EGG-WM-8835
January 1991
Revision 1

INFORMAL REPORT

Idaho National Engineering Laboratory

Managed by the U.S. Department of Energy

SAMPLING AND ANALYSIS PLAN FOR THE ARA-I CHEMICAL EVAPORATION POND (COCA UNIT ARA-01)

R. W. Russell
M. J. Spry
C. K. Hardy

EG&G Idaho

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

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(Original signatures appear on DRR #ERP-207 dated July 25, 1990.)

ABSTRACT

As part of the Resource Conservation and Recovery Act Corrective Action Program at the Idaho National Engineering Laboratory, the EG&G Idaho Environmental Restoration Program is undertaking sampling and analysis at the ARA-I Chemical Evaporation Pond. The sampling and analysis will provide site characterization information to allow permanent site closure activities. In addition to describing details of the intended characterization action, this Sampling and Analysis Plan will also function as a Quality Assurance Project Plan.

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ACRONYMS

AA	atomic absorption
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
ARA	Auxiliary Reactor Area
BNA	base neutral acid extractables
BRC	below regulatory concern
CCC	continuing calibration check
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	chain-of-custody
COCA	Consent Order and Compliance Agreement
CRQL	contract required quantification limit
DOE	U.S. Department of Energy
DOE-HQ	DOE-Headquarters
DOE-ID	Idaho Operations Office of DOE
DOP	dioctyl phthalate
DRR	Document Review Request
EPA	Environmental Protection Agency
GC	gas chromatography
HP	health physics technician
ICP	inductive coupled plasma (spectrometry technique)
IH	industrial hygienist
IHT	industrial hygienist technician
INEL	Idaho National Engineering Laboratory
LDU	land disposal unit
LEL	lower explosive limit
MS	mass spectroscopy
NIOSH	National Institute of Occupational Safety and Health
OMP	Occupational Medical Program
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Act

PCB	polychlorinated biphenyl
PI	principal investigator
PID	photoionization detector
PM	project manager
PPE	personal protective equipment
QA	quality assurance
QAO	quality assurance officer
QC	quality control
RCRA	Resource Conservation and Recovery Act
RESL	Radiological and Environmental Sciences Laboratory
RWMC	Radioactive Waste Management Complex
SIU	International System of Units
SOP	Standard Operating Procedure
SS	site safety supervisor
SWMU	solid waste management unit
TSDF	treatment, storage, and disposal facility
USGS	U.S. Geological Survey
VOA	volatile organic analysis
VOC	volatile organic compound

SAMPLING AND ANALYSIS PLAN FOR THE ARA-I CHEMICAL EVAPORATION POND (COCA UNIT ARA-1)

1. INTRODUCTION

This Sampling and Analysis Plan (SAP) was prepared for the Environmental Restoration Program (ERP), which is responsible for the Resource Conservation and Recovery Act (RCRA) Corrective Action Program at the Idaho National Engineering Laboratory (INEL). The ARA-I Chemical Evaporation Pond is considered to be a Land Disposal Unit under the Consent Order Compliance Agreement (COCA) and is being evaluated in accordance with the COCA requirements. The COCA identified the ARA-I Chemical Evaporation Pond as a RCRA unit to be closed under guidance specified in 40 CFR 265.228, closure of surface impoundments. The COCA, signed in 1987, is a tri-party agreement between the Idaho Operations Office of the Department of Energy (DOE-ID), Region X of the Environmental Protection Agency (EPA) and the United States Geological Survey (USGS) as a technical consultant.

This plan outlines the approach for gathering sufficient and appropriate data to evaluate whether the pond sediments are Resource Conservation and Recovery Act (RCRA) hazardous waste, Class I nonhazardous waste (containing hazardous waste constituents defined by 40 CFR 264, Appendix IX) or unregulated materials. Data obtained from this sampling and analysis effort will determine the ultimate disposal of the materials found in the ARA-I Evaporation Pond. RCRA hazardous waste and Class I nonhazardous waste will be transported to a RCRA-approved landfill. Unregulated waste does not require removal or special handling if removal is desirable.

This Sampling and Analysis Plan also functions as a Quality Assurance Project Plan (QAPP). A QAPP serves as a controlling mechanism during sampling and analysis to ensure all data collected are valid, reliable, defensible, and meet the identified data quality objectives. This document outlines the organization, objectives, and quality assurance/quality control (QA/QC) activities needed to achieve the desired data quality goals. The Programmatic QA/QC requirements for this project are outlined in the Data Collection Quality Assurance Plan (DCQAP) for the Buried Waste Program (EG&G, 1988). The DCQAP is a program plan and does not outline the site specific requirements for the scope of work covered by this Sampling and Analysis Plan (SAP). This plan was prepared following the requirements in the Environmental Restoration Program (ERP), Program Directive PD 5.2 "Preparation of Sampling and Analysis Plans" (EG&G 1989).

1.1 Background Information

1.1.1 General Site Description

The INEL is a 2,315-km^2 (894-mi^2), government-owned, contractor-operated facility in southeast Idaho that is managed by the Idaho Operations Office of the U.S. Department of Energy (DOE-ID). EG&G Idaho, Inc., is the prime site contractor and operates the Auxiliary Reactor Area (ARA) at INEL. Figure 1-1 presents the location of the INEL with respect to the surrounding areas, and Figure 1-2 shows the location of ARA-I within the INEL.

