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April 1988

SAMPLING AND ANALYSIS PLAN

BOREHOLE 8901D
RADIOACTIVE WASTE MANAGEMENT COMPLEX
SUBSURFACE DISPOSAL AREA

Idaho National Engineering Laboratory

Managed by the U.S. Department of Energy

EG&G Idaho

Work performed under DOE Contract No. DE-AC07-76ID01570

INTERNATIONAL TECHNOLOGY CORPORATION

Project No. 301120.15
April 1989

Final Report

Sampling and Analysis Plan

Borehole 8901D
Radioactive Waste Management Complex
Subsurface Disposal Area

Idaho National Engineering Laboratory
Idaho Falls, Idaho

RESPONSIVE TO THE NEEDS OF ENVIRONMENTAL MANAGEMENT

Sampling and Analysis Plan

SAMPLING AND ANALYSIS PLAN
BOREHOLE 8901D
RADIOACTIVE WASTE MANAGEMENT COMPLEX
SUBSURFACE DISPOSAL AREA

APRIL 1989

BURIED WASTE PROGRAM

BOREHOLE 8901D

SAMPLING AND ANALYSIS PLAN

April 20, 1989

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1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) was prepared as part of the Buried Waste Program (BWP), Site Characterization at the Radioactive Waste Management Complex (RWMC) of the Idaho National Engineering Laboratory (INEL). The objective of this SAP is to describe the sampling and analysis procedures that will be employed at Borehole 8901D to aid in the determination of the degree and extent of migration of radioactive constituents in the sedimentary interbeds underlying the Subsurface Disposal Area (SDA) within the RWMC. Samples collected under this SAP will not be analyzed to determine the presence of hazardous constituents.

1.1 BACKGROUND INFORMATION

The INEL is a national engineering facility for nuclear energy research and development managed by the U.S. Department of Energy (DOE). A large variety of laboratory activities and test facilities at the INEL support DOE and other government-sponsored research and development programs. The INEL contains the largest concentration of nuclear reactors in the world.

1.1.1 Radioactive Waste Management Complex

The RWMC, located near the southwestern corner of the INEL (Figure 1-1), was selected as a waste disposal area in 1952 by the Atomic Energy Commission (AEC) based on near-surface studies by the U.S. Geological Survey (USGS) and AEC siting criteria. The RWMC occupies 58 hectares (144 acres) and consists of two main disposal and storage areas: the Transuranic Storage Area (TSA), and the Subsurface Disposal Area (SDA), which includes smaller, specialized disposal and storage sites such as trenches, pits, and soil vaults (Figure 1-2). This SAP addresses activities within the 36-hectare (88-acre) SDA where the waste is buried.

Solid radioactive waste generated in national defense and research programs is stored or buried at the RWMC. Nonradioactive solid and liquid wastes have also been disposed of at the RWMC. In addition to wastes generated at the INEL, wastes from the DOE's Rocky Flats Plant near Golden, Colorado, and other DOE facilities are stored or have been disposed at the RWMC.

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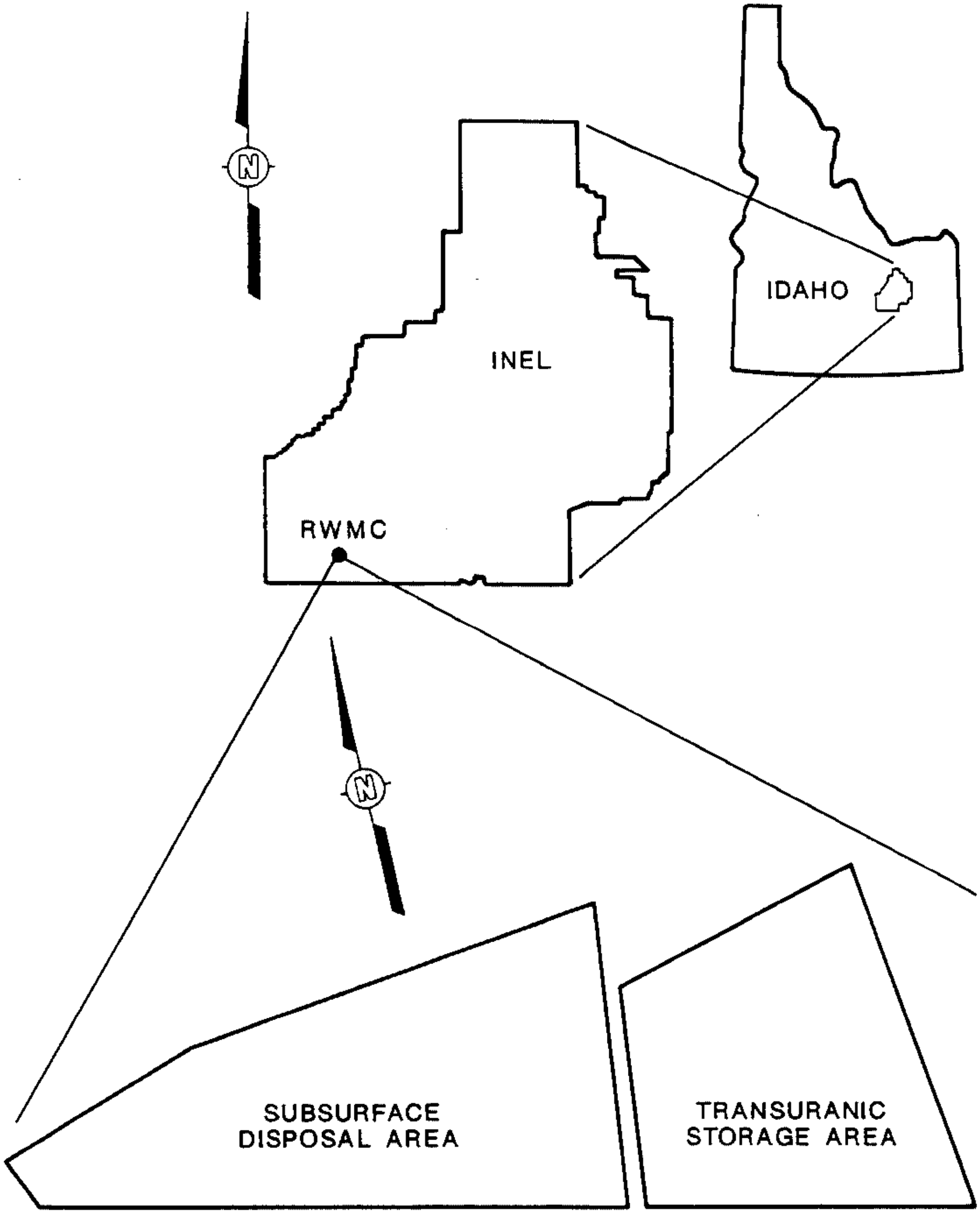

SOURCE: LANEY et al, 1988

FIGURE 1-1

LOCATION OF THE RADIOACTIVE WASTE MANAGEMENT COMPLEX

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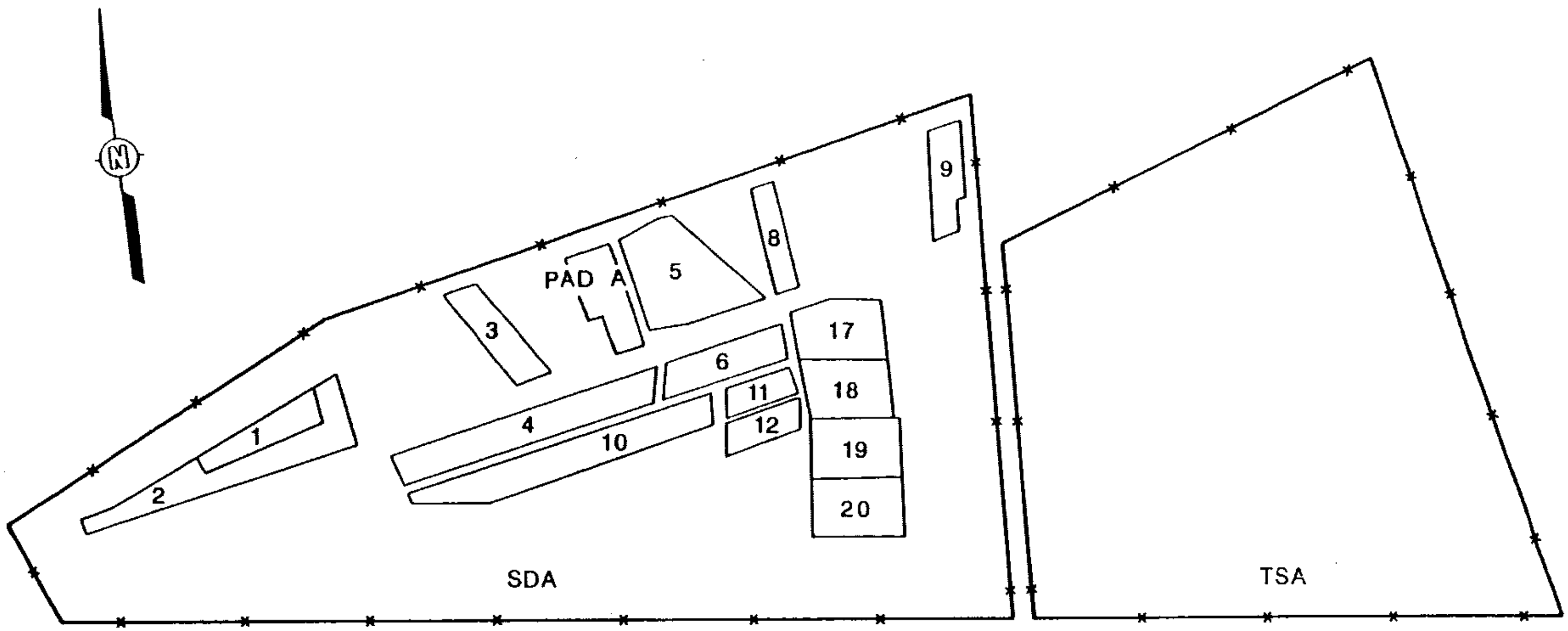

EXPLANATION

- 3 — INEL-DESIGNATED WASTE DISPOSAL AREA
- SDA — SUBSURFACE DISPOSAL AREA
- TSA — TRANSURANIC STORAGE AREA
- —x— FENCE

1200 0 1200 FEET

400 0 400 METERS

FIGURE 1-2

LOCATION OF SELECTED WASTE DISPOSAL SITES WITHIN THE RADIOACTIVE WASTE MANAGEMENT COMPLEX

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SOURCE: LANEY et al, 1988

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1.1.2 Environmental Setting

The INEL is located in southeastern Idaho in a flat to gently rolling, semi-arid, sagebrush desert. The elevation of the SDA ranges between 1,527 and 1,530 meters (5,010 and 5,020 feet) above sea level.

Soil at the SDA ranges from 0.3 to 7 meters (1 to 23 feet) thick. The original irregularities in the soil thickness generally reflect the surface of the underlying basalt bedrock, although some soil thickness variations are the result of recontouring activities. The basalt beneath the SDA is interbedded with sediments that range in texture from gravel to clay. These interbeds were formed during lulls in volcanic activity which allowed alluvial and eolian sediments to be deposited. Three of these interbeds are at 10, 33, and 73 meters (30, 110, and 240 feet) depth beneath the SDA (Figure 1-3). The cross section in Figure 1-3, drawn from natural gamma logs of boreholes that are drilled at the SDA, shows the variable thickness of the 10-, 33- and 73 meter (30-, 110-, and 240-foot) interbeds (Laney et al., 1988).

The Snake River Plain Aquifer underlies the SDA at a depth of 177 meters (580 feet). This aquifer is the only source of water used at the INEL. Production wells at the INEL, including the production well for the RWMC, are regionally upgradient of the SDA. There are four production wells in this aquifer within 32 kilometers (20 miles) downgradient (south-southwest) of the SDA (EG&G, 1988a). These wells are used only for livestock and irrigation, not for human consumption. There are no permanent residences within 32 kilometers (20 miles) downgradient of the SDA.

1.2 DESCRIPTION OF THE PROBLEM TO BE INVESTIGATED

In 1987, sediment samples collected at the SDA confirmed radionuclide migration to the 33-meter (110-foot) interbed and samples from the 73-meter (240-foot) interbed indicated the possible presence of radionuclides (Laney et al., 1988). Interbed sediment samples obtained during drilling activities at the RWMC were analyzed for the presence of 27 radionuclides. The target radionuclides for the activities described in this SAP are listed in Table 1-1. This plan describes the sampling and analysis activities that will provide data to aid in the determination of the degree and extent of radioactive constituents beneath the SDA by drilling borehole 8901D to sample the sedimentary interbeds.

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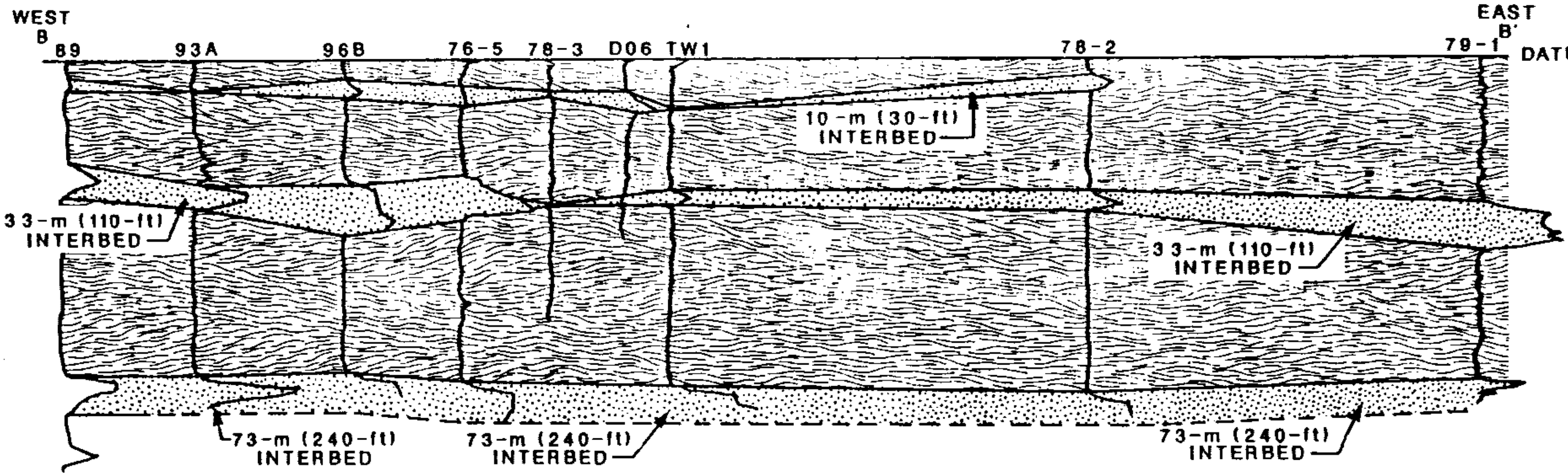

