight seal on the outside edge of the filter.
- d. Replace faceplate being careful not to move the filter, and tighten the wing nuts, evenly until the gasket forms an airtight seal against the filter.

2. Operation Checks

- a. Allow sampler motor to warm up at least 5 minutes to reach normal operating temperature.
- b. Ensure that the flow recorder is connected to the sampler using the same tubing as was used to calibrate the sampler.
- c. Place a new chart on the recorder and set at correct start time.
- d. Record "Run Start" time and date, site identification, and sampler number on the chart.
- e. Turn sampler off and set clock switch to desired setting. Total suspended particulate samples are normally collected over a 24-hour period; however, this requirement may be altered depending on monitoring applications.

***3.4.4.5d Operation of Portable, Field-Operable Chromatographs, Method IV-5,
Characterization of Hazardous Waste Sites, Volume II, 2nd Edition***

- 1. Collection of an air sample can be obtained with a gas-tight syringe at the sampling site. The syringe is filled and emptied several times in the contaminated atmosphere. The syringe is filled once again and the sample is carried off site to an area where the GC is set up for field analysis. The sample can then be injected into the GC column, a

chromatogram produced, and further qualitative/quantitative analysis performed. Sample volumes of 10 ul to 1 ml can be used.

2. Check battery charger level indicator; if in doubt, recharge battery as described in the manual.
3. Turn instrument on and allow adequate warmup time.
4. Follow operating procedures for lighting FID flame (if used), lighting PID lamp (if used), establishing carrier gas flow, zeroing recorder response, etc.
5. Using the procedure described below, inject an appropriate amount of the sample. Hold the syringe in two hands, using one to guide the needle into the septum and the other to provide force to pierce the septum and to prevent the plunger from being forced out by the pressure from the GC. Insert the needle through the septum as far into the injection port as possible, swiftly and smoothly depress the plunger, hesitate one second, and withdraw the needle.
6. Mark injection time and sample I.D. on output recorder strip chart, and start timer for monitoring retention times. Record pertinent parameters in analytical log book for documentation of analytical conditions.
7. Record retention times and peak heights (or integrated peak areas if an integrator is available) of each eluting peak.

3.4.4.5e *Operating Procedures for Stain Detector (Colorimetric) Tubes, Method IV-6, Characterization of Hazardous Waste Sites, Vol. II, 2nd Edition*

1. Break open both ends of detector tube, insert correct end into pump, and sample according to instructions. Most tubes have some kind of indicator (i.e., arrow, prefilter) that helps determine which end of tube is the inlet. The direction of the concentration scale is also a guide.

2. Visually inspect tube for color changes and record corresponding gas concentration.

3.4.4.5f *Operating Procedures for Sampling Volatile Organics Using Solid Sorbents (Tenax/Charcoal) (Method IV-7) or Polyurethane Foam, Method IV-8, Characterization of Hazardous Waste Sites, Vol, II, 2nd Edition*

1. Start pump and observe system to determine if appropriate flow rate is being maintained. For systems utilizing rotameters, the calibrated rotameter setting shall be maintained during the entire run and should be monitored regularly. Any adjustments to the rotameter are made by opening or closing the needle valve and are noted in the field log. Most constant flow sampling pumps have low flow indicators and/or an automatic shut-off feature at low flow conditions. These should be initially observed and periodically monitored during the course of sampling.
2. Allow pump to run for desired sampling time.
3. At the end of the sampling period, observe rotameter level or low flow indicator to determine if flow rate has been maintained. Shut down sampling pump and record all pertinent information (counter reading, time, barometric pressure, relative humidity, ambient temperature, problems, comments, etc.) The final flow rate should not deviate from the initial flow rate by more than ± 5 percent.

3.4.4.6 *Sample Collection and Handling Procedures*

Ambient air samples must be properly collected to minimize contamination or cross-contamination. Latex surgical gloves will be used while collecting all ambient air samples. The gloves will be disposed after equipment has been decontaminated and a clean pair used for the next sample.

Collection and handling procedures are dependent on the particular sampling methodology being utilized. Procedures in accordance with 40 CFR, Part 50, Appendix B, are listed below:

3.4.4.6a Collection and Handling of High Volume Particulate Filters

1. Turn sampler "on" and allow to warm up at least 5 minutes.
2. Check flow recorder chart for proper operation.
3. Turn sampler "off" and record elapsed time in log book and on the data sheet.
4. Remove chart and place in envelope.
5. Carefully loosen wing nuts and remove faceplate gasket.
6. Remove the exposed filter by gently grasping the ends of the filter and lifting it from the screen. Fold the filter lengthwise at the middle with the exposed side "in." If the collected sample is not centered on the filter, fold the filter accordingly so that sample touches sample only.
7. Place the filter in a glassine envelope, and place glassine envelope with data sheet in a folder for return to laboratory.
8. Place sample identification tag on envelope and fill out chain-of-custody form.
9. Visually inspect for signs of leakage, damage, etc., to the sampler and repair if necessary.

3.4.4.6b Collection of Whole Air Volatile Organic Samples Using a Gas-tight Syringe

An air sample can be obtained with a gas-tight syringe at the sampling site. The syringe is filled and emptied several times in the contaminated atmosphere. The syringe is filled once again and the sample is carried off site to an area where the GC is set up for field analysis. The sample can then be injected into the GC column, a chromatogram produced, and further qualitative/ quantitative analysis performed. Sample volumes of 10 ul to 1 ml can be used.

**3.4.4.6c Collection of Volatile Organics Using Solid Sorbents
(Tenax/Charcoal), Method IV-7, Characterization of Hazardous Waste
Sites, Vol. II, 2nd Edition**

1. Remove sorbent cartridge (use clean latex surgical gloves) and place in culture tube. Place cartridge in culture tube with the inlet facing up and mark accordingly on the outside of the culture tube. Do not put any marking on Tenax cartridges.
2. Place plugs of glass wool below and above the cartridge and tightly cap and label the culture tube. Before proceeding with the packing, the tube should be shaken to ensure that the cartridge does not rattle inside the culture tube.
3. Place sample identification tag on culture tube and fill out chain-of-custody form.
4. Calculate total sample volume at standard conditions

$$V_{std} = F \times t$$

where: F = flow rate at standard conditions,
liters/min (ft³/min)
t = total sample time (min)
Vstd = sample gas volume at dry standard
conditions, dsl (dscf)

3.4.4.6d Collection of Semi-Volatile Organic Compounds Using Polyurethane Foam (PUF), Method IV-8, Characterization of Hazardous Waste Sites, Vol, II, 2nd Edition

1. Remove PF cartridge (use clean gloves) and wrap it with hexane-rinsed aluminum foil.
2. Place foil-covered cartridge in a hexane-rinsed glass bottle or culture tube that has been properly labeled. Plugs of glass wool are placed below and above the cartridge and the tube is tightly capped. The tube should be gently shaken to ensure that the cartridge does not rattle inside the culture tube.
3. Place sample identification tag on sample bottle or culture tube and fill out chain of custody form.
4. Calculate total sample volume at standard conditions as in Method IV-7 above.

Immediately following the collection of the sample, the container will be sealed and the sample should be labeled and information entered in the field sampling log book as described in Section 3.3.4 and 3.3.5. At this time, the chain of custody form should note the acquisition of the sample. The sample will be packaged and transported in accordance with procedures listed in Sections 3.3.8, and 3.3.11.

3.4.4.7 Field Quality Control Samples

To ensure that a high sample quality is maintained during collection, transport, storage, and analysis, several types of quality control samples will be collected. For the ambient air medium, quality control samples consist of duplicates, trip blanks, and field blanks.

- **Duplicate Samples:** These are blind quality control samples which are duplicates of field samples, and which are submitted to the contractor laboratory. All duplicate samples for volatile organic analyses will be grab samples as opposed to composite samples for other compounds of interest.

Internal quality assurance duplicate samples will be collected at a frequency of one per sampling methodology utilized or one for each ten samples sent to the Contractor laboratory, whichever is greater. These sample results will be compared to those of the original samples for final data validation.

- **Trip Blank Samples:** These samples, prepared by the contractor laboratory, are used for volatile organic samples only. The samples are submitted blind to the contractor laboratory with each cooler containing volatile organic field samples and other compounds of interest.

Trip blanks are defined as containers filled with unused filter or adsorption media which accompany the field samples during sampling, storage, and transportation to the laboratory. These samples will be analyzed to determine if the storage or handling of the field samples has jeopardized their integrity. The results of these samples will be used for final data validation purposes. Trip blanks will be submitted at a frequency of one per sample shipment or as specified by the RFI Program Team.

- **Field Blanks:** These samples will consist of background ambient air samples taken at a location upwind of the RFI unit. Field blank samples are quality control samples provided to the SRS Quality Assurance Laboratory or its designated laboratory at the

option of SRS. The results of these samples will be used for final data validation purposes. The number of field blanks will be predetermined by the SRS RFI Program Team prior to each RFI project.

3.5 LABORATORY QA/QC

The primary objective of a laboratory QA/QC program is to ensure the precision and accuracy of all data generated by contractor laboratories. All prospective RFI Contractors shall prepare and submit to the SRS RFI Program Team for approval a detailed laboratory QA/QC Plan for all RFI projects. Due to the nature and number of the RFI units at SRS, laboratory uniformity is required in the following areas:

- Sample handling
- Methods control
- Performance evaluation
- Analytical data generation and control
- Data management

To achieve the uniformity described above, SRS will use the EPA Contract Laboratory Program (CLP) Protocols as the standard for all laboratories which will be used during all RFI projects. SRS shall require all laboratories involved in the RFI process to be either contract laboratories to the CLP or laboratories which adhere and conform to all requirements of the CLP.

3.6 REQUIRED DOCUMENTATION

This section presents the documentation requirements for the RFI work at SRS. All documents shall become the property of SRS and no document shall be released by

Consultants or Contractors without the written approval of SRS and DOE. The RFI Program Team will be responsible for ensuring required documents are obtained and stored in accordance with the SRS QA Manual Procedure QAP 17.1.

3.6.1 Contractor Deliverables and Record Requirements

The following documents will be submitted to the RFI Program Team:

- RFI Unit Specific Work Plans
- RFI Report (including all data)
- All progress or interim reports which may be required per SRS RCRA permit Section V.

The Contractor shall also maintain for a period of 3 years or longer if requested, all information, data, or reports in a secured area. The SRS RFI Program Team may request this information from the contractor if required by SCDHEC or EPA. Information to be maintained by the contractor includes, but may not be limited to:

- Preliminary Unit Evaluation Checklists
- Field Log Books
- Field Laboratory Log Book
- Field Instrument Calibration Log Book
- Log book used to document reagent preparation
- Approved RFI Work Plans

- Chain of Custody Forms
- Hand copies of data generated by laboratory
- Laboratory Log Book
- Data reduction calculations
- Internal performance audits
- Laboratory charts, data, etc.
- SHERP data

3.7 STORAGE OF CONTRACTOR DELIVERABLES AND RECORDS

The SRS RFI Program Team will determine for each RFI project the storage location of all contractor deliverables. All documents which will remain at SRS will be stored in areas conforming to SRS QA Manual Procedure QAP 17.1.

All documents and records which are stored by Contractors for SRS will be kept in secured areas for a period of 3 years or longer, if required.

3.8 TRAINING REQUIREMENTS

Personnel involved in RFIs shall be trained to meet the qualification requirements for specific jobs/assignments, and such training shall be documented in a manner that shows preplanning and successful completion of required training program elements. Records shall be maintained for each individual by his organization while he/she is on a particular assignment.

Contractors will submit resumes of all employees who will be involved in the preparation of the RFI work plan and all employees who shall participate in sampling and analysis work. These resumes will outline the qualifications of personnel working on specific RFI projects. The resumes will be submitted as an appendix to the RFI work plan. The SRS RFI Program Team will review and approve all key contractor personnel involved in a specific RFI project.

3.9 SITE INSPECTIONS AND AUDITS

The SRS RFI Program Team shall have the authority to conduct or coordinate unit investigations and audits of unit sampling and laboratory analytical work. Technical audits will be conducted under the direction of the RFI Program Team. QA audits shall be conducted by SRS Quality Department and shall be in accordance with SRS QA Manual Procedure QAP 18-1. The purpose of these inspections or audits will be to identify nonconformances with the requirements outlined herein. Where a nonconformance is identified, the RFI Program Team shall have the authority to stop the contractors work until the non-conformance is corrected.

3.10 CONTROL OF NONCONFORMING ITEMS

Nonconforming items shall be identified, controlled, and documented. After identification (detection) of a nonconforming item, the item shall be tagged and segregated as appropriate to preclude further use until the proper disposition is determined and completed. Acceptable dispositions are: rework, repair, use-as-is, scrap, or return to supplier. The effect of the nonconforming items on the RFI shall be determined and any adverse effect shall be brought to the attention of the SRS RFI Program Team for review, evaluation, and corrective action, as appropriate. Control of nonconforming items shall be in accordance with SRS QA Procedure 15-1.

CHAPTER 4: CONTENTS

PRELIMINARY UNIT EVALUATION REQUIREMENTS

- 4.1 Introduction
- 4.2 Literature Review
 - 4.2.1 Waste Characteristics
 - 4.2.2 RFI Unit/Disposal Design Area Characteristics
 - 4.2.3 Hydrogeological Properties of Soils and Environmental Setting
 - 4.2.4 Sampling/Monitoring Data History
- 4.3 RFI Unit Reconnaissance
- 4.4 Preliminary Evaluation
 - 4.4.1 Soil Medium
 - 4.4.2 Other Media

CHAPTER 4

PRELIMINARY UNIT EVALUATION REQUIREMENTS

4.1 INTRODUCTION

The first step towards determination of the possibility and extent of hazardous substance release from an RFI unit shall consist of a Preliminary Unit Evaluation. The primary goal of this Preliminary Unit Evaluation is to assess the possibility for soil contamination at the RFI unit. Based on the preliminary evaluation results, unit-specific soil screening may be formulated.

The flowchart displayed in Figure 4-1 illustrates the steps of the Preliminary Unit Evaluation. Initially, a literature review of all unit-related data and information shall be performed. A unit reconnaissance to assess existing conditions shall then be conducted. Information gathered during these two steps shall be used to evaluate the possibility for contamination of the soils medium, thus determining the next step in the RFI Program process for the investigated unit.

Information generated and initial assessments made during the Preliminary Unit Evaluation shall serve as the basis for (and be included in) the first phase of the unit-specific plan submitted to SRS, as discussed in Chapter 1.

4.2 LITERATURE REVIEW

Prior to any unit investigations, a review of all existing unit literature and information shall be conducted. The data and information reviewed as part of the Preliminary Unit Evaluation shall include but not be limited to the following:

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- Physical and chemical characteristics of the waste (hazardous and non-hazardous) known to be managed at the unit
- The unit/disposal area characteristics of the RFI unit
- The general hydrogeologic properties of the surrounding soil and the current environmental setting.
- Any previous sampling and/or monitoring data for the unit

Potential sources for the above information include Savannah River Laboratory Environmental Information Documents (EIDs) and Technical Data Summaries (TDSs), SRS Health Protection Department ground water well maps and monitoring reports, U.S. Department of Energy, Savannah River Operations Office environmental reports, and various unit assessments, field investigation reports, and draft closure plans conducted for SRS by outside engineering consultants. A partial list of relevant documents is contained in Appendix D. During the literature review process, the SRS Unit Custodian or RFI Program Team shall be consulted to ensure that all existing literature has been made available.

Once all literature has been reviewed, the RFI Unit Literature Review Checklist (Appendix B) shall be completed, as specified in Sections 4.2.1 thru 4.2.4. This checklist presents RFI unit data and information that is common to all sampling media (Checklist Introduction) and also lists information that is specific to each individual medium (checklist sections I-IV).

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FIGURE 4-1 PRELIMINARY SITE EVALUATION REQUIREMENTS

4.2.1 Waste Characteristics

The physical and chemical properties of a waste material have a significant impact on the retention and transport of hazardous substances throughout the surrounding soil and on releases to other media. General waste characteristics which could commonly impact all media shall be summarized on the Literature Review Checklist (Item B.1, Introduction) in Appendix B.

Most of the RFI units located on SRS property have extensive historical records (e.g., EIDs) on file concerning waste types managed on the specific units. Records also exist that discuss the quantity and composition of waste managed on some units. This and other existing information shall be used to complete the Literature Review Checklist.

The goal of the Preliminary Unit Evaluation is to assess the possibility or extent of a hazardous substance release to the soil. The existing EIDs and other unit-specific information shall be used to complete the waste information section for soils, Section I.A.1, in the Literature Review Checklist. A technical literature search shall be conducted, if necessary, to complete the checklist. The basic physical, chemical, and biological transformation and transport processes occurring in soil and the corresponding key waste factors influencing those processes are listed in Table 4-1. The information in Table 4-1 shall be used to assess the potential for occurrence of these transport processes and shall be listed in Checklist Section I.A.2.

Additional waste characteristics information not previously listed in the checklist which can result in a gaseous release to the air or soil shall be identified and listed in Checklist Section IV.A.1.

TABLE 4-1
TRANSFORMATION/TRANSPORT PROCESSES IN SOIL

<u>Process</u>	<u>Key Factor</u>
Biodegradation	Waste degradability Waste toxicity Acclimation of microbial community Aerobic/anaerobic conditions pH Temperature
Photodegradation	Solar irradiation Exposed surface area
Hydrolysis	Functional group of chemical soil pH
Oxidation/reduction	Chemical class of contaminant Presence of oxidizing agents
Volatilization	Partial pressure Henry's Law Constant Soil diffusion Temperature
Adsorption	Effective surface area of soil Cation exchange capacity (CEC) Fraction organic content (f_{OC}) of soil Octanol/water partition coefficient (k_{OW}) of waste
Dissolution	Solubility Soil pH Complex formation
Mechanical Transport	Grain size of soil

4.2.2 RFI Unit/Disposal Area Characteristics

Each RFI unit can be classified as a Solid Waste Management Unit (SWMU). A SWMU is defined as "...any unit which has been used for the treatment, storage, or disposal of solid waste..." The specific type of SWMU, complexity of design, and operational history are important factors in the assessment of the possibility or extent of contamination from the release of hazardous substances to the soils or to other media. All RFI units located on SRS properties can be classified as, or have characteristics similar to, the following:

- Surface Impoundment
- Landfill
- Waste Pile
- Land Treatment
- Tank Storage
- Container Storage

Section B.2, Introduction, of the Literature Review Checklist in Appendix B shall be completed for the RFI unit, using available literature. This information shall be supplemental or amended after the unit reconnaissance (Section 4.3) is conducted.

Possible waste release mechanisms for various RFI unit types are listed in Table 4-2. This table shall be used to complete Section I.B. of the Checklist.

Further RFI unit design characteristics that can impact hazardous substance release to other media shall be investigated during the literature review. This information shall be entered into the checklist in Sections III.B (surface water/sediment) and IV.B (ambient air and soil gas).

TABLE 4-2

RELEASE MECHANISMS TO SOIL FROM VARIOUS SOLID WASTE MANAGEMENT
UNIT TYPES

<u>Unit Type</u>	<u>Release Mechanism</u>
Surface Impoundment	Releases from overtopping Seepage
Landfill	Migration of spills and other releases outside the unit's runoff collection and containment system Migration of spills and other releases outside the containment area from loading and unloading operations Seepage through dikes or unlined portions to surrounding soils
Waste Pile	Migration of runoff outside the unit's runoff collection and containment system Migration of spills and other releases outside the containment area from loading and unloading operations Seepage through underlying soils
Land Treatment Unit	Migration of runoff outside the containment area Passage of leachate into the soil horizon
Container Storage Area	Migration of runoff outside the containment area
Above-ground Tank	Releases from overflow Leaks through tank shell Leakage from coupling/uncoupling operations Leakage from cracked or corroded tanks

4.2.3 Hydrogeological Properties of Soils and Environmental Setting

The physical and chemical properties of surrounding soil, the hydrological characteristics, the subsurface geological properties, and the meteorological conditions can affect the possibility and extent of a hazardous substance release to the soil or to other media. A majority of this information can be found in existing documentation such as EIDs. Meteorological data such as average temperature and precipitation patterns can be obtained from the "WIND" System, an advanced meteorological station operated by SRS on-site (Appendix J).

Other information as related to the environmental setting, such as vegetation growth and the existence of indigenous fauna, are factors that can be easily overlooked in the assessment of the potential contaminant releases to the soils. The degree of utilization of a unit and its periphery (e.g., by vegetation and indigenous fauna for residence, burrowing, foraging, nesting and watering) can serve as a preliminary indicator of a release of hazardous constituents or waste. Man made features proximate to the unit can also impact the transfer of contaminants from one medium to another.

The available information for evaluating the hydrogeological properties of soils and the environmental setting shall be summarized in The Literature Review Checklist, Section B.3 thru B.5 (Introduction), and in Sections I.C, II.C, III.C, and IV.C. Some of this information may not be readily available without performing additional investigations. Such investigations shall not be conducted at this time. Each of the unavailable parameters will be addressed on a case by case basis as part of the media-specific sampling plans through the use of a document search and/or field work. At that time, The Literature Review Checklist in Appendix B shall be updated or amended as necessary.

4.2.4 Sampling/Monitoring Data History

All available sampling or monitoring data for any medium previously investigated shall be identified and summarized in Section B.6 of The Literature Review Checklist Introduction. The RFI Program Team and Unit Custodian shall be consulted at this stage of the literature

review process to ensure that all previous data are located and made available. Previous data shall be used to make an initial evaluation of the possibility and extent of contamination of individual media. At units where a hazardous substance has been received, unit screening (Chapter 5) shall be a necessary component of the RFI Program. Only in the case where, as a result of the Preliminary Unit Evaluation, contamination of all media by hazardous material is definitely not indicated shall no further field investigations be required. Sufficient documentation shall be developed to satisfy the requirements of the Permit.

4.3 RFI UNIT RECONNAISSANCE

Following a review of all existing data and information, a unit reconnaissance shall be performed. This shall be done while conforming with the Safety, Health and Emergency Response Plan listed in Chapter 2. The unit reconnaissance shall be conducted to further assess the following unit conditions:

- Environmental Setting
- Source Characterization (RFI unit conditions and waste characteristics)
- Waste Release Potential (as impacting each environmental medium)

The Unit Reconnaissance Field Data Sheet in Appendix C lists unit-specific factors that shall be considered during the actual reconnaissance. This data sheet shall be completed in full while at the unit to provide appropriate written documentation. In Section IV of the Data Sheet, a final unit characterization shall be made, providing any additional information not previously listed that is deemed necessary to perform the Preliminary Unit Evaluation (Section 4.4). Following the unit reconnaissance, The Literature Review Checklist shall be updated or amended as necessary to include information and data collected from the unit visit.

4.4 PRELIMINARY EVALUATION

Following the literature review and unit reconnaissance, a Preliminary Evaluation shall be made of each RFI unit. This evaluation will result in a determination of the possibility and extent of soil contamination. An initial evaluation of the possibility or extent of contamination of the other media (i.e., ground water, surface water/sediment, and ambient air) shall also be made, where possible, at this time. The information and data summarized in the RFI Unit Literature Review Checklist and the Unit Reconnaissance Field Data Sheet shall serve as the basis for the Preliminary Unit Evaluation.

4.4.1 Soil Medium

The Preliminary Unit Evaluation shall result in the placement of each RFI unit into one of the two general categories:

1. The RFI unit is known to have received hazardous substances.
2. The RFI unit has not received hazardous substances.

For the first category (known receipt of a hazardous substance), the unit-specific RFI Program will proceed into Unit Screening. The screening process will make use of approved evaluation techniques to assess the possibility of soil contamination by hazardous constituents. The Unit Screening requirements are discussed in Chapter 5.

For the second category (the unit has not received a hazardous substance), it is anticipated that no further field investigations shall be required. For this category, definitive evidence must exist, based on the Literature Review, unit reconnaissance, and the criteria discussed in Section 1.5.2.1, that contamination of soils and all other media has not occurred. This information will be submitted to the regulatory agencies as required by the Permit.

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4.4.2 Other Media

During the Preliminary Unit Evaluation, an initial assessment of the possibility and extent of contamination of ground water, surface water/sediment, and ambient air shall also be made to the degree possible. Information and data summarized during the Literature Review and Unit Reconnaissance shall serve as the basis for the assessment of contamination of other media (according to the Management Plan Flowchart discussed in Section 1.6.2).

**CHAPTER 5: CONTENTS
UNIT SCREENING REQUIREMENTS**

- 5.1 Introduction
- 5.2 Soil Gas Surveys
 - 5.2.1 Soil Gas for Organic Constituent Screening
 - 5.2.2 Soil Gas Measurement Techniques
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 - 5.5.6 Data Reduction and Management
- 5.6 Evaluation of Screening Data

CHAPTER 5

UNIT SCREENING REQUIREMENTS

5.1 INTRODUCTION

The primary objective of the RFI unit screening program is to identify areas of potential hazardous substance release. Geophysical and geochemical survey methodologies can assist in evaluating subsurface conditions. Available geophysical techniques for identifying buried objects and defining burial areas include ground penetrating radar (GPR), electromagnetics (EM), electrical resistivity, seismic refraction and reflection, metal detection (MD), and magnetometry. These techniques are discussed in Appendix L. At all RFI units the use of geophysical screening techniques shall be considered prior to the commencement of media-specific investigations. Any geophysical investigations conducted shall be in accordance with procedures in DPSOP 254, (duPont, 1987).

Geochemical screening has proven to be a rapid and cost-effective unit screening tool for volatile organic compounds and shall be conducted at RFI units where volatile organics are known or suspected to have been disposed. As a general application, the method has proven valuable in identifying the location and nature of potential hazardous substance releases. It will help in selecting sampling locations for the media-specific field efforts where assessment of soil and ground water and soil conditions is required.

Soil gas constituent survey techniques have been used primarily as a means of delineating subsurface presence of volatile organic compounds. Soil gas techniques are applicable to soils and shallow water table aquifers impacted by VOCs, but are relatively ineffective for confined aquifers or soils overlain by impermeable strata.

Soils Confirmation Sampling will also be done as an integral part of the Unit Screening Requirements. This will identify the presence or absence of non-volatile organics, heavy metals, and other contaminants detected during the soil gas survey. In addition, Soils Confirmation will provide quantitative VOC data. The procedural details for soil confirmation sampling are presented in Section 6.4.2.

The flowchart displayed as Figure 5-1 illustrates the steps of the Unit Screening. Unit Screening investigative activity may include the following steps as indicated on the flowchart:

- Geophysical Investigation
- Soil Gas Analysis
- Confirmation Soils Analysis

5.2 SOIL GAS SURVEYS

5.2.1 Soil Gas for Organic Constituent Screening

Applications at waste units rely on the measurement of anomalous elevated concentrations of volatile waste constituents or their breakdown products. Studies at SRS have demonstrated that the use of various soil gas methods can be effective in identifying past chlorinated solvent disposal areas. This is anticipated to be the primary application of soil gas screening.

FIGURE 5-1
SRS RFI PROGRAM PLAN
UNIT SCREENING

Mass transport of volatile organic compounds from the saturated zone or disposal areas is due primarily to molecular diffusion through both gas and non-gas phases. For most volatile compounds with a Henry's Law Constant greater than 0.0001, gas phase diffusion is considered to be dominant. The Henry's Law constants are a function of the aqueous solubility, vapor pressure, and molecular weight of the compound. Those compounds which partition to the greatest extent into the gaseous phase will possess the highest constants.

As an organic compound travels through the soil column in the gas phase, portions are absorbed by water in soil and soil particles. The remainder stays in the gas phase and can be measured.

Soil gas techniques are most effective in sampling chemicals with low water solubilities. These compounds readily partition out of water or soil phase and into the gaseous phase because of the relatively high partitioning coefficients. Compounds with boiling points below 110°C are generally most mobile in the soil gas.

Soil gas techniques generally measure relative differences in sample results rather than discrete concentrations. Higher concentration areas for possible further investigation can be identified. In the case of passive soil gas methods the relative ion count intensity is measured, rather than actual concentrations.

The grid spacing required depends on the given objective of the investigation. Typically, screening studies may use grids from 10 to 50 meters. Sampling closer than a 10-meter grid is generally not recommended.

5.2.2 Soil Gas Measurement Techniques

Although sampling of volatile organic compounds in the unsaturated zone by a variety of techniques has received acceptance for field investigations, no single consistent or standard sampling methodology exists. Several methods have been developed that are potentially appropriate for soil gas unit screening. These methods can generally be classified into two categories: passive sampling methods and dynamic (or direct) sampling techniques.

Three techniques have been identified that have yielded consistent testing results on SRS projects. These would be considered the primary methods for screening conducted as a portion of the RFI Program. The three techniques are:

- Analysis of soil plugs
- Analysis of free gas (whole-volume) samples
- Analysis of buried activated carbon coated wires after a predetermined collection period

Brief descriptions of these three methods, (as they have been applied at SRS), appear in Section 5.4.4. A case by case determination of the most applicable technique, or the justification for some variation, shall be made based on conditions at a given unit, and only with the approval of the RFI Program Team. Soil gas sampling shall be conducted only by contractors who have been approved by the RFI Program Team to perform such investigations at SRS.

5.3 SOILS CONFIRMATION SAMPLING

The objective of Soils Confirmation Sampling is to determine the presence or absence of hazardous substances at a specific RFI unit. This sampling primarily will address non-volatile materials, but also will confirm the absence of volatile organics. It normally will be used in conjunction with soil gas sampling, but may be used in lieu of soil gas

sampling (i.e., at an RFI unit with no known or suspected volatile organic constituents). Section 6.4.2 details the requirements associated with Soils Confirmation Sampling.

5.4 DESIGN OF A UNIT SCREENING PROGRAM

5.4.1 Objectives of the Screening Program

The primary objective of the RFI Unit Screening program is to identify areas of potential hazardous substance releases. Specific sampling objectives may vary from unit to unit. The following objectives are applicable:

- Identify areas where volatile organic compounds, such as chlorinated solvents and oils, and other substances are present in the soils or ground water
- Assess the relative concentrations of volatile organic compounds identified in the soils
- Characterize the lateral extent of subsurface volatile organic compound migration (at units where significant concentrations are detected)
- Locate potential Soils Confirmation and Assessment Sampling points (as discussed in Sections 6.4.2.2 and 6.4.3.2)
- Determine potential soils and ground water sampling background areas (as discussed in Sections 1.8, 6.4.2.3, and 7.4.4)
- Identify areas where non-volatile hazardous substances are present in the soils
- Assess the relative concentrations of non-volatile hazardous substances identified in the soils
- Identify potential areas where containers of hazardous substances may be buried by geophysical screening techniques

All geochemical and geophysical screening shall be completed prior to media-specific field investigations. The geochemical and geophysical surveys will attempt, to the degree possible, to address both soil vadose and saturated zone characteristics. At units where the initial screening indicates above background concentrations of subsurface organics compounds, further soil gas sampling shall be conducted to determine the lateral extent of constituent migration. Therefore, soil gas screening may require "iterations" before the extent of organic compound migration is determined.

Except in special cases, all soil gas analyses shall be performed on-site in a mobile laboratory. Rapid analytical turn-around times shall be maintained to facilitate the iterative sampling process.

Soil Confirmation Sampling shall also be conducted prior to Soil Assessment Sampling and prior to investigation of other media. At units where non-volatile hazardous substance concentrations in the soil are above background levels, the lateral extent of constituent migration shall be determined during Soil Assessment Sampling.

5.4.2 Determination of Sampling Point Locations

During the unit screening process, all sampling points shall be determined through a systematic grid system. The sampling grid shall cover the entire unit area. In conjunction with a grid sampling approach, additional grab samples may be selected based on professional evaluation. Additional samples shall be collected from zones of high vapor phase release potential including:

- Backfill around pipes and outfalls
- Natural animal burrows or habitat openings
- Sand or gravel fill areas

- Cracks from dried soil or sludge
- Jointing in bedrock

The grid spacing (distance between sampling points) shall be determined by considering the unit surface area, the waste disposal history, the type of RFI unit, and the environmental setting. As a general rule, soil gas sampling points shall be uniformly spaced in the range of 10-50 meters apart across the length and width of the unit. The grid matrix for each RFI unit shall be approved by the RFI Program Team prior to soil gas sampling. Soils Confirmation Sampling points shall be spaced as specified in Section 6.4.2.2.

At a minimum, one out of every ten (10) samples shall be a QC duplicate sample. In all cases, the grid sampling points shall be clearly marked by surveyor stakes prior to and after actual sampling.

5.4.3 Determination of Soil Gas Background Area and Soil Gas Background Sampling Point Locations

The unit-specific soil gas background area approach must be distinguished from the background soils characterization approach discussed in Section 1.8.1. For soils characterization, (both the Soils Confirmation and Soils Assessment Sampling phases), the RFI units will be grouped according to commonality of soil profile. For soil gas screening, each RFI unit requires its own unique background area.

The soil gas background area shall be upgradient to the surface runoff and shallow ground water flow directions. The surface runoff direction can be estimated from field observations or by the use of a topographic map. The ground water flow direction may be known through previous field studies. It is essential that the background area be located a sufficient distance from the RFI unit to ensure that subsurface liquid or gas migration from the unit has not occurred. The background area shall be located within proximity of the study area to retain the similarity of soil properties and characteristics.

The soil gas background area shall be selected in a manner which minimizes interferences from naturally occurring organics in the soil. Previous studies by SRS indicate that decaying pine needles in a pine forest can significantly elevate volatile organic gas levels in the soil.

The actual number of background sampling points shall be determined so as to ensure that the natural variability of organic compounds in the soil can be quantified. As a general rule, soil gas sampling points shall be spaced at least 10 meters apart. Soil Confirmation Background Sampling points shall be spaced as specified in Section 1.8.2. Whenever any samples must be taken from a wooded area, the response spectra must be analyzed for typical wood degradation chemicals and proper analytical compensation made.

5.4.4 Soil Gas Sampling Methodology and Equipment

Soil gas sampling, if conducted, shall be performed by one or more of the three SRS-approved methodologies:

- Soil plugs, in which soil samples are collected and placed in a headspace vial
- Free gas (whole-volume) samples
- Soil gas adsorption on activated carbon coated collector rods buried in the ground

The actual technique incorporated at a particular RFI unit may vary slightly from one of the methods described below, depending on unit conditions. Possible variations of these methodologies are listed in Appendix K. Any significant deviations from the techniques listed below shall be approved by the RFI Program Team prior to actual sampling.

5.4.4.1 Soil Plug Sampling

Soil samples are collected by driving a hollow stainless steel pipe into the ground to a depth of approximately 18 inches. The pipe is withdrawn from the ground, and the soil core is removed and discarded. The pipe is once again inserted into the hole, and a 6-inch long soil core is obtained. Samples from greater depths can be collected using an auger and/or split spoon sampling apparatus and associated procedures if necessary.

A portion of the sample core is placed directly into a screw cap sample bottle and sealed with an aluminum foil lined cap. Samples are taken immediately to a mobile field laboratory where an 8.0 ± 0.1 gram portion is placed in a 22 ml headspace vial. Then a 5 ml volume of a standard solution of distilled water, Na_2SO_4 , and H_3PO_4 is added. Samples are analyzed by automated headspace gas chromatography coupled with mass spectrometry.

5.4.4.2 Whole-Volume Soil Gas Sampling

A steel rod equipped with a slide hammer is driven into the ground to create a sampling hole of the desired depth. After the rod is removed, a probe sampler equipped with a rubber packer (to prevent sample dilution by air) is inserted into the hole. A 200cc soil gas sample is collected from the bottom of the sampling hole using a 250cc syringe. A 100cc serum bottle equipped with a septum, from which the air contents have been previously evacuated, is filled with the soil gas sample to a sample pressure of approximately 14 psig. Samples are taken to the on-site field laboratory and analyzed by gas chromatography and mass spectrometry.

5.4.4.3 Soil Gas Sampling by Activated Carbon Adsorbent Methods

Soil gas samples can also be collected using activated carbon adsorbent methods. One currently available technique is the charcoal adsorbent Curie-point method. This method involves the use of specially constructed static collectors, combined with analysis by mass spectrometry, which will screen for VOCs originating from contaminated soils and ground

water. The static collector will be used for trapping the VOCs. It is prepared by applying predetermined sieve-sized activated charcoal to the tip (1 cm) of a ferromagnetic wire. After construction, the collectors are cleaned by heating to 358°C in a high vacuum system followed by placement into a sealed culture tube under an inert atmosphere.

In the field, the static collectors are placed in cored holes to a depth of 1 to 3 feet, backfilled, and left to equilibrate with soil vapors for a period of 7 to 30 days. Multiple tubes are installed in key locations. The collectors are retrieved from the field, sealed, and returned to the field laboratory for analysis by Curie-point desorption mass spectrometry.

The indicated flux values are not direct concentration values, but represent ion count values from the spectra and are proportional to the vapor phase emanation rate at a given unit. The relative flux values cannot be related to absolute concentrations in soil or ground water but can be used to determine the relative magnitude and extent of contamination. The Curie-point method should be evaluated regarding interference from naturally occurring organics in pine forests, prior to use at SRS RFI units.

5.4.5 Volatile Constituents to be Analyzed

Since waste records for many RFI units show that significant amounts of halogenated organics, including chlorinated solvents, have been disposed, chlorinated hydrocarbon species shall be analyzed. Certain aromatic hydrocarbons shall also be analyzed. Compounds considered for analysis shall include, but not necessarily be limited to, the following:

Method 624 Purgeable (Volatile) Organics (Priority Pollutants)

Benzene	1,2-Dichloroethane
Bromodichloromethane	1,1-Dichloroethane
Bromoform	trans-1,2-Dichloroethane
Bromomethane	1,2-Dichloropropane
Carbon tetrachloride	cis-1,3-Dichloropropane

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Chlorobenzene	trans-1,3-Dichloropropane
Chloroethane	Ethyl benzene
2-Chloroethylvinyl ether	Methylene chloride
Chloroform	1,1,2,2-Tetrachloroethane
Chloromethane	Tetrachloroethene
Dibromochloromethane	Toluene
1,2-Dichlorobenzene	1,1,1-Trichloroethene
1,3-Dichlorobenzene	1,1,2-Trichloroethene
1,4-Dichlorobenzene	Trichloroethane
1,1-Dichloroethane	Vinyl chloride

Other Organic Constituents

alpha pinene

beta pinene

Ambient air temperature shall also be recorded during every sampling event.

5.4.6 Soils Confirmation Sampling

As previously stated, Soils Confirmation Sampling shall be considered as a fundamental part of this chapter. It shall be done as an additional screening method within the auspices of Unit Screening. Process details (including non-volatile hazardous substances to be analyzed) are provided in Section 6.4.2.

5.5 IMPLEMENTATION OF A UNIT SCREENING PROGRAM

The procedures for geochemical surveys and soil sampling listed in DPSOP 254 (duPont, 1987) shall be followed prior to implementation of a Unit Screening program.

5.5.1 Soil Gas Sampling Equipment Pre-field Preparation and Cleaning Procedures

All sample containers and headspace vials shall be washed, rinsed, and baked in accordance with standard decontamination procedures. Any other sample collection equipment shall also be properly cleaned prior to field use, using standard laboratory cleaning methods.

All equipment shall be decontaminated between sampling points and between RFI units, in accordance with procedures listed in Section 3.4.1.3.

5.5.2 Soil Gas Sampling Procedures

Before actual sample collection, proposed sampling procedures shall be presented to and approved by the RFI Program Team. All procedures shall be in accordance with the methodologies and guidelines specified in Section 5.4.4.

5.5.3 Sample Collection Order

To minimize the possibility of cross-contamination from one sampling point to another, the following sample order shall be used:

1. Collect background samples first.
2. Decontaminate all hand, truck-mounted, or power tools used to construct the sampling holes and collect the background samples, as specified in Section 3.4.1.3.
3. Collect samples from within the RFI unit using a systematic approach. This approach should also account for sampling of areas of the lowest suspected degree of contamination first, then proceeding toward the collection of samples from areas of the highest suspected degree of contamination.

4. All sampling equipment will be decontaminated between various strata or depths to minimize cross-contamination and false data. Furthermore, all equipment shall be decontaminated between each sampling point location.
5. Upon completion of sampling, all equipment must be decontaminated. All decontamination procedures shall be followed as specified in Section 3.4.1.3. After completion of all sampling activities, all boreholes shall be backfilled in accordance with standard SRS procedures listed in DPSOP 254 (duPont, 1987).

5.5.4 Environmental Conditions During Sampling

Sampling shall be avoided during rainfall events, due to the inability of keeping sampling boreholes opened and uncontaminated. The time since the last rainfall incident shall be entered into the field log book. If no rainfall has occurred for 72 hours prior to sampling, the log book entry shall simply note "more than 3 days."

Environmental obstacles that may be encountered during sampling include rocks, roots, inert debris, and other buried materials. When such obstacles are encountered, a record of the occurrence shall be entered into the field log book. When an obstacle prevents a borehole from being completed, the collection hole shall be relocated just far enough away (e.g., 1-2 feet) to avoid the obstacle.

5.5.5 Sample Preparation and Analysis

5.5.5.1 Soil Plug Samples

As soon as the sample reaches the field laboratory, an 8.0 ± 0.1 gram portion of each sample core shall be placed in a 22ml headspace vial, using a small coring instrument. A 5-ml aliquot of a solution consisting of 1000ml distilled water, 50 grams Na_2SO_4 , and 1.5ml concentrated H_3PO_4 shall be added to each vial. The headspace volume of each vial will remain constant at approximately 10ml. Halocarbon and gasoline range hydrocarbon analyses shall be performed using automated headspace gas chromatography. An electron

capture detector (ECD) shall normally be used to measure halocarbon species. Hydrocarbon species and one halocarbon, vinyl chloride, shall normally be determined using a flame ionization detector (FID).

5.5.5.2 Whole-Volume Soil Gas Samples

Samples from the 100cc pressurized serum bottle shall be analyzed according to the procedure for soil plug headspace samples (Section 5.5.5.1).

5.5.5.3 Charcoal Adsorbent Soil Gas Samples

The adsorbed organic gases are purged from the carbon, separated according to ion mass, counted and a spectrum of ion masses from 29 to 240 is drawn. These mass spectra are compared with mass spectra derived from known volatile organic compounds and the compounds are identified. The relative ion count intensity (relative intensities) of the gases collected on various collectors are correlated with sample locations on a map of the survey area. These relative intensities are useful for inferring relative differences in the concentrations of the compounds in the soil.

5.5.5.4 Soils Confirmation Sampling

Soils Confirmation Sampling preparation and analysis shall comply with the requirements of Sections 3.4.1 and 6.4.2 of this document.

5.5.6 Data Reduction and Management

Data shall be reported and managed in accordance with the Data Management Requirements (Chapter 10). Upon evaluation of the first set of samples, the RFI Program Team shall be consulted regarding the need for additional screening iterations.

5.6 EVALUATION OF SCREENING DATA

Analysis of data from the Unit Screening shall result in the placing of the RFI unit into one of the following two categories:

1. Subsurface hazardous substance concentrations are "above background."
2. Subsurface hazardous substance concentrations are "at or below background."

As indicated in Figure 1-1 (Chapter 1), at units labeled "above background" as a result of unit screening (Category 1 above), investigations shall proceed directly into a Soils Assessment Sampling phase.

Where unit screening indicates "at or below background" constituent concentrations (Category 2), Figure 1-1 (Section 1.5) indicates that no further investigation shall be required. Sufficient documentation will be developed to satisfy requirements of the Permit.

The Soils Confirmation Sampling phase of the unit screening may either "confirm" or refute the soil gas screening results or be done completely independent thereof. If confirmation results, no further investigation of other impact media is anticipated. If refutation results, as indicated by the presence of metals or other organic compounds not detected during soil gas screening, then a Soils Assessment Sampling phase shall be implemented. Confirmation and Assessment Sampling phases of the soils sampling strategy are further discussed in Chapter 6.

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CHAPTER 6

SOILS SAMPLING STRATEGY REQUIREMENTS

6.1 OVERVIEW

The following section has been prepared to provide a uniform approach in performing Confirmation and/or Assessment Sampling of soils of RFI units located on the Savannah River Site (SRS) properties near Aiken, South Carolina. This section discusses the general techniques and procedures, utilizing existing guidelines in the development and implementation of soils sampling plans.

It shall be necessary to consider unit-specific information in the development of unit-specific sampling plans due to the complexity of conditions and general differences that exist from one unit to another. This generic soil sampling plan cannot discuss every unit-specific consideration. This plan does, however, provide general guidelines applicable to most units considered.

6.1.1 Flowchart

A flowchart that illustrates major steps of a decision tree that shall be considered during the development of unit-specific sampling plans appears in Figure 6-1. This flowchart presents the basic or generic approach to sampling soils for hazardous substances in an "Easy to Read" format.

FIGURE 6-1

**SRS RFI PROGRAM PLAN
SOILS SAMPLING STRATEGY
FLOWCHART**

**Soil Assessment (Confirmation)
Sampling Phase**

6.2 INTRODUCTION

Prior to development of the unit-specific sampling plans, consideration shall be given to the information and procedures discussed within the text of this generic soils sampling plan.

Sampling of a specific RFI unit shall be conducted under either or both of two (2) sampling regimes. The first sampling regime, for purposes of this RFI Program Plan, is defined as "Confirmation Sampling". This sampling regime involves those steps and procedures necessary to determine the possibility of soil contamination due to the release of hazardous substances. The second sampling regime is defined as "Assessment Sampling" in which steps and procedures are implemented to determine the extent of soil contamination from the release of hazardous substances.

6.3 PRELIMINARY EVALUATION

The approach in the development of sampling plans for a specific unit begins by reviewing all existing data and information available for that specific unit. The unit-specific literature review is discussed in detail in Section 4.2.

Following a review of all existing data and information, a unit reconnaissance shall be performed (Section 4.3), complying with Chapter 2 (Health and Safety Program Requirements), for the purpose of assessing actual unit conditions. The Field Data Sheet included in Appendix C presents unit-specific factors that shall be considered during the actual reconnaissance. This Field Data Sheet shall be completed by the contractor to provide written documentation of the unit reconnaissance, as described in Chapter 4. Furthermore, the Literature Review Checklist presented in Appendix B shall be completed by the contractor for each unit. A literature search and minimal field work are necessary to complete this form.

After consideration of waste characteristics, design and operational history, geological properties of surrounding soils, and the environmental setting, a Preliminary Evaluation shall be made of each unit. As described in Section 4.4, this assessment will result in the

classification of each unit into one of the three general categories listed in Section 4.4.1. Soil gas screening is conducted (Chapter 5) and the appropriate soils sampling phase is implemented, based on the criteria in Section 5.6.

6.4 DESIGN AND IMPLEMENTATION OF A UNIT SAMPLING PROGRAM

6.4.1 Objectives of the Sampling Program

As discussed previously in Section 1.5, two basic soil sampling regimes will be developed either to determine the possibility of soil contamination or to determine the extent of soil contamination by a hazardous substance. Specific soil sampling objectives will vary from unit to unit and will be considered during the development of unit-specific sampling plans. Objectives that may be applicable to all units include:

- Provide additional data concerning release and transport of waste constituents to the surrounding soil
- Determine the possibility or extent of a contaminant release to soils
- Characterize surrounding soil, hydrogeology and meteorology where contaminant releases have been confirmed
- Generate adequate data necessary to design and implement corrective measures or soil remediation procedures

6.4.2 Confirmation Sampling Phase: Hazardous Substance Identification, Sampling Locations and Sampling Methods

The objective of the Confirmation Sampling phase is to determine the presence of hazardous substances and the possibility of release of such contaminants to the soil. In the Confirmation Sampling phase, parameters to be analyzed, sampling methods and equipment, sample numbers, sample types, sample depths, and sample collection techniques are specified in detail in this section. In conjunction with reviewing this section, Chapter 3 (QA/QC Program Plan) shall be reviewed in detail. Based on the results of the Confirmation Sampling phase, either (1) hazardous substance concentrations are at or below background and no further sampling action proposed, or (2) hazardous substance concentrations are above background and subsequent sampling under an Assessment Sampling phase will be necessary.

6.4.2.1 Hazardous Substances to be Analyzed

Since a hazardous substance release is possible at all units where the Confirmation Sampling phase is to be implemented, both indicator parameters and certain hazardous substances commonly found on similar units may be analyzed, as listed below. The test results of the non-specific indicator parameters shall provide an indication as to the possibility of soil contamination from the release of specific hazardous substances for the specific RFI unit. The following non-specific indicator parameters shall be analyzed:

- Soil pH
- Specific conductance of soil
- Total organic carbon (TOC)
- Volatile organic vapor (field screening)

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Based on the type of unit and knowledge concerning management of waste on the unit, one or more specific parameters may be analyzed during the Confirmation Sampling phase, including, but not limited to the following:

- Volatile organic compounds
- Total concentration test for 8 RCRA metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag)
- EP Toxicity test for 8 RCRA metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag)
- Pesticides and PCBs
- Acid/base/neutral extractables
- Radionuclide indicators (gross alpha, gross beta, radium)
- Non-priority pollutants*

*Any major non-priority pollutant peaks appearing in a gas chromatography scan during this sampling phase will also be considered for further investigation during the Assessment Sampling Phase.

The analytical procedures for the above constituents are referenced in Chapter 3 (QA/QC Program Plan).

All indicator parameters listed above will be analyzed at both the RFI unit and background area. In order to verify the consistency of the soils collected for analyses in both the background and RFI unit, physical parameters of such soils will be classified in the field by a geologist duly registered in the state of South Carolina.

6.4.2.2 Determination of RFI Unit Sampling Points

The RFI unit is an area in which a solid waste has been stored, treated, or disposed of (i.e., managed) for whatever reason over a period of time. The RFI unit is not limited only to the area where disposal actually occurred, but it also includes those areas affected by waste transport such as surface runoff and wind dispersion areas.

In the Confirmation Sampling phase, all sampling locations shall be determined through a grid system or as determined by professional evaluation of existing data. In conjunction with a grid sampling approach, additional samples may be selected based on professional evaluation according to EPA guidance listed in Test Methods for Evaluating Solid Waste, EPA SW-846, November, 1986, page 12-10. A minimum of five (5) samples will be collected at each RFI unit as listed below:

- Three shallow grab samples (1-15 cm depth).
- Two intermediate depth grab samples (1-3 meter depth).
- One QC sample replicate.*

*Identical to one of the three shallow samples.

A minimum of three different sampling locations shall be selected within those units with surface areas less than or equal to 2 acres (Figure 6-2). These guidelines comply with SW-846 criteria.

For those units with areas greater than two acres, the minimum number of sampling locations and samples collected may be increased by an "equal factor" (e.g., two additional samples for each additional two acres). In any case, at a minimum, at least Figure 6-2

FIGURE 6-2
SAMPLING LOCATIONS
SAVANNAH RIVER SITE
AIKEN, SOUTH CAROLINA

one additional sample location composed of one shallow and one intermediate sample shall be considered for every two additional acres. Details concerning the development and implementation of the grid sampling procedure are presented in Appendix O.

Sampling locations shall be based on a division of the unit into three sections of equal area. The sample locations shall be spaced based on professional evaluation within each area to provide representative sampling of the entire unit. Figure 6-2 illustrates an example of sample locations for an RFI unit using soil confirmation sampling.

One grab sample shall be collected at shallow depths from each sample location. At two of the three locations where shallow soil samples were collected, coring shall continue to retrieve soil samples from intermediate depths. The intermediate depth soil samples shall be retrieved from the greatest depth at which contamination is suspected, up to a maximum of three meters depth. The third section, the section in which an intermediate depth soil sample was not retrieved, shall be used to generate a QC sample. The shallow sample collected from this section shall be split to generate the QC sample. The objective of the QC sample is to provide evidence that sample procedures and techniques, as well as analytical results, remain consistent over the entire course of sampling and analysis.

The collection of three shallow samples, two intermediate depth samples and one QC sample is the required minimum. Additional samples may be necessary as unit-specific sampling plans are being developed. Factors that shall be considered when determining the number of samples are:

- Sufficient samples shall be collected to provide representation of the known area
- Surface runoff areas and areas affected by wind dispersion
- Special areas in which there appears to be possible contamination, particularly as indicated during site screening (soil gas sampling)

- Characteristics of soils and possible waste constituents
- At a minimum, 1 out of every 10 samples shall be a QC sample

In all cases, sample points shall be clearly marked by surveyor stakes.

6.4.2.3 Determination of Background Area and Sampling Points

The background area is defined as the region in which the soils have not been impacted by any release of hazardous substances from the RFI unit. Background samples should be taken from areas not generally affected by SRS operations, and not just around unit operations. Background soils analytical data shall be provided to the contractor prior to the formulation of a unit-specific soils sampling plan. See Chapter 1 (RFI Program Plan Overview) for a discussion on the use of common background locations for various topographic areas. In those cases where a common background area is not applicable, it will be necessary to collect samples from a unit-specific background area. Once a unit-specific background area has been determined, it will be necessary to determine the correct sample locations, as indicated in Section 1.8. The source of any background contamination should be identified.

6.4.2.4 Sampling Equipment

During the Confirmation Sampling phase, soil samples shall be collected near the soil surface and to a maximum depth of 1-3 meters. Samples taken at the surface shall be collected by using a stainless steel lawn or tile spade to remove the overlying soil cover down to the specified depth. Then a smaller stainless steel spatula or scoop shall be used to collect the samples. For samples taken from depths greater than a few centimeters, or in situations where the overlying soil is too hard or rocky to be removed by a hand spade, a hand auger and thin-wall tube coring apparatus shall be used. There may be special situations in which power equipment such as one- or two-man augers or a truck-mounted drilling rig are required to complete the boring. In many situations a front end loader or backhoe may be necessary to excavate soil to the required depth. A description of these

soil collection or sampling techniques appears in Appendix M. Since some of the RFI units at the Savannah River Site may contain volatile compounds, samples should be considered for screening with an Organic Vapor Analyzer (OVA) or a Trace Gas Indicator (HNu) for health and safety or organics indication purposes.

The sampling procedures listed in SRP DPSOP 254, Chapter III (duPont, 1987), shall be reviewed prior to formulation of site-specific plans. The DPSOP 254 procedures shall be followed during the field investigation period.

6.4.2.5 Sampling Equipment Pre-field Cleaning and In-Field Decontamination Procedures

Cleaning and decontamination procedures for all soil sampling equipment shall be uniform. All sampler parts shall be decontaminated prior to the collection of each sample unless otherwise specified. Decontamination shall be conducted in accordance with the following procedure:

1. Clean with on-site water supply well water and phosphate-free laboratory detergent (Liquonox or equivalent) using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with on-site water supply well water.
3. Rinse thoroughly with deionized or distilled water.
4. Rinse two times with high grade isopropanol solvent and allow to air dry.
5. Rinse thoroughly with deionized or distilled water and allow to air dry.
6. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is to be stored or transported.

All rinse waters shall be contained in a manner to prevent the introduction of contamination. All rinsate shall be collected in a compatible container then properly disposed of to prevent possible contamination to adjacent areas. See Chapter 3 for requirements on the handling of rinsate.

As an alternative, a cleaning and decontamination procedure is listed below for equipment with possible metals contamination. Because of the nature of the work, complexity of this procedure, and remoteness of the units, the difficulties of using this procedure shall be thoroughly evaluated prior to its implementation and approved by the RFI Program Team.

1. First rinse in non-phosphate detergent wash.
2. Rinse in 1:1 nitric acid water rinse.
3. Rinse in distilled water.
4. Rinse with 1:1 hydrochloric acid/water solution.
5. Rinse with distilled water.

6.4.2.6 Sampling and Screening Procedures

6.4.2.6a Procedures for Surface and Shallow Sampling

For surface and shallow soil sampling (1-15 cm depth), the following procedure (Method II-1) from Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods (USEPA, 1984), shall be followed:

1. Carefully remove the top layer of soil to the desired sample depth with a precleaned spade or other appropriate equipment.

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2. Using a precleaned stainless steel scoop or spatula, remove and discard a thin layer of soil from the area which comes in contact with the shovel.
3. Transfer sample into an appropriate sample bottle using the same stainless steel scoop or spatula listed above. Extra care should be taken to assure that the container is appropriately filled with the sample as presented in Chapter 3, Section 3.4.1.2 (Container Type and Preservation Requirements).
4. Check that a Teflon liner is present in the cap if required. Secure the cap tightly. The chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach supplemented by a minimal holding time. For specific containerization and preservation requirements consult Chapter 3, Section 3.4.1.2.
5. Label the sample bottle with the appropriate sample tag as specified in Chapter 3, Section 3.3.5. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Complete all chain-of-custody documents (Chapter 3, Section 3.3.9) and record pertinent information in the field log book. This information should include at a minimum the following:
 - a. Name of sample collector
 - b. Sampling date
 - c. Meteorological conditions during sampling
 - d. Sample time
 - e. Simple sketch denoting sample locations
 - f. Brief description of sample procedures denoting any unusual problems related to the sampling event

g. OVA or HNu screening values at specified sampling point

6. Decontaminate equipment after use and between sample locations (see Chapter 3, Section 3.4.1.3).

All equipment used to collect the sample (i.e., equipment directly contacting the sample) shall be of stainless steel construction. Equipment plated with chrome, cadmium, or other materials should be avoided, so as not to introduce external contamination to the sample. Alternate soil sample collection techniques are presented in Appendix M.

6.4.2.6b Procedures for Intermediate Depth Sampling

For deeper samples collected at 1-3 depths, the following procedure (Method II-2) from Volume II of Characterization of Hazardous Waste Sites, using a hand or power auger and thin-wall tube coring apparatus, shall be followed:

1. Attach the precleaned auger bit to a drill rod extension and further attach the "T" handle or mechanical power source to the drill rod.
2. Clear the area to be sampled of any surface debris (twigs, rocks, litter). It may be advisable to remove the first 8 to 15 cm of surface soil for an area approximately 15 cm in radius at the drilling point.
3. Begin drilling, periodically removing accumulated soils. This prevents accidentally brushing loose material back down the borehole when removing the auger or adding drill rods.
4. After reaching desired length, slowly and carefully remove auger from boring. (Note: When sampling directly from auger, collect sample after auger is removed from boring and proceed to Step 10.)

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5. Remove auger tip from drill rods and replace with a precleaned thin-wall tube sampler. Install proper cutting tip.
6. Carefully lower corer down borehole and gradually force corer into soil. Care shall be taken to avoid scraping the borehole sides. Hammering of the drill rods to facilitate coring should be avoided as the vibrations may cause the boring walls to collapse.
7. Remove corer and unscrew drill rods.
8. Remove cutting tip and remove core from device.
9. Discard top of core (approximately 2.5 cm), which represents any material collected by the corer before penetration of the layer in question. Place remaining core into sample container. Extra care shall be taken to assure that the container is appropriately filled with the sample as presented in Chapter 3, Section 3.4.1.2. It shall be necessary to split and properly containerize the samples for archiving by the SRL ESD. Furthermore, for health and safety reasons, a portion of the sampled soils shall be screened for organic vapors as described in Chapter 3, Section 3.4.1.8.
10. Check that a Teflon liner is present in the cap if required. Secure the cap tightly. The chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach supplemented by a minimal holding time. Chapter 3, Section 3.4.1.2 shall be consulted for specific containerization and preservation requirements.
11. Label the sample bottle with the appropriate sample tag as specified in Chapter 3, Section 3.3.5. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Complete all chain-of-custody documents (Chapter 3, Section 3.3.9) and record in the field log book that information specified above under Item 5 of the surface and shallow sampling procedures (Section 6.4.2.6a).
12. Decontaminate sampling equipment after use and between sampling locations (Chapter 3, Section 3.4.1.3).

Samples shall not normally be removed directly from the auger, because a disturbed sample may be produced which could be contaminated by overlying soils. In rocky soil, where it is impossible to insert a thin tube sampler, sampling directly from the auger may be the only viable method. In loose soil where the borehole will not remain open when the auger is removed, a temporary casing can be used until the desired sampling depth is reached. In some cases it may be necessary to use a hollow stem auger to prevent the borehole from collapsing. Alternate sample collection techniques are presented in Appendix M.

6.4.2.6c Procedure for Organic Vapor Screening

At each soil sample point (surface, near-surface, or shallow depth), a small portion (230 grams or 0.5 pint) of each sample shall be considered for screening using an OVA or HNu analyzer. Organic vapor screening results can be used for health and safety purposes or as an indicator of the presence of volatile organic compounds. A procedure similar to the following shall be followed for screening for organic vapor concentration:

1. Place small portion of the sample in an air-tight plastic bag. Seal and label the bag. Place the bag in a warm location such as inside a field sampling vehicle.
2. After approximately 20 minutes, the headspace of the bag sample shall be screened using the HNu or OVA. This value shall be recorded in the Field Sampling Log Book by the field manager.

6.4.2.7 Sample Collection Order

To minimize the possibility of cross-contamination from one soil sampling point to another, the following sample order shall be used:

1. In cases where unit-specific background samples are collected, make sure that the sampling equipment is decontaminated according to the procedure in Chapter 3, Section 3.4.1.3 before collecting the next background sample.
2. The collection of samples within an RFI unit shall proceed in a systematic approach starting with soils of the lowest suspected degree of contamination and working toward those soils of the highest suspected degree of contamination. In cases where more than minimum samples are required, samples should be collected in an orderly manner that provides an easy means of tracking. The sampling approach for a specific unit can only be determined based on number of samples and unit characteristics.

Following the collection of samples from a borehole, the hole shall be refilled with the remainder of the excavated soil unless the boring extends beyond 3 meters in depth. In such cases, grouting shall be used to backfill the borehole as specified in Section 6.4.3.7, in accordance with DPSOP 254, Chapter VI, (duPont, 1987). A surveyor stake shall remain in the ground at each sample point location.

6.4.2.8 Environmental Conditions During Sampling

Soil sampling can be conducted during many types of weather conditions. Sampling should be avoided during rainfall events, due to the inability of keeping sampling boreholes open and uncontaminated. If sampling is conducted soon after a rainfall incident has ceased, this information shall be entered into the field log book.

Environmental obstacles that may be encountered during sampling include rocks, roots, inert debris, and other buried materials. When such obstacles are encountered, a record of the occurrence shall be entered into the field log book. In a situation in which an obstacle prevents a sample being collected, a new sample point shall be relocated just far enough away (e.g., 1-2 meters) to avoid the obstacle.

6.4.2.9 Sample Analysis and Data Reduction/Tabulation/Management/ Evaluation

All soil samples shall be analyzed by a South Carolina certified laboratory, in accordance with the procedures listed in Test Methods for Evaluating Solid Waste, Volume I, Part I: Methods for Analytes and Properties (USEPA, 1986). Specific analytical procedures are referenced in Chapter 3.

All data generated during the site investigation shall be reported in accordance with the Data Management Requirements listed in Chapter 10. Data generated during the Confirmation Sampling phase shall be evaluated by comparing background data to information obtained from the soil investigation of the RFI unit. On the basis of this evaluation, one of the following conclusions shall be made:

- Hazardous substance concentrations are at or below background: no further soils sampling required
- Hazardous substance concentrations are present above background: proceed into Assessment Sampling Phase, Section 6.4.3.

6.4.3 Assessment Sampling Phase: Hazardous Substance Identification, Sampling Locations, and Sampling Methods

The Assessment Sampling phase is conducted when either (1) soil contamination is known according to results of the Preliminary Unit Evaluation or, (2) the Confirmation Sampling phase indicates that a hazardous substance release to the surrounding soil has occurred. In the Assessment Sampling phase, the number of contaminants to be analyzed and the frequency of samples collected increases, thus providing a more detailed or unit-specific sampling approach than that utilized for the Confirmation Sampling phase. The Assessment Sampling phase may occur over an extended period of time utilizing several sampling events in order to meet the objective of determining the full extent of soils contamination by a specific hazardous substance.

6.4.3.1 Hazardous Substances and Soil Parameters to be Analyzed

6.4.3.1a Hazardous Substances to be Analyzed

For units investigated during the Assessment Sampling phase, some degree of contamination is "known." During this phase, the following indicator parameters shall continue to be analyzed:

- Soil pH
- Specific conductance of soil
- Total organic carbon (TOC)
- Volatile organic vapor (field screening)

Based on the specific hazardous substances suspected to have been released at the unit, one or more of the specific parameter groups, or individual constituents within a specific group, may be analyzed, including, but not limited to the following:

- Volatile organics
- Acid/base/neutral extractables
- Total metals test for eight RCRA metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag)
- EP toxicity test for eight RCRA metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag)
- Inorganic ions
- Radionuclides
- Pesticides and PCBs

Emphasis shall be placed on identifying and quantifying specific constituents that may have been released to the surrounding soil.

6.4.3.1b Soil Properties to be Determined

In addition to analysis of hazardous substances, a characterization of the soil and rock units in the unsaturated zone (above the ground water table) shall be conducted at all sites where

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a contaminant release is confirmed. Listed below are soil properties that shall be considered in order to properly describe plume movement and magnitude along with the similarity between background and RFI unit soils.

Surface soil distribution

Soil profile, including modified Wentworth

Transects of soil stratigraphy

Hydraulic conductivity (saturated and unsaturated)

Relative permeability

Bulk density

Porosity

Soil sorptive capacity

Cation exchange capacity (CEC)

Soil organic content

Soil pH

Particle size distribution

Depth of water table

Moisture content

Effect of stratification on unsaturated flow

Infiltration

Evapotranspiration

Vertical flow rate

Mineral content

Procedures for determining or addressing the above soil parameters are presented in Appendix N. Existing information is available for most of the above parameters based on previous field studies. It is recommended that existing data such as the EIDs be utilized where available and valid.

6.4.3.2 Determination of Sampling Points

After initial geophysical/geochemical screening, (and prior to assessment sampling), an interim unit drawing shall be prepared to identify the RFI unit boundaries. The site may be extended beyond the existing boundaries to include impacted areas. These impacted areas may contain hazardous substances in quantity and be in need of further evaluation.

As noted earlier, the Assessment Sampling phase shall be designed to determine the extent of known soil contamination. In the Assessment Sampling phase, a minimum of twelve soil samples shall be collected within the boundary of each unit. The twelve analytical soil samples shall be collected from the placement of four corings at locations determined through the use of grid sampling procedures or as determined by professional evaluation. (See Appendix O for grid sampling procedures.) The size of area along with any other unit-specific factors as listed in Section 6.4.2.2, (such as runoff and wind dispersion areas), may necessitate additional sampling.

The minimum number of samples to be collected within the unit during an Assessment Sampling phase are specified by depth as follows:

- Four shallow soil samples (1-15 cm deep)
- Four intermediate depth soil samples (1-3 meters deep)
- Four deep soil samples (greater than 3 meters deep)
- Two QC samples *

*Identical to two of the twelve analytical samples collected.

A minimum of four different sample boring locations shall be selected for those units up to two acres of surface area.

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For those units with large unit boundaries (greater than 2 acres), one additional soil sample boring (composed of three soil samples) at a minimum is required for every two acres in excess of 2 acres of surface area. For instance, the minimum number of soil corings at a 16-acre unit shall be eleven (original minimum of four borings plus an additional seven borings). From these eleven corings, a minimum of thirty-three individual samples, plus five QC samples shall be collected.

Sampling locations shall be located based upon a division of the site into three sections of equal area. One sample boring shall be located on the outermost boundary or periphery of each of the three sections. The fourth sample boring shall be located within the zone where the contamination is believed to be the greatest, possibly on the surface runoff and the ground water flow downgradient end of the site. Figure 6-3 indicates possible sampling point locations.

The objective of the peripheral samples is to define the lateral extent of contamination. The objective of the interior sample(s) is to define the magnitude of soil contamination.

At each of the four sample boring locations, one shallow soil sample, one intermediate depth soil sample, and one deep soil sample shall be collected. All samples shall be collected at each sample location before proceeding to the next sample location. Two of the twelve samples shall be split to generate QC samples. A minimum of one QC sample shall be collected for every ten analytical samples collected.

Based on the analytical results, additional samples may need to be collected to define the lateral extent of contamination. For instance, if results from the first round of sampling indicate that contamination is present at each of the three periphery locations, a second round of sampling may need to be conducted outside the periphery of the unit.

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FIGURE 6-3
SOIL ASSESSMENT
SAMPLING LOCATIONS
SAVANNAH RIVER SITE
Aiken, South Carolina

6.4.3.3 Determination of Background Area and Sampling Points

The background area may be defined as a region in which the soil has not been impacted by any release of hazardous substances from the RFI unit. Background samples should be taken from areas not generally affected by SRS operations, and not just around unit operations. Background soils analytical data shall be provided to the contractor prior to the formulation of a unit-specific sampling plan. The source of any background contamination should be identified. See Chapter 1 (RFI Program Plan Overview) for a discussion on the use of common background locations for geographically common regions at SRS.

6.4.3.4 Sampling Equipment

During the Assessment Sampling phase, soil samples shall be collected at the soil surface and possibly down to depths of 10 meters or to the saturated soil zones. Shallow and intermediate depth samples can probably be collected by hand equipment as specified in Section 6.4.2.4.

Depending on the particular soil stratigraphy encountered, truck-mounted equipment may be required for sample depths in excess of 2-3 meters. Power augers may be used in place of hand augers to sample hard soils or soils difficult to penetrate with hand equipment. In many cases, exploratory excavations shall be required using a backhoe or front end loader or an equivalent means. Deep soil sampling shall be coordinated with any new ground water monitoring well construction and installation. In most cases, the sampling of deep soils shall be accomplished by using a split-spoon or Shelby tube sampler, according to procedures described in DPSOP 254, Chapter III (duPont, 1987). A description of alternate sampling techniques appears in Appendix L. Deep soil sampling procedures are described in Section 6.4.3.6.

6.4.3.5 Sampling Equipment Pre-field Cleaning and In-field Decontamination Procedures

Section 6.4.2.5 outlines the decontamination procedure for surface and shallow sampling equipment. The decontamination procedure for power equipment and the split-spoon sampler is as follows:

1. Clean with water supply well water and phosphate-free laboratory detergent using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with water supply well water.
3. After decontamination, equipment not being used shall be placed on clean plastic.

6.4.3.6 Sampling Procedures

Procedures for sampling at shallow and intermediate depths appear in Section 6.4.2.6. At depths impenetrable by hand equipment, truck mounted drilling rigs may be required.

Test borings shall be completed by a drilling method suitable to expected subsurface conditions, sampling, and safety requirements. Borehole advancement shall be completed by one or a combination of the following drilling methods: solid or hollow stem auger, driven casing, mud-air rotary, or hydraulic percussion. The particular type of borehole advancement must be contingent upon anticipated subsurface geology, and sampling requirements. Drilling methodologies shall be approved by the SRS Ground Water Coordinator prior to initiation of work. All work shall be performed by a driller licensed in the State of South Carolina and in accordance with information presented in Chapter 3.