The INEL is located on the upper Snake River Plain in southeast Idaho near the foothills of the Lost River, Lemhi, and Bitterroot mountain ranges. The average annual precipitation is about 21 cm (8 in.) The mean annual temperature is about 5.5 °C (42 °F). Winters are usually cold, with snowcover persisting from December to March; summers are hot, and temperatures may reach over 38 °C (100 °F).

1.1.2 Geology

The surface of much of the Snake River Plain is covered by waterborne and windborne soils derived primarily from Cenozoic volcanic and Paleozoic sedimentary rocks from the surrounding mountains. Underlying the plain are layers of interbedded volcanic and sedimentary rocks, principally basaltic lava with interflow beds of sedimentary materials (EG&G, 1985).

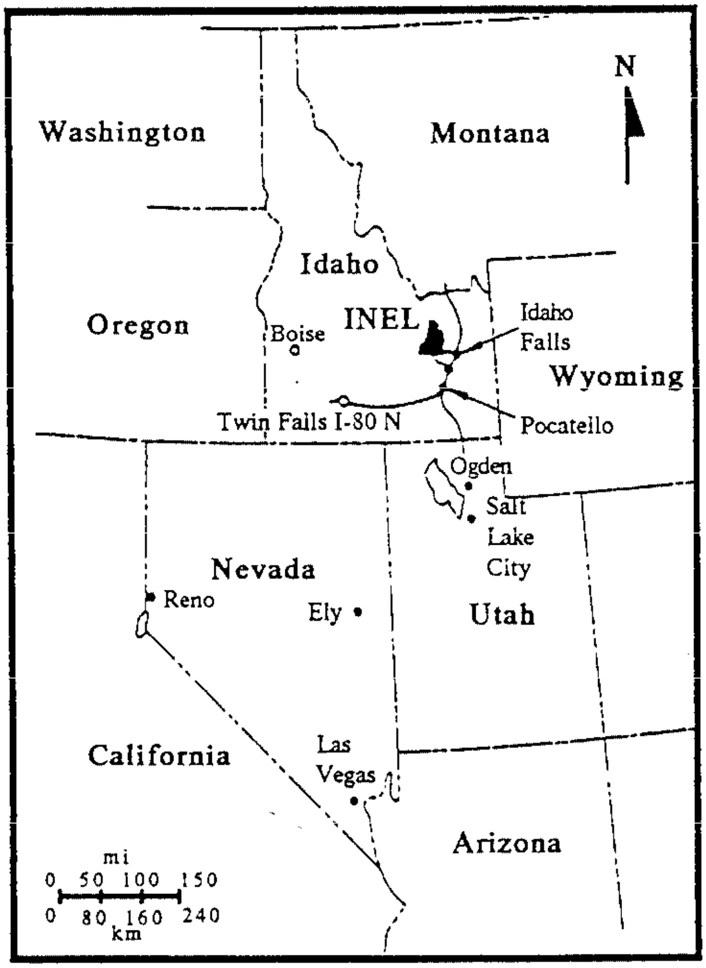

Figure 1-1. Location of the INEL in relation to surrounding areas.