EXPLANATION

GAMMA-RAY LOG OF BOREHOLE

BASALT

INTERBED

SOURCE: LANEY et al, 1988

LOCATION OF CROSS SECTION B-B'

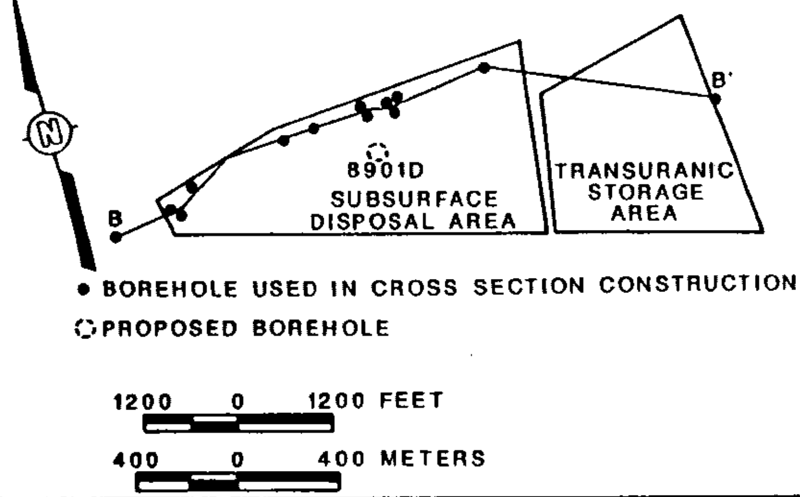

FIGURE 1-3

CROSS SECTION OF RADIOACTIVE WASTE MANAGEMENT COMPLEX

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TABLE 1-1

TARGET RADIONUCLIDES

RADIONUCLIDE	HALF-LIFE
Actinium-228	6.13 hours
Americium-241	458 years
Antimony-125	2.7 years
Bismuth-212	60.6 minutes
Bismuth-214	19.8 minutes
Cerium-144	284 days
Cesium-134	2.05 years
Cesium-137	30.2 years
Cobalt-60	5.27 years
Europium-152	12 years
Europium-154	16 years
Europium-155	1.81 years
Lead-212	10.6 hours
Lead-214	26.8 minutes
Manganese-54	303 days
Plutonium-238	87.7 years
Plutonium-239	24,000 years
Plutonium-240	6,580 years
Protactinium-234	6.7 hours
Radium-226	1600 years
Silver-110 m	253 days
Strontium-90	28.8 years
Thallium-208	3 minutes
Thorium-234	24.1 days
Uranium-234	2.5×10^5 years
Uranium-238	4.5×10^9 years
Zinc-65	245 days

2.0 PROJECT DESCRIPTION

This sampling and analysis plan describes the sampling, and analysis of Borehole 8901D. This borehole will be completed to function as a vapor vacuum extraction well. The Vapor Vacuum Extraction (VVE) Demonstration is defined as Task 12 in the RCRA Facility Investigation (RFI) Workplan (EG&G, 1988a). The instrumentation phase of this borehole is described in another sampling and analysis plan (EG&G, 1989a). The sampling and analysis of Borehole 8901D is in support of the Site Characterization Program and the RWMC RFI, as described below.

The Site Characterization Program was instituted in 1987 and incorporated the objectives and tasks of the Subsurface Investigation Program (SIP). The Subsurface Investigation Program was formally begun in 1983 with the development and release of "A Plan for Studies of Subsurface Radionuclide Migration at the Radioactive Waste Management Complex of the Idaho National Engineering Laboratory" (DOE, 1983). The general objectives of the SIP were to:

- Field-calibrate a model to predict the long-term migration of radionuclides in the unsaturated zone.
- Measure the actual migration of radionuclides to date, in order to determine whether there is a health and safety problem.

Studies conducted under the 1983 SIP were not intended to evaluate the potential migration of any hazardous material in the waste nor evaluate the nonradiological hazards of the radioactive waste. With the implementation of the Site Characterization Program, the studies were broadened to include the characterization of the hazardous components of the waste.

The Deep Drilling task of the Site Characterization Program consists of drilling and sampling sediment and/or basalt series beneath the surficial sediments to depths of up to 80 meters (260 feet). Analytical samples have been collected by coring and/or drive tube sampling. Selected portions of the core recovered from previous boreholes have been analyzed for radionuclides and hydrogeologic and geochemical properties. Previously drilled boreholes have been completed with permanent instrumentation (porous cup samplers and heat dissipation sensors) for moisture monitoring. The Borehole 8901D drilling, sampling, and analysis activities will be similar in scope to the other Deep Drilling boreholes and will provide comparable data.

In the summer of 1987, volatile organic compounds (VOC) were detected in the unsaturated zone and in the groundwater beneath the RWMC. The presence of VOCs constituted a potential release of hazardous constituents from the RWMC, and in accordance with the Consent Order and Compliance Agreement (COCA) provisions, DOE notified EPA Region X. The INEL subsequently initiated a corrective action program, beginning with the development of a RCRA Facility Investigation (RFI) to characterize the site and the contamination, and evaluate possible remediation measures. The Buried Waste Program (BWP) was established within EG&G Idaho, Inc., contractor to DOE-ID, to manage the corrective action program at the SDA. The BWP is responsible for the RFI, the corrective measures study, and the corrective measures implementation for the volatile organic release from the buried waste at the SDA. The BWP is also responsible for the radionuclide investigations and radionuclide corrective measures at the SDA.

The RFI addresses only the contaminants defined as hazardous under RCRA, and does not specifically address the presence or migration of radiological constituents. The RFI Workplan (EG&G, 1988a) describes a series of tasks that are intended to:

- Assess the complex nature of basalt units and sedimentary interbeds in the vadose zone beneath the SDA,
- Determine the degree and extent of current volatile organic contamination in the aquifer,
- Predict future volatile organic migration,
- Assess the risk associated with the presence of volatile organic compounds in the groundwater, drinking water, and air.

Sampling and analysis of vapor samples from 8901D and the instrumentation of this borehole are described in a separate SAP in support of RFI Task 12, Vapor Vacuum Demonstration Extraction (VVE) (EG&G, 1989a).

In summary, Borehole 8901D will be drilled and recovered core will be sampled and analyzed to provide data for DOE's Site Characterization Program. In addition, Borehole 8901D will be completed as part of the RFI Task 12, VVE. As such, information obtained from Borehole 8901D will be used to support the original objectives of the 1983 SIP and the current objectives of the Site Characterization Program.

2.1 REVIEW OF EXISTING DATA

Samples of soil gas, vadose zone water, sediment, and rock have been collected at the SDA as part of various site investigation activities. The progress of those activities has been reported in Hubbell et al. (1985), Hubbell et al. (1987), and Laney et al. (1988). Both radioactive and hazardous constituents have been detected as migrating from the SDA. Eight radionuclides have been positively detected at measurable levels (Laney et al., 1988). These are Pu-238, Pu-239, Pu-240, and Am-241 found in deep holes, and Sr-90, Cs-137, Co-60, and Eu-154 found in shallow borings. Positive detections in shallow borings (less than eight meters) are presumably associated with the migration of radionuclides from the buried waste within the surficial sedimentary deposits of the SDA. It is speculated that the deep migration of radionuclides has followed a downward path from the buried waste through the highly fractured basalt into the 33-meter (110-foot) interbed and possibly the 73-meter (240-foot) interbed. Results of radiological analyses of samples from the 73-meter (240-foot) interbed were inconclusive with respect to radionuclide contamination, because sample integrity could not be assured.

2.2 SAMPLING AND ANALYSIS OBJECTIVES

The sampling and analysis of Borehole 8901D will support the objectives of the RWMC Site Characterization Program. The specific objectives of this SAP are as follow:

- To collect samples from the 10-meter (30-foot) sedimentary layer and the fractured basalt zone surrounding this layer and analyze them for the presence of the radionuclides listed in Table 1-1.
- To collect samples from the 33-meter (110-foot) sedimentary layer and the fractured basalt zone surrounding this layer and analyze them for the presence of the radionuclides listed in Table 1-1.
- To collect samples from the 73-meter (240-foot) sedimentary layer and the fractured basalt zone surrounding this layer and analyze them for the presence of the radionuclides listed in Table 1-1.

- To maintain a high degree of sample integrity by preventing contact with known contaminated layers or the outside environment.

The data collected from Borehole 8901D will provide additional data for the Site Characterization Program. The Site Characterization Program will compile the data from Borehole 8901D and other deep drill holes within the SDA to assess and quantify the extent of radionuclide migration from the SDA.

2.3 DATA QUALITY OBJECTIVES

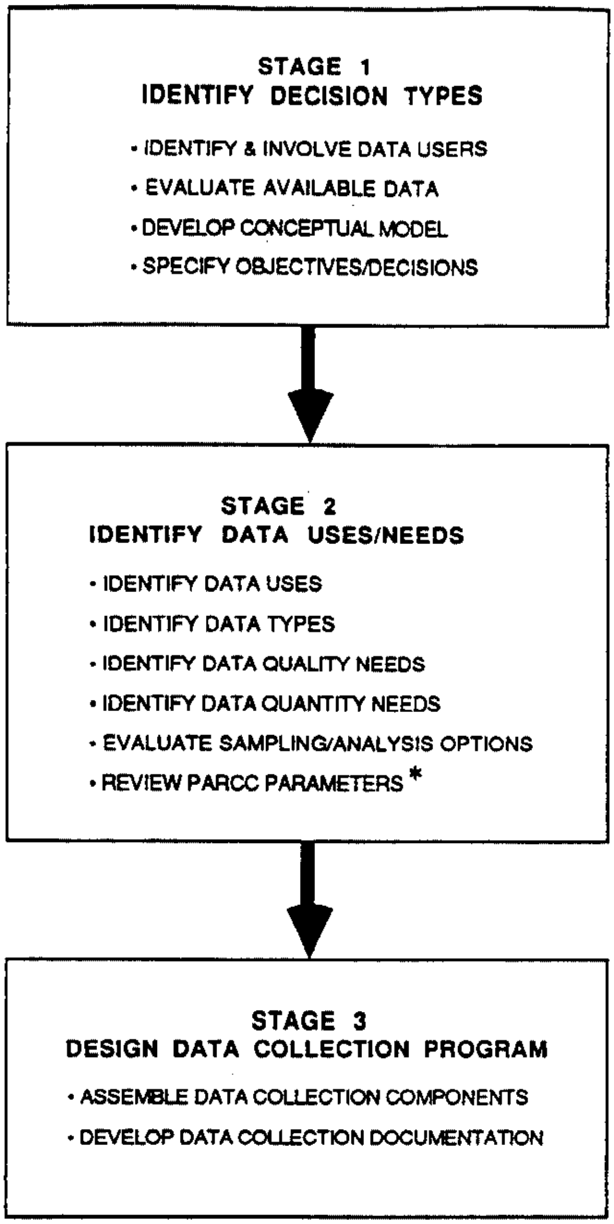
Data Quality Objectives (DQOs) are qualitative and quantitative statements established to ensure that data of appropriate quality are obtained during site investigation activities. DQOs are an integrated set of thought processes which define data quality requirements based on the end use of the data. They are specified for each data collection activity associated with the sampling and instrumentation of the borehole. Guidance for the development of DQOs is provided by EPA in Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-7B (EPA, 1987). The three stage process for the development of the DQO has been documented in accordance with this Directive and is presented in Figure 2-1 and in the following sections.

2.3.1 Stage 1 - Identification of Decision Types

Data resulting from this SAP will be applied to various other tasks within the RFI and Site Characterization Program including: hydrogeologic characterization and groundwater monitoring (RFI Task 9), investigation analysis (RFI Task 10), radionuclide concentrations, characterization of geologic materials, chemical form of radionuclides, and model development.

Existing data (Hubbell et al., 1985; Hubbell et al., 1987; Laney et al., 1988) indicate that some migration of radionuclides has occurred. Difficulties in assuring the integrity of samples from deeper sedimentary interbeds (potential for cross-contamination from shallower interbeds and surficial sediments) has been a problem in previous sampling efforts. Data collected for this SAP will be compared to the previous data to verify radionuclide migration.

A conceptual model (Figure 2-2) was developed to help understand the migration processes at the SDA. The primary hypothesis is that precipitation, snow



* PARCC PARAMETERS ARE:

Precision

Accuracy

Representativeness

Completeness

Comparability

FIGURE 2-1

FLOW CHART OF DATA QUALITY OBJECTIVE THREE STAGE DEVELOPMENT PROCESS

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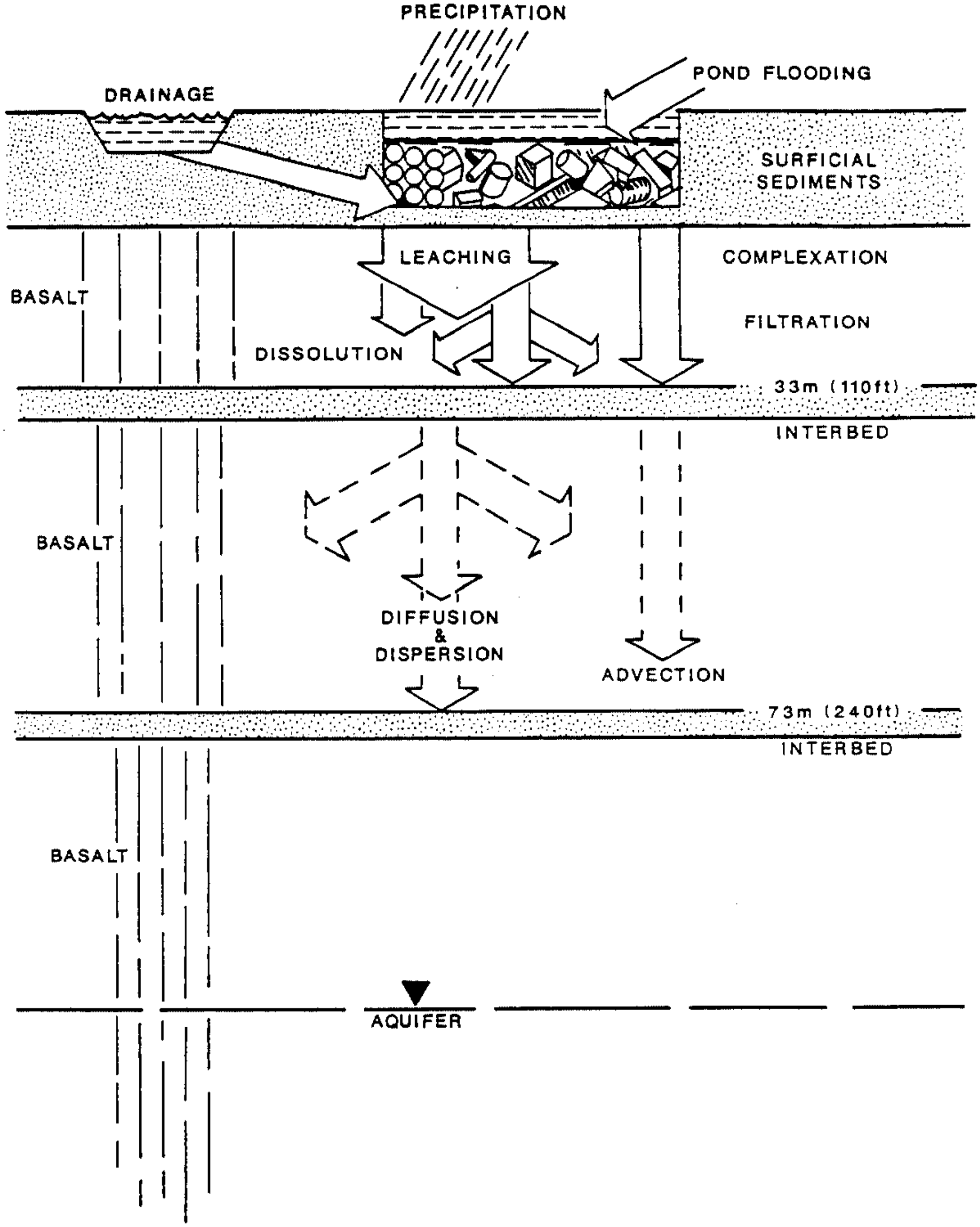

FIGURE 2-2

CONCEPTUAL MODEL OF PROCESSES INVOLVED IN CONTAMINANT TRANSPORT IN THE VADOSE ZONE

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"Do Not Scale This Drawing"

melt, flooding, or water from other sources infiltrating through the soil at the SDA carries radioactive constituents through unsaturated sediment and fractures in the underlying basalt. Downward movement of water has not been conclusively demonstrated as the transport mechanism for radionuclides. The mode of contaminant transport has not been conclusively demonstrated and should be treated as a hypothesis only. The waste constituents accumulate in the basalt and the sedimentary interbeds and possibly in the aquifer. These processes are believed to be the driving force for contaminant migration. By considering these processes the needs and uses for additional data can be determined.