Specific measures shall be undertaken to ensure proper borehole completion and proper integrity of soil samples collected for laboratory analyses in accordance with SRS standards. It is the responsibility of the supervising engineer/hydrogeologist to inform the drilling contractor of any expected subsurface or airborne contamination and of required

safety considerations as referenced in Chapter 2. Necessary safety tests shall be conducted frequently by the supervising engineer/hydrogeologist licensed in the State of South Carolina to determine work area environmental conditions. Soil boring information shall be documented daily on Form OSR 30-3/Form DPSOP 254-V-5, or other approved forms.

Many soil samples shall be taken using a standard, 24-inch long, 1 3/8-inch I.D. (2-inch O.D.) split-spoon or Shelby tube sampler as determined by the contractor, according to the procedures listed in DPSOP 254, Chapter III (duPont, 1987). Any other alternate sampling procedures may be used pending the approval of the SRS RFI Program Team.

Soil samples for lithologic description shall be taken from all borings at every depth that soil samples are collected for analysis of hazardous substances. Changes in soil stratigraphy may necessitate more frequent collection of samples for lithological description. All soil samples shall also be identified in the field by a geologist using visual/manual techniques. The soils shall be classified in accordance with the "Field Classification of Sediments" draft (Appendix I), currently under review for inclusion in DPSOP 254. A log of each boring shall be produced. Specific sample collection volumes, techniques, and preservation methods are discussed in Chapter 3, Section 3.4.1.2.

Further, at each sample point, a small portion (approximately 230 grams or 1 pint) of each sample shall be screened for organic vapor concentration according to the procedure in Section 6.4.2.6c.

6.4.3.7 Sample Collection Order

To minimize the possibility of cross-contamination from one soil sampling point to another, the following sample order shall be used:

1. Collect background samples first (in the case that unit-specific background samples are taken) by utilizing a systematic approach in order to avoid unorganized sampling of the background area.

2. Decontaminate all hand, truck-mount, or power tools used to collect the background samples in an area to facilitate the collection of rinsate and that shall prevent the introduction of contamination into clean soils. Refer to Chapter 3 for specific requirements for decontamination procedures.
3. Collect samples from within the unit boundary using a systematic or organized approach. This approach should also account for sampling of areas of the lowest probable degree of contamination first, proceeding toward the collection of samples from areas of the highest probable degree of contamination.
4. All sampling equipment shall be decontaminated between various strata or depths to minimize cross-contamination and false data. Furthermore, all equipment shall be decontaminated between sample points not to be composited together.
5. Upon completion of sampling, all equipment must be decontaminated. All decontamination procedures shall be followed as specified in Sections 6.4.2.5 and 6.4.3.5.

Upon completion of test boring and sampling activities, boreholes placed by truck-mounted drill rig to depths greater than 3 meters and not scheduled for well placement shall be back-grouted by a suitable admixture of Portland Class A cement and 6-10 percent sodium bentonite. Other compounds needed to ensure proper borehole stabilization and sealing shall be approved by the RFI Program Team. Specific guidelines to be followed during grouting are given in SRS "Specifications for the Advancement of Ground Water Monitoring Wells" [DPSOP 254, Chapter VI (duPont, 1987)]. Necessary health and safety precautions during grouting shall be directed by the supervising engineer/hydrogeologist.

6.4.3.8 Environmental Conditions During Sampling

Section 6.4.2.8 discusses those conditions that may require deviation from the established sampling plan. Refer to this section prior to development of unit-specific sampling plans.

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6.4.3.9 Sample Analysis and Data Reduction/Tabulation/Management/ Evaluation

All data generated during the course of the site investigation shall be reported in accordance with the Data Management Requirements listed in Chapter 10. Upon completion of Assessment Sampling, the extent of contamination shall be determined, thus enabling an RFI Report to be initiated.

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CHAPTER 7

GROUND WATER SAMPLING STRATEGY REQUIREMENTS

7.1 OVERVIEW

For the purpose of this RFI Program Plan, the strategy and procedures for ground water quality sampling are discussed under two sets of conditions. If the Preliminary Evaluation and subsequent Unit Screening/Soils Confirmation sampling indicate that the RFI unit has not received hazardous substances, nor had a release of hazardous substances, ground water sampling will not be undertaken. At most units ground water sampling will be performed to evaluate the possibility of a hazardous substance release to the ground water. Unit-specific conditions will be reviewed to determine if concurrent investigations of soil and ground water should be performed.

The first sampling regime is defined as Ground Water Preliminary Sampling. Preliminary Sampling will evaluate the possibility of hazardous substance release to ground water at a unit. The second sampling regime is defined as Ground Water Assessment Sampling. Assessment sampling procedures are implemented to determine the nature, extent and potential rate of contaminant migration through the ground water.

7.1.1 Flowchart

A flowchart that illustrates major steps of a decision tree that shall be considered during the development of unit-specific plans appears in Figure 7-1.

FIGURE 7-1

SRS RFI PROGRAM PLAN

GROUND WATER SAMPLING STRATEGY FLOWCHART

7.2 INTRODUCTION

This section describes procedures to be followed for the evaluation of suspected or known hazardous substance release to ground water, with specific emphasis on ground water monitoring wells.

A discussion of many factors which shall be considered when selecting monitoring well locations is also included. A determination of the data required and techniques utilized to investigate the hazardous substance release potential shall be made on a unit-specific basis.

7.3 UNIT EVALUATION

Prior to planning a Preliminary or Assessment ground water evaluation, existing data shall be thoroughly reviewed. This includes both unit-specific information and regional surveys available from local, state and Federal agencies. Background data shall include the information gathered during the Preliminary Site Evaluation (Chapter 4) and the following additional information, (as necessary):

- Available geologic/hydrogeologic reports, boring logs, geophysical data, etc.
- Existing well construction details and sampling results
- State water resource publications
- U.S. and State Geological Survey Reports, files and maps
- Topographic maps
- Aerial photographs

The background data review shall determine whether a Preliminary or Assessment ground water sampling strategy is appropriate. If required, it shall also provide information to plan a ground water monitoring well network to meet the objectives of the sampling regime.

In order to design an effective monitoring well network to provide access for ground water sampling, several factors must be considered. These factors include:

- The types and distribution of geologic materials
- Occurrence and movement of ground water through these materials (hydraulic gradients, ground water flow directions, etc.)
- Relative permeability of subsurface materials
- Locations of RFI units with respect to ground water flow directions
- The expected behavior of contaminants in the ground water flow system, including potential interactions with the geochemical and biological constituents present
- The location of ground water recharge and discharge areas in respect to RFI units

At most of the RFI units, sufficient data are available to characterize the subsurface geology and ground water flow systems for the development of effective ground water sampling plans. At some units, however, additional unit characterization may be required to determine appropriate sampling locations and intervals.

Due to the complexities of ground water flow and the behavior of hazardous substances in the subsurface, the exact type, number and locations of sampling points and parameters to be analyzed shall be determined through interactions with the RFI Program Team.

7.4 PRELIMINARY SAMPLING

7.4.1 Preliminary Sampling Objectives

The objective of the Preliminary Sampling effort is to investigate the potential for a release of hazardous substances to the ground water. This objective will be accomplished by collecting and analyzing ground water samples from the most likely potential pathways of contaminant migration. The results of the Preliminary Sampling effort shall indicate that (1) hazardous substance concentrations are at or below background; no further sampling will be required; or (2) hazardous substance concentrations are above background; Ground Water Assessment Sampling will be required.

7.4.2 Determination of Hazardous Substances to be Analyzed

Preliminary Sampling and analysis shall involve a limited set of constituents based on the results of soils analyses or known waste disposal history. Indicator parameters will also be included (pH, specific conductance, TOC, and Total Organic Halogens [TOX]). The following factors will be considered when developing a list of monitoring constituents:

- The nature of the wastes managed at the RFI unit shall be reviewed to determine which constituents (and potential chemical reaction products) are relatively mobile and persistent
- The effects of the unsaturated zone (if present) beneath the unit on the mobility, stability, and persistence of the waste constituents
- The detection limits of the waste constituents
- The concentrations and related variability of the proposed constituents in background ground water

At a minimum, the Preliminary Ground Water Sampling analyses shall include all hazardous substances detected above background during the soils sampling.

7.4.3 Determination of Sampling Locations and Intervals

A minimum of three downgradient wells and one upgradient background well are required for detection monitoring under RCRA regulations. The actual number of wells required to adequately screen for potential contamination shall be determined on a unit-specific basis. Background water quality sampling will be discussed in the following section. Criteria for selection of appropriate downgradient well locations are discussed below.

The Preliminary Sampling system shall be confined to the uppermost aquifer at the unit. The degree of unit characterization required to select adequate sampling locations will depend on the complexity of the geology beneath the unit and the physical/chemical characteristics of the suspected hazardous substances.

The locations of ground water monitoring wells for Preliminary Sampling shall be based on the subsurface geology and hydrogeology at the unit, and on the anticipated behavior of the constituents of concern in the subsurface environment. Downgradient monitoring wells shall be located near the downgradient edge of the RFI unit. The proximity of appropriate well locations to the site, however, will be based on the depth to the water table and the physical/chemical characteristics of the potential contaminant migration pathways to the ground water table. For example, if monitoring wells are located too close to a potential hazardous source, constituents of concern may be deflected past the sampling point by a particular soil stratum, prior to reaching the water table. The horizontal distribution of monitoring wells shall be designed to intercept zones with the greatest potential as pathways of constituent migration. The horizontal spacing between detection monitoring wells shall generally be 100 feet or more.

The vertical sampling interval (screened section) of the Preliminary Sampling wells shall be based on a determination of the stratigraphic horizon(s) that could serve as constituent pathways, considering the physical/chemical characteristics of the hazardous waste or

constituents. Different transport processes may control constituent migration depending on whether the constituents are immiscible or dissolve in water. The density and viscosity of immiscible constituents generally govern, to a large extent, their behavior. Lighter-than-water phases tend to spread rapidly in the capillary zone, just above the water table. Dense organic liquids and heavy metals tend to migrate vertically to tops of confining units, even in horizontally flowing aquifers. Therefore, Preliminary Sampling wells shall be screened in the appropriate interval.

Careful consideration shall also be given to the lengths of screens used in ground water monitoring wells. These shall be as required by DPSOP 254. Screen lengths and positioning shall be selected to sample discrete portions of the formation where constituents are most likely to be found, to avoid excessive dilution.

7.4.4 Selection of Background Sampling Points

The determination of whether a hazardous substance release has occurred will be based on a comparison of background concentrations of a list of waste-specific hazardous substances, potential degradation products, and indicator parameters (pH, specific conductance, TOC, and TOX) with concentrations obtained from downgradient monitoring wells. Background wells shall be sampled each time downgradient wells are sampled. Background wells shall be located upgradient, beyond the potential extent of contamination from RFI units under investigation. These locations shall be based on identification of pertinent recharge and discharge areas and a determination of ground water flow directions from accurate water level measurements made in available piezometers and monitoring wells. Background wells shall be screened in the same formations and the same stratigraphic horizon(s) to ensure comparability of data.

7.4.5 Monitoring Well Installation: General Considerations, Drilling and Installation Procedures, Equipment

All monitoring wells shall be installed in accordance with the requirements of Chapter 5 of DPSOP 254, (duPont, 1987), Specifications for Water Table Monitoring Well Installation.

Screened intervals, however, will vary depending on the physical/chemical properties of the constituents of concern. At units where two or more wells are installed (clusters), well spacing shall be as specified in DPSOP 254. Careful consideration shall be given to the grain size distribution and hydraulic conductivity of soils where clusters are constructed, to evaluate well spacing. At cluster locations, borings and well installations shall be conducted from deepest to shallowest.

Sampling of subsurface soils shall be performed at all monitoring well locations unless such sampling has been conducted in a previous boring within 25 feet of the proposed monitoring well location. Soil samples shall be obtained by driving standard split spoon samplers, pressing or driving thin-walled tubes, or by continuous coring, in accordance with the procedures listed in DPSOP 254 (du Pont, 1987). Where discrete samples are obtained (split spoon samples or thin-walled tubes), sampling intervals shall be no greater than 5 feet. Continuous samples shall generally be obtained from intervals where well screens will be set. Borehole geophysical logging shall generally be conducted prior to well installation (short and long normal resistivity, spontaneous potential, single point resistance, natural gamma, neutron density, borehole caliper). Guidelines for geophysical logging which shall be followed at SRS are given in Chapter 8 of DPSOP 254 (du Pont, 1987).

All monitoring wells constructed for Preliminary Sampling shall be installed at the water table or in the uppermost aquifer. The uppermost aquifer has been defined by EPA as "the geologic formation, group of formations, or part of a formation that is the aquifer nearest to the ground surface and is capable of yielding a significant amount of ground water to wells or springs" (40 CFR 260-10). The water table shall be determined from water level measurements in nearby wells, or if there is any uncertainty, by measuring stabilized water levels in augered boreholes drilled to the anticipated well depth. A temporary PVC casing with an attached well screen may be left in the augered borehole to facilitate accurate water level measurement. Water levels shall be allowed to stabilize for a minimum of 18 hours.

Boreholes for well installations at SRS shall be drilled using either mud-rotary or hollow-stem auger equipment and techniques. Selection of the drilling method to be utilized

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will be made by the drilling contractor and approved by the RFI Program Team. Mud-rotary borings shall be 9-7/8 inch minimum internal diameter. Hollow stem auger borings shall be drilled with 6 inch minimum internal diameter (10 to 12 inch outside diameter) augers. These size requirements will facilitate proper construction of all required filter packs and seals. Where continuous coring is performed, boreholes shall be reamed to the appropriate minimum diameter prior to well installation. The sizes indicated above are based on the installation of 4 inch internal diameter well screens and casing, the size generally used for ground water monitoring wells at SRS.

Borehole deviation surveys shall be conducted at intervals of 100 feet or less to ensure that deviation from vertical does not exceed 2 degrees over the entire borehole depth.

Once a borehole is completed and geophysically logged, an exact determination of screen placement and any modifications to borehole depth shall be made. All well installations shall involve the placement of filter packs, bentonite pellet seals and the placement of cement/bentonite grout through tremie pipes to land surface, either continuously or in stages as specified in DPSOP 254 (du Por, 1987). Frequent measurements will be made with a weighted tag line during well installation to ensure the proper placement of these elements. Wells installed for Preliminary Sampling (to 300 feet or less) will generally be constructed of 4 inch internal diameter, flush-threaded, schedule 40 or 80 PVC casing with either stainless steel or PVC screens. The appropriate screen length and type will be based upon the chemical constituents suspected in the ground water and the hydrogeologic characteristics of the zone to be screened. The screen slot size and gradation of the gravel pack shall be selected based on grain size analyses. This will maximize ground water flow for well sampling and minimize the passage of formation materials into the well. All wells shall be completed by installing concrete pads (5 feet x 5 feet x 6 inches) centered around the well with a lockable steel protective casing (6 inches square x 5 feet long). Four protective posts will be set outside each corner of the pad. Dedicated stainless steel pumps will generally be installed for purging and sampling.

Detailed specifications for well drilling, installation, and materials to be used SRS are given in DPSOP 254 (du Pont, 1987). Special precautions shall be required when installing monitoring wells where soils above the water table are known or suspected to contain hazardous substances. In order to avoid potential contamination of the underlying ground water by drilling activities at these locations, installation of a surface casing may be required. Where the depth of contaminant release to the soils has not been determined, soil samples will be screened to help determine the depth to which surface casings will be installed. Field screening instruments which may be used include: organic vapor analyzers (for volatile organics - HNu, OVA or TIP), combustible gas detectors (for selected hydrocarbons), radiation survey meters, etc. Surface casings installed for this purpose will be large-diameter (generally 12 inches or larger). These casings will generally be installed permanently and, therefore, will be grouted in place. The surface casing shall be flushed out thoroughly with clean potable water or drilling mud no sooner than 24 hours after installation to allow time for grout to set. Mud pits shall be cleaned out and relined prior to continuation of drilling after surface casings have been installed for this purpose.

7.4.6 Monitoring Well Development

All monitoring wells shall be developed to remove drilling mud and sediment from the filter pack surrounding the well screen. Well development will continue until clear, sediment-free water is consistently produced. After well development has been completed, the total well depth shall be sounded and if sediment is found to be present, it shall be cleaned out. During well development, ground water temperature, pH, and specific conductance shall be measured at selected intervals. Development shall continue until stabilization of these parameters is observed. The measurement of these parameters shall be documented in a log which shall include the time of each measurement, approximate total volume of water removed prior to each measurement, and the time intervals during which development is conducted.

Well development techniques which create surges or reversals of flow shall be utilized to ensure effective development and to minimize particle bridging in the well screen. Well development methods can include hydraulic and air jetting, bailing and swabbing, and

pumping with submersible and air lift pumps. Surge blocks may be used to concentrate surging over small intervals of the well screen. Any water introduced into the well during development other than ground water from the well being developed shall be chemically analyzed and approved prior to use. If development by air jetting or airlift pump is to be done, an air compressor with a filtering system certified to remove oil to less than 1 ppb shall be used.

Preliminary well development may be conducted after installation of the well screen, casing and filter pack, but prior to installation of seals and grouting. Additional filter pack shall be added, as needed, after completion of preliminary well development, to bring the filter pack level up to the desired depth. Preliminary well development may consist simply of pumping fresh water for a brief interval (several minutes) through the well screen to flush drilling mud from the filter medium. All preliminary well development shall be completed within five days after the screen, casing, and filter pack are installed, unless for some reason a longer time period is required. If soils above the screened aquifer are known or suspected to contain hazardous substances, preliminary well development will be restricted to flushing the filter medium briefly through the screen. All other development efforts will then be conducted after grout has been placed and allowed to set.

Most well development will be conducted prior to the installation of protective casings and surface pads. Soil shall be mounded around the base of the exposed well casing prior to development in order to direct runoff away from the well annulus. A sheet of plywood (with a hole cut to approximate the well casing diameter) shall be placed over the well casing when development is conducted prior to grouting.

7.4.7 Drilling and Sampling Equipment Cleaning and Decontamination Procedures

Equipment and materials used for monitoring well drilling, installation, and development at SRS which shall be introduced temporarily, installed permanently, or operated in the immediate vicinity of the monitoring well, shall be cleaned and handled in accordance with the following guidelines:

1. The drill rig and all support equipment shall be free from excess grease, oils, and caked-on soils from previous work prior to arrival at the site. Equipment which leaks fuel, coolant, and lubricants shall be removed from the site and repaired prior to use.
2. All equipment that has a potential to leak (i.e., grease, oil, etc.) will be placed on plastic sheeting (6 mil or thicker), including drill rigs.
3. Prior to use, all equipment that will enter the borehole must be cleaned by a pressure washer (water at 200 degrees F and 1500 psi) at the well site. If the equipment will not be used immediately, it must be placed on a plastic sheet, covered with plastic, and stored in a clean area. All other equipment that has a potential to introduce contamination into the borehole (mud pumps, flow lines, etc.) should be flushed clean with approved potable water prior to use.
4. All well casings, screens, centralizers, tremie pipe, measuring lines, etc., shall be steam cleaned immediately prior to well installation.
5. Clean, new disposable rubber gloves shall be worn when handling well screens and casings. Personnel handling these items shall not handle tools or equipment while installing the well.

7.4.8 Ground Water Sample Collection

Ground water samples shall be collected in accordance with procedures described in DPSOP 254.

7.4.9 Sample Analysis and Data Management/Evaluation

Sample analysis shall be conducted in accordance with procedures described in Chapter 3. Data management evaluation techniques are discussed in Chapter 10.

7.5 GROUND WATER ASSESSMENT SAMPLING

7.5.1 Ground Water Assessment Sampling Objectives

If hazardous substance concentrations above background are determined during Preliminary Sampling efforts, a Ground Water Assessment Sampling will be required. The objective of the Ground Water Assessment will be to determine the vertical and horizontal extent of all hazardous substances released from the RFI unit and to assess the rate of constituent migration.

7.5.2 Determination of Hazardous Substances to be Analyzed

The parameters which will be analyzed during an Assessment Sampling will depend on the phase of the assessment effort. A complete Appendix IX Scan plus any additional potential unit-specific constituents will initially be conducted on ground water samples obtained from at least one permanent Preliminary Sampling Well where hazardous substances were detected. This will provide a list of contaminants which appear to be migrating into the uppermost aquifer. A limited number of parameters shall be selected from this list based on constituent mobility and reactivity in the ground water system, for use in general assessment sampling to establish the geometric dimensions and migration rates of the constituent plume(s). Once the horizontal and vertical extent of constituent release has been generally defined, the assessment well network shall be sampled for the complete list of detected parameters and potential degradation/transformation products, to determine the vertical and horizontal limits of all detected hazardous substances in the ground water system.

The specific parameters which shall be analyzed during Ground Water Assessment Sampling shall be identified in unit-specific assessment plans.

7.5.3 Determination of Assessment Sampling Locations and Intervals

The number, depth, and location of ground water assessment sampling wells shall be based on Preliminary Sampling Efforts and unit characterization.

Indirect techniques such as geophysical surveying (including electrical resistivity, electromagnetic conductivity and ground penetrating radar) and soil gas analysis may be used to provide initial plume delineation and therefore minimize the total number of wells needed. Details on the use of geophysical methods are contained in the Appendices of the RCRA TEGD (USEPA, 1986a). Subsurface gas analysis is discussed in Chapter 5 of this RFI Program Plan. Temporary sampling points such as temporary piezometers and drive samplers (i.e., QED HydropunchTM) may be used to facilitate ground water sampling for initial plume delineation during the ground water assessment. Temporary piezometers may also be utilized to obtain additional water level elevation data, and to determine or confirm ground water flow directions and hydraulic gradients. Specifications for piezometer construction are included in DPSOP 254 (du Pont, 1987). All piezometers shall be abandoned in accordance with the "Specifications for the Abandonment of Ground Water Monitoring Wells" contained in Chapter 6 of DPSOP 254 (du Pont, 1987). Exploratory borings shall be abandoned upon completion by tremie grouting from the bottom to land surface, with cement/bentonite grout mixed to the same specifications used for annular seals for monitoring well installations at SRS.

7.5.4 Selection of Background Sampling Points

The criteria presented in Section 7.4.4 are also applicable to the determination of background sampling locations during Ground Water Assessment Sampling. A minimum of one background sampling point shall be established for each aquifer sampled during the Ground Water Assessment. Existing data and wells shall be used where available.

**7.5.5 Assessment Monitoring Well Installation: General Considerations,
Drilling, and Installation Procedures, Equipment**

The procedures and equipment described in Section 7.4.5 pertaining to well installation for preliminary sampling are also applicable to the installation of assessment monitoring wells. However, because assessment monitoring wells at SRS may be installed below the water table aquifer, additional precautions shall also be required to avoid potential contamination of deeper, uncontaminated aquifers. Detailed specifications for the installation of monitoring wells below the water table aquifer at SRS are contained DPSOP 254, Chapter 5 (du Pont, 1987). Some special considerations are discussed below. All boreholes to be drilled below the water table aquifer shall be mud-drilled. Borehole deviation surveys will be conducted at intervals of 100 feet or less. Deviation shall not exceed 2 degrees over the entire hole depth. Boreholes drilled for 4 inch internal diameter well installation shall be a minimum of 9-7/8 inches in diameter. Continuous cores generally shall be obtained at all new locations to determine the stratigraphy and enable the identification of confining units. The need for continuous coring shall be determined, through the RFI program Team, based on the proximity of existing wells.

Well clusters shall be installed at units which will be identified in the unit-specific work plan. The well clusters shall be used to determine the vertical distribution of hazardous constituents at the unit. Where well clusters are intended, the deepest well shall be installed first. The initial borehole shall be advanced by continuous coring. Subsequent wells in the cluster shall be drilled with conventional mud-rotary equipment. Wash samples shall be collected and logged at 5 foot intervals. All boreholes shall be geophysically logged prior to final determination of screen placement and the details of well installation. For those cases in which well clusters are installed, the horizontal distance from one well cluster to another shall not be less than 25 feet. Any spacing closer than 25 feet must be approved by the RFI Program Team. The grain size distributions and anticipated hydraulic conductivities of screened formation shall be evaluated when determining the acceptable proximity of wells installed in clusters.

Lost circulation zones may be encountered when drilling deep wells at SRS. These zones will require special techniques to minimize the loss of drilling fluids and cuttings. Wheat bran, MicatexTM, or bentonite granules or pellets shall be used to maintain circulation through these zones in sands and slightly fractured carbonates. Where these methods are unsuccessful, the use of quick-setting cement such as Calseal or cement with sodium chloride additives may be required. Use of drilling fluid additives shall be in accordance with DPSOP 254. The use of these materials shall be approved in advance by the Site Ground Water Coordinator (SGWC). The SGWC shall contact SCDHEC when the use of these materials is required.

Surface casings shall be installed at all locations where a confining unit separating aquifers must be penetrated. In some cases this will require the installation of multiple surface casings. Surface casings may be either permanent or temporary; however, permanent surface casing will be installed at all locations where a potential for cross-contamination exists. All permanent surface casings shall be grouted in place and the annular space between casings shall also be filled with grout. Surface casings shall be used for the following reasons:

- To prevent migration of ground water from a contaminated aquifer to an uncontaminated aquifer (upward or downward)
- To seal off zones of excessive fluid loss
- To seal off unconsolidated zones where repeated caving occurs

Wells greater than 300 feet deep will require carbon steel pipe, non-mill coat, as specified in DPSOP 254 (duPont, 1987).

7.5.6 Monitoring Well Development

Development techniques presented in Section 7.4.6 shall also be used for developing assessment monitoring wells.

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7.5.7 Drilling and Sampling Equipment Cleaning and Decontamination Procedures

The procedures described in Section 7.4.7 shall be followed for all assessment monitoring well drilling, installation and development activities conducted at SRS.

7.5.8 Ground Water Sample Collection

All ground water samples shall be collected in accordance with procedures described in Chapter 3.

7.5.9 Sample Analysis and Data Management/Evaluation

Sample analysis shall be conducted in accordance with procedures described in Chapter 3. Data management and evaluation is discussed in Chapter 10.

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CHAPTER 8

SURFACE WATER/SEDIMENT SAMPLING STRATEGY REQUIREMENTS

8.1 OVERVIEW

The following section has been prepared to provide a uniform approach in performing Preliminary and/or Assessment Sampling of surface waters and their sediments on, or contiguous with, RCRA Facility Investigation (RFI) units located on the Savannah River Site (SRS) properties near Aiken, South Carolina. This section discusses the general techniques and procedures, utilizing existing regulatory guidelines for the development and implementation of RFI sampling plans.

The surface water/sediment sampling strategy presumes that a Preliminary Evaluation (Chapter 4), a Unit Screening (Chapter 5), and/or Soils Sampling (Chapter 6), have been previously conducted. If soils contamination has not been detected, then it shall not be necessary to conduct a unit-specific surface water/sediment evaluation in most instances. If soils contamination has been confirmed, (or the RFI unit is deemed to be a source of release impacting surface water/sediment), then a surface water/sediment evaluation shall be conducted according to the criteria presented in Sections 8.2 thru 8.5. RFI units which are surface water bodies (e.g., seepage basin) may default directly to this sampling strategy.

Because of the complexity of conditions and general differences that exist from one unit to another, this generic surface water/sediment sampling plan cannot discuss every unit-specific consideration. This plan does, however, provide general guidelines applicable to most specific unit considerations. It shall be necessary to consider unit-specific information in developing unit-specific sampling plans.

8.2 FLOWCHART

A flowchart that illustrates major steps and decision pathways to be considered in the development of unit-specific sampling plans appears in Figure 8-1. This flowchart

FIGURE 8-1

SRS RFI PROGRAM PLAN

SURFACE WATER/SEDIMENT SAMPLING STRATEGY FLOWCHART

presents the basic or generic approach to sampling a variety of aquatic habitats for hazardous substances. The flowchart indicates that a surface water/sediment sampling strategy will be implemented at RFI units only when one (or more) of the following conditions occurs:

- The RFI unit is deemed to be a source of release of hazardous substances potentially impacting surface water/sediment.
- The unit is a surface impoundment containing residual water and/or deposited sediment or sludge, in which case the water and/or sediment or sludge will be sampled.
- Wet weather drainage swales or runoff channels radiate from or within the unit, in which case runoff should be sampled during or following rainfall.
- A surface water body (e.g. stream, pond, wetland) is located within approximately 100 meters downgradient from the unit, in which case the water body will be sampled. Unit-specific hydrogeologic characteristics and histories may dictate examination of surface water features further downgradient than 100 meters. The actual surface water bodies to be investigated at a particular unit shall be determined by the RFI Program Team.

8.3 INTRODUCTION

Prior to development of the unit-specific sampling plans, consideration shall be given to the information and procedures discussed within the text of this generic surface water/sediments sampling plan.

Sampling of a specific RFI unit and/or its contiguous surface water systems can be conducted under either one or two sampling regimes. The first, for purposes of this RFI Program Plan, is defined as "Preliminary Sampling". This sampling regime involves those steps and procedures necessary to determine the possibility of surface water networks contamination due to the release of hazardous substances. The second sampling regime is

defined as "Assessment Sampling" in which steps and procedures are implemented to determine the extent of contamination to aquatic habitats from the release of hazardous substances.

8.4 UNIT INFORMATION

The approach in the development of sampling plans for a specific unit begins by reviewing all existing data and information available for that specific unit. The unit-specific literature review is discussed in detail in Section 4.2 and will have been conducted prior to sampling of the soil and other media.

Following a review of all existing data and information, a unit reconnaissance will have been performed (Section 4.3) and will have identified the following actual unit conditions:

- All surface water features including drainage swales, springs, and seeps which may carry surface water flow from the unit
- The interconnections/relationships between these features and the subsequent receiving water bodies
- All surface water features which may be affected by the release

The Field Data Sheet included in Appendix C contains the specific factors that were considered during the actual reconnaissance. This Field Data Sheet will have been completed by the Contractor to provide written documentation of the unit reconnaissance, as described in Chapter 4.

8.4.1 Waste Characteristics

A number of environmental processes are important in controlling the fate of contaminants in the aquatic environment. These are related to (1) the physicochemical properties of the

pollutants, (2) the environmental transport processes, and (3) the environmental transformation processes.

Table 8-1 summarizes pertinent information necessary for assessing the possibility and extent of contaminant releases to the aquatic environment from an RFI unit and/or contiguous areas. The Unit Literature Review Checklist in Appendix B shall be updated at this time, utilizing information from Environmental Information Documents (EIDs), field reconnaissance, and chemical literature. The investigator shall attempt to characterize and identify transport processes and chemical fates prior to initiating sampling activities.

8.4.2 RFI Unit Design, Characteristics, and Operational History

While a variety of scenarios could be presented for release mechanisms; hazardous substances generally are released to surface water systems via three possible mechanisms: overland flow, intermedia transport (ground water discharge and atmospheric deposition), or direct placement as indicated in Table 8-1, Part I. By utilization of the unit's existing database and judicious unit reconnaissance, the Contractor will be able to identify potential waste release mechanism(s) from the waste unit to accessible aquatic environments. A checklist for RFI unit design/history and potential release mechanisms may be found in the Unit Literature Review Checklist, Appendix B.

8.4.3 Environmental Setting and Existing Data

Physiography of the drainage basin under investigation will determine the possibility and potential extent of contaminant release. Relevant features include:

- Size and shape of drainage area
- Tributaries
- Landform
- Vegetative Cover

TABLE 8-1
FACTORS AFFECTING TRANSFORMATION AND TRANSPORT OF
CONTAMINANTS TO SURFACE WATER ENVIRONMENTS

I. Release Mechanism

- A. Overland Flow
 - 1. Runoff
 - 2. Seeps
 - 3. Springs
- B. Intermedia Transfer
 - 1. Ground Water Discharge
 - 2. Atmospheric Deposition
- C. Direct Placement
 - 1. Engineered Conveyance
 - 2. Dumping

II. Waste and Unit Factors

- A. Unit Operational and Design Influences
 - 1. Waste Matrix and Composition
 - 2. Rate and Schedule of Waste Generation/Disposal
 - 3. Type and Size of Waste Generation/Disposal
 - 4. Unit Environmental Controls
- B. Waste Composition and Fate in the Environment
 - 1. Phase and Mobility
 - 2. Chemical Composition

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3. Fate
 - a. Dissolved
 - b. Suspended
 - c. Precipitated
 - d. Biological uptake/degradation
 - e. Photolysis
 - f. Hydrolysis
 - g. Oxidation
 - h. Volatilization
 - i. Adsorption

III. Environmental Factors

- A. Surface Water Network Hydraulics
 1. Type of Surface Water Features
 - a. Swales and Runoff Channels
 - b. Streams and Rivers
 - c. Lakes and Ponds
 - d. Wetlands
 2. Flow Rates and Velocity
 3. Control Structures
 4. Deposition Areas
 5. Drainage Area
- B. Climate and Geography
 1. Rain/Dry
 2. Freeze/Thaw
 3. Stratification/Mixing
 4. Soil Type
 5. Vegetation

- Geology/Ground Water Formation
- Climatologic Factors

Existing documentation, such as the EIDs, will supply much of the unit information. The Weather Information and Display (WIND) System (Appendix J) will augment these data with historical and real-time meteorological and hydrologic information for key locations at SRS.

Before completing the design for the aquatic survey, the investigator shall conduct a field reconnaissance to provide an overview of the entire drainage basin and each component's potential for having received a release. Preliminary investigations may also reveal specific information regarding erosion, fluvial deposits, and the condition of the habitat (e.g. eutrophication, stressed vegetation).

8.5 UNIT EVALUATION

Upon consideration of waste characteristics, design and operational history and the environmental setting, a unit evaluation of the potential impacts to surface water shall be made for each RFI unit. This evaluation will result in the placement of each unit into one of the three general categories described as follows:

1. Surface water/sediment contamination, resulting from the release of hazardous substances, is known.
2. Surface water/sediment contamination, resulting from the release of hazardous substances, is suspected.
3. Surface water/sediment contamination, resulting from the release of hazardous substances, is absent.

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For the first category (those aquatic habitats of known contamination), the unit investigation will proceed directly into an Assessment Sampling phase to determine the magnitude and extent of contamination. It shall not be necessary to implement a Preliminary Sampling phase or one designed to detect the presence of contamination within surface waters and sediments.

For the second category (those aquatic habitats of suspected contamination), the unit investigation will proceed into the development and implementation of a Preliminary Sampling phase designed to detect the presence of contamination by hazardous substances. Once information has been generated and evaluated under the preliminary sampling phase, the unit will be reevaluated. This reevaluation shall result in categorizing the unit as one of known contamination or one classified as having no contamination.

For units having no contamination, no further sampling of surface water environments is anticipated. The need for a surface water investigation may default to this category depending upon results of other media and history investigations occurring at the RFI unit.

8.6 DESIGN AND IMPLEMENTATION OF A UNIT SAMPLING PROGRAM

8.6.1 Preliminary Sampling Phase: Hazardous Substance Identification, Sampling Locations, and Sampling Methods

The objective of the Preliminary Sampling phase is to verify the presence or absence of hazardous substances to surface waters as determined by the Preliminary Assessment. The parameters to be analyzed, sampling equipment, RFI unit and background area sampling locations, sample numbers, sample types, sample strata, and sample collection techniques are specified in detail in Chapter 3.

Based on the results of the Preliminary Sampling phase, (1) if contamination is determined to be at or below background levels, no further sampling action need be proposed, or (2) if contamination is present, subsequent sampling under an Assessment Sampling phase shall be necessary.

8.6.1.1 Hazardous Substances to be Analyzed

For the Preliminary Sampling phase, the selection of analytes will be based on reasonable assumptions of waste characteristics and mobility, and unit conditions.

Since a contaminant release is possible at all units where the Preliminary Sampling phase is to be implemented, both indicator parameters and certain hazardous substances commonly found on similar units may be analyzed, as listed below. The test results of the non-specific indicator parameters may provide evidence as to the possibility of surface water/sediment contamination from the release of specific hazardous substances within the RFI unit (if applicable), or at aquatic environments hydrologically connected with the unit.

Positive results from other media investigations (i.e. soils/soil gas) will most often trigger surface water/sediment contamination investigations. Specific contaminants found during these investigations may modify the list of sampling parameters given below.

Some or all of the following non-specific parameters will be analyzed:

Water (one or more strata)

Depth
Temperature
Dissolved Oxygen
pH
Specific Conductivity
Total Dissolved Solids (TDS)
Total Suspended Solids (TSS)
Total Organic Carbon (TOC)
Total Organic Halogens (TOX)

Sediment/Sludge

pH
Specific Conductivity
Total Organic Carbon (TOC)
Total Organic Halogens (TOX)

Based on the type of unit background information concerning management of waste on the unit, or results of other media investigations (soils/soil gases), one or all of the following specific parameters may be analyzed during the Preliminary Sampling phase for either or both matrices:

- Specific volatile organic compounds
- Total concentration of specific metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag)
- Extraction Procedure toxicity test for specific metals
- Pesticides and PCBs
- Acid/base/neutral extractibles
- Specific priority pollutants*

* During this sampling phase, any major non-priority pollutant peaks appearing in a gas chromatography scan will also be noted for further investigation during the Assessment Sampling Phase.

The analytical procedures for the above contaminants are referenced in Chapter 3.

Samples collected from the RFI unit (where aquatic habitats exist) at contiguous aquatic environments suspected of having received unit runoff or leachate, and at a background area, either upstream of suspected contamination or representative of the unit aquatic ecosystem under investigation, shall be analyzed for the above parameters.

8.6.1.2 Determination of Sampling Points

Because extensive information exists for many RFI units located on the SRS properties, reasonable engineering judgment will be used to identify the potential off-unit aquatic receptors. The information taken into account when establishing sampling locations for Preliminary Sampling shall include historical management practices, design and operating information, field or laboratory analysis, as well as field observations for any adjacent impacted areas. Once these have been defined, unit-specific background area(s) will be determined (See Section 8.6.1.3).

Due to the dynamics of the system being investigated, sampling locations shall be selected based on professional evaluation. Conditions determined during reconnaissance, conditions found at the time of sampling, and relevant information concerning the unit/system being sampled are the evaluation criteria. Any necessary field adjustments to the sampling plan should be carefully documented in the field log. When final sampling points have been established, it is important to ensure that each location represents a particular aspect of the surface water system being measured (e.g., habitat type, matrix, strata).

In the Preliminary Sampling phase, a minimum of three (3) samples shall be collected within each targeted matrix (i.e., water or sediment), strata (surface/bottom for deep or stratified surface water systems), and habitat type (e.g., wetlands, drainage ditch). This guideline for a minimum number of sampling locations (3) complies with the criteria for land treatment units listed in EPA SW-846, page 12-10. This preliminary sampling may reveal the presence of contamination and sample variability within RFI units having surface water systems. For off-site surface water systems which may be potential receptors of RFI unit releases, the sample locations shall be strategically chosen to demonstrate sampling variability. It is expected that this will provide the investigator with a cursory insight to the gradations and extent of contamination.

In consideration of the potential diversity of aquatic habitat types likely to be encountered, the following sampling strategies are suggested:

- **Impoundments/Ponds:** Surface water grab samples shall be obtained at a minimum of three separate locations, according to guidance listed in EPA SW-846, page 12-10. If lateral mixing is believed to be incomplete, the investigation should focus sampling on areas/pockets suspected of harboring maximum contaminant concentrations. For water bodies exhibiting vertical stratification, three samples also should be obtained from the lower strata in conjunction with the surface water sampling.

Sediment samples shall be obtained following surface water sampling and generally at the same locations where water sampling has occurred. Exceptions to this strategy may include the targeting of obvious fluvial deposits downstream of suspected hazardous substance contamination. Trace metals (and some organics) have a strong affinity for adsorption to suspended soils and inorganic sediments. The "deltas" formed by fluvial deposition are likely to represent maximum contamination areas for sampling during this Preliminary Sampling.

- **Wetlands:** If surface waters are present, collect grab samples at three separate locations (EPA SW-846). Where evidence of hazardous substance release exists (e.g., stressed vegetation, fluvial deposits) concentrate Preliminary Sampling at this location. If no such evidence is present, collect samples near the influent or areas which may receive major runoff or flow. For wetland waters exhibiting vertical stratification, obtain three additional grab samples within the bottom strata.

Three sediment samples (SW-846) shall be collected in the same location as the water samples. Again, focus sampling efforts on zones which may display effects of upstream releases. During dry seasons, soil sampling techniques described in Chapter 6, Soil Sampling, may be employed.

- **Streams/Rivers:** For shallow streams with adequate mixing, the investigator shall obtain grab samples from three locations downstream of the RFI unit release. The first will be a point immediately below the suspect waste input. The two additional samples should be taken downstream of this location, particularly targeting pools which may

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harbor hazardous constituent deposition. For deep, slow moving streams and rivers, additional deep water sampling also will be required, if stratification is encountered.

Sediment sampling shall follow the same strategy with at least one sample collected at the suspected inflow and the others in areas of downstream fluvial deposits, such as sandbars or pools.

- Drainage Ditches/Swales: Standing/flowing water is not likely to be encountered if sampling this habitat type except during rainfall events. If flowing water is encountered, defer to sampling procedures outlined above.

Sediment sampling should occur immediately below the point of discharge and those areas with obvious sediment deposits or pooling.

For some RFI units it may be necessary to collect more than the minimum numbers of samples. A sufficient number of samples shall be collected to provide representation of the known habitat, matrix, and strata. Factors that shall be considered when determining the number of samples are:

- Surface runoff areas, seepage areas, and areas affected by wind deposition
- Special areas (e.g., stressed vegetation) in which there appears to be possible contamination
- Characteristics of the matrix and possible waste constituents

Sample points will be clearly marked by surveyor stakes, a blaze on trees, or some other suitable semi-permanent marker.

8.6.1.3 *Determination of Background Area and Sampling Points*

In those cases where a common background area is not applicable, it will be necessary to collect samples from a unit-specific background area. Once a unit-specific background area has been determined, it will be necessary to determine the correct sample locations.

In order to have a basis for comparison, sampling from control stations or background area will be necessary. To obtain representative results for the aquatic ecosystem types and matrices being sampled, special reconnaissance efforts and planning will, in most cases, be required to identify appropriate locations.

Generally speaking, the background area is defined as a region in which the aquatic environment would not have been impacted by any potential release of contaminants from the RFI unit. Typically, the background area will be hydrologically upgradient from the RFI unit. The surface runoff/flow direction can be estimated from field observations or by the use of a topographic map. The ground water flow direction may be known through previous field studies or evaluation of the topographic map. The background area shall be located at sufficient distance from the RFI unit to ensure that subsurface liquid or gas migration from the unit will not occur. When practical, the background area will be located near the study area to minimize habitat variability.

For many situations, background sampling locations for RFI units will be determined on a case by case basis. For example:

- Lagoons/seepage basins which may comprise the RFI unit will be sampled for water and sediments. A background environment of this type is not likely to be encountered. Judicious use of water quality data from surrogate aquatic environments may be necessary to achieve this requirement.
- Drainage ditches and swales leading from an RFI unit may require sampling. A background ("upgradient") ditch may not be available for control sampling. While other intermittent surface water ditches and swales may provide background

information, judicious selection of units and interpretation of the results will be required due to potential impacts from unidentified point/non-point contaminant sources.

- In most cases, stream background samples should be readily obtainable (i.e., upstream of the point where the suspected releases from the RFI unit intercept the stream). However, the investigator should be cognizant of any non-RFI unit upstream sources which may interfere or bias control sampling efforts.

Control samples for each matrix/strata will be collected from the targeted habitats within the boundaries of the background area provided that the area meets the above criteria. It is important to establish valid surface water/sediment background values for each hazardous constituent to be sampled. The background values shall be established by collecting at least three samples within the specific habitat, matrix and /or strata as was collected in the study locations. The samples specified will indicate potential for variability and should adequately serve the Preliminary Sampling phase. Total sample numbers cannot be specified due to the variety of sampling conditions and habitats encountered. However, sampling strategies shall follow those defined in Section 8.6.1.2. The sampling points will be marked by wooden surveyor stakes or by some other easily identifiable means.

8.6.1.4 Sampling Equipment

8.6.1.4a Water

During the Preliminary Sampling phase, grab sampling will be employed for both water and sediment samples. Grab samples (vs. composite samples) are single samples collected at a specific time and location. Grab samples collected and analyzed individually provide better information than composite sampling by indicating analyte (and sampling) variability, and by eliminating the possibility of sample dilution.

For surface water samples, direct dipping of the sample container into the water will be most effective. This method is advantageous for the collection of many sample parameters in that alteration or aeration of the sample can be minimized. Also the potential for sample

cross-contamination is eliminated. Though simple and appropriate for most surface water sample collections, decontamination of the container's exterior may be required in certain sampling situations. All sample vessels shall be of the type, volume, and contain the preservative according to the analyte being measured, as specified in Section 3.4.3.2. The Contractor shall ensure that appropriate hand and foot protection are worn to eliminate exposure to contaminants at units suspected of having high levels of contamination.

For samples to be taken below stratified water layers (e.g. thermocline) in deep or still water bodies, a Kemmerer bottle or its equivalent shall be used. Such a device minimizes sample disturbance at the point of collection and may deliver the collected water to the final sample containers with minimum agitation or aeration. This sampler should be constructed of an inert material such as Teflon and stainless steel; such a device is easily cleaned and decontaminated in the field and will not impart trace contaminants which may bias the sample (particularly important when sampling trace organics).

A multiparameter portable water quality monitor shall be utilized to obtain in-situ dissolved oxygen, temperature, pH and conductivity. All applicable daily calibration checks and other QC procedures shall be field logged as specified in Section 3.3.2.

8.6.1.4b Sediment

Sediment samples may be retrieved by a number of methods, contingent upon field conditions, including coring or dredging.

Dredging will accommodate most sediment sampling conditions encountered. Typical grab/dredge designs are the Ponar, Eckman, and Peterson. While none of these offer deep penetration of substrates, vertical profiling is not critical since hazardous substance deposition will represent relatively recent accumulations. Dredges sample a greater surface area than either a scoop or core, and are able to collect representative sample sizes within substrate types. Subsampling of material secured by dredging with coring tubes or Teflon scoops will minimize the chance of metal contamination from the frame of the dredge. Submerged or emergent soils typical of wetland habitats are generally easier to sample with

corers. The coring device can be forced through vegetation and roots to collect a sample. They may also be selectively placed in small clearings between plants for easier sampling. Coring tubes shall be constructed of an inert material to minimize the possibility of sample contamination. The disadvantage to the coring device is that it typically samples a small surface area, sometimes requiring repetitive sampling to obtain quantities necessary for analysis.

8.6.1.5 Sampling Equipment Pre-Field Cleaning and In-Field Decontamination Procedures

Cleaning and decontamination procedures for all sampling equipment will be uniform. All sampler parts shall be decontaminated prior to the collection of each sample unless otherwise specified. Decontamination shall be conducted in accordance with the following procedure:

1. Clean with on-site water supply well water and phosphate-free laboratory detergent (Liquonox or equivalent) using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with on-site water supply well water.
3. Rinse thoroughly with deionized or distilled water.
4. Rinse two times with high grade isopropanol solvent and allow to air dry.
5. Rinse thoroughly with deionized or distilled water and allow to air.
6. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is to be stored or transported.

All rinse waters will be contained in a manner to prevent the introduction of contamination. All rinsate will be collected in a compatible container then properly disposed of to prevent

possible contamination to adjacent areas. See Chapter 3 for requirements on the handling of rinsate.

8.6.1.6 Procedures For Water Sampling

8.6.1.6a Procedure for Surface Water Grab Sampling

For sampling shallow surface waters the following procedures shall be followed:

1. Remove the sample bottles to be used at the unit from the coolers. Fill in all information indicated on the bottle label with a water proof marker or ball point pen.
2. Care should be exercised when opening and filling the bottles since some of the bottles contain carefully measured amounts of chemical preservatives. The preservatives vary but some are small amounts of concentrated sulfuric and nitric acid which are extremely corrosive.
3. Do not mix the caps or rinse the sample containers.
4. Surface grab samples may be collected directly in the sampling container. Reduce risk of sample contamination by sampling against the flow.

IMPORTANT NOTES:

- Disposable gloves should be used during sampling operations where the technician's hands are in contact with the water.
- Never touch the inside of any bottle.
- Avoid contaminating sample with bug repellents, perfume, lotions and fuel vapors, etc. Extreme care must be employed with their use in the field.

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- THINK.

5. Fill the sample containers with the proper sample of water. DO NOT OVERFLOW (except in case of VOCs - refer to special VOCs sampling instructions) to prevent loss of preservative.
6. Cap the containers tightly. Place the sample container in a plastic bag and tie.
7. Place sample in cooler, add ice or blue ice (preferred).
8. Observe and make note of any visible contamination at the unit, (e.g., sheen on water, floating debris, odors, fish kills, etc.) and note in Field Log.
9. Measure designated in-situ field parameters, and record data in Field Log.

8.6.1.6b Procedure for Deep (Stratified) Water Grab Sampling

Continue from Step 9 above, by obtaining in-situ readings near the bottom and mid-depth to establish the water body depth and the existence of any stratification (e.g., temperature, specific conductivity, dissolved oxygen). If no stratification is noted and the water is less than 2 meters in depth then no further sampling is required.

For waters exhibiting stratification or exceeding 2 meters in depth, also obtain a grab sample one foot above the bottom utilizing a pre-cleaned Kemmerer bottle and the procedures given below:

1. Inspect Kemmerer bottle for thorough cleaning and ensure that sample drain valve is closed (if bottle is so equipped).
2. Measure and then mark sample line at desired sampling depth.
3. Open bottle by lifting top stopper-trip head assembly.

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4. Gradually lower bottle until desired level is reached (predesignated mark from Step 2).
5. Place messenger on sample line and release.
6. Retrieve sampler; hold sampler by center stem to prevent accidental opening of bottom stopper.
7. Rinse or wipe off exterior of sampler body (wear proper gloves and protective clothing).
8. Recover sample by grasping lower stopper and sampler body with one hand (gloved), and transfer sample by either (a) lifting top stopper with other hand and carefully pouring contents into sample bottles, or (b) holding drain valve (if present) over sample bottle and opening valve.
9. Allow sample to flow slowly down side of sample bottle with minimal disturbance.
10. Select sample bottles and preserve the sample if necessary as per guidelines in Chapter 3.
11. Check that a Teflon liner is present in the cap if required. Secure the cap tightly.
12. Label the sample bottle with an appropriate tag. Be sure to complete the tag with all necessary information. Record the information in the field log book and complete all chain-of-custody records.
13. Decontaminate sampler and messenger following procedures outlined in Section 8.6.1.5 after use and between sampling locations.

8.6.1.7 Procedures for Sediment Sampling

Obtain all water samples and in-situ physical measurements prior to the initiation of any sediment sampling activity.

Determine the habitat/substrate type in order to identify which sediment sampling device is appropriate. For example, the use of a coring device may be more appropriate in wetlands or other vegetated submerged soils.

8.6.1.7a Sampling Bottom Sludges or Sediments with a Ponar Grab

The dredge or grab will be capable of sampling most of the aquatic sediment types encountered at SRS. The procedures outlined below are for the Ponar grab but will be applicable to the other clamshell type scoops commercially available. The procedures are:

1. Attach a precleaned Ponar to the necessary length of sample line. Solid braided 5 mm (3/16 inch) nylon line is usually of sufficient strength; however, 20 mm (3/4 inch) or greater nylon line allows for easier hand hoisting.
2. Measure and mark the distance to bottom on the sample line. A secondary mark, 1 meter shallower, will indicate proximity so that lowering rate can be reduced, thus preventing unnecessary bottom disturbance.
3. Open sampler jaws until latched. From this point on, support sampler by its lift line or the sampler will be tripped and the jaws will close.
4. Tie free end of sample line to fixed support to prevent accidental loss of sampler.
5. Begin lowering the sampler until the proximity mark is reached.
6. Slow rate of descent through last meter until contact is felt.

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7. Allow sample line to slack several centimeters. In strong currents more slack may be necessary to release mechanism.
8. Slowly raise dredge clear of water surface.
9. Place Ponar into a stainless steel or Teflon tray and open. Lift Ponar clear of the tray.
10. Collect a suitable aliquot with a stainless steel lab spoon or equivalent and place sample into appropriate sample bottle. Chapter 3 contains containerization and preservation requirements.
11. Check for a Teflon liner in cap if required and secure cap tightly. The chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach, supplemented by a minimal holding time.
12. Label the sample bottle with the appropriate sample tag. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Complete all chain-of-custody documents and record in the field log book.
13. Consult Section 8.6.1.5 for appropriate decontamination procedures to be used on sampling equipment after use and between sampling locations.

8.6.1.7b Sampling Sludge or Sediments With a Hand Corer

Obtaining sediment samples through vegetated soils likely to be encountered in wetlands or floodplains shall be performed with the use of a hand corer. Such a device can be strategically placed to sample in small clearings and is capable of cutting through underlying root mats to obtain a discrete sample. A number of core types may be utilized effectively, but all will essentially follow the procedure presented below:

1. Inspect the corer for proper precleaning, and select sample location.

2. Force corer in with smooth continuous motion.
3. Twist corer then withdraw in a single smooth motion.
4. Withdraw sample into a stainless steel or Teflon tray.
5. Transfer sample into an appropriate sample bottle with a stainless steel lab spoon or equivalent.
6. Check that a Teflon liner is present in cap if required. Secure the cap tightly. The chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach supplemented by a minimal holding time. Chapter 3 should be consulted for specific containerization and preservation requirements.
7. Label the sample bottle with the appropriate sample tag. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Complete all chain-of-custody documents and record in the field log book.
8. Decontaminate sampling equipment after use and between sample locations as required.

8.6.1.8 Surface Water/Sediment Collection Order

To minimize the possibility of cross-contamination from one sampling point to another and one matrix to another the following sampling order shall be used:

1. In flowing surface water networks, sample downstream locations first; thus, sediments or contaminants resuspended in the water column due to sampling activities cannot be inadvertently transported to another sampling location.
2. While at the specific sampling location, obtain surface water grab samples prior to those collected at deeper strata.

3. While at a specific sampling location, obtain all in-situ physical data prior to collecting deeper water samples. First, such information is used for the determination of stratification within the water column (and the need for further water sampling), and second, any unnecessary disturbance of the water column due to premature sampling efforts may lead to erroneous measurements.
4. While at a specific sampling location, conduct all sediment sampling last. Suspended solids are temporarily generated during this sampling activity and will affect the validity of water samples if collected prematurely.

8.6.1.9 *Environmental Conditions at Sampling*

Sampling efforts within a drainage basin potentially affected by a RFI unit should be intensive over a short period of time (preferably one day) during a period of hydrologic stability and normal waste loading in order to relate water quality with the stable conditions which produced it. Major rainfall events are likely to bring about fluctuations in runoff and erratic sampling results. Rainfall, while producing runoff and seepage, will bring about dilution of soluble constituents in the water column and possibly wash away fluvial deposition and sedimentation.

The Contractor shall obtain records of stream flow and rainfall from the WIND System at SRS to determine the period(s) in which flows and temperatures are relatively stable. Whenever possible, the Contractor shall attempt to collect surface water/sediment samples during this period. The field log should contain weather information for the day of sampling and the preceding three days.

Other environmental factors to be noted are turbidity and eutrophication. While both are natural occurrences, they may influence sample results and shall be noted in the field log.

**8.6.1.10 *Sample Analysis and Data Reduction/Tabulation/Management
Evaluation***

All water and sediment samples will be analyzed by a South Carolina certified laboratory.

All data generated during the unit investigation shall be reported in accordance with the Data Management Requirements listed in Chapter 10. Data generated during the Preliminary Sampling phase will be evaluated by comparing background data to information attained from the investigation of the RFI unit. On the basis of this evaluation, one of the following conclusions will be made:

1. Hazardous substance concentrations are at or below background: no further sampling required.
2. Hazardous substance concentrations are above background: proceed into Assessment Sampling Phase, Section 8.6.2.

**8.6.2 *Assessment Sampling Phase: Hazardous Substance Identification,
Sampling Locations and Sampling Methods***

The Assessment Sampling phase is conducted when either (1) surface water/sediment contamination is known according to results of the Preliminary Unit Evaluation or, (2) the Preliminary Sampling phase indicates that a hazardous substance release to the surrounding surface water network has occurred. In the Assessment Sampling phase, the number of contaminants to be analyzed and the frequency of samples collected typically increases, thus providing a more detailed or unit-specific sampling approach than that utilized for the Preliminary Sampling phase. The Assessment Sampling phase may occur over an extended period of time utilizing several sampling events in order to meet the objective of determining the full extent of surface water/sediment contamination by a specific hazardous substance.

8.6.2.1 Hazardous Constituents to be Analyzed

For units investigated during the Assessment Sampling Phase, some degree of contamination is "known". During this phase the following indicator parameters shall be analyzed:

Water (one or more strata)

Depth
Temperature
Dissolved Oxygen
pH
Specific Conductivity
Total Dissolved Solids (TDS)
Total Suspended Solids (TSS)

Sediment/Sludge

pH
Specific Conductivity

Based on the specific hazardous substance known to be released at the unit, one or all of the specific parameter groups, or individual contaminants within a specific group, may be analyzed for either or both matrices.

Volatile organics
Acid-base/neutral extractables
Total concentration of 8 RCRA metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag)
EP Toxicity test for 8 RCRA metals
Inorganic ions
Radionuclides
Pesticides and PCBs

Emphasis will be made on identifying and quantifying specific contaminants that may have been released to the surrounding aquatic environments.

8.6.2.2 Surface Water Body Characterization

In addition to analysis of hazardous substances, a detailed characterization of the surface water bodies hydrologically connected to the RFI unit shall be conducted where hazardous substance release has been verified. Listed below are parameters that may be considered in order to properly describe contamination movement and magnitude through the surface water network.

- Description of the temporal and permanent surface water bodies including:
 - For lakes and estuaries: location, elevation, surface area, inflow, outflow, depth, temperature stratification, and volume.
 - For impoundments: location, elevation, surface area, depth, volume, freeboard, and construction and purpose.
 - For streams, ditches, and channels: location, elevation, flow, velocity, depth, width, seasonal fluctuations, flooding tendencies (i.e., 100 year event), discharge point(s), and general contents.
 - Drainage patterns.
- Description of the chemistry of the natural surface water and sediments. This includes determining the pH, total dissolved solids, total suspended solids, biochemical oxygen demand, alkalinity, conductivity, dissolved oxygen profiles, nutrients (NH₃, NO₃-/NO₂-, PO₄-), chemical oxygen demand, total organic carbon, specific contaminant concentrations, etc.
- Description of sediment characteristics including:

- Deposition area
- Thickness profile
- Physical and chemical parameters (e.g., grain size, density, organic carbon content, ion exchange capacity, pH, etc.)

Existing information is available for many of the above parameters based on previous field studies. It is recommended that existing data such as the EIDs be utilized where available.

8.6.2.3 Determination of Sampling Points

For units containing known contamination, Assessment Sampling locations will be determined within habitats, matrices, and strata utilizing the strategy established in 8.6.1.2.

Assessment Sampling of aquatic habitats within the RFI unit is intended to provide a detailed characterization of the condition of the aquatic system by focusing analyses on specific hazardous substances.

Assessment Sampling of aquatic habitats hydrologically connected with the RFI unit also will require the determination of the extent of contamination downgradient. Strategies for sampling locations will follow those presented in 8.6.1.2. However, the determination of appropriate downstream sampling points will require some professional judgment on the part of the investigator. The following factors shall be considered when establishing sampling points along a stream:

- Generally, sampling points should be spaced on intervals based on time-of-water travel -- not distance.
- If the study is to be compared to a previous study, the same sampling stations should be used, if possible, for comparison purposes. Consider extending sampling locations

downstream of Preliminary Sampling stations to further define extent of contamination, if significant concentrations were encountered.

- A station should be located whenever a marked physical change occurs in the stream channel. Example: A stream reach between two adjacent stations should not include both a long rapids section of swift shallow water with a rocky bottom, and a long section of deep, slow-moving water with a muddy bottom. Stations at each end of the combined reach would yield data on certain rates of change, such as reaeration, that would be an unrealistic average of two widely different rates. Much more would be learned of the actual natural characteristics of the stream by inserting a third sampling station within the reach, between the rapids and the quiet water sections.
- Typical sediment deposition areas are located inside of river bends, downstream of islands, and downstream of obstructions in the water.
- Sites that are located immediately above or below the confluence of two streams or rivers should generally be avoided since flows from two tributaries do not necessarily immediately mix, and the sediment may be moving almost as two streams in proportion to the inflow from two tributaries.
- Potential sites upstream from the confluence with another stream may also be unsuitable at times due to possible backflow which can upset the normal movement of sediment.
- Contaminant concentrations may increase with increased stream flow (for low soluble compounds and suspended particles), or decrease due to dilution (for water soluble compounds).

Initially the Contractor should sample three locations downstream of the unit which target some of the criteria listed above. The first sampling location shall be established relatively close to the point of suspected contaminant discharge, with consideration of the above factors. The remaining sampling points also shall be determined according to the above guidelines to account for variability within each sampling location. However, Assessment

Sampling may be an iterative process involving multiple sampling events in order to define the limits of contamination downgradient of a RFI unit; thus, specific numbers of sampling locations will need to be determined on a case-by-case basis. For instance, if results from the first round of sampling indicate that significant contamination is present at the most downstream locations, a second round of sampling will need to be conducted downstream of the original locations. Due to considerations unique to each specific unit, an iterative sampling plan can only be developed as part of the specific unit sampling plan.

8.6.2.4 Determination of Background Area and Sampling Points

A general description for the determination and sampling of background areas is given in Section 8.6.1.3. For establishing background values, three samples shall be collected within the specific habitat, matrix, and/or strata as was collected in the study locations. However, due to temporal variability within surface water systems, these background samples shall be collected concurrently with the unit samples to minimize the potential for variability between locations.

8.6.2.5 Sampling Equipment

Sampling equipment described in Section 8.6.1.4 for Preliminary Sampling will be utilized for Assessment Sampling activities.

8.6.2.6 Sampling Equipment Pre-field Cleaning and In-field Decontamination Procedure

Section 8.6.1.5 outlines the decontamination procedure for surface water and sediment sampling equipment.

8.6.2.7 Sampling Procedures

Procedures for sampling surface waters and sediments are provided in Sections 8.6.1.6 and 8.6.1.7.

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8.6.2.8 Surface Water/Sediment Collection Order

The sample collecting order specified in Section 8.6.1.8 will apply during all Assessment Sampling.

8.6.2.9 Environmental Conditions for Sampling

Section 8.6.2.9 discusses those conditions that may require deviation from the established sampling plan. Refer to this section prior to development of unit-specific sampling plans.

***8.6.2.10 Sample Analysis and Data Reduction/Tabulation/Management/
Evaluation***

All data generated during the course of the unit investigation will be reported in accordance with the Data Management Requirements listed in Chapter 10. Upon completion of Assessment Sampling, the extent of contamination will be determined.

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CHAPTER 9

AMBIENT AIR SAMPLING STRATEGY REQUIREMENTS

9.1 OVERVIEW

The following section has been prepared to provide a uniform approach in performing Preliminary and/or Assessment sampling of the ambient air at RFI units located on the Savannah River Site near Aiken, South Carolina. This section discusses the general techniques and procedures, within existing regulatory guidelines, to be used in the development and implementation of ambient air sampling plans.

The ambient air sampling strategy presumes that a Soils Sampling/ Confirmation Program previously has been conducted. Evaluation of the air medium is only conducted at units where soils contamination has been confirmed, or the RFI unit is deemed to be a source of release potentially impacting the ambient air. At units where hazardous substance concentrations are at or below background, as determined by Preliminary/Confirmation Sampling of soils, no ambient air investigation shall be required.

Sampling, if required, can be conducted under either one or both of two sampling regimes. The first sampling regime of this RFI Program Plan is defined as "Preliminary Sampling". This sampling regime involves those steps and procedures necessary to determine the possibility of ambient air contamination due to the release of hazardous substances. The second sampling regime is defined as "Assessment Sampling", in which steps and procedures are implemented to determine the extent of contaminant release to the ambient air from the RFI unit.

9.1.1 Flowchart

A flowchart illustrating major steps and decision points that shall be considered during the development of unit-specific sampling plans is presented in Figure 9-1. This flowchart presents the basic approach to ambient air sampling for contaminants, in a step-by-step format, presuming that soils contamination has previously been confirmed. This presumes the unit is deemed to be a source of release of the hazardous substance potentially impacting the ambient air.

9.2 INITIAL APPROACH

The development of sampling plans for a specific unit begins by reviewing all existing data and information available for that unit, as discussed in Chapter 4. The data and information to be analyzed as part of the literature review for the ambient air medium shall include, but not be necessarily limited to, the following:

- Physical and chemical characteristics of the waste(s) (hazardous and nonhazardous) known to be managed on the unit
- The design and operational history of the RFI unit
- The climatology, meteorology, and the environmental setting of the unit
- Existing ambient air sampling data for the unit

Accumulated unit data should have already been entered into the pertinent sections of the Literature Review Checklist in Appendix B. A unit reconnaissance also has been performed for the purpose of assessing actual unit conditions (Section 4.3 and Appendix C).

FIGURE 9-1

SRS RFI PROGRAM PLAN

AMBIENT AIR SAMPLING STRATEGY FLOWCHART

A further ambient air medium evaluation shall be made prior to any field investigations. Each of the four areas listed below shall be considered.

9.2.1 Waste Characteristics

The physical and chemical properties of waste components have a significant impact on the potential for hazardous substance release to the ambient air. Release via the air pathway occurs primarily by one of two mechanisms: vaporization or particulate entrainment. A knowledge of the waste characteristics will help assess the potential for release by those mechanisms. Any additional waste characteristics information not available at the time of the Preliminary Evaluation shall be entered into Section IV.A of the Literature Review Checklist. A literature search to further characterize the physical and chemical properties of the waste managed at the unit shall be conducted at this time, if necessary.

9.2.2 Unit Data and Operational History

The predominant phase of release to the air, (vapor or particulate), is dependent on the type of RFI unit, as indicated in Table 9-1. Certain operational practices can result in the occurrence of a "worst-case" air emissions potential, as listed in Table 9-2. While these procedures are most pertinent to active treatment units, there may be some applicability to units in which operations have long ceased. Any suspected "worst-case" operational practices still occurring shall be listed on the Literature Review Checklist, Section IV.B.2.

9.2.3 Meteorological Factors and Environmental Setting

The climatology and meteorology of the region surrounding an RFI unit can significantly influence the release rate, travel direction, and plume dispersion of a hazardous substance. Existing long-term meteorological data from Savannah River Laboratory WIND System will be assembled to help characterize ambient wind patterns. Meteorological parameters

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TABLE 9-1

**SUMMARY OF SOURCE TYPE, TYPICAL UNITS AND PREDOMINANT TYPE
OF AIR RELEASE**

<u>Source Type</u>	<u>Typical Unit Type</u>	<u>Predominant Phase of Release</u>	
		<u>Vapor</u>	<u>Particulate</u>
Area Source with Liquid Surface	Surface Impoundments	X	
	Open Roof Storage/ Treatment Tanks	X	
Area Source with Solid Surface	Waste Piles	X	
	Landfills	X	X
	Land Treatment	X	X
Point Sources	Vent from Container Handling and Storage Facilities	X	
	Landfill Vents	X	
	Leaking Drums	X	

TABLE 9-2

OPERATIONAL PRACTICES LEADING TO "WORST-CASE" EMISSIONS

Volatile Emissions:

- Open storage or handling of wastes containing highly volatile compounds
- Aeration of open surface impoundments
- Splash loading of surface impoundments, tanks, drums
- Bulk evaporative disposal
- Spray evaporation of liquid wastes
- Surface spreading of wastes or sludges
- Tank filling operations
- Cleaning operations
- Draining into open sumps or drains
- Vapor release control techniques inoperative or not in use

Particulate Emissions:

- Heavy vehicular traffic over the release area
- Operations involving open loading or unloading of waste
- Particulate control techniques inoperative or not in use
- Handling of wastes with little moisture content

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that are available for the SRS facility, or even for particular RFI units, shall be listed in the Literature Review Checklist, Section IV.C.1.

The environmental impact of a hazardous substance release to the ambient air is greatest during "worst-case" meteorological conditions, defined as "conditions under which the highest concentrations of contaminants could be found at some downwind receptor unit". Table 9-3 lists "worst-case" conditions in which vapor phase and particulate release extremes are suspected. An ambient air sampling program shall take into account such conditions by including these time periods in the sample collection and measurement schedule. "Worst-case" conditions "will generally occur between 4:00 p.m. and 7:00 p.m. during the hot, summer months." Using a 5-year meteorological data history from the SRL WIND System, the frequency of "worst-case" meteorological conditions shall be noted in the checklist, Section IV.C.2.

9.2.4 Sampling/Monitoring Data

All sampling or monitoring data for the RFI unit being investigated shall be accumulated and reviewed prior to development of unit-specific ambient air sampling plans.

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TABLE 9-3

**METEOROLOGICAL CONDITIONS FOR "WORST-CASE" EMISSIONS:
VAPOR PHASE AND PARTICULATE RELEASES**

**METEOROLOGICAL CONDITIONS FOR "WORST-CASE" EMISSIONS-VAPOR PHASE
RELEASES FROM AREA SOURCES**

Wind Speed	Steady at 1-3 mph
Stability Class	D (Neutral)
Ambient Temperature	High (e.g., 90-100°F)
Solar Radiation	Moderate to High
Precipitation	None

**METEOROLOGICAL CONDITIONS FOR "WORST-CASE" EMISSIONS-PARTICULATE
RELEASES FROM AREA SOURCES**

Wind Speed	Steady at >5 mph
Stability Class	D (Neutral)
Precipitation	None or little over the previous 7 days

9.3 AMBIENT AIR CONTAMINATION EVALUATION

After consideration of waste characteristics, design, operational history, regional climatology, meteorology, and environmental setting, an ambient air contamination evaluation of each RFI unit shall be made. Each unit shall be classified into one of the three general categories listed below:

1. Ambient air contamination, resulting from the release of a hazardous substance, is absent.
2. Ambient air contamination, resulting from the release of a hazardous substance, is suspected.
3. Ambient air contamination, resulting from the release of a hazardous substance, is known.

For the second category (those units of suspected air contamination), a "Preliminary Sampling" phase (Section 9.4.2) designed to detect the possibility of ambient air contamination from a hazardous substance shall be developed and implemented. Once information has been generated and evaluated under the Preliminary Sampling phase, the unit shall be reevaluated. This reevaluation will result in categorizing the unit under contamination absent (Category 1) or contamination known (Category 3).