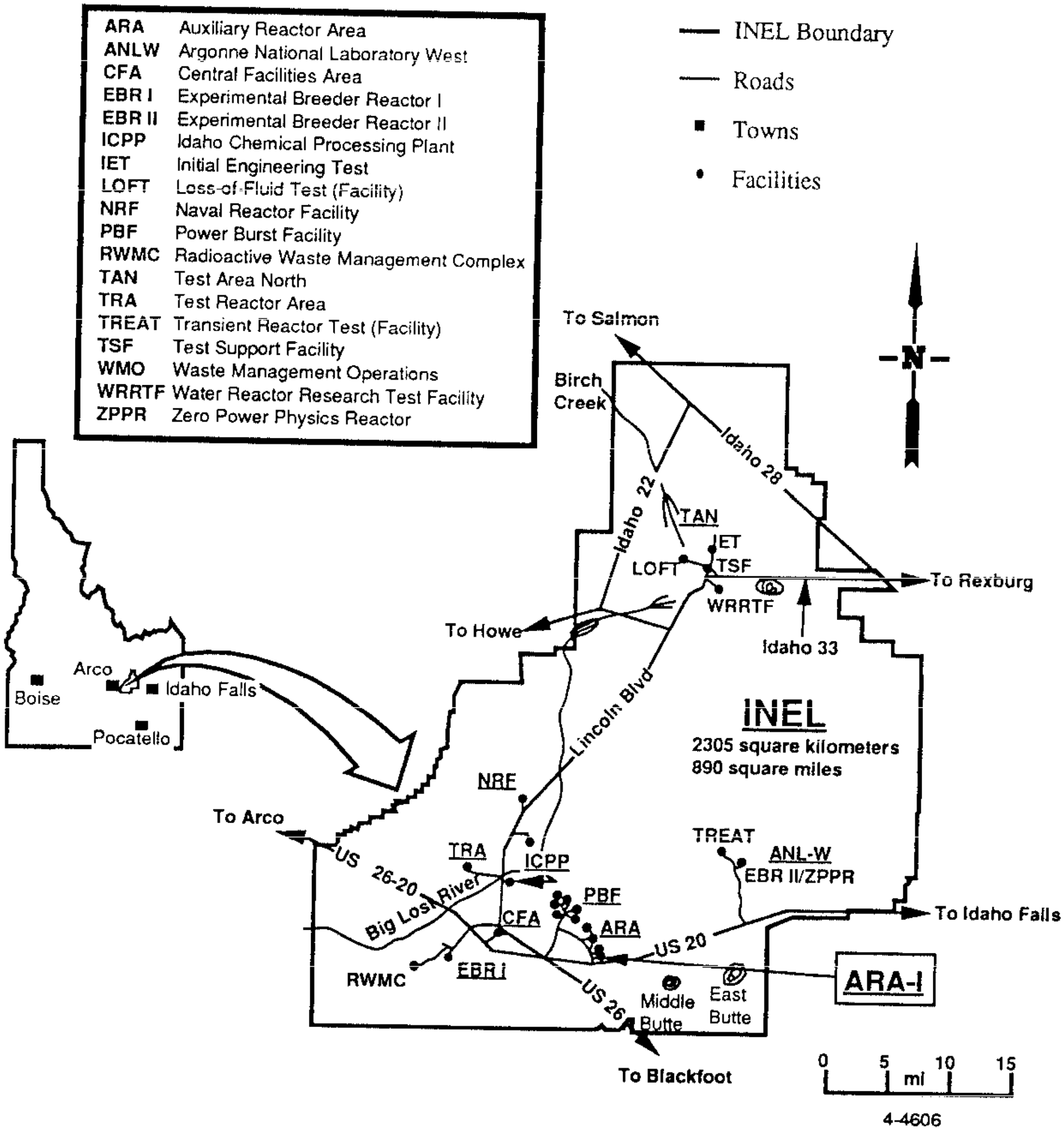

Figure 1-2. The Idaho National Engineering Laboratory and associated facilities.

1.1.2.1 Properties of INEL Surface Materials. The geology of the INEL site has been studied extensively since the early 1950s. Over this 35-year period, many parameters, characteristics, and properties of the geologic materials have been measured. Most of the information has been collected from only a few locations at the INEL. This information is presented here to provide an idea of the "normal" values expected at INEL. However, accurate predictions about lithologic rock textures from one location to the next are difficult to make. Those properties include mineralogy, cation exchange capacity, and sorption coefficients.

1.1.2.1.1 Mineralogy--The mineral composition of the silt- and clay-sized fractions has been determined for the surficial sediments at 29 locations in the northern part of INEL. The average mineral composition of these 29 surficial sediment samples is presented in Table 1-1. The average mineral composition of the clay-sized fraction contains an average of only 68 percent clay minerals. The common clay minerals are montmorillonite, hydrous mica (illite), and kaolinite. The silt- and sand-sized particles are composed of quartz, calcite, feldspar, and dolomite (Table 1-2). This mineralogic difference between the two size fractions suggests little of the clay has formed in situ by the devitrification of feldspars, but rather has been transported to the area by wind and/or water (Nace et al. 1956).

The Snake River Plain basalts are homogeneous mineralogically. The typical basalt is an olivine tholeiite. These rocks contain up to 20 percent in volume of the combined plagioclase and olivine phenocrysts, with the former being dominant. The groundmass commonly consists of olivine, plagioclase, clinopyroxene, magnetite, and ilmenite with minor apatite, glass, rutile, and oxidation products. Cristobalite and calcite also occur in the basalts as secondary vesicle lining and fracture fillings (Leeman 1982).

Table 1-1. AVERAGE MINERAL COMPOSITION OF 29 SURFICIAL SEDIMENT SAMPLES FROM INEL (Nace et al., 1956)

				Minerals present (approximate percent of each fraction)												
				Clay Fraction						Silt Fraction						
Sample Number	Location	Type of Material	Depth (feet below land Surface)	Montmorillonite	Hydrous mica	Kaolinite	Quartz	Calcite	Feldspar	Montmorillonite	Hydrous mica	Kaolinite	Quartz	Calcite	Feldspar	Dolomite
7 N., R. 31E																
1	SE 1/4 NW 1/4 sec. 34	Gravel, sandy	10	P	S	--	5	20	--	S	S	S	30	30	5	10
2	do	do	22	P	S	--	tr	10	--	S	S	S	40	15	tr	S
6 N., R. 30 E.																
3	SE 1/4 SE 1/4 SE 1/4 sec. 12	do	1	15	30	10	5	35	5	--	--	--	50	30	10	10
6 N., R. 31 E.																
4	NE 1/4 NW 1/4 NE 1/4 sec.12	do	.7	25	25	20	5	25	tr	--	--	--	70	10	10	10
5	NE 1/4 NW 1/4 NE 1/4 sec. 13	Silt, sandy, with some clay	5-5.5	45	15	5	15	10	tr	10	5	--	45	30	5	5
6	SW 1/4 NE 1/4 sec. 13	do	15	35	25	15	15	10	--	--	tr	--	45	20	25	10
7	do	do	10	40	20	10	15	15	--	5	5	--	45	35	10	5
8	SE 1/4 NE 1/4 sec. 13	do	21	P	P	S	S	--	--	--	--	--	--	--	--	--
9	NE 1/4 SW 1/4 sec. 13	do	2-4	S	P	P	S	--	--	--	--	--	--	--	--	--
10	do	do	do	S	P	P	S	--	--	--	--	--	--	--	--	--
11	SW 1/4 SW 1/4 SW 1/4 sec. 13	Silt, clayey, sandy	5	35	20	20	15	10	tr	--	--	--	55	25	10	10
12	SE 1/4 SW 1/4 SW 1/4 sec. 13	Silt, sandy, with some clay	10	35	20	15	15	15	tr	--	--	--	60	25	5	10
13	NW 1/4 NW 1/4 SE 1/4 sec. 13	do	14.4	45	15	10	15	15	--	--	10	--	45	20	5	20
14	SE 1/4 NE 1/4 sec. 14	Silt, clayey,	10	30	20	15	15	15	5	--	--	--	60	10	20	10

Table 1-1. (Continued).