The specific decisions that are required in Stage 1, based on the data users, available data and the conceptual model, include:

- Type of samples
- Number of samples
- Parameters to be analyzed
- Analytical level and analytical methods
- Required precision, accuracy, representativeness, completeness, and comparability.

Decisions that will be made based on the data resulting from the activities described in this SAP include:

- Are the strata underlying the SDA contaminated with radionuclides?
- Are additional boreholes necessary?
- Is the environment and/or human health and safety threatened by the concentration of radionuclides present?
- What are viable remediation alternatives?

2.3.2 Stage 2 - Identification of Data Uses/Needs

Data collected for this SAP will be used for the following:

- Support the decisions stated in Stage 1
- Refine understanding of geologic site characteristics

- Provide additional data to determine if radionuclide migration can be detected
- Provide radiological results for radionuclide transport model.

Data developed from this SAP provide the following uses:

- Analytical results from radionuclide analysis (pCi/g)
- Depths, thickness and geologic descriptions of the sampled sedimentary interbeds (meters and centimeters).

As depicted in Figure 2-2, the sedimentary layers of interest in this SAP overlie each other. This poses the possibility of cross contamination between layers. Samples collected during this investigation need a high level of quality to assure that they are representative of the actual subsurface conditions and that no cross contamination has occurred during collection. Sample collection procedures are contained in specific Standard Operating Procedures (SOP) for this investigation and are summarized in Section 5.0, Sampling Procedures. Section 6.0, Sample Control and Document Management, describes procedures to ensure sample integrity and traceability. The procedures described in these sections will be closely adhered to so that samples are as complete and representative as possible.

A review of previously collected samples shows positive results for radionuclides where reported values are at least three times the standard deviation, and where one standard deviation represents all random uncertainties and analytical error appropriately propagated through the calculations of the radioactivity. The previously collected samples have concentrations on the order of 1×10^{-1} picoCuries per gram. Analytical detection limits must be at least this sensitive. Analytical procedures are listed in Section 8.0, Analytical Procedures, and the quality control to be used for these analyses is discussed in Section 10.0, Quality Assurance.

Samples will be collected from the 10-meter (30-foot), 33-meter (110-foot), and 73-meter (240-foot) sedimentary interbeds for radionuclide analysis. Samples will consist of a 6.4-centimeter (2.5-inch) diameter subcore taken from an undisturbed core. Samples will be collected from the sedimentary interbed approximately every 10 centimeters (4 inches).

In addition, one sample will be collected from fracture fillings in the basalt, just above and below the sedimentary interbed. Sample collection is further outlined in Section 5.0, Sampling Procedures.

Table 2-1 presents the PARCC parameters to be used in this SAP. PARCC refers to precision, accuracy, representativeness, completeness and comparability. These terms are further discussed in Section 4.2, Data Quality.

2.3.3 Stage 3 - Design Data Collection Program

With the objectives, decision types, and data uses/needs identified in Stages 1 and 2, all the components required for completion of Stage 3 are available. Stage 3 compiles the information and DQOs developed for this specific task into a comprehensive data collection program. That program is contained in the remaining sections of this SAP.

TABLE 2-1

PARCC PARAMETERS

	FIELD	ANALYTICAL
Precision	None specified	Determined by Poisson counting statistics for each analyte in each analyzed sample.
Accuracy	None specified	Internal standards assure accuracy will be within the stated precision for each analyte in each analyzed sample.
Representativeness	Grab samples used, samples are representative of discrete stratigraphic layer	Not specified
Completeness	90% of identified samples	85% of submitted samples
Comparability	Standard Operating Procedures for sample collection will ensure comparability between samples	Consistent use of standard analytical methods will ensure comparability of analytical results

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

3.1 OWNERSHIP

The Idaho National Engineering Laboratory (INEL) is managed by the Department of Energy-Idaho Operations Office (DOE-ID). EG&G Idaho, Inc. is the site contractor responsible for operations of the RWMC facility, including the Buried Waste Program. DOE-ID has primary responsibility and authority for the Resource Conservation and Recovery Act/Comprehensive Environmental Response Compensation and Liability Act (RCRA/CERCLA) EPA regulatory compliance activities at the RWMC.

3.2 PROJECT PERSONNEL

The organization and responsibility for activities covered under this SAP are shown in Figure 3-1. The responsibilities of individual positions directly related to this project are described below.

3.2.1 Buried Waste Program (BWP) Manager

The BWP Manager is ultimately responsible for the success of all activities performed as part of the Buried Waste Program. This includes all administrative functions, site characterization/investigation activities, and evaluation of remediation technology alternatives at the RWMC.

3.2.2 BWP QA Officer

The BWP Quality Assurance (QA) Officer's duties include: obtaining the necessary technical expertise to review analytical data; performing field, system, and laboratory audits; assisting in the development of QA/QC procedures for the program; developing audit checklists; as well as assisting the BWP Manager and Cost Account Manager with monthly and annual report development.

3.2.3 BWP Site Characterization Cost Account Manager

The BWP Cost Account Manager is responsible for ensuring that all activities related to this SAP are conducted following approved procedures. This manager also provides coordination and interface with the DOE-ID program personnel.

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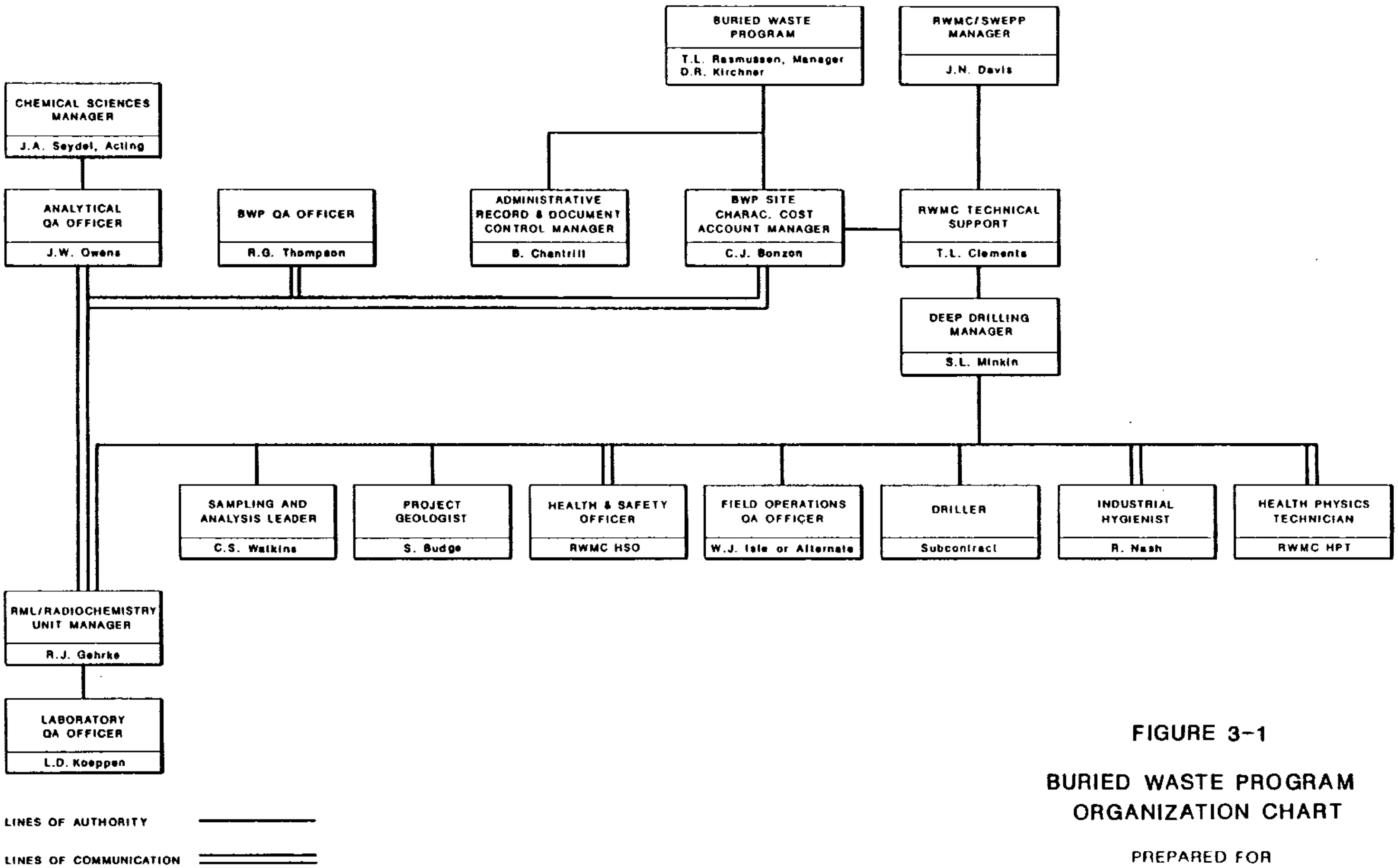

FIGURE 3-1

BURIED WASTE PROGRAM ORGANIZATION CHART

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3.2.4 Administrative Record and Document Control Manager

The Administrative Record and Document Control Manager will maintain a supply of all controlled documents and have a documented filing system for the storage of all administrative documents (e.g., reports, correspondence), all field and laboratory data (e.g., field notebooks, raw data and laboratory data packages) and all references and final reports. This manager will have a documented checkout system for the control and release of all documents, reports, and records.

3.2.5 RWMC Manager and Technical Support Liaison

The RWMC Operations Manager has responsibility for the safe completion of drilling activities. The RWMC Technical Support Liaison will represent the Operations Manager and will be kept informed of all field activities. The RWMC Technical Support Liaison will also serve as advisor to the drilling/sampling crew with regard to RWMC operations. This will facilitate interaction and communication between drilling and sampling personnel and RWMC operations.

3.2.6 Deep Drilling Program Manager

The Deep Drilling Program Manager (DDPM) is responsible for the safe and successful completion of the sampling effort. Should a potentially hazardous health and safety issue arise, the DDPM will halt drilling and/or sampling operations until the Industrial Hygienist (IH), Health and Safety Officer (HSO), and RWMC Technical Support Liaison have determined a safe solution to the problem. In addition, the DDPM shall ensure that the sampling procedures, Health and Safety Plan, and any Detailed Operating Procedures are followed during all phases of sampling.

3.2.7 Sampling and Analysis Leader

The Sampling and Analysis Leader will be responsible for providing sample selection guidance based on programmatic objectives, will provide an oversight and audit function for the completion of "Request for Analysis" forms and for the shipment of analytical samples to the appropriate analytical laboratories.

3.2.8 Project Geologist

The Project Geologist has technical responsibility for the successful completion of the coring activities. Routine responsibilities of the Project Geologist include: (a) preparing the weekly summary of drilling and core recovery progress, (b) maintaining the sample and core description log, (c) maintaining the daily drilling log, (d) collecting the driller's daily drilling summary, (e) monitoring the completion of the boreholes, (f) supervision of chain-of-custody control in the field, and (g) supervision of completing "Request for Analysis" forms to accompany analytical samples to the appropriate laboratory.

3.2.9 Health and Safety Officer

The Health and Safety Officer (HSO) will be responsible for ensuring compliance with and execution of the BWP Health and Safety Plan (EG&G, 1989d) which is summarized in Section 12, Safety and Training. The HSO will be supported by the Industrial Hygienist and the Health Physics Technician.

3.2.10 Field Operations QA Officer

The Field QA Operations Officer is responsible for overseeing the sampling process. This position requires a quality assurance professional who has experience with previous sampling projects.

3.2.11 Driller

The Driller is responsible for the operation and maintenance of drilling equipment, collection of samples as required by the Project Geologist, and supervision of the drilling crew. The Driller has responsibility for conducting drilling and sampling activities in accordance with the BWP Health and Safety Plan. The Driller will be responsible for optimizing sample recovery.

3.2.12 Industrial Hygienist

The Industrial Hygienist (IH) will be responsible for monitoring the exposure to hazardous chemicals throughout the sampling activities. The IH is responsible for operating, daily cleaning, and calibrating all chemical monitoring equipment and maintaining a daily logbook of monitoring activities. The IH will be at the site during all drilling and sample collection activities. The IH will inform the DDPM and HSO of any changes in the concentration of monitored constituents which warrant the reevaluation of personal protective equipment, evacuation, or re-entry into an evacuated area. The IH will enter each work site before any other personnel to assess initial hazards.

The IH will make provisions with analytical laboratories for 24- to 48-hour turnaround for air filter samples in the event of a suspected acute exposure to hazardous chemical vapors. The IH will inform the DDPM and the HSO of any suspected acute exposure to hazardous chemical vapors, liquids, or solids.