For Category 1 (units where ambient air contamination is absent) no further detailed sampling shall be required.

For the last category (those units of known contamination), the sampling program shall proceed directly into an "Assessment Sampling" phase (Section 9.6.3) to determine the magnitude and extent of ambient air contamination. It shall not be necessary to implement a Preliminary Sampling phase, designed to detect the possibility of air contamination.

9.4 DESIGN AND IMPLEMENTATION OF A UNIT SAMPLING PROGRAM

9.4.1 Objectives of the Sampling Program

Ambient air sampling regimes can be developed to either (1) determine the possibility of air contamination (Preliminary Sampling Phase), or (2) determine the extent of air contamination by hazardous substances (Assessment Sampling Phase). Specific ambient air sampling objectives will vary from unit to unit and shall be considered during the development of unit-specific sampling plans. General objectives applicable to all units include:

- Provide data concerning release to and dispersion of waste constituents into the surrounding atmosphere
- Determine the possibility or extent of a contaminant release to the ambient air
- Generate adequate data necessary for the design of corrective measures or remediation procedures if required

9.4.2 Preliminary Sampling Phase: Hazardous Substance Identification, Sampling Locations, and Sampling Methods

The objective of the Preliminary Sampling phase is to determine the possibility of hazardous substance release for units in which ambient air contamination has been suspected.

For the Preliminary Sampling phase, hazardous substances and meteorological parameters to be analyzed, sampling methods and equipment, background and study area locations, sampling point locations, and sample number, type, height, and collection techniques are detailed in this Section. Based on the results of the Preliminary Sampling phase either (1) contamination will be absent and no further sampling action proposed, or (2) contamination will be confirmed and further investigation under an Assessment Sampling phase will be implemented.

9.4.2.1 Hazardous Substances to be Analyzed and Meteorological Parameters to be Determined

In the Preliminary Sampling phase, sampling procedures shall be used which will detect the presence of vapor phase organics and/or particulate releases. At units where volatile emissions are suspected, as indicated in Tables 9-1 and 9-2, sampling for volatile organics shall be conducted. In certain situations, a general indicator parameter such as volatile organic vapor and gas can be measured. In other cases, based on waste constituents present at the unit, sampling for specific organics listed in Appendix P shall be required. All constituents proposed to be analyzed shall be approved by the RFI Program Team prior to field investigations.

At the units where particulate releases are suspected, as indicated from Tables 9-1 and 9-2, sampling for airborne particulate matter will be conducted. The indicator parameter is total suspended particulates, (TSP), as defined in 40 CFR, Part 50. TSP will be measured using a high volume sampler.

In addition to indicator parameters, the following meteorological parameters will be measured:

- Horizontal Wind Speed
- Horizontal Wind Direction
- Ambient Air Temperature
- Barometric Pressure

Portable wind measurement devices will be used to conduct unit monitoring. At least 2 days of wind speed and direction monitoring data will be collected. Ambient temperature shall be monitored during the same period. During the monitoring period, unit-specific meteorological data shall be compared or verified with data from the nearest SRL WIND System instrumentation tower.

9.4.2.2 *Determination of Background Area and Sampling Points*

A unit-specific rather than regional background measurement shall be conducted at all units where ambient air sampling is conducted. The background area is defined as an area in which the ambient air is not impacted by any contaminant release from the RFI unit. This area, from which background readings, measurements, and samples will be taken, shall be located upwind from the RFI unit. The upwind direction can be assessed through unit observations and verified in the Preliminary Sampling phase. The background area shall be located at a sufficient distance upwind from the study area to ensure that air contamination from the RFI unit has not occurred. The background area shall be located in the proximity of the study area, so that wind speed and direction in both areas will be similar.

It is necessary to establish ambient air background values for each indicator parameter or hazardous constituent to be sampled. The background values will be established by collecting one volatile organic sample (and one total suspended particulate sample, if necessary) from the background area. Wind speed and direction, barometric pressure, and ambient air temperature measurements shall be conducted during each sampling event. All sampling shall be done at "breathing height" (5 1/2 feet).

The background and RFI unit sampling points shall be marked by surveyor stakes or by some other easily identifiable means. The sampling locations will also be clearly marked on the RFI unit maps. Background samples shall be collected and measurements made at the same height as study area samples.

9.4.2.3 *Sampling Equipment*

The sampling equipment requirements are dependent on the specific constituents analyzed and the sampling methodology selected. A list of ambient air sampling methodologies for constituents with air release potential appears in Appendix P. A flame ionization detector commonly known as an organic vapor analyzer (OVA), or a photoionization detector, known as a tracer gas analyzer (HNu), may be used at certain RFI units where applicable, with the approval of the RFI Program Team.

A portable, field-compatible anemometer will be used to measure wind conditions. Capability for continuous wind speed and direction and barometric pressure monitoring is preferable, but not essential. Meteorological equipment specifications and requirements are listed in USEPA PSD Monitoring Guidelines (1980). A high-quality, unbreakable, laboratory grade thermometer will be used for temperature measurements. Capability for continuous temperature recording is not necessary during the Preliminary Sampling phase.

Sample collection for TSP during the Preliminary Sampling phase shall be conducted using portable field equipment. A high volume particulate sampler is recommended because particulate release levels are expected to be low for the vast majority of RFI units. Particulate measurement equipment specifications are listed in 40 CFR, Part 50. Unit meteorological parameters (wind speed and direction, temperature, barometric pressure) shall be measured during the TSP sampling period.

9.4.2.4 Equipment Calibration, Preparation, and Chemical Decontamination

General calibration and preparation procedures are listed in the QC Program Requirements, Section 3.4.4.2, for the following sampling equipment and methodologies:

- Flame Ionization and Photoionization Detectors
- High-Volume Particulate Samplers
- Volatile Organics Sampling Pumps
- Field-Operable Gas Chromatographs
- Stain Detector (Colorimetric) Tubes
- Solid Sorbent (Tenax or Charcoal) Tubes
- Polyurethane Foam Cartridges

Meteorological measurement equipment shall be calibrated as specified in the operating manual before being used in the field. Volatile organics sampling equipment shall also be re-calibrated, according to the operating manual, when moved to a different RFI unit.

High-volume particulate samplers must be calibrated when first purchased, after major maintenance on the sampler (e.g., replacement of motor or brushes), any time the flow measuring device (rotameter or recorder) has been replaced or repaired, or any time a one-point calibration check deviates from the calibration curve by more than ± 6 percent (see discussion in Section 3.4.4.2). Leak checks shall be periodically conducted according to the equipment operating manual, to ensure that no leaks are occurring.

Equipment must be chemically decontaminated between sampling locations within the same unit, even if hazardous constituents are not detected at a sampling location. The decontamination procedure for electronic equipment appears in Section 3.4.4.4.

9.4.2.5 Equipment Operating Procedures

Equipment operating procedures for the sampling methodologies listed above appear in QC Section 3.4.4.5. The procedures listed are intentionally general. The operating manual for the equipment being utilized should be consulted for specific instructions.

9.4.2.6 Sample Collection, Handling, and Sampling Order

Proper sample collection and handling procedures shall be followed in order to eliminate contamination or cross-contamination. Collection and handling procedures depend on the particular sampling methodology being utilized. Collection and handling requirements for high-volume particulate filters are listed in the QC Program Requirements, Section 3.4.4.6a.

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The potential for cross-contamination from one ambient air sampling point to another is not as great as during sampling events in other media. Nevertheless, to further minimize the possibility of cross-contamination, the following sampling order shall be followed:

1. Collect background samples or measurements. Decontaminate equipment according to the procedure in Section 3.4.4.4.
2. The collection of RFI unit samples shall proceed systematically, starting with regions of lowest suspected contamination and finishing with regions of highest suspected contamination. Sample collection or measurement points shall be clearly marked in the field using surveyor stakes or other easily-recognizable means.

The QC Sections 3.4.4.2 and 3.3 will be consulted regarding sample container, preservation, packaging, and shipping requirements.

9.4.2.7 Environmental Conditions during Sampling

During the Initial Sampling Phase, the primary objective is to determine whether or not hazardous substance releases to the ambient air are occurring. If possible, ambient air sampling shall take place during "worst-case" meteorological conditions as identified in Table 9-3.

Ideal times for sampling would be between 3:00 to 7:00 p.m. during the following conditions:

- (1) wind speeds are in the 3-5 mph range and steady, (2) ambient air temperature is greater than 90°F (if seasonally possible), and (3) no precipitation has occurred during the past three days. Sampling may be done at other times during the day if wind speeds are near the stated 3-5 mph range. Meteorological conditions during sampling shall be recorded in the field log book.

A number of the RFI units are located in the vicinity of currently-operating units, such as in the reactor areas. Volatile and particulate releases from these operating units could significantly impact air sampling at RFI units, particularly when the unit being investigated is downwind from current operations. Air sampling shall be conducted, if at all possible, when the wind is not blowing from the direction of operating units.

9.4.2.8 *Sample Analysis and Data Reduction/Tabulation/Management/Evaluation*

All ambient air sampling field analyses, measurements, and associated procedures shall be conducted in accordance with applicable USEPA protocols.

All ambient air samples will be analyzed by a South Carolina certified laboratory. Data will be reported in accordance with the Data Management Requirements listed in Chapter 10. Data generated during the Preliminary Sampling Phase will be evaluated in accordance with the ambient air standards. On the basis of the Preliminary Sampling Phase results, a recommendation will be made to the SRS RFI Program Team that one of the following two actions be taken:

1. Hazardous substance concentrations are at or below background: no further ambient air investigation is required.
2. Hazardous substance concentrations are above background: proceed into the Assessment Sampling phase, Section 9.4.3.

9.4.3 *Assessment Sampling Phase: Hazardous Substance Identification, Sampling Locations, and Sampling Methods*

The Assessment Sampling phase is conducted when either (1) ambient air contamination is known according to results of the Preliminary Assessment or, (2) the Preliminary Sampling phase confirms that a hazardous substance release to the ambient air has occurred. In the Assessment Sampling Phase the number of contaminants to be analyzed, the amount of meteorological data generated, and the sample number, frequency, and heights are increased. More sophisticated sampling equipment and procedures will be used where

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needed, as specified in Section 9.4.3.6 and Appendix P. The objective of this sampling phase is to determine the extent and magnitude of ambient air contamination by a specific hazardous substance.

9.4.3.1 Hazardous Substances to be Analyzed and Meteorological Parameters to be Determined

For all units investigated during the Assessment Sampling Phase, some degree of contamination is "known." During this phase, the following parameters will be analyzed:

- Volatile organics vapor (where such potential is indicated by Tables 9-1 and 9-2) including constituent(s) identification
- Total suspended particulates (where such potential is indicated by Tables 9-1 and 9-2)
- Ambient air temperature
- Horizontal wind speed and direction
- Barometric pressure

Specific contaminants known to have been managed at a specific RFI unit will be analyzed for that unit. The table in Appendix P lists constituents which exhibit the potential for release to the ambient air. The recommended sampling methods, where available, are also listed in Appendix P and discussed in Sections 3.4.4. At units where ambient air contamination is known, the following meteorological parameters must be addressed:

- Annual and monthly rainfall averages
- Monthly temperature averages and extremes
- Wind speed and direction

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- Relative humidity/dew point
- Atmospheric pressure
- Evaporation data
- Development of inversions
- Climate extremes that have been known to occur in the vicinity of the facility, including frequency of occurrence

The Savannah River Laboratory (SRL) WIND System, described in Appendix J, has generated a meteorological data base which includes most of the above information. WIND system data should be sufficient for addressing the meteorological conditions at most units. Where data gaps exist, or at remote units in which the meteorology is known to vary significantly from that at the wind monitoring stations, a unit-specific meteorological characterization may be conducted.

Adequate hazardous substance and meteorological data bases must be developed for sites in which an air release is confirmed, in order to describe or predict:

- Horizontal and vertical direction and velocity of contaminant movement
- The rate and amount of release
- The chemical and physical composition of the contaminant(s) released

9.4.3.2 *Determination of Sampling Points*

At units containing known contamination, the boundaries shall be defined using procedures discussed in Section 9.4.2.2. The boundaries may be extended beyond the original unit boundaries to include regions impacted by wind dispersion, surface runoff, and sub-surface migration.

The Assessment Sampling phase will be designed to determine the extent and magnitude of ambient air contamination. A minimum of three (3) organic vapor (and total suspended particulate (TSP), where necessary) measurements shall be made within each waste management area, one from each of three equally-sized sections. This guidance for establishing a minimum number of sampling locations complies with the criteria for land treatment units listed in EPA SW-846. One volatile organic (and total suspended particulate, where necessary) sample shall be taken at the downwind external periphery of each of the three sections as indicated in Figure 9-2, in order to define the lateral extent of contamination. Samples and measurements shall be taken at "breathing height", but not less than one meter above the ground surface. A sampling duration of 24 hours (midnight to midnight) shall be used for all TSP measurements. The specific volatile organic constituents to be analyzed, if any, and number of samples collected will depend on the quantity, age, and characteristics of the waste managed at the unit.

Meteorological monitor siting, if required at the RFI unit, shall be conducted in accordance with meteorological monitor siting requirements appearing in USEPA PSD Guidance (1980).

9.4.3.3 Determination of Background Area and Sampling Points

After determination of the RFI unit limits, a background area shall be selected in accordance with the procedures listed in Section 9.4.2.3. A minimum of one (1) volatile organics sample (and one total suspended particulate sample, if necessary), shall be taken from the background area. Wind speed and direction, ambient air temperature, and barometric pressure shall be measured during each sampling event.

NOTE: ALL SAMPLES SHALL BE
COLLECTED AT BREATHING
HEIGHT (5 1/2 FEET.)

FIGURE 9-2
AIR SAMPLING LOCATIONS
SAVANNAH RIVER SITE
AIKEN, SOUTH CAROLINA

9.4.3.4 Sampling Equipment

During the Assessment Sampling phase, more complex ambient air sampling trains may be required to measure the magnitude of hazardous constituent releases. A listing of ambient air sampling methodologies is contained in Appendix P. The particular methodology chosen is dependent on the hazardous substance being analyzed.

Methodologies which may be utilized include (1) field-operable gas chromatograph, (2) colorimetric stain detection tubes, (3) tenax or (4) charcoal sorbent cartridges, or (5) polyurethane foam (PUF) trapping. The first two methods will provide some form of unit constituent concentration results. The other three methodologies preconcentrate the particular organic species on an adsorbent medium. The organics are then desorbed in the laboratory and subjected to chromatographic analysis followed by flame ionization or mass spectrometric detection.

Extensive unit meteorological monitoring will not be required at all RFI units for which an ambient air release has been confirmed. Data generated through Savannah River Laboratory WIND System is adequate to characterize the meteorology at the majority of units. Only at remote sites in which the meteorology is known to vary significantly from that at the SRL meteorological station will more extensive unit-specific data collection be considered.

For units at which additional meteorological data bases are desired, a portable field meteorological monitoring system must be utilized. This system shall be equipped with an electronic sensor, signal conditioning module, and continuous data acquisition and recording device for the measurement of wind speed and direction, relative humidity/dew point, barometric pressure, precipitation, solar radiation, and temperature. The data recording components should be equipped to record parameters either continuously or at least hourly. The field monitoring system should also be equipped with appropriate mounting hardware and supporting and stabilizing guy wires, with a 33-foot crank up tower, to allow for monitoring at the standard 10 meter height. Monitoring procedures shall follow the operating guidelines for the specific equipment chosen.

The wind measurement devices, temperature probe, and dew cell shall be mounted on the support devices and raised to a height of 10 meters above the ground surface. The solar radiometer, barometer, and rain gauge shall be attached to free-standing support masts at ground level. All equipment shall be located in an area of level open terrain. "Open terrain" is defined as an area where the distance between the anemometer and any obstruction to the wind flow (trees, buildings, steep slopes, ridges, cliffs, or hollows) is at least five times the height of the obstruction (USEPA, 1980, pages 39-40). At units where the specified instrument placement criteria cannot be followed, explicit notation shall be made in the field log book. The exact location of the anemometer shall be marked on unit maps and in the field once the analytical period has been completed. At least three (3) days of continuous monitoring is recommended at each unit where contaminant release is confined.

9.4.3.5 Sampling Equipment Calibration, Preparation, and Decontamination

General calibration and preparation procedures are listed in the QC Program Requirements, Section 3.4.4.2, for the following sampling equipment and methodologies:

- Flame Ionization and Photoionization Detectors
- High-Volume Particulate Samplers
- Volatile Organics Sampling Pumps
- Field-Operable Gas Chromatographs
- Stain Detector (Colorimetric) Tubes
- Solid Sorbent (Tenax or Charcoal) Tubes
- Polyurethane Foam Cartridges

Meteorological measurement equipment shall be calibrated as specified in the operating manual before being used in the field. Organic vapor measurement equipment shall also be re-calibrated according to the operating manual when moved to a different RFI unit.

Sampling equipment must be chemically decontaminated between sampling locations within the same unit and between different sites. Decontamination procedures for electronic equipment and whole air collection syringes appear in Section 3.4.4.4.

9.4.3.6 Equipment Operating Procedures

During the Assessment Sampling phase, specific hazardous substances being released to the ambient air shall be identified and quantified. It is anticipated that any releases from RFI units at the SRS facility, would probably be vaporous rather than particulate. For many of the specific hazardous substances which exhibit potential for release to the ambient air (Appendix P), no reliable sampling and analysis protocols have been developed. Those contaminants for which reliable sampling methodologies do exist, along with the recommended sampling protocols, are listed in Appendix P. Several of these vapor phase sampling procedures are described in QC Section 3.4.4.5.

The discussion includes two procedures in which analysis can be directly performed in the field (field-operated gas chromatograph and colorimetric stain detection tube). Two protocols in which volatile organics are adsorbed in the field on a collection media and then desorbed and analyzed in the laboratory (Tenax/charcoal and polyurethane foam sorbent cartridges) are also described.

9.4.3.7 Sample Collection, Handling, and Sampling Order

Proper sampling and handling procedures are necessary for minimizing the possibility of cross-contamination among sampling points. During the Assessment Sampling phase,

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samples will be collected and handled as specified in QC Program Requirements, Section 3.4.4.6, for the sampling methodologies listed below:

- High Volume Particulate Filters
- Whole Air Samples Using a Gas-Tight Syringe
- Solid Sorbent (Tenax/Charcoal) Tubes
- Polyurethane Foam Cartridges

Samples shall be collected in the order specified in Section 9.4.2.7. The QC Sections 3.4.4.2 and 4.3 shall be consulted regarding sample container, preservation, packaging, and shipping requirements.

9.4.3.8 *Environmental Conditions for Sampling*

During the Assessment Sampling phase, the primary objective is to determine the extent and magnitude of hazardous substance releases to the ambient air. Therefore, sampling events do not necessarily have to be conducted during "worst case" meteorological conditions. "Average" environmental conditions (wind speeds less than 5 miles per hour) are appropriate for sampling. Wind speed and direction, barometric pressure, and ambient air temperature shall be measured during all sampling events. Ambient air sampling shall not be conducted if measurable precipitation has fallen in the past 3 days or if the ground surface is still wet or damp.

Ambient air sampling shall be conducted at times when the wind is not blowing from the direction of SRS production facilities to avoid contamination from external sources.

9.4.3.9 Sample Analysis and Data Reduction/Tabulation/Management/Evaluation

Data will be reported in accordance with the Data Management Requirements listed in Chapter 10. Once the Assessment Sampling phase is completed, the extent and magnitude of ambient air contamination will have been determined.

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CHAPTER 10

DATA MANAGEMENT REQUIREMENTS

10.1 INTRODUCTION

Data management requirements are essential as part of the development and completion of the RFI Program. The data management requirements as listed herein provide procedures necessary to properly document, track and manage all field data and laboratory data generated during the course of each unit-specific investigation. The purpose of the RFI Program Data Management Plan is to:

- Identify SRS and Contractor personnel data management responsibilities
- Identify all field, laboratory and development data to be recorded and maintained
- Identify data coding requirements
- Identify data to be included on progress and unit investigation reports to SRS

10.2 CONTRACTOR AND SRS PERSONNEL DATA MANAGEMENT RESPONSIBILITIES

This Data Management Plan shall provide format requirements for presenting raw data, tabulated data and summary data of the field investigations and laboratory analyses. Deviations of data formats and required information will not be permitted unless written approval for such is obtained from the RFI Program Team. Where applicable, all data management activities shall conform to the requirements specified in the SRS DPSOP-254 manual (duPont, 1987).

10.2.1 Data Management Responsibilities of the Contractor RFI Project Manager

The Contractor RFI Project Manager shall be responsible for ensuring that all field and laboratory information managed by the contractor or submitted to SRS is recorded accurately and completely.

10.2.2 Data Management Responsibilities of the Contractor Field Manager

The Contractor Field Manager shall be responsible for maintaining and recording all information and data required in the field log book discussed in Chapter 3.

10.2.3 Data Management Responsibilities of the Contractor Health and Safety Officer

The Contractor Health and Safety Officer shall be responsible for maintaining and recording all information and data required by Chapter 2 (SHERP).

10.2.4 Data Management Responsibilities of the Contractor Laboratory Project Manager

The Contractor Laboratory Project Manager shall be responsible for ensuring that all laboratory data to be submitted to SRS is recorded in the proper format.

10.2.5 Data Management Responsibilities of the SRS RFI Program Team and RFI Unit Custodian

The SRS RFI Program Team and RFI Unit Custodian shall perform similar roles during the course of the unit investigations. The RFI Program Team shall be responsible for approving any changes or deviations to the reporting of data as required under this Data Management Plan. The RFI Program Team shall, should a change occur, promptly notify the RFI Unit Custodian of the change.

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Jointly the RFI Program Team and the RFI Unit Custodian shall be responsible for ensuring that data received by SRS meet the requirements of this plan. Furthermore, the RFI Program Team and Unit Custodian shall be responsible for performing inspections related to the generation, collection and storage of data under the scope of work required of the contractor and in accordance with SRS QA Manual procedure QAP 18-1.

10.2.6 Data Management Responsibilities of the SRL Technical Liaison

The SRL Technical Liaison shall be responsible for receiving and answering questions concerning data management from the Contractor Laboratory Project Manager. The SRL Technical Liaison shall be responsible, along with the SRS RFI Program Team and RFI Unit Custodian, for ensuring that all laboratory data received by SRS meets the requirements of this plan.

10.3 RECORDING OF FIELD DATA

The Contractor shall be responsible for recording all data from the start of a unit investigation, including the information and data required in Chapter 5 (Unit Screening Requirements), to the finish of the investigation.

All data, checklists, photographs, calibration logs, etc., generated during the course of the investigation shall be included as part of the RFI Project File and/or Log books. After completion of the investigation; information, data and reports shall be maintained by the Contractor in accordance with Section 3.7.

In all cases the field log book, calibration logs, and all laboratory log books shall always be maintained by the Contractor until the completion of the investigation. The Contractor shall label each of the log books on the front cover with the information presented in Section 3.3.6.

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It shall be the responsibility of the responsibility of the Contractor to ensure that all data recorded in the field log book is printed in a legible manner using water proof ink. All log book entries shall contain accurate and inclusive documentation of project activities, specifically daily activities. Because the information contained in these log books forms a basis for the later written reports, such information and data must contain only facts and observations. Language shall be objective, factual, and free of personal feelings or any other terminology that may prove to be inappropriate or irrelevant. The field log book shall denote that information, at a minimum, specified in Chapter 3 (RFI QA/QC Program Requirements), specifically Section 3.3.6. The field log book shall be maintained at the RFI unit during all times that the Contractor is present.

All field calibration forms specified in Appendix Q shall be completed as necessary and stored in the project files.

10.3.1 Additional Field Data

During the course of the RFI, additional field data will be generated which may not be directly entered into the field log book but shall eventually become an integral part of the project files. The additional information and data will include, (but is not limited to), the following:

- Monitoring Well Specifications Form DPSOP-254-V-1
- Monitoring Well Installation Form DPSOP-254-V-2
- Monitoring Well Construction Details Form DPSOP-254-V-3
- Well Development Form DPSOP-254-V-6

These data shall be entered or included as part of the project files for each particular unit. This information shall be maintained by the Contractor as specified in Chapter 3.

10.3.2 Photographs

Photographs may be requested by the Contractor as a means of providing visual evidence of unusual items and anomalies discovered during the course of the RFI. Such photographs will only be taken by SRS approved personnel. The Contractor will be responsible for references to these photographs as part of the field log book. Photographs shall be taken in accordance with the requirements specified in Chapter 3.

10.3.3 Other Field Data Not Part of the Field Log Book

Most hydrogeological data, etc. shall be managed and transferred between parties in accordance with DPSOP 254, Chapter XVI. A field data record in the format specified in form DPSOP 254-XVI-3 shall be maintained by the Contractor after completion of the RFI.

Figure 10-1 presents a copy of the field data collection form developed by SRS for soil cores, which shall be completed to facilitate entrance into computer files. Directions for completing this form are included as part of Figure 10-1 and also appear in Appendix R. The data record shall be completed and submitted to SRS.

Figure 10-2 presents a copy of the field data collection form developed by SRS as related to ground water sampling, which shall be completed to facilitate entrance into computer files.

Directions for completing this form appear in DPSOP-254-XVI and Appendix R. The data record shall be completed and submitted to SRS.

Copies of these forms will be sent with the chain-of-custody forms and respective samples when the samples are sent to the laboratory for analysis.

10.4 RECORDING OF LABORATORY DATA

This Data Management Plan does not require recording of particular procedures related to the management of data delivered to the laboratory from the Contractor (excluding the use of the required sample labeling, chain-of-custody forms, and analysis request forms).

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SAMPLE DESCRIPTION CODING FORM FOR SOIL CORES

<u>No.</u>	<u>Cols.</u>	<u>Description</u>	<u>Type & Format</u>
1	1-10	Sample identifier	
	1-5	Facility	5 Alpha-numeric starting with a letter
	6-7	Number of core	2 Integer ¹
	8-9	Number of sample	2 Integer ¹
	10	Other	1 Alpha-numeric
2	11-16	Date sample collected	6 Integer ¹ in MM/DD/YY form
3	17-20	Time sample coordinate	4 Integer ¹ in form of 24 hr military time
4	21-26	SRP North coordinate	6 Integer, in feet
5	27-32	SRP East coordinate	6 Integer in feet
6	33-39	Depth to top of sample	7 Real numeric, in decimal feet
7	40-48	Depth to bottom of sample	7 Real numeric, in decimal feet
8	47-48	Reason for sampling	2 Alpha-numeric
9	49-51	Logbook	3 Integer
10	52-54	Page in Logbook	3 Integer
11	55-56	Type of medium	2 Alpha-numeric

¹All columns in the field must be filled in. For integer fields, use leading zeros.

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Coding Instruction

Four kinds of fields are specified: alpha, alpha-numeric, integer, and real numeric. The general instructions for these field types are as follows.

Alpha - Fields are left justified and may contain only capital letters and blanks. Left justified means that the first letter is placed in the left-most column of the field and if the entry is shorter than the field, blank spaces remain on the right side of the field.

Alpha-numeric- Fields are left justified and may contain capital letters, the numbers from 0 to 9, and blanks.

Integer- Fields are right justified and may contain blanks and the numbers from 0 to 9. All blanks must precede the number.

Real numeric - Fields are right justified and may contain blanks must precede the numbers and the decimal point. The decimal point.

Some fields will have coded entries. All codes will be assigned by Du Pont unless otherwise noted.

Facility - Is an alpha-numeric field that uses a code to describe the study area. This field must start with a letter. Du Pont will assign the codes for this field for each study.

Number of core - Is an integer field that may not have blank columns. This field represents the number of the sampling. Site within the study. The field sampling team will assign this number. If there are more than 99 sites within a study, a second facility identifier for that study will be assigned.

Number of sample - Is an integer field that may not have blank columns. This field represents the sequential number of the sample collected from the core. Special samples such as rinse water from the coring equipment will also be assigned a number.

Other - Is an alpha-numeric field to further identify samples. This field will normally be blank.

Date sample collected - Is an integer field in the MM/DD/YY format. For January 9, 1988, the entry is 010988.

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Time sample collected - Is an integer field reported as military time. For example, 2:15 p.m. is reported as 1415, and 8:30 a.m. is reported as 0830.

SRP North coordinate and SRP East coordinate - Are integer fields reported in whole feet. Algorithms are available for conversion of SRP coordinates to latitude and longitude (Looney et al., 1987).

Depth to top of sample and depth to bottom of sample - are real numeric fields recorded in decimal feet. A decimal point should be included in one column unless the depth is in whole feet. All depths should be recorded from the ground surface.

Reason for sampling - Is an alpha-numeric code that will be assigned by the Du Pont coordinator. SC=Screening. BG=Background, CA=Characterization/Assessment.

Logbook - Is an integer field referring to the numbered logbook containing the field information collected about the sample. Each project should have its own numbered logbooks.

Page in logbook - Is an integer field referring to the number of the first page of the logbook that contains field information about the sample.

Type of medium - Is an alpha-numeric field for type of material sampled. Du Pont will assign the codes.

References

Looney, B. B., J. T. Marsh, Jr., and D. W. Hayes, 1987. Development of Accurate Standardized Algorithms for Conversion Between SRP Grid Coordinates and Latitude/Longitude, DPST-87-724, Savannah River Laboratory, E. E. Du Pont de Nemours and Company, Aiken, SC.

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FIGURE 10-2
FIELD DATA COLLECTION FORM
GROUNDWATER SAMPLING

[illegible]

READ AND UNDERSTOOD BY:

PAGE

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These forms shall not be included as part of the field log book but shall be part of the data received from the laboratory by the Contractor to be maintained as part of the project files. The Contractor shall be responsible for storing all information and data received from the laboratory and related to the RFI unit investigation as specified in the contract with SRS. This information and data includes, but is not limited to:

- Chain-of-Custody Forms
- Analysis Request Forms
- Laboratory Notes
- Internal Laboratory performance audits
- Chromatograms
- Raw Data Printouts
- Tabulated Data Printouts
- Laboratory QA/QC Data

This data shall be maintained in a manner that provides the above information concerning each unit investigation. It shall be available within 48 hours, upon request by SRS.

This data and information shall be stored in an environmentally sound manner that would protect the integrity of the data until relief from these requirements is provided by SRS. All reports and data as requested by SRS shall be stored in accordance with SRS QA Manual procedure QAP 17-1.

Appendix S presents those forms required for use, completion, and storage as part of the laboratory data to be generated.

10.4.1 Field Laboratory Data Requirements

A field laboratory log book shall be utilized by the analysts who conduct mobile or field analyses. This log book shall include information documenting the analyses performed. It shall also document the dates and results of any calibration of any mobile laboratory equipment. It shall be a record of any incidents that occur during the survey, such as

power outage, tampering of equipment, etc. Appropriate notations of visitors to the mobile laboratory, (such as facility personnel), shall be entered into the log book.

10.4.2 Off-Site Laboratory Data Requirements

An off-site laboratory log book shall be utilized by the analysts who conduct analyses on all media samples received from the Contractor. This log book shall not only include information documenting the analyses performed but shall also document the dates and results of equipment calibrations, incidents that occur during analyses and visitors to the laboratory. Laboratory performance audits shall be recorded in this log book as well as other requirements set forth under the work contract. Sample "Chain of Custody" shall be maintained throughout the process.

The Contractor shall be responsible for ensuring the proper recording of laboratory data generated for the analyses of media samples. Forms developed by SRS for this purpose, such as "Chemical Analysis Results Coding Forms and Descriptions" for ground water (See Appendix T) shall be used as appropriate. The directions for use of this form are included in Appendix T. Upon development and implementation by SRS, the "Chemical Analysis Results Coding Forms and Descriptions" and directions for other media, shall be added to Appendix T for reference. Tables 1, 2 and 3 along with the supplemental code list presented in Appendix U are to be used in completing the form currently developed by SRS for groundwater. This information as presented in Appendix U may be used upon final development and implementation of the media forms.

The Contractor shall ensure that these forms are accurately completed and transferred to SRS. The contractor shall be responsible for maintaining and storing the diskettes in an acceptable, environmentally controlled manner to prevent any degradation thereof.

10.5 RECORDING OF DEVELOPMENT DATA

Development Data is identified as that information or data, (such as isopleths, geological cross sections, potentiometric diagrams, well logs, etc.), developed as a result of data and information gathered from field or laboratory based activities. The Contractor shall be

responsible for generating development data as necessary. These data shall be included in progress reports and in the final report. These data shall be prepared in a clear, concise manner using graphical displays and standard symbols or, where necessary, those symbols approved by SRS. It shall be the responsibility of the Contractor to store and maintain these data in an environmentally sound manner to prevent any degradation thereof.

10.6 RECORDING OF SHERP DATA

SHERP data is identified as that information or data (such as training records, medical surveillance files, safety and emergency procedures, etc.), required by Chapter 2 (Safety, Health and Emergency Response Plan) of this RFI PROGRAM PLAN. The Contractor shall be responsible for generating these data as necessary. These data shall be prepared in a clear concise manner. It shall be the responsibility of the Contractor Health and Safety Officer to store and maintain these data in an environmentally sound manner and prevent any degradation thereof. All or any part of these data records shall be produced within 48 hours if so requested by the SRS RFI Program Team.

10.7 RFI DATA REPORTING REQUIREMENTS

10.7.1 Progress Reports

The Contractor will be responsible for developing progress reports after each of the major activities identified in the Unit Specific Management Plan Flowchart (Figure 1-3). Specifically, reports will be presented to the RFI Program Team after completion of the following activities:

- Preliminary Unit Evaluation
- Unit Screening
- Soil Assessment
- Ground Water, Surface Water, Ambient Air Assessments

The Contractor shall use professional judgement in determining the degree of information to be included in progress reports. Sufficient information shall be provided to enable the

RFI Program Team to understand the progression of activities and the investigation results. An outline of any subsequent investigation activities shall also be provided. For those RFI units which require no further investigation after the preliminary unit evaluation or unit screening, the Contractor shall prepare an abbreviated final report.

10.7.2 RFI Final Report Requirements

The Contractor shall be responsible for preparing a final report upon completion of the Unit-specific RFI. This report shall be submitted to SRS, specifically to the RFI Program Team for appropriate distribution and review.

This final report shall detail all RFI activities completed. The final report shall include a discussion about key decision points encountered and resolved during the course of the investigation. This report shall contain all data necessary to understand the project in its entirety including all investigative methods and procedures.

At a minimum the following information shall be included in this report:

- Conclusions related to the RFI unit preliminary evaluation
- Data and results generated from the preliminary unit screening
- Analytical data generated from the soils sampling
- Analytical data generated from the ground water sampling
- Analytical data generated from the surface water sediment sampling
- Analytical data generated from the ambient air sampling
- Factors considered as part of the receptor analysis and a receptor analysis
- Topographic map of unit denoting all sample locations

In addition to this data and information it will be necessary to discuss any upset conditions that occurred during any sampling events or laboratory analyses that may influence the results. It will also be necessary to enter into the text of the final report "development data," (i.e., well drilling logs, stratigraphic cross-sections, etc.), that provide additional support to the data and interpretations discussed. It may be necessary to introduce key

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elements of the development data into the text of the final report using graphical displays (isopleths, potentiometric, ecological, cross-sections, etc.).

The object of the final report is to describe the whole unit investigation and present the basic results. The final report shall not detail any further recommendations for additional unit work or remediation efforts.

10.7.3 Quality of Reports

All reports shall be prepared on classic crest grade paper or better. Only black ink will be used in conjunction with standard type at 1' spacing. The front and back of each page shall be used unless otherwise specified by SRS. All reports shall be securely bound and clearly identified for each specific unit. It will be the responsibility of the contractor to supply the required number of copies of all reports prepared in accordance with instructions from the SRS RFI Program Team. All reports shall be presented to the SRS RFI Program Team upon completion.

10.8 DIRECTIVES

At anytime during the RFI, the Contractor shall be prepared to submit unsorted raw data, chain-of-custody forms, chromatograms, etc., as requested by SRS. This type of information shall not be included as part of the final report unless requested.

Contractors/Consultants shall have no contact with any regulators (EPA, SCDHEC, etc.) about this RFI Program (or any element thereof), without express written permission of the SRS. The written permission will be authorized by the RFI Program Team and signed by a designated RFI Program Team member.

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CHAPTER 11

RECEPTOR ANALYSIS REQUIREMENTS

11.1 INTRODUCTION

A Receptor Analysis shall be performed for each RFI unit, unless the Preliminary Unit Evaluation (Chapter 4) or unit screening (Chapter 6) has determined that no further investigation will be required at a unit. The overall objective of the Receptor Analysis is to provide the information necessary to identify potential receptor populations that may be exposed to a release of a hazardous waste from the RFI units located at SRS.

The special conditions present at SRS (limited access and institutional custodianship) will be best focused upon by this approach. By following the outlined procedures, the information provided in the Receptor Analysis may be easily expanded into a risk assessment if this becomes necessary during later stages of the RFI process.

11.2 SOURCES OF DATA

The identification of potential receptors for a specific site begins with a thorough review of the data and information available for that site. The Receptor Analysis process is based primarily on existing data.

An extensive body of information already exists for the RFI units located at SRS. Major sources of information are the Savannah River Laboratory Environmental Information Documents and Technical Data Summaries, as well as U.S. Department of Energy, Savannah River Operations Office environmental reports and various unit assessments, field investigation reports, and closure plans done for SRS by outside engineering consultants. The Literature Review conducted as part of the Preliminary Evaluation required for each RFI unit (Section 4.2) and the completed RFI Unit Literature Review Checklist shall also be used as part of the background data review for the Receptor Identification.

11.3 POTENTIAL CHEMICAL RISK IDENTIFICATION

The first step in the Receptor Analysis procedure shall be to screen the information available on hazardous substances present at the RFI unit and identify chemicals of concern. The objective of this step is to narrow the field of chemicals at the unit to those that pose the greatest potential of release.

Chemicals of concern have been selected for environmental assessment at various waste units at SRS (Looney et al., 1987), as part of the background technical documentation for the Department of Energy's Environmental Impact Statement (EIS) on Waste Management Activities for Ground Water Protection, Savannah River Plant, Aiken, South Carolina, (USDOE, 1988). Chemical constituents that have been disposed of at existing RFI units were identified and their inventories estimated. Available data, including ground water analyses, soil characterization studies, influent records and process chemical use, were analyzed to determine what chemicals might have been released to each waste unit.

The concentration of each chemical was then compared to a selection criterion. The criteria, based on technical and regulatory information about toxicity, are contained in Tables 1 and 2 in Looney et al. (1987). If the ground water or soil concentration for that chemical exceeded its selection criterion, the chemical was selected as a part of the transport modeling and risk calculation studies. In addition, if large amounts of specific chemicals were believed to have been released to the unit, they were included for assessment, even if the soil or ground water characterization data did not indicate their presence.

For RFI units not included in Looney et al (1987), the Contractor shall select indicator chemicals by a similar methodology.

11.4 POTENTIAL RECEPTORS

The second step in the Receptor Analysis procedure is the identification of potential receptors. The objectives of this step are to identify actual or potential points of exposure

and to characterize the human populations and environmental systems that may potentially be exposed to a release of chemicals from an RFI unit.

11.4.1 Ground Water

One of the potential transport media for off-site migration of hazardous constituents released from an RFI unit is ground water. Current local uses of ground water and planned future uses shall be identified, including the following:

- Type of use, (i.e., drinking water (residential or municipal), agricultural, non-potable domestic, and industrial)
- Location of ground water users, including discharge as well as withdrawal wells, within one mile of any plume of chemicals originating from the RFI unit

The aquifer or hydrogeologic unit used and/or impacted shall be identified for each user.

Considerable information is available on the ground water resources of SRS and its surroundings. Information on ground water usage is contained in the Department of Energy's EIS on Waste Management Activities for Ground Water Protection at SRP (USDOE, 1988).

The aquifers used for water supply in the SRS area are, beginning with the deepest, the Middendorf/Black Creek, Congaree, McBean and Barnwell Formations. The Middendorf/Black Creek aquifers form the base for most municipal and industrial water supplies in Aiken County. In Allendale County, the shallower Congaree and McBean Formations supply some municipal, industrial and agricultural users.

11.4.2 Surface Water

Surface water is another potential transport medium for chemicals released at an RFI unit. Current local uses and planned future uses of surface water systems directly impacted by the release of chemicals shall be identified. The following uses shall be included:

- Domestic and municipal (i.e., potable and lawn/garden watering)
- Recreational (i.e., swimming, fishing)
- Agricultural
- Industrial
- Environmental (i.e., fish and wildlife propagation)

The previously mentioned EIS (USDOE, 1988) summarizes available information on the use of surface water systems within SRS and nearby sections of the Savannah River. Surface water at SRS consists of the Savannah River, several surface streams that transect the plant and drain to the Savannah River, and two cooling lakes, Par Pond and L-Lake. A swamp borders the river along most of the southwestern plant boundary.

11.4.3 Human Access

Human use of or access to the RFI units and adjacent lands shall be identified. All of the RFI units are located well within the SRS boundaries. Therefore, human access will need to be identified only for the RFI units themselves, (and adjacent lands within the SRS facility).

The special conditions present at SRS (i.e., institutional custodianship and limited access) restrict human access to the SWMUs. DOE is committed to a minimum of a 100-year institutional control period for SRS. This commitment is detailed in DOE/EIS-0120 "Waste

Management Activities for Groundwater Protection Savannah River Plant-Aiken, SC". The commitment is a public record by virtue of being published in the Federal Register on 3/9/88 (page 7557). As stated in the EIS, the 100 year commitment begins when the active use of SRS ceases and dedication beyond 100 years, if necessary, is provided for. The commitment extends only to the boundaries of waste units and/or contaminant plumes. Access to SRS is controlled at primary roads by manned barricades. Other roads entering the site are closed. The only through-road open to the general public is SC Route 125. Use of this highway is strictly monitored, with checkpoints at both ends. The SRS facility, except along the Savannah River, is fenced. Operating areas are separately fenced and continuously patrolled.

Hazardous substances released to the air may be transported off-site by air movement. Human use of and access to potentially affected areas, therefore, shall also include an identification of populated areas located downwind.

11.4.4 General Area Ecology

A general description of the aquatic and terrestrial floral and faunal populations within and adjacent to the RFI units shall be provided. This shall include the biota in any surface water systems impacted by the release of hazardous constituents from the RFI unit.

SRS is a designated National Environmental Research Park and its environment has been extensively studied. Basic information on the terrestrial and aquatic ecology of SRS can be found in the EIS (USDOE, 1988). Other more in-depth sources of biological information are referenced, therein.

11.4.5 Demographics

A demographic profile of the people who will potentially be exposed to a release of hazardous substances shall be prepared for each RFI unit requiring a Receptor Analysis. It shall include the identification of those groups (i.e., infants, elderly, women of

child-bearing age) within the potentially exposed population which may be more sensitive to a given exposure level.

A general demographic profile of the potentially exposed human population is presented in the SRP EIS (USDOE, 1988). Additional data are available in the Socioeconomic Data Base Report for Savannah River Plant (USDOE, 1984).

11.4.6 Endangered Species

Any endangered or threatened plant or animal species known to occur in the vicinity of the RFI unit shall be identified. The EIDs prepared for the RFI units contain information on threatened and endangered species. Four species of fauna listed as endangered by the US Fish and Wildlife Service have been identified at SRS. They are the American alligator, the bald eagle, the wood stork, and the red-cockaded woodpecker. One plant species, smooth coneflower (Echinacea laevigata), found at SRS is currently under status review by the U.S. Fish and Wildlife Service.

11.5 RECEPTOR ANALYSIS REPORT

The Receptor Analysis Report shall be contained in the RFI final report for each unit. Information on the potentially exposed populations shall be identified on the Receptor Analysis Checklist (Appendix V). This section presents and discusses the content and format of the Receptor Analysis Report. Use of a standardized format will ensure that all major issues are adequately addressed and documented and that comparable documents are produced for different RFI units.

The written documentation of the Receptor Analysis findings is meant to be a summary and, therefore, should be brief. Existing documents shall be referenced wherever appropriate. The outline presented in Table 11-1 shall be followed for each Receptor Analysis Report.

TABLE 11-1

OUTLINE OF A RECEPTOR ANALYSIS REPORT

- 1.0 Introduction
 - 1.1 Unit description and history
 - 1.2 Chemicals found at unit
- 2.0 Potential Receptors
 - 2.1 Routes of exposure
 - 2.2 Access to site
 - 2.3 Population exposed
- 3.0 Conclusions
- 4.0 References

The following is a description of each of the major components of the Receptor Analysis Report.

11.5.1 Introduction

11.5.1.1 Unit Description and History

This subsection shall summarize the background information on the characteristics and history of the RFI unit. It should include geographic location, topography, unit use and management practices, a brief description of any facilities and containment systems and an identification of the substances brought onto the unit. A map of the unit, showing site features and boundaries, shall be included.

11.5.1.2 Chemicals Found at the Unit

This subsection shall identify, and to the extent possible from existing data, quantify the chemicals present at the unit and in the environmental media.

11.5.2 Potential Receptors

11.5.2.1 Exposure Routes and Points

This subsection shall identify potential routes of exposure and exposure points. It must consider the unique situation at SRS (size and access).

11.5.2.2 Access to Unit

The level and nature of human use of the unit shall be described. The relationship between populated areas and prevailing wind direction must be identified.

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11.5.2.3 Populations Exposed

This subsection shall identify and characterize the potentially exposed human and environmental populations.

11.5.3 Conclusions

This section shall present the results of the Receptor Analysis process in a very brief statement, including a general description of human and environmental populations that may be exposed.

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 - 12.3.9 D-Area Ash Basin
 - 12.3.10 716-A Motor Shop Seepage Basin
 - 12.3.11 Road A Chemical Basin
 - 12.3.12 Gunsite 720 Rubble Pit
 - 12.3.13 SRL Oil Test Site
 - 12.3.14 Rubble Pits/Piles
 - 12.3.15 D-Area Oil Seepage Basin
 - 12.3.16 Radioactive Waste Burial Grounds
 - 12.3.17 Miscellaneous Chemical Basin/Metals Burning Pit
 - 12.3.18 Old F-Area Seepage Basin
 - 12.3.19 SRL Seepage Basins
 - 12.3.20 Acid/Caustic Basins
 - 12.3.21 New TNX Seepage Basin
 - 12.3.22 Ford Building Seepage Basin
 - 12.3.23 Tank 16
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 - 12.4.3 M-Area West
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 - 12.4.7 Central Shops Sludge Lagoon
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 - 12.4.9 G-Area Oil Seepage Basin
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CHAPTER 12

SCHEDULE FOR UNIT-SPECIFIC RFI PLANS

12.1 INTRODUCTION

SCDHEC/USEPA have required that a schedule for the development of unit-specific RFI plans be an integral part of this RFI PROGRAM PLAN. This chapter will present a brief summary description of each unit (or group of units), followed by the schedule (Figure 12-1).

12.2 GROUPINGS

The identified solid waste management units (SWMUs) listed in Part V.A.1 of the SRS (formerly SRP) Hazardous Waste Permit (issued by SCDHEC) have logically been grouped into multiple-unit RFI plans. The criteria for such an approach may be geographics, similarity of wastes received, or other common denominator. Three examples of the groupings are:

- The D-Area Burning/Rubble Pits, (431-D & -1D) are geographically contiguous
- The six Acid/Caustic Basins, while geographically remote from each other, all received deionizer regeneration wastes, both sulfuric acid and sodium hydroxide
- The seven CMP Pits are physically one site

The RFI plan groupings for the original 65 units are listed in Table 12-1.

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TABLE 12-1
RFI PLAN GROUPINGS

<u>RFI PLAN FOR:</u>	<u>CUSTODIAN</u>
7 CMP PITS (080-17G, -17.1G, -18G, -18.1G, -18.2G, -18.3G & -19G)	WMO
2 D-AREA BURN/RUBBLE PITS (431-D, & -1D)	CSWE
3 F-AREA BURN/RUBBLE PITS (231-F, -1F & -2F)	CSWE
3 G-AREA BURN/RUBBLE PITS (631-1G, -3G & -5G)	WMO
8 BURNING/RUBBLE PITS (731-A & -1A, 131-C, -K, -L, -P, -R & -1R)	CSWE
BURNING/RUBBLE PIT (631-6G)	WMO
SILVERTON ROAD WASTE SITE (731-3A)	WMO
SANTTARY LANDFILL (740-G)	WMO
OLD H-AREA SEEPAGE BASIN (904-46G)	WMO
OLD TNX SEEPAGE BASIN (904-76G)	SRL
L-AREA OIL/CHEMICAL BASIN (904-83G)	REACTORS
7 COAL PILE RUNOFF BASINS	POWER
(189-C, -K, -P; 289-F, -H; 489-D & 788-3A)	
D-AREA ASH BASIN (488-D)	POWER
MOTOR SHOP SEEPAGE BASIN (904-101G)	CSWE
ROAD A CHEMICAL BASIN (904-111G)	RMET
GUNSITE 720 RUBBLE PIT (631-16G)	CSWE
SRL OIL TEST SITE (080-16G)	SRL
RUBBLE PIT (131-1L)	CSWE
RUBBLE PIT (131-3L)	WMO
BURMA ROAD RUBBLE PIT (231-4F)	WMO
RUBBLE PILE (731-6A)	CSWE
RUBBLE PIT (731-2A)	CSWE
D-AREA OIL SEEPAGE BASIN (631-G)	CSWE
OLD RW BURIAL GROUND (643-G)	WMO
ACTIVE RW BURIAL GROUND (643-7G)	WMO
MISC. CHEM. BASIN/METALS BURN PIT (731-4A & 5A)	RMET
OLD F-AREA SEEPAGE BASIN (904-49G)	SEPARATIONS
4 SRL SEEPAGE BASINS (904-53G1, -53G2, -54G & 55G)	SRL
6 ACID/CAUSTIC BASINS	POWER
(904-74G, -75G, -80G, -79G, -78G & -77G)	
NEW TNX SEEPAGE BASIN (904-102G)	SRL
FORD BUILDING SEEPAGE BASIN (904-91G)	REACTORS
HIGH LEVEL WASTE TANK 16	WMO

WMO = Waste Management Operations
CSWE = Central Services Works Engineering
SRL = Savannah River Laboratory
RMET = Raw Materials and Engineering Technology

12.3 UNIT SUMMARIES

Summaries for each unit, or grouping of units, follow the sequence listed in the Permit.

12.3.1 CMP Pits

The seven CMP (Chemical, Metals, and Pesticides) Pits are located at one site on the top of a knoll about one mile north of L area. Their assigned numbers are 080-17G, -17.1G, -18G, -18.1G, -18.2G, -18.3G, and -19G. They are accessible from SRS Road C. These pits received wastes such as oil, solvents, heavy metals, and pesticides. The wastes in the pits were excavated and removed to storage in 1984. The pits were backfilled and capped. Detailed information is contained in Environmental Information Document DPST-85-712 and other documents.

12.3.2 Burning/Rubble Pits

There are 15 Burning/Rubble Pits on SRS property. All Burning/ Rubble Pits received wastes that were basically the same in composition. Typically, each pit received burnable wastes such as paper, plastics, wood, rubber, rags, oil, and solvents.

Two of the burning/rubble pits (431-D & -1D) combine into one geographic unit for RFI purposes. Two others (231-F & -1F) logically combine with Rubble Pit 231-2F into a single unit for RFI purposes. Still a third pair (631-1G & -5G) are contiguous with 631-3G, making a third logical geographical grouping.

Eight of the remaining pits received similar wastes and are geographically non-contiguous with any other RFI unit. Because of the similarity in wastes and the singularity in custodianship, they will be covered by a single RFI plan. Those pits are 731-A, 731-1A, 131-C, 131-K, 131-L, 131-P, 131-R, and 131-1R. Burning/Rubble Pit 631-6G stands alone both geographically and in custodianship.

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In summary, 5 RFI plans will cover these 15 B/R Pits and 3 Rubble Pits that are on the SWMU list. EID #DPST-85-690 applies to all Burning/Rubble Pits on SRS. The 2 Rubble Pits mentioned in this subsection are not detailed in any EID.

12.3.3 Silverton Road Waste Site

The Silverton Road Waste Site (731-3A) is located about 2 miles southwest of A/M Area. While there is no detailed inventory of wastes disposed of at this unit, photographic documentation does exist. It indicates wastes such as metal shavings, construction debris, tires, drums, tanks, and other materials were deposited there. The unit was taken out of service in 1974. EID DPST-85-702 is the most pertinent of several documents pertaining to this site.

12.3.4 Sanitary Landfill

The sanitary landfill (740-G) is located about a mile east of B-Area, within the drainage of the lower portions of Upper-Three-Runs Creek. Domestic/office type wastes and other non-hazardous materials are the only wastes disposed of in this RFI unit. It remains an operating unit and is anticipated to be one until the early 1990s.

12.3.5 H-Area Seepage Basin

This unit, (904-46G), is known as H-3 or the "old" H-Area Seepage Basin. It is contiguous with the other, operating, H-Area seepage basins. It is currently planned to close this basin as an integral part of the closure of the other basins. The RFI document for this unit will establish this commitment.

12.3.6 Old TNX Seepage Basin

This Solid Waste Management Unit (904-76G) is located in the TNX-Area of the SRS. During the years of its operation (1958-1980) it received wastewater from the TNX (pilot

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plant) processes. This basin has been backfilled and capped with clay. More detail is available in EID #DPST-85-710.

12.3.7 L-Area Oil/Chemical Basin

This basin (904-83G) is located immediately southeast of L reactor. When in operation (between 1961 and 1979) it received small volumes of radioactive, oil, and chemical wastes. DPST-85-700 (the applicable EID) states that a total volume of approximately 1,250,000 gallons was disposed of into this basin. At this time, it is an open basin with monitoring wells surrounding it.

12.3.8 Coal Pile Runoff Basins

There are seven Coal Pile Runoff Basins (CPRB) at SRS. They were constructed between 1978 and 1981, at the request of SCDHEC. Their purpose is to contain rainfall runoff from coal storage piles. They are located in A(788-3A), C(189-C), D(489-D), F(289-F), H(289-H), K(189-K), and P(189-P) Areas. All of these basins receive/received similar wastes (i.e., rainwater that drains/drained through a coal pile). There is no Environmental Information Document for these units.

12.3.9 D-Area Ash Basin

The 488-D Ash Basin is located immediately southwest of the D-Area powerhouse. This basin has received boiler ash and coal rejects since D-Area started up (circa 1951). Although it no longer receives ash, it is still receiving coal rejects. There is no EID specific to this Ash Basin.

12.3.10 716-A Motor Shop Seepage Basin

This Seepage Basin (904-101G) is just across the railroad tracks and southeast of the Motor Shop (716-A Building). Effluent discharges from the Motor Shop included

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wastewater containing trace amounts of engine oil, grease, kerosene, antifreeze, and soapstocks. It was used from 1977 until 1983. DPST-85-701 is the relevant EID.

12.3.11 Road A Chemical Basin

The Road A Chemical Basin (904-111G) is just off Baxley Road about 1/2 mile southwest of the junction of SRS Roads A and 6. The nature and quantity of wastes disposed of in this basin are unknown. It is believed that this basin received miscellaneous aqueous wastes, perhaps of a chemical and/or radioactive nature. The basin was backfilled in 1973. A ring of monitoring wells was installed and have been sampled since 1984. More detailed information may be found in EID DPST-85-699.

12.3.12 Gunsite 720 Rubble Pit

Although the Permit lists this unit as having no building number, the correct nomenclature is 631-16G. The unit is located about 1/10 mile northwest of SRS Road 2 and 1/4 mile West of SRS Road A. Eight drums of unknown origin exist at this site. They have been placed on a wooden pallet. The pallet and the immediate area have been marked off with yellow chains. There is a lack of information about this former gun-emplacernent and these drums. Most of the information that does exist is contained in DPST-85-713 and DPST-87-667.

12.3.13 SRL Oil Test Site

The Savannah River Laboratory Oil Test Site (080-16G) is located about 1/3 mile south of the Central Shops complex at SRS. Wastes received by this unit were machine cutting oils, hydraulic fluid, and paint thinner. This large open field has also received asphaltic rubble and construction debris. The unit is currently inactive. DPST-85-697 is the EID for this site.

12.3.14 Rubble Pits/Piles

There are five Rubble Pits/Piles, other than those previously mentioned, on the SWMU list (Item V.A.1 of the SRS Hazardous Waste Permit). They are 131-1L, 131-3L, 231-4F, 731-2A, and 731-6A. Characteristics of these sites dictate that each one will have its own unique RFI plan. There are no EIDs for these sites.

Rubble Pit 131-1L is located just north of the L-Area perimeter fence. It is believed that metal, lumber, poles, concrete detritus, and transite were disposed of there.

Rubble Pit 131-3L is located east of the intersection of SRS Road 7-1 and Pen Branch. It is believed that metal, lumber, paper cans, and glass were disposed of here.

The Burma Road Rubble Pit (231-4F) is located at the junction of SRS Road C and the Burma Road. Miscellaneous construction detritus of all types was disposed of here.

Rubble Pit 731-2A is located beneath the active ash pile 788-2A and not contiguous to burning/rubble pits 731-A & 731-1A. It is believed that paper, wooden pallets, cans, and glass were disposed of in this pit.

Rubble Pile 731-6A is located to the southeast of the 716-A Motor Shop Seepage Basin. A wide variety of old debris (perhaps from original SRS construction) is visible.

12.3.15 D-Area Oil Seepage Basin

This basin (631-G) is located between SRS Roads A-4.3 and A-4.4 near D-Area. Between 1952 and 1975 this site received waste oils in unknown quantities. The basin was backfilled in 1975. DPST-85-701 is the EID applicable to this basin.

12.3.16 Radioactive Waste Burial Grounds

The Radioactive Waste (RW) Burial Grounds are waste units used for the disposal of radioactive solid waste at the Savannah River Site (SRS). There are three facilities which constitute the Radioactive Waste Burial Grounds: (1) the "Old" RW Burial Grounds, (2) the "Active" RW Burial Grounds, (3) and the Mixed Waste Management Facility. Waste disposed of at these facilities include contaminated equipment, reactor hardware and resins, spent fuel components, tritiated oil and mercury, incidental laboratory waste, and offsite shipments of U.S. military waste.

The "Old" RW Burial Ground (643-G) was used for the disposal of radioactive solid waste from 1952 to 1972. Included in this area are 22 tanks which store low-level radioactive solvents. These tanks will be decommissioned after isotopic analysis and regulatory approval. This inactive site has been covered with soil.

The "Active" RW Burial Ground (643-7G) is adjacent to and immediately north of the "Old" RW Burial Ground. This area, which began receiving waste in 1969, is currently being used to dispose of radioactive solid waste generated at SRS.

The Mixed Waste Management Facility (643-28G) is an inactive unit within the Active RW Burial Ground which is closed as a RCRA unit. The 643-28G site is not part of this RFI Program.

Additional information on the RW Burial Grounds can be found in the Environmental Information Document DPST-85-694.

12.3.17 Miscellaneous Chemical Basin/Metals Burning Pit

These two units (731-4A and 731-5A) are located on either side of SRS Road C-1, a power line road. They are about 1.5 miles south of M-Area.

12.3.18 Old F-Area Seepage Basin

The Old F-Area Seepage Basin, (904-49G), is located just northwest of the F-Area perimeter fence. It is estimated that this basin has received about 10,000,000 gallons of miscellaneous/mixed Separations Area wastes. The basin is presently inactive. It has never been backfilled. Environmental Information Document DPST-85-692 provides details about this basin.

12.3.19 SRL Seepage Basins

These four basins, numbered 904-53G1, -53G2, -54G, and -55G, are located immediately northeast of A-Area between SRS Roads A-1 and D-1. During the years of their operation (1954-1982), these basins received an estimated 34,000,000 gallons of irradiated wastewater. Usage of the basins stopped in the fall of 1982. These basins are being closed like a RCRA unit. It is anticipated that an RFI "document", identifying "RCRA-like" closure, (rather than an RFI plan), will be submitted for these. DPST-85-688 is the EID pertaining to these four basins.

12.3.20 Acid/Caustic Basins

There are a total of six Acid/Caustic Basins on the SRS. They are located in F-Area, 904-74G; H-Area, 904-75G; K-Area, 904-80G; L-Area, 904-79G; P-Area, 904-78G, and R-Area, 904-77G. These RFI units received diluted sulfuric acid and sodium hydroxide solutions from water treatment deionizers. They were in use from SRS start-up until either the operating area they served was shut down, or they were replaced by neutralization facilities.

All of these basins have been inactive since 1982 and remain open. Information about these basins is contained in DPST-85-705. It was anticipated, because of the similarity of usage, that one RFI plan will suffice for all six basins. Four of these basins will be closed under "RCRA-like" requirements as a result of a court order. The other 2 basins will be treated as RFI SWMU's.

12.3.21 New TNX Seepage Basin

This site, 904-102G, is located across SRS's River Road from the TNX Area. It was built in 1980 to replace the Old TNX Seepage Basin. The Basin receives process wastewater from the TNX (pilot plant) facility. The basin will be shut down as soon as the TNX Effluent Treatment Plant is satisfactorily in operation. More detail is available in EID #DPST-85-698.

12.3.22 Ford Building Seepage Basin

The Ford Building Seepage Basin is identified as building number 904-91-G. It is located about 100 feet from the "Ford" building and is due east of the Central Shops area, across SRS Road 3. This basin has received approximately 400,000 gallons of slightly irradiated wastewater. It is suspected that the wastes may have also contained traces of surfactants, oils, grease, and other chemicals. The unit was retired from service in 1984 and is presently dry, except for occasional rainwater. The EID pertaining to this site is DPST-85-709.

12.3.23 Tank 16

Tank 16 is located inside the H-Area Waste Tank Farm perimeter fence. This tank is constructed in a partial "double-wall" fashion. Liquid radioactive wastes were stored in this tank from 1959 until it was removed from service in 1972. In 1960, the interior wall was breached and the stored wastes leaked into the annular secondary containment "pan". The depth of liquid exceeded the height of the pan sidewall and may have seeped into the soil around the tank. DP-1358, "LEAKING FROM WASTE TANK 16 - AMOUNT, FATE AND IMPACT", is the most comprehensive, informative document pertaining to this unit.

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12.4 UNIT SUMMARIES FOR NEWLY IDENTIFIED SWMUs

Since the issuance of SRS's Part B Permit, continued efforts have resulted in locating additional units which are now being added to the SWMU/RFI list. Summaries of each unit follow.

12.4.1 Grace Road

This unit (631-22G) is located about a mile south of SRS's B-Area. Approximately 100 drums and grease pots have been seen, scattered throughout a shallow gully. Some of the drums are partially buried. Car-seat springs and internal combustion engine parts reinforce the appearance of a garage/motor pool waste disposal location.

12.4.2 Gunsite 218

This unit (631-23G) is shown as Gunsite 218 on a 1957 USGS Topographic Map, hence the name. The gunsite consists of two concrete slabs, visible fuel tank riser pipes, and two possible ammunition magazines. Scattered about the area are paint cans, solvent cans, oil cans, antifreeze containers, scrap metal, RC pipe, and old domestic trash.

12.4.3 M-Area West

This unit (631-21G) is located deep in the pine forest about 3 miles west of M-Area. There are six 55-gallon drums lying on the ground. One drum is marked "Motor Oil" and a drum lid in the area is marked "Perm-A-Chlor".

12.4.4 Gunsite 113 Access Road

This unit (631-24G) is located on the northeast side of Gunsite 113 Access Road approximately 1/4 mile northwest of SRS Road 8. The area (about 30' in diameter) is devoid of trees. There are indications of organic waste disposal.

12.4.5 K-Area Rubble Pile

This unit (631-20G) is located about 100' southwest of the K-Area Burning/Rubble Pit. The debris deposited here has the appearance of being from the original construction of SRS. Piles of asphalt, concrete, wood, aluminum grating, paint buckets, and scrap metal constitute the vast majority of this site. There are a few rusty drums interspersed in this pile.

12.4.6 Georgia Fields

This unit (631-19G) is located about 1/2 mile west of a Savannah River Ecology Laboratory Area known locally as Georgia Fields. Piles of rotting green burlap, two drums, rusting wire and several 5-gallon buckets have been left here. One drum is marked "solvent".

12.4.7 Central Shops Sludge Lagoon

The site (080-24G) consists of an excavated earthen basin (sized approximately 60' x 40' x 5') that received stabilized sludge from extended aeration activated sludge sewage treatment plants from about 1955 to 1988. An estimated 200 gallons of asphalt from a spill entered the basin in the early 1970s. The basin was backfilled as part of remediation activities in 1989. Laboratory analyses, conducted in accordance with the SCDHEC approved closure plan, indicate the sludge and soils immediately beneath the Central Shops location contained chlordane.

12.4.8 Sludge Land Application Sites

Prior to knowledge of the presence of chlordane, the sludge removed from the Central Shops Sludge Lagoon in 1989 was applied to the K-Area Borrow Pit and the Par Pond Borrow Pit as part of closure activities. These sites are now known as Sludge Land Application Sites.

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The K-Area Sludge Land Application (761-4G) SRS site is approximately 20 acres and is located east of the junction of SRS Roads B and 6. The site received 350,000 gallons of liquid sludge in December 1980. Hardwood trees and pines were planted at this site in February 1981.

The Par Pond Sludge Land Application site (761-5G) covers approximately 22 acres and is located northwest of the junction of SRS Roads B and F at the south end of Par Pond. The site received 300,000 gallons of sludge in December 1980.

12.4.9 G-Area Oil Seepage Basin

This unit consists of a seepage basin (approximately one-quarter acre) located about 500 feet south of the Ford Building Seepage Basin. This basin may have been used for the disposal of waste oil and transformer oil in the 1950s and early 1960s.

12.4.10 F-Area Clay Lateral to ETF

In February 1989 it was discovered in F-Area that an 8" vitrified clay pipe leading to Manhole P-19A leaked over 100 lbs of a characteristic hazardous waste (pH of 1.09) that was slightly radioactive (<1 mR/hr). Use of the pipe was curtailed and a temporary line was installed from the Separations area to the Effluent Treatment Facility (ETF). The leak was reported as a Superfund spill and the soil adjacent to the pipe was excavated in accordance with the site spill procedures. The soil and wastewater removed from the site were determined to be mixed waste.

12.5 SCHEDULE FOR SUBMISSIONS

It is the intent of SRS to have all required Unit-Specific (US) RFI Plans submitted to SCDHEC within 30 months of program approval. The schedule developed is a reasonable target only because some of the RFI sites listed in Item V.A.1 of the PERMIT could be combined. These 33 Unit-Specific RFI Work Plans are listed in Table 12-1.

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It is anticipated that the eleven newly identified SWMUs will require the development of 10 unit-specific RFI work plans. These additional requirements have been blended into the existing schedule. Each site is noted by an asterisk on the revised Figure 12-1. The target date has been established as a 30-month time window from the date of regulatory approval of these revisions.

As shown in Figure 12-1, Unit-Specific RFI plans will be submitted to USEPA/SCDHEC beginning two months after regulatory approval of this RFI Program Plan. Within 12 months of approval, 18 of the required 43 plans will have been submitted. Twelve plans will be submitted between 12 and 18 months, eight plans between 18 and 24 months, and the final five between 24 and 30 months of program approval.

SRS desires to maintain flexibility within the overall time frame presented. It is readily possible, therefore, that some unit-specific RFI PLANS may be submitted earlier than indicated in Figure 12-1. Conversely, if some are accelerated, others may be deferred to maintain a manageable workload. Most importantly, it is the intent of SRS to have all presently required unit-specific RFI PLANS submitted to the USEPA/SCDHEC within 30 months of approval of this PROGRAM PLAN (contingent upon adequate funding being provided).

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**FIGURE 12-1
UNIT-SPECIFIC RFI WORKPLANS DEVELOPMENT SCHEDULE FOR SRS**

WASTE UNIT NAME	BUILDING NUMBER	MONTHS TO SUBMIT/EPA	DATE REQ'D BY EPA
MISC. CHEM BASIN/METALS BURN PIT (2)	731-4A,731-5A	2	Nov-89
ROAD A CHEMICAL BASIN	904-111G	2	Nov-89
TANK 16	241-H	7	Apr-90
F-AREA BURNING/RUBBLE PITS (3)	231-F,-1F,-2F	8	May-90
D-AREA BURNING/RUBBLE PITS (2)	431-D, -1D	8	May-90
OLD F-AREA SEEP. BASIN	904-49G	8	May-90
D-AREA OIL SEEPAGE BASIN	631-G	9	Jun-90
716-A MOTOR SHOP SEEP. BASIN	904-101G	9	Jun-90
BURMA ROAD RUBBLE PIT	231-4F	10	Jul-90
M-AREA WEST	631-21G	11	Aug-90
GUNSITE 113 ACCESS ROAD	631-24G	11	Aug-90
ACID/CAUSTIC BASINS (R & L)	904-79G,904-77G	11	Aug-90
GUNSITE 218	631-23G	12	Sep-90
COAL PILE RUNOFF (A,C,D,F,H,K&P)	189-C,-K,-P,788-3A,489-D,289-F,-H	12	Sep-90
SRL OIL TEST SITE	080-16G	12	Sep-90
BURNING/RUBBLE PIT 631-6G	631-6G	12	Sep-90
GUNSITE 720	631-16G	13	Oct-90
RUBBLE PIT 731-2A	731-2A	13	Oct-90
L-AREA OIL/CHEM. BASIN	904-83G	13	Oct-90
GEORGIA FIELDS	631-19G	13	Oct-90
NEW TNX SEEPAGE BASIN	904-102G	13	Oct-90
OLD H-AREA SEEPAGE BASIN	904-46G	14	Nov-90
SILVERTON ROAD WASTE SITE	731-3A	14	Nov-90
BURNING/RUBBLE PITS (8)	131-C,-K,-L,-P,-R,-1R,731-A,-1A	15	Dec-90
OLD RW BURIAL GROUND	643-G	15	Dec-90
SRL SEEPAGE BASINS - (4)	904-53G1,-53G2,-54G,-55G	16	Jan-91
GRACE ROAD	631-22G	16	Jan-91
G-AREA BURNING/RUBBLE PITS (3)	631-1G,-3G,-5G	18	Mar-91
ACID/CAUSTIC BASINS (F,H,P&K)	904-74G,-75G,-78G,-80G	20	May-91
G-AREA OIL SEEPAGE BASIN	761-13G	20	May-91
D-AREA ASH BASIN (488-D)	488-D	20	May-91
RUBBLE PIT 131-3L	131-3L	21	Jun-91
K-AREA RUBBLE PILE	631-20G	22	Jul-91
K-AREA & PAR POND SLUDGE APPL. SITES & CENTRAL SHOPS SLUDGE LAGOON (3)	761-4G,761-5G,080-24G	22	Jul-91
RUBBLE PILE 731-6A	731-6A	23	Aug-91
OLD TNX SEEPAGE BASIN	904-76G	23	Aug-91
FORD BUILDING SEEPAGE BASIN	904-91G	24	Sep-91
RUBBLE PIT 131-1L	131-1L	26	Nov-91
F-AREA CLAY LATERAL TO ETF	N/A	26	Nov-91
CMP PITS (7)	080-17G,-17.1G,-18G,-18.1G, 080-18.2G,-18.3G,-19G	28	Jan-92
ACTIVE RW BURIAL GROUND	631-7G	30	Mar-92
ENTIRE SANITARY LANDFILL	740-G	30	Mar-92
SRL 904-A PROCESS TRENCH		30	Mar-92

TOTAL NO. OF SWMU'S = 77

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APPENDIX A

PROJECT MANAGEMENT PLAN

FOR

DEVELOPMENT OF

RCRA FACILITY INVESTIGATION (RFI) PROGRAM

SAVANNAH RIVER SITE

AIKEN, SOUTH CAROLINA

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SUMMARY

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The development of all RCRA Facility Investigation (RFI) Plans, (The Project), shall be in accordance with professional standards. The Project shall be managed by a task team of environmental professionals reporting to the Savannah River Site (SRS) Waste Site Closure Task Force (WSCTF). Personnel representing selected SRS operating departments have been assembled into an RFI Program Team, (RFIPT).