Sample Number	Location	Type of Material	Depth (feet below land Surface)	Minerals present (approximate percent of each fraction) — Clay Fraction: Montmorillonite	Hydrous mica	Kaolinite	Quartz	Calcite	Feldspar	Silt Fraction: Montmorillonite	Hydrous mica	Kaolinite	Quartz	Calcite	Feldspar	Dolomite
15	NW 1/4 WE 1/4 sec. 14	do	5	30	25	10	20	15	tr	--	5	--	60	25	10	10
16	Center sec. 14	do	0	35	20	15	20	10	tr	--	--	--	60	25	5	5
17	Center sec. 14	do	5	30	20	15	20	15	tr	--	--	--	65	20	5	10
18	SW 1/4 SW 1/4 sec. 23	do	5	40	20	10	15	15	tr	--	--	--	60	20	10	10
19	SE 1/4 sec. 23	Sand, silty	4.8.5.8	P	S	--	10	10	--	S	--	--	30	15	tr	5
20	NE 1/4 NW 1/4 SW 1/4 sec. 24	Silt, sandy, with some clay	10	40	15	10	20	15	tr	10	10	--	40	30	5	5
21	NW 1/4 NW 1/4 NE 1/4 sec. 28	Silt and sand,	3.8.4.5	P	--	--	10	10	--	S	S	S	50	10	5	5
22	NW 1/4 SW 1/4 sec. 28	Sand, silty	5.2.6	P	P	--	15	5	tr	S	--	S	50	10	5	15
23	SE 1/4 SE 1/4 SW 1/4 sec. 27	Sand, silty, clayey	--	P	P	5	10	10	--	S	S	--	40	15	10	15
24	SE 1/4 NE 1/4 sec. 34	do	5.2.6	P	P	S	15	10	--	S	S	S	45	25	tr	10
25	SW 1/4 SW 1/4 SW 1/4 sec. 34	Sand, silty	0.0.5	P	P	--	10	10	--	S	--	--	40	15	5	tr
26	do	Silty, sandy	0.5	P	P	S	15	15	--	S	--	--	50	10	10	10
27	do	Sandy, silty,	1	P	P	--	15	tr	tr	S	--	--	45	5	10	5
6 N., R. 32 3.																
28	Center sec. 22	Sand, clayey, silty	0	P	P	S	10	10	tr	S	--	--	35	15	5	5
6 N., R. 33 3.																
29	NE 1/4 WE 1/4 sec. 21	Silt	1	P	P	S	S	--	--	--	--	--	--	--	--	--

P = Predominant in amount.
S = Subordinate in amount.
tr = Trace amount.

TABLE 1-2. AVERAGE MINERAL COMPOSITION OF THE SILT- AND CLAY-SIZED FRACTIONS IN SAMPLES COLLECTED AT THE NORTHERN PART OF THE INEL

	Clay (%)	Silt (%)
Clay minerals		
Montmorillonite	34	8
Hydrous mica	21	7
Kaolinite	13	--
Quartz	14	48
Calcite	13	20
Feldspar	<5	8
Dolomite	--	9
TOTAL	100	100

1.1.2.1.2 Cation Exchange Capacity and Sorption Coefficients--Cation exchange capacity (CEC) is a measure of the ability of a material to remove cations from solution by exchanging them for cations held loosely within the structure of the material (Rightmire 1984). CEC is an important parameter in controlling the migration of contaminants. CECs have been determined for a large number of surface materials throughout INEL and are presented in Table 1-3. The CECs are generally low, reflecting the coarse-grained nature of most alluvial and earlier material.

Because studies have not been performed on the ability of soils in the vicinity of ARA-I to retain radionuclides, the results from a study by Schmalz (1977) at the Test Reactor Area of INEL are presented. Sorption coefficients are defined as:

$$K_d = Cs/Cw$$

where

K_d=sorption coefficient, mL/g

C_s=concentration of radionuclide on the soil, mCi/g

C_w=concentration of radionuclide in the water, mCi/mL.

The sorption coefficients were measured in batch experiments, measured in laboratory column experiments, and calculated from soil and water samples collected in the field. K_d values for cesium ranged from a low of 285 mL/g for batch experiments to 450 to 900 mL/g calculated from field data. K_d values for strontium ranged from a low of 7.2 mL/g for batch experiments to 40 mL/g calculated from field data. Because the field data reflect the most realistic conditions for sorption, these values would be most indicative of the sorptive properties of the Big Lost River alluvium.

Sorption of plutonium on soils of INEL was studied by Miner et al. (1982). They measured K_d values for plutonium by using batch experiments and a range of initial plutonium concentrations from 10^{-8} to 10^{-6} moles/L. The sorption coefficients ranged from 140 to 5,000 mL/g, with a geometric mean of 1,160 mL/g. The reversibility of the sorption process was also evaluated by running elution experiments on soil columns. In no case was more than 2 percent of the total sorbed plutonium removed from the soil by column leaching.