3.2.13 Health Physics Technician

The Health Physics (HP) Technician will be the primary source of information and guidance for the monitoring of radiological hazards. The HP Technician will be present during all drilling and sampling of surficial sediments and when cored samples are recovered. The HP Technician will perform instrument surveys for radiological contamination on borehole cuttings, sampling tools, and samples. The HP Technician will collect smear samples on tools and equipment for alpha contamination analysis, and is responsible for the calibration of all radiological instruments, control of the calibration logbook, maintenance and proper operation of monitoring equipment.

3.3 ANALYTICAL QUALITY ASSURANCE

The positions which have responsibility for analytical quality assurance (QA) for on-site laboratories performing analyses for this project are identified in the following sections.

3.3.1 Chemical Sciences Manager

The Chemical Sciences Manager is responsible for all on-site chemical analytical laboratories. The Chemical Sciences Manager will select the Analytical QA Officer for on-site audits.

3.3.2 Analytical Quality Assurance (QA) Officer

The Analytical QA Officer is responsible for on-site audits of laboratory procedures and records, reviewing analytical field data, providing blind samples with the proper levels of analyte to evaluate laboratory performance, and compiling corrective action measures. This position will be filled from the

Chemical Sciences Group and will not be responsible to the laboratory performing any analysis for this project.

3.3.3 RML/Radiochemistry Unit Manager

The RML/Radiochemistry Unit Manager has overall responsibility for laboratory technical quality, cost control, laboratory personnel management, and adherence to schedules. The RML/Radiochemistry Unit Manager will serve as the primary contact for coordinating field and laboratory activities.

3.3.4 Laboratory QA Manager

The Laboratory QA Manager is responsible for preparing the analytical reports and ensuring that analytical procedures are performed properly, custodial information is complete, all specified Quality Control procedures are implemented and recorded, and that only valid data are reported.

4.0 SAMPLING AND ANALYSIS STRATEGY

The sampling and analysis strategy for Borehole 8901D has been developed to ensure that the resulting data support the objectives of the investigation, the data are compatible with other tasks, and that the quality of the data is appropriate for defined data uses. Figure 4-1 shows the interrelationship between the sampling and analysis process, the flow of data, and the data qualification procedures for this activity. The following sections describe the sampling and analysis strategy and the required data quality.

4.1 COLLECTION AND ANALYSIS OF SAMPLES

Sediment samples will be collected from Borehole 8901D and analyzed to detect the presence of radioactive constituents within the strata underlying the SDA. The samples will be collected every 10 centimeters (4 inches) within the sedimentary interbeds at the 10-meter (30-foot), 33-meter (110-foot), and 73-meter (240-foot) intervals. Table 4-1 lists the sampling interbed, the range of expected interbed thickness, and the maximum number of samples that could be collected assuming 100 percent recovery. Table 4-1 also indicates the percent core recovery in the nearest borehole (8801D); core recovery similar to 8801D is likely to be achieved during sampling of Borehole 8901D. Basalt samples with sedimentary fracture fillings will also be collected from above and below the sedimentary interbeds. Additional samples may be selected as duplicates for radiological analyses to allow comparison of potentially cross-contaminated outer core surfaces with samples taken from the center of the core.

The location of Borehole 8901D (Figure 4-2) was selected based on the following criteria:

- To corroborate radionuclide presence in the 73-meter (240-foot) interbed that was detected in Borehole 8801D (Laney et al., 1989).
- For the Vapor Vacuum Extraction Demonstration, an area of high concentrations of volatile organic compounds based on the soil-gas survey (Laney et al., 1988).
- Within 25 meters (82 feet) of Borehole 8801D as required for validation of organic vapor transport model for BWP vapor vacuum extraction model.

TABLE 4-1

EXPECTED SAMPLING INTERVALS IN BOREHOLE 8901D

SAMPLE INTERVAL	RANGE OF EXPECTED INTERBED THICKNESS m (ft)(1)	MAXIMUM NUMBER OF SAMPLES(2) (ASSUMING 100% RECOVERY)	CORE RECOVERY IN NEAREST BOREHOLE (PERCENT) (3)
10-m (30-ft) Interbed	0 to 0.6 m (0 to 2.0 ft)	0-6	Not present
33-m (110-ft) Interbed (4)	0.5 to 3.0 m (1.6 to 10.0 ft)	5-30	35 percent
73-m (240-ft) Interbed	4.8 to 6.0 m (5.0 to 20.0 ft)	48-60	44 percent

NOTE: Additional samples of sedimentary fracture fillings in basalt may be collected at the discretion of the Project Geologist.

(1) Range of expected interbed thickness is interpolated from structure contour and isopach maps of the interbeds presented in Laney et al. (1988).

(2) Maximum number of samples represents the maximum number of 10-centimeter (4-inch) long samples that could be split out from a core with the maximum and minimum expected interbed thickness, assuming 100 percent core recovery.

(3) Interbed core recovery in Borehole 8801D, approximately 25 m (82 ft) from location of Borehole 8901D (Laney et al., 1989 Draft).

(4) Residual material will be archived for possible future use.

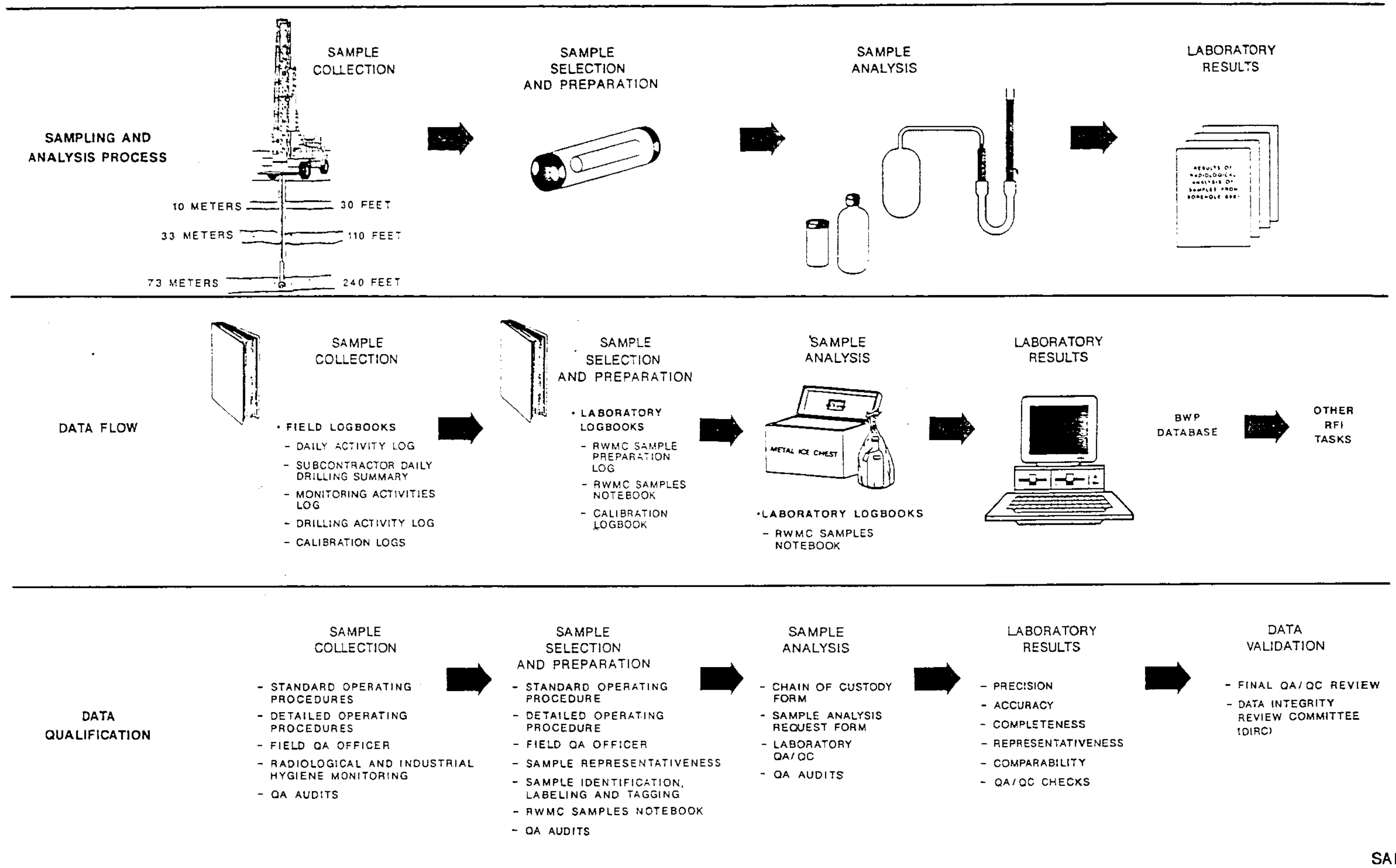

FIGURE 4-1

SAMPLING AND ANALYSIS PROCESS, DATA FLOW, AND DATA QUALIFICATION FOR SAMPLING AND ANALYSIS OF BOREHOLE 8901D

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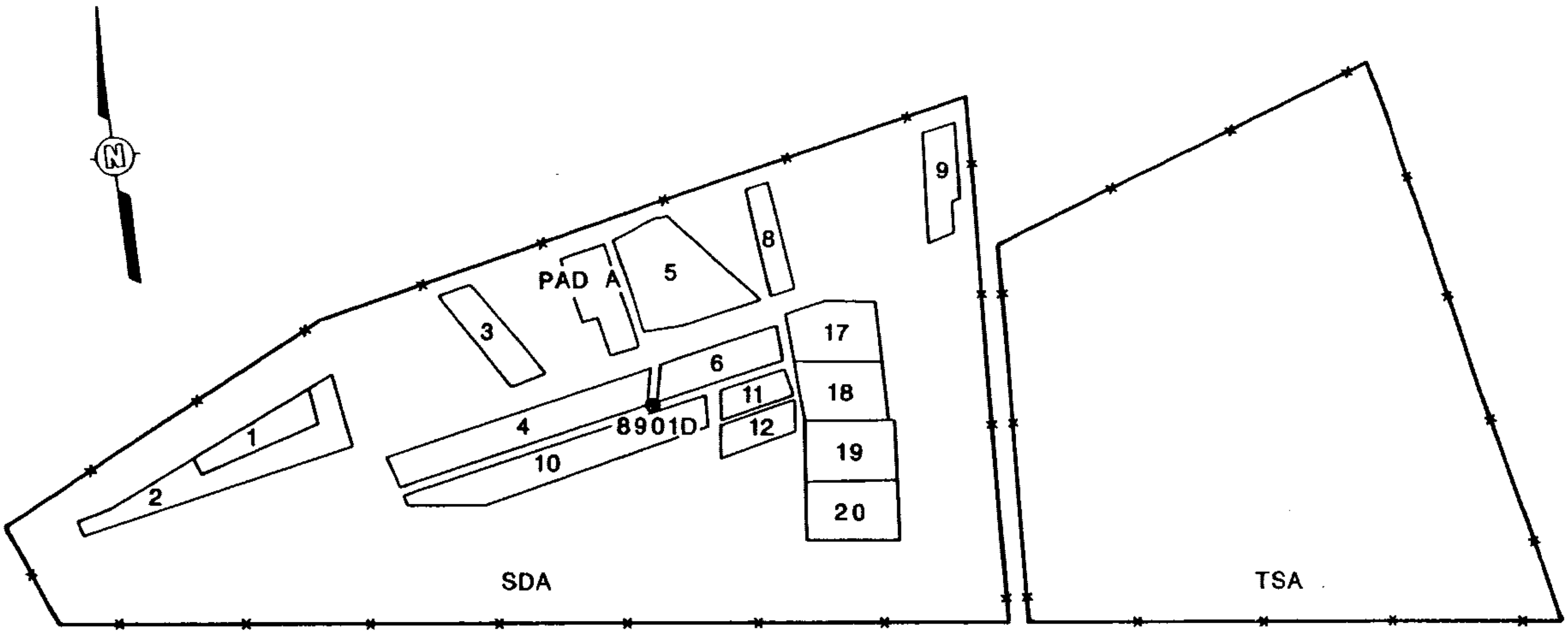

EXPLANATION

3 INEL-DESIGNATED WASTE DISPOSAL AREA

SDA SUBSURFACE DISPOSAL AREA

TSA TRANSURANIC STORAGE AREA

● BOREHOLE

—x— FENCE

1200 0 1200 FEET

400 0 400 METERS

FIGURE 4-2

LOCATION OF FY89 BOREHOLE WITHIN THE RADIOACTIVE WASTE MANAGEMENT COMPLEX

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SOURCE: LANEY et al, 1988

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- To provide additional data to facilitate determination of radionuclide migration or cross contamination.

The borehole location will be surveyed after drilling operations by siting off existing benchmarks. Samples will be selected by the Project Geologist and Deep Drilling Project Manager, with concurrence from the BWP Site Characterization Manager, Chris Bonzon, from core recovered during drilling operations.

Core will be obtained with a core bit and barrel assembly and a lexan inner tube. The clear lexan inner tube allows the core to be visually examined and samples for analysis selected without handling the core and exposing personnel. Sample selection and handling will be conducted in accordance with procedures described in EG&G (1989b) and summarized in Section 5.0, Sampling Procedures. Sample preparation procedures will be in accordance with the Standard Operating Procedures (SOP) for sample preparation (EG&G, 1989c); these procedures are summarized in Section 5.0, Sampling Procedures. As many 7.5- to 10-centimeter (3- to 4-inch) long samples as possible will be collected from each sedimentary interbed, depending on the amount of core recovered (Table 4-1). Additional samples will be collected of fracture fillings in basalt just above and below the sedimentary interbed. Archived material may be sampled at the Project Geologist's and BWP Site Characterization Manager's discretion for duplicate radiological analyses. The decision to sample archives and any minor changes in the procedures will be documented accordingly.

The samples will be analyzed for specific alpha-, beta-, and gamma-emitters (Table 1-1). A radionuclide will only be considered present if the measured value is greater than three times the standard deviation, where one standard deviation represents all random uncertainties and analytical error appropriately propagated through the calculation of the activity. If cross-contamination is avoided, the presence of radionuclides in a sample of the sedimentary interbed would indicate migration from the disposal area.

4.2 DATA QUALITY

The Data Quality Objectives (DQO) for the field sampling and sample radiological analyses are very different and are addressed separately in the following sections. The quality objectives will be strictly adhered to in order to ensure that:

- The technical data will be of sufficient quality to meet scientific and legal scrutiny;
- Data will be collected in accordance with procedures appropriate for the intended use of the data;
- Laboratory data will be of acceptable precision and accuracy;
- Field sampling will satisfy the requirements of representativeness, completeness and comparability specified in Table 2-1.

4.2.1 Field Data Quality Objectives

Field precision is a measure of the variability which is determined by the sample heterogeneity, within-sample heterogeneity, and spatial (population) heterogeneity. Since each source of variability differs between the different interbeds or geologic strata, each of the types of variability should be measured in each stratum independently of the other strata. Measurement of these three sources of variability is accomplished through the use of an adequate sample design and collection of duplicate (replicate) samples and split samples.