The RFIPT will be coordinated by an environmental professional from the Environmental Protection Section (EPS). The Program Team has retained the services of SIRRINE Environmental Consultants to assist in the development of the RFI Program Plan required by sub-part C of Part V of the SRS (formerly SRP) RCRA PART B PERMIT, (the PERMIT), issued by the South Carolina Department of Health and Environmental Control (SCDHEC).

The interrelationships of the Task Force, Program Team, Project Director and Consultants are depicted in Figure 1.

FIGURE 1

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OVERALL MANAGEMENT APPROACH

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The overall management approach shall be to prepare an RFI PROGRAM PLAN, generic in nature, that fulfills the requirements of Appendix C of the SRS RCRA PART B PERMIT.

The RFI PROGRAM PLAN shall be developed in such a fashion that it is an effective "How-To" manual. To accomplish this, common elements of unit-specific RFI Plans will be incorporated into this document. Sections of the PROGRAM PLAN, at a minimum, will be: Sample Collection and Documentation Methodologies and Standards, Field Measurement and Documentation Methodologies and Standards, Sample Analysis and Documentation Methodologies and Standards, Data Management Materials and Procedures; Environmental Information that is unit-wide in nature (i.e.: generalized Hydrogeology and Topography, Fluvial Waters, Air Quality, etc.); Approaches to Characterization/Assessment Techniques; and generic Demographic/Receptor Data.

A Schedule detailing generation of unit-specific RFI Plans will be included as an integral part of the PROGRAM PLAN. Where logic indicates, one or more inactive waste units will be grouped with others. One example is the grouping of all six (6) Acid/Caustic Basins into one RFI Plan. Some other possible groupings are: Burning/Rubble Pits; SRL Seepage Basins and Bingham Pump Pits. This schedule will be Chapter 12 of the PROGRAM PLAN.

The SIRRINE work effort is broken down into milestones in Table 1. The work product of this effort, (the RFI PROGRAM PLAN), shall be complete on or before 04/15/88. The document shall be submitted to DOE-SR/ED on or before 05/01/88 by the WSCTF.

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TABLE 1

<u>EFFORT</u>	<u>MILESTONE DATE</u>
RFI Unit Reconnaissance	12/18/87
Working Draft of Employee Safety Section	01/10/88
Working Draft Sample Collection Section	01/15/88
Working Draft of Sample Analysis Section	01/20/88
Working Draft of Field Measurement Section	01/30/88
Working Draft of Data Management Section	02/05/88
Working Draft of Unit-Wide Environmental Information Section	02/10/88
Working Draft of C/A Techniques Section	02/20/88
Working Draft of Demographic/Receptor/ Pathway Section	02/28/88
Revised Draft of Employee Safety Section	02/10/88
Revised Draft of Sample Collection Section	02/15/88
Revised Draft of Sample Analysis Section	02/20/88
Revised Draft of Field Measurement Section	02/28/88
Revised Draft of Data Management Section	03/01/88
Revised Draft of EI Section	03/05/88
Revised Draft of C/A Techniques Section	03/05/88
Revised Draft of D/R/P Section	03/11/88
Entire Document in Final Draft Form	03/21/88
Entire Document in Final Form	04/15/88

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Using the RFI PROGRAM PLAN (HOW-TO-MANUAL) as a guide, unit-specific RFI plans will be created according to the schedule (Figure 12-1). Each unit-specific plan, whether it be for a grouping of units or an individual unit, will, additionally, consider existing documentation. Examples of existing documentation are Environmental Information Documents (EID), the Waste Site Closure Manual and the Technical Summary of Groundwater Quality Protection Program at Savannah River Site. Table 2 is a list of such documentation. While it is the intent of SRS to meet the schedule as proposed, it is possible that shifts may occur. SRS reserves the right to accelerate some unit-specific plans and retard others. The overall timetable of completion for all necessary RFI Plans will be adhered to, subject to Congressional funding limitations.

TABLE 2

ENVIRONMENTAL INFORMATION DOCUMENTS

DPST-85-688	SRL Basins
DPST-85-689	Metallurgical Laboratory Basin
DPST-85-690	Burning/Rubble Pits
DPST-85-691	Metals Burning Pile/Miscellaneous Chemical Basin
DPST-85-692	Old F-Area Seepage Basin
DPST-85-693	Separations Area Retention Basins
DPST-85-694	Radioactive Waste Burial Grounds
DPST-85-695	Bingham Pump Outage Pits
DPST-85-696	Hydrofluoric Acid Spill Area
DPST-85-697	SRL Oil Test Site
DPST-85-698	New TNX Seepage Basin
DPST-85-699	Road A Chemical Basin
DPST-85-700	L-Area Oil and Chemical Basin
DPST-85-701	Waste Oil Basins
DPST-85-702	Silverton Road Waste Site
DPST-85-703	M-Area Settling Basin and Vicinity
DPST-85-704	F-Area Seepage Basins
DPST-85-705	Acid/Caustic Basins
DPST-85-706	H-Area Seepage Basins
DPST-85-707	Reactor Seepage Basins
DPST-85-708	Ford Building Waste Site
DPST-85-709	Ford Building Seepage Basin
DPST-85-710	Old TNX Seepage Basin
DPST-85-711	TNX Burying Ground
DPST-85-712	CMP Pits
DPST-85-713	Gunsite 720 Rubble Pit

SITE ASSESSMENT REPORT - CMP PITS
Woodward-Clyde Consultants, 1985

**HYDROGEOLOGIC AND GROUNDWATER QUALITY ASSESSMENT SILVERTON ROAD
WASTE SITE**
Geraghty and Miller Consultants, 1985

**DPST-83-829 TECHNICAL SUMMARY OF GROUNDWATER QUALITY
PROTECTION PROGRAM AT SAVANNAH RIVER PLANT**
E.I. duPont de Nemours and Company, 1983

**DOE/EIS-0120D Environmental Impact Statement
WASTE MANAGEMENT ACTIVITIES FOR GROUNDWATER PROTECTION -
SAVANNAH RIVER PLANT**
United States Department of Energy, 1987

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TECHNICAL SUMMARY - GROUNDWATER QUALITY IMPACT OF WASTE DISPOSAL
AT SAVANNAH RIVER PLAN (Draft)
E.I. duPont de Nemours and Company, 1987

GROUNDWATER IMPACT ASSESSMENT: CPRB
O'Brien and Gere Engineers, 1987

TECHNICAL DATA SUMMARY: WASTE ACID/CAUSTIC BASINS
O'Brien and Gere Engineers, 1986

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TECHNICAL APPROACH

FOR

DEVELOPMENT OF

RCRA FACILITY INVESTIGATION (RFI) PROGRAM

SAVANNAH RIVER SITE

AIKEN, SOUTH CAROLINA

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Technically, these RFI requirements shall be approached in a professional manner. The USEPA waste site manual will be reviewed. Sampling methodology and documentation will be used wherever applicable. In the event no EPA Standard exists, an SRS or other appropriate standard, will be followed. Chain-of-custody requirements for environmental samples are currently in force on the SRS and shall be used where appropriate.

Chain-of-custody, storage and preparation methods shall all be in accordance with accepted standard methods.

QA/QC Procedures shall meet the requirements of SRS and ASME-NQA-1-1986 as they apply to inactive waste units. A QA/QC guidance document shall be developed concurrent with the RFI Program Plan.

The provisions of 29 CFR 1910.120 shall apply to personnel visiting and/or working at hazardous waste sites. The provisions of SRS safety requirements shall apply. The SRS Health Physics group will provide radiation scanning and other appropriate assistance as necessary.

Detailed waste-unit specific safety requirements will be developed. These will be added to the QA/QC document mentioned in the preceding paragraph. Security procedures at SRS shall be the determinant standard for security.

A Data Management Plan will be developed to document and track investigation data and results. This plan will be used as a guideline to provide a standardized format for the documentation and presentation of raw data, and also for the reporting of conclusions to the investigation.

The documentation section of the Data Management Plan will provide a standardized format for the recording and tracking of relevant data. This section will define the sampling and field measurement code, laboratory analysis identification number, sampling or field measurement raw data, and the properties being measured.

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The Data Management Plan will provide a standardized format for the displaying of relevant data. Unit specific maps showing the sampling location(s) and/or field measurement location(s) will be included. Within the presentation section, a data record will be used to exhibit the sampling or field measurement type, property or component measured, and the results of the analyses. This information will be presented in both tabular and graphic displays, as best fits the situation.

Tabular displays will be used to exhibit data in a unit-specific format (e.g., P Area Acid/Caustic Basin Data...), data in a specific analysis format (e.g., EPA Toxicity Test Results, Soil pH...), data based on soil layers (e.g., Soil/Sediment Sampling Intervals), and data reduction for statistical analysis.

Graphical displays will include, but not be limited to, bar graphs, line graphs, area or plan maps, a cross-sectional plots. These displays will be utilized to indicate unit sampling locations, show geographical extent of contamination, illustrate changes in other parameters, indicate potential pathways and receptors of constituent releases, and to support related tabular displays.

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PERSONNEL QUALIFICATIONS

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The EPS Project Director for this task will also function as the coordinator of the RFI Program Team. He shall report to the Waste Site Closure Task Force. The coordinator for the WSCTF is C.R. Sherman, P.G.

Table 3 lists the membership of the RFI Program Team and the SRS Department to which they report. They represent a broad cross-section of Operations and Maintenance at the SRS.

As previously mentioned, the consultant selected to assist in the PROGRAM PLAN development is SIRRINE Environmental Consultants of Greenville, South Carolina. They have identified their key personnel as indicated in Table 4. Because of the size of the RFI Program at SRS, several other Consulting Firms will be retained to aid in the development of unit-specific plans. They will be selected by site custodians from a list of pre-qualified firms. Some of the firms on the list are:

Bechtel
Camp, Dresser and McKee
CH₂M Hill
Dames and Moore
Sirrinc Environmental Consultants
Soils and Materials Engineering

**TABLE 3
ORIGINAL RFI PROGRAM TEAM**

D.T. Bignell*	Power
K.M. Bultman	Environment and Energy
E.A. Campbell, P.E.-Coordinator	Environment and Energy
J.E. Cantrell	Waste Management Technology
B.S. Christie*	Separations
L.S. Clifton	Power Technology
B. Eichlin	Power Technology
J.R. Floyd Jr., P.E.	Power Technology
M.A. Houston	Reactors
C.E. Jewell*	Reactors
T.H. Killian	Waste Management Operations
C.S. Leason	Power Technology
R. Nichols	Savannah River Laboratories
J.B. Pickett*	Raw Materials and Engineering Technology

*exofficio

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TABLE 4

SIRRINE ENVIRONMENTAL CONSULTANTS KEY PERSONNEL

J.R. Brooks	- Chief, RCRA Compliance Group
A.B. Brower, P.E.	- V.P. Hazardous Waste and Environmental Sciences Group
H.E. Corbett	- Geologist
N.B. Cormany	- Environmental Engineer
S.A. Daves	- Civil Engineer
D.R. Oliphant	- Environmental Engineer
G.A. Peterson, P.E.	- Chief, Hydrogeology Section
E.J. Zillioux	- Chief, Health and Safety Section

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APPENDIX B

RFI UNIT LITERATURE REVIEW CHECKLIST

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RFI UNIT LITERATURE REVIEW CHECKLIST

INTRODUCTION: GENERAL UNIT DATA AND INFORMATION

A. Unit Identification

1. RFI Unit Name: _____
2. RFI Unit Location¹: _____

B. General Information (Common To All Media Investigations)

1. General Waste Characteristics:
 - a. Known Nonhazardous Waste Managed at the Unit: _____
 - b. Known Hazardous Waste Managed at the Unit: _____
 - c. Hazardous Classification (e.g., flammable, corrosive): _____
 - d. Quantity of Each Waste Managed at the Unit: _____
 - e. Chemical Composition of Each Waste: _____
2. General RFI Unit/Disposal Area Characteristics:
 - a. Type of RFI Unit (from Section 4.2.2): _____
 - b. Operational Period: _____
 - c. Operational Capacity (Surface Area and/or Volume): _____
 - d. Unit Dimensions at Closure or Discontinued Use: _____

¹ Building number and SRS coordinates shall be used to identify the unit location.

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- e. Description of Unit Design Features: _____

- f. Description of Operational History Detailing All Problems: _____

- g. Known Spills, Leaks, Odors, or Rupture Resulting in Waste Release: _____

- h. Method Used to Close Unit (if applicable): _____

- 3. General Geological Properties:
 - a. Detailed Contour Map Available? _____
 - b. Depth to Water Table: _____
 - c. Distinction of Underlying Strata: _____

 - d. Classification of Surface and Subsurface Soils: _____

- 4. General Environmental Setting:
 - a. Average Temperature (Annual/Monthly²): _____
 - b. Average Precipitation (Annual/Monthly²): _____
- 5. Proximate Natural or Manmade Features (also list approximate distance from RFI unit):
 - a. Ridges, Hills: _____
 - b. Valleys, Ravines: _____
 - c. Surface Water Bodies: _____
 - d. Buildings: _____
 - e. Hard-Surfaced or Heavily-Trafficked Roads: _____

² These averages shall be calculated for the previous 5-year period.

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6. Previous Sampling or Monitoring Data:

- a. Date or Time Period of Sampling/Monitoring: _____

- b. Source of Data (e.g., list specific EID): _____

- c. Medium (Media) Sampled (e.g., ground water, soil): _____

- d. Results of Sampling (e.g., no contamination detected, contaminant plume identified): _____

I. SOILS SAMPLING CONSIDERATIONS

A. Waste Characteristics

1. Specific Waste Information (complete for each specific waste):

- a. Physical State of Waste During Operational Period: _____

- b. General Chemical Class (e.g., acid, base, solvent): _____

- c. Water Solubility: _____
- d. Molecular Weight: _____
- e. Density: _____
- f. Viscosity: _____
- g. Boiling Point: _____
- h. Waste pH: _____
- i. Vapor Pressure: _____
- j. Cohesiveness of Waste: _____

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2. Potential Transport Processes of Waste Managed at Unit³:

- a. Biodegradation Potential: _____

- b. Photodegradation Potential: _____

- c. Hydrolysis Potential: _____

- d. Oxidation/Reduction Potential: _____

- e. Volatilization Potential: _____

- f. Absorption Potential: _____

- g. Dissolution Potential: _____

B. RFI Unit Design and Operational History

1. Potential Waste Release Mechanisms (Based on RFI Unit Type, Table 4-2):

- a. Visible Release Mechanism(s): _____

- b. Suspected Release Mechanism(s): _____

³ For each transport process listed above, indicate the potential for occurrence: "high", "low", or "uncertain". Assessment will be based on key waste factors listed in Table 4-1, Section 4.2.1.

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C. Soil Properties and Environmental Setting

1. Specific Soil Properties:

- a. Effective Porosity: _____
- b. Hydraulic Conductivity (Permeability): _____

- c. Relative Conductivity: _____

- d. Soil pH: _____

2. Environmental Setting:

- a. Description of Vegetation: _____

- b. Description of Fauna: _____

II. GROUNDWATER SAMPLING CONSIDERATIONS

A. Waste Characteristics (See I.A. above)

B. RFI Unit Design and Operational History (See I.B. above)

C. Soil Properties and Environmental Setting

1. Additional Soil Properties:

- a. Hydraulic Gradients: _____

- b. Groundwater Flow Directions: _____

III. SURFACE WATER/SEDIMENT SAMPLING CONSIDERATIONS

A. Waste Characteristics (See I.A. above)

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B. RFI Unit Design and Operational History

1. Design Controls (or absence of):
 - a. Description of Environmental Controls (e.g., dikes, contours, pumping operations): _____

 - b. Description of Any Cracks, Flaws, Ruptures: _____

C. Environmental Factors

1. Surface Water Network Hydraulics:
 - a. Type of Surface Water Feature (e.g., drainage swale, stream, pond): _____

 - b. Distance from RFI Unit: _____

 - c. Flow Rate/Velocity of Feature: _____

 - d. Description of Any Depositional Areas: _____

2. Climatology:
 - a. Temperature Stratification Potential: _____

 - b. Freeze/Thaw Potential: _____

IV. AMBIENT AIR AND SOIL GAS SAMPLING CONSIDERATIONS

A. Waste Characteristics

1. Additional Waste Information (complete for each specific waste):
 - a. Physical State of Waste at Time of Disposal/Treatment: _____

 - b. Vapor Pressure (if applicable): _____
 - c. Water Solubility: _____

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- d. Molecular Weight: _____
- e. Moisture Content: _____
- f. Percent Volatile Material: _____

B. Unit Design and Operational History

- 1. Unit Design: Zones of High Vapor Phase Release Potential:
 - a. Pipes, Outfalls, or Backfills Around Each Structure: _____
 - b. Natural Animal Burrows or Habitat Openings: _____
 - c. Sand or Gravel Lens Fill: _____
 - d. Cracks From Soil or Sludge Drying: _____
 - e. Jointing in Bedrock: _____
- 2. Operation History:
 - a. Any Known Odor or Air Release Incidents: _____
 - b. Known "Worst-Case" Operational Practices Currently Being Followed (See Table 9-2, Section 9.2.2): _____

C. Meteorological Factors and Environmental Setting

- 1. Additional Meteorological Parameters:
 - a. Description of Wind Speed and Direction: _____
 - b. Description of Wind Fluctuation/Stability: _____
 - c. Relative Humidity/Dew Point: _____

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d. Atmospheric Pressure: _____

e. Evaporation Rate: _____

2. "Worst-Case" Meteorological Conditions:

a. Description of Known Occurrences During Past 5 Years: _____

b. Frequency of Occurrence During Past 5 Years: _____

Checklist Completion Date: _____

Checklist Completion By: _____

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APPENDIX C

UNIT RECONNAISSANCE FIELD DATA SHEET

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**UNIT RECONNAISSANCE
FIELD DATA SHEET
SAVANNAH RIVER SITE, AIKEN, SOUTH CAROLINA**

RFI Unit Name¹: _____ Completed By: _____
RFI Unit Location: _____ SRS Representative Name: _____
Date: _____

I. ENVIRONMENTAL SETTING

Unit Arrival Time: _____ a.m/p.m.
Health/Safety Recommendation Initiated: Yes No

1. Meteorological Conditions

- a. Temperature _____ °F Sky Cover: sunny partly cloudy cloudy
b. Precipitation: rain drizzle N/A
c. Wind Conditions: negligible light moderate gusty

2. Topographical/Biological Description

- a. Description of corresponding natural features (hills, valleys, depressions, etc.):

b. Description of corresponding surface water bodies (stream, river, lake, leachate):

c. Description of corresponding vegetation (weeds/grass, underbrush, small/mature trees):

d. Description of animal presence/habitat (tracks, nests, dens, etc.):

¹ Building number and SRS coordinates shall be used to identify the unit location.

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3. Man-Made Features

- a. Description of corresponding features (buildings, roads, powerlines, wells):

II. SOURCE CHARACTERIZATION

1. Unit Area Characteristics

- a. Description of waste management activities (landfill, surface impoundment, etc.):
- b. Estimation of waste management area size:
- c. Construction of waste management area (earthen, liners, cement, above grade, etc.):
- d. Is the unit in current use/operation: Yes No
Comment:

2. Waste Characteristics

- a. Description of any visible waste:
- b. Quantity of waste (number of drums, pile size, % S.I./basin filled):

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III. WASTE RELEASE POTENTIAL

1. To Soil/Groundwater/Surface Water

- a. Description of waste run-off/leachate (soil discoloration, dead vegetation or no growth, erosion, etc.):

- b. Estimate of impacted area (size of area, distance from the source, etc.):

2. To Atmosphere/Subsurface Gas

- a. Description of gas release to atmosphere (odors, dead vegetation, visible odor, etc.):

- b. Estimate of impacted area:

IV. FINAL CHARACTERIZATION

- 1. Additional comments:

- 2. Follow-up questions:

- 3. Health/safety concerns:

- 4. Unit Departure Time: _____ a.m./p.m.

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V. PHOTOGRAPHS

1. Photographs Taken: Yes No
2. Quantity of Photographs Taken:

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APPENDIX D
ENVIRONMENTAL INFORMATION DOCUMENTS

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ENVIRONMENTAL INFORMATION DOCUMENTS

DPST-85-688	SRL Basins
DPST-85-689	Metallurgical Laboratory Basin
DPST-85-690	Burning/Rubble Pits
DPST-85-691	Metals Burning Pile/Miscellaneous Chemical Basin
DPST-85-692	Old F-Area Seepage Basin
DPST-85-693	Separations Area Retention Basins
DPST-85-694	Radioactive Waste Burial Grounds
DPST-85-695	Bingham Pump Outage Pits
DPST-85-696	Hydrofluoric Acid Spill Area
DPST-85-697	SRL Oil Test Site
DPST-85-698	New TNX Seepage Basin
DPST-85-699	Road A Chemical Basin
DPST-85-700	L-Area Oil and Chemical Basin
DPST-85-701	Waste Oil Basins
DPST-85-702	Silverton Road Waste Site
DPST-85-703	M-Area Settling Basin and Vicinity
DPST-85-704	F-Area Seepage Basins
DPST-85-705	Acid/Caustic Basins
DPST-85-706	H-Area Seepage Basins
DPST-85-707	Reactor Seepage Basins
DPST-85-708	Ford Building Waste Site
DPST-85-709	Ford Building Seepage Basin
DPST-85-710	Old TNX Seepage Basin
DPST-85-711	TNX Burying Ground
DPST-85-712	CMP Pits
DPST-85-713	Gunsite 720 Rubble Pit

SITE ASSESSMENT REPORT - CMP PITS
Woodward-Cycle Consultants, 1985

HYDROGEOLOGIC AND GROUND WATER QUALITY ASSESSMENT SILVERTON ROAD WASTE SITE
Geraghty and Miller Consultants, 1985

DPST-83-829 TECHNICAL SUMMARY OF GROUND WATER QUALITY PROTECTION PROGRAM AT
SAVANNAH RIVER PLANT
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DOE/EIS-0120D Environmental Impact Statement
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SAVANNAH RIVER PLANT
(Draft) - United States Department of Energy, 1987

TECHNICAL SUMMARY - GROUND WATER QUALITY IMPACT OF WASTE DISPOSAL AT
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E. I. duPont de Nemours and Company, 1987

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GROUND WATER IMPACT ASSESSMENT: CPRB
O'Brien and Gere Engineers, 1987

TECHNICAL DATA SUMMARY: WASTE ACID/CAUSTIC BASINS
O'Brien and Gere Engineers, 1986

WASTE MANAGEMENT UNITS - SAVANNAH RIVER PLANT, DOE,
August, 1987

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APPENDIX E

**POTENTIAL CONTAMINATION CATEGORIES FOR
SELECTED RFI WASTE UNITS**

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APPENDIX E-1

SELECTED RFI WASTE UNITS

WASTE UNITS	BUILDING/ COORDINATE	RECEIVING WASTE	POTENTIAL CATEGORY
A- AND M-AREAS			
716-A Motor Shop Seepage Basin	904-101G	No	Hazardous
Metals Burning Pit	731-4A	No	Hazardous
Silverton Road Waste Site	731-3A	No	Hazardous
Miscellaneous Chemical Basin	731-5A	No	Hazardous
A-Area Burning/Rubble Pit	731-A	No	Hazardous
A-Area Burning/Rubble Pit	731-1A	No	Hazardous
SRL Seepage Basin	904-53G1	No	Mixed
SRL Seepage Basin	904-53G2	No	Mixed
SRL Seepage Basin	904-54G	No	Mixed
SRL Seepage Basin	904-55G	No	Mixed
F- AND H-AREAS			
F-Area Acid/Caustic Basin	904-74G	No	Hazardous
H-Area Acid/Caustic Basin	904-75G	No	Hazardous
F-Area Burning/Rubble Pit	231-F	No	Hazardous
F-Area Burning/Rubble Pit	231-1F	No	Hazardous
F-Area Seepage Basin (Old)	904-49G	No	Mixed
H-Area Seepage Basin	904-46G	No	Mixed
Radioactive Waste Burial Ground	643-7G	Yes	Low-Level Radioactivity
Old Radioactive Waste Burial Ground	643-G	No	Low-Level Radioactivity
TNX-AREA			
TNX Seepage Basin (Old)	904-76G	No	Mixed
TNX Seepage Basin (New)	940-102G	Yes	Mixed
D-AREA			
D-Area Oil Seepage Basin	631-G	No	Hazardous
D-Area Burning/Rubble Pit	431-D	No	Hazardous
D-Area Burning/Rubble Pit	431-1D	No	Hazardous
K-AREA			
K-Area Burning/Rubble Pit	131-K	No	Hazardous
K-Area Acid/Caustic Basin	904-80G	No	Hazardous

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APPENDIX E-1 (Continued)

SELECTED RFI WASTE UNITS BY GEOGRAPHIC GROUPING

WASTE UNITS	BUILDING/ COORDINATE	RECEIVING WASTE	POTENTIAL CATEGORY

L-AREA			
L-Area Burning/Rubble Pit	131-L	No	Hazardous
L-Area Acid/Caustic Basin	904-79G	No	Hazardous
CMP Pit	080-17G	No	Hazardous
CMP Pit	080-17.1G	No	Hazardous
CMP Pit	080-18G	No	Hazardous
CMP Pit	080-18.1G	No	Hazardous
CMP Pit	080-18.2G	No	Hazardous
CMP Pit	080-18.3G	No	Hazardous
CMP Pit	080-19G	No	Hazardous
R-AREA			
R-Area Burning/Rubble Pit	131-R	No	Hazardous
R-Area Burning/Rubble Pit	131-1R	No	Hazardous
R-Area Acid/Caustic Basin	904-77G	No	Hazardous
C- AND CS-AREAS			
CS Burning/Rubble Pit	631-1G	No	Hazardous
CS Burning/Rubble Pit	631-5G	No	Hazardous
CS Burning/Rubble Pit	631-6G	No	Hazardous
C-Area Burning/Rubble Pit	131-C	No	Hazardous
Ford Building Seepage Basin	904-91G	No	Mixed
L-Area Oil and Chemical Basin	904-83G	No	Mixed
P-Area			
P-Area Burning/Rubble Pit	131-P	No	Hazardous
P-Area Acid/Caustic Basin	904-78G	No	Hazardous
MISCELLANEOUS AREAS			
SRL Oil Test Site	080-16G	No	Hazardous
Gunsite 720 Rubble Pit	631-16G	No	Hazardous
Road A Chemical Basin	904-111G	No	Mixed

SOURCE: Adapted from DOE/EIS-0120D

APPENDIX E-2 (Continued)

**RFI WASTE UNITS NOT CONTAINING HAZARDOUS, LOW-LEVEL
RADIOACTIVE, OR MIXED WASTES**

Waste Units	Description
Rubble and scrap pits piles (includes former military sites)	Contain nonhazardous and nonradioactive materials such as concrete, brick, tile, asbestos (transit), asphalt, hard plastics, glass, rubber products, scrap metal, burn wood, and non-returnable drums. Rubble pits no longer receive waste material.
Ash basins and piles	Contain ash sluice water or dry ash from powerhouses. Sampling results indicate waste concentrations are not hazardous.
Coal-pile runoff containment basins	Contain runoff from coal piles. Results of sampling indicate a pH greater than 2.0; waste constituents, including heavy metals, are less than the EP toxicity maximum concentrations.
Sanitary landfill	Contains material such as paper, plastics, rubber, wood, cardboard, and rags. Landfill operated under a domestic waste permit issued by SCDHEC.

SOURCE: Adapted from DOE/EIS-0120D

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REFERENCES

DOE (U.S. Department of Energy), 1987. Draft Environmental Impact Statement, Waste Management Activities for Ground Water Protection, Savannah River Plant, DOE/EIS-0120D, Savannah River Operations Office, Aiken, South Carolina.

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APPENDIX F
CHEMICAL EXPOSURE LIMITS

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INTRODUCTION

The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) in the work environment are given for volatile chemicals. Two TLV standards are presented for each chemical. The Time Weighted Average (TWA) is the time-weighted average concentration for a normal 8-hour work day and a 40-hour work week. The Short Term Exposure Limit (STEL) is a 15-minute time-weighted average exposure that should not be exceeded at any time during a work day even if the 8-hour time weighted average is within the TLV. Also presented, when available, are the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL), the National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL), and the NIOSH and OSHA Standards Completion Program (SCP) Immediately Dangerous to Life or Health (IDLH) level. The PEL and REL values are presented either as a TWA or a ceiling (CEIL) limit. The IDLH value represents a maximum concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects.

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Chemical Exposure Limits Based on Human Health Criteria

Compound	TLV-TWA(1)	TLV-STEL(1)	PEL(2)	REL(2)	IDLH(2)
The following limits are in ppm:					
Methylene Chloride	100	500	500 1,000 (Ceiling) 2,000 (Peak Above Ceiling - 5 min. in any 2 hours)	75 500 (Ceiling - 15 min.)	(Ca)
Ethylene Glycol Vapor	50 (Ceiling)				
Chloroform (Trichloromethane)	10, A2	50		2 (Ceiling - 1 hr.)	(Ca)
Methyl Chloroform (1,1,1-Trichloroethane)	350	450	350	350 (Ceiling - 15 min.)	1,000
Trichloroethylene	50	200	100 200 (Ceiling) 300 (Peak Above Ceiling - 5 min. in any 2 hours)	25	(Ca)
Tetrachloroethylene (Perchloroethylene)	50	200	100 200 (Ceiling) 300 (Peak Above Ceiling - 5 min. in any 3 hours)	Lowest Feasible Limit	(Ca)

(1) Values obtained from ACGIH TLVs and BEIs for 1987-1988.

(2) Values obtained from NIOSH Pocket Guide to Chemical Hazards, 1985.

(3) Values expressed in mg/m³.

A1 Confirmed Human Carcinogen

A2 Suspected Human Carcinogen

(Ca) NIOSH has recommended that this chemical be treated as an occupational carcinogen.

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Chemical Exposure Limits Based on Human Health Criteria

Compound	TLV-TWA(1)	TLV-STEL(1)	PEL(2)	REL(2)	IDLH(2)
Copper Dusts & Mists, as Cu	1.0		0.1 (Fume)		
Lead, In- organic Dusts & Fumes, as Pb	0.15		0.05	<0.1	
Manganese, Dusts & Compounds, as Mn	5 (Ceiling)		5 (Ceiling)		10,000
Nickel, Soluble Com- pounds, as Ni	0.1		1	0.015	(Ca)
Iron Oxide Fume	5		10		
Zinc Oxide Fume	5	10	5	5 (Ceiling - 15 min.)	
Lithium	None Established				
PCBs	0.5(S)	1.0	0.5	0.001	(Ca)

S An "S" after a value indicates that absorption through the skin will add significantly to the inhaled dose.

- (1) Values obtained from ACGIH TLVs and BEIs for 1987-1988.
(2) Values obtained from NIOSH Pocket Guide to Chemical Hazards, 1985.
(3) Values expressed in mg/m³.

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Chemical Exposure Limits Based on Human Health Criteria

Compound	TLV-TWA(1)	TLV-STEL(1)	PEL(2)	REL(2)	IDLH(2)
Benzene	10, A2		1 5 (15 min. TWA)	1 (Ceiling - 1 hr.)	(Ca)
Toluene	100	150	200 300 (Ceiling) 500 (Peak Above Ceiling - 10 min.)	100 200 (Ceiling - 10 min.)	2,000
Petroleum Distillate (Stoddard Solvent)	100		500	350(3) 1800(3) (15 min. TWA)	5,000
Di-Octyl- Phthalate	5	10			

The following limits are in mg/m^3 :

Cadmium and Compounds, as Cd	0.05		0.2 0.6 (Ceiling)	Lowest Feasible Limit	(Ca)
Chromium VI) Compounds, as Cr	0.05 (Certain water insoluble, A1)		0.5 (Soluble) 1 (Insoluble)	0.001 (For Carcin- ogenic Cr) 0.025 (For Other Cr) 0.050 (Ceiling - 15 min.)	250

(1) Values obtained from ACGIH TLVs and BEIs for 1987-1988.

(2) Values obtained from NIOSH Pocket Guide to Chemical Hazards, 1985.

(3) Values expressed in mg/m^3 .

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(Ca) NIOSH has recommended that this chemical be treated as an occupational carcinogen.

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**APPENDIX G
TOXICITY SUMMARIES**

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Relevant health-based information that applies to this SHERP or to the employee's right to know is discussed under summary health reviews given in this Appendix for chemicals which may pose a hazard during the work on this site. It is hoped that this will provide the Contractor with a substantive base of information to initiate the site specific SHERP. It is not intended as a substitute to the detailed investigation required prior to the initiation of any RFI site activities.

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a. Benzene

Physical Properties:

Flash Point	12F
UEL	7.9
LEL	1.35
Vapor Pressure	100 torr at 26C
Density	0.87 g/cc
Water solubility	0.08g/100 cc
Respirator cartridge breakthrough	73 min. at 1000 ppm

Toxicity Summary:

Carcinogen Status: yes

IARC Carcinogenic Assessment: Human Positive

NTP: yes

This material will cause eye irritation and may cause a burn which would heal in a day or two. It may remove fat from the skin which results in a loss of pliability and cracking on long term exposure. Inhalation of 100 ppm over 8 hours can cause drowsiness, fatigue and dizziness from central nervous system depression. Headache may accompany or follow exposure. Higher concentrations produce the same effect but sooner. Unconsciousness would likely result from exposure, to 7500 ppm for 10 minutes, and death from 20,000 ppm for 5 minutes.

Skin Adsorption: no

Long term overexposure may result in permanent nervous system damage. Long term exposure to much lower concentrations can affect the blood forming organs. Aplastic anemia may result from exposure to 60 ppm 8 hr. TWA and 2.5 ppm 8 hr. TWA causes clinically detectable changes in the blood forming system. A number of cases of leukemia have been associated with exposure to an estimated 40 ppm 8 hr. TWA with very

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substantial peak exposures. The OSHA PEL has been lowered to 1 ppm to minimize the formation of leukemia.

Ingestion of small amounts will add to the body burden of the inhaled dose. Larger amounts may cause nausea and vomiting.

b. Nickel

Toxicity Summary:

Carcinogen Status: yes

IARC Carcinogenic Assessment: Animal Positive

NTP: yes

Eyes may suffer irritation upon contact. Repeated contact can cause sensitization which results in skin itching and burning followed by reddening and pustules and possibly fever upon contact.

Ingestion of 1/8 teaspoonful per day should cause no effect other than sensitization while larger amounts may adversely affect the heart and liver.

Skin Adsorption: no

Inhalation of large amounts may cause sensitization while 40 times the TLV has caused increased amounts of lung cancer in animals. The TLV and OSHA PEL are both 1 mg/m³.

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c. Phenols

Toxicity Summary:

Carcinogen Status: no

In man, phenol usually exerts (directly and indirectly) a predominant action upon the higher centers resulting in sudden collapse. Following absorption of a toxic dose the heart rate first increases, then becomes slow and irregular.

The blood pressure increases slightly at first, then falls markedly. There are some salivation, marked dyspnea, and usually a decrease in body temperature.

Skin adsorption: yes

Prolonged oral or subcutaneous administration can cause damage to the lungs, liver, kidneys, heart, and genitourinary tract.

d. Toluene

Toxicity Summary:

Carcinogen Status: no

High vapor concentrations, 800-1,000 ppm, and liquid contact can cause eye irritation. The liquid may cause a mild burn which will usually heal within 2 days. Repeated contact can result in defatting of the skin with loss of pliability and easy cracking on flexion.

Skin Adsorption: no

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Inhalation of 200 ppm over 8 hours can result in mild fatigue, weakness, confusion and a prickly, creepy sensation on the skin; 600 ppm causes the same result in 3 hours and, after 8 hours, can cause incoordination, insomnia, and nervousness which may last several days; while higher concentrations can cause these symptoms more quickly, they can also cause unconsciousness and death from anesthesia. Long-term exposure to 1,500 ppm 8 hr. TWA may cause reduced red cell count increased red cell size, and increased white cell count. Inhalation of 100 ppm 8 hr. TWA for a working lifetime is not expected to cause adverse health effects.

e. Cadmium

Toxicity Summary:

Carcinogen Status: yes

IARC Carcinogenic Assessment: Animal Positive

NTP: yes

Cadmium may cause irritation of the eyes and skin. If the skin contact is accompanied by mechanical action from clothing, open sores may result. Inhalation of substantial amounts of cadmium salts may result in dry throat, cough, tightness in the chest, difficulty in breathing, nausea, vomiting, serious lung damage, and heart or kidney failure. Long term intake of cadmium can result in lung fibrosis, emphysema, bronchitis and kidney damage. Inhalation of 0.05 mg/m³ 8 hr. TWA for a working lifetime is not expected to have a significant impact on a substantial number of people.

Skin Adsorption: no

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f. Chromium (VI)

Toxicity Summary:

Carcinogen Status: yes

IARC Carcinogenic Assessment: Animal Positive

NTP: yes

Concentrated chromium (VI) may cause a serious eye burn which may result in some loss of vision. Chronic exposure to diluted material may result in red eye and discoloration of the area surrounding the cornea. Contact with the skin may result in irritation and, possibly, ulceration. Chronic skin contact may result in sensitization. This material may absorb through the skin in toxic amounts. Inhalation of substantial amounts of Chromium (VI) may cause severe irritation of the nose, throat and lungs, resulting in labored breathing or shortness of breath. Chronic exposure to excessive concentrations of chromium (VI) may cause perforation of the nasal septum, degeneration of the mucous membranes and lung cancer. Ingestion of substantial amounts of this material may result in serious kidney damage. Inhalation of 0.05 mg/m³ 8 hr. TWA is not expected to have a significant effect on a substantial number of people.

Skin Adsorption: no

g. Methylene Chloride

Physical Properties:

Density	1.33 g/cc
Vapor Pressure	440 torr at 25C
Flash Point	None
UEL	None
LEL	None
Water Solubility	2 g/100cc
Respirator Cartridge Breakthrough:	
Time, min.	10.1
At Conc.	1000 ppm

Toxicity Summary:

Carcinogenic Status: Currently no

This material is very irritating to the skin and eyes. If confined to the skin under clothing, a burn may result.

Short-term inhalation of this material at a few thousand parts per million (ppm) in air may cause dizziness, nausea, tingling or numbness in the hands, arms, feet and legs, a sensation of heat and fullness in the head, stupor lethargy, and poor mental function. Removal to fresh air usually results in rapid cessation of symptoms. Exposure to higher concentrations may result in death from narcosis. As in exposure to carbon monoxide, some hemoglobin is converted to carboxyhemoglobin which will not transport oxygen in the blood stream. The amount of carboxyhemoglobin formed at 500 ppm is about the same as carbon monoxide at the TLV of 50 ppm and is about half of that at 150 ppm, after 8 hour exposures.

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Chronic inhalation of several hundred ppm may result in damage to the liver and nervous and digestive systems. Animals inhaling 3500 ppm showed an increase in tumors of the neck.

Skin Adsorption: no

Ingestion of 7 ounces of this material may cause death from narcosis. One group of animals given large doses by a tube leading into their stomachs developed increased numbers of tumors.

The OSHA PEL is 500 ppm and the TLV is 100 ppm.

h. Trichloroethylene

Carcinogen Status: no

The following health effects of TCE were reviewed and evaluated by the Health Assessment Document published by OHEA in July 1985.

Skin Adsorption: no

Acute exposure to TCE has been documented in human case histories to cause visual disturbances, mental confusion, fatigue and nausea, increasing to unconsciousness and death at high concentrations. In a limited number of controlled human studies, headaches and decreases in performance ability for tests of perception, manual dexterity, reaction time and memory are associated with short-term exposures near 100 ppm, with a progressive decrease in psychomotor performance as TCE concentrations increase from 100 to 500 ppm. In limited epidemiological studies of chronically-exposed workers, symptoms related to nervous system disorders increased in frequency with both longer exposures and higher concentrations of TCE for concentrations ranging from 5 to 629 ppm.

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TCE is rated by the EPA as a probable human carcinogen. The National Primary Drinking Water Regulations cite an estimated one in one million lifetime cancer risk at a chronic exposure of 2.6 ppb.

i. Methyl Chloroform

Carcinogen Status: no

Liquid contact with the eye can cause irritation with some reddening. Short-term skin contact may cause reddening and drying which results in a white scaly surface. Long-term skin contact defats the skin resulting in loss of pliability and cracking.

Inhalation of 1000 ppm for up to 30 minutes can cause mild eye and nasal discomfort; 5,000 ppm for 5 minute results in some incoordination from central nervous system (CNS) depression; 10,000 ppm for 5 minute results in severe incoordination; while 20,000 ppm for one hour can cause unconsciousness and, possibly, death from anesthesia or heart rhythm disturbance. Long term, many years, exposure to 3,000-4,000 ppm 8 hr. TWA may cause weight loss as well as short-term effects; 1,000 ppm 8 hr. TWA will cause short-term effects but no long-term effects are expected; and no adverse effects are expected from 350 ppm 8 hr. TWA.

Skin Adsorption: no

Ingestion of this material will add to the inhalation effects.

j. Petroleum Distillate

Carcinogen Status: no

Liquid petroleum distillate is expected to irritate the eye and cause redness. Prolonged contact with the skin, such as wetted clothing, can cause a burn, the severity of which depends upon the duration and

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pressure of that contact. Early symptoms of inhalation overexposure are nausea, dizziness, and loss of balance; at 85 ppm, these symptoms appear in about 8 hours, at 430 ppm about 3 hours, and 685 ppm about 30 minutes. Longer exposures or higher concentrations can result in cessation of breathing and death. Ingestion of this material will add to the inhaled dose and may damage the liver. Inhalation of 60 ppm 8 hr. TWA for a working lifetime is not expected to cause significant health problems.

Skin Adsorption: no

k. Lead

Carcinogen Status: no

Lead has no significant effect on the skin or eye, other than mechanical irritation. The inhalation and ingestion of lead are additive. Lead intake results in an accumulation of lead in the blood and other body parts. The affect on the body is directly related to the lead content of the blood but the response at different blood lead content varies from person to person. At blood leads up to 40 micrograms per deciliter (ug/dl), adults show no decrement in function; between 40 and 80 ug/dl, adults show reduced fertility and nerve conduction velocity, changes in heme formation and microscopic inclusion of lead in the kidneys. Above 80 ug/dl, the effects, in order of increasing blood lead concentration, expected are anemia, disturbed sleep, inflammation of nerve centers, jaw degeneration, leadline on gums, wrist and foot drop, kidney failure, loss of memory, delirium and coma. Blood lead concentration has been roughly correlated to the inhalation of certain concentrations of airborne lead. At background airborne lead, the blood leads range from 10-15 ug/dl; at 50 ug/m³, the blood leads are about 40 ug/dl; and at 200 ug/m³, they are about 80 ug/dl.

Skin Adsorption: no

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1. Mineral Oil

Carcinogen Status: yes

IARC Carcinogenic Assessment: Animal Positive

Exposures to mineral oil considerably in excess of the acceptable exposure limit, 5 mg/m^3 , may cause chemical pneumonia. Exposures of 5 mg/m^3 are expected to have no adverse effect.

Skin Adsorption: no

m. PCBs

Carcinogen Status: yes

IARC Carcinogenic Assessment: Human suspected

Polychlorinated biphenyls (PCBs) are both toxic and persistent. Persons exposed to PCBs can develop chloracne (a disfiguring skin illness), and based on laboratory animal data, there is a potential for reproductive effects and developmental toxicity as well as oncogenicity in humans exposed to PCBs. PCBs are resistant to degradation and bioaccumulate and bioconcentrate in the fatty tissue of organisms. PCBs are very stable compounds which can persist for years when released into the environment. EPA's Cancer Assessment Group and the Office of Toxic Substances have estimated an increased risk of one cancer developing in a population of one million from a lifetime exposure of 0.0175 microgram PCB per day.

Skin Adsorption: yes

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n. Hydrogen Sulfide

Carcinogen Status: no

Exposure to 20 ppm for several hours results in a feeling of sand in the eye and increased, almost uncontrollable, urge to blink. This concentration may also cause mild corneal damage which readily heals. Inhalation of 20-40 ppm may cause headache, nausea, irritation of the nose and throat. A few hundred ppm may lower blood pressure and affect oxygen utilization after 1/2-1 hour. 500-700 ppm can cause unconsciousness in fifteen minutes or less. 1000 ppm or above causes instantaneous unconsciousness. Prompt removal from exposure and artificial respiration will usually result in complete recovery. Several thousand ppm will usually result in death upon inhalation.

Skin Adsorption: no

o. Iron

Carcinogen Status: no

Iron salts may irritate and temporarily discolor the surface of the eye. Most salts are non-irritating to the skin but may temporarily discolor it. Ingestion of large amounts of iron may result in reduced absorption of iron for several days.

Inhalation of insoluble forms of iron may result in accumulation of the compound in the lung tissue. This accumulation may show up on lung X-rays but produce only minor reductions in lung function. There is evidence that concurrent exposure to silica from high temperature foundry work may cause fibrosis. Certain iron mining operations have been related to increased lung cancer.

Skin Adsorption: no

Inhalation and ingestion of soluble forms of iron will supplement the bodily intake of this nutrient.

p. Manganese

Carcinogen Status: no

Manganese compounds may be damaging to the eyes and skin depending on the pH. Strongly acidic or alkaline materials will be more damaging than those near neutral.

Inhalation of manganese in the higher oxidation states can cause pneumonitis with congestion and swelling. Delayed effects may be the formation of granulomas and abnormal cells. Chronic intake of manganese may result in central nervous system damage similar to Parkinson's Disease. The first symptoms include a lack of energy, sleepiness, and weakness in the legs. Later symptoms include a stoic masklike face, spastic gait and incoordination, and emotional disturbances such as uncontrolled laughter. No cases have been reported among persons chronically exposed to 5 mg/m³ or less.

Skin Adsorption: no

q. Mercury (Inorganic)

Carcinogen Status: no

Mercury salts which readily ionize are very irritating to the eye and mucous membranes. These salts also absorb through the skin in significant amounts. Intake of 700 mg may result in death. Smaller amounts may initially cause inflammation of the pharynx, loss of ability to use or understand language, abdominal pain, nausea, bloody diarrhea, vomiting, and circulatory shock. Later symptoms may be swelling of the salivary glands, inflammation of the stomach, liver, and kidneys, lack of urination, and loosening of the teeth.

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Skin Adsorption: yes

Inhalation of a vapor concentration in the range of 5-10 mg/m³ can cause a metallic taste in the mouth, nausea, abdominal pain, vomiting, diarrhea, headache, and possibly albumin in the urine. Delayed symptoms may include swelling of the salivary glands, inflammation of the stomach and gums, a dark line on the gums, and possibly loose teeth, ulcers on the inside of the mouth, muscle tremors, and psychic disturbances.

Long-term overexposure to mercury can result in muscle tremors, personality changes such as psychosis, insomnia, weight loss, digestive disturbances, visual problems, and kidney damage. Exposure to 0.05 mg/m³ is expected to have no adverse effect over many years.

r. Tetrachloroethylene

Physical Properties

Density	1.62
Vapor Pressure	19 mm Hg at 25C
Flash Point	None
LEL	None
UEL	None
Water Solubility	0.015 g/100 cc
Odor Threshold	50 ppm
Respirator Cartridge Breakthrough:	
Time, min.	107
At Con:	1000 ppm

Toxicity Summary

Carcinogen Status: no

Tetrachloroethylene (Perchloroethylene, PCE) was listed as a "Potentially Toxic Air Pollutant" on February 26, 1986. The NIOSH Recommended Exposure Limit (REL) is given as the "lowest feasible limit." The following health effects of PCE were reviewed and evaluated by the Health Assessment Document published by EPA Office of Health and Environmental Assessment (OHEA) in July 1985.

General decreases in task performance and coordination are the first gross signs of central nervous system and behavioral alterations observed in controlled human studies in which individuals were exposed to about 100 ppm of PCE for up to 7 hours. Other short-term effects of PCE exposure to humans seem to occur beginning at 100 to 200 ppm. Such effects include dizziness, confusion, nausea, headache and irritation of the eye and mucous tissue. Higher levels of exposure increase the symptoms and eventually produce faintness and unconsciousness. Long-term exposures are reported to make the above symptoms more pervasive and also to affect short-term memory and produce disorientation, irritability, ataxia and sleep disturbance. Newer, more sensitive methods, better experimental control, more quantitative analysis, and a wider range of dependent variables could demonstrate effects at lower levels.

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Clear evidence for carcinogenicity of PCE in animals has been cited in the March 1986 Addendum to the Health Assessment Document for Tetrachloroethylene, and in a February 1987 Technical Report on Toxicology and Carcinogenesis Studies of Tetrachloroethylene by the National Toxicology Program. PCE is cited by the EPA as a probably human carcinogen. The National Primary Drinking Water Regulations cite an estimated one in one million lifetime cancer risk at a chronic exposure of 0.67 ppb (calculated for a 70 kg adult drinking an average of 2 liters of water per day for an average lifetime of 70 years).

Soil Adsorption: no

s. Chloroform

Carcinogen Status: yes

IARC Carcinogenic Assessment: Human suspected

NTP: yes

Chloroform (Trichloromethane) is classified by the EPA Chemical Emergency Preparedness Program as moderately toxic. The NIOSH REL has been established at 2 ppm for a 60-minute ceiling based upon its potential as an "occupational carcinogen."

Probable oral lethal dose for humans is 0.5 to 5 g/kg (between 1 ounce and 1 pint) for a 150 lb person. The mean lethal dose is probably near 44 g. It is a central nervous system depressant and a gastrointestinal irritant and, at high concentrations, has caused rapid death attributable to cardiac arrest and delayed death from liver and kidney damage.

Symptoms of acute exposure include fainting sensation, vomiting, dizziness, salivation, nausea, fatigue, and headache. Other symptoms of exposure to high concentrations are respiratory depression, coma, kidney damage, and liver damage. Liquid in the eye causes tearing and conjunctivitis. Symptoms of chronic exposure include loss of appetite, hallucinations, moodiness, and physical and mental sluggishness.

Skin Adsorption: no

Trichloromethane is rated by the EPA as a probable human carcinogen. Based upon the potency slope modeled by EPA's Carcinogen Assessment Group, there is an estimated one in one million cancer risk associated with a continuous lifetime exposure of 0.43 ppb in drinking water.

t. Ionizing Radiation

In general, the hazard from external radiation increases through the series in direct relation to the radiations ability to penetrate tissue, alpha, beta, and gamma. On the other hand, alpha and beta emitting species are very hazardous when taken into the body with the exception of beta emitting tritium. Many alpha and beta emitters are incorporated in body tissue where they may remain for a long time and damage the surrounding tissue. Tritium usually enters the body as part of a water molecule which is then readily excreted, minimizing the time during which damage may occur. Additional instruction will be provided by SRP HP Area Survey when suspect sites have been identified.

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u. Di-sec-octyl phthalate

Physical Properties

B.P. 387° at 5 TORR
V.P. <0.01 TORR at 20°C
F.P. 325°F
LEL 0.3 at 474°F
UEL Not Available
Water Solubility 0.5 g/100 ml
Respirator Cartridge breakthrough >100 min. at 1000 ppm density 1 g/cc

Toxicity Summary

Carcinogen Status: no

This material has little impact on the skin or eyes. Inhalation of large amounts of mist may cause an inflammation of the lungs. Ingestion of 3-1/2 lbs. may be fatal. Ingestion of 4 grams per day should show no effect, while higher doses may affect the liver and kidney. Higher doses fed to laboratory animals resulted in increased number of tumors.

Skin Adsorption: no

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v. Ethylene Glycol

Physical Properties

F.P.	240°F
B.P.	197.6°C
V.P.	0.06 TORR at 20°C
LEL	3.2%
UEL	Not Available
Density	1.11 g/cc
Water Solubility	miscible
Respirator cartridge breakthrough >100 min. at 1000 ppm	

Toxicity Summary

Carcinogen Status: no

This material may irritate the eye. Prolonged contact will soften the skin and significant amounts can absorb through the skin. Inhalation of 100 ppm may cause throat irritation, while 500-1000 ppm can cause intoxication after a 1 hour exposure. Repeated exposures to 12 ppm may cause headache, throat irritation and backache. Ingestion of 20-40 cc (1/2-1 ounce) can cause intoxication, 50-80 cc may cause headache, random eye movement, high blood lymphocyte count and kidney failure, and 90 cc can cause death. Inhalation, ingestion and skin absorption of this material is addictive. Long term intake may enhance the generation of kidney stones.

Skin Adsorption: no

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w. Lithium (Soluble Compounds)

Toxicity Summary

Carcinogen Status: no

This material may irritate the skin, eyes and respiratory system. Intake of 1/8 teaspoonful may cause vomiting, nausea, and excessive urination. Between 1/8 and 1/4 teaspoonful, may cause eruptions of the hair follicles (which clear when intake ceases) and, when repeated over a few weeks, kidney damage indicated by excessive urination dry mouth, dehydration, fatigue, weight loss and loss of appetite, central nervous system changes such as tremors, ringing in the ears, slurred speech, drowsiness, giddiness and muscle weakness, intestinal irritation such as diarrhea, vomiting and bloody stools, and birth defects. Intake of 1/4 to 1/2 teaspoonful may result in blurred vision in addition to the above effects. Low salt or sodium diets increase the response to a specific dose or reduce the dose to attain a specific response. The amounts inhaled, absorbed through the skin, and ingested are additive. An acceptable exposure limit of 5 mg/m³ has been suggested.

Skin Adsorption: no

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APPENDIX H

**MAXIMUM PERMISSIBLE CONCENTRATIONS IN
AIR AND WATER FOR SELECTED RADIONUCLIDES**

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MAXIMUM PERMISSIBLE CONCENTRATIONS
IN AIR AND WATER FOR OCCUPATIONAL EXPOSURES¹
OF RADIONUCLIDES (uCi/ml)

Radionuclide	Principal Emission(s)	Radiotoxicity ²	(MPC) _w ³	(MPC) _a ⁴
Cobalt-60	beta; gamma	moderate	10 ⁻³	3 x 10 ⁻⁷
Strontium-90	beta	very high	4 x 10 ⁻⁶	3 x 10 ⁻¹⁰
Cesium-137	beta; gamma	moderate	4 x 10 ⁻⁴	6 x 10 ⁻⁸
Plutonium-239	alpha	very high	10 ⁻⁴	2 x 10 ⁻¹²
Plutonium-239	alpha	very high	10 ⁻⁴	2 x 10 ⁻¹²
Tritium	beta	slight	0.1	5 x 10 ⁻⁶
Unidentified	alpha	-	10 ⁻⁷	4 x 10 ⁻¹³
Unidentified	beta	-	10 ⁻⁷	4 x 10 ⁻¹³

- ¹ From "Radiological Health Handbook, " U.S. Dept. of Health, Education and Welfare, Washington, D.C.
- ² From "Safe Handling of Radionuclides," Safety Series No. 1, International Atomic Energy Agency, Vienna.
- ³ (MPC)_w = Maximum Permissible Concentration in water except (MPCU)_w for unidentified radionuclides.
- ⁴ (MPC)_a = Maximum Permissible Concentration in air except (MPCU)_a for unidentified radionuclides.

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APPENDIX I

FIELD CLASSIFICATION OF SEDIMENTS

APPENDIX I: FIELD CLASSIFICATION OF SEDIMENTS

I. INTRODUCTION

The classification system presented in this document is based upon information from a number of sources. The methods provided here are designed to be useful for classifying the sediments underlying the Savannah River Site (SRS), to be consistent with previous SRS practice, and to be consistent with the Savannah River Laboratory (SRL) laboratory sediment classification system.

Objectives: The objectives of the system are listed below:

- to provide a method by which consistent descriptions may be made
- to provide standard terms, definitions and symbols suitable for use at SRS
- to provide a classification system that will result in the production of field logs that will be useful in future drilling projects
- to provide a system that will result in field logs useful for stratigraphic and hydrogeologic interpretations.

The formats used are consistent with standard geologic practice and adopted specifically for use under the conditions encountered at SRS.

II. GENERAL CLASSIFICATION SYSTEM

Equipment - Equipment to be maintained at the site consists of standard tools for field classification and for handling of cores.

1. Pencils
2. Clip board, preferably aluminum water resistant 9" x 12"
3. Straight edge
4. Engineers scale
5. Engineers rule 6 ft. folding
6. Pocket knife, locking blade
7. Tape 100 ft.
8. Indelible felt-tip marking pens
9. Calculator
10. Dilute hydrochloric acid (10%)
11. Hand lens
12. Grain size chart
13. Percentage charts
14. Roundness and sphericity charts
15. MunsellTM color chart, GSA.

Procedure - The classification of a particular sediment will be recorded on the form shown as Figure 1. The procedure to be followed for field classification of sediments is outlined as follows:

1. Determine the major soil type present - At SRS this usually will be based upon major grain-size characteristics.
2. Estimate volume percent of secondary and minor constituents present - Generally this will involve estimating percentages of various grain sizes to further define the overall grain size distribution.

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FIELD GEOLOGIC LOG

PROJECT				DATE	SHEET
REFERENCE DATUM				DRILLING CONTRACTOR	
WELL NO.				DRILLER	
LOGGED BY				DRILLING METHOD	
COMPANY					

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	0				
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	0				
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	0				

3. Describe colors - Colors will be determined from comparison with the GSA (MunsellTM) color chart. The written color description shown on the chart is sufficient.
4. Describe other textural characteristics - This description will generally include sorting, roundness, etc.
5. Describe sedimentary structures and accessory minerals.
6. Estimate moisture content.
7. Provide drilling comments - The drilling activities should be described in detail. These may be used to estimate sediment types if no recovery is obtained. The comments could also be useful for future drilling projects.

Order of Description - This section presents a general order of description. Each line under the major sediment type should be indented. Each part of the description should be followed by a comma, except the final part, which should be followed by a period. The general order of description to be used for preparing field logs is as follows:

1. Major sediment type (capitalized and underlined),
2. Grain size distribution (coarse-grained sediments),
3. Color,
4. Other textural characteristics - sorting, roundness, sphericity,
5. Cement and/or matrix materials,
6. Sedimentary structures,

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7. Fossils and accessory minerals,
8. Degree of saturation.

Major Sediment Type - The two major sediment types commonly encountered at SRS are granular and carbonaceous. Occasionally, indurated rocks are encountered but these are rare. The distinction between granular and carbonaceous sediments is made by observing its reaction with dilute hydrochloric acid. Granular sediments may be subdivided into coarse-grained and fine-grained sediments. Coarse-grained sediments consist of grains that are larger than 0.063mm. Fine-grained sediments consist of grains that are smaller than 0.063mm. Carbonaceous sediments may be divided into limestone and dolostone. Examples of major sediment types are as follows:

Coarse Grained

Cobbles
Pebbles
Granules
Sand

Fine Grained

Silt
Clay

Carbonaceous

Limestone
Dolomitic Limestone
Calcareous Dolostone
Dolostone

The major sediment type will be selected based upon volume percent estimates. The sediment type having the largest volume percent will be considered the major constituent.

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III. GRANULAR SEDIMENTS

A. Coarse-Grained Sediments

Grain Size Classification - The grain-size classification system selected for use at SRS is based upon the Udden-Wentworth Scale. This scale is consistent with SRL core logging practices. The field grain-size classification system to be used for the range of sediments typically encountered in drill holes at SRS is as follows:

<u>Classification</u>	<u>Size (mm)</u>
Small Cobbles	64
Very Coarse Pebbles	32 - 64
Coarse Pebbles	16 - 32
Medium Pebbles	8-16
Fine Pebbles	4 - 8
Granules (very fine pebbles)	2 - 4
Very Coarse Sand	1/2 - 1
Medium Sand	1/4 - 1/2
Fine Sand	1/8 - 1/4
Very Fine Sand	/16 - 1/8
Silt	1/256 - 1/16
Clay	1/256

A typical classification is:

SAND, fine to very coarse grained.

Color - Color descriptions of sediments from drill holes at SRS are to be based upon comparison of the sediment with a GSA Rock Color Chart (MunsellTM Chart). The colors of sediment samples may be a mass effect of the colors of constituent grains, or may be the color of the cement or matrix material. Color should be described on wet samples under 10-power magnification (Swanson, 1981).

The most important staining or coloring agents are:

- Ferruginous,
- Carbonaceous,
- Siliceous, and
- Calcareous materials.

Limonite or hematite yield yellow, red, or brown colors. Carbonaceous or phosphatic material, iron sulfide, or manganese yield gray to black colors. Glauconite, ferrous iron, serpentine, chlorite, and epidote impart green coloring. Red or orange mottlings are derived from surface weathering or subsurface oxidation (Swanson, 1981). Drilling mud additives may also cause staining.

A typical classification is:

SAND, fine to very fine grained, dark yellowish orange.

Texture - The texture of a sediment is described by the grain size, arrangement and shape. Grain size is discussed previously. Sorting is a measure of the range of grain-size classes present in a particular sediment sample Mayer (1964). Several sorting classifications are available including Payne (1942) and Compton (1962). The classification system used by SRL for laboratory soils analysis may also be applied to field classification as follows:

Well Sorted: 90% of sample within 2 size classes

Moderately Sorted: 90% of sample within 4 size classes

Poorly Sorted: 90% of sample within 5 to 6 size classes

Very Poorly Sorted: 90% of sample greater than 6 size classes.

If the predominant size is coarse grained, include the fine-grained constituents when describing sorting. If the predominant size is fine grained, describe the sorting of the coarse-grained fraction only or omit.

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A typical description is:

SAND, fine to medium grained, dark yellowish orange, well sorted.

Grain shape consists of roundness and sphericity. Roundness is classified by comparison with charts (AGI Data Sheet 18.1), and by the following (Swanson, 1981):

<u>Angular:</u>	Edges and corners are sharp; little or no evidence of wear.
<u>Subangular:</u>	Faces untouched but edges and corners are rounded.
<u>Subrounded:</u>	Edges and corners rounded to smooth curves; areas of original faces reduced.
<u>Rounded:</u>	Original faces almost completely destroyed, but some flat faces are present; all original edges and corners smoothed to broad curves.
<u>Well Rounded:</u>	No original faces, edges, or corners remain; entire surface consists of broad curves, flat areas are absent.

A typical description is:

SAND, fine to coarse grained, dark yellowish orange, moderately sorted, subrounded to subangular.

The classification system for sphericity ranges from spherical to discoidal. Sphericity is described by comparison with charts (AGI Data Sheet 18.1). Describe roundness of all coarse-grained sediments. Describe sphericity as classified for pebble size and larger particles.

A typical description is:

SAND, fine to very coarse grained, trace granules, dark yellowish orange, poorly sorted, angular, discoidal.

Cement and/or Matrix Material - Cement refers to a chemical precipitate deposited around the grains and in the interstices of a sediment as aggregates of crystals or as growths on grains of the same composition. The matrix consists of small individual grains that fill interstices between the larger grains. Cement is deposited chemically and matrix material is deposited mechanically (Swanson, 1981).

Siliceous and calcareous cements are among the most common encountered in sediments. Silica cement is common to quartz sandstone. Opal, chalcedony and chert are other siliceous cements. Calcite and dolomite are calcareous cements. Other types of cementing materials include hematite, limonite, and manganese oxide.

Matrix materials are generally silt and clay. These are described under grain-size classification or as minor or secondary constituents. Methods for preparing these descriptions will be discussed in a later section.

A typical description is:

SANDSTONE, fine grained, reddish brown, well sorted, subrounded, hematite cement.

Sedimentary Structures - Sedimentary structures such as cross-bedding lamination and bed thickness should be described. Care should be taken in removing the core from the core barrel so that sedimentary structures are not destroyed. Additional structures may include fractures and fracture patterns, graded bedding, banding, and modular or concretion characteristics (Leroy, 1977). Particular attention should be paid to repeated structural features.

Structural features of fine-grained materials may be described as massive, lumpy, platy, laminated, fissile, splintering, flaky, and fractured. Bed thickness may generally be described from cores. The following thickness classification (McCollough, 1984) should be used for field classification:

<u>Classification</u>	<u>Thickness</u>
Very thickly bedded	1 m
Thickly bedded	30 - 100 cm
Medium bedded	10 - 30 cm
Very thinly bedded	1 - 3 cm
Thickly laminated	3 - 10 cm
Thinly laminated	3 mm

A typical description is:

SAND, fine to medium grained, white to dark yellowish orange, well sorted, angular, thinly laminated.

Fossils and Accessory Minerals - Fossils are generally fragmented in cores and drill holes however, some whole mega fossils may be found in cores (Mayer, 1964). Some typical fossils that may be encountered are:

Sponge Spicules
Pelecypods
Crassostrea Gigantissima
Barnacle
Ostracode
Bryozoan
Echinoid and spine
Small Gastropods.

The fossils present in a sample may be difficult to classify, depending on the quality of the specimen.

A typical description is:

SAND, fine grained, light gray, well sorted, subrounded, calcareous cement, trace small gastropods.

Accessory minerals constitute only a minor percentage of the bulk of a sediment sample. However, these minerals may provide significant indicators of both depositional environment as well as correlation.

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Common accessory minerals are:

Glaucanite
Pyrite
Feldspar
Mica
Siderite
Lignite
Heavy Minerals
Chert
Manganese oxide.

Lignite and manganese oxide are frequently encountered and frequently confused, one with the other.

A typical description is:

SAND, fine to very coarse grained, dark yellowish orange, moderately sorted, subrounded, trace mica.

Degree of Saturation - The degree of saturation may be estimated from cores. Care must be taken when samples are obtained from mud rotary drilling techniques. The major classification is as follows:

<u>Description</u>	<u>Criteria</u>
Dry	Absence of moisture, dry to the touch
Moist	Damp but no visible water
Saturated	Visible free water, usually occurs in sediments below water table.

If large intervals of core are saturated, this description may be omitted after the initial saturated intervals described.

A typical description is:

SAND, fine grained, dark yellowish orange, well sorted, angular to subrounded, moist.

B. Fine-Grained Sediments

Fine-grained sediments consist of silt and clay. Classification of fine-grained sediments may be based upon mineralogy, grain-size, or physical behavior. Mineralogy is difficult to determine in the field without previous geologic information based upon such techniques as X-ray diffraction. Grain-size is difficult to estimate because of the size classes involved and the limitations imposed by field equipment such as hand lenses. Therefore, the field classification system used at SRS is based primarily on physical behavior with limited consideration of grain-size and known mineralogy. Two common field tests used to distinguish silt from clay are the thread test and the smear test. The thread test consists of rolling the thinnest thread possible while adjusting the water content. The thinner the thread, the higher the clay content. The thread test is performed as described below.

Select a representative sample approximately 1/2 cubic inch in volume and add water, if necessary, until the soil has a soft but not sticky consistency. Roll the sample into the smallest thread possible, adjusting the water content as necessary. The following table is useful for estimating silt and clay percentages:

<u>Thread Diameter</u>	<u>Classification</u>
No threads rolled	Silt
1/4 inch	Silt, clay (0-10%)
1/8 to 1/16 inch	Silt, clay (15-45%)
1/32 inch	Clay, silt (15-45%)
1/64 inch	Clay, silt (0-10%)

When mixtures of fine grained and coarse grained materials are encountered, the thread test may be difficult to use. The test should be used after removing materials longer than the number 40 sieve size from the sample. The smear test consists of smearing a pat of soil between the fingers or in the palm of the hand and observing the luster of the smears. A dull smear is characteristic of silt. A smooth smear and a high degree of stickiness is indicative of high plasticity and such a sample, therefore, may be classified as having a high clay content.

An additional aid in distinguishing silt and clay is by visual inspection under a hand lens. If grains are visible to indistinctly visible under 6.3x magnification, the sample is silt. If the sample has no visible grains under 6.3x magnification, then the sample is clay (Mayer, 1964). Since most hand lenses are equipped with 10x magnification, this method is approximate as some clay grains may be indistinctly visible under 10x magnification.

The above tests are approximate and may not correlate precisely to results of laboratory grain size or mineralogical analyses. The tests do provide a method for consistent field classification, however.

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Colors of fine-grained sediments are also described using the GSA Rock Color Chart. Two color characteristics common of fine-grained sediments are banding and mottling. If layers of the same material having different colors in layers occur, the sediment is banded. Mottling is a variation in color occurring in localized patches or spots.

Shape parameters and sorting are not described for fine-grained sediments. The consistency (compactness, density) or hardness of the fine-grained material should, however, be described. The following field classification test (Howard, 1976) may be used for descriptive purposes:

<u>Consistency</u>	<u>Identification Procedure</u>
Very soft	Easily penetrate soil several inches using high thumb pressure
Soft	Penetrate soil about 1 inch using high thumb pressure
Firm	Soil indented less than 1/4 inch using high thumb pressure
Hard	Soil not indented using high thumb pressure; readily indented by using thumbnail
Very hard	Not indented with thumbnail.

Sedimentary Structure - Fine-grained sediments may be stratified or laminated. The bedding characteristics of fine-grained material may be classified using the same criteria as for coarse-grained sediments. Fine-grained sediments may be fissured, blocky and/or slickensided. A slickensided clay is characterized by striated and polished surfaces of easy parting resulting from relative movement of the surfaces. The striations are generally parallel to the direction of movement.

The amount and type of organic material should also be described. Moisture content is described as for coarse-grained sediments.