TABLE 1-3. SUMMARY OF CATION EXCHANGE CAPACITY (CEC) OF SEDIMENTS AND BASALT (Nace et al. 1956).

Type of Sample	Number of Samples	CEC (meq/100 g) Range	CEC (meq/100 g) Average
Surface Sediments			
Gravel			
Coarse, clean	2	1.0-2.9	2.0
Sandy	52	1.4-15.6	4.1
Sand			
Clean	19	1.6-18.0	7.6
Silty	24	1.8-23.6	8.5
Silty and clayey	21	3.3-20.0	10.3
Silty, windblown	5	3.0-7.5	5.2
Silt			
Clean	4	6.2-34.8	20.4
Sandy	9	5.3-38.0	21.9
Sandy and clayey	17	7.1-30.4	13.5
Clayey	3	7.5-42.0	20.3
Clay, silty	1	--	13.7
Soil over silicic rock	1	--	4.4
Basalt			
Sieve fraction			
0.5 mm	6	0.4-1.4	0.8
0.5-0.62 mm	8	0.6-12.2	3.9
0.62 mm	1	--	2.3

1.1.2.2 Soils and Subsurface Geology at the ARA-I Chemical Evaporation Pond. Soils in the vicinity of the Chemical Evaporation Pond are generally shallow and poorly developed. Much area has been disturbed by past construction activities as shown in Figure 1-3. Based on a preliminary site visit, it appears that the pond was constructed by removing native soil and excavating into the basalt. At least 0.6 m (2 ft) and possibly as much as 3 m (10 ft) of sediments now overlie the basalt. The sediments were probably windblown, although some materials may have been deposited by localized runoff. Other areas surrounding the pond including the overflow areas and secondary discharge unit contain very shallow, 0 to 30 cm (0 to 12 in.), soils over basalt. Basalt outcrops are prevalent and soil materials are poorly developed with sparse vegetative cover.

Very little information is available that describes the geology at ARA-I. Some information is available from the drillers' log for a production well located 183 m northwest of the Chemical Evaporation Pond within Building 629. The geologic descriptions from this log are poor but can be used to assemble a limited picture of the subsurface geology at ARA-I. The log indicates that the ARA is underlain by more than 183 m (600 ft) of relatively thin basalt flows interbedded in places with fine grained sedimentary clastic materials. A generalized lithology taken from the drilling log is presented in Figure 1-4. The drillers' log is presented in Appendix A.

1.1.3 Hydrology

The surface water hydrology of INEL is controlled by the flow of the Big Lost River, the Little Lost River, and Birch Creek which drain mountain watersheds and provide intermittent flow to INEL. Flow from these streams terminate in closed drainage basins (playas) or flow out onto the plain where the water is evaporated or lost to percolation. The Big Lost River, which is the main waterway at INEL, flows from the southwest boundary toward the northeast, and terminates in a series of playas near Test Area North (TAN) (Barraclough, Lewis, and Jensen, 1981). Water from the river recharges the