A duplicate is a second complete sample that is collected to represent the same point in time and space as its associated pair. If there are more than two "duplicates," technically they would be called "replicates." A split sample, on the other hand, is a single complete sample that is split into two or more samples. A duplicate pair of samples measures sample heterogeneity. A split sample measures within-sample heterogeneity.

Sample heterogeneity measures the variability between two samples that are believed to represent the same point in time and location within the site. It is also a function of the sampling techniques, such as volume of sample and method of collection. It is important to measure the sample heterogeneity so that the quality of the data can be adequately assessed. To accomplish this, a minimum of one sample duplicate per sedimentary interbed and/or one sample duplicate every ten samples per sedimentary interbed will be collected. In addition, one duplicate will be submitted with each fracture filling sample submitted.

Within-sample heterogeneity is a measure of the differences in the way samples are handled during sample preparation and analysis. Within-sample heterogeneity is measured using split samples. Theoretically, split samples are assumed to have exactly the same split. However, the use of split samples is not always effective in quantifying the difference in sample handling and splitting for very low-level radiochemical analyses. If the volume of the sample is large relative to the concentration of the isotope of interest, the concentration of an isotope may vary greatly within the sample. For some radionuclides, concentrations may be associated with only one of two particles of the isotope. It then becomes possible to split a sample so that the radionuclide is heterogeneously distributed between splits. The very low concentration of radionuclides in environmental samples and the effect of small particles must be considered in evaluating the data for split samples. A minimum of one split per sedimentary interbed will be submitted for analysis.

Spatial or population heterogeneity is a characteristic of the site of interest. Spatial heterogeneity results from the natural geologic processes that formed the site. It is a fixed quantity that cannot be changed by taking more samples or using more exact sampling techniques. Spatial heterogeneity depends on the distance between the sample locations and the physical proximity of the samples at each location. An estimate of spatial heterogeneity for each interbed can be obtained from comparison of several samples from each sample location or from comparison of samples between several different locations.

The number of duplicate pairs and split pairs required to estimate sample heterogeneity and within-sample heterogeneity depends on how precise a measure of these sources is required. However, practical problems (drilling technique, schedules, costs, etc.) limit the number of splits or duplicates that can be taken. The precision can be estimated from the number of samples actually obtained. It will be assumed that the variances follow Chi-Square distribution. This is true if the data follow a normal distribution, and is approximately true for the large sample Poisson distribution. The Chi-Square distribution, and associated precision, are calculated as follows:

Let σ^2 denote the variance to be estimated (either sample or within-sample variance). Let s^2 denote the estimate of σ^2. Let n denote the number of pairs of samples (either duplicates or splits) collected. And let χ^2_α denote the Chi-Square value that has an area of α to left of it (less than it) under the Chi-Square distribution. Then the precision obtained with confidence $1-\alpha$ is given by

$$\frac{ns^2}{\chi^2_{\alpha/2}} \leq \sigma^2 \leq \frac{ns^2}{\chi^2_{1-(\alpha/2)}}$$

The following gives examples of the use of this formula for 95 percent confidence:

n	Precision
2	$0.27s^2 \leq \sigma^2 \leq 39.21s^2$
5	$0.39s^2 \leq \sigma^2 \leq 6.02s^2$
10	$0.49s^2 \leq \sigma^2 \leq 3.08s^2$
20	$0.58s^2 \leq \sigma^2 \leq 2.08s^2$

Hence, if one takes 5 pairs of samples, one can be 95 percent confident that the true amount of variability lies between $0.39s^2$ and $6.02s^2$. Decreasing the confidence level will decrease the width of the interval.

4.2.2 Radiological Analytical Data Quality

The procedure for determination of transuranic (TRU) radionuclides (non-gamma emitting radionuclides) in soil requires a 10-gram sample counted for 1000 minutes in an alpha spectrometer having a counting efficiency of 25 percent and a background of about eight counts in 1000 minutes. About 10 disintegrations per minute of isotopic tracer containing less than 0.1 percent of other isotopic activity is used and the chemical yield is at least 80 percent. Under these conditions, the detection limit for each radionuclide as defined by Currie is 3×10^{-3} pCi/g (Currie, 1968). The precision increases from a relative standard deviation of about 15 percent at 1×10^{-2} pCi/g to about 3 percent at 5×10^{-1} pCi/g. The accuracy obtained on standard soils containing exactly known activities is generally within the precision with which the measurement is carried out, i.e., there are no significant systematic errors in the analytical procedure. Curries's (1968) definition of detection limit for paired observations of sample and blank is:

$$C = 2.71 + 4.65 \sqrt{(B)}$$

The detection limit represents the total counts under the stated conditions, where "B" is the total number of counts accumulated in the background (Currie, 1968).

The gamma spectroscopy procedures and quality controls for analysis of gamma-emitting radionuclides are addressed in the "Quality Assurance/Quality Control for the Radiation Measurement Laboratory - Gamma Spectroscopy," (EG&G 1989e).

5.0 SAMPLING PROCEDURES

Samples will be collected from the sedimentary interbeds encountered in Borehole 8901D. Detailed sampling procedures are described in the Buried Waste Program Site Characterization Procedures: Deep Drilling Project for Vacuum Extraction Borehole (EG&G, 1989b). Detailed sample preparation procedures are described in Standard Operating Procedure for Soil Sample Preparation for the RWMC Site Characterization Program (EG&G, 1989c). These procedures are summarized in the following sections.

5.1 SAMPLE COLLECTION

Samples will be collected in the laboratory from each inner lexan tube assembly that has penetrated the sedimentary interbeds encountered during drilling. The first anticipated sampling interval in this borehole is the 10-meter (30-foot) interbed. The next sampling interval is expected to begin at the 33-meter (110-foot) interbed, and the final interval will be at the 73-meter (240-foot) interbed. When the planned total depth of the borehole has been reached [approximately 1.5 meters (5 feet)] below the 73-meter (240-foot) interbed, it will be completed as a well for the Vapor Vacuum Extraction Demonstration, as shown in Figure 5-1.

Approximately 1.5 meters (5 feet) above the expected depth of the interbed, the drill steel and tricone bit will be replaced with core steel and a CP-series oversize core bit. When the basalt-sediment interface is breached, the diamond core bit will be replaced by a tungsten carbide core bit. The tungsten carbide diamond core bit drill string set-up will be used to core all of the interbeds. When the base of each interbed is encountered, the tungsten carbide core bit will be replaced by the diamond core bit to core an additional 1.5 meters (5 feet) below the basalt-sediment interface.

The core will be recovered from the borehole by withdrawing the inner tube assembly from the outer tube assembly using wireline. At the surface, the inner tube assembly will be surveyed for both radioactivity and organic vapors prior to removal from the outer assembly. If the inner core barrel shoe contains core, the shoe will be sent to the laboratory for subsequent sampling. The shoe may be transported attached to the inner tube or separate,

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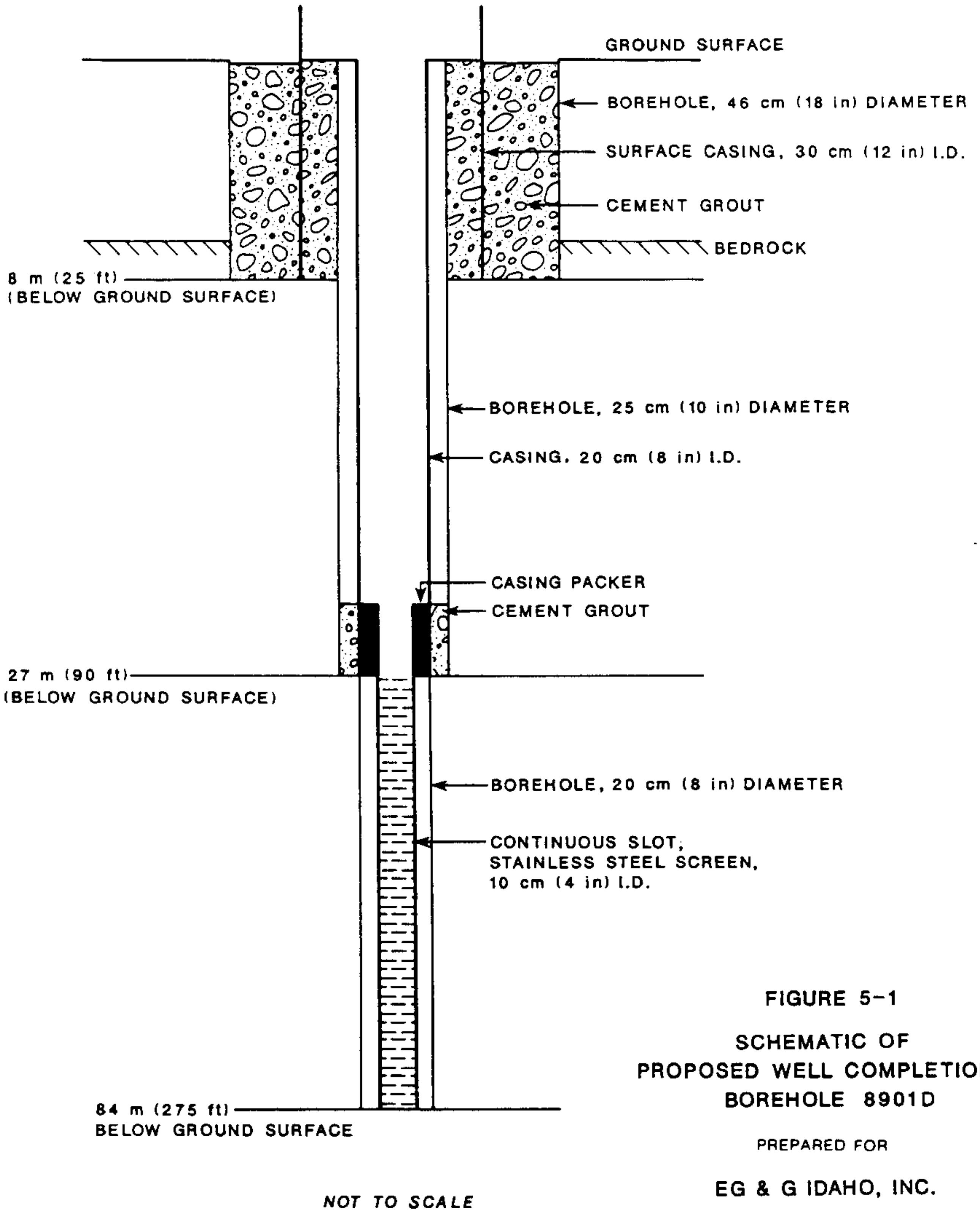

FIGURE 5-1

SCHEMATIC OF
PROPOSED WELL COMPLETION,
BOREHOLE 8901D

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depending on the drilling technique being used. The inner tube (and the shoe, if separated) will be removed, labeled, and plastic caps placed on the open ends of the tube.

The Project Geologist will record a field description of the core within the inner tube, including texture, color, and general appearance. If any portions of the inner tube are empty, the empty section of tube will be cut off with a pipecutter and a new plastic cap placed on the open end. After the core has been recovered from the borehole and properly logged and documented (Chain-of-Custody forms completed), the core will be delivered to the laboratory for sample selection and preparation. Core sent to the sample preparation laboratory must be transported in a vertical position to avoid disturbance of the core.

Following transportation of the inner tube assembly to the laboratory, the Project Geologist will select approximately 7.5 to 10 centimeters (3 to 4 inches) of undisturbed core for radiological analysis. For sample collection, priority is given to the interface at the top of the interbed (preferably the top 0.5 meter [1-2 feet]) and the bottom interface (preferably the last 0.3 meter [1 foot]). Samples will be collected every 10 centimeters (4 inches) where possible. One sample out of every ten samples collected (a minimum of one per interbed) will be collected from the "rind" material, outer sedimentary material after subcoring, as a field duplicate to evaluate potential cross-contamination.

Additional samples will be collected approximately every 0.3 meter (1 foot) of the remaining interbed. The additional samples will be selected to provide a core interval [7.5- to 10-centimeter (3 to 4 inches)] duplicate that will allow comparison of radionuclide data from potentially cross-contaminated outer core surfaces with data derived from the center of the same 7.5- to 10-centimeter (3 to 4 inches) core interval.

The selected sections will be cut off with a pipecutter, labeled and capped. The sample will be prepared for analysis as described in "Standard Operating Procedure for Soil Sample Preparation for the RWMC Site Characterization Program" (EG&G, 1989c).

The Project Geologist will also examine the core retrieved from the 1.5 meter (5 feet) interval above and below the interbed to evaluate the sedimentary fracture filling in the basalt. If possible, one sample will be taken from the fracture fillings in the basalt just above and below the sedimentary interbed following instructions in Section 6, steps 1 through 13 of the SOP (EG&G, 1989c) and will be submitted for radiological analysis. All remaining core material will be archived. Archived samples will be stored in a well-sealed, unbreakable container, labeled, recorded in the RWMC Sample Preparation Logbook and on the Master Core Diagram, and placed in the storage area.

During the drilling and sampling, the Project Geologist shall maintain the following logs:

- Drilling Activity Log
- Sample and Core Description log
- Weekly Summary of Drilling and Sampling Collection Progress.

Changes to the sample collection procedures will be made by Document Revision Request (DRR) and approved by the approval committee of the original document. The nature of drilling and sampling activities is such that variations from the procedures are occasionally required to complete the task. These small irregularities in field drilling and sampling procedures are one-time occurrences (such as using a different type of bit in one interval because of the condition of the rock) for which a document revision is not necessary or desirable, and will be documented in the Daily Activity Log maintained by the Deep Drilling Project Manager.

5.2 DECONTAMINATION

Contamination control procedures will be followed during the sampling effort to minimize cross-contamination of samples and after equipment use to prevent contamination of the environment away from the drill site. Contamination control procedures are described in Section 5 of the "Buried Waste Program Site Characterization Procedures: Deep Drilling Project for Vapor Vacuum Extraction Borehole (EG&G, 1989b) and are summarized in the following sections.

5.2.1 Contamination Control Procedures

The procedures that will be used for contamination control include the use of smears. Smears will be taken from sample collection equipment and tools before and after each interbed has been sampled and before and after tooling or steel are put in the borehole. Control of radionuclide contamination will be accomplished by maintaining all tools and equipment used in and around the drill site at 50 disintegrations per minute/100 square centimeters, beta-gamma, and $1x10^{-5}$ microCuries/100 square centimeters, Plutonium-238, -239, -240 or Americium-241, as determined by analyzing smears on the gross beta-gamma counter or the alpha spectrometer. Past experience has shown that most of the smears from equipment are near the laboratory detection limit of $1x10^{-9}$ microcuries/gram, alpha. Therefore, if the equipment is kept at the prescribed levels, it is unlikely that detectable levels of radioactivity will be introduced into the samples.