A typical description is:

CLAY, reddish brown to yellowish brown, mottled, hard, thinly bedded, slickensided, dry.

SILT, double yellowish orange, soft, saturated.

IV. CARBONACEOUS SEDIMENT CLASSIFICATION

For the purposes of field description, carbonates will be classified as either limestone or dolostone. The following table (McPater, 1983), which is based on the reaction of the material with dilute (10%) hydrochloric acid, is useful for estimating the percentage of calcite in the sample:

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<u>Lithology</u>	<u>% CaCO₃</u>	<u>Reaction</u>
Limestone	90-100	(1) Instant violent reaction. (2) Sample is made buoyant by escaping carbon dioxide gas, and floats on the surface. (3) Dissolution of sample in five minutes.
Dolomitic Limestone	50-90	(1) Moderate, but continuous reaction.
Calcareous Dolomite	10-50	(1) Weak, but increasing reaction.
Dolomite	10	(1) Slow reaction up to thirty minutes. (2) Acid turns milky.

A typical classification is:

LIMESTONE, dolomitic (35%), light gray.

If the dominant mineral is dolomite, the rock is classified as a dolostone or a calcareous dolostone. Note the color of the rock and attempt to identify any grains in the rock. Dolomitization sometimes masks the original texture of a rock, therefore making this task difficult.

A typical classification is:

DOLOSTONE, calcareous (30-40%) light gray.

If the predominant mineral is calcite, the term limestone along with terms described elsewhere in this classification system should be sufficient in most cases.

V. COMBINATIONS OF SEDIMENTS

Combinations of sediments particularly fine and coarse grained, are often encountered at SRS. Mixtures of sediments may be classified by first determining the major sediment type, then determining secondary and minor constituents. The major sediment type is defined in a previous section. Secondary constituents are present in lesser amounts than the major constituent, but also represent greater than 25 percent of the sample. Minor constituents makeup less than 25 percent of the sample.

If secondary constituents are present, modifiers may be used following the major sediment type. A modifier will be used in describing constituents having percentages greater than 25 but less than the percentage of the major constituent. Modifiers such as clayey, sandy, silty, pebbly, calcareous, and dolomitic may be used.

If a minor constituent is present in a percentage between 5 and 25, the term "with" will be used. If a constituent is present, but the percentage is less than 5, use trace. Percentage estimates should also be used with modifiers other than trace. The percentage estimates should be placed in parentheses. In general, the major constituent should be followed immediately by modifiers indicating the secondary constituents. The minor constituents should usually be last. For example:

SAND, clayey (40-45%), trace silt.

SAND, calcareous (30-35%), trace clay.

SAND, clayey (30-35%), with silt (10-15%).

If the minor constituent and the major constituent are both coarse grained, and subsequent descriptions generally pertain to both, the minor constituent may follow the grain size classification. For example:

SAND, fine to very coarse grained, trace pebbles, dark yellowish orange, poorly sorted, subrounded, discoidal, saturated.

In this description, it is understood, by definition, that discoidal refers only to the pebbles. However, the color, sorting, roundness, and moisture descriptions pertain to both the sand and the pebbles.

The characteristics of the major constituent should be described first. Secondary constituents should be described second. Minor constituents usually should be described third. Descriptions of major and secondary constituents should be separated by a semicolon. Examples are:

CLAY, sandy (25-30%), dark yellowish orange to dusky red, hard, mottled; fine grained, trace silt, dry.

SAND, fine to medium grained, light brown, poorly sorted, subangular, with clay (10-15%), trace fine pebbles, saturated.

CLAY, hard, dark yellowish orange to dark gray, thinly laminated, trace fine-grained sand, silt, and fibrous organics, moist.

CLAY, sandy, (25-30%), pebbly (25-30%), dark yellowish orange, hard, banded, thickly bedded; sand and pebbles coarse to very coarse grained, moderately sorted, subrounded, discoidal, saturated.

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Mixtures of granular and calcareous sediments are commonly encountered. Calcareous materials may be classified by using modifiers:

Percent Calcareous

Material

Classification

>25% Major Constituent

Calcareous

5-25%

with Calcareous material

1-5%

Trace Calcareous Material

Examples are:

SAND, fine grained, light gray, well sorted, subangular, with calcareous material (10-15%), saturated.

CLAY, soft, light gray, with calcareous material (15-20%), saturated.

SAND, calcareous (30-40%), fine to medium grained, light gray, well sorted, subangular, saturated.

The term "marl" sometimes appears in logs and in literature. If this term appears, the following definition is used; 25 percent of the size fraction is larger than clay size and 30-70 percent is calcite (Berger, 1974). The use of this term should be avoided.

VI. PREPARATION OF GEOLOGIC LOGS

Descriptions of geologic samples should be recorded on the standard SRS field log form (Figure 1). The description should be neatly printed and legible. The logs should be written dark enough for copying. No abbreviations should be used since these may lead to confusion later. Each log should be prepared with a lithologic symbol log drawn under the Lithology column. Standard symbols for preparing the log are shown in Figure 2. These

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symbols, and their combinations should be sufficient to describe most of the sediments encountered at SRS.

Drilling comments should also be included in the field log. The behavior of drilling tools provides valuable insight regarding subsurface conditions. Such occurrences as changes in the penetration rate and the degree of chattering of the bit provides insight on particularly important when the core recovery percentages are low. Zones where significant amounts of drilling fluid are lost are important to note. Changes made to drilling fluid dynamics should be included. Of particular importance are zones where circulation is lost entirely. Adjustments made to regain circulation should be briefly described. Any adjustments to coring tools to enhance the percent of recovery should be noted. These types of descriptions are valuable for interpreting the geologic conditions, and provide us information for future drilling projects conducted under similar geologic conditions.

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APPENDIX J

**THE WEATHER INFORMATION AND DISPLAY (WIND)
EMERGENCY RESPONSE SYSTEM**

THE WEATHER INFORMATION AND DISPLAY EMERGENCY RESPONSE SYSTEM

NUCLEAR SAFETY

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The Weather Information and Display (WIND) system is an automated emergency response system for real-time predictions of the consequences of liquid and airborne releases from Savannah River Plant (SRP). The system consists of a minicomputer and associated peripherals necessary for acquisition and handling of large amounts of meteorological data from a local tower network and the National Weather Service. The minicomputer uses these data and several predictive models to assess the impact of accidental releases. The system is fast and easy to use, and output is displayed both in tabular form and as trajectory map plots for quick interpretation. The rapid response capabilities of the WIND system have been demonstrated in support of SRP operations.

I. INTRODUCTION

An automated emergency response system, the Weather Information and Display (WIND) system, has been developed at the Savannah River Plant (SRP) in South Carolina. This system predicts the real-time consequences of both airborne and liquid releases of radionuclides or toxic chemicals from production areas distributed over 800 km² at SRP. The system uses data from a local meteorological network, along with data from the National Weather Service (NWS), to predict downwind concentrations and doses from atmospheric releases. Dispersion parameters developed from tracer studies of the many SRP streams and the Savannah River are used to predict downstream concentrations and travel times for liquid releases to plant streams.

Operated by E. I. du Pont de Nemours & Com-

pany, SRP produces nuclear materials for the U.S. Department of Energy (DOE). As shown in Fig. 1, SRP is a complete nuclear complex. Fuel and target assemblies are fabricated on the plant site and irradiated in the SRP production reactors (three currently operating). The irradiated assemblies are then taken to the separation facilities for chemical processing to recover the isotopes of interest. The remaining radioactive waste material is stored in large underground steel tanks (for liquid waste) or at a burial ground (for solid waste and contaminated materials used in processing). In addition, the heavy water, used as primary coolant and moderator in the production reactors, is also produced on the plant site.

In this paper, the various components of the WIND system are described. These include the meteorological input data, the minicomputer and associated peripherals, and the transport models used to predict the consequences of releases. Examples of the system output are presented, and an example of system performance is described.

II. METEOROLOGICAL DATA

II.A. Local

Local meteorological data are obtained from seven instrumented towers located adjacent to the seven production areas on SRP. Each tower is 62 m in height, corresponding to the stack heights in each operating area. A turbulence-quality vector vane is located at the top of each tower, and provides data on wind speed and direction, and horizontal and vertical wind fluctuations. In addition, an instrumented 330-m television tower (WJBF-TV) located ~15 km northwest of the plant boundary also collects meteorological data. Instruments are located at seven levels between 10 and 304 m above the ground. The locations of the television tower and

Fig. 1. The SRP site (T denotes the 62-m tower; A denotes the Doppler acoustic echo sounder).

seven production area towers on the SRP site are shown in Fig. 1. The seven meteorological towers and television tower at SRP are monitored by the WIND system minicomputer. The meteorological data are time-averaged over 15-min intervals. The mean wind speeds and directions, along with standard deviations of the horizontal (σ_A) and vertical (σ_g) wind directions, are permanently stored on magnetic tape. The standard deviations are a measure of atmospheric turbulence and determine the rate at which pollutants will disperse. These data are also temporarily stored on disks that are readily accessible by the minicomputer. Quality control is used for 15-min averaged data, and erroneous data are replaced with appropriate estimates. The quality control algorithm is described in detail by Pendergast.¹ Briefly, the algorithm first averages the raw 15-min data from all eight towers. Individual 15-min averages from each tower are then compared to the eight-tower average, and rejected if they deviate from the eight-tower average by more than an empirically specified amount. If any tower is rejected, then the average is recalculated using the remaining seven towers, and the procedure continues. If some disaster took out all eight towers, then wind data from nearby Augusta, Georgia, would be used as a last resort. When data from an individual tower are rejected, they are replaced by the average data from the remaining towers.

III.B. National

Weather data gathered by the NWS are received in the Weather Center Analysis Laboratory (WCAL) by the Automated Field Operations and Service (AFOS) minicomputer system. The AFOS is supported by a network of Weather Forecast Offices throughout the United States. Weather data from any point within the network are available on a "store-and-forward, instant replay basis." Data are received in alphanumeric and graphic display form on color display consoles. Local weather data, state-wide forecasts, or information on any sector within the network can be obtained. If the data requested are not available locally, AFOS will request this data and transmit it within minutes. An AFOS system (in Fig. 2) is currently operational in the WCAL and will be linked to the WIND system in the future, so NWS data can be selectively transferred for use in the emergency response codes.

The WIND system also contains forecasts of winds and turbulence for up to 30 h. These forecasts are generated by the Model Output Statistics (MOS) technique,² in which meteorological variables forecast by the NWS hydrodynamic models [e.g., the limited-area fine mesh (LFM) model] are correlated with SRP observations to form regression equations for site-specific predictions. The MOS technique thus

Fig. 2. The APOS computer systems.

accounts for the effects of local topography on winds. It also allows prediction of variables not predicted by the LFM, such as σ_A and σ_g , through statistical correlation with variables that are predicted by the LFM. The WIND system thus has the ability to make predictions of the future movement and dispersal of pollutants.

III. THE WIND SYSTEM

The WIND system consists of a minicomputer and associated peripherals necessary for handling large amounts of meteorological data and for computing requirements of models that predict the movement and dispersion of accidental releases. The heart of the WIND system is a PDP 11/40 minicomputer by Digital Equipment Corporation. The PDP computer is used to archive the meteorological data, to perform research and development, and to provide real-time emergency response for the SRP site. Input channels collect meteorological data from the television tower, the seven-tower system, and both teletype circuits. The minicomputer drives graphical display units in the WCAL, the SRP Emergency Operating Center (EOC), and the seven production areas. The EOC is staffed 24 h/day with a small crew that monitors the SRP operations. In an emergency situation, the center is fully activated and staffed by SRP, Savannah River Laboratory (SRL), and DOE management and technical personnel. An operating crew of shift SRP personnel are the first to arrive at the EOC; they have been trained to use the WIND system.

A computer terminal in each production area is linked to the WIND system and has access to the system data and emergency response codes. In the

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event of an accident within a specific area, health protection personnel in the production area can use the system. Each area terminal is tailored to meet the area's needs and provide information pertinent for consequence-limiting decisions.

An additional minicomputer is being added to the WIND system. The new computer is a VAX 11/780, also by Digital Equipment Corporation, which has 512 000 bytes of high-speed memory. After installation is completed, and the VAX 11/780 is linked to the PDP 11/40, the terminal system will be operated from the VAX 11/780. The PDP 11/40 will then be used solely for data acquisition and archiving, and all computing will be performed by the VAX 11/780. The increased memory will allow the implementation of more sophisticated models, the use of additional meteorological information, the use of real-time stack monitoring data, and the use of real-time environmental monitoring data.

Another system,³ called the Atmospheric Release Advisory Capability (ARAC), is operated by Lawrence Livermore National Laboratory (LLNL). An ARAC site terminal is located in the WCAL for use in evaluating the consequences of atmospheric releases from SRP in the event of a WIND system failure. The two systems have also been used to cross-check predictions. The ARAC system was used as a backup system during the SRP incident described later in this paper.

IV. TRANSPORT MODELS

IV.A. Atmospheric

Emergency response codes must execute rapidly, so mathematical economy must be balanced with physical realism in their formulation. The simplified atmospheric transport, diffusion, and deposition model described below was developed by Garrett and Murphy.⁴

The fundamental equation to be solved is the general advection-diffusion equation, including gravitational settling, rainout, and radioactive decay:

$$\frac{\partial X}{\partial t} + u \frac{\partial X}{\partial x} - v_s \frac{\partial X}{\partial z} = -\Lambda_R X - kX - \frac{\partial u'X'}{\partial x} - \frac{\partial v'X'}{\partial y} - \frac{\partial w'X'}{\partial z} \quad (1)$$

where

X = concentration (g/m³ or Ci/m³)

t = time

u = mean wind speed (directed along x axis, m/s)

v_s = gravitational settling velocity (always >0, m/s)

z = vertical axis

Λ_R = rainout coefficient (s⁻¹)

k = decay constant for radionuclides

$\overline{u'X'}, \overline{v'X'}, \overline{w'X'}$ = turbulent flux terms along the x , y , and z axes, respectively.

General analytical solutions to Eq. (1) are not available. However, if the turbulent fluxes are modeled by diffusion terms and the mixing coefficients (eddy viscosities) are assumed constant, and Λ_R , k , v_s , and u are treated as constants over suitably small intervals of time and space, a Gaussian solution satisfies Eq. (1). But the earth's surface limits downward diffusion and removes material from a pollutant cloud; therefore, boundary effects must also be modeled with a surface deposition velocity. This complication requires that numerical methods be used to solve Eq. (1).

To avoid time-consuming numerical methods as much as possible, operationally oriented model-makers have resorted to heuristic alterations of the reflecting (nondeposition) Gaussian model. Two of the better known attempts are those by Van der Hoven⁵ and Horst.⁶ The Horst model is considered to be better because deposition depletes the cloud at the surface, rather than instantaneously throughout the entire cloud. However, the disadvantage of the Horst model is that it requires more numerical integration than the Van der Hoven source depletion model. The Horst model also does not consider basic atmospheric boundary layer features, such as the surface layer and the mixed-layer depth, which are relevant to the diffusion-deposition problem. These boundary layer features were used to scale and simplify Eq. (1). The result was two ordinary differential equations that govern vertical transport of pollutants to the surface layer from the well-mixed layer above as a function of time. Pollutant concentrations in the horizontal plane are not determined by these equations, so Gaussian distributions are assumed (as the best approximation available). The material deposited over a time step is evenly distributed along the cloud track and according to a Gaussian distribution along the lateral axis.

Diffusion parameters for an instantaneous or puff release are calculated from equations developed by F. B. Smith and documented by Pasquill.⁷ For continuous (plume) releases, the horizontal diffusion parameters are calculated from equations developed by Pasquill.⁸ Vertical diffusion parameters for plume releases are calculated from equations developed by G. A. Briggs and reviewed by Gifford.⁹ Calculation of the diffusion parameters requires the standard

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deviations of the horizontal and vertical wind fluctuations as input. These quantities are determined directly from SRP meteorological tower data.

The mathematical model for calculating the deposition velocity (v_d) contains separate algorithms for gaseous and particle deposition. The particle deposition algorithm requires an initial particle size distribution function. The distribution function measured at SRP for particles containing trace amounts of ^{239}Pu and ^{240}Pu is lognormal and truncated at 15 μm . The distribution function is divided into eight size classes, each of which is treated separately in the atmospheric transport computations.

Given the distribution function, the deposition velocity can be calculated with the resistance analogue method.¹⁰ A resistance is defined as the ratio of a flux to a concentration. Separate resistances describe transfer of pollutants through the air above a forest canopy (r_a), within the canopy (r_b), and an individual leaf or pine needle boundary layer (r_l). The deposition velocity for particles is defined by these resistances and by the gravitational settling velocity (v_g):

$$v_d = \frac{1}{r_a + r_b + r_l} + v_g \quad (2)$$

The resistance r_a and r_b in Eq. (2) are determined from basic atmospheric surface layer theory, and r_l requires calculation of the Brownian diffusivity of the particle. The settling velocity (v_g) is calculated from Stokes' Law.

Gas deposition is also modeled with the resistance method, but the calculation is more complicated because gases are removed from the air by vegetation and by soil microorganisms. Metabolic and stomatal resistances for vegetation and metabolic resistances for soil microorganisms replace the leaf boundary layer resistance for the particle deposition calculation.

Transport and diffusion of nondepositing radionuclides, such as noble gases, is modeled by a Gaussian distribution bounded by the ground and the top of the turbulent or "well-mixed" layer of the atmosphere. In the case of a noble gas release, the dose is calculated by integrating the gamma flux over the Gaussian cloud.

IV.B. Stream or River

Radionuclides or other pollutants in a moving fluid stream¹¹ are transported by the combined effects of turbulent diffusion and differential mass transfer. These combined effects can be represented in one dimension as

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial x} D \frac{\partial C}{\partial x} - \frac{\partial}{\partial x} (UC) \quad (3)$$

where

C = concentration of pollutant in stream or river at a point x and time t

D = dispersion coefficient at a point x

U = longitudinal transport velocity at a point x .

In the derivation of Eq. (3), conservative constituents were assumed, i.e., radioactive decay and pollutant interaction such as sorption/desorption, volatilization, and neutralization were not accounted for. Also, departure of the stream flow behavior from the one-dimensional bulk dispersion model description [Eq. (3)] due to the presence of stagnant flow zones is neglected. Thus the solution of Eq. (3) represents a conservative prediction of the concentrations and travel times.

Transport velocities and dispersion coefficients for the SRP streams and the Savannah River have been determined by an extensive series of tracer studies. These data are available for distinct stream/river segments, called "reaches." Equation (3) is solved by a routing procedure in which the release profile is divided up into a large number of small segments that are treated as instantaneous point sources. Individual segments of the release profile are routed from reach to reach as the pollutant is transported through the plant stream system to the Savannah River and then to the Atlantic Ocean.

V. SAMPLE CALCULATIONS

Examples of output from the different codes on the WIND system are presented in this section. All of the numerical and graphical output from any of these codes can be generated and displayed on a CRT and on paper in 5 min or less. Five codes are available, the first of which (function 1) checks on the status of the computers.

V.A. Function 2: Meteorological Data

Data summaries from the WIND system are printed every hour to allow SRP meteorologists to check the status of the instrumentation and assess local winds and turbulence levels (Fig. 3). Wind, turbulence (σ_A and σ_E), and temperature data from a 300-m television tower are plotted and tabulated on the left side of Fig. 3. The graph on the right side shows average wind vectors at 61 m at the SRP production areas, the 300-m television tower, and the 10-m wind vector from the NWS station in Augusta, Georgia. These data are tabulated below the graph. In addition to the average wind speed and direction, the maximum gust (GST) is also recorded.

Fig. 3. The SRP tower data, latest 15-min average—function 2.

V.B. Function 3: Limited Area Calculation

If radionuclides or toxic chemicals are released from a production facility, the immediate concern will be for workers in the area. If the release is significant, safe evacuation routes will be of primary importance. The WIND system contains a separate transport and diffusion code for evaluation of the consequences of an accidental release near the release point. The code uses a nondeposition, reflecting Gaussian model for transport and diffusion calculations, and plots the output on a detailed map of the production area (Fig. 4). The predicted trajectory and isopleths of dose or concentration are plotted, based on the most recent 15 min of meteorological observations from the production area.

V.C. Function 4: Stream Transport Calculation

This function performs the stream transport calculation previously described. The input requirements are supplied in a query-response format. The user specifies the location, amount and type of material released, operating conditions if a reactor area is involved, and the time concentration profile of the release. Based on these input data, the code calculates the downstream concentrations and travel times and presents the results in tabular form, as shown in Fig. 5. The locations of the computed

concentrations in Fig. 5 correspond to plant road crossings on-site and major highway crossings and water plant intakes off the plant site. Note that the concentration drops most rapidly near the point where the pollutant enters the Savannah River and is mixed into a much larger volume of water. Additional dilution of the pollutant is small, as it travels downstream to the Savannah Water Treatment Plant.

V.D. Function 5: Regional Transport and Dose Calculation

The primary transport and diffusion code in the WIND system is called "PFPL." It allows up to 12-h predictions and includes deposition calculations (see Sec. IV). The user interacts with the system, supplying information as requested by the program. Dose conversion constants and half-lives for radionuclides are automatically incorporated into the calculation. Most chemical releases are treated as dilute, passive contaminants, although removal by vegetation is included in the computations. However, a heavier-than-air model is used to calculate the initial dispersion pattern for liquefied H_2S . Questions are asked regarding location, release magnitude, height and time of release, rain intensity, and initial cloud size. In the event of a reactor accident, the user can request the integral gamma dose from the noble gases that would be released.

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DATE: 10/19/81 TIME: 3:14:59 PM EDT
15 min-AVERAGED WIND FROM 291 deg AT 9.1 mph
BAND WIDTH IS 140 deg, SIGEL IS 10 deg.

B AREA

HES SOURCE
8000.000 lb/min

ISOPLETHS (ppm)

----- 1.0E+02
----- 1.0E+01
----- 1.0E+00
----- 1.0E-01

Fig. 4. An area map of the heavy water facility—function 3. A hypothetical plume of H_2S ($Q = 4000$ lb/min) is depicted by the isopleths. Latest meteorology is given at the top of the map.

Tabular results of the calculation (Fig. 6) are presented as a function of distance from the release point and time after release. The approximate cloud width is presented in terms of the distance needed for a two standard deviation ($2\sigma_y$) decrease in concentration to 13.5% of the centerline value, based on a Gaussian profile. Cloud centerline doses (in rems) and concentrations at ground level (pCi/m^3) are

calculated next. The dose at the edge of the cloud ($2\sigma_y$) is listed next, followed by computed centerline deposition at the ground. Deposition is expressed in terms of disintegrations per minute for the convenience of field verification crews. Finally, the percentage of the original release that has been removed from the atmosphere by surface deposition, rain, and radioactive decay is listed. This final column gives the operator a quick impression of the net efficiency of all removal processes.

Figures 7a and 7b present cloud widths and trajectories on successively larger grids. The plotted cloud width is $4\sigma_y$, and thus encompasses ~95% of a Gaussian cloud. The plots represent puff trajectories, which are calculated with observed winds from individual towers and with forecast winds, which do not distinguish between the different production areas.

The system is also capable of responding to off-site accidents. On several occasions, the DOE Savannah River Operations Office has requested activation of the system for off-site emergency planning exercises at nuclear power plants in the southeastern United States. State officials normally request assistance from DOE under the Radiological Assistance Program. A meteorologist in the WCAL has to enter the meteorological data for that site based on analysis of the NWS data in the WCAL or on telephone information from the site. The WIND system is capable of responding to an incident anywhere in the southeast, providing the latitude and longitude are known and meteorological data are available.

VI. SYSTEM PERFORMANCE

On March 27, 1981, the WIND system was tested during release of a small quantity of tritium from a processing facility at the SRP. The WIND system was used to predict the release trajectory and downwind air concentrations, and to direct field measurement teams that were collecting air and vegetation samples. An early prediction of the tritium plume trajectory is shown in Fig. 8a. The solid line

DOWNSTREAM CONCENTRATIONS CALCULATED FOR A RELEASE AT P-AREA OUTFALL

	MAXIMUM CONCENTRATION (Ci/l)	ETA (min)	TIME	DATE
ROAD A	0.78920E-03	659.00	8.59 PM	10/19/81
SAVANNAH RIVER	0.11673E-05	2539.00	4.19 AM	10/21/81
U.S. HIGHWAY 301	0.93293E-07	3463.00	7.43 PM	10/21/81
STATE HIGHWAY 119	0.93073E-07	5748.00	9.48 AM	10/23/81
BEAUFORT JASPER	0.92987E-07	6652.00	12.52 AM	10/24/81
SAVANNAH WATER PLANT	0.92947E-07	7661.00	7.41 AM	10/24/81

Fig. 5. Function 4—typical results for stream transport calculation (1000 Ci released in 8 min).

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DEMO		10/19/81		41 4 PM DT		PAGE 3	
DISTANCE	ETA	2-SIGY	CENTERLINE	2-SIGY	CENTERLINE	PERCENT	
(km)	h:min	(km)	DOSE	DOSE	DEP	GONE	
1.75	41:13 PM DT	0.45	3.90E-03	1.41E-08	5.27E-04	1.54E-05	0.0
3.49	41:23 PM DT	0.89	1.03E-03	1.87E-07	1.35E-04	2.89E-05	0.0
5.24	41:33 PM DT	1.34	4.62E-04	8.60E-06	8.26E-05	3.39E-05	0.0
6.99	41:43 PM DT	1.79	2.61E-04	2.37E-06	3.63E-05	3.70E-05	0.0
8.74	41:53 PM DT	2.23	1.84E-04	1.34E-06	2.49E-05	3.86E-05	0.0
10.48	81:3 PM DT	2.68	1.53E-04	9.28E-05	2.07E-05	3.99E-05	0.0
12.23	81:33 PM DT	3.13	1.02E-04	4.12E-05	1.38E-05	4.29E-05	0.1
13.97	81:3 PM DT	3.57	7.64E-05	2.32E-05	1.03E-05	3.24E-05	0.1
15.72	81:33 PM DT	4.02	6.50E-05	1.88E-05	8.80E-06	3.53E-05	0.2
17.47	81:3 PM DT	4.47	5.72E-05	1.30E-05	7.75E-06	3.83E-05	0.3
19.22	71:3 PM DT	4.92	4.94E-05	1.12E-05	6.89E-06	3.97E-05	0.4
20.97	81:3 PM DT	5.37	4.63E-05	9.82E-06	6.25E-06	4.39E-05	0.5
22.72	81:3 PM DT	5.82	2.99E-05	8.66E-06	4.05E-06	2.96E-05	0.6
24.47	81:3 PM DT	6.27	2.73E-05	7.60E-06	3.70E-06	2.87E-05	0.7
26.22	81:33 PM DT	6.72	2.15E-05	6.89E-06	2.90E-06	2.90E-05	0.8
27.97	81:33 PM DT	7.17	2.01E-05	6.30E-06	2.72E-06	3.82E-05	0.9
29.72	101:3 PM DT	7.62	1.77E-05	5.88E-06	2.40E-06	3.40E-05	1.0
31.47	101:33 PM DT	8.07	1.68E-05	5.50E-06	2.28E-06	3.28E-05	1.1
33.22	111:3 PM DT	8.52	1.54E-05	5.31E-06	2.08E-06	3.08E-05	1.2
34.97	111:33 PM DT	8.97	1.52E-05	5.18E-06	2.05E-06	2.95E-05	1.2
36.72	81:3 AM DT	9.42	1.51E-05	5.07E-06	2.04E-06	2.84E-05	1.3
38.47	81:33 AM DT	9.87	1.49E-05	4.96E-06	2.62E-06	2.62E-05	1.4
40.22	81:3 AM DT	10.32	1.48E-05	4.86E-06	2.81E-06	2.81E-05	1.5
41.97	81:3 AM DT	10.77	1.47E-05	4.77E-06	1.99E-06	1.85E-05	1.5
43.72	81:33 AM DT	11.22	1.46E-05	4.68E-06	1.98E-06	1.87E-05	1.6
45.47	81:33 AM DT	11.67	1.45E-05	4.59E-06	1.96E-06	1.91E-05	1.7
47.22	81:3 AM DT	12.12	1.54E-05	4.52E-06	2.08E-06	2.21E-05	1.8
48.97	81:33 AM DT	12.57	1.52E-05	4.45E-06	2.06E-06	2.18E-05	1.8

ALL CONCENTRATIONS AT GROUND LEVEL IN $\mu\text{Ci}/\text{m}^3$, DEPOSITION IN $\text{d}/\text{m}^2 \cdot \text{m}^{-1}$.
ALL DOSES ARE GROUND LEVEL 70-YR DOSE COMMITMENT IN rem.

Fig. 6. Function 5—atmospheric release calculations.

Fig. 7a. Trajectory and plume widths on SRP map.

Fig. 7b. Trajectory and plume width on three-state map.

indicates the movement of the center of the plume. The circles indicate the horizontal spread of the cloud at 1-h intervals after the release. The WIND system predictions helped to direct field measure-

ment teams during the late morning and continued until the early evening of March 27. Figure 8b shows a prediction of the plume trajectory based on updated forecasts received from NWS in the early

Fig. 8. Some WIND system projected trajectories: (a) early forecast trajectory and (b) updated forecast trajectory of tritium movement.

afternoon of March 27. The initial estimates of the maximum individual dose at the plant boundary in the hours immediately after the release were all ~2.5 mrem.

Fig. 9. Best estimate of cloud trajectory based on locations of concentration measurements and meteorological data (stippled and hatched areas of trajectory are based only on meteorological data).

Figure 9 shows the best estimate of the trajectory, determined several days after the release from an analysis of NWS and SRP meteorological data. During the first 7 h after the release, the tritium moved east-northeast at ~15 mph. The movement of the plume then shifted to a more easterly direction and was ~60 km from the Atlantic Ocean in the late afternoon. At this point, surface winds decreased and the lowest part of the plume was left behind the elevated portion. A cold front moving in from the north blew the lower portion of the plume (<10% of total) offshore north of Charleston later in the night. The remaining elevated portion (higher than 100 m) continued to move in an easterly direction, passing just south of Myrtle Beach during the pre-dawn hours of March 28.

When Figs. 8 and 9 are compared, it is apparent that the updated trajectory forecast (Fig. 8b) was closer to the observed trajectory, which demonstrates the usefulness of wind forecasts in an emergency response system. Although the initial forecast (Fig. 8a) erred by only ~30 km at a downwind distance of ~100 km, this would have been sufficient for the sampling teams to miss the plume. It is evident that even small errors in a wind forecast can cause a sampling team to lose a plume at large downwind distances.

The field measurements confirmed the predicted and diagnosed trajectory. The field measurements consisted of a series of 30-min surface air samples

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taken from the boundary of SRP to a distance of 170 km downwind (to the beginning of the stippled and hatched areas in Fig. 9). Analysis of the samples at the SRL showed tritium concentrations well above background with one exception, which was taken at a location that was not close to the predicted plume centerline. Ten samples were taken, which were scattered fairly uniformly from the SRP boundary to 170 km downwind. A more detailed description of the sampling operation is presented by Garrett et al.¹²

Further WIND system calculations one day after the release with all available data for the time of the release showed a maximum individual dose at the plant boundary of 0.3 mrem. This best estimate was close to the maximum measured dose of 0.2 mrem from subsequently analyzed urine samples taken from persons living near the plant boundary. When compared to natural background sources of radiation and medical x rays, this dose is clearly inconsequential.

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APPENDIX K

ADDITIONAL OR ALTERNATE SOIL GAS SAMPLING TECHNIQUES

APPENDIX K. ADDITIONAL OR ALTERNATE SOIL GAS SAMPLING TECHNIQUES

Three SRS-approved soil gas sampling methodologies have been discussed in Section 5.3.4. The following additional or alternate techniques for soil gas sampling are currently available and may have application at specific RFI units. These techniques are listed for comparison purposes only and shall not be utilized without permission of the SRS RFI Program Team.

1. Soil Headspace Measurement

This procedure is a variation of Method IV-12, Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, (USEPA, 1984), page 4-68.

Soil samples are collected by driving an 18-inch split spoon sampler fitted with three clean brass sleeves into undisturbed soil beneath the lead auger. After retrieval, the sampler is opened and the contents of one brass sleeve are immediately pushed to fill a 236 ml (8 oz.) glass jar containing 100 ml of carbon-free water.

The soil/water samples are transferred to the mobile laboratory, placed in a sonic bath and agitated for 5 minutes to volatilize the volatile organic compounds from the liquid and solid matrix. A 100 μ l air sample then is drawn for injection into the field gas chromatograph (GC).

3 2

For further reference: See Soil Gas Sensing for Detection and Mapping of Volatile Organics (Devitt et al., 1987) and Soil Gas Studies for Volatile Organic Compounds at Selected SRP Wastesites (Price et al., 1986).

2. Test Hole Measurements

The following procedures are modifications of Method IV-10, from USEPA (1984), page 4-62.

2a. Direction Injection - Auger (DIA)

Samples are collected by lowering a 500 μ l gas-tight, side port syringe to the bottom of the hollow stem auger immediately upon reaching the desired depth. The syringes are filled remotely by manipulating two attached rods. Elapsed time between hole completion and sample collection at each location must be uniform to minimize sampling variability. A 100 μ l aliquot from the syringe then is injected directly into a field laboratory GC.

2b. 1-Liter Syringe Sample

Samples are collected by lowering a 10-foot length of Teflon tubing attached to a 1-liter gas-tight syringe to the bottom of the hollow stem auger (same as DIA method). The Teflon line is conditioned by drawing a 500 ml air sample, disconnecting the Teflon line and evacuating the syringe. The Teflon then is reattached to the syringe, and the 1-liter sample is withdrawn from the bottom of the auger. The entire sample then is injected into a purge and trap unit for concentration followed by analysis on a GC.

3. Driven Ground Probe Techniques

The following procedures are modifications of driven ground probe techniques discussed in Devitt et al. (1987), pages 130-151.

3a. Hollow Probe

This method requires that a 3/4-inch diameter steel probe be driven into the ground and a small amount (5 to 10 liters) of soil gas be pumped to the surface via a vacuum pump.

Hydraulic equipment can be used to drive the probes; however, soil gas probes may be driven either normally or with pneumatic equipment. The soil gas sample is collected in a 10cc syringe during the evacuation step by inserting the needle through the evacuation line and drawing an aliquot from the gas stream. Samples are immediately injected into the field GC for analysis.

3b. Direct Injection - Stopper

Gas samples are collected from finished probes after a 2-day equilibration period. Syringes are inserted through the probe stoppers and 100 μ l of soil gas drawn for direct GC injection. After sampling, the stoppers are visually examined for leaks and replaced, if necessary, to maintain an adequate seal on the sample probe.

4. Sorbent Sampling Techniques

Sorbent sampling techniques are modifications of Methods IV-6, IV-7, and IV-8 in USEPA (1984), pages 4-31 through 4-54. The following procedure is an example of another available sorbent sampling technique:

4a. Tenax Tube

The Tenax Tube sampling set-up includes tenax packed into stainless steel desorption tubes connected in line to a Gillian pump. The pump is set to deliver a flow rate of 100 ml/min. The Tenax Tubes are suspended 3 feet down the probe on a section of rubber tubing that passes through a stopper at the top of the probe, before connection to the pump. Three liters of soil gas are pumped through each tube. The Tenax Tubes are taken to the field or remote laboratory, contaminants are thermally driven off the column, and a 100 μ l sample aliquot is injected into a GC for analysis.

For further reference: See Devitt et al. (1987), pages 151-157.

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5. Other Available Techniques

5a. Monitoring Well Gas Sampling: See Method IV-11, USEPA (1984).

5b. Surface Flux Chamber Techniques

Refer to Devitt et al. (1987), pages 149-151.

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APPENDIX L

GEOPHYSICAL TECHNIQUES

APPENDIX L. GEOPHYSICAL TECHNIQUES

Introduction

Unit characterization, especially of the subsurface, is an important part of any RCRA Facility Investigation. Unit characterization determines the necessity for remedial action, the extent of any remedial action, and the feasibility of potential remedial action. Several geophysical methods play a major role, often during an initial reconnaissance, in generating a data base needed to support decisions made in the RFI Report. This document discusses seven geophysical techniques that are regularly used and have been proven effective for hazardous waste unit assessments.

Numerous geophysical surveys have been conducted at SRS in the past. A review of all the procedures and methodologies of the different geophysical techniques performed at the site is beyond the scope of the RFI Program Plan. Refer to the current DPSOP 254 for specification and forms required for geophysical surveys conducted at the SRS unit.

Geophysical Techniques

Proper assessment of unit conditions requires that the unit be considered at various dimensional scales. Important information can be obtained from remote sensing methods which are applied in three modes: airborne, surface, and downhole.

While a specific waste unit may be only an acre in size, its contamination may be spread over tens of acres. Knowledge of the local setting can be derived from information of the broader regional picture. Therefore, it may be necessary to plan the investigation to include an area greater than the hazardous waste unit itself. Airborne or satellite remote sensing methods can be employed to obtain important data characterizing regional conditions. While this type of remote sensing provides advantages in terms of spatial coverage per unit time and cost, relatively poor resolution of local details is obtained. Airborne or satellite methods also gather little, if any, subsurface data.

Surface remote sensing methods yield less spatial coverage per unit time but can significantly improve resolution and provide subsurface information. A disadvantage of surface geophysical methods is that their resolution (ability to detect a small feature) decreases with depth.

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Downhole remote sensing methods provide improved vertical resolution, but the volume analyzed is usually limited to the area immediately around the boring, or that between two borings, and the cost per unit area of coverage is high. The major benefit of downhole methods is that detailed high-resolution information may be acquired at significant depths.

Although all three modes of remote sensing have a place in subsurface investigation, this document deals primarily with surface geophysical methods. Any of these surface methods also have applications in the downhole mode. The geophysical methods discussed here are:

- ground penetrating radar
- electromagnetics
- resistivity
- seismic refraction
- seismic reflection
- metal detection
- magnetometry

The primary tasks to which these methods may be applied include:

- mapping of natural hydrogeologic features
- mapping of conductive leachates and contaminant plumes (landfill leachates, acids, bases)
- mapping of non-conductive organic contaminants
- location and boundary definition of buried trenches
- location and definition of buried metallic objects (drums, pipes, tanks, utilities)

A brief description of each of the geophysical techniques is presented in the following sections.

Ground Penetrating Radar

Ground penetrating radar (GPR) systems in common use are impulse systems that transmit short-duration electromagnetic pulses into the ground from an antenna which is moved slowly across the ground surface. These pulses are reflected from a variety of subsurface interfaces back to the receiver section of the antenna and then returned to a control unit (receiver, tape recorder, and graphic recorder) for processing and visual display.

GPR generates data "on the spot". As the antenna is towed along a traverse line, the GPR signals are processed and displayed on the graphic recorder. The displayed data is a vertical, two-dimensional continuous profile along the traverse line. The display is very similar to a geologic cross-section, but it should be noted that the GPR record is a time section rather than a depth section. Velocity variations can create vertical distortion analogous to those in a seismic reflection record.

The continuous nature of the radar method offers a number of advantages over some other geophysical methods. The continuous vertical profile produced by radar permits much more data to be gathered along a traverse, thereby providing a substantial increase in detail. The high speed of data acquisition permits many lines to be run across a site, and in some cases, total site coverage of large areas can be accomplished using a vehicle to tow the radar antenna at speeds up to 5 mph (8 km/hr). Very high resolution work or work in areas where vehicles cannot travel can be accomplished by towing the antenna by hand at much slower speeds. Resolution ranges from inches to several feet depending upon the antenna and frequencies used. Signal processing equipment provides band pass filtering and stacking ability for post-survey data enhancement.

Depths of radar penetration are very site-specific and are dependent on the properties of the unit's soil and rock. The depth of penetration is reduced if shallow ground water increases the electrical conductivity of the porous media. Generally, better overall penetration is achieved in dry, sandy, or rocky areas; poorer results are obtained in moist, clayey, or conductive soils. However, many times data can be obtained from a considerable depth in saturated materials if the specific conductance of the pore fluid is sufficiently low. Radar penetration depths of a few meters to 10

meters are regularly attained, while depths of up to 20-30 meters can be attained under ideal soil and moisture conditions.

Radar responds to changes in soil and rock conditions. An interface between two soil or rock layers having sufficiently different electrical properties (dielectric and conductivity) will show up in the radar profile. Such interfaces are often associated with natural hydrogeologic conditions such as bedding, cementation, moisture and clay content, voids, fractures, and intrusion as well as man-made objects. Buried pipes and other discrete objects will also be detected.

Radar applications to hazardous waste site assessment include:

- evaluation of the natural soil, top of rock, and geologic conditions,
- location and delineation of buried waste materials, including both bulk and drummed waste,
- location and delineation of buried trenches commonly found at hazardous waste sites,
- location and delineation of contaminant plume areas,
- location and mapping of buried utilities (both metallic and non-metallic).

Electromagnetics

The electromagnetic (EM) method provides a means of measuring the electrical conductivity of subsurface soil, rock, and ground water. Electrical conductivity is a function of the type of soil and rock, its porosity and permeability, and the fluids which fill the pore space. In most cases, the conductivity (specific conductance) of the pore fluids will dominate the measurement. Therefore, the EM method is applicable both to assessment of natural hydrogeologic conditions and to mapping of many types of contaminant plumes. Additionally, trench boundaries, buried wastes and drums, and metallic utility lines can be located with EM techniques.

Natural variation in subsurface conductivity may be caused by changes in soil moisture content, ground water specific conductance, depth of soil and thickness of soil and rock layers. Changes in basic soil or rock types and structural features such as fractures or voids may also produce changes in conductivity. Localized deposits of natural organics, clay, sand, gravel, or salt-rich zones will also affect subsurface conductivity.

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Many inorganic contaminants introduced into the soil or ground water system will produce an increase in free ion concentration (specific conductance). This increase over background conductivity enables detection and mapping of contaminated soil and ground water at hazardous waste sites, landfills, and impoundments. Large quantities of organic fluids such as diesel fuel can displace the normal soil moisture, causing a decrease in conductivity which may also be mapped. Therefore, conductivity measurements aid in mapping the areal extent and local flow direction of a contaminant plume and establishing migration rates.

The absolute values of conductivity are not necessarily diagnostic, but the variations in conductivity, both horizontally and vertically within the subsurface are significant. It is these variations (anomalies) which enable the investigator to rapidly find potential problem areas.

The relative ease of data collection gives EM a distinct advantage over conventional electrical resistivity profiling. EM equipment is extremely portable and allows data to be collected as fast as the operator can walk. Therefore, subsurface conductivities are collected rapidly and continuously as operator and instrument traverse the waste unit. The principal value of the EM method is that it provides continuous, high resolution data at very low cost. Thus, reconnaissance investigations that effectively define the location and extent of potential problem areas at shallow depths can be performed rapidly.

Several EM systems (i.e., e.g. The Geonics EM-31, EM-34-3, and EM-39 borehole logger) provide a means - when used together - to characterize the three-dimensional configurations of conductive ground water contaminant plumes.

The EM-31 measures the apparent conductivity of the soil to a depth of approximately 20 ft. by utilizing the principles of electromagnetic induction. The EM-31 consists of two horizontal coplanar loops, one acting as a transmitter and the other as a receiver, which are separated on a rigid boom. The entire apparatus is carried, via a shoulder strap, by one operator at hip level. A 9.9 khz signal in the transmitter coil induces circular eddy currents in the earth, and they in turn produce a secondary magnetic field. The receiver coil intercepts this secondary field, and the EM-31 measures the terrain conductivity by comparing the strength of the secondary field to that of the primary. The terrain conductivity meter responds to electrical conductivity contrasts in

subsurface materials and is useful for locating buried drums, tanks, pipes, and contaminant plumes by virtue of their contrasting electrical properties. The terrain conductivity data can be digitally recorded in the field using a portable data logger. This device provides an efficient RS-232 computer data interface and allows the acquisition of information from both the quadrature and in-phase channels of the EM-31. The quadrature phase channel yields the apparent conductivity of the soil, while the in-phase channel provides a measure of the terrain magnetic susceptibility. Application experience indicates that maps prepared from the in-phase data are very effective for locating buried metallic objects including pipes, drums, and tanks.

The EM-34-3 operates on the same principles of electromagnetic induction as the EM-31 but is designed to achieve a substantially increased depth of exploration and a vertical conductivity profile. The EM-34-3 can be used at three fixed intercoil spacings of 10, 20, or 40m. In the vertical coplanar operating mode, the instrument senses to approximately 75 percent of the fixed intercoil spacing. In the horizontal coplanar mode, the instrument can sense to 1.5 times the intercoil spacing. The maximum depth of exploration is approximately 60m. The EM-34-3 provides an efficient and cost effective tool for subsurface conductivity mapping.

For surveys in regions of high cultural and atmospheric noise, the EM-34-3XL may be used. It reduces the noise at the 40m spacing by a factor of 10 and by a factor of 4 at the 10m and 20m spacings.

The EM-37-3 is a high-powered transient electromagnetic system designed to meet the requirements of greater depth of exploration, improved rejection of conductive overburden or lost rock response, and enhanced definition of potential ore-bearing structures. This system comes with 3 frequencies and 30 ampere capability for greater noise rejection and depth of exploration. The EM-37-3 can sound terrain conductivity to depths greater than 500 meters.

The EM-42 is a high power ground transient electromagnetic system that can be used to determine the complete geoelectrical sections from surface to depths of 300 meters. This system is used for deep geological mapping applications.

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The Geonics EM-39 borehole conductivity meter operates on the same principle as the others, i.e., a small transmitter coil induces eddy currents in the surrounding material and a receiver coil measures the magnetic field to obtain electrical conductivities without electrodes. Use of a focusing coil causes measurement sensitivity to peak approximately 12 inches from the borehole axis. It is the conductivity of water in the surrounding soil or rock that is measured, not the conductivity of the water in the well. The well diameter can be as small as 2 inches and as large as 6 inches. The EM-39 can be used in PVC and teflon-lined boreholes. The short intercoil spacing allows resolution of layers as thin as 20 inches. For still thinner layers, the EM-39 measures the product of conductivity contrast times layer-thickness. Data from the EM-39 can provide detailed knowledge of the vertical structure and extent of a ground water plume which has been detected and defined laterally by the EM-31, EM-34-3, or other resistivity techniques.

Other electromagnetic survey equipment is available (e.g. the EM-47 for shallow tests) and may be obtained through various geophysical exploration companies.

Most of the EM surveys performed at SRS in the past were conducted primarily for pure geological applications. However, some EM work has been performed at various waste sites in the past include the EM-34-3 and EM-37 systems. Refer to the current DPSOP 254.

At hazardous waste sites, applications of electromagnetics may provide:

- assessment of natural hydrogeologic conditions
- locating and mapping of burial trenches and pits containing drums and/or bulk wastes
- locating and mapping of plume boundaries
- determination of flow direction in both unsaturated and saturated zones
- rate of plume movement by comparing measurements taken at different times
- locating and mapping of utility pipes and cables which may affect other geophysical measurements, or whose trench may provide a permeable pathway for contaminant flow.

Electrical Resistivity

The resistivity method is used to measure the electrical resistivity of the hydrogeologic section which includes the soil, rock, and ground water (just as with the EM method). The interpretation of resistivity data provides information on layering of strata and the depth of contrasting strata horizons as well as lateral changes of strata composition occurring in the subsurface. The presence, amount (saturated vs. partially saturated porous media) and accordingly, the method may be used to assess lateral changes and vertical cross sections of the natural hydrogeologic settings. In addition, it can be used to evaluate contaminant plumes and locate buried wastes.

Application of the method requires that an electrical current be injected into the ground by a pair of surface electrodes. The resulting potential field (voltage) is measured at the surface between a second pair of electrodes (a common electrode configuration is known as the Wenner array). The subsurface resistivity can be calculated by knowing the separation and geometry of the electrode positions, applied current, and measured voltage. (Resistivity is the reciprocal of conductivity, the parameter directly measured by the EM technique.)

In general most soil and rock minerals are electrical insulators (highly resistive); hence, the flow of current is conducted primarily through the moisture-filled pore spaces within the soil and rocks. Therefore, the resistivity of soils and rocks is predominantly controlled by the porosity and permeability of the system, the amount of pore water, and the concentration of dissolved solids in the pore water.

The resistivity method is applied by "sounding" or "profiling". Vertical electrical soundings are obtained by observing the apparent resistivities that result with increasing electrode spacings (and the correspondingly greater depth of current penetration). These apparent resistivity values are plotted as a function of electrode spacing, resulting in a plot that can be interpreted in terms of the depth and thickness of subsurface strata of differing resistivities. Profiling methods employ a constant electrode spacing which is successively occupied at intervals across the site. The method is primarily used in the search for lateral variations in resistivity. The resulting maps are very similar to those obtained using EM methods.

Applications of the resistivity method at hazardous waste sites include:

- defining natural hydrogeologic conditions such as
 - depth to water table or to water-bearing horizons
 - depth to bedrock, thickness of soil
- locating and mapping contaminant plumes
- determining of flow direction in both unsaturated and saturated zones
- determining rate of plume movement by comparing measurements taken at different times
- location of burial sites and trenches containing drums and/or bulk wastes.

Seismic Refraction and Reflection

Seismic refraction and reflection techniques are used to determine the thickness and depth of geologic layers and the velocity of seismic waves which is an indication of the soil and rock physical properties. The seismic methods are often used to map depths to bedrock, clay layers, and water table. Refraction is commonly applied to shallow investigations up to a few hundred feet deep. The reflection technique can be used effectively to depths ranging from about 50 to a few thousand feet. Seismic waves transmitted into the subsurface by an acoustic source travel at different velocities in various types of soil and rock. The wave advances in all directions from the source and is reflected and refracted when it impinges on an interface between geologic layers. The combination of the ray pattern and velocity will affect the travel time. An array of geophones on the surface measure the travel time of the seismic waves from the source to the geophones at a number of spacings. The refraction and reflection techniques use the travel times of the waves to provide data on subsurface layers including the number of layers, the thicknesses of the layers and their depths, as well as the seismic velocity of each layer. The wave velocity in each layer is directly related to its material properties such as density and hardness.

The refraction survey requires an array length (4-5 times the depth of investigation) and a greater energy source as depth of investigation increases. In addition it is unable to detect lower velocity layers beneath higher velocity layers and the number of layers which can be determined is limited.

By comparison the reflection survey is capable of much deeper investigations and can provide relatively detailed geologic sections. It, however, requires considerably more skill, equipment and data processing to successfully complete a survey.

A seismic source, geophones, and a seismograph are required to make the measurements. The seismic source may be a simple sledge hammer with which to strike the ground. Explosives and any other seismic sources may be utilized for deeper or special applications. Geophones implanted in the surface of the ground translate the received vibrations of seismic energy into an electrical signal. This signal is displayed on the seismograph, permitting measurement of the arrival time of the seismic wave. Since the seismic method measures small ground vibrations, it is inherently susceptible to vibration noise from a variety of natural and cultural sources.

At hazardous waste sites, the seismic techniques may be used to:

- define natural hydrogeologic conditions, including:
 - Thickness and depth of soil and fill layers
 - Rock layers, an estimate of their composition and physical properties
 - Depth to bedrock or water table
 - Lateral soil/rock changes or discontinuities
- detect and locate pits and trenches
- evaluate the depth of burial sites or landfills (National Water Well Association, 1984).

Metal Detection

Metal detectors (MD) are designed to locate buried metallic objects. They are commonly used by treasure hunters searching for coins and by utility crews for locating buried pipes and cables. In HWS investigations, MD are invaluable for detecting buried drums and for delineating the boundaries of trenches containing metallic drums.

Metal detectors can detect any kind of metallic material, including both ferrous metals such as iron and steel and non-ferrous metals, such as aluminum and copper. (In contrast, another search device, the magnetometer, discussed in the following section, responds only to ferrous metals.)

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Metal detectors have a relatively short detection range. Small metal objects such as spray cans or quart-sized containers can be detected at a distance of approximately 3 feet (1 meter). Because the response of a metal detector increases with the target surface area, larger objects like 55-gallon drums may be detected at depths of 3 to 10 feet (1 to 3 meters). Massive piles of metallic materials may be detected at depths of 10 to 20 feet (3 to 6 meters).

The metal detector is a continuously-sensing instrument which can provide total site coverage and which is well suited for locating buried metal. Experience at hazardous waste units has shown that metal detectors may be effectively used to:

- locate buried metallic containers of various sizes
- define boundaries of trenches containing metallic containers
- locate buried metallic storage tanks
- avoid buried utilities when drilling or trenching
- locate utility trenches which may provide a permeable pathway for contaminants (National Water Well Association, 1984).

Magnetometer

Magnetometer surveys can successfully detect anomalies in the geomagnetic field due to buried ferromagnetic objects. An induced magnetization is produced in any magnetic material within the earth's magnetic field. This induced field is superimposed on the regional magnetic field. If the induced field is strong enough, it produces an anomaly in the regional geomagnetic field. The magnetometer response is proportional to the mass of the ferrous target and inversely proportional to the cube of the distance to the target. Typically, a single drum can be detected at depths up to 20 feet (6 meters), while massive piles of drums can be detected at depths up to 65 feet (20 meters) or more.

A number of magnetometers are available for different types of surveys. Both total field and gradiometer search magnetometers are used. The gradiometer systems have the ability to sense vertical field gradients while remaining insensitive to horizontal gradient components. This feature

is advantageous in that it allows gradiometers to sense the vertical field of subsurface objects in the near proximity of potential horizontal interference objects such as steel fences.

The EDA OMNI IV magnetic gradiometer is used in the search for buried metallic objects. This instrument can measure the disturbance in the earth's total magnetic field created by iron and steel (ferromagnetic) objects, such as buried tanks and stacks of drums. In addition to measuring variations in the total magnetic field strength, the EDA magnetometer has the further capability of performing a simultaneous measurement of the vertical gradient of the total magnetic field. This mode of operation has been found to be an effective technique for search applications, in that vertical gradient data tend to have greater lateral resolution than total field data. Thus, multiple buried objects which appear as a single composite total field anomaly can often be individually identified on vertical gradient profiles or maps. This greater spatial resolution is important for hazardous waste sites because it can help reduce the area of search at individual anomalies. (Foster *et al.*, 1987.)

Note: A magnetometer survey has been conducted on a waste site at SyRS for the purpose of locating an underground gas storage tank. The type of equipment used is not known.

At hazardous waste sites, magnetometers may be used to:

- locate buried steel containers such as 55-gallon drums
- define boundaries of trenches filled with ferrous containers
- locate ferrous underground utilities, such as iron pipes or tanks, and, therefore, the permeable pathways often associated with them
- select drilling locations that are clear of buried drums, underground utilities, and other obstructions.

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APPENDIX M

SOIL SAMPLING TECHNIQUES

APPENDIX M. SOIL SAMPLING TECHNIQUES

Several alternate techniques for collecting soil samples are currently available and are described below.

Surface and Shallow Sampling Techniques

The following sampling devices are capable of retrieving samples of soil from the upper 1 ft. to 18 inches. These types of samplers are most suitable for obtaining shallow surface samples rapidly. For example, when a grid of sample locations of surface soils has been constructed, these sampling devices allow the field sampler to rapidly collect samples from all locations in the grid. These sampling devices are as follows:

- **Compact Sampler** - This sampler collects 1 foot long tube samples. The handle is attached directly to the sampling tube. The sampler can be pushed into the soil by foot or twisted in by hand. One side of the tube is cut away so that relatively undisturbed samples can be easily described before removal. The cut away tube also facilitates easy removal of samples. This sampler is small and compact for easy transport to inaccessible units. The major disadvantage is that extensions cannot be added to the sampler and therefore the sampling depth is limited to 1 foot. A soil sampling tube is also available that is identical to the compact sampler except that the sample is slimmer and the depth is 19 inches.
- **Footstep Sampler** - The footstep sampler is similar to the compact sampler except that it is equipped with a handle that may be hand held while pushing the tube. A step is provided so that the tube can be pushed by a combination of stepping down on the step and pushing on the handle. The sampling depth is 1 foot. This sampler is also relatively small and compact but less so than the compact sampler.

- **Hankinson Soil Sampling Tube** - This sample is a variation on the above samplers. It collects a tube sample and has a similar cut away tube. However, this sampler must be twisted in or pushed in using the hands; it does not allow pushing with the feet. The advantage over the previously discussed samplers is that samples may be collected from up to 3 feet. This sampler can also be easily transported.

Intermediate Depth Borehole Installation and Sampling Techniques

The following discussion includes samplers which can be used to collect various types of samples. Many of these samplers can be drilled deeper than those discussed above. These types are:

- **Screw Type Sampler** - This sampler collects a relatively disturbed sample on the auger flutes. The sample is collected by screwing the auger into the ground six inches at a time and pulling the auger out to remove the sample. These foot long extensions are available and depth may be to 15 feet or more depending on soil types. This type sample is useful when relatively undisturbed samples are unnecessary.
- **Oakfield Soil Sampler** - This sampling kit allows screw type samples, as discussed above, or tube type samples to be collected when relatively undisturbed samples are necessary for description. A tube with cut away section or screw auger may be used with twist handle and extensions. This sampler is very versatile and may be used for collecting both disturbed and relatively undisturbed samples at deeper depths.
- **Veihmeyer Sampling Tubes** - These take cylindrical soil samples. Various models are available that collect cores that are either 4, 6, 8 or 9 feet long. This sampler must be driven with a drop hammer. A puller jack may be required for extracting the sampler from hard soils.

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- **Bucket Augers** - These augers collect larger diameter samples (3-inch) than any discussed above. The sampler can be advanced 6 to 12 inches at a time. Both sand and clay buckets are generally available. This type of sampler can be drilled to a depth of about 20 feet; however, holes drilled up to 100 feet deep have been reported. These augers are available with stainless steel construction.
- **AMS - SRA Bucket Auger** - This auger is constructed of stainless steel and is equipped with an inner liner to facilitate easy removal of the sample. The liners are available in stainless steel, teflon, aluminum and plastic. The liners are also a useful aid in shipping of samples and can minimize contact with heavily contaminated samples.

Most of the samplers discussed above are available with stainless steel construction. Stainless steel, rather than chrome-plated instruments shall be used so as not to introduce contamination into samples.

- **Hand Held Power Auger** - Hand held power augers and portable augers may be useful up to a depth of about 10 feet. They are useful in sands but problems may be encountered when drilling in clays. Cuttings can be collected from the auger flights.
- **Portable Auger Drills** - Portable auger drill rigs generally will fit into the back of a pick up truck. They may be useful at depths up to 50 feet. These rigs can be used to drill with solid continuous flight augers. Various soil sampling devices such as Shelby-tube samplers can be attached to the bottom of the auger flights for retrieval of a relatively undisturbed sample. This necessitates removing the auger from the hole for each sample collection. These rigs are very useful when the unit is inaccessible or located under power lines where drill rig derricks cannot be raised.

- **Power Drills** - Various drill rigs can be mounted on a truck, trailer, or all-terrain vehicle. Many of these are equipped with auger capabilities. These rigs are capable of drilling to about 100 feet; however, problems may be encountered when drilling deeply in sands and below the water table. Under such conditions, solid continuous flight or hollow stem augers can be used. When using solid augers, samples must be collected from auger flights or by sampling devices attached to the bottom of the augers as described above. Hollow-stem augers allow sampling devices such as split spoons or Shelby-tubes to be lowered inside the augers. Therefore, the need for removing the auger flights each time is eliminated and faster drilling and sample collection can occur. A 5-foot core barrel is available for running on wire line inside hollow stem augers. This is an extremely fast drilling technique; however, core catchers must be used in the barrel to retrieve sand.

Intermediate Depth Sampling Techniques

Many sampling devices are available for collecting samples, depending upon the type of soil and the use of the sample. These samplers are used to collect soils from intermediate to deep depths:

- **Split Spoon** - A split spoon is a cylindrical tube about 2 feet in length. The ends are unscrewed and the cylinder splits in half for removal of the sample. Samplers can be 18 inches or 2 feet in length. One and one-half inch diameter to 3 inch diameter samplers may be obtained. The tube is generally driven by a 140 lb. or 300 lb. hammer. Split spoons are available in stainless steel for collection of samples for chemical analysis. However, these samplers are expensive and have a relatively short life span. The samples are relatively undisturbed for description but are unsuitable for laboratory tests such as vertical hydraulic conductivity or strength tests. Laboratory grain size analyses are commonly obtained from split spoon samples however DPSOP 254, Chapter III, shall be consulted when using this procedure.
- **Shelby Tube** - This type of sampler consists of a thin walled cylinder 3 feet long and 3 inches in diameter. The tube is pushed into the soil and slowly retracted. The sample produced is relatively undisturbed and suitable for most laboratory soils analyses. This tube is suitable for sampling cohesive soils. Clean sands generally will not stay in the tube. In addition, the tube may be crushed when sampling very hard clays and over compacted silts. Therefore, some

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judgment is necessary when using a Shelby tube. Consult DPSOP 254 for sampling procedures.

- **Pitcher Barrel** - This type of sampler is a single barrel core barrel with a Shelby-type tube inside. The tube is spring loaded and the end of the tube rides outside the outer core barrel. The length of the tube outside the barrel is determined by the hardness of the formation. The sample is more disturbed than a Shelby tube sample but is sufficient for many laboratory applications. This type of sampler is useful where Shelby tubes would be crushed due to the hardness of the formations.
- **Dennison Barrel** - This sample is similar to a split spoon except that it is generally larger and can be drilled into the formation. This sampler is equipped with sample catchers and is used when recovery is difficult to obtain. It is useful in clean sands when recovery is of primary concern. The sample is relatively disturbed and unsuitable for hydraulic conductivity testing.

Deep Borehole Installation Techniques

- **Bucket Augers** - See Intermediate Depth Borehole Installation Techniques
- **AMS-SRA Bucket Auger** - See above
- **Power Auger Drills** - See above
- **Power Drills** - See above
- **Wire Line Continuous Coring** - Continuous cores can be collected to extreme depths using a drilling rig. The fastest and most productive method is by wireline techniques. An outer core casing is drilled to the desired depth. The core barrel, generally 10 feet long, is placed inside the core casing. The core barrel is pulled by lowering an overshot tool on a cable, and a second barrel is dropped inside the outer casing and the coring is continued. This technique is capable of retrieving a 10 foot long core.

However, for use at SRS, the core runs should be 2 to 4 feet shorter depending on soil types. This is because of the sandy soils underlying most of the facility. For sandy soils, the inner core barrel shoe should be drilled in slightly ahead of the bit, which is attached to the outer casing. This prevents the sand from being washed out of the hole before entering the core barrel. This shoe must be retracted behind the bit for coring clay. Core catchers inside the barrel are also necessary. A typical system is the Cristiensen CP System.

Deep Sampling Techniques

See Intermediate Depth Sampling Techniques

Field Exploratory Excavation Procedure

- The field manager shall make all required entries into the field log book such as excavation time, meteorological conditions, sampling location, etc. The field manager shall further ensure that all protective clothing is available for use as required by the Health and Safety Plan, Chapter 2.
- All sampling equipment shall be located at a staging area some safe distance at least 20 feet, from the approximate test pit location and upwind. This distance shall be maintained during the course of the excavation.
- Prior to excavation, the field manager and any other individuals designated by the contractor, and the designated representative of the RFI Program Team shall inspect the projected excavation site. Items such as surface debris, disturbance of soil, odor, general direction of surface water runoff shall be noted and recorded in the field log book by the field manager. At this time, a discussion shall be conducted in the field among members present to adequately characterize the area and assess the feasibility of the location for exploratory excavation. Notes of this conversation shall be recorded by the field manager in the field log book.

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- Using heavy equipment approved by the contractor and the RFI Program Team perform required decontamination procedures on bucket, etc. that directly contacts soils for excavation, if not previously decontaminated prior to arrival on site.
- Carefully begin digging with equipment. While excavating, the field manager shall observe all excavated material and walls of pit for location of contamination zone and following geologists log for indication of disturbed soil zone.
- At all times when the depth of the excavation exceeds 3 feet, a 45 degree side slope shall be maintained to prevent collapse of side walls. If at a 45 degree side wall slope allows soils continue to slide back into the excavation, the slope shall be decreased accordingly. At no time shall mechanical or man-made equipment be used to support sides unless approved by the RFI Program Team.
- The Field Manager shall designate an individual to take readings with field monitoring equipment for each type of waste excavated, discernable differences in soil types, etc.
- The Field Manager and RFI Program Team shall decide when the exploratory excavation is complete, thus eliminating further excavation.
- Soil samples shall be collected at the appropriate depths specified in Chapter 6 or at depths where waste and disturbed soils are visible. Such samples shall be collected based upon the use of equipment and procedures specified in Chapter 3.
- A series of poles and rope shall be used to mark the outermost boundaries of the open excavation, thus limiting access. Furthermore, a sign shall be placed in a conspicuous location denoting the following:

DANGER
DO NOT ENTER THIS AREA
WASTE EXPLORATION SITE

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- Upon completion of soil sampling, the excavation shall be backfilled by placing soils back into the excavation. Soils should be placed at the same approximate depths at which they were originally excavated from unless otherwise directed by the RFI Program Team.
- After completion of backfilling, equipment shall be decontaminated based upon procedures specified in Chapter 3 unless deemed unnecessary by the RFI Program Team.
- Once an excavation is properly filled and returned to surface conditions, its use should not be unduly restricted.

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APPENDIX N

PROCEDURES FOR DETERMINING SOIL PROPERTIES

APPENDIX N. PROCEDURES FOR DETERMINING SOIL PROPERTIES

- a. Surface Soil Distribution: The surface soil distribution can be characterized by using the U.S. Department of Agriculture Soil Classification System (U.S.D.A., 1975).

The U.S.D.A. system was primarily developed for agricultural purposes. This system provides information on typical soil profiles (e.g., 1-foot fine sandy loam over gravelly sand, depth to bedrock 12 feet), ranges of permeabilities for each layer, and approximate particle size ranges. These values are not accurate enough for predictive purposes, however, and should not be used to replace information collected on site. Existing information on regional soil types is available, but suitable for initial planning purposes only. U.S. Department of Agriculture (U.S.D.A.) county soil surveys may be obtained for each county represented at the Savannah River Site.

- b. Soil Profile: A modified Wentworth scale (Lane, et al, 1947) can be used for classifying various layers of soil encountered in soil borings at SRS. This scale has been used to formulate the soil's classification system listed in Appendix I (currently under review for inclusion in DPSOP 254).

This scale is based upon a visual inspection of soil samples in the field and comparison with percentage and color charts. Grain size fractions, degree of sorting, color, roundness, sphericity, fossils present, presence of carbonate zones, texture and accessory minerals are noted for each soil layer. The Wentworth Scale is described in Mayer, 1964, p. 35-36.

- c. Transects of Soil Stratigraphy: See introductory geologic textbooks for standard procedures for preparing stratigraphic cross-sections.
- d. Hydraulic Conductivity: An essential physical property affecting contaminant mobility in soil is the hydraulic conductivity. This property indicates the ease with which water at the prevailing viscosity will flow through the soil, and is dependent on the porosity of the soil, grain size, degree of consolidation and cementation, and other soil factors.

1. Saturated Soils - The hydraulic conductivity of saturated soils can be measured in both the laboratory and in the field using various techniques. Laboratory methods for the determination of saturated hydraulic conductivity include both constant and falling head methods. Recommended sources for these methods are Klute (1965a) and SW-846, Method 9100 (U.S. EPA, 1986).
2. Unsaturated Soils - Measurement of unsaturated conductivity is difficult because the value changes with changing soil moisture content. Therefore, conductivities for the entire range of field moisture content may need to be determined for each type of soil at the site. It is also important to note that, unless otherwise specified, unsaturated hydraulic conductivity refers to flow in the vertical direction, while saturated conductivity refers to flow in the horizontal direction.

A detailed discussion of field and laboratory methods for determining saturated and unsaturated hydraulic conductivity is contained in Soil Properties Classification and Hydraulic Conductivity Testing (U.S. EPA, 1984). In general, field tests are required when the soil is heterogenous, while laboratory tests may suffice for a soil without stratigraphic changes. Estimation of hydraulic conductivity from the particle size distribution may be used as a rough estimate if precise values are not required.

The determination of hydraulic conductivity in unsaturated soils is more restricted in the number of techniques and is generally more difficult than in saturated soils. Hydraulic conductivity declines many fold for most soil material as tension increases from saturation to 0.1 bar. Measuring unsaturated hydraulic conductivity requires information on both the tension and the rate of water movement. The relationships and some methods are described by: Klute (1965b), Bouwer and Jackson (1974) and Bouma, Baker and Veneman (1974).

- e. Relative Permeability: The ratio of the permeability of a soil to a non-aqueous solution and its permeability to water is known as relative permeability. The importance of determining this value is due to the potential effects of leachate on soil hydraulic properties. Changes in

conductivity from infiltration of leachate may result from differences in the viscosity or surface tension of the waste, or the leachate may affect the soil structure so as to alter permeability. Studies of waste migration through landfill liners have demonstrated that certain wastes may cause shrinking or expansion of clay molecular structures, dissolve clays and organic matter, clog soil pores with fine particles, and cause other changes that affect permeability.

The procedure for determining relative permeability requires the permeability of the soil to water (K) and the permeability of the soil to leachate (K_l). The relative permeability of a given soil infiltrated by the specific leachate studied can be determined using the following expression:

$$K_r = \frac{K_l}{K}$$

The expression states the relative or effective permeability of the soil to the specific leachate studied.

- f. **Bulk Density:** ASTM procedures for bulk density pertain only to "peat" (ASTM D 4531-06) or "compacted bituminous mixtures" (ASTM D 1188). The more appropriate technique for SRS RFI sites is an in-place density of natural soils. A sample is collected using a Shelby tube or other soil coring technique. Weight and volume measurements are conducted to determine "wet density". Based on soil moisture content, "dry density" is then calculated. The laboratory procedures are listed in U.S. Army Corps of Engineers, EM-1110-2-1906, Appendix 2, as "Unit Weight Determination".
- g. **Porosity:** Soil porosity is the volume percentage of the total soil volume not occupied by solid particles (i.e., the volume of the voids). In general, the greater the porosity, the more readily fluids may flow through the soil.

An exception is clay soils, in which fluids are held tightly by capillary forces. Porosity is usually measured by oven-drying an undisturbed sample and weighing it. It is then saturated with liquid and weighed again. Finally, the saturated sample is immersed in the

same liquid, and the weight of the displaced liquid is noted. Porosity is the weight of liquid required to saturate the sample divided by the weight of liquid displaced, expressed as a decimal fraction.