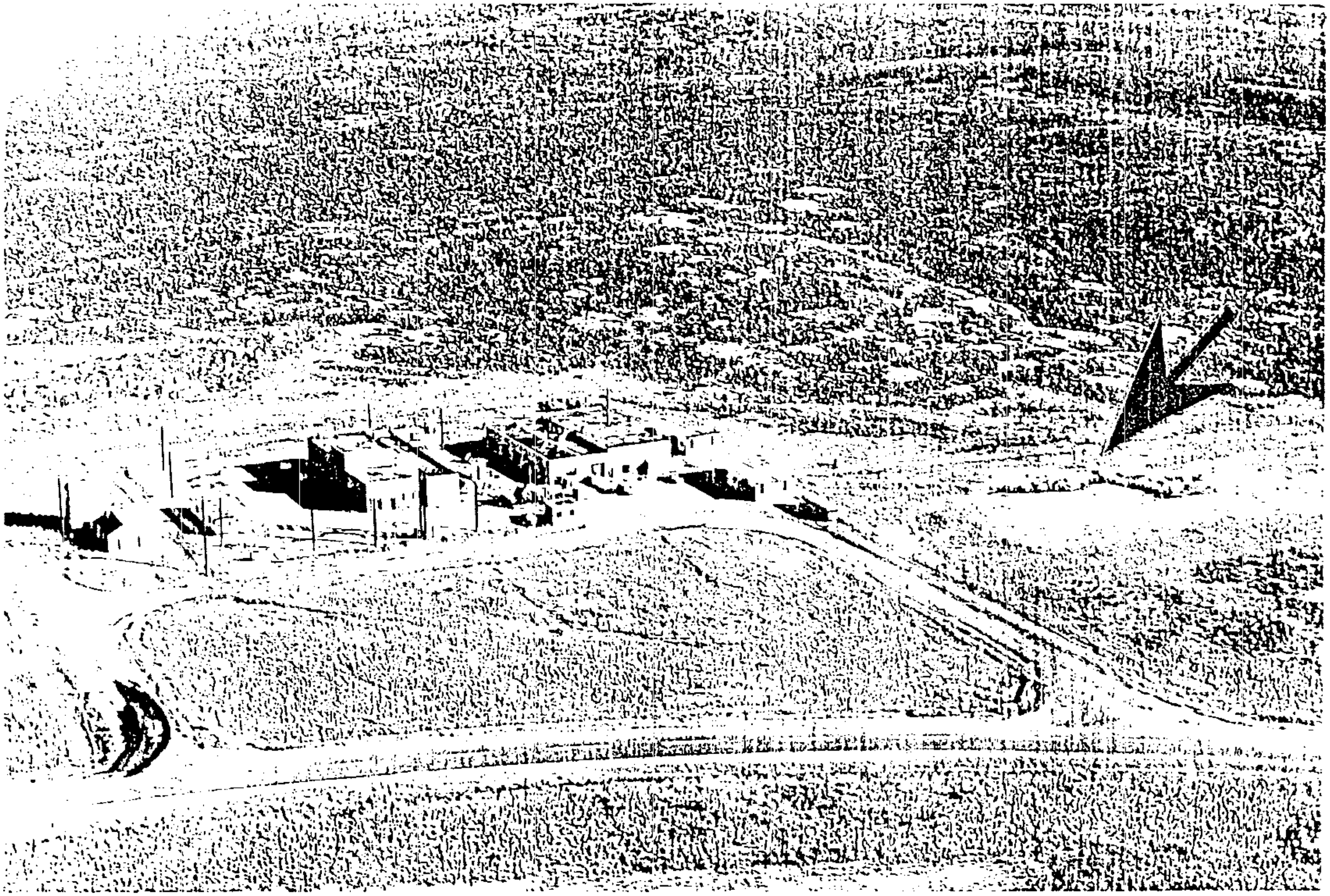

Figure 1-3. Aerial photograph depicting the ARA-I Complex, with the arrow pointing to the Chemical Evaporation Pond.

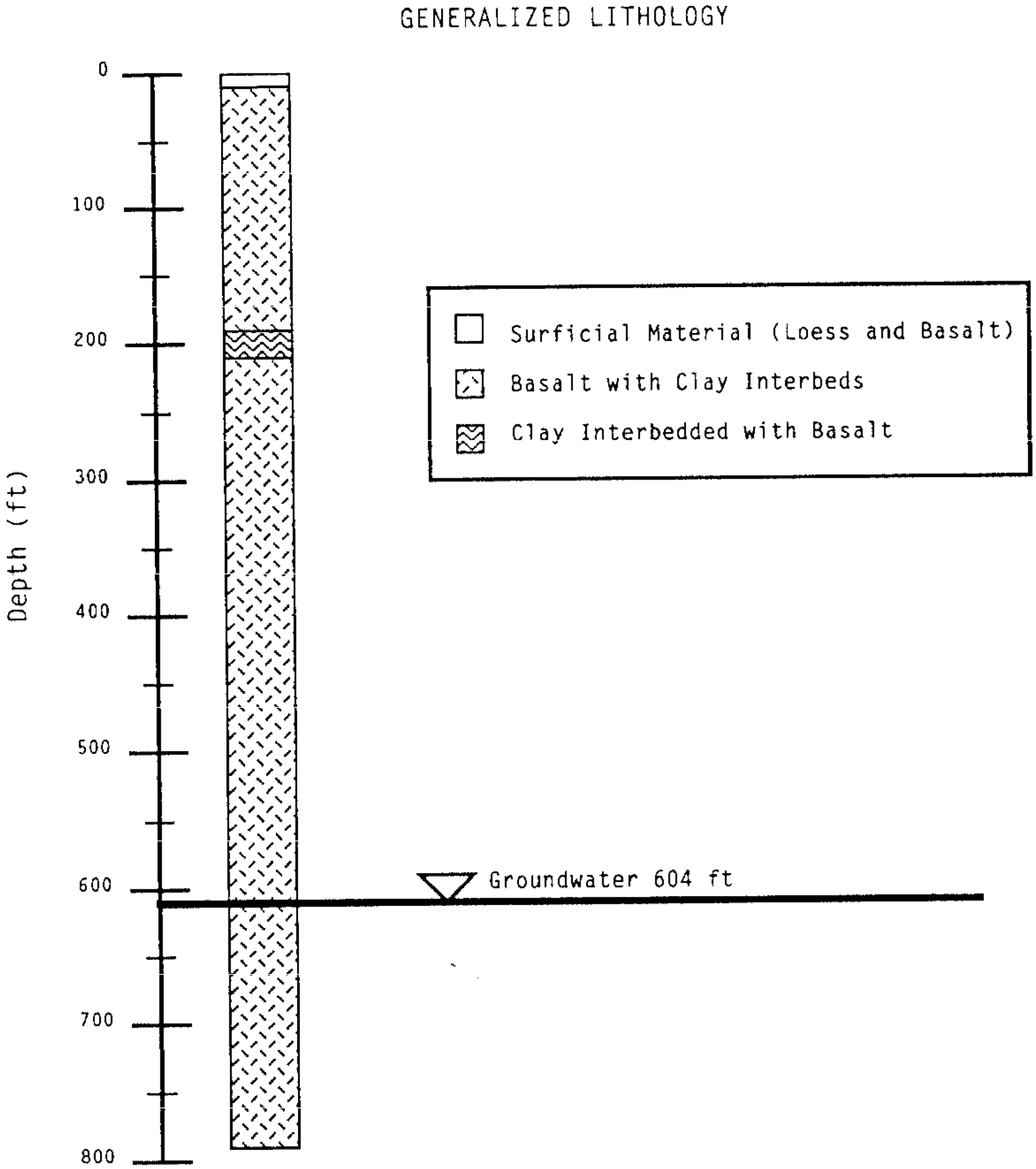

Figure 1-4. Generalized lithology constructed from the drillers' log for the ARA-I production well.