All counted smears will be separated into four categories (drilling area, smear counting area, decontaminated equipment, and sample preparation area) and retained until the end of each day. At the end of the day, a composite sample consisting of 15 percent of the total smears from each category will be submitted to the Radiological Measurements Laboratory.

5.2.2 Decontamination Procedures

All equipment that is used in drilling, the collection of samples, and sample handling may contain hazardous or radiologically contaminated material and will be discarded or decontaminated using the procedures described in Section 5.0 of the Standard Operating Procedures (EG&G, 1989b). These procedures include decontamination of laboratory equipment, the sampling equipment prior to use, and the drill string.

Sampling equipment and the core barrel assembly will be steam cleaned, rinsed with distilled water, rinsed with methanol and hexane with intervening and final distilled water rinses, then left to air dry. Sampling equipment and the core barrel assembly will be labeled and tripled bagged in plastic when not in use. Drill pipe and coring drill string will be steam cleaned, stacked, and wrapped in plastic when not in use.

6.0 SAMPLE CONTROL AND DOCUMENT MANAGEMENT

The collection of data and samples from Borehole 8901D will be fully documented in field logbooks and progress reports. All samples and core materials sent to the laboratory or the core repository will be labeled, tagged, and accompanied by a Chain-of-Custody form. These samples will be screened in the field for gross radionuclide contamination and for volatile organic vapors using field instruments. After appropriate labeling and packaging, the samples will be transported to the laboratory for analysis. Procedures for the documentation of data and sampling collection, for the control and tracking of samples, and for ensuring the integrity of the samples are described in the following sections.

6.1 DOCUMENTATION

Documentation of drilling and sampling activities will include the use of sample labels, sample tags, custody seals, sample identification numbers, field logbooks, and sample tracking. This documentation is necessary to ensure that all of the appropriate data is collected and, further, to aid in interpreting and validating the data. Photographs will be taken of the drilling operations, sample collection, and sample preparation to further document the sampling process. The field documentation is described in detail below.

6.1.1 Sample Labels

All physical samples collected during the sampling of Borehole 8901D will be labeled. Gummed labels will be affixed to the sample container and to any outer wrapping of the sample. Samples selected for analysis by the radiological laboratory will be labeled with the borehole identification number, sample identification number, date and time of sample collection, analysis requested, preservative, name of collector, sample weight, and sample depth. Labels on core will include the location of the top of the core, core identification number, drill hole number, date collected, core interval, collector's initials, organic vapor reading, and radiation reading if above background. An example of a label is shown in Figure 6-1.

TOP OF SAMPLE
RWMC SUBSURFACE INVESTIGATIONS
CORE NUMBER 8802D28
Date Collected _______ Time _______
Interval (Ft) From ______ To ______
HNU (Above Background) _______ ppm
Collector ________________________

A. EXAMPLE OF SAMPLE LABEL

RWMC/BWP SAMPLE TAG

Sample I.D. Number:	Date: / / Time: : :
Sampling Location:	Sampler:
Analysis:	
Concentration: ☐ Environmental ☐ Hazardous ____________ (hazard)	
RAD Screen: ____________ mREM/hr Activity: ____________ mCi Isotope(s): ____________	

B. EXAMPLE OF SAMPLE TAG

CUSTODY SEAL

DATE ______________________________

SIGNATURE ______________________________

C. EXAMPLE OF CUSTODY SEAL

FIGURE 6-1

EXAMPLE OF A SAMPLE LABEL, A SAMPLE TAG, & A CUSTODY SEAL TO BE USED IN SAMPLING AND ANALYSIS OF BOREHOLE 8901D

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6.1.2 Sample Tags

The sample tag is attached to the sample to identify the sample and to indicate to the lab the potential for hazardous constituents, if known. All samples collected during this activity will have a sample tag in addition to the sample label. A rubber band, wire fastener or piece of tape will be used to attach the tag to the sample container. If a plastic bag is used to contain a sample, the tag will be attached to the plastic bag. The sample tag will include the sample identification number, sampling location, sample collector, date and time of collection, analysis requested, concentration, and radiation screen results. An example of a sample tag is shown in Figure 6-1.

6.1.3 Custody Seals

The Project Geologist is responsible for the proper recovery, preservation, and storage (in locations locked to prevent unauthorized access) of the samples until the samples are delivered to the laboratory. Custody seals or evidence tape will be used to detect tampering of samples between the time the samples are collected and the time the laboratory opens the samples for analysis. The seal or tape will be attached in such a way that the seal or tape must be broken to open the sample container. The seal or tape will contain the following information: name and address of collecting organization, signature of person collecting the sample, sample identification number, and date and time of collection. An example of a custody seal is shown in Figure 6-1.

6.1.4 Sample Identification Number

A unique sample identification number will be assigned to each sample. The sample identification number must be: (1) unique to distinguish the sample from other similar evidence; (2) traceable throughout the sampling and analysis process; (3) not longer than 12 digits; and (4) consist of numeric characters 0 through 9 and upper case alphabetic characters A through Z.

To meet these requirements, the sample identification number will have the following sequence of alphanumeric characters:

CHARACTERS	DEFINE	CODE
1	BWP task	E
2 & 3	Year of collection	89

The remaining characters of the sample identification numbers will be specified prior to initiation of sampling Borehole 8901D.

6.1.5 Field Logbooks

Logbooks will be used to document the daily activities, the core retrieved, samples selected, and other aspects of this activity. Table 6-1 lists the logs that will be maintained, who is responsible for log maintenance, and the data required in the log. The field logbooks will be bound with consecutively numbered pages. An exception to this is the RWMC Samples Notebook, which is a loose-leaf binder intended to hold completed forms, e.g. sample tracking form, chain-of-custody form, for easy reference until the completion of the activity. All entries will be made in permanent black ink, dated, and signed by the person making the entry. The individual listed in the "Responsible Position" on Table 6-1 is responsible for retaining and ensuring the proper use of the field logbook.

If an error is made in the logbooks, corrections will be made by drawing a single line through the error and the correct information entered. All corrections will be initialed and dated by the individual making the correction. Logbook pages will not be removed for any reason. If documents are lost, new documents will be completed. A description of the documents lost and an explanation of how the loss was rectified will be recorded in the Daily Activity Log.

6.1.6 Chain-of-Custody

The Chain-of-Custody (COC) record establishes the documentation necessary to trace the sample possession from the time of collection to analysis. This record will be initiated by the field staff and a copy of the record will be kept in the RWMC Samples Notebook. The COC record will accompany the samples to the laboratory where it will be signed and dated by the Laboratory Manager or Laboratory Custodian accepting delivery of the samples. The laboratory and field COC record will be returned to the Deep Drilling Program to be filed at the Administrative Record and Document Control (ARDC) after the sampling and analysis is complete. The COC may be combined with the Sample Analysis Request form.

TABLE 6-1

LOGBOOKS REQUIRED FOR DRILLING AND SAMPLING ACTIVITIES

LOGBOOK TITLE	RESPONSIBLE POSITION	INFORMATION REQUIRED
Daily Activity Log	Deep Drilling Program Manager	Decontamination, Daily Safety Meeting, approval of sampling site locations, driller's activities, changes in procedures, documentation of circumstances, field observations, weather conditions, name and address of field contacts, site visitors.
Subcontractor Daily Drilling Summary	Driller	Footage, equipment used, supplies used, hours worked.
Weekly Summary of Drilling and Sample Collection Progress	Project Geologist	Footage drilled, footage cored, number of samples collected, types of analyses, problems.
Sample and Core Description Log	Project Geologist	Description of core, borehole ID number, sample ID number, date and time of collection, type of analysis, name of collector, document core preparation.
Monitoring Activities Log	Industrial Hygienist	Organic vapor levels, equipment used, calibration results.
Drilling Activity Log	Project Geologist	Footage drilled, footage cored, drilling rate, coring rate, recovery, equipment used, supplies used, hours worked, problems encountered.
Site Attendance Log	Deep Drilling Program Manager	Name, affiliation, time of entry and exit, reason for visit.
RWMC Sample Preparation Log	Project Geologist	Sample preparation procedures, deviations from established procedures, geologic description of sample, smear results, calibration check, equipment model and serial number, OVA readings, sample length, sample weight, sample interval, disposition of excess sample material.
RWMC Samples Notebook	Project Geologist	Sample tracking form, Chain-of-Custody form, Master Core Diagram, Sample Diagram.

The COC record (Figure 6-2) will contain, at a minimum, the following information:

- Sample identification number
- Signature of collector
- Date and time of collection
- Sample type
- Signatures of all persons receiving and relinquishing samples
- Inclusive dates of sample possession.

6.1.7 Sample Analysis Request

The Request for Analysis form (Figure 6-3) must be fully completed by the sampling personnel. The information provided on the form will be consistent with information on the Sample Collection Log and the Chain-of-Custody Record to ensure complete tracking of the samples. The laboratory portion of the form will be completed by the analytical laboratory. The Request for Analysis form will accompany the COC record and the sample shipment. A copy of the form will be retained in the field record. The form will include the following information:

- Chain-of-Custody control number
- Project name and number, and the Sampling Leader's name
- Laboratory destination and contact
- Report due date and designated recipients
- Sample identification number
- Type of sample
- Sample size/weight (in grams)
- Preservation
- Requested analyses and special instructions
- Turnaround time
- Possible hazard(s) identification
- Sample disposal instructions
- Sample collection procedure.

6.1.8 Green Tag or Radioactive Shipment

All samples will be surveyed by the HP technician. If the samples are within EG&G Idaho limits for clean material (2100 disintegrations/minute, beta/gamma), a green tag will be issued and the sample may leave the site. If the samples are above the 2100 disintegrations/minute (beta/gamma) limit, DOE Form ID-F-5480.1A (Rev. 7-83) will be filled out and the sample will be sent as a radioactive shipment, in accordance with DOT regulations 49 CFR 170 through 179.

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BURIED WASTE PROGRAM CHAIN OF CUSTODY FORM

Page ______ of ______

Project Name	Contract No.	Sampler (Signature)	Project Contact / Phone

Sample Number			Sampling Date	Sample Matrix	Remarks / Descriptions
Item	Field I.D.	Lab I.D.			

Special Instructions:

Item	Relinquished by: (Signature)	Received by: (Signature)	Date	Time	Item	Relinquished by: (Signature)	Received by: (Signature)	Date	Time

[illegible]

FIGURE 6-2

EXAMPLE OF A BURIED WASTE PROGRAM CHAIN OF CUSTODY FORM

PREPARED FOR

EG & G IDAHO, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

RML/RADIOCHEMISTRY ANALYSIS REQUEST/CUSTODY FORM
PHONE: 6-4177 / 6-4182

ONE SAMPLE PER SHEET!

SAMPLE NAME OR DESCRIPTION: ______________________________

FACILITY/AREA SAMPLE ID #: ______________________________

REQUESTING FACILITY: ______________ SEND RESULTS TO: ______________

SUBMITTED BY: ____________________ EXT.: ______________

REQUESTOR, PLEASE CHECK TYPE OF ANALYSES DESIRED:

____ Isotopic gamma scan
____ Gross alpha/beta
____ Strontium beta
____ Tritium
____ Actinide
____ Other ______________

RML/CHEM USE ONLY

DATE RECEIVED: ____________
INITIAL: ____________

DATE COMPLETED		INITIAL
________	Gamma	________
________	A/Beta	________
________	Sr-90	________
________	H-3	________
________	Actinide	________
________	Other	________

FORWARDED TO: ____________
DATE: ____________

REQUESTOR, PLEASE FILL IN APPROPRIATE INFORMATION BELOW:

Activity (mr/hr): ______________________________

Sample On (time & date): ______________________________

Sample Off (time & date): ______________________________

Collection time (hrs): ______________________________

No. of cams in envelope: ______________________________

Stack flow (cfm): ______________________________

Filter flow (cfm): ______________________________

Filter fraction (%): ______________________________
(Area used)

Effluent volume (gal.): ______________________________
(Total gal. discharged)

REMARKS: ______________________________

____

FIGURE 6-3

EXAMPLE OF A REQUEST FOR ANALYSIS FORM

PREPARED FOR

EG & G IDAHO, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWING NUMBER 301120 15 A7

CHECKED BY 4-13-89

APPROVED BY 4/13/89

DRAWN BY SM 4/13/89

"Do Not Scale This Drawing"

133974

6.1.9 Equipment Calibration Logbook

Each piece of equipment used to evaluate the safety of the work or contamination/radiation levels will have an equipment calibration logbook. A complete description of the location, instrument used, calibrations performed, and data obtained will be included in the logbook. Additional information logged will include:

- Sample taken
- Standardizations performed
- Usage maintenance
- Anomalies, fluctuations in readings, strange behavior
- Climatic conditions.

6.1.10 Sample Tracking

After core recovery, field chain-of-custody will be initiated by completing BWP for 114. The core will then be transported to the site core storage area or to the sample preparation laboratory. When the core is received at the sample preparation laboratory, the core will be logged on an internal sample tracking form, as described below. If the core is sent to a storage area, the BWP Chain-of-Custody form 114 will be completed and a copy sent to the Administrative Record and Document Control (ARDC).

The laboratory will have a QA/QC program that, as a minimum, will accomplish the following. Upon sample(s) receipt by the laboratory, the Laboratory Custodian will inspect the sample(s) and sample seal(s) condition, reconcile the information on the sample label and seal against that of the chain-of-custody record, assign a laboratory number, log in the sample(s) in the Laboratory Logbook, and store the sample(s) in a secured sample storage room or cabinet until assigned to an analyst.

The Laboratory Custodian will inspect the sample(s) for any leakage. A leaky container containing a multiphase sample should not be accepted for analysis because the sample(s) may no longer be representative. If the sample is under pressure, or releasing gases, the sample should be treated as potentially explosive or as possibly containing hazardous gases. Any discrepancies between the information on the sample label and seal, and the information on the chain-of-custody record and the Sample Analysis Request Sheet will be resolved before the sample is assigned for analysis. This effort may require communications with the sample collector. Results of the inspection will be noted on the Sample Analysis Request Sheet and on the Laboratory Sample Logbook.

Incoming sample(s) will carry the collector's identification number. To further identify these samples, the laboratory should assign its own identification numbers which normally are given consecutively. Each sample should be marked with the assigned laboratory number. This number is correspondingly recorded on a Laboratory Sample Logbook, along with the information describing the sample. The sample information is copied from the Sample Analysis Request Sheet and cross referenced against the information on the sample label. In most cases, the Laboratory Manager assigns the sample to an analyst. The Manager shall review the information on the Sample Analysis Request Sheet, which includes inspection notes recorded by the Laboratory Custodian. The analyst assigned to analyze the sample shall record in the Laboratory Notebook the identifying information about the sample, the receipt date, analysis date, and other pertinent information. This notebook shall also include the subsequent testing data and calculations, recorded on the "Radiation Measurements Laboratory - Sample and Counting Information" form (Figure 6-4).