- h. Soil Sorptive Capacity and Soil-Water Partition Coefficient (K_D): The mobility of contaminants in soil depends not only on properties related to the physical structure of the soil, but also on the extent to which the soil material will retain, or adsorb, the hazardous constituents. The extent to which a constituent is adsorbed depends on chemical properties of the constituent and of the soil. Therefore, the sorptive capacity must be determined with reference to particular constituent and soil pair. The soil-water partition coefficient (K_D) is generally used to quantify soil sorption. K_D is the ratio of the adsorbed contaminant concentration to the dissolved concentration, at equilibrium.

There are two useful approaches to determining K_D : (1) soil adsorption laboratory tests, and (2) prediction from soil and constituent properties.

The Soil Adsorption Isotherm (AI) test is widely used to estimate the extent of adsorption of a chemical (i.e., contaminant) in soil systems. Adsorption is measured by equilibrating aqueous solutions containing different, environmentally realistic, concentrations of the test chemical with a known quantity of clean soil. After equilibrium is reached, the distribution of the chemical between the soil and water (K_D) is measured by a suitable analytical method.

The AI test has several desirable features. Adsorption results are highly reproducible. The test provides excellent quantitative data, readily amenable to statistical analysis. In addition, it has relatively modest requirements for chemicals, soils, laboratory space and equipment. The ease of performing this test will depend on the physical/chemical properties of the contaminant and the availability of suitable analytical techniques to measure the chemical.

The AI test can be used to determine the soil adsorption potential of slightly water soluble to infinitely water soluble chemicals. In general, a chemical having a water solubility of

less than 0.5 ppm is not tested with this method because these chemicals are essentially immobile in soil. The U.S. EPA Office of Pesticides and Toxic Substances (U.S. EPA 1982a, 1982b) has compiled information on the use of the AI test, including a detailed discussion of apparatus, procedures, sources of error, statistical requirements, calculation methods, and limitation of the test.

The second approach for determining K_D is to estimate the value from soil and waste properties. Soil properties that should be considered under this approach are: (1) particle size distribution; (2) cation exchange capacity; and (3) soil organic carbon content. The waste properties that must be determined will vary depending on the type of waste. Lyman et al. (1981) discuss several methods for estimating K_D from chemical properties of the constituent (i.e., K_{OW} and water solubility) and the soil organic content. Data collection needs for waste properties were discussed earlier in this section.

- i. Cation Exchange Capacity (CEC): This parameter represents the extent to which the clay and humic fractions of the soil will retain charged species such as metal ions. The CEC is an important factor in evaluating transport of lead, cadmium, and other toxic metals. Soils with a high CEC will retain correspondingly high levels of these inorganics. The hazardous chemicals will be prevented from leaching to ground water in the short-term, but in the long-term these soils may be a reservoir for continuing releases. A method for the determination of CEC is detailed in SW-846, Method 9081 (U.S. EPA, 1986).
- j. Organic Carbon Content: The amount of natural organic material in a soil has a strong effect on retention of organic pollutants. The greater the fraction by weight of organic carbon (f_{OC}), the greater the adsorption of organics. Soil f_{OC} ranges from under 2 percent for many subsurface soils to over 20 percent for a peat soil. An estimate of f_{OC} based on literature values for similar soils, if unit-specific information is not available.
- k. Soil pH: Soil pH affects the mobility of potentially ionized organic and inorganic chemicals in the soil. Compounds in these groups include organic and inorganic acids and bases, and metals. The method for testing pH in soil is presented in SW-846, method Number 9045

(U.S. EPA, 1986). This method describes two procedures, one for non-calcareous and one for calcareous soils, which are summarized below:

1. Non-Calcareous Soils

Mix 20 grams of soil and 20 milliliters of Type II water and stir several times for 30 minutes. After allowing suspension to stand for 1 hour, submerge electrodes in accordance with manufacturer's recommendations while maintaining electrode above settled solids to measure pH. If temperature of suspension is greater/less than 2°C from calibration temperature, appropriate temperature correction should be made.

2. Calcareous Soils

Mix 10 grams of soil with a 0.01 molar calcium chloride solution and stir several times for 30 minutes. After allowing suspension to stand for 1/2 hour, submerge electrodes in accordance with manufacturer's recommendations while maintaining electrode above settled solids to measure pH. If temperature of suspension is greater/less than 2°C from calibration temperature, appropriate temperature corrections should be made.

1. Particle Size Distribution: A measurement of particle size distribution should be made for each layer of soil potentially affected by the release. The recommended method for measurement of particle size distribution is ASTM D421 and D422 (ASTM, 1984).

The particle size distribution has two uses in a soils investigation: (1) estimation of the hydraulic conductivity of the soil by use of the Hazen formula, and (2) assessment of soil sorptive capacity.

1. The hydraulic conductivity (K) may be estimated from the particle size distribution using the Hazen formula:

$$K = Ad_{10}^2$$

Where d_{10} is equal to the effective grain size, which is that grain-size diameter at which 10 percent by weight of the particles are finer and 90 percent are coarser (Freeze and Cherry, 1979). The coefficient A is equal to 1.0 when K is in units of cm/sec and d_{10} is in mm. Results should be verified with in-site hydraulic conductivity techniques.

2. Particle size affects sorptive capacity and, therefore, the retardation of contaminants in the soil. Sandy soils generally have low sorptive capacity while clays have a high affinity for heavy metals and some organic contaminants. This is due in part to the fact that small clay particles have a larger surface area in relation to their volume than do large sand particles. Large surface areas lead to stronger interactions with waste molecules. Clays also bind contaminants due to the chemical structure of the clay matrix.
- m. Depth to Water Table: The thickness of the unsaturated zone may affect the retardation capacity of the soil and the time taken for contaminants to migrate to ground water. Seasonal fluctuations should be identified if significant, as well as changes due to pumping or other factors.

The depth to the water table can be determined at a given unit by installing a piezometer or well into the uppermost water bearing formation. After the water table has reached static conditions, the depth to the water table can accurately be measured using an electronic water level tape.

- n. Moisture Content (Volumetric Water Content): The volumetric water content is the percent of total soil volume which is filled with water. It is equal to the amount of water lost from the soil upon drying to constant weight at 105°C, expressed as the volume of water/bulk

volume of soil. This parameter affects the unsaturated hydraulic conductivity, and is required for calculation of pore water velocity. At saturation, the volumetric water content is equal to the porosity of the soil.

The moisture content of a soil sample can be determined using ASTM method D2216.

- o. Effect of Stratification on Unsaturated flow: The effect of stratification on unsaturated flow can be determined based upon an empirical evaluation of the soil profile, stratigraphic cross-sections, unsaturated hydraulic conductivity and infiltration.
- p. Infiltration: Infiltration refers to the movement of water into a soil as contrasted to the movement of water through a soil. Because the infiltration rate is influenced by the water content and surface condition of the soil, correct use of these factors is important when interpreting the results. To date, no single measuring technique that will work under all conditions has been developed. However, two general methods, flooding and rainfall simulators, are widely used.

The double-ring infiltrometer is probably the most widely used instrument for measuring the rate of water intake. A large plot bounded by a wall of soil or some impermeable material to contain the water may be used. Recommended sources for this method are: Bertrand (1965), Johnson (1970) and ASTM D 3385-75.

Obtaining a satisfactory measurement of infiltration with the rainfall simulation method requires that the artificial rain closely simulate natural rainfall and that the plot areas be large enough to represent the given soil. Infiltration equals the difference between the amount of water applied and the amount of runoff. The recommended source for this method is Bertrand (1965).

- q. Evapotranspiration: Two methods are generally used for estimating the rate of evaporation in South Carolina. These methods are found in Kish (1977) and Palmer and Havens (1958).

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- r. Vertical Flow Rate: Pore water velocity impacts the time of travel of contaminants from soil to ground water. The pore water velocity can be calculated by the following equation:

$$V = q/\theta$$

where: V = pore water velocity, cm/day
 q = volumetric flux/unit area, cm/day
 θ = volumetric water content, dimensionless

Percolation (volumetric flux per unit area) - Movement of contaminants from soil to ground water occurs primarily via dissolution and transport with percolating soil water. It is important, therefore, to determine the volume of water passing through the soil. The percolation rate, or volumetric flux, must be determined in order to calculate pore water velocity through the unsaturated zone. The rate of percolation can be estimated from the water balance equation:

$$PER = P - ET - DR$$

where: PER = Percolation/Recharge to ground water, cm/yr
 P = Precipitation and irrigation
 ET = Evapotranspiration
 DR = Direct Surface Runoff

Annual averages for P , ET and DR should be obtained from existing local sources. Sources of information to estimate PER include:

- State or Regional water agencies;
- Federal water agencies (US Geological Survey, National Weather Service, Forest Service); and
- Weather stations.

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It is recommended that unit-specific ET and DR data be used if possible, since local conditions can vary significantly from regional estimates.

- s. **Mineral Content:** Several methods are available for identification of minerals in rocks and soils. These methods include: evaluation of chemical and physical characteristics, optical mineralogy and X-ray diffraction.

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APPENDIX O
RANDOM GRID SAMPLING PROCEDURE

APPENDIX O. RANDOM GRID SAMPLING PROCEDURE

Soil characteristics, waste type, and waste application rate are all important factors for determining the environmental impact of a particular RFI site or part of a site on the environment. Therefore, areas of the RFI unit for which these characteristics are similar (i.e., uniform areas) shall be sampled as a single monitoring unit. A uniform area is defined as the area of a unit which is composed of soils of the same soil series (U.S.D.A., 1975) and to which similar wastes or waste mixtures are applied. If, however, the texture of the surface soil differs significantly among soils of the same series classification, the phase classification of the soil should be considered in defining "uniform areas." A state of South Carolina certified professional engineer or soil scientist shall be consulted in designating uniform areas.

Based on that definition, the location of soil core sampling or soil-pore liquid monitoring devices within a given uniform area can be randomly selected. Random selection of samples ensures a more accurate representation of conditions within a given uniform area. It is convenient to locate soil core and soil-pore liquid devices by selecting random distances as the location at which a soil core should be taken or a soil-pore liquid monitoring device installed. This system works well for field of both regular and irregular shape because the points outside the area of interest are merely discarded and only the points inside the area are used in the sample.

The location within a given uniform area of an RFI unit at which a soil core should be taken or a soil-pore liquid monitoring device installed can be determined using the following procedure:

1. Divide the unit into uniform areas under the direction of a certified professional soil scientist or engineer.
2. Set up coordinates for each uniform area by establishing two base lines at right angles to each other which intersect at an arbitrarily selected origin, for example, the southwest corner. Each baseline shall extend for enough for all of the uniform area to fall within the quadrant.

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3. Establish a scale interval along each base line. Both base lines shall have the same units.
4. Draw two random numbers from a random-number table (available in most basic statistics books). Use these numbers to locate one point along each of the base lines.
5. Locate the intersection of two lines drawn perpendicular to the base lines through these points. This intersection represents one randomly selected location for collection of one soil core, or for installation of one soil-pore liquid device. If this location at the intersection is outside the uniform area, disregard and repeat the above procedure.
6. For soil core monitoring, repeat the above procedure as many times as necessary to obtain the desired number of locations within each uniform area of the RFI unit. This procedure for randomly selecting locations must be repeated for each soil core sampling event but will be needed only once in locating soil-pore liquid monitoring devices.

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APPENDIX P

**RECOMMENDED SAMPLING METHODOLOGIES
FOR ORGANIC CONSTITUENTS EXHIBITING POTENTIAL
FOR RELEASE TO AMBIENT AIR**

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RECOMMENDED SAMPLING METHODOLOGIES FOR ORGANIC
CONSTITUENTS EXHIBITING POTENTIAL FOR RELEASE TO AMBIENT AIR

Recommended Sampling Methodology

Constituent (demonstrating air release potential)	Field GC ¹	Stain Detector Tube ^{2,3}	Tenax Cartridge ⁴	Hi-Vol. Polyurethane Foam ⁵
acetaldehyde		X		
acrolein		X		
arochlor 1016				X
arochlor 1221				X
arochlor 1232				X
arochlor 1242				X
arochlor 1248				X
arochlor 1254				X
arochlor 1260				X
arsenic (total)				
barium (total)				
benzene	X	X	X	
benzylchloride			X	
beryllium (total)				
bromomethane			X	
cadmium (total)				
carbon tetrachloride	X	X	X	
chlorobenzene	X	X	X	
2-chloro-1,3-butadiene		X		
p-chloro-m-cresol				
chlorodibromomethane				
chloroethane				
1-chloro-2,3-epoxypropene				
chloroform	X	X	X	
chloromethane				
3-chloropropene				
chromium (total)				
copper (total)				
creosol		X		X
cumene				

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RECOMMENDED SAMPLING METHODOLOGIES FOR ORGANIC
CONSTITUENTS EXHIBITING POTENTIAL FOR RELEASE TO AMBIENT AIR
(Continued)

Recommended Sampling Methodology

Constituent (demonstrating air release potential)	Field GC ¹	Stain Detector Tube ^{2,3}	Tenax Cartridge ⁴	Hi-Vol. Polyurethane Foam ⁵
cyanide (total)				
DDD				X
DDE				X
DDT				X
1,2-dibromo-3-chloropropane				
1,2-dibromomethane			X	
o-dichlorobenzene		X		
p-dichlorobenzene		X	X	
dichlorodifluoromethane				
1,1-dichloroethane	X		X	
1,2-dichloroethane	X		X	
1,1-dichloroethylene			X	
1,2-dichloroethylene		X		
dichloromethane	X	X		
dimethyl benzene	X		X	
1,4-dioxane		X		
ethyl benzene	X		X	
ethylene oxide		X		
formaldehyde		X		X
hexachlorobutadiene				X
hexachlorocyclopentadiene				X
hydrocyanic acid				
hydrofluoric acid				
hydrogen sulfide		X		
kepone				
lead (total)				
maleic anhydride				

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CONSTITUENTS EXHIBITING POTENTIAL FOR RELEASE TO AMBIENT AIR
(Continued)

Recommended Sampling Methodology

Constituent (demonstrating air release potential)	Field GC ¹	Stain Detector Tube ^{2,3}	Tenax Cartridge ⁴	Hi-Vol. Polyurethane Foam ⁵
mercury (total)		X		
methyl acetate		X		
methyl ethyl ketone	X	X		
naphthalene		X		
2-naphthylamine				
nitrobenzene	X		X	
n-nitrosodimethylamine				
n-nitrosomorpholine				
phenol		X	X	X
phosgene		X		
phthalic anhydride				
propylene oxide		X		
selenium (total)				
silver (total)				
tetrachlorodibenzo-p-dioxins				
tetrachloroethene		X		
1,1,2,2-tetrachloroethane			X	
2,3,4,6-tetrachloride				
thallium (total)				
toluene	X	X	X	
toxaphene				

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RECOMMENDED SAMPLING METHODOLOGIES FOR ORGANIC
CONSTITUENTS EXHIBITING POTENTIAL FOR RELEASE TO AMBIENT AIR
(Continued)

Recommended Sampling Methodology

Constituent (demonstrating air release potential)	Field GC ¹	Stain Detector Tube ^{2,3}	Tenax Cartridge ⁴	Hi-Vol. Polyurethane Foam ⁵
trichloroethene	X	X	X	
1,1,1-trichloroethane	X		X	
1,1,2-trichloroethane			X	
trichloromono-fluoromethane				
2,4,5-trichlorophenol				X
vanadium (total)				
vinyl chloride		X		
xylene		X	X	
zinc (total)				

Note: All particulate-phase metals can be collected using high-volume sampling filter methodologies.

¹Characterization of Hazardous Waste Sites, Vol. II, 2nd Edition, p. 4-20.

²Detector Tube Handbook, National Draeger, 6th Edition, 1985.

³"List of "Kitagawa" Precision Detector Tubes," Matheson Gas Products, Secaucus, NJ, 1987.

⁴Characterization of Hazardous Waste Sites, pp. 4-36, 4-37.

⁵Characterization of Hazardous Waste Sites, pp. 4-49, 4-50.

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**APPENDIX Q
FIELD CALIBRATION FORMS**

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Sample Instrument Calibration

Make _____

Model # _____

Serial # _____

1. Recommended Calibration Frequency: _____
2. Last Calibration Date: _____
3. Calibrated By: _____
4. Calibration Standards Used: _____
5. Source of Calibration Standard: _____
6. Calibration Procedure Used if more than one method in manual

7. Usage Date	<u>Sample ID Number</u>	<u>Location</u>
_____	_____	_____
_____	_____	_____

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[illegible][illegible]

M8910001

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CALIBRATED

CALIBRATED

48910001

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APPENDIX R

DIRECTIONS FOR COMPLETING FIELD DATA COLLECTION FORMS

- (1) SOIL CORE SAMPLING
- (2) GROUND WATER COLLECTION

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FIELD CODING FORM FOR SOIL CORES

[illegible]

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Field Coding Form

**RFI--SRP
SAMPLE DESCRIPTION CODING FORM FOR SOIL CORES**

<u>Field No.</u>	<u>Cols.</u>	<u>Description</u>	<u>Type & Format</u>
1	1-10	Sample identifier	
	1-5	Facility	5 Alpha-numeric starting with a letter
	6-7	Number of core	2 Integer ¹
	8-9	Number of sample	2 Integer ¹
	10	Other	1 Alpha-numeric
2	11-16	Date sample collected	6 Integer, ¹ in MM/DD/YY Form
3	17-20	Time sample coordinate	4 Integer, ¹ in form of 24 hr military time
4	21-26	SRS North Coordinate	6 Integer in feet
5	27-32	SRS East Coordinate	6 Integer in feet
6	33-39	Depth of top of sample	7 Real numeric, in decimal feet
7	40-48	Depth of bottom of sample	7 Real numeric, in decimal feet
8	47-48	Reason for sampling	2 Alpha-numeric
9	49-51	Logbook	3 Integer
10	52-54	Page in Logbook	3 Integer
11	55-56	Type of medium	2 Alpha-numeric

¹ All columns in the field must be filled in. For integer fields, use leading zeros.

Coding Instructions

Four kinds of fields are specified: alpha, alpha-numeric, integer, and real numeric. The general instructions for these field types are as follows:

Alpha - Fields are left justified and may contain only capital letters and blanks. Left justified means that the first letter is placed in the left most column of the field and if entry is shorter than the field blank, spaces remain on the right side of the field.

Alpha-numeric - Fields are left justified and may contain capital letters, the numbers from 0 to 9, and blanks.

Integer - Fields are right justified and may contain blanks and the numbers from 0 to 9. All blanks must precede the numbers.

Real numeric - Fields are right justified and may contain blanks, a decimal and the numbers from 0 to 9. If present, blanks must precede the numbers and the decimal point. The decimal point is optional but there cannot be more than one decimal point.

Some fields will have coded entries. All codes will assigned by WSRC unless otherwise noted.

Facility - is an alpha-numeric field that uses a code to describe the study area. This field must start with letter. WSRC will assign the coded entry for this field for each study.

Number of core - Is an integer field that may have blank columns. This field represents the number of the sampling site within the study. The field sampling team will assign this number. If there are more than 99 sites within a study, a second facility identifier for that study will be assigned.

Number of sample - Is an integer field that may not have blank columns. This field represents the sequential number of the sample collected from the core. Special samples such as rinse water from the coring equipment will also be assigned a number.

Other - Is an alpha-numeric field used to further identify samples. This field will normally be blank.

Date sample collected - Are integer fields in the MM/DD/YY format. For January 9, 1988, the entry is 010988.

Time sample collected - Is an integer field reported as military time. For example, 2:15 p. m. is reported as 1415, and 8:30 a. m. is reported as 0830.

SRS North coordinate and SRS East coordinate - Are integer fields reported in whole feet. Algorithms are available for conversion of SRS coordinates to latitude and longitude (Looney et al., 1987).

Depth to top of sample and depth to bottom of sample - are real numeric fields recorded in decimal feet. A decimal point should be included in one column unless the depth is in whole feet. All depths should be recorded from the ground surface.

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Reason for sampling - Is an alpha-numeric code that will be assigned by the WSRC coordinator. SC=Screening. BG=Background, CA=Characterization/Assessment.

Logbook - Is an integer field referring to the numbered logbook containing the field information collected about the sample. Each project should have its own numbered logbooks.

Page in logbook - Is an integer field referring to the number of the first page of the logbook that contains field information about the sample.

Type of medium - Is an alpha-numeric field for type of material sampled. WSRC will assign the codes.

References

Looney, B. B., J. T. Marsh, Jr., and D. W. Hayes, 1987.
Development of Accurate Standardized Algorithms for Conversion Between SRP Grid Coordinates and Latitude/ Longitude, DPST-87-724, Savannah River Laboratory, E. I. Du Pont de Nemours and Company, Aiken, SC.

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**DIRECTIONS FOR FILLING OUT THE FIELD DATA COLLECTION FORM
DPSOP 254-XVI-3**

INTRODUCTION

The pages of the field data collection log book are designed for rapid entry into the computer files. The information on each line must be filled out carefully using the following directions.

GENERAL RULES

Place only one character per space. That character may be a capital letter, a number, or a decimal point.

Use a black ballpoint pen.

Before copying or reviewing any page any blank lines on that page should be marked through and not used.

Comments about the well or sampling event may be written on lines following the data line for that well. Place a line through the well name column to indicate that the data are not to be entered into the computer. Any number of these lines may be used. There is no specific format for these lines.

SPECIFIC INSTRUCTIONS FOR EACH COLUMN

WELL

The well name consists of three fields. The first three columns are numbers or letters, left justified. The second three columns are numbers, right justified. The last two columns are numbers or letters, left justified.

DATE

The date has two columns for the months, two for the day, and two for the year. Use only numbers and leave no blanks.

DUPLICATE #

The duplicate sample identifier may be a letter or number but is normally left blank. The duplicate sample identifier is used to distinguish field data lines recorded at a well during a day.

TIME

The time is a numeric field written as military time. Use only numbers and leave no blanks.

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WATER TEMPERATURE

The temperature of the water in degrees Centigrade is entered if it is measured.

pH

The pH of the water is entered if it is measured.

SPECIFIC CONDUCTANCE

The specific conductance of the water in micro-mhos/cm is entered if it is measured.

DEPTH TO WATER

The depth to the water from the top of the casing in feet is entered if it is measured.

VOLUME PURGED

The number of gallons of water evacuated from the well prior to sampling is entered if samples are collected. If no water is evacuated, then enter zero.

X/PUMPED DRY

Enter the letter "X" if the well is pumped dry prior to sampling. Enter the letter "D" if the well is dry.

AIR TEMPERATURE

The temperature of the air in degrees centigrade is entered if it is measured.

METHOD

The code for the sampling method is entered if samples are collected.

PROGRAM

The code for the program the samples were collected for is entered if samples are collected.

SAMPLER INITIALS

The initials of the person recording the data are entered.

**P
INSTRUMENT CALIBRATION**

Field instruments should be calibrated according to the sample collecting procedures. The calibration results should be recorded on pages 31 to 40 of this log.

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CODES FOR SAMPLING PROGRAMS

The following codes are used for the sampling programs on the coding forms. New codes should be added to this list as needed.

<u>CODE</u>	<u>Meaning</u>
Q1	The well is being visited as part of the Waste-Site Ground Water Monitoring Program routine program.
T1	The well is being visited to be sampled to determine radioactivity levels for shipping purposes.
WL	The well is being visited to determine water levels.
R1	The well is being visited as part of the Radioactive Ground Water Monitoring Program.

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CODES FOR SAMPLING PROGRAMS

The following codes are used for the sampling methods on the coding forms. New codes should be added to this list as needed.

<u>CODE</u>	<u>Meaning</u>
P	Sample is collected from well using centrifical downhole pump. Samples collected for metals analyses are filtered through a 0.45 micron filter.
B.	Sample is collected from well using an open bucket bailer. Samples collected for metals analysis are filtered through a 0.45 micron filter.
Source:	duPont (E.I. duPont de Nemours and Company). 1987. Hydrogeologic Data Collection Methods, Procedures and Specifications. DPSOP254. Savannah River Plant, Aiken, South Carolina.

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APPENDIX S

**CHAIN-OF-CUSTODY FORM AND
REQUEST FOR ANALYSIS FORM**

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CHAIN OF CUSTODY FORM

CUSTODY TRANSFER RECORD

SHIP TO:

Sample I.D.		SAMPLE DATE	DUPLICATE ID
ITEM	PRESERV.	CONTAINER	ANALYSES REQUESTED
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

ITEMS	RELINQUISHED BY	DATE	TIME	RECEIVED BY	DATE	TIME	REASON FOR TRANSFER

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OSR 14-31 (Rev. 11-88)

ANALYSIS REQUEST - SAVANNAH RIVER PLANT

DISTRIBUTION: WHITE - LABORATORY RETURN TO ORIGINATOR PINK - LABORATORY YELLOW - ORIGINATOR

LABORATORY		SUBMITTED BY		LOCATION	
DATE SUBMITTED			STUDY NO. OR ACCOUNT CODE		
SAMPLE DESCRIPTION AND IDENTIFICATION					
SPECIAL SAFETY PRECAUTIONS					
ACTIVITY				LAB. SERIAL NO.	
ANALYSES REQUESTED		ESTIMATED		FOUND BY LABORATORY	
REQUEST APPROVED		ANALYSIS APPROVED		DATE COMPLETED	

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APPENDIX T

**"CHEMICAL ANALYSIS RESULTS CODING FORMS AND DESCRIPTIONS"
AND ASSOCIATED DIRECTIONS**

- (1) SOIL CORE ANALYSIS
- (2) GROUND WATER ANALYSIS

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Analytical Coding Form

**RFI--SRP
CHEMICAL ANALYSIS CODING FORM DESCRIPTION -- SOIL CORES**

<u>Field No.</u>	<u>Cols.</u>	<u>Description</u>	<u>Type & Format</u>
1	1-10	Sample identifier	
	1-5	Facility	5 Alpha-numeric starting with a letter
	6-7	Number of core	2 Integer ¹
	8-9	Number of sample	2 Integer ¹
	10	Other	1 Alpha-numeric
2	11-16	Date sample collected	6 Integer, ¹ in MM/DD/YY Form
3	17-22	Date analysis performed	6 Integer, ¹ in MM/DD/YY Form
4	23-26	Batch Number	4 Integer, ¹ Number less than 2400
5	27-28	Analytical laboratory	2 Alpha, ¹
6	29-40	Laboratory ID	12 Alpha-numeric
7	41	Quality Control Identifier	1 Alpha
8	42-47	Analytical test	6 Alpha-numeric, refer to codes
9	48-49	Analytical method	2 Alpha-numeric ¹
10	50-51	Result modifier	2 Alpha, refer to codes
11	52-61	Analytical result	10 Real numeric
12	62-65	Result units of measurement	4 Alpha, refer to codes

¹ All columns in the field must be filled in. For integer fields, use leading zeros.

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Analytical Coding Form, Contd

RFI--SRP
CHEMICAL ANALYSIS CODING FORM DESCRIPTION -- SOIL CORES

<u>Field No.</u>	<u>Cols.</u>	<u>Description</u>	<u>Type & Format</u>
13	66-69	Statistically measurement of test result	4 Real numeric
14	70-75	Dilution factor used for test result	6 Real numeric
15	76	Number of Dilutions	1 Integer
16	77-78	Instrument used for analysis	2 Alpha-numeric
17	79-81	Analyst's initials	3 Alpha
18	82-91	Spike concentration	10 Real numeric, enter 0 if this is an unspiked sample

Coding Instructions

Four kinds of fields are specified: alpha, alpha-numeric, integer, and real numeric. The general instructions for these field types are as follows:

Alpha - Fields are left justified and may contain only capital letters and blanks. Left justified means that the first letter is placed in the left most column of the field and if entry is shorter than the field blank, spaces remain on the right side of the field.

Alpha-numeric - Fields are left justified and may contain capital letters, the numbers from 0 to 9, and blanks.

Integer - Fields are right justified and may contain blanks and the numbers from 0 to 9. All blanks must precede the numbers.

Real numeric - Fields are right justified and may contain blanks, a decimal and the numbers from 0 to 9. If present, blanks must precede the numbers and the decimal point. The decimal point is optional but there cannot be more than one decimal point.

Some fields will have coded entries. All codes will assigned by WSRC unless otherwise noted.

Facility - is an alpha-numeric field that uses a code to describe the study area. This field must start with letter. WSRC will assign the coded entry for this field for each study.

Number of core - Is an integer field that may have blank columns. This field represents the number of the sampling site within the study. The field sampling team will assign this number. If there are more than 99 sites within a study, a second facility identifier for that study will be assigned.

Number of sample - Is an integer field that may not have blank columns. This field represents the sequential number of the sample collected from the core. Special samples such as rinse water from the coring equipment will also be assigned a number.

Other - Is an alpha-numeric field used to further identify samples. This field will normally be blank.

Date sample collected and date analysis performed - Are integer fields in the MM/DD/YY format. For January 9, 1988, the entry is 010988.

Batch Number - Is an integer field. A unique number assigned to each batch run to identify lab controls with test results.

Analytical laboratory - Is an alpha field. WSRC will assign a code to each lab. WA is the code for Weston Analytics, and MT is the code for Metatrace.

Quality Control Identifier - Is an alpha field. R=Replicate, S=Spike, T=Duplicate Spike

Laboratory ID - is an alpha-numeric field containing the identification assigned to the sample by the laboratory.

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Analytical test - Is an alpha-numeric field containing the code for the analyte. WSRC will assign all codes.

Analytical method - Is an alpha-numeric field containing the code established by each laboratory to define the method used to determine the concentration of the analyte. Each laboratory must provide documentation for each code used.

Result modifier - Is an alpha field used to qualify the result. WSRC will assign all codes.

Analytical result - is a numeric field.

Result units of measurement - Is an alpha field with codes for the units of measurement. WSRC will assign all codes.

Statistically measured accuracy of test result - Is a real field with the counting error of the analytical measurement. This field will be blank for most measurements except radiation counting.

Dilution factor used or test result - Is a real field with the counting error of the analytical measurement. This field will be blank for most measurements except radiation counting.

Number of dilutions - Is an integer field containing the number of steps used to reach the final dilution. A zero (0) should be entered for undiluted samples.

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Chemical Analysis Results Coding Form - Ground Water

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DATA MANAGEMENT - USERS GUIDE

**DUPONT - SRS
CHEMICAL ANALYSIS RESULTS CODING FORM DESCRIPTION -
WATER**

<u>Field No.</u>	<u>Cols.</u>	<u>Field Name</u>	<u>Description</u>	<u>Variable¹ Type & Format</u>
1	1-8 1-3 4-6 7-8	WELL NUMBER	sample identifier; facility number of well additional ID	-- 3 char. alpha 3 char. integer 2 char. alpha
2	9-14	SAMPLE DATE	date sample collected	² 6 char. integer, in form of MM/DD/YY
3	15	duplicate identifier (DI)	extra ID space if necessary usually blank	1 char. alpha- numeric
4	16-21	ANALYSIS DATE	date sample analyzed for test name	² 6 char. integer, in form of MM/DD/YY
5	22-25	analysis time (ANALY TIME)	time sample analyzed for test name	² 4 char. integer, in form of 24 hr. military time
6	26-27	laboratory (EE)	lab performing chemical analyses	² 2 char. alpha; note: EE is only accepted code
7	28-33	SAMPLE NUMBER	lab sample number assigned on log in	6 char. alpha- numeric; usually 5 char.
8	34-39	TEST NAME	analytical test	6 char. alpha- numeric; refer to list of test name codes for acceptable entries

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<u>Field No.</u>	<u>Cols.</u>	<u>Field Name</u>	<u>Description</u>	<u>Variable¹ Type & Format</u>
9	40-41	analytical method (ANL MTH)	approved method for test name analyzed	² 2 char. alpha-numeric; refer to list of analytical methods codes for water
10	42-43	measurement boolean (MEA BOO)	used when measured quantity above or below limits	² 2 char. alpha; blank-results are within certified range LT-results less than detection limit GT-results greater than upper limit. ^b Used to flag results in question.
11	44-53	TEST RESULTS	analytical test results for test name	² up to 10 char. numeric, integer or real
12	54-57	measurement units (MEAS UNITS)	result units of measurement	4 char. alpha, usually, refer to measurement unit code
13	58-61	accuracy (ACCRY)	statistically measured accuracy of test result	² ₄ char. real
14	62-65	precision (PREC)	statistically measured precision of test result	² ₄ char. real
15	66-71	DILUTION FACTOR	dilution factor used for test result	6 char. integer note: 1 means no dilution; other entries are the ratio to 1, e.g. 1000 means a dilution ratio of 1:1000

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<u>Field No.</u>	<u>Cols.</u>	<u>Field Name</u>	<u>Description</u>	<u>Variable¹ Type & Format</u>
16	72	number of dilutions (ND)	the number of dilutions used previous factor	² 1 char. integer; acceptable entries: 0 - no dilution, 1-9 no. times diluted
17	73-74	instrument number (IN NO)	instrument test analysed on	² 2 char. in alpha-numeric note: refer to list of instrument number codes
18	75-77	initials (INIT)	person's initials performing analysis	3 char. alpha
19	78-80	visual contamination (VIS CONTM)	visual contamination if any, noted in sample bottles during log in	3 char. alpha-numeric, note: refer to list of codes
20	81-90	nominal concentration (NOMINAL CONC)	spike concentration	up to 10 char. numeric, integer or real, refer to list of coding of quality control samples

NOTES: ¹ alpha and alphanumeric entries must be left justified in field; numeric (integer & real) entries must be right justified in field

¹ all columns in field must be filled

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SUPPLEMENTAL CODE LISTS

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Testnames, sorted by code.

AACHXE	ACETIC ACID, CYCLOHEXYL ESTER
ABHC	ALPHA-BENZENEHEXACHLORIDE / ALPHA-HEXACHLOROCYCLOHEXANE
AC	HYDROGEN CYANIDE / HYDROCYANIC ACID
ACET	ACETONE
ACHE	ANTICHOLINESTERASE
ACIDIT	ACIDITY
ACPHN	ACETOPHENONE
ACROLN	ACROLEIN
ACRYLO	ACRYLONITRILE
ADHP	AMMONIUM DIHYDROGEN PHOSPHATE
AENSIF	ALPHA-ENDOSULFAN / ENDOSULFAN I
AG	SILVER
AL	ALUMINIUM
ALAL	ALIPHATIC ALCOHOL
ALORN	ALORIN
ALHC	ALIPHATIC HYDROCARBON
ALHMW	ALCOHOLS (HIGH MOLECULAR WEIGHT)
ALK	ALKALINITY
ALKN	ALKANE
ANAPNE	ACENAPHTHENE
ANAPYL	ACENAPHTHYLENE
ANIL	ANILINE
ANTRC	ANTHRACENE
AS	ARSENIC
ASBEST	ASBESTOS
ASEXT	ARSENIC EXTRACTABLE
ASTOT	ARSENIC TOTAL
ATNBA	2,4,6-TRINITROBENZALDEHYDE
ATNT	ALPHA-TRINITROTOLUENE (OBSOLETE; USE 246TNT)
ATZ	ATRAZINE
AYLETH	ALLYL ETHER
AZACN	AZACYCLONONANE
B	BORON
BA	BARIUM
BAANTR	BENZO(A)ANTHRACENE
BAHXE	BUTANOIC ACID, 1-HEXYL ESTER
BAPYR	BENZO(A)PYRENE
BBHC	BETA-BENZENEHEXACHLORIDE / BETA-HEXACHLOROCYCLOHEXANE
BBZP	BUTYLBENZYL PHTHALATE
BCHPD	BICYCLO[2.2.1] HEPTA-2,5-DIENE
BCPHCE	2,2-BIS(4CHLOROPHENYL) CHLOROETHYLENE ODT RELATED
BCY3HX	BICYCLO (3.1.0) HEXANE
BE	BERYLLIUM
BEETO	1-(2-BUTOXYETHOXY) ETHANOL
BENSIF	BETA-ENDOSULFAN / ENDOSULFAN II
BENZA	BENZANTHRONE
BENZAL	BENZALDEHYDE
BENZOA	BENZOIC ACID
BEP	2-BUTOXYETHANOL PHOSPHATE
BF2ANT	BENZO BIFLUOROANTHENE
BGHIPY	BENZO(G,H,I)PERYLENE
BIDBI	1,5-BIS(1,1-DIMETHYLETHYL)-3,3-DIMETHYLBICYCLO(3.1.0)- HEXANE-2-ONE
BLOX	BLADEX
BMP	BUTYLMETHYL PHTHALATE
BOD	BIOLOGICAL OXYGEN DEMAND
BPEG	BUTYLPHENALYL BUTYLGLYCOLATE
BRCLM	BROMOCHLOROMETHANE
BRDCLM	BROMODICHLOROMETHANE
BRNCIL	BROMACIL
BTA	BENZOTHIAZOLE

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B1MS0A	BIS(TRIETHYLSILYL) OXALIC ACID
BUEETH	BUTYLETHYL ETHER
BZ	3-QUINOLIDINYL BENZILATE
BZALC	BENZYL ALCOHOL
BZFANT	BENZ-FLUORANTHENE
BZOTHP	BENZO(B)THIOPHENE
BZPA	BENZENE PHOSPHONIC ACID
BZYLBR	BENZYL BROMIDE / ALPHA BROMOTOLUENE
BZCEXM	BIS(2-CHLOROETHOXY) METHANE
BZCLEE	BIS(2-CHLOROETHYL) ETHER
BZEMP	BIS(2-ETHYLHEXYL) PHTHALATE
CA	CALCIUM
CALLMH	HYDROCARBONS (ALL MOLECULAR WEIGHTS)
CAME	CARBAMIC ACID, METHYL ESTER
CAMP	CAMPOR
CAPLCT	CAPROLACTAM / 6-AMINOHXANOIC ACID LACTAM
CBA	O-CHLOROBENZALDEHYDE
CBCCH	CIS-1-BROMO-2-CHLOROCYCLOHEXANE
CBOA	O-CHLOROBENZOIC ACID
CCL2F2	DICHLORODIFLUOROMETHANE
CCL3F	TRICHLOROFUOROMETHANE
CCL4	CARBON TETRACHLORIDE
CC3	XXXX
CD	CADMIUM
CDACH	CIS-1,2-DIACETOXYCYCLOHEXANE
CDNBIS	CHLORODINITROBENZENE ISOMER
CEC	CATION EXCHANGE CAPACITY
CG	PHOSGENE / CARBONYL CHLORIDE
CHBR3	BROMOFORM
CHCL3	CHLOROFORM
CHO	1,2-CYCLOHEXANE OXIDE
CHOLA	CHOLESTANE
CHONE	CYCLOHEXANONE
CHRY	CHRYSEN
CH2CL2	METHYLENE CHLORIDE
CH3BR	BROMOMETHANE
CH3CL	CHLOROMETHANE
CK	CYANOGEN CHLORIDE
CL	CHLORIDE
CLC605	CHLOROBENZENE-05
CLC615	CHLOROBENZENE
CLD	CHLORINE DEMAND
CLOAN	CHLORDANE
CLOEN	CHLORDENE
CLNAP	CHLORONAPHTHALENES
CLD3	CHLORATE
CLP	CHLOROPHENOLS
CLVRA	2-CHLOROVINYL ARSONIC ACID
CLXB	CHLORINATED BENZENE
CLANAP	CHLORINATED NAPHTHALENES
CL2	CHLORINE
CL2BZ	DICHLOROBENZENES
CL2NAP	DICHLORONAPHTHALENES
CL3NAP	TRICHLORONAPHTHALENES
CL4NAP	TETRACHLORONAPHTHALENES
CL5B	PENTACHLOROBENZENE
CL5BP	PENTACHLOROBIPHENYL
CL5ET	PENTACHLOROETHANE

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CL68P	HEXACHLOROBIPHENYL
CL68Z	HEXACHLOROBENZENE
CL6CP	HEXACHLOROCYCLOPENTADIENE
CL6ET	HEXACHLOROETHANE
CL7NB	HEPTACHLORONORBORNADIENE
CMWOK	CARBON MONOXIDE
CN	CHLOROACETOPHENONE
CO	COBALT
COO	CHEMICAL OXYGEN DEMAND
CONO	SPECIFIC CONDUCTIVITY
CO3	CARBONATE
CPCXAL	CYCLOPENTANE CARBOXYALDEHYDE
CPMS	P-CHLOROPHENYLMETHYL SULFIDE
CPMSO	P-CHLOROPHENYLMETHYL SULFOXIDE
CPMSO2	P-CHLOROPHENYLMETHYL SULFONE
CPO	CYCLOPENTANONE
CR	CHROMIUM
CRMEX	HEXAVALENT CHROMIUM
CR04	CHROMATE
CS	CESIUM
CSOL	CRESOLS
CS2	CARBON DISULFIDE
CU	COPPER
CUEXT	COPPER EXTRACTABLE
CUTOT	COPPER TOTAL
CA	PHOSGENE (XIME / DICHLOROFORMOXIME
CYN	CYANIDES
CYPD	CYCLOPENTADIENE
C10	DECANE
C11	UNDECANE
C12	DODECANE
C12DCB	CIS-1,2-DICHLOROETHENE
C13DCP	CIS-1,3-DICHLOROPROPYLENE / CIS-1,3-DICHLOROPROPENE
C16A	HEXADECANOIC ACID / PALMITIC ACID
C16SAT	SATURATED HYDROCARBONS (C16)
C17	HEPTADECANE
C18	OCTADECANE
C18AE	OCTADECANOIC ACID, ETHYL ESTER
C18UNS	C18H300 UNKNOWN
C19	NONADECANE
C2H3CL	CHLOROETHENE / VINYL CHLORIDE
C2H5CL	CHLOROETHANE
C20	EICOSANE
C22UNS	C22H400 UNKNOWN
C4HX1L	CIS-4-HEXEN-1-OL
CSA	PENTANOIC ACID / VALERIC ACID
C6D6	BENZENE-D6
C6H6H	CYCLOHEXANOL
C6H6	BENZENE
C7A	HEPTANOIC ACID
C7H81	HEPTACHLORONORBORENE
DBAHA	DIBENZO(A,H)ANTHRACENE
DBATTS	2,4-DIMETHOXYBENZOIC ACID, TRIS-TRIMETHYSILYL
DBCP	DIBROMOCHLOROPROPANE
DBHC	DELTA-BENZENEHEXACHLORIDE / DELTA-HEXACHLOROCYCLOHEXANE
DBRCLM	DIBROMOCHLORODIMETHANE
DBTSPY	4,5-DIMETHYL-2,6-BIS(TRIMETHYLSILOXY) PYRIMIDINE
DCAMBA	2-METHOXY-3,6-DICHLOROBENZOIC ACID

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DCBPH	DICHLOROBENZOPHENONE
DCHP	DICYCLOHEXYL PHTHALATE
DCMBF	5,7-DICHLORO-2-METHYL BENZOFURAN
DCPD	DICYCLOPENTADIENE
DOVP	VAPONA
DEA	DIETHYL AMINE
DEDMF	DIETHYLDIMETHYL DIPHOSPHONATE
DETH	DIETHYL ETHER
DEP	DIETHYL PHTHALATE
DHBZPY	3,4-DIHYDRO-2H-1-BENZOPYRAN
DIAAL	DIACETONE ALCOHOL / 4-HYDROXY-4-METHYL-2-PENTANONE
DIAOS	BIS(DIISOPROPYLAMINOETHYL) DISULFIDE
DIAEL	DIISOPROPYL AMINOETHANOL
DIAEP	S-DIISOPROPYLAMINOETHYLMETHYL PHOSPHONOTHIOATE
DIAET	DIISOPROPYL AMINOETHANETHIOL
DIAS	BIS(DIISOPROPYLAMINOETHYL) SULFIDE
DIAZ	DIAZINON
DIBP	DIISOBUTYL PHTHALATE
DICLP	DICHLOROPHENOLS
DIDOP	DIISOPROPYLDIMETHYL DIPHOSPHONATE
DIMP	DIISOPROPYLMETHYL PHOSPHONATE
DIPUR	DIISOPROPYL UREA
DITH	DITHIANE
DLORN	DIELORIN
DL2HPG	DL-2-(3-HYDROXYPHENYL) GLYCINE
DM	ADAMSITE
DMA	DIMETHYL ANILINE (OBSOLETE; USE NNOMA)
DMCAR	DIMETHYL DITHIOCARBONATE
DMCPDE	1,2-DIMETHYL CYCLOPENTADIENE
DMOS	DIMETHYL DISULFIDE
DMETH	DIMETHYL ETHER
DMMP	DIMETHYLMETHYL PHOSPHATE
DMP	DIMETHYL PHTHALATE
DMPCH	3-(2,2-DIMETHYLPROPOXY) CYCLOHEXENE
DMPTHF	2,2-DIMETHYL-5-(1-METHYLPROPYL) TETRAHYDROFURAN
DMACH	2,2-DIMETHYL-1-ACETYL CYCLOHEXANE
DNBE	1,1-DI-N-BUTYL ETHYLENE / 1,1-DI-N-BUTYL ETHENE
DNBP	DI-N-BUTYL PHTHALATE
DNCP	DI-N-OCYL PHTHALATE
DNPP	DI-N-PENTYL PHTHALATE
DNTISO	DINITROTOLUENE ISOMER
DO	DISSOLVED OXYGEN
DOAU	DIOCTYL ADIPATE
DOAZ	DIOCTYL AZELATE
DOETH	DIOCTYL ETHER
DOPAM	4-(2-AMINOETHYL) PYROCATECHOL / DOPAMINE
DPA	DIPHENYL AMINE
DPETH	DIPHENYL ETHER
DPHNY	DIPHENYL
DPHTLL	D-(1-)-PANTOLYL LACTONE
DPSO	DIPHENYL SULFOXIDE
DTBAC	2,6-DI-TERT-BUTYL-4-CRESOL
DTCHBO	1-ALPHA-(E),4-ALPHA,-1-(1,4-DIHYDROXY-2,6,6-TRIMETHYL-2-CYCLOHEXEN-1-YL)-2-BUTEN-1-ONE
OURS	OURSBAH
DYSCAM	GC-MS GYE SCAN
EBCPGL	ETHYL-2,2-BIS(4-CHLOROPHENYL) GLYCOLATE
ED	DICHLOROETHYL ARSINE

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EMP	ETHYLMETHYL PHOSPHONATE
EMPA	ETHYLMETHYL PHOSPHONIC ACID
ENDRN	ENDRIN
ENMETH	ETHYL-N-HEXYL ETHER
ESFSO4	ENDOSULFAN SULFATE
ETCBHS	ETHYL BENZENE
ETCN	ETHANOL
F	FLUORIDE
FABPEE	FORMIC ACID, BETA-PHENYLETHYL ESTER
FANT	FLUORANTHENE
FARN	FARNESOL
FATAL	FATTY ALCOHOL
FE	IRON
FLRENE	FLUORENE
FREON	FREON / DICHLOROFLUOROMETHANE
FIOBP	DECAFLUOROBIPHENYL
GA	TABUN / ETHYL-N,N-DIMETHYL PHOSPHORAMIDOCYANIDATE
GB	SARIN / ISOPROPYLMETHYL PHOSPHONOFUORIDATE
GD	SOMAN / PINACOLYLMETHYL PHOSPHONOFUORIDATE
GRNDY	GREEN DYE
H	LEYNSTEIN MUSTARD
HARD	TOTAL HARDNESS
HCDD	HEXACHLOROBUTADIENE
HCHB	HEXACHLORONORBORNADIENE
HCO3	BICARBONATE
HO	DISTILLED MUSTARD / BIS(2-CHLOROETHYL) SULFIDE
HEXANE	HEXANE
HG	MERCURY
HGEXT	MERCURY EXTRACTABLE
HGTOT	MERCURY TOTAL
HMX	CYCLOTETRAMETHYLENETETRANITRAMINE
HN	NITROGEN MUSTARD
HPCL	HEPTACHLOR
HPCLE	HEPTACHLOR EPOXIDE
HPC4	HYDROLYZABLE PHOSPHATE
HWX013	HALOWAX 1013
HWX099	HALOWAX 1099
HXA00E	HEXANEDIOIC ACID, DIBUTYL ESTER / DIBUTYL ADIPATE
HXA00E	HEXANEDIOIC ACID, DIOCTYL ESTER
HXCOS	HEXACOSANE
HXMMAZ	4,5,6,7,8,8A-HEXAHYDRO-8A-METHYL-2(1H)-AZULENONE
HYNB	7-HYDROXY NORBORNADIENE
H2S	HYDROGEN SULFIDE
H3PO4	PHOSPHORIC ACID
ICOPYR	INDENO(1,2,3-C,D)PYRENE
IMP	ISOPROPYLMETHYL PHOSPHONATE
IMPA	ISOPROPYLMETHYL PHOSPHONIC ACID
INDAN	1-HYDROXY-2,3-METHYLENE INDAN [M.W.146]
ISODR	ISODRIN
ISOP02	ISOPROPYL BENZENE / CUMENE
ISOPHR	ISOPHORONE
K	POTASSIUM
KEND	KETO-ENDRIN
L	LEWISITE
LACY00	LACTIC ACID CYCLIC BUTANEBORONATE
LAURIC	LAURIC ACID
LIN	LINDANE/GAMA-BENZENEHEXACHLORIDE/GAMMA-HEXACHLOROCYCLOHEXANE
LIPID	X LIPIDS

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LO	LEWISITE OXIDE
MALO	MALONONITRILE
MBADOE	3-METHYL BUTANOIC ACID, 3,7-DIMETHYL-2,4,6-OCTATRIENYL ESTER
MBAS	FOAMING AGENTS / METHYALYNE BLUE ACTIVE SUBSTANCE
MBCH	ALPHA-METHYLBENZYL ALCOHOL
MBZA	ALPHA-METHYLBENZYL ACETOACETATE
MBZCL	ALPHA-METHYLBENZYL-2-CHLOROACETOACETATE
MOCL	2-METHYL UNDECANAL / 2-METHYL HENDECANAL
MEBPIP	1,1'-METHYLENEBIS-PIPERIDINE
MECCB	METHYL CYCLOHEXANE
MECYBU	METHYL CYCLOBUTANE
MECYPE	METHYL CYCLOPENTANE
MECSDB	TOLUENE-D8
MECSHS	TOLUENE
MENG	METHYL MERCURY
MEK	METHYLETHYL KETONE
MECH	METHANOL
MEPOH	2-METHYL PENTANOL
MESTOX	MESITYL OXIDE / 4-METHYL-3-PENTEN-2-ONE
METLAP	METHYL NAPHTHALENE
MEXCLR	METHOXYCHLOR
ME2HPL	METHYL-2-HEPTANOL
ME2HPO	METHYL 2-HEPTANONE
MG	MAGNESIUM
MIBK	METHYLISSOBUTYL KETONE
MIPK	METHYLIISOPROPYL KETONE
MIREX	MIREX
MLTHN	MALATHION
MN	MANGANESE
MO	MOLYBDENUM
MP	METHYL PHENOL
MPA	METHYL PHOSPHONIC ACID
MPDDO	2-(META-CHLOROPHENYL)-2-(PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
MSSCAN	GC-MS ORGANIC SCAN
MTRZL	METRAZOL / CARBIAZOLE
NA	SODIUM
NAP	NAPHTHALENE
NAPOB	NAPHTHALENE-D8
NB	NITROBENZENE
NBDS	NITROBENZENE-D5
NC	NITROCELLULOSE
NCLN	NORTRICYCLANOL
NCPPPA	N-(4-CHLOROPHENYL)-3-PHENYL-2-PROPENAMIDE
NC1	NITROCELLULOSE 12% N
NC2	NITROCELLULOSE 12.4% N
NOHXA	N-NITRODIHEXYL AMINE
NOIOX	NITROGEN DIOXIDE
NONPA	NITROSODI-N-PROPYL AMINE
NECHXA	N-ETHYLCYCLOHEXYL AMINE
NE2PEA	N-ETHYL-2-PROPENAMIDE
NG	NITROGLYCERINE
NH3	AMMONIA
NH3N2	AMMONIA NITROGEN
NI	NICKEL
NIT	NITRITE, NITRATE-NON SPECIFIC
NMCANE	N-METHYL CARBAMIC ACID, 1-NAPHTHYL ESTER
NNOMA	N,N-DIMETHYL ANILINE
NNOPA	N-NITROSODIPHENYL AMINE

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NNPIPA	N-NITROSOPENTYLISOPENTYL AMINE
NN4MPL	N-NITROSO-4-HYDROXY PROLINE
NO2	NITRITE
NO3	NITRATE
N2KJEL	NITROGEN BY KJELDAHL METHOD
ODAPDM	OCTADECANOIC ACID, (2-PHENYL-1,3-DIOXOLAN-4-YL)-METHYL ESTER
ODECA	OCTADECANOIC ACID / STEARIC ACID
OEMP	O-ETHYLMETHYL PHOSPHONATE
OILGR	OIL & GREASE
JP200	2-(ORTHO-CHLOROPHENYL)-2-(PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
OPDOE	2-(ORTHO-CHLOROPHENYL)-2-(PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
OPDOT	2-(ORTHO-CHLOROPHENYL)-2-(PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
OPCH	ORGANOPHOSPHATES
OXAT	1,4-OXATHIANE
OXCN	OXACYCLOWANANE
OZONE	OZONE
PAD4NE	PHOSPHORIC ACID, DIETHYL 4-NITROPHENYL ESTER
PAM	POLYNUCLEAR AROMATIC HYDROCARBON
PARTIC	PARTICULATE MATTER
PA2HDE	PROPANOIC ACID, 2-HYDROXYDECYL ESTER
PA2MOE	PENTANOIC ACID, 2-METHYLBUTYL ESTER
PB	LEAD
PBSTY	LEAD STYPMATE
PCB016	PCB 1016
PCB221	PCB 1221
PCB232	PCB 1232
PCB242	PCB 1242
PCB248	PCB 1243
PCB254	PCB 1254
PCB260	PCB 1260
PCB262	PCB 1262
PCP	PENTACHLOROPHENOL
PO	DICHLOROPHENYL ARSINE
POMSLX	POLYDIMEHYL SILOXANE / DIMETHYLPOLY SILOXANE
PEGE	POLYETHYLENE GLYCOL ETHERS
PENAUO	N-PENTAUIDE
PENTAN	PENTANE
PETN	PENTAERYTHRITOL TETRANITRATE
PFP	PENTAFLUOROPHENOL
PH	PH
PHANTR	PHENANTHRENE
PHENAA	PHENYL ACETIC ACID
PHEND6	PHENOL-D6
PHENIC	PHENOLICS (NON SPECIFIC)
PHENOL	PHENOL
PHTHA	1,2-BENZENEDICARBOXYLIC ACID / PHTHALIC ACID
PHTHL	PHTHALATES
PHYCP	1,2,3,4,5-PENTAHYDROXYCYCLOPENTANE
PIPER	PIPERIDINE
POX	PURGEABLE ORGANIC HALOGEN
PO4	PHOSPHATE
PO4ORT	ORTHOPHOSPHATE
PPCDO	2,2-BIS(PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
PPDDE	2,2-BIS(PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
PPDOT	2,2-BIS(PARA-CHLOROPHENYL)-1,1,1-TRICHLOROETHANE
PPTDE	2,2-BIS(PARA-CHLOROPHENYL)-2-PHENYL-1,1-DICHLOROETHANE
PRTHN	PARATHION
PYR	PYRENE

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P4	PHOSPHORUS
ROX	CYCLONITE / HEXAHYDRO-1,3,5-TRINITRO-1,3,4-TRIAZINE
REDOY	RED DYE
RESACI	RESIN ACIDS
S	SULFUR
SB	ANTIMONY
SCN	THIOCYANATE
SE	SELENIUM
SIL	SILICONE
SILVEX	SILVER
SN	TIN
SO3	SULFITE
SO4	SULFATE
SPIRO	(1',5 TRANS)-7-CHLORO-6-HYDROXY-2',4-DIMETHOXY-6'-METHYL- SPIRO(BENZOFURAN-2(3H),1'-(2) CYCLOHEXENE)-3,4'-DIONE
SQUAL	SQUALENE
SR	STRONTIUM
STIGMA	STIGMASTENAL
STYPH	STYPHATE ION
STYPHA	STYPHNIC ACID
STYR	STYRENE
SULFID	SULFIDE
S2CL2	SULFUR MONOCHLORIDE
TBA	TRIBUTYL AMINE
TBASDE	THIOBUTYRIC ACID, 5-DECYL ESTER
TBP	TRIBUTYL PHOSPHATE
TCB	TETRACHLOROBENZENES
TCB1	1,2,4,5-TETRACHLOROBENZENE
TCB2	1,2,3,4-TETRACHLOROBENZENE
TCB3	1,2,3,5-TETRACHLOROBENZENE
TCHDCS	TRANS-1,2-CYCLOHEXANDIOL, CYCLIC SULFITE
TCLEA	1,1,2,2-TETRACHLOROETHANE
TCLEE	TETRACHLOROETHYLENE / TETRACHLOROETHENE
TCLTFE	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE
TCOS	TETRACOSANE
TCSAME	15-TETRACOSENOIC ACID, METHYL ESTER
TCST	TRICHLOROSTYRENE
TOGCL	THIODIGLYCOL
TDMMSX	TETRADECANETHYL HEXASILOXANE
TDOTL	TERT-DODECANE THIOL
TDS	TOTAL DISSOLVED SOLIDS
TEGLME	TRIETHYLENE GLYCOL, METHYL ETHER
TEMP	TEMPERATURE
TEPO4	TRIETHYL PHOSPHATE
TETPT	TETRACHLOROCYCLOPENTENE
TETR	TETRAZENE
TETRYL	NITRAMINE / N-METHYL-N,2,4,6-TETRANITROANILINE
TFAAPE	TRIFLUOROACETIC ACID, 1,3-PENTANEDIYL ESTER
TFDCLE	1,1,2-TRIFLUORO-1,2-DICHLOROETHANE
THF	TETRAHYDROFURAN
THP2ML	TETRAHYDROPYRANYL-2-METHANOL
TL	THALLIUM
TMHPOO	3,3,6-TRIMETHYL-1,5-HEPTADIEN-4-ONE
TMHXL	3,5,5-TRIMETHYL-1-HEXANOL
TMODEO	2,2,7,7-TETRAMETHYL-4,5-OCTADIEN-3-ONE
TMPO3	TRIMETHYL PHOSPHITE
TMPO4	TRIMETHYL PHOSPHATE
TMUR	TETRAMETHYL UREA

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TM3PL	2,3,4-TRIMETHYL-3-PENTANOL
TNTISO	TRINITROTOLUENE ISOMER
TOC	TOTAL ORGANIC CARBON
TOTDOT	TOTAL VALUE OF ALL DOT, DOE, DOD ISOMERS
TOTGAF	TOTAL GRAVIMETRIC, ACID FRACTION
TOTM12	TOTAL MERCURY
TOT/PCB	TOTAL PCB
TOA	TOTAL ORGANIC HALOGENS
TPH	THIOPHENE
TPCA	TOTAL PHOSPHATES
TRCLE	TRICHLOROETHYLENE / TRICHLOROETHENE
TR1B2	TRICHLOROBENZENES (ALL ISOMERS)
TR1B2	TRIMETHYL BENZENE
TR1PT	TRICHLOROCYCLOPENTENE
TR1TDE	2,3,4-TRIMETHYL-4-TETRADECENE
TR1MET	TRIMETHANES
TS	TOTAL SULFUR
TSS	TOTAL SUSPENDED SOLIDS
TVS	TOTAL VOLATILE SOLIDS
TAPHEN	TOXAPHENE
T1B2BC	TRANS-1-BROMO-2-BUTYL CYCLOPROPANE
T12DCE	TRANS-1,2-DICHLOROETHENE / TRANS-1,2-DICHLOROETHYLENE
T13DCE	TRANS-1,3-DICHLOROPROPENE
T2DEC	TRANS-2-DECENE
UOMH	UNSYMMETRICAL DIMETHYL HYDRAZINE
UNKXXX	UNKNOWN COMPOUND 001 THRU 999. NOTE: 001-999 FULL FIELD AS SHOWN
V	VANADIUM
VARMY	VARIOUS HYDROCARBONS WITH INCREASING M.W.
VFA	VINYL FORMATE
VM	O-ETHYL-S-(2-DIETHYLAMINOETHYL)-METHYL PHOSPHONOTHIOLATE
VX	O-ETHYL-S-(2-DIISOPROPYLAMINOETHYL)-METHYL PHOSPHONOTHIOLATE
WP	WHITE PHOSPHORUS
XPLOSV	EXPLOSIVE SPRAY
XYLEN	XYLENES
YELDY	YELLOW DYE
ZN	ZINC
ZR	ZIRCONIUM
1A3MP2	1-ACETYL-3-METHYL-5-PYRAZOLONE
1B4HB	1-BENZYL-4-HYDROXYBENZIMIDAZOLE
1CDMP2	1-CARBAMOYL-3,5-DIMETHYL-2-PYRAZOLINE
1CLODC	1-CHLOROOCCTADECANE
1DODCL	1-DODECANOL
1EMB	1-ETHYLHEXYL BENZENE
1FNAP	1-FLUORONAPHTHALENE
1H2E	1-HEXENE
1H3OL	1-HEXEN-3-OL
1MEIND	1-METHYL INDAN
1MNAP	1-METHYLNAPHTHALENE
1NHP	1-NITROHEPTANE
1N2ONE	1-NITRO-2-OCTANONE
1OCTOL	1-OCTANOL
1TBCHA	1-T-BUTYL CYCLOHEXANECARBOXYLIC ACID
11DCE	1,1-DICHLOROETHYLENE / 1,1-DICHLOROETHENE
11DCE	1,1-DICHLOROETHANE
111TCE	1,1,1-TRICHLOROETHANE
112TCE	1,1,2-TRICHLOROETHANE
12DCD4	1,2-DICHLOROETHANE-D4
12DCLB	1,2-DICHLOROBENZENE

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120CLE	1,2-DICHLOROETHANE
120CLP	1,2-DICHLOROPROPANE
120MB	1,2-DIMETHYL BENZENE / O-XYLENE
120NAP	1,2-DIMETHYLNAPHTHALENE
120PH	1,2-DIPHENYL HYDRAZINE
12EPCN	CYCLOHEXENE OXIDE / 1,2-EPOXY CYCLOHEXENE
12EPEB	1,2-EPOXYETHYL BENZENE / STYRENE OXIDE
123CPR	1,2,3-TRICHLOROPROPANE
124TCB	1,2,4-TRICHLOROBENZENE
130BM	1,3-DIMETHYL BENZENE / M-XYLENE
130CLB	1,3-DICHLOROBENZENE
130EB	1,3-DIETHYL BENZENE
130FB	1,3-DIFLUOROBENZENE
130NB	1,3-DINITROBENZENE
13TDAM	13-TETRADECYNOIC ACID, METHYL ESTER
135TNB	1,3,5-TRINITROBENZENE
140CBU	1,4-DICHLOROBUTANE
140CLB	1,4-DICHLOROBENZENE
140MNP	1,4-DIHYDRO-1,4-METHANONAPHTHALENE
140MKA	1,4-DIMETHOXY ANTHRACENE
140NB	1,4-DINITROBENZENE
1402EB	1,4-DIMETHYL-2-ETHYL BENZENE
180NAP	1,8-DIMETHYL NAPHTHALENE
18CISO	1,2,3,4,4A,5,8,8A-OCTAHYDRO-1,4,5,8-DIMETHANOLNAPHTHALEN-2-OL
2A450A	2-AMINO-4,6-DINITROANILINE
2A460T	2-AMINO-4,6-DINITROTOLUENE
28EETO	2-(2-N-BUTOXYETHOXY) ETHANOL
28EMDE	2,2-BIS(ETHYLMERCAPTO)-DIETHYL ETHER
28MMPR	2,2-BIS(METHYL MERCAPTO) PROPANE
28MNM	2-BUTYL-N-METHYL NORLEUCINE, METHYL ESTER
28RMKA	2-BROMOHENANOIC ACID
28UXEL	2-BUTOXYETHANOL
281CP	2-BROMO-1-CHLOROPROPANE
2810OL	2-BUTYL-1-OCTANOL
2CBMN	O-CHLOROBENZYLIDINEMALONONITRILE
2CECHO	2-(2-CYANOETHYL) CYCLOHEXANONE
2CHAEF	2-CYCLOPENTENE-1-HENDECANOIC ACID, ETHYL ESTER
2CHEIL	2-CYCLOHEXEN-1-OL
2CHEIO	2-CYCLOHEXEN-1-ONE
2CLP	2-CHLOROPHENOL
2CMCHO	2-(CYANOMETHYL) CYCLOHEXANONE
2CNAP	2-CHLORONAPHTHALENE
2CNO-N	2,2-DIMETHYL PENTANE
2ECYOL	2-ETHYLCYCLOBUTANOL
2E2HPD	2-ETHYL-2-HYDROXYMETHYL-1,3-PROPANEDIOL
2E4MPL	2-ETHYL-4-METHYL-1-PENTANOL
2F8P	2-FLUORODIPHENYL
2FNAP	2-FLUORONAPHTHALENE
2FP	2-FLUOROPHENOL
2HNDOL	2-HENDECANOL / 2-UNDECANOL
2MBZA	2-METHYLBENZYL ALCOHOL
2MCPNE	2-METHYL CYCLOPENTANONE
2MEPEN	2-METHYL PENTANE
2MP	2-METHYL PHENOL / 2-CRESOL
2MTHPM	2-METHYLTHIO-4-HYDROXYPYRIMIDINE
2M10OL	2-METHYL-1-ODECANOL
2M1PNE	2-METHYL-1-PENTENE
2M28DA	2-METHYL-2-BUTENEDIAMIDE

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2M2H3B	2-METHYL-2-HYDROXY-3-BUTYNE
2M24P	2-METHYL-2,4-PENTANEDIOL
2M3HKE	2-METHYL-3-HEXENE
2M8ZLZ	2-NITROBENZALAZINE
2MCDCO	2-NONADECANONE
2NP	2-NITROPHENOL
2NT	2-NITROTOLUENE
2N3C	3-METHYL-2-NITROPHENOL / 2-NITRO-M-CRESOL
2OX8EL	2,2-OXY-DIS-ETHANOL
2TCLEA	1,1,1,2-TETRACHLOROETHANE
225TCB	2,2',5-TRICHLOROBIPHENYL
2255CB	2,2',5,5'-TETRACHLOROBIPHENYL
23DCLP	2,3-DICHLOROPHENOL
23D2HL	2,3-DIMETHYL-2-HEXANOL
23TNP	2,2,3,3-TETRAMETHYLPENTANE
2345CB	2,3,4,5-TETRACHLOROBIPHENYL
2346CP	2,3,4,6-TETRACHLOROPHENOL
2356CP	2,3,5,6-TETRACHLOROPHENOL
236TMM	2,3,6-TRIMETHYL NAPHTHALENE
24D	2,4-DICHLOROPHENOXACETIC ACID
24DCB	2,4'-DICHLOROBIPHENYL
24DCLP	2,4-DICHLOROPHENOL
24DMPN	2,4-DIMETHYL PHENOL
24DNP	2,4-DINITROPHENOL
24DNT	2,4-DINITROTOLUENE
245PCB	2,2',4,5,5'-PENTACHLOROBIPHENYL
245T	2,4,5-TRICHLOROPHENOXACETIC ACID
245TCP	2,4,5-TRICHLOROPHENOL
246TCA	2,4,6-TRICHLOROANILINE
246TCP	2,4,6-TRICHLOROPHENOL
246TNP	2,4,6-TRINITROPHENOL / PICRIC ACID
246TNR	2,4,6-TRINITRORESORCINOL / STYPMNIC ACID
246TNT	2,4,6-TRINITROTOLUENE
25C14D	2,5-CYCLOHEXADIEN-1,4-DIONE
25DCLP	2,5-DICHLOROPHENOL
25HPCB	2,2',3,4,5,5',6-HEPTACHLOROBIPHENYL
25HXCB	2,2',3,4,5,5'-HEXACHLOROBIPHENYL
25CCCB	2,2',3,3',4,4',5,5'-OCTACHLOROBIPHENYL
2608MP	2,6-DI-T-CUTYL-4-METHYL PHENOL
26DCLP	2,6-DICHLOROPHENOL
26DMST	2,6-DIMETHYL STYRENE
26DNA	2,6-DINITROANILINE
26DNT	2,6-DINITROTOLUENE
264PCB	2,2',3,4,4',5,6-HEPTACHLOROBIPHENYL
3BPETH	3-BUTENYLPENTYL ETHER
3CCLP	3-CHLOROPHENOL
3CCLP	3-(CHLOROMETHYL) CYCLOHEXENE
3E4XCE	3-ETHYL-1,4-HEXADIENE
3MDMPL	3-(HYDROXYMETHYL)-4,4-DIMETHYL PENTANAL
3MDMPT	3-HYDROXY-2,7-DIMETHYL-4(3H)-PTERIDINONE
3MXE2O	3-HEXEN-2-ONE
3MEPEN	3-METHYL PENTANE
3MP	3-METHYL PHENOL / 3-CRESOL
3MXIMZ	3-METHOXYIMIDAZOLE
3M1PL	3-METHYL-1-PENTANOL
3M2CHO	3-METHYL-2-CYCLOHEXEN-1-ONE
3M2C1O	3-METHOXY-2-CYCLOPENTEN-1-ONE
3M2HXL	3-METHYL-2-HEXANOL

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3NT	3-NITROTOLUENE
3OCTOL	3-OCTANOL
3OPPAE	3-OXO-3-PHENYL PROPANOIC ACID, ETHYL ESTER
34DCLP	3,4-DICHLOROPHENOL
34ST1H	3,4,5-TRIMETHYL-1-HEXENE
35ONA	3,5-DINITROANILINE
35ONP	3,5-DINITROPHENOL
35ONT	3,5-DINITROTOLUENE
36DF9D	3,6-DICHLOROFLUOREN-9-ONE
4AJ5DT	4-AMINO-3,5-DINITROTOLUENE
4BRPPE	4-BROMOPHENYLPHENYL ETHER
4CLPPE	4-CHLOROPHENYLPHENYL ETHER
4CL2C	2-METHYL-4-CHLOROPHENOL / 4-CHLORO-2-CRESOL
4CL3C	3-METHYL-4-CHLOROPHENOL / 4-CHLORO-M-CRESOL / 4-CHLORO-3-CRESOL
4C3WDE	4-CHLORO-3-METHYL-1-PENTENE
4DM2PL	4,4-DIMETHYL-2-PENTANOL
4E2OCE	4-ETHYL-2-OCTENE
4FANIL	4-FLUOROANILINE
4FT	4-FLUOROTOLUENE
4HAZOB	4-HYDROXYAZOBENZENE
4HYBA	4-HYDROXYBENZALDEHYDE
4ICWJU	4-IODOMETHYL GUINOLCTUINE
4MP	4-METHYL PHENOL / 4-CRESOL
4MXCHL	4-METHOXYCYCLOHEXANOL
4MXD	4-METHOXYPHENOL
4M2PPL	4-METHYL-2-PROPYL-1-PENTANOL
4NP	4-NITROPHENOL
4TCB	4-T-OCTYL PHENOL
44DFBZ	4,4-DIFLUOROBENZOPHENONE
44DMPE	4,4-DIMETHYL-2-PENTENE
46DN2C	2-METHYL-4,6-DINITROPHENOL / 4,6-DINITRO-2-CRESOL
48DNHD	4,8-DIMETHYL HENDECANE
5CL2C	5-CHLORO-0-CRESOL / 2-METHYL-5-CHLOROPHENOL
5ESMD	5-ETHYL 5-METHYL DECANE
5MSHAL	5-METHYL-5-HYDROXYHEXANOIC ACID LACTONE
5N2OL	5-NORBOREN-2-OL
6CL3C	3-METHYL-6-CHLOROPHENOL / 6-CHLORO-3-CRESOL
6E6MFV	6-ETHYL-6-METHYL FULVENE
6MEPUR	6-METHYL PURINE