Snake River Plain aquifer, although some water may be held, at least temporarily, in perched water zones (EG&G, 1985).

The INEL is situated over the Snake River Plain aquifer. The depth to the aquifer from the land surface ranges from approximately 60 meters (200 ft.) in the northeast corner of the INEL to 305 m (1000 ft.) in the southeast corner (Figure 1-5) (Lewis and Jensen, 1984). Transmissivities range from 3.7 x 10^5 to 2.2 x 10^8 liters per day per meter (3 x 10^4 to 1.8 x 10^7 gallons per day per foot) and storage coefficients range from 0.01 to 0.06. Regional ground water flow is to the southwest, with discharge into the Snake River near Hagerman, Idaho. Groundwater velocities range from 1.5 to 6 meters per day (5 to 20 ft. per day) (Robertson, Schoen, and Barraclough, 1974).

Groundwater flow velocity in the vicinity of ARA-I is estimated to be less than 0.3 m/day (1 ft/day), assuming average parameters for the aquifer and an aquifer thickness of 76 m (250 ft). Based on the drillers' log for the ARA-I production well, the depth to groundwater (i.e., the Snake River Plain aquifer) at ARA-I is approximately 185 m (604 ft). The regional groundwater flow direction is to the southwest; therefore, the production well is upgradient of the Chemical Evaporation Pond.

The primary layer responsible for creating perched water tables at INEL is the clay layer that overlies the basalt at the basalt/surficial sediment interface. The clay fills fractures in the basalt, thereby decreasing the permeability of the unit. It is unlikely that perched water is present beneath the ARA-I Chemical Evaporation Pond because the basalt either outcrops or is located only a few feet beneath ground surface. In addition, the pond has been dry for several years and is, thus, not a source of water for recharging a perched zone.

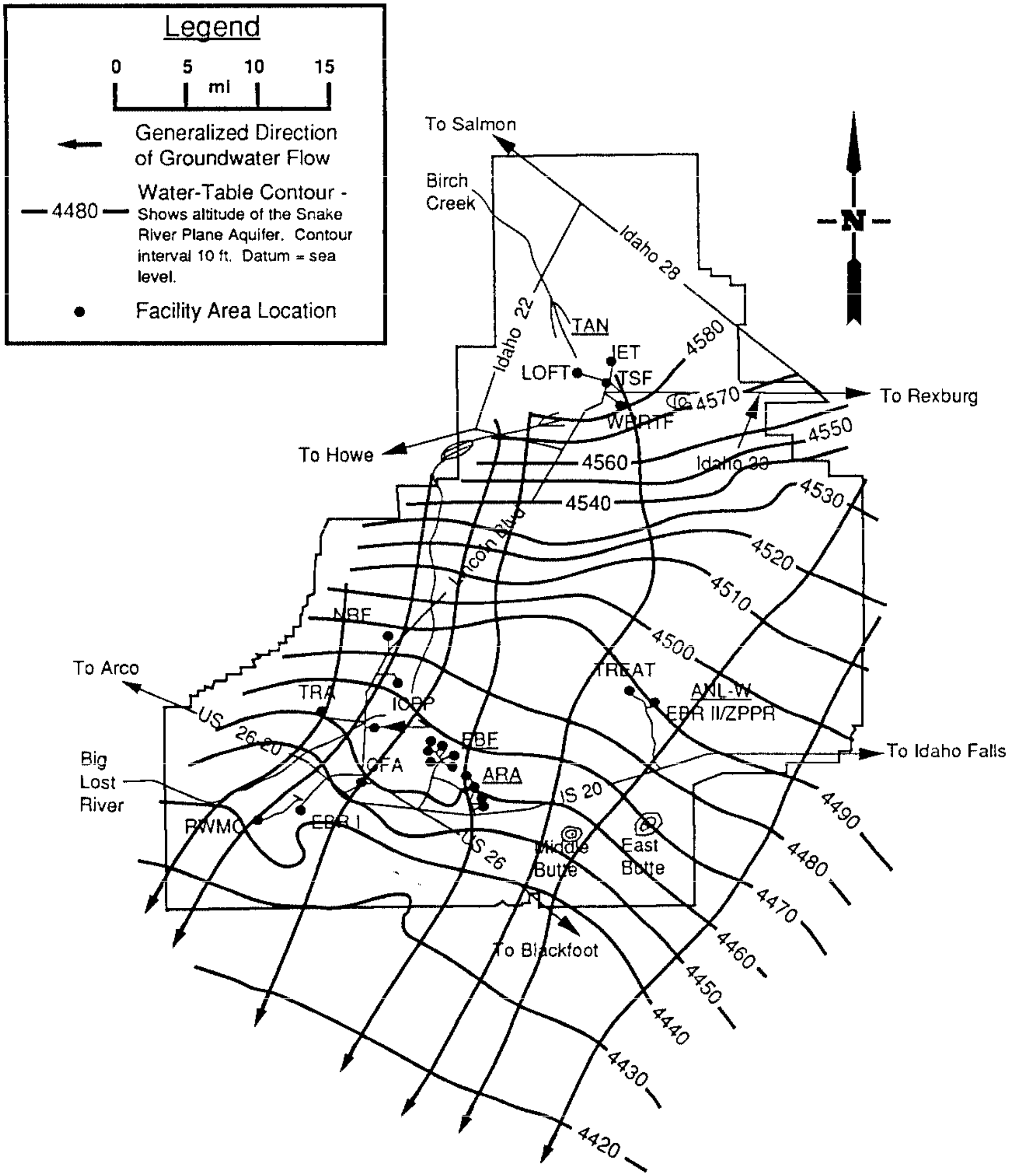

Figure 1-5. Inferred directions of groundwater flow, INEL and vicinity.