The sample(s) may have to be split with other laboratories in order to obtain all the necessary analytical information. In this case, the same type of chain-of-custody procedures must be followed at the other laboratories and while the sample is being transported to the other laboratories.

Once the sample has been received in the laboratory, the Laboratory Manager or assignee is responsible for the sample care and custody. The Laboratory Manager or assignee should be prepared to testify that the sample was in his/her possession or secured in the laboratory at all times from receipt until the analyses were completed.

6.2 SAMPLE HANDLING

To prevent contamination and to ensure that the analytical data are truly representative of the sample media collected, the samples must receive proper handling.

EG&G Idaho Inc

FORM EG&G-1490
Rev. 12-87

RADIATION MEASUREMENTS LABORATORY - SAMPLE AND COUNTING INFORMATION

Sample: NAME ______ Transferred ☐ Analyzed ☐
ESPID or S.T. # ID ______ ID ______ CODE ______
Sample/Filter (In Time) ______ Date ______ Irradiation Time (HRS) ______
Sample Count Started: Time ______ Date ______ Count Time (MIN) ______
Detector # ______ Distance (cm) ______ Sample Volume ______ Volume Units ______
Eff. Corr. Factor ______ Efficiency Table ______ Analyst ______

Additional Analyses Requested: Remarks:

No. of CAMS ______ ___ None ______
Stack Flow (CFM) ______ ___ Gross Alpha ______
Filter Flow (CFM) ______ ___ Gross Beta ______
Coll. Time (HRS) ______ ___ Sr ______
Filter Frac. (%) ______ ___ H-3 ______
Reactor Power (MW) ______ ___ ______ ______
Effluent Volume (GAL) ______ ___ Stored ______
Date Received ______ ___ Dumped or Disposed of ______

Sample Forwarded to ______ Date ______

Sample: NAME ______ Transferred ☐ Analyzed ☐
ESPID or S.T. # ID ______ ID ______ CODE ______
Sample/Filter (In Time) ______ Date ______ Irradiation Time (HRS) ______
Sample Count Started: Time ______ Date ______ Count Time (MIN) ______
Detector # ______ Distance (cm) ______ Sample Volume ______ Volume Units ______
Eff. Corr. Factor ______ Efficiency Table ______ Analyst ______

Additional Analyses Requested: Remarks:

No. of CAMS ______ ___ None ______
Stack Flow (CFM) ______ ___ Gross Alpha ______
Filter Flow (CFM) ______ ___ Gross Beta ______
Coll. Time (HRS) ______ ___ Sr ______
Filter Frac. (%) ______ ___ H-3 ______
Reactor Power (MW) ______ ___ ______ ______
Effluent Volume (GAL) ______ ___ Stored ______
Date Received ______ ___ Dumped or Disposed of ______

Sample Forwarded to ______ Date ______

Sample: NAME ______ Transferred ☐ Analyzed ☐
ESPID or S.T. # ID ______ ID ______ CODE ______
Sample/Filter (In Time) ______ Date ______ Irradiation Time (HRS) ______
Sample Count Started: Time ______ Date ______ Count Time (MIN) ______
Detector # ______ Distance (cm) ______ Sample Volume ______ Volume Units ______
Eff. Corr. Factor ______ Efficiency Table ______ Analyst ______

Additional Analyses Requested: Remarks:

No. of CAMS ______ ___ None ______
Stack Flow (CFM) ______ ___ Gross Alpha ______
Filter Flow (CFM) ______ ___ Gross Beta ______
Coll. Time (HRS) ______ ___ Sr ______
Filter Frac. (%) ______ ___ H-3 ______
Reactor Power (MW) ______ ___ ______ ______
Effluent Volume (GAL) ______ ___ Stored ______
Date Received ______ ___ Dumped or Disposed of ______

Sample Forwarded to ______ Date ______

FIGURE 6-4

EXAMPLE OF THE
INEL RADIATION MEASUREMENTS
LABORATORY SAMPLE
AND COUNTING INFORMATION FORM

PREPARED FOR

EG & G IDAHO, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWING NUMBER 301120 15 A21
CHECKED BY / APPROVED BY
SM 4/13/89
DRAWN BY

133974

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6.2.1 Sample Containers

The samples will be placed in pre-cleaned containers of the appropriate size for the analysis being performed. The laboratory will provide clean containers that will remain sealed until used to contain the samples. Table 5-1 indicates the proper container, preservative, and holding time for the parameter of interest.

6.2.2 Sample Preservatives

To preserve the sample integrity as collected in the field for the analyte of interest, it may be necessary to preserve the sample. Soil and recovered core samples collected solely for radiological analysis require no preservatives and are not subject to holding times.

6.2.3 Field Radiation Screening

All samples will be measured for direct radiation and results will be logged in the sample logbook. The specific procedures for the field measurements will depend upon the type and brand of instrument chosen for the field work. The direct radiation measurement will be used for the purpose of health protection and locating "hot spots" for sampling. The instrument will be calibrated by EG&G's instrument laboratory prior to field use. It will be used by a trained Health Physics Technician (HP) to insure the safety of field personnel.

6.2.4 Field Screening for Hazardous Substances

Employee exposure to hazardous substances will be monitored during the sampling activities, using a combination of techniques addressed in the Health and Safety Plan (EG&G, 1989d). Organic vapor measurements will be taken periodically from the spin-off soil and the hole being drilled. Measurements will also be taken from the core barrel as it is raised out of the hole. A portable gas chromatograph and/or HNu will be used to take these measurements.

6.2.5 Transportation of Samples

After sample collection and packaging in the field, the samples must reach the laboratory intact and in a timely manner. Samples will be packaged according to the Department of Transportation (DOT) shipping requirements. There are two basic categories for samples under the DOT regulations: environmental samples and hazardous substance samples. The nature of the samples collected for this project are considered environmental samples, unless the field survey of the samples indicate otherwise.

This section applies to samples that have been collected and are ready for packaging prior to shipment to the radiological laboratory. The procedures below should be implemented immediately after collection to ensure proper handling.

1. Sign (field sample custodian or person doing the packaging) the chain-of-custody form upon receiving the sample from sampler.
2. Check to see if each container is properly labeled.
3. Attach sample security seal to sample containers in such a way that it is necessary to break it in order to open the sample container.
4. Place sample container, properly labeled and sealed, in a plastic bag.

All on-site shipments must follow the proper DOT shipping requirements. If the suspected radioactivity per unit mass of the sample is above EG&G and DOT 49 CFR standards (0.002 microCuries/gram), procedures for shipping radioactive materials will be implemented. DOE-ID Form 5480 will be filled out prior to removing the sample from the site.

7.0 EQUIPMENT MAINTENANCE AND CALIBRATION

The following is a list of field equipment that will be used in this activity. The field equipment is generally for monitoring health and safety conditions around the drilling area, although measurements from these instruments may be used in interpreting the data later in the program. The field equipment is divided into two categories, radiological monitoring and industrial hygiene monitoring. Calibration, operation and maintenance procedures for this equipment can be found in the SOP for drilling and sampling of Borehole 8901D (EG&G, 1989a). Drilling and sampling equipment are not included, but are described in Section 5.0, Sampling Procedures.

RADIOLOGICAL MONITORING EQUIPMENT	INDUSTRIAL HYGIENE MONITORING EQUIPMENT
Alpha Continuous Air Monitor	11-7 Lamp
Beta-Gamma Continuous Air Monitor	10-2 Lamp
TLD Dosimeter	HNu Organic Vapor Analyzer
Pencil Dosimeter	Draeger Tubes
Pancake Detector	Vapor Badges
GM Detector	Mercury Badges
	Personal Monitoring Pump (organic vapors)
	Personal Monitoring Pump (particulates)
	Explosivity Meter
	Barometer

Calibration of field equipment will be in accordance with the calibration program described in QPP-149. The guidance of SW-846 (third edition) (EPA, 1986) will be followed in determining, industrial hygiene instrument calibration frequency and concentrations based on the methodology employed for sampling. Equipment of the proper type, range, accuracy, and precision to provide data compatible with the data quality objectives of this activity will be employed. Calibration of measuring and test equipment will be performed internally using standards traceable to the National Bureau of Standards, where applicable, or externally by the equipment manufacturer or approved calibration facility. If no nationally recognized standard exists for the equipment to be calibrated, the bases for calibration shall be documented.

7.1 RESPONSIBILITIES

Responsibility for calibration and maintenance of radiological monitoring equipment resides with the Health Physics Technician. The Industrial Hygienist will be responsible for industrial hygiene equipment calibration and monitoring. Calibration and maintenance of any laboratory equipment is the responsibility of the Laboratory Manager. The Project Geologist is responsible for ensuring equipment used by the subcontractor in the field is calibrated.

It is the responsibility of the personnel using the equipment to check the calibration status in the log or record prior to use and to ensure that the equipment is operational. All personnel handling, transporting or storing measuring equipment will do so in a manner which will minimize the risk of adversely affecting the calibration.

7.2 MAINTENANCE AND OPERATION

The following preventive maintenance items will be accomplished before sampling begins:

1. Monitoring equipment calibration status and operability will be checked.

2. All sample containers will be prepared in advance - extra containers will be provided in case of breakage, sample contamination, etc.

3. Spare monitoring equipment will also be provided to minimize downtime due to equipment malfunction to the greatest extent possible.

Laboratory equipment requiring routine maintenance will have an individual instrument file indicating the frequency of required maintenance, maintenance history, spare parts maintained by the laboratory, directions for maintenance, and any external service contracts. Preventive maintenance will be the responsibility of the Laboratory Manager. As a minimum, the laboratory will be required to have:

1. Spare parts, as recommended by the instrument manufacturer, and

2. The above items delineated in the Laboratories' written QA/QC plans.

7.3 CALIBRATION

Documented and approved procedures will be used to calibrate all measuring and test equipment. Whenever possible, widely accepted procedures will be used, such as those published by the USEPA SW-846 (third edition) (EPA, 1986) or procedures provided by the equipment manufacturer.

7.3.1 Procedures

As a minimum, calibration procedures shall include:

a. Type of equipment to be calibrated
b. Calibration method and sequential actions
c. Calibration data recording form and format
d. A list of critical or replacement parts.

Each piece of equipment will be identified so that the pertinent calibration information can be retrieved. The equipment will have an individual calibration log and be calibrated/standardized prior to use or as part of the operational use following the manufacturer's recommended calibration/standardization procedure(s).

Field equipment will be calibrated at prescribed intervals and/or prior to use. Frequency will be based on the type of equipment, inherent stability, manufacturer's recommendations, intended use, and experience.

Reference standards (physical and chemical) will be used only for calibration. Physical standards will be stored separately from working equipment. Chemical standards will be stored separately from analytical reagents/solvents and samples, and changed at recommended intervals. Radiation check sources will be stored in appropriate containers away from working equipment.

7.3.2 Records

Records will be prepared and maintained for each piece of calibrated equipment to indicate that established calibration procedures have been followed. Calibration records for the equipment controlled by the various laboratories, offices, and groups will be maintained by the respective organization. Records for subcontractor equipment use will be kept in the Project Files in the BWP Document Control Coordinator's office at project completion.

7.3.3 Calibration Failure

Equipment that fails calibration or becomes inoperable during use will be removed from service and segregated to prevent inadvertent use, or will be tagged to indicate it is out of calibration. Such equipment will be repaired and/or recalibrated to the satisfaction of the Health Physics Technician, the Laboratory Manager or BWP Cost Account Manager, as appropriate, prior to further use. Equipment that cannot be repaired will be replaced.

Results of activities performed using equipment that requires adjustment during recalibration will be evaluated by the Analytical QA Officer or the Laboratory Manager. If the activity results are adversely affected, the BWP Cost Account Manager will determine if the data can be adjusted or if new sample analyses are required. The results of the evaluation will be documented and retained in the Project Files.

8.0 ANALYTICAL PROCEDURES

Samples of core recovered from Borehole 8901D will be analyzed for the radioactive constituents identified in Table 1-1. The radiological analyses will be performed at the INEL Radiation Measurement Laboratory (RML). The samples will be analyzed following the methods outlined in Table 8-1.

Reporting requirements for the analytical work performed for this SAP include, at a minimum, the following:

- Narrative report, describing analytical problems encountered and internal QC processes applied
- Copies of sample tracking reports
- Quality control summary, instrument tuning, and performance information
- Sample data, including tabulated results (with uncertainties) of the radionuclides identified and quantified
- Sample and accompanying data to be archived.

Radionuclide analysis by gamma spectroscopy analytical procedures can be found in Quality Assurance/Quality Control Document for Gamma Spectroscopy at Radiation Measurement Laboratory (EG&G, 1989e). Analysis for alpha emitting radionuclides is described in "Preparation and Testing of Standard Soils Containing Known Quantities of Radionuclides," (Sill and Hindman, 1974).

TABLE 8-1

ANALYTICAL METHODS FOR RADIOACTIVE CONSTITUENTS

PARAMETER	SAMPLE SIZE	COUNTING TIME	APPLICABLE ANALYTICAL PROCEDURE	EXPECTED DETECTION LIMITS (ESTIMATED)
Mn-54	100 g	2 hrs	Gamma Spectroscopy	0.4 pCi/g
Co-60	100 g	2 hrs	Gamma Spectroscopy	0.4 pCi/g
Zn-65	100 g	2 hrs	Gamma Spectroscopy	0.8 pCi/g
Sr-90	10 g	200 min	Beta Radiochemistry	0.1 pCi/g
Ag-110m	100 g	2 hrs	Gamma Spectroscopy	0.4 pCi/g
Sb-125	100 g	2 hrs	Gamma Spectroscopy	0.8 pCi/g
Cs-134	100 g	2 hrs	Gamma Spectroscopy	0.4 pCi/g
Cs-137	100 g	2 hrs	Gamma Spectroscopy	0.4 pCi/g
Ce-144	100 g	2 hrs	Gamma Spectroscopy	2.0 pCi/g
Eu-152	100 g	2 hrs	Gamma Spectroscopy	2.0 pCi/g
Eu-154	100 g	2 hrs	Gamma Spectroscopy	0.8 pCi/g
Eu-155	100 g	2 hrs	Gamma Spectroscopy	3.0 pCi/g
Pu-238	10 g	1,000 min	Alpha Radiochemistry	2×10^{-3} pCi/g
Pu-239	10 g	1,000 min	Alpha Radiochemistry	2×10^{-3} pCi/g
Pu-240	10 g	1,000 min	Alpha Radiochemistry	2×10^{-3} pCi/g
Am-241	10 g	1,000 min	Alpha Radiochemistry	3×10^{-3} pCi/g
Bi-214	100 g	2 hrs	Gamma Spectroscopy	NA
Ra-226	100 g	2 hrs	Gamma Spectroscopy	NA
Pa-234	100 g	2 hrs	Gamma Spectroscopy	NA
Tl-208	100 g	2 hrs	Gamma Spectroscopy	NA
Pb-212	100 g	2 hrs	Gamma Spectroscopy	NA
Bi-212	100 g	2 hrs	Gamma Spectroscopy	NA
Th-234	100 g	2 hrs	Gamma Spectroscopy	NA
U-234	100 g	2 hrs	Gamma Spectroscopy	NA
U-238	100 g	2 hrs	Gamma Spectroscopy	NA

Source: L. D. Koeppen, personal communication, 1989.