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ANAPNE	ACENAPHTHENE
ANAPYL	ACENAPHTHYLENE
AACHXE	ACETIC ACID, CYCLOHEXYL ESTER
ACET	ACETONE
ACPHN	ACETOPHENONE
ACIDIT	ACIDITY
ACROLN	ACROLEIN
ACRYLO	ACRYLONITRILE
DM	ADAMSITE
ALHMH	ALCOHOLS (HIGH MOLECULAR WEIGHT)
ALDRN	ALDRIN
ALAL	ALIPHATIC ALCOHOL
ALMC	ALIPHATIC HYDROCARBON
ALK	ALKALINITY
ALKM	ALKANE
AYLETH	ALLYL ETHER
ABHC	ALPHA-BENZENEHEXACHLORIDE / ALPHA-HEXACHLOROCYCLOHEXANE
AENSLF	ALPHA-ENDOSULFAN / ENDOSULFAN I
MBZA	ALPHA-METHYLBENZYL ACETOACETATE
MBCH	ALPHA-METHYLBENZYL ALCOHOL
MBZCL	ALPHA-METHYLBENZYL-2-CHLOROACETOACETATE
ATNT	ALPHA-THINITROTOLUENE (OBSOLETE: USE 246TNT)
AL	ALUMINIUM
NH3	AMMONIA
NH3N2	AMMONIA NITROGEN
ADHP	AMMONIUM DIHYDROGEN PHOSPHATE
ANIL	ANILINE
ANTRC	ANTHRACENE
ACHE	ANTICHOLINESTERASE
SB	ANTIMONY
AS	ARSENIC
ASEXT	ARSENIC EXTRACTABLE
ASTOT	ARSENIC TOTAL
ASBEST	ASBESTOS
ATZ	ATRAZINE
AZACH	AZACYCLOHEXANE
BA	BARIUM
BENZAL	BENZALDEHYDE
BENZA	BENZANTHRONE
CSH6	BENZENE
BZPA	BENZENEPHOSPHONIC ACID
CSO6	BENZENE-D6
BF2ANT	BENZO BIFLUOROANTHENE
BFN2OA	BENZOIC ACID
BT	BENZOTHAZOLE
BAANTR	BENZO(A)ANTHRACENE
BAPYR	BENZO(A)PYRENE
BZOTHP	BENZO(B)THIOPHENE
BGHIPY	BENZO(G,H,I)PYRENE
BZALC	BENZYL ALCOHOL
BZYLOR	BENZYL BROMIDE / ALPHA BROMOTOLUENE
BZFANT	BENZ-FLUOROANTHENE
BE	BERYLLIUM
BBHC	BETA-BENZENEHEXACHLORIDE / BETA-HEXACHLOROCYCLOHEXANE
BENSLF	BETA-ENDOSULFAN / ENDOSULFAN II
HCO3	BICARBONATE
BCHPD	BICYCLO[2.2.1] HEPTA-2,5-DIENE
BCYJHX	BICYCLO (3.1.0) HEXANE
BOD	BIOLOGICAL OXYGEN DEMAND
DIAOS	BIS(DIISOPROPYLAMINOETHYL) DISULFIDE
DIAS	BIS(DIISOPROPYLAMINOETHYL) SULFIDE
BIMSQA	BIS(TRIMETHYLSILYL) OXALIC ACID
BZCEAM	BIS(2-CHLOROETHOXY) METHANE
BZCLEE	BIS(2-CHLOROETHYL) ETHER

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B2EMP	BIS(2-ETHYLHEXYL) PHTHALATE
BLOX	BLADEX
B	BORON
BRACIL	BROMACIL
BRCLM	BROMOCHLOROMETHANE
BRDCLM	BROMODICHLOROMETHANE
CHBRJ	BROMOFORM
CHJBR	BROMOMETHANE
BAHXE	BUTANOIC ACID, 1-HEXYL ESTER
BBZP	BUTYLBENZYL PHTHALATE
BUEETH	BUTYLETHYL ETHER
BMP	BUTYLMETHYL PHTHALATE
BPBG	BUTYLPHTHALYL BUTYLGLYCOLATE
CD	CADMIUM
CA	CALCIUM
CAMP	CAMPHOR
CAPLCT	CAPROLACTAM / 6-AMINOHENANOIC ACID LACTAM
CAME	CARBAMIC ACID, METHYL ESTER
CS2	CARBON DISULFIDE
CMCNOX	CARBON MONOXIDE
CCL4	CARBON TETRACHLORIDE
COJ	CARBONATE
CEC	CATION EXCHANGE CAPACITY
CS	CESIUM
COO	CHEMICAL OXYGEN DEMAND
CLCJ	CHLORATE
CLDAN	CHLORDANE
CLOEN	CHLORDENE
CL	CHLORIDE
CLXB	CHLORINATED BENZENE
CLXNAP	CHLORINATED NAPHTHALENES
CL2	CHLORINE
CLD	CHLORINE DEMAND
CN	CHLOROACETOPHENONE
CLCBHS	CHLOROBENZENE
CLCBDS	CHLOROBENZENE-D5
CONBIS	CHLORODINITROBENZENE ISOMER
C2H5CL	CHLOROETHANE
C2H3CL	CHLOROETHENE / VINYL CHLORIDE
CHCLJ	CHLOROFORM
CHJCL	CHLOROMETHANE
CLNAP	CHLORONAPHTHALENES
CLP	CHLOROPHENOLS
CHOLA	CHOLESTANE
CRD4	CHROMATE
CR	CHROMIUM
CHRY	CHRYSENE
CBCCCH	CIS-1-BROMO-2-CHLOROCYCLOHEXANE
CDACH	CIS-1,2-DIACETOXYCYCLOHEXANE
C12DCE	CIS-1,2-DICHLOROETHENE
C13DCP	CIS-1,3-DICHLOROPROPYLENE / CIS-1,3-DICHLOROPROPENE
C4HX1L	CIS-4-HEXEN-1-OL
CO	COBALT
CU	COPPER
CUEXT	COPPER EXTRACTABLE
CUTOT	COPPER TOTAL
CSOL	CRESOLS
CYN	CYANIDES
CK	CYANOGEN CHLORIDE
CBHOM	CYCLOHEXANOL
CHONE	CYCLOHEXANONE
12EPCN	CYCLOHEXENE OXIDE/1,2-EPOXY CYCLOHEXENE
ROX	CYCLONITE / HEXAHYDRO-1,3,5-TRINITRO-1,3,4-TRIAZINE
CYPO	CYCLOPENTADIENE
CPCXAL	CYCLOPENTANE CARBOXYALDEHYDE

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CPO	CYCLOPENTANONE
MMX	CYCLOTETRAETHYLENETETRANITRAMINE
C18UNS	C18H300 UNKNOWN
C22UNS	C22H400 UNKNOWN
F10BP	DECAFLUOROBIPHENYL
C10	DECANE
DBHC	DELTA-BENZENEHEXACHLORIDE / DELTA-HEXACHLOROCYCLOHEXANE
DIACAL	DIACETONE ALCOHOL / 4-HYDROXY-4-METHYL-2-PENTANONE
DIAZ	DIAZINON
DBAHA	DIBENZO(A,H)ANTHRACENE
DBRCLM	DIBROMOCHLOROMETHANE
DBCP	DIBROMOCHLOROPROPANE
CL2BZ	DICHLOROBENZENES
DCBPH	DICHLOROBENZOPHENONE
CCL2F2	DICHLORO(1,1,2,2)TETRAFLUOROETHANE
ED	DICHLOROETHYL ARSINE
CL2NAP	DICHLORONAPHTHALENES
DICLP	DICHLOROPHENOLS
PD	DICHLOROPHENYL ARSINE
DCMP	DICYCLOHEXYL PHTHALATE
DCPD	DICYCLOPENTADIENE
DLDRN	DIELDRIN
DEA	DIETHYL AMINE
DEETH	DIETHYL ETHER
DEP	DIETHYL PHTHALATE
DEOMP	DIETHYLDIMETHYL DIPHOSPHONATE
DIBP	DIISOBUTYL PHTHALATE
DIAET	DIISOPROPYL AMINOETHANETHIOL
DIAEL	DIISOPROPYL AMINOETHANOL
DIPUR	DIISOPROPYL UREA
DIOOP	DIISOPROPYLDIMETHYL DIPHOSPHONATE
DIMP	DIISOPROPYLMETHYL PHOSPHONATE
DMA	DIMETHYL ANILINE (OBSOLETE: USE NNOMA)
DMOS	DIMETHYL DISULFIDE
DMCAR	DIMETHYL DITHIOCARBONATE
DMETH	DIMETHYL ETHER
DMP	DIMETHYL PHTHALATE
DMMP	DIETHYLMETHYL PHOSPHATE
DNTISO	DINITROTOLUENE ISOMER
DOAO	DIOCTYL ADIPATE
DOAZ	DIOCTYL AZELATE
DOETH	DIOCTYL ETHER
DPHNY	DIPHENYL
DPA	DIPHENYL AMINE
DPETH	DIPHENYL ETHER
OPSO	DIPHENYL SULFOXIDE
DO	DISSOLVED OXYGEN
MO	DISTILLED MUSTARD / BIS(2-CHLOROETHYL) SULFIDE
DITH	DITHIANE
DNBP	DI-N-BUTYL PHTHALATE
DNOP	DI-N-OCTYL PHTHALATE
DNPP	DI-N-PENTYL PHTHALATE
DL2HPG	DL-2-(3-HYDROXYPHENYL) GLYCINE
C12	DODECANE
DURS	DURSBAN
DPNTLL	D-(-)-PANTOLYL LACTONE
C20	EICOSANE
ESFS04	ENDO-SULFAN SULFATE

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ENDRN	ENDRIN
ETCM	ETHANOL
ETCHMS	ETHYL BENZENE
EMP	ETHYLMETHYL PHOSPHONATE
EMPA	ETHYLMETHYL PHOSPHONIC ACID
ENHETH	ETHYL-N-HEXYL ETHER
EBCPOL	ETHYL-2,2-DIS(4-CHLOROPHENYL) GLYCOLATE
XPLOSV	EXPLOSIVE SPRAY
FARN	FARNESOL
FATAL	FATTY ALCOHOL
FANT	FLUORANTHENE
FLRENE	FLUORENE
F	FLUORIDE
MBAS	FOAMING AGENTS / METHYALYNE BLUE ACTIVE SUBSTANCE
FABPEE	FORMIC ACID, BETA-PHENYLETHYL ESTER
FREDN	FREON / DICHLOROFLUOROMETHANE
DYSCAN	GC-MS DYE SCAN
MSSCAN	GC-MS ORGANIC SCAN
GRNOY	GREEN DYE
MX013	HALOWAX 1013
MX099	HALOWAX 1099
C11	HEXODECANE
HPCL	HEPTACHLOR
HPCLE	HEPTACHLOR EPOXIDE
CL7NB	HEPTACHLORONORBORNADIENE
C7NB1	HEPTACHLORONORBORNENE
C17	HEPTADECANE
C7A	HEPTANOIC ACID
CL6BZ	HEXACHLOROBENZENE
CL6BP	HEXACHLOROBIPHENYL
MCBD	HEXACHLOROBUTADIENE
CL6CP	HEXACHLOROCYCLOPENTADIENE
CL6ET	HEXACHLOROETHANE
MCNB	HEXACHLORONORBORNADIENE
MXCOS	HEXACOSANE
C19A	HEXADECANOIC ACID / PALMITIC ACID
HEXANE	HEXANE
MXADBE	HEXANEDIOIC ACID, DIBUTYL ESTER / DIBUTYL ADIPATE
MXADDE	HEXANEDIOIC ACID, DIOCTYL ESTER
CRHEX	HEXAVALENT CHROMIUM
CALLMW	HYDROCARBONS (ALL MOLECULAR WEIGHTS)
AC	HYDROGEN CYANIDE / HYDROCYANIC ACID
H2S	HYDROGEN SULFIDE
HPCM	HYDROLYZABLE PHOSPHATE
ICDPYR	INDENO(1,2,3-C,D)PYRENE
FE	IRON
ISDR	ISODRIN
ISOPHR	ISOPHORONE
ISOPBZ	ISOPROPYL BENZENE / CUMENE
IMP	ISOPROPYLMETHYL PHOSPHONATE
IMPA	ISOPROPYLMETHYL PHOSPHONIC ACID
KEND	KETO-ENDRIN
LACYBB	LACTIC ACID CYCLIC BUTANEBORONATE
LAURIC	LAURIC ACID
PB	LEAD
PBSTY	LEAD STYPPHATE
M	LEVINSTEN MUSTARD
L	LEWISITE

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LO	LEWISITE OXIDE
LIN	LINDANE/GAMA-BENZENEHEXACHLORIDE/GAMMA-HEXACHLOROCYCLOHEXANE
MG	MAGNESIUM
MLTHN	MALATHION
MALO	MALONONITRILE
MN	MANGANESE
MO	MERCURY
MGEXT	MERCURY EXTRACTABLE
MGTOT	MERCURY TOTAL
MESTOX	MESITYL OXIDE / 4-METHYL-3-PENTEN-2-ONE
MECH	METHANOL
MECHL	METHOXYCHLOR
MECYBU	METHYL CYCLOBUTANE
MECCB	METHYL CYCLOHEXANE
MECYP	METHYL CYCLOPENTANE
MEHG	METHYL MERCURY
METLAP	METHYL NAFHTHALENE
MP	METHYL PHENOL
MPA	METHYL PHOSPHONIC ACID
ME2HPO	METHYL 2-HEPTANONE
CH2CL2	METHYLENE CHLORIDE
MEK	METHYLETHYL KETONE
MIBK	METHYLISOBUTYL KETONE
MIPK	METHYLISOPROPYL KETONE
ME2HPL	METHYL-2-HEPTANOL
MTRZL	METRAZOL / CAROIAZOLE
MIREX	MIREX
MO	MOLYBDENUM
NAP	NAPHTHALENE
NAPDS	NAPHTHALENE-DS
NI	NICKEL
TETRYL	NITRAMINE / N-METHYL-N,2,4,6-TETRAMITROANILINE
NO3	NITRATE
NO2	NITRITE
NIT	NITRITE,NITRATE-NON SPECIFIC
NO	NITROBENZENE
NBDS	NITROBENZENE-DS
NC	NITROCELLULOSE
NC1	NITROCELLULOSE 12% N
NC2	NITROCELLULOSE 13.4% N
N2KJEL	NITROGEN BY KJELDAHL METHOD
NO2X	NITROGEN DIOXIDE
MN	NITROGEN MUSTARD
NG	NITROGLYCERINE
NONPA	NITROJODI-N-PROPYL AMINE
C19	NONADECANE
NCLN	NORTRICYCLANOL
NECHXA	N-ETHYLCYCLOHEXYL AMINE
NE2PEA	N-ETHYL-2-PROPENAMIDE
NMCANE	N-METHYL CARBAMIC ACID, 1-NAPHTHYL ESTER
NOHXA	N-NITRODIHEXYL AMINE
NIDPA	N-NITRODIPHENYL AMINE
NNPDA	N-NITRODIPENTYLISOPENTYL AMINE
NN4HPL	N-NITRO-4-HYDROXY PROLINE
PENANO	N-PENTANIDE
NCPPA	N-(4-CHLOROPHENYL)-3-PHENYL-2-PROPENAMIDE
NIDMA	N,N-DIMETHYL ANILINE
C18	OCTADECANE

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OEECA	OCTADECANOIC ACID / STEARIC ACID
C18AE	OCTADECANOIC ACID, ETHYL ESTER
OOAPOM	OCTADECANOIC ACID, (2-PHENYL-1,3-DIOXOLAN-4-YL)-METHYL ESTER
OILGR	OIL & GREASE
OPC4	ORGANOPHOSPHATES
PO4ORT	ORTHOPHOSPHATE
OXCN	OXACYCLONONANE
OZONE	OZONE
CBA	O-CHLOROBENZALDEHYDE
CBOA	O-CHLOROBENZOIC ACID
2CBMN	O-CHLOROBENZYLIDINEMALONONITRILE
OEMP	O-ETHYLMETHYL PHOSPHONATE
VM	O-ETHYL-S-(2-DIETHYLAMINOETHYL)-METHYL PHOSPHONOTHIOATE
VX	O-ETHYL-S-(2-DIISOPROPYLAMINOETHYL)-METHYL PHOSPHONOTHIOATE
PRTHN	PARATHION
PARTIC	PARTICULATE MATTER
PCB016	PCB 1016
PCB221	PCB 1221
PCB232	PCB 1232
PCB242	PCB 1242
PCB248	PCB 1248
PCB254	PCB 1254
PCB260	PCB 1260
PCB262	PCB 1262
CL58	PENTACHLOROBENZENE
CL58P	PENTACHLOROBIPHENYL
CL5ET	PENTACHLOROETHANE
PCP	PENTACHLOROPHENOL
PETN	PENTAERYTHRITOL TETRANITRATE
PFP	PENTAFLUOROPHENOL
PENTAN	PENTANE
PA2MOE	PENTANOIC ACID, 2-METHYLBUTYL ESTER
CSA	PENTANOIC ACID/VALERIC ACID
PH	PH
PHANTR	PHENANTHRENE
PHENOL	PHENOL
PHENLC	PHENOLICS (NON SPECIFIC)
PHEND6	PHENOL-D6
PHENAA	PHENYL ACETIC ACID
CX	PHOSGENE OXIME / DICHLOROFORMOXIME
CG	PHOSGENE / CARBONYL CHLORIDE
PO4	PHOSPHATE
H3PO4	PHOSPHORIC ACID
PAD4NE	PHOSPHORIC ACID, DIETHYL 4-NITROPHENYL ESTER
P4	PHOSPHORUS
PMTHL	PHTHALATES
PIPER	PIPERIDINE
POMSLX	POLYDIMETHYL SILOXANE / DIMETHYLPOLY SILOXANE
PEGE	POLYETHYLENE GLYCOL ETHERS
PAH	POLYNUCLEAR AROMATIC HYDROCARBON
K	POTASSIUM
PA2HOE	PROPANOIC ACID, 2-HYDROXYDECYL ESTER
POX	PURGEABLE ORGANIC HALOGEN
PYR	PYRENE
CPMS	P-CHLOROPHENYLMETHYL SULFIDE
CPMSO2	P-CHLOROPHENYLMETHYL SULFONE
CPMSO	P-CHLOROPHENYLMETHYL SULFOXIDE
REDDY	RED DYE

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RESAC1	RESIN ACIDS
QB	SARIN / ISOPROPYLMETHYL PHOSPHONOFUORIDATE
C16SAT	SATURATED HYDROCARBONS (C16)
SE	SELENIUM
SIL	SILICONE
AG	SILVER
SILVEX	SILVEX
NA	SODIUM
GD	SOMAN / PINACOLYLMETHYL PHOSPHONOFUORIDATE
COND	SPECIFIC CONDUCTIVITY
SQUAL	SQUALENE
STIGMA	STIGMASTENAL
SR	STRONTIUM
STYPH	STYPHNATE ION
STYPHA	STYPHNIC ACID
STYR	STYRENE
SO4	SULFATE
SULFID	SULFIDE
SO3	SULFITE
S	SULFUR
S2CL2	SULFUR MONOCHLORIDE
OIAEP	S-DIISOPROPYLAMINOETHYLMETHYL PHOSPHONOTHIOATE
GA	TABUN / ETHYL-N,N-DIMETHYL PHOSPHORAMIDOCYANIDATE
TEMP	TEMPERATURE
TDOTL	TERT-DODECANETHIOL
TCB	TETRACHLOROBENZENES
TETPT	TETRACHLOROCYClopentene
TCLE	TETRACHLOROETHYLENE / TETRACHLOROETHENE
CL4NAP	TETRACHLORONAPHTHALENES
TCOS	TETRACOSANE
TMMSX	TETRADECAMETHYL HEXASILOXANE
THF	TETRAHYDROFURAN
THP2ML	TETRAHYDROPIRANYL-2-METHANOL
TMUR	TETRAMETHYL UREA
TETR	TETRAZENE
TL	THALLIUM
TBASDE	THIOBUTYRIC ACID, S-DECYL ESTER
SCN	THIOCYANATE
TDGCL	THIODIGLYCOL
YPM	THIOPHENE
SN	TIN
MEC6H5	TOLUENE
MEC5D8	TOLUENE-D8
TDS	TOTAL DISSOLVED SOLIDS
TOTGAF	TOTAL GRAVIMETRIC, ACID FRACTION
HARD	TOTAL HARDNESS
TOTMG2	TOTAL MERCURY
TOC	TOTAL ORGANIC CARBON
TOX	TOTAL ORGANIC HALOGENS
TOTPCB	TOTAL PCB
YPO4	TOTAL PHOSPHATES
TS	TOTAL SULFUR
TSS	TOTAL SUSPENDED SOLIDS
TOTDOT	TOTAL VALUE OF ALL DOT, DDE, DDD ISOMERS
TVS	TOTAL VOLATILE SOLIDS
TXPHEN	TOXAPHENE
T1820C	TRANS-1-BROMO-2-BUTYL CYCLOPROPANE
TCHDCS	TRANS-1,2-CYCLOHEXANDIOL, CYCLIC SULFITE

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T120CE	TRANS-1,2-DICHLOROETHENE / TRANS-1,2-DICHLOROETHYLENE
T130CP	TRANS-1,3-DICHLOROPROPENE
T20EC	TRANS-2-DECENE
TBA	TRIBUTYL AMINE
TBP	TRIBUTYL PHOSPHATE
TR1BZ	TRICHLOROBENZENES (ALL ISOMERS)
TR1PT	TRICHLOROCYCLOPENTENE
TRCLE	TRICHLOROETHYLENE / TRICHLOROETHENE
CCL3F	TRICHLOROFLUOROMETHANE
CL3NAP	TRICHLORONAPHTHALENES
TCST	TRICHLOROSTYRENE
TEPO4	TRIETHYL PHOSPHATE
TEGLME	TRIETHYLENE GLYCOL, METHYL ETHER
TFAAPE	TRIFLUOROACETIC ACID, 1,5-PENTANEDIYL ESTER
TRAMEY	TRIMALOMETHANES
TR1MBZ	TRIMETHYL BENZENE
TMPO4	TRIMETHYL PHOSPHATE
TMPO3	TRIMETHYL PHOSPHITE
TNTISO	TRINITROTOLUENE ISOMER
UNKXXX	UNKNOWN COMPOUND 001 THRU 999. NOTE: 001-999 FULL FIELD AS SHOWN
UDLM	UNSYMMETRICAL DIMETHYL HYDRAZINE
V	VANADIUM
DOVP	VAPONA
VARMY	VARIOUS HYDROCARBONS WITH INCREASING M.W.
VFA	VINYL FORMATE
WP	WHITE PHOSPHORUS
CC3	XXCC3
XYLEN	XYLENES
YELDY	YELLOW DYE
ZN	ZINC
ZR	ZIRCONIUM
SPIRO	(1',5 TRANS)-7-CHLORO-6-HYDROXY-2',4-DIMETHOXY-6'-METHYL- SPIRO(BENZOFURAN-2(3H),1'-(2) CYCLOHEXENE)-3,4'-DIONE
LIPID	X LIPIDS
1A3M2	1-ACETYL-3-METHYL-5-PYRAZOLONE
1B4MB	1-BENZYL-4-HYDROXYBENZIMIDAZOLE
1CDMPZ	1-CARBAZOYL-3,5-DIMETHYL-2-PYRAZOLINE
1CLODC	1-CHLORO-OCTADECANE
1OOCCL	1-ODODECANOL
1EMB	1-ETHYLHEXYL BENZENE
1FNAP	1-FLUORONAPHTHALENE
1HAE	1-HEXENE
1H3OL	1-HEXEN-3-OL
1INDAN	1-HYDROXY-2,3-METHYLENE INDAN [M.W.146]
1MEIND	1-METHYL INDAN
1MNP	1-METHYLNAPHTHALENE
1NHP	1-NITROHEPTANE
1N2ONE	1-NITRO-2-OCTANONE
1OCTOL	1-OCTANOL
1TSCHA	1-T-BUTYL CYCLOHEXANECARBOXYLIC ACID
BEETO	1-(2-BUTOXYETHOXY) ETHANOL
11DCE	1,1-DICHLOROETHANE
11DCE	1,1-DICHLOROETHYLENE / 1,1-DICHLOROETHENE
ONEEE	1,1-DI-N-BUTYL ETHYLENE / 1,1-DI-N-BUTYL ETHENE
111TCE	1,1,1-TRICHLOROETHANE
2TCLEA	1,1,1,2-TETRACHLOROETHANE
112TCE	1,1,2-TRICHLOROETHANE
1CLTFF	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE

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TFDCL	1,1,2-TRIFLUORO-1,2-DICHLOROETHANE
TCLEA	1,1,2,2-TETRACHLOROETHANE
MEBP	1,1'-METHYLENEBIS-PIPERIDINE
PHTHA	1,2-BENZENEDICARBOXYLIC ACID/PHTHALIC ACID
CHO	1,2-CYCLOHEXANE OXIDE
12OCLB	1,2-DICHLOROBENZENE
12OCL	1,2-DICHLOROETHANE
12DCD4	1,2-DICHLOROETHANE-D4
12OCLP	1,2-DICHLOROPROPANE
12DMB	1,2-DIMETHYL BENZENE / O-XYLENE
DMCPDE	1,2-DIMETHYL CYCLOPENTADIENE
12DMAP	1,2-DIMETHYLNAPHTHALENE
12DPH	1,2-DIPHENYL HYDRAZINE
12EPB	1,2-EPICLAYETHYL BENZENE / STYRENE OXIDE
123CPR	1,2,3-TRICHLOROPROPANE
TCB2	1,2,3,4-TETRACHLOROBENZENE
18O1ND	1,2,3,4,4A,5,8,8A-OCTAHYDRO-1,4,5,8-DIMETHANOLNAPHTHALEN-2-OL
PHYCP	1,2,3,4,5-PENTAHYDROXYCYCLOPENTANE
TCB3	1,2,3,5-TETRACHLOROBENZENE
124TCB	1,2,4-TRICHLOROBENZENE
TCB1	1,2,4,5-TETRACHLOROBENZENE
13OCLB	1,3-DICHLOROBENZENE
13OEB	1,3-DIETHYL BENZENE
13OFB	1,3-DIFLUOROBENZENE
13DBM	1,3-DIMETHYL BENZENE / M-XYLENE
13ONB	1,3-DINITROBENZENE
135TNB	1,3,5-TRINITROBENZENE
14OCLB	1,4-DICHLOROBENZENE
14DCBU	1,4-DICHLOROBUTANE
14DMNP	1,4-DIHYDRO-1,4-METHANONAPHTHALENE
14DMXA	1,4-DIMETHOXY ANTHRACENE
14D2EB	1,4-DIMETHYL-2-ETHYL BENZENE
14DNB	1,4-DINITROBENZENE
ORAT	1,4-ORATHANE
810BI	1,5-BIS(1,1-DIMETHYLETHYL)-3,3-DIMETHYLBICYCLO(3.1.0)-HEXANE-2-ONE
18ONAP	1,8-DIMETHYL NAPHTHALENE
13TDAM	13-TETRADECYNOIC ACID, METHYL ESTER
TC5AME	15-ETRADECENOIC ACID, METHYL ESTER
DTCH00	1.ALPHA.(E).4.ALPHA.-1-(1,4-DIHYDROXY-2,6,6-TRIMETHYL-2-CYCLOHEXEN-1-YL)-2-BUTEN-1-ONE
2A46DA	2-AMINO-4,6-DINITROANILINE
2A46OT	2-AMINO-4,6-DINITROTOLUENE
2BRMIA	2-BROMOMEXANOIC ACID
2B1CP	2-BROMO-1-CHLOROPROPANE
2BUXEL	2-BUTOXYETHANOL
BEP	2-BUTOXYETHANOL PHOSPHATE
2BNMNM	2-BUTYL-N-METHYL NORLEUCINE, METHYL ESTER
2B1QOL	2-BUTYL-1-OCTANOL
2CNAP	2-CHLORONAPHTHALENE
2CLP	2-CHLOROPICICOL
CLVRA	2-CHLOROVINYL ARSONIC ACID
2CHE1L	2-CYCLOHEXEN-1-OL
2CHE1O	2-CYCLOHEXEN-1-ONE
2CHAE	2-CYCLOPENTENE-1-MENDECANOIC ACID, ETHYL ESTER
2ECYBL	2-ETHYLCYCLOBUTANOL
2E2HPO	2-ETHYL-2-HYDROXYMETHYL-1,3-PROPANEDIOL
2E4MPL	2-ETHYL-4-METHYL-1-PENTANOL

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2FBP	2-FLUOROBIPHENYL
2FNAP	2-FLUORONAPHTHALENE
2FP	2-FLUOROPHENOL
2HNDOL	2-HENDECANOL / 2-UNDECANOL
OCAMDA	2-METHOXY-2,6-DICHLOROBENZOIC ACID
2MCPNE	2-METHYL CYCLOPENTANONE
2MEPEN	2-METHYL PENTANE
MEPOH	2-METHYL PENTANOL
2MP	2-METHYL PHENOL / 2-CRESOL
MDCL	2-METHYL UNDECANAL / 2-METHYL HENDECANAL
2MSZA	2-METHYLBENZYL ALCOHOL
2MTMPM	2-METHYLTHIO-4-HYDROXYPYRIMIDINE
2MIDOL	2-METHYL-1-DODECANOL
2MIPNE	2-METHYL-1-PENTENE
2M2BDA	2-METHYL-2-BUTENEDIAMIDE
2M2H3B	2-METHYL-2-HYDROXY-3-BUTYNE
2M24P	2-METHYL-2,4-PENTANEDIOL
2M3HXE	2-METHYL-3-HEXENE
4CL2C	2-METHYL-4-CHLOROPHENOL / 4-CHLORO-2-CRESOL
4BDN2C	2-METHYL-4,6-DINITROPHENOL / 4,6-DINITRO-2-CRESOL
2N8ZLZ	2-NITROBENZALAZINE
2NP	2-NITROPHENOL
2NT	2-NITROTOLUENE
2NCOCO	2-NONADECANONE
2CNCHO	2-(CYANOMETHYL) CYCLOHEXANONE
NP000	2-(META-CHLOROPHENYL)-2-(PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
OP000	2-(ORTHO-CHLOROPHENYL)-2-(PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
OP00E	2-(ORTHO-CHLOROPHENYL)-2-(PARA-CHLOROPHENYL)-1,1-DICHLOROETHENE
CP00T	2-(ORTHO-CHLOROPHENYL)-2-(PARA-CHLOROPHENYL)-1,1,1-TRICHLOROETHANE
2CEC10	2-(2-CYANODETHYL) CYCLOHEXANONE
2BEE10	2-(2-N-BUTOXYETHOXY) ETHANOL
BCPHCE	2,2-BIS(CHLOROPHENYL) CHLOROETHYLENE DOT RELATED
2BEMOE	2,2-BIS(ETHYLMERCAPTO)-DIETHYL ETHER
2B5MPR	2,2-BIS(METHYL MERCAPTO) PROPANE
PP000	2,2-BIS(PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
PP00E	2,2-BIS(PARA-CHLOROPHENYL)-1,1-DICHLOROETHENE
PP00T	2,2-BIS(PARA-CHLOROPHENYL)-1,1,1-TRICHLOROETHANE
PPT0E	2,2-BIS(PARA-CHLOROPHENYL)-2-PHENYL-1,1-DICHLOROETHENE
2DMPEN	2,2-DIMETHYL PENTANE
DM1ACH	2,2-DIMETHYL-1-ACETYL CYCLOHEXANE
DMPTHF	2,2-DIMETHYL-5-(1-METHYLPROPYL) TETRAHYDROFURAN
2OXBEL	2,2-OXY-BIS-ETHANOL
23TMP	2,2,3,3-TETRAMETHYLPENTANE
TMCOEO	2,2,7,7-TETRAMETHYL-4,5-OCTADIEN-3-ONE
25CCCB	2,2',3,3',4,4',5,5'-OCTACHLOROBIPHENYL
26HPCB	2,2',3,4,4',5,6-HEPTACHLOROBIPHENYL
25HPCB	2,2',3,4,5,5'-HEXACHLOROBIPHENYL
25HPCB	2,2',3,4,5,5',6-HEPTACHLOROBIPHENYL
225TCB	2,2',5-TRICHLOROBIPHENYL
2255CB	2,2',5,5'-TETRACHLOROBIPHENYL
245PCB	2,2',4,5,5'-PENTACHLOROBIPHENYL
23DCLP	2,3-DICHLOROPHENOL
23D2HL	2,3-DIMETHYL-2-HEXANOL
1M3PL	2,3,4-TRIMETHYL-3-PENTANOL
TRMTUE	2,3,4-TRIMETHYL-4-TETRADECENE
2345CB	2,3,4,5-TETRACHLOROBIPHENYL
2346CP	2,3,4,6-TETRACHLOROPHENOL
2356CP	2,3,5,6-TETRACHLOROPHENOL

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236TUN	2,3,6-TRIMETHYL NAPHTHALENE
240CLP	2,4-DICHLOROPHENOL
240	2,4-DICHLOROPHENOXYACETIC ACID
08ATTS	2,4-DIHYDROXYBENZOIC ACID, TRIS-TRIMETHYSILYL
240MPN	2,4-DIMETHYL PHENOL
240NP	2,4-DINITROPHENOL
240NT	2,4-DINITROTOLUENE
245TCP	2,4,5-TRICHLOROPHENOL
245T	2,4,5-TRICHLOROPHENOXYACETIC ACID
246TCA	2,4,6-TRICHLOROANILINE
246TCP	2,4,6-TRICHLOROPHENOL
ATHBA	2,4,6-TRINITROBENZALDEHYDE
246TNP	2,4,6-TRINITROPHENOL / PICRIC ACID
246TNR	2,4,6-TRINITRORESORCINOL / STYPMNIC ACID
246TNT	2,4,6-TRINITROTOLUENE
24DCB	2,4'-DICHLOROBIPHENYL
25C140	2,5-CYCLOHEXAADIEN-1,4-DIONE
250CLP	2,5-DICHLOROPHENOL
260CLP	2,6-DICHLOROPHENOL
260NST	2,6-DIMETHYL STYRENE
260NA	2,6-DINITROANILINE
260NT	2,6-DINITROTOLUENE
0184C	2,6-DI-TERT-BUTYL-4-CRESOL
260BMP	2,6-DI-T-BUTYL-4-METHYL PHENOL
30PETM	3-BUTENYLPENTYL ETHER
3CLP	3-CHLOROPHENOL
3ENXDE	3-ETHYL-1,4-HEXAADIENE
3MXE20	3-HEXEN-2-ONE
3HOLPT	3-HYDROXY-2,7-DIMETHYL-4(3H)-PTERIDINONE
3MXIMZ	3-METHOXYIMIDAZOLE
3M2C10	3-METHOXY-2-CYCLOPENTEN-1-ONE
MBAD0E	3-METHYL BUTANOIC ACID, 3,7-DIMETHYL-2,4,6-OCTATRIENYL ESTER
3MEPN	3-METHYL PENTANE
3MP	3-METHYL PHENOL / 3-CRESOL
3M1PL	3-METHYL-1-PENTANOL
3M2CHO	3-METHYL-2-CYCLOHEXEN-1-ONE
3M2HXL	3-METHYL-2-HEXANOL
2N3C	3-METHYL-2-NITROPHENOL / 2-NITRO-M-CRESOL
4CL3C	3-METHYL-4-CHLOROPHENOL / 4-CHLORO-M-CRESOL / 4-CHLORO-3-CRESOL
6CL3C	3-METHYL-6-CHLOROPHENOL / 6-CHLORO-3-CRESOL
3NT	3-NITROTOLUENE
3OCTOL	3-OCTANOL
3OPPAE	3-OXO-3-PHENYL PROPANOIC ACID, ETHYL ESTER
BZ	3-QUINUCRIDINYL BENZILATE
3CMCH	3-(CHLOROMETHYL) CYCLOHEXENE
3HDMPL	3-(HYDROXYMETHYL)-4,4-DIMETHYL PENTANAL
0MPCHE	3-(2,2-DIMETHYLPROPOXY) CYCLOHEXENE
TMHPDO	3,3,6-TRIMETHYL-1,5-HEPTADIEN-4-ONE
340CLP	3,4-DICHLOROPHENOL
0H8ZPY	3,4-DIHYDRO-2H-1-BENZOPYRAN
345T1H	3,4,5-TRIMETHYL-1-HEXENE
350NA	3,5-DINITROANILINE
350NP	3,5-DINITROPHENOL
350NT	3,5-DINITROTOLUENE
TMHXL	3,5,5-TRIMETHYL-1-HEXANOL
36DF90	3,6-DICHLOROFLUOREN-9-ONE
4A350T	4-AMINO-3,5-DINITROTOLUENE
48RPPE	4-BROMOPHENYLPHENYL ETHER

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Testnames, sorted by test name, continued.

4CLPPE	4-CHLOROPHENYLPHENYL ETHER
4C3M8E	4-CHLORO-3-METHYL-1-BUTENE
4E2OCE	4-ETHYL-2-OCTENE
4FANIL	4-FLUOROANILINE
4FT	4-FLUOROTOLUENE
4HAZOB	4-HYDROXYAZOBENZENE
4HYBA	4-HYDROXYBENZALDEHYDE
4ICMOU	4-1000METHYL QUINULCIDINE
4MXCHL	4-METHOXYCYCLOHEXANOL
4MXP	4-METHOXYPHENOL
4MP	4-METHYL PHENOL / 4-CRESOL
4M2PPL	4-METHYL-2-PROPYL-1-PENTANOL
4NP	4-NITROPHENOL
4TCP	4-T-OCTYL PHENOL
DOPAM	4-(2-AMINOETHYL) PYROCATECHOL / DOPAMINE
44DF8Z	4,4-DIFLUOROBENZOPHENONE
4DM2PL	4,4-DIMETHYL-2-PENTANOL
44DMPE	4,4-DIMETHYL-2-PENTENE
DBTSPY	4,5-DIMETHYL-2,6-BIS(TRIMETHYLSILOXY) PYRIMIDINE
HXHMZ	4,5,6,7,8,8A-HEXAHYDRO-8A-METHYL-2(1H)-AZULENONE
48DMHD	4,8-DIMETHYL HENDECANE
5CL2C	5-CHLORO-O-CRESOL / 2-METHYL-5-CHLOROPHENOL
5E5MD	5-ETHYL 5-METHYL DECANE
5MSHAL	5-METHYL-5-HYDROXYHEXANOIC ACID LACTONE
5N2OL	5-NORBOREN-2-OL
DCMBF	5,7-DICHLORO-2-METHYL BENZOPURAN
6E6MFV	6-ETHYL-6-METHYL FULVENE
6MEPUR	6-METHYL PURINE
MYNB	7-HYDROXY NORBORNADIENE

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ADDITIONAL TEST NAMES

<u>Test Name Code</u>	<u>Actual Test Name</u>
SUR	Surfactants
TUR	Turbidity
DOC	Dissolved Organic Carbon
ODOR	Odor
COLOR	Color
CORR	Corrosivity
GO	Grease & Oil
FECAL	Fecal Coliform
COND	Conductivity
GCSCN	GC Scan
12TDCE	1,2-trans-dichloroethylene
ALPHAG	Gross Alpha
BETAG	Gross Beta
TOTRAD	Total Radium

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MEASUREMENT UNIT CODE LIST - WATER & SEDIMENT ANALYSIS

<u>Code</u>	<u>Measurement Unit</u>	<u>Description</u>
APC	Alpha Platinum Cobalt Units (EPA #110.2)	used in water analysis for color
FECL	Fecal Coliform Colonies per 100 milliliters	used in water analysis for coliform
MGG	Milligrams per gram	used in soil and sediment analysis
MGL	Milligrams per liter	used in water analysis
PCL	Picocuries per liter	used in test for radio-activity in water analysis
PCG	Picocuries per gram	used in test for radio-activity in soil and sediment analysis
PCKG	Picocuries per kilogram	used in test for radio-activity in soil and sediment analysis
PH	Concentration of hydrogen ions	used in water, soil and sediment analysis
THON	Threshold Odor Number (EPA #140.1)	used in water analysis for odor
UGG	Micrograms per gram	used in soil and sediment analysis
UGL	Micrograms per liter	used in water analysis
UMHC	Micromhos per centimeter	used in test for conductivity in water
TU	Turbidity Units	based on amount of SO ₂ in water
MMY	Millimeters per Year	corrosivity measurement in water analysis

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**CHEMICAL ANALYSIS RESULTS - WATER
ANALYTICAL METHOD CODE NUMBERS**

<u>Method Code Numbers</u>	<u>Test Name</u>	<u>Method Reference</u>
1B	AG, AS, BE, CR, CU, NI, PB, SB, SE, TL, CD	EPA Section 200.0 (AA-flameless)
1D	HG	EPA 245.1
1M	HG, K, BA, AL, ZN, CD, CA, FE, NA, MN	EPA Section 200.00 (AA-flame)
1U	NO2,NO3	EPA 353.3
1X	Acids & Base-Neutrals	EPA 625.0
2F	Pesticides, Herbicides	EPA 608.0 EPA 615.0
2J	VOAs, TCEs, THM	EPA 601.0 (GC) EPA 624.0 (GC/MS)
2X	GCSCN (GC-Scan for hydrocarbons)	
4K	CYN	EPA 335.2
4L	SULFID	EPA 376.1
4M	NH3N2	EPA 350.1
4U	SO4	EPA 375.2
5D	PO4	EPA 365.1
6X	CL	EPA 325.3
8E	F	EPA 340.1
9C	COLOR	EPA 110.2
9D	ODOR	EPA 140.1
9F	FECAL	APHA-AWWA 909.C

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<u>Method Code Numbers</u>	<u>Test Name</u>	<u>Method Reference</u>
9I	TOC	EPA 415.1
9X	GO	EPA 413.1
9J	COND	EPA 120.1
9H	DOC	Filtered-then EPA 415.1
9L	SUR	EPA 425.1
9M	TUR	EPA 180.1
9N	CORR	EPA Sec. 5.0 40 CFR 261.22
9P	TDS	EPA 160.1
9Q	Phenol	EPA 420.2
9R	pH	EPA 150.1
1F	Dissolved metals; passed through .45 micron filter	EPA Sec. 200, Part 3.4
9T	TOX	EPA 450.1
9W	BETAG, ALPHAG	Teledyne Procedure; PRO-032-1 & PRO-032-41
9Y	TOTRAD	Teledyne Procedure; PRO-032-77

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**CHEMICAL ANALYSIS RESULTS - SOIL & SEDIMENT
ANALYTICAL METHOD CODE NUMBERS**

<u>Method Code Number</u>	<u>Test Name</u>	<u>Method Reference</u>
1J	AG, AS, PB, SB, SE, TL	EPA Section 200.0 (AA-flameless)
1N	BE, CD, CR, CU, NI, ZN, AL, BA, FE, MG, MN, NA	EPA Section 200.0 (AA-flame)
1T	NO2, NO3	EPA 353.2
2D	HG	EPA 245.5
2H	TP04	EPA 365.4
2G	VOAs, TCEs, THM	EPA 601 (GC) EPA 624 (GC/MS)
6R	SO4	EPA 375.2
6S	CYN	EPA 335.2
6V	Pesticides Herbicides	EPA 608.0 EPA 615.0
7A	B	EPA 212.3
7M	NH3NH2	EPA 350.1
7E	F	EPA 340.1
7X	CL	EPA 325.3
7L	SULFID	Standard Method 228A 13 Ed.

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CHEMICAL ANALYSIS RESULTS
INSTRUMENT CODE NUMBERS

<u>Code No.</u>	<u>Instrument Name</u>	<u>Parameters Analyzed</u>
ø1	Technicon #1 (Auto Analyzer)	NO ₂ , NO ₃ , PO ₄ , NH ₃ N ₂ , Phenol
ø2	Technicon #2 (Auto Analyzer)	SO ₄
ø3	Spectrophotometer 100	CYN, F, TUR
ø4	Atomic Absorption- flameless	Water: Sb, As, Be, Cr, Cu, Pb, Ni, Se, Ag, Tl, Cd Soil: Sb, As, Pb, Se, Ag, Tl
ø5	Atomic Absorption- flame	Water: Cd, Al, Zn, Ca, Mg, Ba, Fe, Mn, Na, Soil: Be, Cd, Cr, Cu, Ni, Al, Ba, Fe, Mg, Mn, Na, Zn
ø6	Atomic Absorption- mercury analyzer	Hg
ø7	GC #7 (HP 5840)	Pesticides
ø8	GCMS (HP 5985)	GCMS VOAs and NVOs
ø9	Titration	SULFID
1ø	Titration	Cl
11	GC #4 (HP 5840)	Pesticides
12	GCMS (HP 5993)	NVOs
13	GC (Tracor)	TCEs
14	GC #8 (HP 5730)	THM
15	GC #2 (HP 5840)	GC Scan

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CHEMICAL ANALYSIS RESULTS
INSTRUMENT CODE NUMBERS

(Continued)

<u>Code No.</u>	<u>Instrument Name</u>	<u>Parameters Analyzed</u>
16	Wet Method	SUR, ODOR, TDS, GO, COR FECAL
17	Total Organic Carbon Analyzer (TOCA) - Beckman Model 915	TOC, DOC
18	pH Meter	pH
19	Conductivity Meter	Conductivity (COND)
20	Color Comparator	COLOR
21	Dohrmann Colorimetric- Titration System (MRTL Analytical Services, Subcontractor)	TOX
22	Beckman Wide Beta II Automatic Alpha-Beta Counting System (Teledyne Isotopes)	BETAG, ALPHAG
23	Beckman Wide Beta II Automatic Alpha-Beta Counting System (Teledyne Isotopes)	TOTRAD
24	Total Organic Carbon Analyzer (TOCA) Dohrman Model 180	TOC, DOC

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VALID INSTRUMENT CODES
- WESTON - ANALYTICS DIVISION

REVISED FEBRUARY 13, 1989

AA - GRAPHITE FURNACE AA
AN - ANALYTICAL BALANCE
BE - BECKMAN LS-200
BR - BERTHOLD LB700
DO - DOHRNAMM TOC ANALYZER
EB - EBERLINE SAC-R5
GC - GAS CHROMATOGRAPH
HA - HACH-2100A TURBIMETER-SO4
HG - HG-CVAA
IC - ICP61
LA - LAMBDA 3
ME - SPECIFIC CONDUCTIVITY METER
MS - MASS SPECTROMETER
OR - ORION PROBE
PH - PH PROBE
PM - PENSKEY MARTINS' CLOSED CUP APARATUS
RA - RATIO - TURB
SP - UV-VIS SPECTROPHOTOMETER
TE - TECHNICON AUTO ANALYZER
TI - TITRATION
TU - NEPHELOMETER
TX - TOX
10 - 105 OVEN
13 - GAS CHROMATOGRAPH

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CHEMICAL ANALYSIS RESULTS

VISUAL CONTAMINATION CODES (columns 78-80)

<u>Code</u>	<u>Description</u>
S	sand
B	bubbles (VOAs)
L	solids; other than sand
M	Multiphased
F	floc; algae, bacteria, etc.
C	color
D	odor

Note: up to 3 codes per record may be entered

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PROCEDURES FOR IDENTIFICATION & CODING OF QUALITY CONTROL
SAMPLES - SEDIMENT & WATER

<u>Field No.</u>	<u>Field Name</u>	<u>Description</u>	<u>Code</u>	<u>Cols.</u>
1	Well Number - Water	Field Blank	FB	2-3
1	Site ID - Sed			(col. 1 blank)
		Lab Blank	LB	2-3
				(col. 1 blank)
		Calibration	CS	2-3
		Standard		(col. 1 blank)
		Cooler Blank	CB	2-3
				(col. 1 blank)
		Blind Standard	BS	2-3
				(col. 1 blank)
7-water	Sample Number	Duplicate	1	33
9-sed	Sample Number	Duplicate	1	43
11-water	Test Results	¹ Spike-total	integer	44-53
		conc. measured	or real	
13-sed	Test Results	¹ Spike-total	integer	54-63
		conc. measured	or real	
20-water	Nominal Conc.	¹ amount of	integer	81-90
		spike added	or real	
22-sed	Nominal Conc.	¹ amount of	integer	91-100
		spike added	or real	

¹Should be reported in same units as Test Results

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**APPENDIX V
RECEPTOR ANALYSIS CHECKLIST**

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RECEPTOR ANALYSIS CHECKLIST

A. General RFI Unit Information.

Unit Name: _____

Unit Location: _____

B. General RFI Unit Information

1. Current local ground water uses

1a. Type of use _____

1b. Location of user _____

2. Planned future ground water uses

2a. Type of use _____

2b. Location of user _____

3. Current surface water uses

1a. Type of use _____

C. Human Access

1. On-site _____

2. Adjacent areas of SRS _____

3. Populations located in
direction of prevailing wind _____

D. Potentially Exposed Populations

1. Biota

1a. Terrestrial flora and fauna _____

1b. Aquatic flora and fauna _____

2. Human demographics _____

3. Endangered and threatened species _____

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**APPENDIX W
HAZARDOUS WASTE PERMIT**

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**South Carolina Department of Health
and Environmental Control**

2600 Bull Street
Columbia, S.C. 29201

Commissioner
Michael D. Jarrett

Board
Moses H. Clarkson, Jr., Chairman
Oren L. Brady, Jr., Vice-Chairman
Eula M. Colvin, M.D., Secretary
Harry M. Hallman, Jr.
Henry S. Jordan, M.D.
James A. Spruill, Jr.
Toney Graham, M.D.

September 30, 1987

CERTIFIED MAIL

Mr. S. R. Wright, Director
Environmental Division
Department of Energy
Savannah River Operations Office
Post Office Box A
Aiken, South Carolina 29802

RE: Hazardous Waste Permit
Savannah River Plant
SCI 890 008 989

Dear Mr. Wright:

Enclosed is the hazardous waste permit for the Savannah River Plant. In addition, a copy of the responsiveness summary, which addresses those comments noted during the public comment period, is included.

Please contact this office if you have any questions.

Sincerely,

David E. Wilson, Jr., P.E.
Hazardous Waste Permitting
Bureau of Solid and Hazardous Waste
Management

DEWjr:jth

cc: Kim Carthan
Jim Ferguson

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Toney Graham, M.D.

OFFICE OF ENVIRONMENTAL QUALITY CONTROL
BUREAU OF SOLID AND HAZARDOUS WASTE MANAGEMENT

HAZARDOUS WASTE PERMIT

Date of Issue: September 30, 1987 Expiration Date: September 30, 1992

Identification Number/Permit No: SC1 890 008 989

Permission is hereby granted to:

Name of facility: Savannah River Plant

Address: P. O. Box A

Aiken, South Carolina 29802

Supervisor: Mr. Steve Wright

Phone: 803-725-3957

for the operation of hazardous waste storage buildings 710U, 709-G, 709-2G, 709-4G and post closure of the M-Area Hazardous Waste Management Facility located at the Savannah River Plant.

This permit is issued pursuant to Section 44-56-10 et seq. and Regulation 61-79 of the 1976 South Carolina Code of Laws, as amended. The authority granted hereunder is subject to the requirements of the aforementioned laws and regulations and the following conditions:

(See attached list of conditions)

William W. Culler
William W. Culler, P.E., Director
Division of Facility Engineering
Bureau of Solid and Hazardous Waste
Management

This permit is non-transferable and is the property of the Bureau of Solid and Hazardous Waste Management and must be surrendered on demand. Keep posted at all times in a conspicuous place on the premises.

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**FACT SHEET FOR
THE U. S. DEPARTMENT
OF ENERGY'S
SAVANNAH RIVER PLANT**

JUNE 12, 1987

SCI 890 008 989

The South Carolina Department of Health and Environmental Control (DHEC) has prepared a Draft Hazardous Waste Permit for the U. S. Department of Energy's Savannah River Plant centrally located approximately 25 miles southeast of Augusta, Georgia, 22 miles south of Aiken, S.C. and 100 miles from the Atlantic coast.

This fact sheet is being prepared in accordance with the requirements of R.61-79.124.8.

I. FACILITY DESCRIPTION

The Department of Energy (DOE) has applied for a Hazardous Waste Permit for the storage of hazardous waste in containers and post closure of the M-Area Hazardous Waste Management Facility.

The container storage facility consists of four buildings (710-U, 709-G, 709-4G and 709-2G) designed to store 752,880 gallons of hazardous waste.

The 710U building is an enclosed building with a four foot elevated concrete floor subdivided into three bays. The North and Middle Bays are used for the storage of hazardous waste with the South Bay utilized only for machinery storage. The storage capacity of the 710U Building is 60,280 gallons.

The 709-G building is a partially enclosed metal building with a slab on-grade concrete floor subdivided into seven cells, of which six are used for the storage of hazardous waste. The 709-G has a maximum storage capacity of 106,920 gallons.

The 709-4G is an enclosed metal building with a concrete slab floor. The storage capacity of the 709-4G building is 431,900 gallons.

The 709-2G is an enclosed metal building with a concrete slab floor. The 709-2G contains six storage areas to store hazardous waste with a total capacity of 153,780 gallons. An additional area is used to reclaim leaking or damaged drums.

Each storage area is equipped with a sump and curbing to contain any spills or leaks from the containers.

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The M-Area Hazardous Waste Management Facility consists of an unlined settling basin (surface impoundment), overflow ditch, seep area, and a Carolina Bay (Lost Lake). These areas received the effluent discharge from the M-Area fuel fabrication operations. This effluent contained solvents and degreasers which are considered hazardous under South Carolina Law. The settling basin is an 8,000,000 gallon surface impoundment in which liquid entered through a underground sewer on the north side and discharged on the west side into a 920 foot overflow ditch, through the Seep Area, and to Lost Lake.

The Seep Area is approximately two to three acres in size with Lost Lake covering an area of approximately 25 acres.

II. PURPOSE OF THE PERMITTING PROCESS

The purpose of the permitting process is to afford the Department, interested citizens and other governmental agencies the opportunity to evaluate the ability of the Permittee, U. S. Department of Energy's Savannah River Plant, to comply with the applicable South Carolina Hazardous Waste Management Regulations, for the operation of a hazardous waste storage facility and the post closure care of a surface impoundment. The Department is required to prepare a draft permit which sets forth in one concise document all of the applicable requirements which the Department intends to require the Permittee to comply with during the five (5) year duration of the permit. The public will be given forty-five (45) days to review the application, comment on the draft permit conditions and to request a public hearing prior to the Department taking any final permitting action on the application for a hazardous waste management permit.

III. PROCEDURE FOR REACHING A FINAL DECISION

The issuance of a hazardous waste permit to the U.S. Department of Energy's Savannah River Plant will be coordinated by the South Carolina Department of Health and Environmental Control (SCDHCEC) and the United States Environmental Protection Agency (EPA). At this time, the regulations require a permit to be issued for all facilities which treat, store or dispose of hazardous waste. South Carolina Hazardous Waste Management Regulation R.61-79.124.10 requires that the public be given a forty-five (45) day comment period for all hazardous waste draft permits. The comment period will begin on the date of publication of the public notice in a major local newspaper of general circulation. Any person interested in commenting on the application or draft permit or requesting a public hearing must do so in writing within forty-five (45) days after the public notice is published.

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All persons wishing to comment on any of the permit conditions or the permit application should submit their comments in writing to:

South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, South Carolina 29201
Attention: Hartsill W. Truesdale, P.E., Chief
Bureau of Solid and Hazardous Waste Management

When the Department makes a final permit decision, notice will be given to the applicant and each person who has submitted written comment or requested notice of the final permit decision.

Contact persons for the U.S. Department of Energy's Draft Hazardous Waste Permit are:

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

Bureau of Solid and Hazardous Waste Management
Attention: Eric J. Gleason or David Wilson
2600 Bull Street
Columbia, South Carolina 29201

and

ENVIRONMENTAL PROTECTION AGENCY

US Environmental Protection Agency
Attention: John Dickinson
Residuals Management Branch
345 Courtland Street, NE
Atlanta, Georgia 30365

IV. BRIEF SUMMARY OF THE PERMIT CONDITIONS

The permit for the Savannah River Plant is divided into four (4) categories:

1) Part I - Standard Conditions:

Conditions listed in Part I are located in R.61-79.270.30 and apply to all hazardous waste facilities.

**2) Part II - General Facility Conditions
Part III - Storage in Containers, and
Part IV - Post closure Requirements**

Conditions listed in these sections are to insure that the design and operation of the Savannah River Plant's hazardous waste container storage facilities and surface impoundment comply with all applicable regulations listed in R.61-79.264. The Permittee

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will be required to comply with all current applicable South Carolina Hazardous Waste Management Regulations and subsequent revisions.

3) Part V - Solid Waste Management Units:

Conditions listed in this section are to insure that the Permittee investigates all solid waste management units onsite and determines whether a prior or continuing release of hazardous waste or hazardous constituents has occurred from each unit. In addition, should it be determined that a prior or continuing release has occurred, the Permittee will be required to institute the corrective action necessary to protect human health and the environment. The provisions required by this part of the permit are authorized by R.61-79.264.101 of the South Carolina Solid and Hazardous Waste Management Regulations.

4) Part VI - Waste Minimization:

The condition required by this part of the permit is authorized by Section 44-56-170(a) of the South Carolina 1976 Code of Laws, as amended.

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PART I - STANDARD CONDITIONS

I.A. The permittee must comply with all applicable South Carolina Hazardous Waste Management Regulations. Many changes are anticipated in State requirements and at such time as the Department accomplishes the necessary regulatory changes, you will be required to comply with any applicable portions of such revisions as provided for by R.61-79.270.41 (a) (3).

I.B. The Permittee shall operate this facility in accordance with the Hazardous Waste Permit Application dated April 30, 1987, for the M-Area hazardous waste management facility and the 709-G, 709-2G, 709-4G, and 710-U storage buildings.

I.C. EFFECT OF PERMIT

The Permittee is allowed to store hazardous waste in accordance with the conditions of this permit. Issuance of this permit does not convey property rights of any sort or any exclusive privilege; nor does it authorize any injury to persons or property, any invasion of other private rights, or any infringement of state or local law or regulations. Compliance with the terms of this permit does not constitute a defense to any order issued or any action brought under the authority of any other law providing for protection of public health or the environment.

I.D. PERMIT ACTIONS

This permit may be modified revoked and reissued, or terminated for cause as specified in R.61-79.270.41, 270.42, and 270.43. The filing of a request for a permit modification, revocation and reissuance, or termination, or the notification of planned changes or anticipated non-compliance on the part of the Permittee does not stay the applicability or enforceability of any permit condition.

I.E. SEVERABILITY

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this permit shall not be affected thereby.

I.F. DUTIES AND REQUIREMENTS

I.F.1. Duty to Comply

The Permittee shall comply with all conditions of this permit, approved permit application and approved amendments thereto except to the extent and for the duration such noncompliance is authorized by an emergency permit. Any permit noncompliance, other than non-compliance authorized by an emergency permit, constitutes a

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violation of the South Carolina Hazardous Waste Management Act and is grounds for enforcement action, permit termination, revocation and reissuance, modification, or denial of a permit renewal application.

I.P.2. Duty to Reapply

If the Permittee wishes to continue an activity allowed by this permit after the expiration date of this permit, the Permittee shall submit a complete application for a new permit at least 180 days before this permit expires.

I.P.3. Permit Expiration

This permit and all conditions therein will remain in effect beyond the permit's expiration date if the permittee has submitted a timely, complete application and through no fault of the permittee, the Department has not issued a new permit.

I.P.4. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for the Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

I.P.5. Duty to Mitigate

The Permittee shall take all reasonable steps to minimize releases to the environment, and shall carry out such measures as are reasonable to prevent significant adverse impacts on human health or the environment.

I.P.6. Proper Operation and Maintenance

The Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of a backup or auxiliary facility or similar systems only when necessary to achieve compliance with the conditions of the permit.

I.P.7. Duty to Provide Information

The Permittee shall furnish to the Department, within a reasonable time, any relevant information which the Department may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The Permittee shall also furnish to the Department, upon request, copies of records required to be kept by this permit.

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I.F.8. Inspection and Entry

The Permittee shall allow the Department, or an authorized representative, upon the presentation of credentials and other documents as may be required by law to:

- I.F.8.a. Enter at reasonable times upon the Permittee's premises where a regulated activity is located or conducted, or where records must be kept under the conditions of this permit;
- I.F.8.b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
- I.F.8.c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices or operations regulated or required under this permit; and
- I.F.8.d. Sample or monitor, at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by RCRA, any substances or parameters at any location.

I.F.9. Monitoring and Records

- I.F.9.a. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. The method used to obtain a representative sample of the waste to be analyzed must be the appropriate method from Appendix I of R.61-79.261 or the waste analysis plan as approved by SCDHEC. Laboratory methods must be those specified in the approved waste analysis plan contained in the permit application or for those analysis beyond the scope of the plan by an analytical technique approved by SCDHEC.
- I.F.9.b. The Permittee shall retain at the facility records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports and records required by this permit, and records of all data used to complete the application for this permit for a period of at least 3 years from the date of the sample, measurement, report or record. These periods may be extended by request of the Department at any time and are automatically extended during the course of any unresolved enforcement action regarding this facility. The Permittee shall submit all monitoring results at the interval, specified elsewhere in this permit. The Permittee shall maintain records of all groundwater monitoring wells and associated groundwater surface elevations for the active life of the facility and, for disposal facilities, for the post-closure care period as well.
- I.F.9.c. Records of monitoring information shall specify:
 - I.F.9.c.i. The dates, exact place, and times of sampling or measurements;
 - I.F.9.c.ii. The individuals who performed the sampling or measurements;
 - I.F.9.c.iii. The dates analyses were performed;

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- I.F.9.c.iv. The individuals who performed the analyses;
- I.F.9.c.v. The analytical techniques or methods used; and
- I.F.9.c.vi. The results of such analyses.

I.F.10. Reporting Planned Changes

The Permittee shall give notice to the Department as soon as possible of any planned physical alterations or additions to the permitted facility.

I.F.11. Anticipated Noncompliance

The Permittee shall give advance notice to the Department of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

I.F.12. Transfer of Permits

This permit may be transferred to a new owner or operator only if it is modified or revoked and reissued pursuant to R.61-79.270.41(b) (2) or 270.42(d). Before transferring ownership or operation of the facility during its operating life, the Permittee shall notify the new owner or operator in writing of the requirements of R.61-79.264, R.61-79.270 and this permit.

I.F.13. Compliance Schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date,

I.F.14. Twenty-four Hour Reporting

The Permittee shall report to the Department any noncompliance with the permit which may endanger health or the environment. Any such information shall be reported orally within 24 hours from the time the Permittee becomes aware of the circumstances. This report shall include the following:

- I.F.14.a. Information concerning the release of any hazardous waste which may endanger public drinking water supplies.
- I.F.14.b. Information concerning the release or discharge of any hazardous waste, or of a fire or explosion at the facility, which could threaten the environment or human health outside the facility. The description of the occurrence and its cause shall include:
 - I.F.14.b.i. Name, address, and telephone number of the owner or operator;
 - I.F.14.b.ii. Name, address, and telephone number of the facility;

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- I.F.14.b.iii. Date, time, and type of incident;
- I.F.14.b.v. The extent of injuries, if any;
- I.F.14.b.vi. Name and quantity of materials involved;
- I.F.14.b.vii. An assessment of actual or potential hazard to the environment and human health outside the facility, where this is applicable; and
- I.F.14.b.viii. Estimated quantity and disposition of recovered material that resulted from the incident.

A written submission shall also be provided within 15 days of the time the Permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the periods of noncompliance (including exact dates and times); whether the noncompliance has been corrected; and if not, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

I.F.15. Other Noncompliance

The Permittee shall report all other instances of noncompliance not otherwise required to be reported above within 15 days of the time the Permittee becomes aware of the circumstances. The reports shall contain the information listed in Condition I.F.14.

I.F.16. Other Information

Whenever the Permittee becomes aware that he failed to submit any relevant facts in the permit application, or submitted incorrect information in a permit application or in any report to the Department the Permittee shall promptly submit such facts or information.

I.G. SIGNATORY REQUIREMENT

All applications, reports, or information submitted to the Department shall be signed and certified in accordance with R.61-79.270.11.

I.H. CONFIDENTIAL INFORMATION

The Permittee may claim confidential any information required to be submitted by this permit in accordance with R.61-79.270.12.

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I.I. DOCUMENTS TO BE MAINTAINED AT FACILITY SITE

The Permittee shall maintain at the facility, until closure is completed and certified by an independent registered professional engineer, the following documents and amendments, revisions and modifications to these documents:

- I.I.1. Waste Analysis Plan as required by R.61-79.264.13 and this permit.
- I.I.2. Personnel training documents and records as required by R.61-79.264.16(d) and this permit.
- I.I.3. Contingency Plan as required by R.61-79.264.53(a) and this permit.
- I.I.4. Closure Plan as required by R.61-79.264.112(a) and this permit.
- I.I.5. Operating records as required by this permit and applicable regulations.
- I.I.6. Inspection schedules as required by R.61-79.264.15(b) and this permit.
- I.I.7. Post Closure Plans as required by R.61-79.264.118, R.61-79.270.1(c) and this permit.
- I.I.8. Documentation of compliance with R.61-79.264.120, notice in deed to property, and applicable requirement of this permit.
- I.I.9. Corrective Action Plan(s) and reports as required R.61-79.264.100 and 264.101 and this permit.
- I.I.10. Groundwater monitoring records required to develop reports required by R.61-79.264.100 and this permit.

I.J. DOCUMENTS TO BE MAINTAINED DURING POST CLOSURE PERIOD

The following documents and information shall be maintained during the post closure period at the location specified in Volume III Book 1 section E.6 of the approved permit application and as required by R.61-79.264.118.

- I.J.1. Groundwater monitoring records required to develop reports required by R.61-79.264.100 and this permit.
- I.J.2. Corrective Action Plans and reports required by R.61-79.264.100, R.61-79.264.101 and this permit.
- I.J.3. Post Closure Plan(s) as required by R.61-79.264.118 and R.61-79.270.1(c) and this permit.
- I.J.4. Documentation of compliance with R.61-79.264.119, R.61-79.264.120 and this permit.

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I.J.5. A survey plat and record of the type, location and description of hazardous constituents disposed of within the M-area hazardous waste management area.

I.J.6. All reports and documentation of compliance with R.61-79.264.118(a)(1) and (2) and this permit during the post closure period.

I.K. DEFINITIONS

For purposes of this permit, terms used herein shall have the same meaning as those in R.61-79.124, 260, 264 and 270, unless this permit specifically provides otherwise; where terms are not defined in the regulations or the permit, the meaning associated with such terms shall be defined by a standard dictionary reference or the generally accepted scientific or industrial meaning of the term.

I.K.1. The term "solid waste" means any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923).

I.K.2. Hazardous constituents for purposes of this permit are those substances listed in Appendix IX of R.61-79.261.

I.K.3. A Solid Waste Management Unit for the purposes of this permit includes any unit which contains or has contained solid waste at any time, irrespective of whether the unit is or ever was intended for the management of solid waste.

I.K.4. A unit for the purposes of this permit includes, but is not limited to, any landfill, surface impoundment, waste pile, land treatment unit, incinerator, injection well, tank, container storage area, wastewater treatment unit, elementary neutralization unit, transfer station or recycling unit.

I.K.5. Release for purposes of this permit includes any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of any hazardous waste or hazardous constituents.

I.K.6. Contamination for purposes of this permit refers to the presence of any hazardous constituent in a concentration which exceeds the naturally occurring concentration of that constituent in the immediate vicinity of the facility (in areas not affected by the facility).

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I.X.7. Corrective action, for purposes of this permit, may include "corrective action" as provided in R.61-79.264.100 and/or other remedial activities for any media until otherwise defined in R.61-79.264.101.

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PART II - GENERAL FACILITY CONDITIONS

II.A. DESIGN AND OPERATION OF FACILITY

The Permittee shall maintain and operate the facility in accordance with the approved permit application and approved amendments thereto and in a manner to minimize the possibility of a fire, explosion, or any unplanned sudden or nonsudden release of hazardous waste constituents to air, soil, or surface water which could threaten human health or the environment.

II.B. REQUIRED NOTICE

II.B.1. The Permittee shall notify the Department in writing at least four weeks in advance of the date the Permittee expects to receive hazardous waste from a foreign source. Notice of subsequent shipments of the same waste from the same foreign source in the same calendar year is not required.

II.B.2. When the Permittee is to receive hazardous waste from an off-site source (except where the Permittee is also the generator), he must inform the generator in writing that he has the appropriate permits for, and will accept the waste the generator is shipping. The Permittee must keep a copy of this written notice as part of the operating record. (See Condition II.K.1).

II.C. GENERAL WASTE ANALYSIS

The Permittee shall follow the procedures described in the Waste Analysis Plan of the approved permit application as required under R.61-79.264.13 for the analysis of any hazardous waste or suspected hazardous waste as appropriate.

II.D. SECURITY

The Permittee shall comply with the security provisions of R.61-79.264.14(b) and (c).

II.E. GENERAL INSPECTION REQUIREMENTS

The Permittee shall follow the inspection schedule contained in the approved application. The Permittee shall remedy any deterioration or malfunction discovered by an inspection as required by R.61-79.264.15(c). Records of inspections shall be kept as required by R.61-79.264.15(d).

II.F. PERSONNEL TRAINING

The Permittee shall conduct personnel training as required by R.61-79.264.16. This training program shall follow the outline included in the approved application. The Permittee shall maintain training documents and records as required by R.61-79.264.16(d) and (e).

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II.G. GENERAL REQUIREMENTS FOR IGNITABLE, REACTIVE, OR INCOMPATIBLE WASTE

The Permittee shall comply with the requirements of R.61-79.264.17(a).