EGG:2015-T8-1A

9.0 DATA MANAGEMENT

Data management for this task includes data reporting, data reduction, and data validation. The data management procedures that will be employed for this activity are described in the following sections.

9.1 DATA REPORTING

Results of all analyses will be reported to EG&G Idaho Buried Waste Program via the BWP Site Characterization Cost Account Manager.

The results of the radiological analyses will be reported in a mutually agreed-upon format. Data reduction from raw counts to a reportable value is performed by the radiological laboratory following internal procedures to provide data with precision and accuracy within acceptable limits.

The principal criteria to validate data during collection of the samples, and collection and reporting of the data will be:

- Ensure unique sample numbers have been used
- Check for use of required chain-of-custody for samples
- Check that the aforementioned unique sample numbers are associated with the samples used for analysis
- Determine that precision, accuracy and completeness objectives stated in Section 4.0 have been met for every subsample
- Check for geological or statistical explanations for outliers (see below).

Sample collection history and analytical data for outliers will be examined to determine possible natural causes for the outliers. If an outlier exists because of error in statistical treatment, the cause will be noted, and the value of the outlier will be adjusted to accommodate the error. If a geological, hydrogeological, or radiochemical explanation can be found to support the validity of an outlier, the reason will be given and the data will be used without adjustment. If no geologic or statistical explanation of an outlier is apparent, the outlier will be reported with a warning statement. Unexplained outliers will not be used for decisions.

The recovered core from Borehole 8901D, properly packaged and handled, will be sent to the sample preparation laboratory for sample selection and collection, and then to the Radiation Measurement Laboratory for analysis. The laboratory will provide the analytical results requested and will return any remaining sample, the analytical data, and the requested quality control information to the BWP. The BWP will see that the data are reviewed/validated by the Data Integrity Review Committee (DIRC). The validated data will be made available to the users. The flow of data collection and reporting will involve the following key individuals:

- Sample Collection Personnel:
- Radiological Laboratory:
- BWP Data Manager:
- DIRC
- Users
- BWP Quality Officer:

9.2 DATA REDUCTION

Data reduction methods will be limited to placing the data in an EG&G standardized format for future incorporation into the Buried Waste Information System data base. Units of measure will be consistent with units used in the data base.

9.3 DATA VALIDATION

The BWP DIRC has the ultimate responsibility to review and validate the data collected and reported. The DIRC may call on different technical experts to assist the task of data validation. Data will not be made available for use until it has been validated by the DIRC.

The use of QA samples submitted with each batch of samples, range checks to assure that the analytical results are reasonable and within known anticipated limits, and procedures will be used for data validation. Data quality will be checked using data from the QA samples to develop control charts for performance evaluation. All aspects of the sampling program will be subject to managerial audits.

The integrity of the samples will be ensured through use of daily log books, labels, and the chain-of-custody reports for all transported samples. The Field Operations QA Officer shall assist the Buried Waste Program in assuring sample integrity by witnessing the sampling process to verify that sampling procedures are followed.

10.0 QUALITY ASSURANCE

All sampling and analysis activities described in this SAP will be conducted in accordance with the QA/QC practices described in the Buried Waste Program Data Collection Quality Assurance Plan (DCQAP) (EG&G, 1988b). The DCQAP contains guidance for the following:

- Sampling and Decontamination
- Sample Custody
- Calibration Procedures and Frequency
- Analytical Procedures
- Data Reduction, Validation, and Reporting
- Internal Quality Control Checks and Frequency
- Performance and System Audits
- Preventive Maintenance
- Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness
- Corrective Actions
- Quality Assurance Reports to Management.

This section summarizes QA/QC practices to be followed during the execution of this SAP.

10.1 FIELD QA/QC

Field QA/QC measures will include duplicate and split samples. The field quality control samples should comprise at least 20 percent of the total samples collected.

Duplicate samples will be included at a frequency of at least one in ten samples. Duplicate samples will be collected from the core material remaining after subcoring. The sample numbers will be identified as being duplicates or splits in the sample collection logbook, but not on the sample containers.

10.2 LABORATORY QA/QC

Radiological analyses will be preformed by the Radiation Measurement Laboratory (RML) at the INEL. Analytical methods to be used are presented in Section 8.0, Analytical Procedures.

10.2.1 Analytical Quality Control

Quality control on analytical performance properly starts with the analytical procedure itself. A procedure based on more reliable individual steps and reactions will obviously require less control and verification than one based on less reliable chemistry. Ten-gram samples of soil are fused with potassium fluoride in platinum dishes at 846°C in the presence of isotopic tracer to guarantee complete dissolution of the sample, including the most refractory compounds that could be present, and ensuring complete exchange with tracer. Except for contamination, anything that happens subsequently will affect the tracer quantitatively to the same extent as the nuclide being determined so that accuracy is guaranteed.

The principal quality control technique involves actual analysis of standard soils containing exactly known activities of any radionuclide of interest, and which are known to be homogeneous down to at least 0.5-gram samples. Two levels of activity are employed: one at two or three times the expected detection limit to verify that the detection limit is being achieved; and another at 50 to 100 times the detection limit to give sufficient precision to determine the accuracy actually being obtained. Because alpha spectrometry permits identification of all alpha-emitting radionuclides by their energies, backgrounds and calibrations are only necessary when use indicates that something has changed. For example, each sample analyzed that contains no detectable activity is in fact as good as a formal "blank." Similarly, every sample containing activity, even if it is only radon or thoron daughters from the air, is an automatic check on the energy calibrations. The most important quality check must come from the actual analysis of known samples. About 10 percent of the total effort is directed at quality control (Sill and Hindman, 1974).

10.2.2 General Laboratory Controls

In addition to instrument calibration and the analysis of quality control samples, the following controls will be implemented:

- Reagents and solvent will be of certified composition. Reagent storage environment and duration will meet manufacturer's guidelines.
- Laboratory equipment will be calibrated regularly.
- Volumetric measurements will be made with certified glassware.
- Data reduction computations will be independently checked.

10.2.3 Laboratory Management Review

The Laboratory Manager or designee will review testing results prior to external distribution. The reviewer will:

- Compare analyses performed to the request-for-analysis forms
- Review results for reasonableness
- Review quality control data results
- Verify that required checking was properly performed.

If the Laboratory Manager finds that the review indicates the data meet the project quality requirements, the data will be released as final information.

10.3 AUDITS

An audit is a systematic check to determine whether project personnel are adhering to the steps, methods, protocols, and SOPs outlined and referenced in this SAP. The Buried Waste Program DCQAP discusses audits to be performed during the activities covered by this SAP. Procedures and guidelines for performing audits contained in the BWP Program Directive on Audits (EG&G 1989f) and will be followed.

Performance and system audits will be performed on field operations for Borehole 8901D two days after the start of sample collection activities. The field QA officer will conduct weekly field audits during the drilling operation. The exact date will be decided upon after consultation with the BWP QAO, BWP Site Characterization Cost Account Manager, Deep Drilling Manager, and the Field QAO. Performance and system audits will be performed on laboratory operations one week after the first sample from Borehole 8901D arrives for analysis. The exact date will be decided upon after consultation with the BWP QAO, Analytical QAO, Laboratory Manager, and the Laboratory QAO.

After the completion of the audits, any deficiencies will be discussed with the responsible project staff and the corrections identified. Significant problems, if encountered, will result in the ceasing of both field collection and laboratory analyses. Such a decision would only be made after discussion with the Deep Drilling Manager, the BWP Site Characterization Cost Account Manager, and the BWP Program Manager, as well as laboratory and field personnel.

Corrective action may include, but not necessarily be limited to:

- Rechecking quantitative calculations
- Recalibrating instruments using freshly prepared calibration standards
- Repreparing and analyzing the original field sample
- Reanalyzing all real samples analyzed after the last conforming QC sample and prior to corrective action
- Conducting additional training of laboratory personnel
- Correcting sample preparation and analysis methods
- Reassigning personnel to improve the overlap between operator skills and method requirements.

The BWP QAO will review results of major corrective actions after implementation to determine the effectiveness of the actions and will provide a written report of this review to the BWP Program Manager.

10.4 REPORTS TO MANAGEMENT

A monthly report on the performance of the quality assurance program will be prepared by the BWP QAO and presented to the BWP Program Manager. When appropriate, analytical laboratory QA/QC reports will be included. At the completion of a task and after data verification and validation, all QC data will be sent to the Administrative Record and Document Control Officer to become part of the program files.

Monthly QA reports will include:

- Results of any systems and performance audits conducted during the period
- An assessment of accuracy, precision, completeness, representativeness, and comparability of data collected during the period
- A list of any changes that have occurred in the SAP
- Identification of any significant quality assurance problems and recommended solutions.

11.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Procedures that will be used to assess the precision, accuracy, and completeness of the data collected from sampling and analysis of Borehole 8901D are different for field data and laboratory data. Field and laboratory procedures are described in the following sections.

11.1 FIELD DATA

Field data includes all data recorded in field and laboratory logbooks during the field sampling activities, e.g., coring depths, core descriptions, radiation and industrial hygiene surveys, sample intervals, and sample descriptions. Field precision and accuracy will be assessed by field audits conducted to ensure the use of uniform sample collecting, handling, and shipping procedures.

11.1.1 Procedures to Assess Field Data Precision

Field precision will be assessed by field audits and checklists performed on a routine basis. These audits will document the use (or non-use) of uniform sampling methods, handling and shipping procedures. Field sampling precision will be assessed by taking duplicate and split samples.

11.1.2 Procedures to Assess Field Data Accuracy

Accurate sample collection will be evaluated from the results of field systems audits that include on-site evaluations of sample collection procedures, instrument performance, and calibration procedures.

11.1.3 Procedures to Assess Field Data Completeness

Completeness of the field data will be assessed by calculating the ratio of samples analyzed to the total number of samples collected, stated as a percentage. The completeness goal for field data is a ratio of 0.90, or 90 percent.

11.2 LABORATORY DATA

The QAPP and SOPs of the radiological laboratory will describe procedures to evaluate precision, accuracy, and completeness. This includes the preparation of blanks, replicates, and spikes. The accuracy, precision, and completeness of the data will be assessed for each sample lot using samples spiked to a known level and the percent recovery calculated.

11.2.1 Procedures to Assess Laboratory Precision

Precision of laboratory data will be measured by the analysis of duplicates. Laboratory reagent blanks will be analyzed to monitor the introduction of artifacts into the process. The data obtained will be within the prescribed control limits for accuracy and precision, as stated in Section 2.3, Data Quality Objectives, to achieve acceptable QA objectives.

11.2.2 Procedures to Assess Laboratory Accuracy

Accuracy of the laboratory data will be assessed by examining the analyses of certified EPA or National Bureau of Standards (NBS) QC check samples.

11.2.3 Procedures to Assess Laboratory Completeness

Completeness of the laboratory data will be measured by the ratio of samples with results that are of acceptable accuracy and precision to the total number of samples analyzed, stated as a percentage. The completeness goal for laboratory data is a ratio of 0.85, or 85 percent.

12.0 HEALTH AND SAFETY PROGRAM

Health and Safety (H&S) procedures to be followed during operations performed for the Buried Waste Program (BWP) are described in the Health and Safety Plan (HASP) for Operations Performed for the Buried Waste Program (EG&G 1989d). Specific actions to be taken in regard to work for this program will include:

- Medical Program - Prior to work at the site, all personnel will undergo medical screening as required by DOE and OSHA regulations.
- Personal Dosimetry - All personnel will wear personal dosimeters provided by EG&G personnel to measure exposure to penetrating radiation as specified by DOE guidance documents.
- Safety Orientation Meetings - These meetings will be held prior to all work performed at the site. All field personnel will participate.
- Training - All site personnel will have received appropriate training as required under DOE and OSHA standards and regulations.
- Site Monitoring - Appropriate monitoring procedures will be established and followed prior to the initiation of work.
- Regulated Areas - An exclusion zone, contamination reduction zone and a support zone will be established and barricaded prior to work on each task.
- Protective Equipment - During investigation activities where types and quantities of hazardous materials are not certain and organic vapor levels exceed 5 ppm in the breathing zone, work will be performed wearing "Level B" protection, including the following equipment:
  - Positive pressure supplied air
  - Chemical resistant suit
  - Chemical resistant hood
  - Chemical resistant inner and outer gloves
  - Chemical resistant boots with steel toe and shank
  - Hard hat
  - Safety glasses
  - Hearing protection if noise levels are in excess of 85dBA.
- During drilling and sampling work at the site, the following modified Level C protective equipment will be used if initial investigations establish that hazardous chemical concentrations are below 5 ppm and monitored radiation levels are below DOE derived concentration guide limits for radionuclides in air:

- Full face air purifying respirator with organic vapor cartridges and High Efficiency Particulate Air (HEPA) prefilters
- Chemical resistant suit
- Chemical resistant boots with steel toe and shank
- Chemical resistant inner and outer gloves
- Hard hats
- Safety glasses
- Hearing protection if noise levels are in excess of 85dBA.

• Personnel and Equipment Decontamination - Decontamination procedures will be specified and followed during site work.

All other pertinent aspects of the H&S program will be followed as described in the HASP.

13.0 RECORDS MANAGEMENT

All information, logbooks, analyses, project files, and field records will be submitted to the Administrative Records and Document Control Manager upon completion of the sampling and analysis of Borehole 8802D. In addition, any physical data discovered during the sampling and analysis shall be included in the project files. These records will be maintained under lock and key, and provided to interested EG&G Idaho and DOE-ID personnel after data validation via a records checkout process.

This record checkout process will consist of requiring the Administrative Records and Document Control Manager or designated alternate to fill out a card identifying the records removed, the date removed, and the person receiving the record. Upon return of the record, it will be placed back under lock and key and the checkout card removed.

It is the responsibility of the Administrative Records and Document Control Manager to ensure all records of the sampling and analysis of Borehole 8901D are maintained under lock and key. When issuing all or parts of these records, the Administrative Records and Document Control Manager shall direct the person receiving the records to maintain the records under lock and key while in their possession.

14.0 LOGISTICS

Field logistics involve the procurement, maintenance, and transport of personnel, materials, and facilities for field sampling. Overall coordination of field logistics will be the responsibility of the Deep Drilling Program Manager. He will communicate and coordinate between the field drilling and sampling teams and the laboratories. Daily meetings at the start or end of the day will help ensure communication and coordination among the field drilling and sampling teams.

All field sampling equipment will be provided by EG&G Idaho, Inc. Drilling equipment will be provided by the drilling contractor or EG&G Idaho, Inc.

15.0 REFERENCES

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