II.H. PREPAREDNESS AND PREVENTION

II.H.1. Required Equipment

At a minimum, the Permittee shall equip the facility with the equipment set forth in the Contingency Plan required by R.61-79.264.32 and contained in the approved application.

II.H.2. Testing and Maintenance of Equipment

The Permittee shall test and maintain the equipment specified in the previous permit condition as necessary to assure its proper operation in time of emergency.

II.H.3. Access to Communications or Alarm System

The Permittee shall maintain access to the communications or alarm system as required by R.61-79.264.34.

II.H.4. Required Aisle Space

At a minimum, the Permittee shall maintain aisle space as required by R.61-79.264.35. This includes a minimum of four (4) feet for primary aisles and three (3) feet for secondary aisles.

II.H.5. Arrangements with Local Authorities

The Permittee shall attempt to make or maintain, arrangements with local authorities as required by R.61-79.264.37. If local officials refuse to enter into preparedness and prevention arrangements with the Permittee, the Permittee must document this refusal in the operating record.

II.I. CONTINGENCY PLAN

II.I.1. Implementation of Plan

The Permittee shall immediately carry out the provisions of the Contingency Plan, contained in the approved application and follow the emergency procedures described by R.61-79.264.56 whenever there is a fire, explosion, or release of hazardous waste or constituents which threatens or could threaten health or the environment.

II.I.2. Copies of Plan

The Permittee shall comply with the requirements of R.61-79.264.53.

II.I.3. Amendments to Plan

The Permittee shall review and immediately amend, if necessary, the Contingency Plan, as required by R.61-79.264.54, subject to the requirement of R.61-79.270.41 and 270.42.

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II.I.4. Emergency Coordinator

The Permittee shall comply with the requirements of R.61-79.264.55, concerning the emergency coordinator.

II.J. MANIFEST SYSTEM

The Permittee shall comply with the manifest requirements of R.61-79.264.71, 264.72, and 264.76. or R.61-79.264.71(c).

II.K. RECORDKEEPING AND REPORTING

In addition to the recordkeeping and reporting requirements specified elsewhere in this permit the Permittee shall do the following:

II.K.1. Operating Record

II.K.1.a. The Permittee shall maintain a written operating record at the facility in accordance with R.61-79.264.73.

II.K.1.b. The Permittee shall certify annually that a program is being conducted to reduce the volume and toxicity of hazardous wastes generated at the facility to a degree that the Permittee determines is economically practicable. The program must be developed in a manner that minimizes present and future threats to human health and environment.

II.K.2. Quarterly Report

The Permittee shall comply with the quarterly report requirements of R.61-79.264.75.

II.L. CLOSURE

II.L.1. Performance Standard

The Permittee shall close the facility as required by R.61-79.264.111 and in accordance with the approved Closure Plan.

II.L.2. Amendment to Closure Plan

The Permittee shall amend the Closure Plan in accordance with R.61-79.264.112(b) whenever necessary.

II.L.3. Notification of Closure

The Permittee shall notify the Department at least 180 days prior to the date he expects to begin Closure of any hazardous waste management unit.

II.L.4. Time Allowed For Closure

After receiving the final volume of hazardous waste, the Permittee shall treat or remove from the site all hazardous waste in

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accordance with the schedule specified in the Closure Plan contained in the approved permit application. After receiving the final volume of hazardous waste, the Permittee shall complete closure activities in accordance with the schedule specified in the Closure Plan contained in the approved permit application.

II.L.5. Disposal or Decontamination of Equipment

The Permittee shall decontaminate and/or dispose of all facility equipment as required by R.61-79.264.114 and the Closure Plan contained in the approved permit application.

II.L.6. Certification of Closure

The Permittee shall certify that the facility has been closed in accordance with specifications in the Closure Plan as required by R.61-79.264.115.

II.M. POST CLOSURE

The Permittee shall monitor, maintain and perform post closure care of the facility as described in the post closure plan in the approved permit application and as required under R.61-79.264.117, 264.228, and 264.310.

PART III - STORAGE IN CONTAINERS

III.A. WASTE IDENTIFICATION

The Permittee may store only those hazardous waste identified in the approved permit application and in containers of the type, capacity, size and at locations shown in the approved permit application and subject to the terms of this permit.

III.B. CONDITION OF CONTAINERS

If a container holding hazardous waste is not in good condition (e.g., severe rusting, apparent structural defects) or if it begins to leak, the Permittee shall transfer the hazardous waste from such container to a container that is in good condition or otherwise manage the waste in compliance with the conditions of this permit.

III.C. COMPATIBILITY OF WASTE WITH CONTAINERS

The Permittee shall assure that the ability of the container to contain the waste is not impaired as required by R.61-79.264.172.

III.D. MANAGEMENT OF CONTAINERS

III.D.1. The Permittee shall manage containers as required by R.61-79.264.173.

III.D.2. The Permittee shall maintain a primary aisle space of four (4) feet and a secondary aisle space of three (3) feet to ensure for the proper inspection of containers and immediate access to any leaking containers.

III.E. CONTAINMENT

The Permittee shall construct and maintain the containment system in accordance with the requirements of R.61-79.264.175 and as specified in the plans and specification included in the approved permit application.

III.F. SPECIAL REQUIREMENTS FOR IGNITABLE OR REACTIVE WASTE

The Permittee shall not locate containers holding ignitable or reactive waste within fifteen (15) meters (50 feet) of the facility's property line.

III.G. SPECIAL REQUIREMENTS FOR INCOMPATIBLE WASTE

III.G.1. Prior to placing incompatible wastes or incompatible waste and materials in the same container, the Permittee shall comply with R.61-79.264.17(b) and procedures specified in the approved permit application.

III.G.2. The Permittee shall not place hazardous waste in an unwashed container that previously held an incompatible waste or material.

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III.G.3. The Permittee shall separate containers or incompatible waste as required by R.61-79.264.177(c) and indicated in the approved permit application.

III.G.4. The Permittee must document compliance with III.G.(1) and (2) as required by R.61-79.264.17(c) and place this documentation in the operating record (Condition II.K.1).

III.H. CLOSURE

The Permittee shall close the container storage areas in accordance with the closure plan contained in the approved permit application and R.61-79.112 and 264.178.

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PART IV - POST CLOSURE CARE REQUIREMENTS

IV.A. POST CLOSURE REQUIREMENT

The Permittee shall conduct corrective action, monitor and maintain the facility in accordance with the post closure plan described in the approved permit application, as required by R.61-79.264.228(b) and 264.117 through 264.120.

IV.B. GROUNDWATER REQUIREMENTS

IV.B.1. Well Location and Construction

The Permittee shall install and/or maintain a groundwater monitoring system to comply with the requirements of the R.61-79.264.95, 264.97 and 264.100 as specified below.

IV.B.1.a. The Permittee shall maintain groundwater monitoring wells MSB 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 6C, 7A, 7B, 7C, 8A, 8B, 8C, 9A, 9B, 9C, 10A, 10B, 10C, 11A, 11B, 11C, 11D, 11E, 11F, 12A, 12B, 12C, 12D, 12TA, 12TB, 13A, 13B, 13C, 14A, 14B, 14C, 15A, 15C, 17A, 17B, 17C, 18A, 18B, 18C, 20A, 20C, 21A, 21C, 21TA, 22, 29B, 29C, 29D, 36A, 36B, 36C, 36D, 36TA, 39A, 39B, 39C, 39D, 39TA, 40A, 40B, 40C, 40D, 40TA, 43A, 43B, 43D, 57A, 58A, 59A, 60A, 62A, 62B, 62C, 63A, 63B, 63C, 64A, 64B, 64C and other wells as shown on attachment B-1 and B-2 in the approved permit application.

IV.B.1.b. Groundwater monitoring wells MSB 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 6C, 7A, 7B, 7C, 8A, 8B, 8C, 13A, 13B, 13C, 57A, 58A, 59A, 60A, 62A, 62B, 62C, 63A, 63B, 63C, 64A, 64B, 64C shall define the point of compliance (POC) and will be the Compliance Point wells for the Hazardous Waste Management Facility. Groundwater monitoring well clusters MSB-29 and MSB-43 will be monitored as background/upgradient wells.

IV.B.1.c. All POC wells surrounding the overflow ditch, seep area and Lost Lake must be completed as three well clusters, screening the water table and both the upper and lower portions of the uppermost aquifer. These wells must be installed within four months of closure certification.

IV.B.1.d. The Permittee shall install additional wells as necessary to assess changes in the rate and extent of any plume of contamination or to assess the effectiveness of corrective action as required under R.61-79.264.100. A plan for the design, location and installation of any additional monitoring well(s) shall be submitted to the Department for approval ninety (90) days prior to installation.

IV.B.2. Groundwater Protection Standard

IV.B.2.a. The groundwater protection standard as required under R.61-79.264.92 shall consist of the table in Appendix A of this permit which lists

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the hazardous constituents and their respective concentration limits as required under R.61-79.264.93 and 264.94. Permittee may petition the Department for consideration of alternate concentration limits by providing the Department with the information specified in R.61-79.264.94(b) (1) and (2).

- IV.B.2.b. The groundwater protection standard as defined in IV.B.2.a. applies to all hazardous waste or hazardous constituent releases as deemed appropriate by the Department to protect public health and the environment.

IV.B.3. Compliance Period

The compliance period, during which the ground water protection standard applies, is equal to thirty (30) years. The compliance period shall begin at the time the Permittee begins the compliance monitoring program in conformance with Section 264.99. If the Permittee is conducting corrective action at the end of the compliance period specified immediately above, the compliance period shall be extended until the Permittee demonstrates that the Ground Water Protection Standard has not been exceeded for three consecutive years.

IV.B.4. Groundwater Monitoring Program

The Permittee shall establish and implement a groundwater monitoring program to demonstrate the effectiveness of the corrective action program required under R.61-79.264.100 and 264.101. Groundwater monitoring shall be conducted in conformance with requirements of R.61-79.264.100(d) and as specified below:

- IV.B.4.a. The Permittee shall collect, preserve and analyze all groundwater samples as required by Condition IV.B.6.
- IV.B.4.b. The Permittee shall continue the corrective action monitoring program as described in sections I and J in Volume III Book 1 of the approved permit application until compliance with the groundwater protection standard of IV.B.2 is reached as determined under R.61-79.264.100 and in accordance with IV.B.3 and IV.B.8.
- IV.B.4.c. The Permittee shall analyze samples taken from all monitoring wells in conjunction with the monitoring program described in Condition IV.B.4.b. for the parameters listed in Appendix A and additionally the following parameters:
- a. Copper
 - b. Nickel
 - c. Zinc

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- d. pH
- e. Specific Conductance
- f. Temperature
- g. Chloride
- h. Aluminum
- i. Sodium
- j. Nitrate
- k. Total Phosphate
- l. Sulfate
- m. Uranium

IV.B.4.d. Annually, the permittee shall collect samples from the point of compliance wells specified in Condition IV.B.1.b. to be analyzed for the Appendix IX constituents. If constituents from Appendix IX are found that were not identified as hazardous constituents in the permit application, the permittee shall report the concentrations of these constituents to the Department in writing within seven (7) days of completing the analysis. The Permittee shall also submit, within 90 days of receiving the analytical results, an application for a permit modification to incorporate the new constituents into the groundwater monitoring program.

IV.B.4.e. The Permittee shall determine the groundwater flow rate and direction in the uppermost aquifer at least annually.

IV.B.4.f. The groundwater monitoring program must include a determination of groundwater surface elevation each time the groundwater is sampled. A topographic map showing the groundwater elevation shall be included with the quarterly reporting of the groundwater monitoring data.

IV.B.4.g. Compliance with the groundwater protection standard as defined under condition IV.B.2. will be based upon groundwater monitoring data obtained under condition IV.B.4. that indicated that all constituents listed in Appendix A of this permit no longer exceed the groundwater protection standard at the point of compliance.

IV.B.5. Corrective Action Program

IV.B.5.a. The Permittee shall continue implementation of the corrective action program as required under R.61-79.264.100 and 264.101 and as described in Sections I and J, Volume III, Book 1 of the approved permit application for those hazardous constituents that exceed the groundwater protection standard specified in IV.B.2.a. of this permit.

IV.B.5.b. The Permittee shall ensure that the corrective action program described in Section J, Volume III, Book 1 of the approved permit

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application. Any measures taken to meet these conditions shall be reported in the quarterly report required by condition IV.B.7.b.

IV.B.5.c. Additional groundwater monitoring wells must be installed in downgradient areas east, southeast, south, southwest and west of the Hazardous Waste Management Facility to evaluate the effectiveness and suitability of the corrective action program and to identify areas where additional corrective action measures may be needed. A detailed plan and implementation schedule as specified by the Department must be submitted within five (5) months of permit issuance.

IV.B.5.d. The quarterly report on the effectiveness of corrective action shall contain the items described in sections J6 and J9 Volume III Book 1 in the approved permit application and shall also include a statistical evaluation of the groundwater quality data. The Permittee must include a description of statistical procedures to be used in the first quarterly report.

IV.B.5.e. The Permittee should treat, store and/or dispose of all contaminated groundwater in accordance with all applicable, federal, state and local laws.

IV.B.6. Sampling and Analysis Procedures

As required under R.61-79.264.97(d) and (e) the Permittee shall use the following techniques and procedures when obtaining samples and analyzing samples from the groundwater monitoring wells described in condition IV.B.1.

IV.B.6.a. Samples shall be collected, preserved, and shipped (when shipped off-site for analysis) in accordance with the procedures specified in Volume III Appendix E (Sampling and Analytical Procedures) in the approved permit application.

IV.B.6.b. Samples shall be analyzed according to the procedures specified in Volume III Appendix E (Sampling and Analytical Procedures) with minimum detection limits at 5 parts per billion for the Volatile Organic Compounds (VOC) as specified in Volume III Book 1 page I-3 in the approved permit application or in the current EPA Manual SW-846 using whichever procedure is more recent at the time of analysis.

IV.B.6.c. Samples shall be tracked and controlled using the chain of custody procedures specified in Volume III Appendix E (Sampling and Analytical Procedures) in the approved permit application.

IV.B.6.d. Whenever the Permittee changes laboratories, the permittee shall submit to the Department within 30 days of such change a copy of the new Laboratory QA/QC Program. The Department will evaluate the new QA/QC program and determine if it differs significantly from the QA/QC program in the approved application. If the program differs

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significantly the Department will notify the permittee and require that he submit a permit modification pursuant to R.61-79.270.41. If the new program does not differ significantly a permit modification will not be required.

IV.B.7. Reporting Recordkeeping and Response

IV.B.7.a. The Permittee shall enter all monitoring, testing and analytical data obtained pursuant to conditions IV.B.4 and IV.B.5. in the operating record as required by R.61-79.264.73(b)(6).

IV.B.7.b. The Permittee shall submit a report to the Department on the effectiveness of the corrective action program on a quarterly basis as required by R.61-79.264.100(g) to include all monitoring, testing and analytical data obtained under conditions IV.B.6. and IV.B.5.

IV.B.8. Permit Modification

IV.B.8.a. If the Permittee at any time determines that the corrective action program no longer satisfies the requirements of R.61-79.264.100, 264.101, or condition IV.B.5. for releases of hazardous constituents that originate from regulated units or solid waste management units, he must within 90 days, submit an application for a permit modification to make any appropriate changes in the program, as required under R.61-79.264.100(h).

IV.B.8.b. If the Permittee meets or exceeds the requirements of R.61-79.264.100 and 264.101 and meets the groundwater protection standard at the point of compliance for three (3) consecutive years the permittee may submit an application for a permit modification pursuant to R.61-79.270.41 to terminate corrective action and establish an alternate groundwater monitoring program as described in IV.B.4.b.

IV.B.9. Duty of Permittee

The Permittee shall assure that groundwater monitoring and corrective action measures to achieve compliance with R.61-79.264.100 and 264.101 and the groundwater protection standard are taken during the compliance period.

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Part V - SOLID WASTE MANAGEMENT UNITS

V.A. APPLICABILITY

- V.A.1. The Conditions of Part V.C. of this permit apply to the solid waste management units listed below as indentified in the RCRA Facility Assessment (RFA) report, which is attached hereto and incorporated herein as Appendix B of this permit.

SITE NAMES	BUILDING NUMBER
CMP PITS	080-17G
CMP PITS	080-17,1G
CMP PITS	080-18G
CMP PITS	080-18.1G
CMP PITS	080-18.2G
CMP PITS	080-18.3G
CMP PITS	080-19G
C-AREA BURNING/RUBBLE PIT	131-C
K-AREA BURNING/RUBBLE PIT	131-K
P-AREA BURNING/RUBBLE PIT	131-P
F-AREA BURNING/RUBBLE PIT	231-F
F-AREA BURNING/RUBBLE PIT	231-1F
A-AREA BURNING/RUBBLE PIT	731-A
A-AREA BURNING/RUBBLE PIT	731-1A
SILVERTON ROAD WASTE SITE	731-3A
SANITARY LANDFILL	740-G
H-AREA SEEPAGE BASIN	904-46G
TNX SEEPAGE BASIN (OLD)	904-76G
L-AREA OIL AND CHEMICAL BASIN	904-83G
C-AREA COAL PILE RUNOFF BASIN	189-C
F-AREA COAL PILE RUNOFF BASIN	289-F
A-AREA COAL PILE RUNOFF BASIN	788-3A
D-AREA ASH BASIN	488-D
716-A MOTOR SHOP SEEPAGE BASIN	904-101G
ROAD A CHEMICAL BASIN	904-111G
GUNSITE 720 RUBBLE PIT	---
SRL OIL TEST SITE	080-16G
L-AREA BURNING/RUBBLE PIT	131-L
L-AREA RUBBLE PIT	131-1L
R-AREA BURNING/RUBBLE PIT	131-R
R-AREA BURNING/RUBBLE PIT	131-1R
K-AREA COAL PILE RUNOFF BASIN	189-K
P-AREA COAL PILE RUNOFF BASIN	189-P
F-AREA RUBBLE PIT	231-2F
BURMA ROAD RUBBLE PIT	231-4F
H-AREA COAL PILE RUNOFF BASIN	289-H
D-AREA BURNING/RUBBLE PIT	431-D
D-AREA BURNING/RUBBLE PIT	431-1D
D-AREA COAL PILE RUNOFF BASIN	489-D
D-AREA OIL SEEPAGE BASIN	631-G
CS BURNING/RUBBLE PIT	631-1G
CS RUBBLE PIT	631-3G
CS BURNING/RUBBLE PIT	631-5G
CS BURNING/RUBBLE PIT	631-6G
OLD RW BURIAL GROUND	643-G
PRESENT RW BURIAL GROUND	643-7G
A-AREA RUBBLE PIT	731-2A

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MISC. CHEMICAL PIT	731-5A
F-AREA SEEPAGE BASIN (OLD)	904-49G
SRL SEEPAGE BASIN	904-53G1
SRL SEEPAGE BASIN	904-53G2
SRL SEEPAGE BASIN	904-54G
SRL SEEPAGE BASIN	904-55G
F-AREA ACID/CAUSTIC BASIN	904-74G
H-AREA ACID/CAUSTIC BASIN	904-75G
R-AREA ACID/CAUSTIC BASIN	904-77G
P-AREA ACID/CAUSTIC BASIN	904-78G
L-AREA ACID/CAUSTIC BASIN	904-79G
K-AREA ACID/CAUSTIC BASIN	904-80G
L-AREA RUBBLE PIT	131-3L
METALS BURNING PIT	731-4A
A-AREA MISC RUBBLE PIT	731-6A
NEW TNX SEEPAGE BASIN	904-102G
FORD BUILDING SEEPAGE BASIN	904-91G
HIGH LEVEL WASTE TANK 16	241-B

V.A.2. The Condition of Part V.C. also apply to any and all additional units identified pursuant to Condition V.A.3 and V.B.1.

V.A.3. The Permittee will continue to assess the contamination in the Black Creek Aquifer and Well Cluster MSB-37 and in the uppermost aquifer upgradient of the H-Area Hazardous Waste Management Facility and identify the source(s) of the contamination.

V.B. RCRA Facility Assessment (RFA)

V.B.1. The Permittee shall notify the Department in writing of any units not listed in Condition V.A.1 that are determined to have a known release of a high potential for a release. This notice shall be submitted within 15 days of making such a determination.

V.B.2. The Permittee shall at least annually update the document entitled Waste Management Units: Savannah River Plant, February , 1987. Each update must include any new information, including recategorization of units already addressed in the document, and all pertinent information on additional waste management units discovered to exist or newly constructed during the year. The first annual update shall also include photographs of all units listed in Table A and B of the document.

V.C. RCRA Facility Investigation (RFI) Plan

V.C.1.1. The Permittee shall prepare a RFI Program Plan for investigating all SWMUs identified in Condition V.A.1. The RFI Program Plan shall specify all operating procedures that are standard to all SWMUs (i.e., drilling specifications, etc.), shall prioritize the SWMUs for investigation, and shall propose the schedule for submitting the RFI plan specific to each SWMU as required by Condition II.A.1.ii.

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V.C.1.ii. The Permittee shall prepare a RCRA facility investigation (RFI) plan for each unit identified in Condition II.A.1. which includes schedules of implementation and completion of specific actions necessary to determine the nature and extent of releases and the potential pathways of contaminant releases to the air, land, surface water, and groundwater. The Permittee must provide documentation that a release is not probable if no further investigation is proposed for a unit listed in Condition II.A.1.

V.C.2. The Permittee shall prepare an RFI plan for those units identified under Condition V.A.2. which includes schedules of implementation and completion of specific actions necessary to determine the nature and extent of releases and the potential pathways of contaminant releases to the air, land, surface water, and groundwater.

V.C.3. The Permittee shall utilize Appendix B as guidance in preparation of the RCRA Facility Investigation Plans (RFIs). The RFIs shall be conducted in accordance with the approved RFI Plans.

V.D. RCRA Facility Investigation Reporting Requirements

V.D.1. Progress Reports

If the time required to complete the RFI is greater than one year, the permittee shall provide the Department with signed, interim progress reports containing:

- a. A description of the portion of the RFI completed;
- b. Summaries of findings;
- c. Summaries of all changes made in the RFI during the reporting period;
- d. Summaries of all problems or potential problems encountered during the reporting period;
- e. Projected work for the next reporting period; and
- f. Copies of inspection reports, laboratory/monitoring data, etc.

V.D.2. Imminent Hazard Report

The Permittee shall report any imminent or existing hazard to public health or the environment from the present or past release of hazardous constituents to the Department in accordance with condition I.F.14.

V.D.3. RFI Report

The Permittee shall prepare a RCRA Facility Investigation Report. The RCRA Facility Investigation Report shall be developed in draft form for U.S. EPA review. The RCRA Facility Investigation Report

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shall be developed in final format within thirty (30) days of receipt of EPA comments on the Draft RCRA Facility Investigation Report. The RFI Report shall include an analysis and summary of all facility investigations of solid waste management units and their results. The summary shall include a report on the type and extent of contamination at the facility, including sources and migration pathways, and a description of actual or potential receptors. The report shall also describe the extent of contamination (qualitative/quantitative) in relation to background levels indicative for the area. The objective of this task shall be to ensure that the investigation data is sufficient in quality (e.g. quality assurance procedures have been followed) and quantity to describe the nature and extent of contamination, potential threat to human health and/or the environment, and to support a Corrective Action Study, if necessary.

All reports must be signed and certified in accordance with 40 CFR 270.11.

Three (3) copies of all reports shall be provided by the Permittee to U.S. EPA at the following address:

Mr. James H. Scarbrough, P.E., Chief	Environmental Protection
Residuals Management Branch	Agency Region IV,
Waste Management Division	345 Courtland Street, N.E.
	Atlanta, Georgia 30365

V.E. Corrective Action Plans

- V.E.1.** The Department shall review the final reports on the remedial investigations conducted under Condition V.D. and notify the Permittee of the need for further investigative actions and/or the need for corrective action as required under R.61-79.264.101 (a). The Department shall specify the time frame for the submittal of the corrective action plans upon notification.
- V.E.2.** Upon determination that corrective action is needed, the Permittee shall submit a corrective action plan within the time frame as set under Condition V.E.1. to the Department. The proposed corrective action plan must include a description of the corrective measures to be taken at each unit, a schedule of implementation and completion, and a cost estimate for completion of corrective action.
- V.E.3.** If the Permittee at any time determines that the solid waste management unit remedial investigations or corrective action plans required under Conditions V.C. or V.E. no longer satisfy the requirements of R.61-79.264.101 or this permit for prior or continuing releases of hazardous waste or hazardous constituents from solid waste management units, he must submit an amended plan(s) to the Department within ninety (90) days of such determination.

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V.F. Schedules of Compliance

- V.F.1. All plans and schedules shall be subject to the approval of the Department prior to implementation. The permittee shall prepare the plans as required in this permit and submit them for the Department's review. If needed, the Permittee will be provided comments that require revisions to the plans and schedules; with a resubmittal required. Upon completion of the necessary revisions, the Department will approve the documents for implementation.
- V.F.2.1. The Permittee shall submit the plan required by Condition II.C.1.1. and the associated documentation to the Department within one hundred eighty (180) days of the effective date of this permit.
- V.F.2.1i. The Permittee shall submit the RFI plan for each solid waste management unit in accordance with the schedule in the approved RFI Program Plan developed under Condition II.C.1.1.
- V.F.3. The Permittee shall submit the annual assessment updates required under Condition V.B.2. to the Department on or before each anniversary date of this permit.
- V.F.4. The Permittee shall submit the RFI Plan(s) required under Condition V.C.2 within ninety (90) days after the notification required under Condition V.B.1.
- V.F.5. If the time required to complete any activity or interim activity required by this permit is more than one year, the schedule shall specify interim dates for the submission of reports of progress toward satisfaction of the interim requirements as required by Condition V.D.1.
- V.F.6. The results of all plans and reports shall be submitted in accordance with the approved schedule. Extensions of the due date for submittals may be granted by the Department based on the Permittee's demonstration that sufficient justification for the extension exists.

V.G. Permit Modifications

If required to develop a corrective action plan under V.E., the Permittee shall apply for a permit modification pursuant to R.61-79. 270.41 to incorporate the plan into the permit.

V.H. Interim Measures

- V.H.1. The Permittee may conduct interim measures to contain, remove or treat contamination resulting from the release of hazardous constituents from a Solid Waste Management Unit in order to protect human health and the environment upon approval by the Department. Such interim measures may be conducted concurrently with investigations required under the terms of this permit.

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PART VI - WASTE MINIMIZATION

The following condition is pursuant to R.61-79.264.73(b)(9):

WASTE MINIMIZATION CERTIFICATION

The Permittee shall be required to certify, no less often than annually, that he has a program in place to reduce the volume and toxicity of hazardous waste that he generates to the degree determined by the permittee to be economically practicable and the proposed method of treatment, storage or disposal is that practicable method currently available to the Permittee which minimizes the present and future threat to human health and the environment.

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- V.H.2. The Permittee shall submit to the Department a description and a schedule of implementation of any proposed interim measures for approval prior to implementation.
- V.H.3. The Permittee shall include information on all plans and schedules for interim measures in reports required under Condition V.D. For interim measures conducted during the term of this permit this shall include:
- a. A description of measures implemented;
 - b. Summaries of results;
 - c. Summaries of all problems encountered during the reporting period;
 - d. Summaries of accomplishments and/or effectiveness of interim measures to date; and
 - e. Copies of all relevant reports, inspection records, laboratory/monitoring data, etc. in accordance with Condition I.P.9.
- V.H.4. The Permittee shall give notice to the Department as soon as possible of any planned changes, reduction or additions to the interim measures.
- V.H.5. Interim measures implemented for releases of hazardous constituents shall be reviewed in accordance with condition V.E. and included as part of the corrective action plan required under 264.101 as appropriate. Final approval of the interim measures shall be in accordance with Condition V.G. as a permit modification in pursuant to 270.41.

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**APPENDIX A
GROUNDWATER PROTECTION STANDARD**

Hazardous Constituents	Concentration Limits (mg/l)
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I. EPA Interim Primary Drinking Water Standards:

Arsenic	0.05 mg/l
Barium	1.0 mg/l
Cadmium	0.01 mg/l
Chromium	0.05 mg/l
Cyanide	0.2 mg/l
Lead	0.05 mg/l
Mercury	0.002 mg/l
Selenium	0.01 mg/l
Silver	0.05 mg/l

II. Appendix VIII of R.61-79.261 Constituents:

1,1-Dichloroethylene	0.007 mg/l
1,1,1-Trichloroethane	0.2 mg/l
Trichloroethylene	0.005 mg/l
Tetrachloroethylene	MDL
Trans-1,2 -Dichloroethylene	MDL

- MDL shall be defined as the Method Detection Level for the constituent list using the analytical method required under condition IV.B.6. for the specific sample analyzed.

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APPENDIX B

RCRA Facility Assessment (RFA) Report

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RCRA Facility Assessment Report
U. S. Department of Energy
Savannah River Plant - SCI 890 008 989

Introduction

The Savannah River Plant (SRP) is a large government reservation owned and operated by the U. S. Department of Energy with the assistance of numerous contractors and subcontractors. The primary mission of this plant is to produce nuclear materials for national defense purposes. In fulfilling this mission, a number of industrial operations are carried out which produce the desired products along with a wide variety of wastes. The purpose of this report is to inventory all waste management units at SRP and to determine what further actions are needed under RCRA to identify units which have a release of hazardous wastes or hazardous waste constituents (as defined in 40 CFR §261) to the environment. The Department of Energy (DOE) will be required to further assess all known releases from solid waste management units and releases discovered in the future to determine corrective action needs. Under the authority of 3004(u) of RCRA, DOE will be required to develop and implement corrective action plans where deemed necessary.

The information presented in this report was gathered through various means including file reviews, a 3007 information request to DOE, an RFA site visit to the plant (May 11-13, 1987), and knowledge of the plant from several previous site visits. Further information on specific units identified in this report is available in DOE's response to the 3007 information request (Waste Management - Savannah River Plant, February, 1987).

Regulated Units

"Regulated unit" for purposes of this report refers to any hazardous waste management unit subject to the permitting requirements as specified in 40 CFR §270.1. Active hazardous waste treatment, storage, and disposal facilities and inactive land disposal units that have received hazardous waste since November 19, 1980, and have not been formally closed under RCRA prior to January 26, 1983, are regulated units. The universe of regulated units at the Savannah River Plant includes "radioactive mixed waste" units since the RCRA regulations do not differentiate, these wastes from other hazardous waste.¹ Appendix I of this report is a list of the regulated units at the Savannah River Plant.

1. Note that there are wastes, however, that are completely exempt from RCRA as they receive only "byproduct material". See attached Table D.

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there has been no known release to the environment. This table is further broken down into categories.

The waste disposal sites in this table are not known to have releases to the environment. The Environmental Protection Agency, however, considers waste disposal units to have a high potential for release to the groundwater. It is therefore, recommended that DOE be required to submit results of past remedial investigations and, where appropriate, plans for further investigation to verify that there have been no releases to groundwater. Units for which releases are discovered should be included in corrective action plans or shown not to merit corrective action as with the Table A units. The Mixed Waste Management Facility is a regulated hazardous waste unit which need not be addressed in these plans. Reference the previous discussion on regulated units.

No releases have been identified from the remaining units on the Table B list. Past or continuing releases to the environment from these units are considered unlikely for the following reasons:

- All storage buildings, the mixed waste storage tank, and the M-Area process waste interim storage facility are regulated units which will be adequately controlled under the state RCRA permit.
- The SRL Low Level Rad Tanks are the only below grade tanks on Table B. Although the tanks themselves could not be inspected, the control room and tank farm area was inspected. Piping and instrumentation diagrams in the control room indicate that each tank is equipped with level alarms and bypasses to prevent overfilling. These tanks have secondary containment with collection sumps and leak detection systems so that no leak would go undetected or be released to the environment.
- The M-Area Liquid Effluent Treatment Facility is less than 1 year old. A consent agreement between SC DHEC and DOE addresses sludge and used filter paper that is being stored outside of the facility in violation of RCRA. No releases were evident through visual inspection.
- The Demineralization Neutralization systems are above ground tanks that are directly connected to the regeneration units. These tanks do not receive any hazardous constituents, but may receive corrosive characteristic hazardous waste. The pH is adjusted to a range of 6 to 9 prior to discharge to an NPDES permitted outfall. Visual inspection of the P-Area neutralization system revealed that the tank is on a concrete pad and appeared to be well maintained with no signs of leaks, etc.

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Units that have not Received Hazardous Waste or Constituents

The units in Table C are reported by DOE not to have received hazardous wastes or hazardous constituents and therefore have no potential for release of such waste or constituents to the environment. There are several units, however, that are considered suspect of having received hazardous waste or constituents. It is recommended that these units be included in the RFI plan required by the federal permit. Further investigation in the form of sampling and analysis is needed to verify that these units are properly classified.

The units in question and recommended analytical parameters are:

<u>Unit</u>	<u>Parameter(s)</u>
Earthen Basin Adj. to 108-3C	Organics
Earthen Basin Adj. to 108-3K	Organics
Earthen Basin Adj. to 108-3L	Organics
Coal Pile Runoff Basins:	pH, Metals
C-Area (198-C)	(Sample influent
F-Area (289-F)	streams if possible)
A -Area (788-3A)	
D-Area Ash Basin (488-D)	pH, Metals
Gunsite 720 Rubble Pit	Organics, Metals

There are two additional units recommended for investigation that DOE's 3007 response had listed as having received no hazardous waste or constituents. These units are recommended for investigation because DOE's recent draft EIS on waste management had them identified as hazardous. The units are:

<u>Unit</u>	<u>Bldg. Number</u>
716-A Motor Shop Seepage Basin	904-101G
Road A Chemical Basin	904-111G

Byproduct Material Waste Management Units

Table D is a listing of waste management units which have been considered to receive only "byproduct material" which is exempt from the definition of solid waste in section 1004 of RCRA. DOE recently (52 FR 15937, May 1, 1987) published a final rule that interprets the AEA definition of byproduct material. As of June 1, many of the units listed in Table D will no longer be exempt pursuant to this interpretation. It is recommended that a 3007 letter be written to DOE requiring them to re-evaluate the units listed in Table D and recategorize them as appropriate.

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APPENDIX II

TABLE A

**SOLID WASTE DISPOSAL UNITS HAVING RECEIVED HAZARDOUS WASTE OR HAZARDOUS
CONSTITUENTS WITH A KNOWN RELEASE TO THE GROUND WATER**

SITE NAMES	BUILDING NUMBER
<hr/>	
CMP PITS	080-17G
CMP PITS	080-17.1G
CMP PITS	080-18G
CMP PITS	080-18, 1G
CMP PITS	080-18, 2G
CMP PITS	080-18, 3G
CMP PITS	080-19G
C-AREA BURNING/RUBBLE PIT	131-C
K-AREA BURNING/RUBBLE PIT	131-K
P-AREA BURNING/RUBBLE PIT	131-P
F-AREA BURNING/RUBBLE PIT	231-F
F-AREA BURNING/RUBBLE PIT	231-1F
A-AREA BURNING/RUBBLE PIT	731-A
A-AREA BURNING/RUBBLE PIT	731-1A
SILVERTON ROAD WASTE SITE	731-3A
SANITARY LANDFILL	740-G
F-AREA SEEPAGE BASIN	904-41G
F-AREA SEEPAGE BASIN	904-42G
F-AREA SEEPAGE BASIN	904-43G
H-AREA SEEPAGE BASIN	904-44G
H-AREA SEEPAGE BASIN	904-45G
H-AREA SEEPAGE BASIN	904-46G
M-AREA SEEPAGE BASIN	904-51G
H-AREA SEEPAGE BASIN	904-56G
TNX SEEPAGE BASIN (OLD)	904-76G
723-A MET LAB BASIN	904-110G
LOST LAKE	904-112G
L-AREA OIL AND CHEMICAL BASIN	904-83G

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TABLE B

SOLID WASTE DISPOSAL UNITS HAVING RECEIVED HAZARDOUS WASTE OR HAZARDOUS
CONSTITUENTS WITH NO KNOWN RELEASE TO THE ENVIRONMENT

SITE NAMES	BUILDING NUMBER
<hr/>	
SRL OIL TEST SITE	080-16G
L-AREA BURNING/RUBBLE PIT	131-L
L-AREA RUBBLE PIT	131-1L
R-AREA BURNING/RUBBLE PIT	131-R
R-AREA BURNING/RUBBLE PIT	131-1R
K-AREA COAL PILE RUNOFF BASIN	189-K
P-AREA COAL PILE RUNOFF BASIN	189-P
F-AREA RUBBLE PIT	231-2F
BURMA ROAD RUBBLE PIT	231-4F
H-AREA COAL PILE RUNOFF BASIN	289-H
D-AREA BURNING/RUBBLE PIT	431-D
D-AREA BURNING/RUBBLE PIT	431-1D
D-AREA COAL PILE RUNOFF BASIN	489-D
D-AREA OIL SEEPAGE BASIN	631-G
CS BURNING/RUBBLE PIT	631-1G
CS RUBBLE PIT	631-3G
CS BURNING/RUBBLE PIT	631-5G
CS BURNING/RUBBLE PIT	631-6G
OLD RW BURIAL GROUND	643-G
MW MANAGEMENT FACILITY	643-28G
A-AREA RUBBLE PIT	731-2A
MISC. CHEMICAL BASIN	731-5A
F-AREA SEEPAGE BASIN (OLD)	904-49G
SRL SEEPAGE BASIN	904-53G1
SRL SEEPAGE BASIN	904-53G2
SRL SEEPAGE BASIN	904-54G
SRL SEEPAGE BASIN	904-55G
F-AREA ACID/CAUSTIC BASINS	904-74G
H-AREA ACID/CAUSTIC BASINS	904-75G
R-AREA ACID/CAUSTIC BASINS	904-77G
P-AREA ACID/CAUSTIC BASINS	904-78G
L-AREA ACID/CAUSTIC BASINS	904-79G
K-AREA ACID/CAUSTIC BASINS	904-80G
L-AREA RUBBLE PIT	131-3L
METALS BURNING PIT	731-4A
A-AREA MISC RUBBLE PIT	731-6A
NEW TNX SEEPAGE BASIN	904-102G

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TABLE B (Cont.)

SOLID WASTE TREATMENT UNITS HAVING RECEIVED HAZARDOUS WASTE OR HAZARDOUS
CONSTITUENTS WITH NO KNOWN RELEASE TO THE ENVIRONMENT

SITE NAMES	BUILDING NUMBER
M-AREA LIQUID EFFLUENT TREATMENT FACILITY	341-M
F-AREA DEMINERALIZER NEUTRALIZATION SYSTEM	
H-AREA DEMINERALIZER NEUTRALIZATION SYSTEM	
P-AREA DEMINERALIZER NEUTRALIZATION SYSTEM	
K-AREA DEMINERALIZER NEUTRALIZATION SYSTEM	
C-AREA DEMINERALIZER NEUTRALIZATION SYSTEM	
D-AREA DEMINERALIZER NEUTRALIZATION SYSTEM	

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TABLE B (Cont.)

**SOLID WASTE SATELLITE/STAGING AREAS UNITS HAVING RECEIVED HAZARDOUS WASTE OR
HAZARDOUS CONSTITUENTS WITH NO KNOWN RELEASE TO THE ENVIRONMENT**

SITE NAMES	BUILDING NUMBER
100-AREA	108-2C 108-1K 108-3K 108-2L 108-1P 184-K 184-P
200-AREA	232-H 254-5P 254-5H
300-AREA	284-H 313-M 320-M 321-M
400-AREA	484-D
TNX-AREA	1G, 3G, 6G
600-AREA	679-T
700-AREA	679-T 704-U 735-A 735-7G
CS-AREA	773-A 619-G 710-G 711-A 716-A 745-A 789-A
600-G AREA	CS 617-G 661-G 703-6B 703-6G 707 TCL
NAVAL FUELS WACKENHUT SERVICES	247-P TC & U AREA

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TABLE C (Cont.)

SOLID WASTE DISPOSAL UNITS HAVING RECEIVED NO HAZARDOUS WASTE OR
HAZARDOUS CONSTITUENTS

SITE NAMES	BUILDING NUMBER
FORD BUILDING WASTE SITE	634-11G
40-ACRE HARDWOOD SITE	761-G
LOWER KATO ROAD SITE	761-1G
ORANGEBURG SITE	761-2G
LUCY SITE	761-3G
K-AREA BORROW PIT	761-4G
PAR POND BORROW PIT	761-5G
KATO ROAD SITE	761-6G
ROAD F SITE	761-7G
SECOND PAR POND SITE	761-8G
SREL RUBBLE PILE	761-9G
SREL RUBBLE PILE	NBN
A-AREA ASH PILE	788-A
A-AREA ASH PILE	788-2A
A-AREA COAL PILE RUNOFF BASIN	788-3A
716-A MOTOR SHOP SEEPAGE BASIN	904-101G
ROAD A CHEMICAL BASIN	904-111G
FIRE DEPT HOSE TRAINING FAC	904-113G
RUBBLE PILE @ CEMETERY ROAD	NBN
RUBBLE PILE @ B/W CEMETERY & BRAG	NBN
RUBBLE PILE @ ROAD 781.1	NBN
RUBBLE PILE @ BRAG BAY ROAD	NBN
GUNSITE 720 RUBBLE PIT	NBN
RISHER ROAD OPEN METAL PIT	NBN
SCRAP METAL PILE	NBN
SRFS RUBBLE PILE	NBN

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TABLE C (Cont.)

OTHER SOLID WASTE MANAGEMENT UNITS HAVING RECEIVED
NO HAZARDOUS WASTE OR HAZARDOUS CONSTITUENTS

SITE NAMES	BUILDING NUMBER
DWPF CONCRETE BATCH PLANT LAGOON	None

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TABLE D (Cont.)

WASTE TREATMENT AND STORAGE UNITS HAVING RECEIVED SOURCE, SPECIAL
NUCLEAR, OR BYPRODUCT MATERIAL ONLY

SITE NAMES	BUILDING NUMBER
TANKS WMT-074 - WMT-082 (EXCLUDING T-080)	643-7G
TANKS WMT-052 - WMT-073	643-G
WMO HIGH LEVEL RAD TANKS	241-F
WMO HIGH LEVEL RAD TANKS	241-H
BETA-GAMMA INCINERATOR	230-H

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APPENDIX C

RCRA Facility Investigation (RFI) Workplan Guidance

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RCRA FACILITY INVESTIGATION (RFI) PLANS

I. RFI WORKPLAN REQUIREMENTS

The Permittee shall prepare a RCRA Facility Investigation (RFI) workplan that meets the requirements of Part II of this document. This Attachment is provided as guidance for the development of the RFI workplan.

A. Project Management Plan

The Permittee shall prepare a Project Management Plan which will include a discussion of the technical approach, schedules, and personnel. The Project Management Plan will also include a description of qualifications of personnel performing or directing the RFI, including contractor personnel. This plan shall also document the overall management approach to the RCRA Facility Investigation.

B. Sampling and Analysis Plan

The Permittee shall prepare a plan to document all monitoring procedures: sampling, field measures and sample analysis performed during the investigation to characterize the environmental setting, source, and releases of hazardous constituents, so as to ensure that all information and data are valid and properly documented.

1. Sampling/Field Measurements

The sampling section of the Sampling and Analysis Plan shall be in accordance with Characterization of Hazardous Waste Sites A Methods Manual: Volume II. Available Sampling Methods, EPA-600/4-83-040, and at a minimum discuss:

- a. Selecting appropriate sampling locations, depths, etc.;
- b. Obtaining all necessary ancillary data;
- c. Determining conditions under which sampling should be conducted;
- e. Determining which media are to be sampled (e.g., groundwater, air, soil, sediment, etc.);
- f. Determining which parameters are to be measured and where;
- g. Selecting the frequency of sampling and length of sampling period;
- h. Selecting the types of samples (e.g., composites vs. grabs) and number of samples to be collected.
- i. Documenting field sampling operations and procedures, including:
 - i) Documentation of procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., filters, preservatives, and absorbing reagents);

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- ii) Procedures and forms for recording the exact location and specific considerations associated with sample acquisition;
- iii) Documentation of specific sample preservation method;
- iv) Calibration of field instruments;
- v) Submission of field-biased blanks, where appropriate;
- vi) Potential interferences present at the facility;
- iii) Construction materials and techniques, associated with monitoring wells and piezometers;
- ix) Field equipment listing and sampling containers;
- x) Sampling order; and
- xi) Decontamination procedures.

J. Selecting appropriate sample containers;

K. Sampling preservation; and

1. Chain-of-custody, including:

- i) Standardized field tracking reporting forms to establish sample custody in the field prior to shipment; and
- ii) Pre-prepared sample labels containing all information necessary for effective sample tracking.

2. Sample Analysis

Sample Analysis shall be conducted in accordance with SW-846:
"Test Methods for Evaluating Solid Waste - Physical/Chemical Methods"

The sample analysis section of the Sampling and Analysis Plan shall specify the following:

a. Chain-of-custody procedures, including:

- i) Identification of a responsible party to act as sampling custodian at the laboratory facility authorized to sign for incoming field samples, obtain documents of shipment, and verify the data entered onto the sample custody records;
- ii) Provision for a laboratory sample custody log consisting of serially numbered standard lab-tracking report sheets; and
- iii) Specification of laboratory sample custody procedures for sample handling, storage, and dispersment for analysis.

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- b. Sample storage;
- c. Sample preparation methods;
- d. Analytical procedures, including:
 - i) Scope and application of the procedure;
 - ii) Sample matrix;
 - iii) Potential interferences;
 - iv) Precision and accuracy of the methodology; and
 - v) Method detection limits.
- e. Calibration procedures and frequency;
- f. Data reduction, validation and reporting;
- g. Internal quality control checks, laboratory performance and systems audits and frequency, including:
 - i) Method blank(s);
 - ii) Laboratory control sample(s);
 - iii) Calibration check samples(s);
 - iv) Replicate sample(s);
 - v) Matrix-spiked sample(s);
 - vii) Control charts;
 - viii) Surrogate samples;
 - ix) Zero and span gases; and
 - x) Reagent quality control checks.
- h. Preventive maintenance procedures and schedules;
- i. Corrective action (for laboratory problems); and
- j. Turnaround time.

C. Data Management Plan

The Permittee shall develop and initiate a Data Management Plan to document and track investigation data and results. This plan shall identify and

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set up data documentation materials and procedures, project file requirements, and project-related progress reporting procedures and documents. The plan shall also provide the format to be used to present the raw data and conclusions of the investigation.

1. Data Record

The data record shall include the following:

- a. Unique sample or field measurement code;
- b. Sampling or field measurement location and sample or measurement type;
- c. Sampling or field measurement raw data;
- d. Laboratory analysis ID number;
- e. Property or component measured; and
- f. Result of analysis (e.g. concentration).

2. Tabular Displays

The following data shall be presented in tabular displays:

- a. Unsorted (raw) data;
- b. Results for each medium, or for each constituent monitored;
- c. Data reduction for statistical analysis, as appropriate;
- d. Sorting of data by potential stratification factors (e. g., location, soil layer, topography); and
- e. Summary data

3. Graphical Displays

The following data shall be presented in graphical formats (e. g., bar graphs, line graphs, area or plan maps, isopleth plots, cross-sectional plots or transects, three dimensional graphs, etc.):

- a. Display sampling location and sampling grid;
- b. Indicate boundaries of sampling area, and area where more data are required;
- c. Display geographical extent of contamination;

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- d. Illustrate changes in concentration in relation to distances from the source, time, depth or other parameters; and
- e. Indicate features affecting intramedia transport and show potential receptors.

II. RCRA Facility Investigation (RFI) Requirements

RCRA Facility Investigation:

The Permittee shall conduct those investigations necessary to: characterize the facility (Environmental Setting); define the source (Source Characterization); define the degree and extent of release of hazardous constituents (Contamination Characterization); and identify actual or potential receptors.

The investigations should result in data of adequate technical content and quality to support the development and evaluation of the corrective action plan if necessary. The information contained in a RCRA Part B permit application and/or RCRA Section 3019 Exposure Information Report may be referenced as appropriate.

All sampling and analyses shall be conducted in accordance with the Sampling and Analysis Plan. All sampling locations shall be documented in a log and identified on a detailed site map.

A. Environmental Setting

The Permittee shall collect information to supplement and/or verify Part B information on the environmental setting at the facility. The Permittee shall characterize the following as they relate to identified sources, pathways and areas of releases of hazardous constituents from Solid Waste Management Units.

1. Hydrogeology

The Permittee shall conduct a program to evaluate hydrogeologic conditions at the facility. This program shall provide the following information:

- a. A description of the regional and facility specific geologic and hydrogeologic characteristics affecting ground-water flow beneath the facility, including:
 - i) Regional and facility specific stratigraphy: description of strata including strike and dip, identification of stratigraphic contacts:
 - ii) Structural geology: description of local and regional structural features (e. g., folding, faulting, tilting, jointing, etc.);

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- iii) Depositional history;
 - iv) Regional and facility specific ground-water flow patterns; and
 - v) Identification and characterization of areas and amounts of recharge and discharge.
- b. An analysis of any topographic features that might influence the ground water flow system.
- c. Based on field data, tests, and cores, a representative and accurate classification and description of the hydrogeologic units which may be part of the migration pathways at the facility (i. e., the aquifers and any intervening saturated and unsaturated units), including:
- i) Hydraulic conductivity and porosity (total and effective);
 - ii) Lithology, grain size, sorting, degree of cementation;
 - iii) An interpretation of hydraulic interconnections between saturated zones; and
 - iv) The attenuation capacity and mechanisms of the natural earth materials (e. g., ion exchange capacity, organic carbon content, mineral content etc.).
- e. Based on data obtained from groundwater monitoring wells and piezometers installed upgradient and downgradient of the potential contaminant source, a representative description of water level or fluid pressure monitoring including:
- i) Water-level contour and/or potentiometric maps;
 - ii) Hydrologic cross sections showing vertical gradients;
 - iii) The flow system, including the vertical and horizontal components of flow; and
 - iv) Any temporal changes in hydraulic gradients, for example, due to tidal or seasonal influences.
- f. A description of manmade influences that may affect the hydrology of the site, identifying:
- i) Local water-supply and production wells with an approximate schedule of pumping; and
 - ii) Manmade hydraulic structures (pipelines, french drains, ditches, etc.).

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2. Soils

The Permittee shall conduct a program to characterize the soil and rock units above the water table in the vicinity of contaminant release(s). Such characterization may include, but not be limited to, the following types of information as appropriate:

- a. Surface soil distribution;
- b. Soil profile, including ASTM classification of soils;
- c. Transects of soil stratigraphy;
- d. Hydraulic conductivity (saturated and unsaturated);
- e. Relative permeability;
- f. Bulk density;
- g. Porosity;
- h. Soil sorptive capacity;
- i. Cation exchange capacity (CEC);
- j. Soil organic content;
- k. Soil pH;
- l. Particle size distribution;
- m. Depth of water table;
- n. Moisture content;
- o. Effect of stratification on unsaturated flow;
- p. Infiltration;
- q. Evapotranspiration;
- r. Storage capacity;
- s. Vertical flow rate; and
- t. Mineral content.

3. Surface Water and Sediment

The Permittee shall conduct a program to characterize the surface water bodies in the vicinity of the facility. Such characterization may include, but not be limited to, the following activities and information:

- a. Description of the temporal and permanent surface water bodies including:
 - i) For lakes and estuaries: location, elevation, surface area, inflow, outflow, depth, temperature stratification, and volume;
 - ii) For impoundments: location, elevation, surface area, depth, volume, freeboard, and construction and purpose;
 - iii) For streams, ditches, and channels: location, elevation, flow, velocity, depth, width, seasonal fluctuations, flooding tendencies (i. e., 100 year event), discharge point(s), and general contents.
 - iv) Drainage patterns; and
 - v) Evapotranspiration.

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- b. Description of the chemistry of the natural surface water and sediments. This includes determining the pH, total dissolved solids, total suspended solids, biological oxygen demand, alkalinity, conductivity, dissolved oxygen profiles, nutrients (NH_3 , $\text{NO}_3^-/\text{NO}_2^-$, PO_4^{3-}), chemical oxygen demand, total organic carbon, specific contaminant concentrations, etc.
- c. Description of sediment characteristics including:
 - i) Deposition area;
 - ii) Thickness profile; and
 - iii) Physical and chemical parameters (e. g., grain size, density, organic carbon content, ion exchange capacity, pH, etc.)

4. Air

The Permittee shall provide information characterizing the climate in the vicinity of the facility. Such information may include, but not be limited to:

- a. A description of the following parameters:
 - i) Annual and monthly rainfall averages;
 - ii) Monthly temperature averages and extremes;
 - iii) Wind speed and direction;
 - iv) Relative humidity/dew point;
 - v) Atmospheric pressure;
 - vi) Evaporation data;
 - vii) Development of inversions; and
 - viii) Climate extremes that have been known to occur in the vicinity of the facility, including frequency of occurrence.
(i. e. Hurricanes)
- b. A description of topographic and manmade features which affect air flow and emission patterns, including:
 - i) Ridges, hills or mountain areas;
 - ii) Canyons or valleys;
 - iii) Surface water bodies (e. g. rivers, lakes, bays, etc.);
 - iv) Buildings.

B. Source Characterization

For those sources from which releases of hazardous constituents have been detected the Permittee shall collect analytic data to completely characterize the wastes and the areas where wastes have been placed, to the degree that is possible without undue safety risks, including: type, quantity; physical form; disposition (containment or nature of deposits); and facility characteristics affecting release (e. g., facility security, and engineering barriers). This shall include quantification of the following specific characteristics, at each source area:

1. Unit/Disposal Area Characteristics:

- a. Location of unit/disposal area;
- b. Type of unit/disposal area;
- c. Design features;
- d. Operating practices (past and present)
- e. Period of operation;
- f. Age of unit/disposal area;
- g. General physical conditions; and
- h. Method used to close the unit/disposal area.

2. Waste Characteristics:

- a. Type of wastes placed in the unit;
 - i) Hazardous classification (e. g., flammable, reactive, corrosive, oxidizing or reducing agent);
 - ii) Quantity; and
 - iii) Chemical composition.
- b. Physical and chemical characteristics such as;
 - i) Physical form (solid, liquid, gas);
 - ii) Physical description (e. g., powder, oily sludge);
 - iii) Temperature;
 - iv) pH;
 - v) General chemical class (e. g., acid, base, solvent);
 - vi) Molecular weight;
 - vii) Density;
 - viii) Boiling point;
 - ix) Viscosity;

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- x) Solubility in water;
 - xi) Cohesiveness of the waste; and
 - xii) Vapor pressure.
- c. Migration and dispersal characteristics of the waste such as:
- i) Sorption capability;
 - ii) Biodegradability, bioconcentration, biotransformation;
 - iii) Photodegradation rates;
 - iv) Hydrolysis rates; and
 - v) Chemical transformations.

The Permittee shall document the procedures used in making the above determinations.

C. Characterization of Releases of Hazardous Constituents

The Permittee shall collect analytical data on groundwater, soils, surface water, sediment, and subsurface gas contamination in the vicinity of the facility in accordance with the sampling and analysis plan as required above. These data shall be sufficient to define the extent, origin, direction, and rate of movement of contamination. Data shall include time and location of sampling, media sampled, concentrations found, conditions during sampling, and the identity of the individuals performing the sampling and analysis. The Permittee shall address the following types of contamination at the facility:

1. Groundwater Contamination

The Permittee shall conduct a groundwater investigation to characterize any plumes of contamination detected at the facility. This investigation shall at a minimum provide the following information:

- a. A description of the horizontal and vertical extent of any plume(s) of hazardous constituents originating from the facility;
- b. The horizontal and vertical direction of contamination movement;
- c. The velocity of contaminant movement;
- d. The horizontal and vertical concentration profiles of hazardous constituents in the plume(s);
- e. An evaluation of factors influencing the plume movement; and

- f. An extrapolation of future contaminant movement.

The Permittee shall document the procedures used in making the above determinations (e. g., well design, well construction, geophysics, modeling, etc.).

2. Soil Contamination

The Permittee shall conduct an investigation to characterize the contamination of the soil and rock units above the saturated zone in the vicinity of any contaminant release. The investigation may include the following information:

- a. A description of the vertical and horizontal extent of contamination;
- b. A description of appropriate contaminant and soil chemical properties within the contaminant source area and plume. This may include contaminant solubility, speciation, adsorption, leachability, exchange capacity, biodegradability, hydrolysis, photolysis, oxidation and other factors that might affect contaminant migration and transformation;
- c. Specific contaminant concentrations;
- d. The velocity and direction of contamination movement; and
- e. An extrapolation of future contaminant movement.

The Permittee shall document the procedures used in making the above determinations.

3. Surface Water and Sediment Contamination

The Permittee shall conduct a surface water investigation to characterize contamination in surface water bodies resulting from releases of hazardous constituents at the facility.

The investigation may include, but not be limited to, the following information:

- a. A description of the horizontal and vertical extent of any plume(s) originating from the facility, and the extent of contamination in underlying sediments;
- b. The horizontal and vertical direction of contaminant movement;
- c. The contaminant velocity;
- d. An evaluation of the physical, biological and chemical factors influencing contaminant movement;
- e. An extrapolation of future contaminant movement; and

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- .. a description of the chemistry of the contaminated surface waters and sediments. This includes determining the pH, total dissolved solids, specific contaminant concentrations, etc.

4. Air Contamination

The Permittee shall conduct an investigation to characterize gaseous releases of hazardous constituents into the atmosphere or any structures or buildings. This investigation may provide the following information:

- a. A description of the horizontal and vertical direction and velocity of contaminant movement;
- b. The rate and amount of the release; and
- c. The chemical and physical composition of the contaminants(s) released, including horizontal and vertical concentration profiles.

The Permittee shall document the procedures used in making the above determinations.

D. Potential Receptors

The Permittee shall collect data describing the human populations and environmental systems that are susceptible to contaminant exposure from the facility. Chemical analysis of biological samples and/or data on observable effects in ecosystems may also be obtained as appropriate. The following characteristics shall be identified:

1. Current local uses and planned future uses of groundwater:
 - a. Type of use (e. g., drinking water source: municipal or residential, agricultural, domestic/non-potable, and industrial); and
 - b. Location of ground water users, to include withdrawal and discharge wells, within one mile of the impacted area.

The above information should also indicate the aquifer or hydrogeologic unit used and/or impacted for each item.
2. Current local uses and planned future uses of surface waters directly impacted by the facility:
 - a. Domestic and municipal (e. g., potable and lawn/gardening watering);
 - b. Recreational (e. g. swimming, fishing);
 - c. Agricultural;
 - d. Industrial; and
 - e. Environmental (e. g., fish and wildlife propagation).
3. Human use of or access to the facility and adjacent lands, including but not limited to:

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- a. Recreation;
 - b. Hunting;
 - c. Residential;
 - d. Commercial; and
 - e. Relationship between population locations and prevailing wind direction.
- 4. A general description of the biota in surface water bodies on, adjacent to, or affected by the facility.
 - 5. A general description of the ecology within and adjacent to the facility.
 - 6. A general demographic profile of the people who use or have access to the facility and adjacent land, including, but not limited to: age; sex; and sensitive subgroups.
 - 7. A description of any known or documented endangered or threatened species near the facility.

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LIST OF DEFINITIONS

LIST OF DEFINITIONS

Assessment Sampling: The sampling phase implemented to determine the magnitude and extent of a hazardous constituent release to a particular environment medium (i.e., soil, ground water, surface water/sediment, ambient air).

Aquifer: A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs (40 CFR 260.10).

Breathing Height: The average height at which the ambient air is inhaled, assumed to be 5-1/2 feet.

Capillary Zone: The subsurface zone immediately above the water table.

Chain of Custody: The quality control procedures implemented to document the transport and handling of an environmental sample from the time of collection until disposal.

Contamination Control Line: The boundary between the support zone and the contamination reduction zone, which separates the possibly low contamination area from the clean support zone.

Contamination Reduction Zone: The area located between the designated contamination area (exclusion zone) and the clean area (support zone). This zone is designed to reduce the spreading of contamination into the support zone. All decontamination efforts are carried out within contamination reduction zone boundaries.

Contract Laboratory Program: An Environmental Protection Agency program developed to ensure the quality of laboratory analyses.

Development Data: The information or data (such as isopleths, geologic cross sections, potentiometric diagrams, well logs) formulated from field or laboratory results.

Drainage Swale: A wetland formed from precipitation runoff, which may become dry between rainfall events.

Duplicate Samples: Two or more blind quality control samples which have been collected in the identical manner from the same source and submitted to the contractor laboratory.

Endangered Species: Those wildlife and plant species which have been determined by the U.S. Fish and Wildlife Service or the South Carolina Wildlife and Marine Resources Department to be endangered or threatened.

Exclusion Zone: The portion of the unit considered to be contaminated based on environmental monitoring results and professional judgement. All personnel within exclusion zone boundaries are expected to wear specified personal protective equipment and follow published procedures.

Ground Water Assessment Sampling: The sampling phase implemented to determine the magnitude and extent of a hazardous constituent release to the ground water.

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Ground Water Preliminary Sampling: The sampling phase implemented to determine the possibility of a hazardous constituent release to the ground water.

Hazardous Substance: Any substance designated pursuant to Section 101(4) of CERCLA.

Henry's Law Constant: The portioning ratio of a chemical between air and water phases at equilibrium.

Hotline: The outer boundary of the exclusion zone, clearly marked by lines, placards, hazard type and/or signs; or enclosed by physical barriers, such as chains, fences, or ropes.

Land Disposal Unit: A facility or part of a facility where hazardous wastes have been placed in or on the land for disposal purposes, including, but not limited to placement in a landfill, surface impoundment and waste pile.

Literature Review: The compilation and analysis of all existing RFI site data, conducted prior to any field investigations.

Lost Circulation Zone: A geologic zone in which monitoring well drilling fluids escape into the subsurface environment and are thereby not returned to the surface.

Open Terrain: An area where the distance between the wind measurement device (anemometer) and any obstruction to the wind flow (trees, building, steep slopes, ridges, cliffs, or hollows) is at least five times the height of the obstruction (USEPA, 1980).

Point of Exposure: The location in the environment at which contact is made between a receptor and a hazardous constituent.

Preliminary Unit Evaluation: The first step of the RFI Program, consisting of a review of all site-related data and a site reconnaissance.

Quality Assurance: The recordkeeping and management system which ensures proper documentation of all activities including traceability, completeness and security.

Quality Control: The activities which provide for the measurement of the characteristics of an item or process in accordance with established requirements.

Receptor Analysis: The identification and characterization of human populations and environmental systems that are susceptible to exposure to hazardous constituents released from an RFI unit.

Receptor Populations: Those human populations and environmental systems (wildlife and plants) that will potentially be exposed to hazardous constituents emanating from a unit.

Regulated Unit: Any waste unit subject to the permitting requirements as specified in 40 CFR, part 270.1.

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Resource Conservation and Recovery Act (RCRA): The Resource Conservation and Recovery Act of 1976 as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

Rinsate Samples: Samples collected from waters used to decontaminate sampling equipment.

Route of Exposure: The pathway(s) by which a hazardous constituent travels from its initial release, through the environmental media (ground water, surface water, soil, soil gas, and ambient air), to a receptor population.

RCRA Facility Assessment: The evaluation conducted at a RCRA facility by the regulatory agency to identify releases or potential releases of hazardous constituents.

RCRA Facility Investigation (RFI): The evaluation conducted by the owner/operator of a RCRA facility to characterize the possibility, extent, and magnitude of a hazardous constituent release.

RFI Program: The application of the RFI Requirements, as listed in Appendix C of the Hazardous Waste Permit, at the Savannah River Site.

RFI Program Management Plan (also termed Project Management Plan): The guidelines specifying the technical approach, schedules, and personnel qualifications for performing and directing the RFI.

RFI Program Plan: The guidance document for conducting the RFI, in fulfillment of the requirements of Appendix C, Hazardous Waste Permit.

RFI Program Team: The group, composed of specific SRS Operations and Maintenance Department representatives, to which oversight of the RFI Program has been delegated.

RFI Site: A waste unit at which a RCRA Facility Investigation is conducted.

Saturated Zone: That part of the earth in which all voids are filled with water (40 CFR 260.10).

SHERP Data: The information or data (such as training records, medical surveillance files, safety and emergency procedures) required by the Safety, Health and Emergency Response Plan (Chapter 2) of the RFI Program Plan.

Soils Assessment Sampling: The sampling phase implemented to determine the magnitude and extent of a hazardous constituent release to the surrounding soils.

Soils Confirmation Sampling (also termed Confirmation Soils Analysis): The site screening phase used to identify the presence, location, and relative magnitude of subsurface non-volatile constituents and to confirm the absence of volatile organic constituents.

Solid Waste Management Unit (SWMU): Any unit which has been used for the treatment, storage, or disposal of solid waste at any time, irrespective of whether the unit is or ever was intended for the management of solid waste.

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Stream Reach: The segment of a stream which contains the surface water/sediment sampling points.

Support Zone: The uncontaminated area located outside the contamination reduction zone. Administrative and other support functions necessary for operations in the exclusion and contamination reduction zones are located in the support zone.

SRS Quality Assurance Laboratory: The SRS laboratory designated to verify contractor laboratory analytical results.

Trip Blanks: Contamination free soils samples which accompany field samples to the laboratory and are then analyzed to determine if storage and handling has jeopardized sample integrity.

Unit Screening: The step of the RFI Program conducted to identify areas of potential hazardous constituent release.

Unit Screening/Geophysical Investigation: The Unit Screening phase performed to locate buried materials.

Unit Screening/Soil Gas Analysis: The Unit Screening phase performed to identify the presence, location, and relative magnitude of subsurface volatile organic constituents.

Unit Screening/Confirmation Soils Analysis: The Unit Screening phase used to identify the presence, location, and relative magnitude of subsurface non-volatile constituents and to confirm the absence of volatile organic constituents.

Unit-Specific Management Plan: The checkpoint system of reviews by the RFI Program Team.

Unit-Specific RFI Plans: The step-wise series of work plans developed by the Contractor, containing methods and procedures to be used to conduct unit-specific investigations.

Unsaturated Zone: The zone between the land surface and the water table (40 CFR 260.10), also known as the vadose zone.

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LIST OF ACRONYMS

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ACGIH	American Conference of Governmental Industrial Hygienists
AFOS	Automated Field Operations and Service
AI	Soil Absorption Isotherm
AIR	Accident Investigation Report
AS	Alpha Spectrometry
ASTM	American Society for Testing and Materials
CDC	Center for Disease Control
CEC	Cation Exchange Capacity
CEIL	Ceiling Limit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLP	Contract Laboratory Program
CM	Corrective Measures
CMP	Chemicals, Metals, and Pesticides (Pits)
CNS	Central Nervous System
CPRB	Coal Pile Runoff Basin
CSWE	Central Services Works Engineering
DOE	Department of Energy
DPSM	duPont Standard Manual (adopted by Westinghouse Savannah River Company)
DPSOP	duPont Standard Operating Procedures (adopted by Westinghouse Savannah River Company)
DPSPM	duPont Procurement Specification Manual (adopted by Westinghouse Savannah River Company)
ECD	Electron Capture Detector
E&E	Environmental Protection Section (EPS)
EID	Environmental Information Document
EM	Electromagnetics
EOC	SRS Emergency Operating Center
EP	Extraction Procedure Toxicity
EPA	U.S. Environmental Protection Agency
ES	Electromagnetic Surveys

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FID	Flame Ionization Detector
GC	Gas Chromatography
GPC	Gas Proportional Counter
GPR	Ground Penetrating Radar
GS	Gamma Spectrometry
HEPA	High Efficiency Particulate Air (air filter)
HP	SES Health Protection/Health Physics
HSD	Health and Safety Director
HSO	Health and Safety Officer
HNu	Trace Gas Analyzer
IDLH	Immediately Dangerous to Life or Health
IP	Ionization Potential
LEL	Lower Explosion Limit
LFM	Limited-Area Fine Mesh
MCL	Maximum Contaminant Level
MD	Metal Detection
MOS	Model Output
MPC	Maximum Permissible Concentration
MWMF	Mixed Waste Management Facility
NBS	National Bureau of Standards
NEIC	National Enforcement Investigation Center
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
OHEA	U.S. EPA Office of Health and Environmental Assessment
OSHA	Occupational Safety and Health Administration
OVA	Organic Vapor Analyzer
PASI	Preliminary Assessment Site Investigation
PC	Program Coordinator
PCB	Polychlorinated Biphenyls
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PM	Project Manager

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PMT	Project Management Team
PPB	Parts Per Billion
PPE	Personal Protective Equipment
PPM	Parts Per Million
PPS	U.S. EPA Personnel Protection and Safety
PPT	Parts Per Trillion
PSD	Prevention of Significant Deterioration
PQL	Practical Quantification Limit
PUF	Polyurethane Foam
QA	Quality Assurance
QAP	Quality Assurance Procedure
QC	Quality Control
QCP	Quality Control Plan
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RFIPT	RCRA Facility Investigation Program Team
RFIG	RCRA Facility Investigation Guidance
RI	Remedial Investigation
RMET	Raw Materials and Engineering Technology Department of WSRC
SARA	Superfund Amendment and Reauthorization Act
SCBA	Self-Contained Breathing Apparatus
SCDHEC	South Carolina Department of Health and Environmental Control
SCP	NIOSH and OSHA Standards Completion Program
SD	SRS Safety Division
SGWC	Site Ground Water Coordinator
SHERP	Safety, Health and Emergency Response Plan
SM	<u>Standard Methods for the Examination of Water and Wastewater</u>
SRL	Savannah River Laboratory
SRS	Savannah River Site
SRS PC	SRS Program Coordinator

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STEL	Short Term Exposure Limit
SWMU	Solid Waste Management Unit
TCLP	Toxicity Characteristic Listing Procedure
TDS	Technical Data Summary
TDS	Total Dissolved Solids
TDGD	RCRA Ground Water Monitoring Technical Enforcement Guidance Document
TIP	Total Ionizables Present (Photo Ionization Detector)
TLD	Thermoluminescent Dosimeters (Badges)
TLV	Threshold Limit Value
TOC	Total Organic Carbon
TOX	Total Organic Halogens
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
TWA	Time Weighted Average
USCS	Unified Soil Classification
USDA	U.S. Department of Agriculture
US	Unit-Specific
USEPA	U.S. Environmental Protection Agency
UV	Ultraviolet Light
VOC	Volatile Organic Compounds
VRO	Variable Resistance Orifice
WCAL	Weather Center Analysis Laboratory
WIND	Weather Information and Display System
WMO	Waste Management Operations Department of WSRC
WSCTF	SRS Waste Site Closure Task Force
WSRC	Westinghouse Savannah River Company

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