1.1.4 Ecology

Vegetation communities at INEL are typical of the sagebrush steppe/cold desert ecosystem. The ecosystem is composed of shrubs, primarily belonging to the genus Artemisia, and an understory of perennial grasses and forbs. No plant species listed by the federal government as threatened or endangered occur on the INEL. However, two resident species of milkvetch (Astragalus ceramicus) var. apus and A. purshii var. ophigenes are being reviewed for endangered or threatened status (EG&G, 1985).

Big sagebrush (Artemisia tridentata) with the perennial grass species, thickspike wheatgrass (Agropyron dasystachyum) and needle-and-thread (Stipa comata), are the dominant vegetation types in undisturbed areas adjacent to the ARA-I Evaporation Pond.

Vegetation in the disturbed areas consists of species that colonized the site as well as seeded species. The main chemical waste pond was colonized by cattail (Typha latifolia) and willow (Salix spp.). Cattails occupied the entire basin when discharges were frequent. Since the effluent stream has decreased, cattails and willows now occupy a small area immediately adjacent to the inlet. Outer areas of the pond are now being colonized by thistle (Cirsium or Sonchus spp.) and other weedy species tolerant of drier soils. The overflow area east of the main pond has been seeded with crested wheatgrass (Agropyron cristatum). Other disturbed areas contain remnant native vegetation, halogeton (Halogeton glomeratus) and other chenopods, and other weedy species.

The sagebrush ecosystem supports a variety of diverse wildlife, including invertebrates, amphibians, reptiles, birds, and mammals. Lists of commonly occurring animal species have been compiled by the Radiological and Environmental Sciences Laboratory of DOE-ID and are summarized in the INEL Environmental Characterization Report (EG&G, 1985).

The bald eagle and the American peregrine falcon are the only species observed on INEL that are classified as endangered or threatened wildlife. Several bald eagles (endangered status) usually winter on or near INEL. The peregrine falcon (endangered status) has been observed infrequently on the northern portion of INEL. There are no known endangered or threatened species residing year round on INEL and no known critical habitats (Reynolds et al., 1985).

The ARA-I area provides habitat for various animal species commonly found on INEL. The sage brush lizard, short-horned lizard, gopher snake, and rattlesnake occur sitewide and may be found near this site. The sage thrasher, sage sparrow, Brewer's sparrow, horned lark, western meadowlark, black-billed magpie, and robin are species of passerines found throughout INEL and could be expected to occur at this site.

Species of mammals that may inhabit this area include several species of mice, chipmunks, voles, and ground squirrels: Black-tailed jack rabbits, Nuttall's cottontails, mule deer, and pronghorn are also found in similar areas of INEL.

1.1.5 Archaeology

Archaeological investigations have been conducted at various locations of INEL; however, such cultural resource surveys have not been conducted in the vicinity of ARA-I. Sampling activities can be undertaken without a further investigation if they are contained within facility areas that have been previously disturbed. If cultural or paleontological materials are encountered during sampling activities, work will stop until a professional can assess the significance of the discovery.

1.1.6 Land Use

The Auxiliary Reactor Area (ARA) is located 7.5 miles east of the Central Facilities Area and encompasses four satellite areas: ARA-I, ARA-II, ARA-III, and ARA-IV. These facilities were constructed in 1957 to test U.S. Army portable power reactors. The location of the ARA is illustrated in Figure 1-2.

ARA-I is the southernmost of the four ARA areas. It has two main buildings, initially constructed about 1957 to support the Stationary Low Power Reactor No.1, which was located at what is now called ARA-II. Figure 1-6 shows the plot plans for ARA.

Building 626 is a hot cell building, presently used to support materials research. It also contains a small laboratory area for sample preparation and inspection which is not currently being used.

Building 627 was a print shop from about 1955 to 1971. During 1971, this building was expanded and modified to serve as a research laboratory for materials development and testing. In 1980, the building was further modified to incorporate a radiochemistry laboratory. During 1984, use of the building ceased, with the exception of the radiochemistry laboratory, which was then moved to TRA in 1988.

Other facilities located at ARA-I are ARA 629, a pump house with a groundwater well that provides potable water and fire water that is stored in Tank 727; ARA 628; the guard house, Tank 728; a fuel storage tank, and Tank 729; a hot-waste storage tank. The pump house is located approximately 183 m (600 ft) northwest of the Chemical Evaporation Pond, as described in Figure 1-6.

The hot cells, ARA 626, have been in operation since 1957. They were originally used to support operations for the Nuclear Reactor Program of the

U. S. Army conducted at ARA-I. In 1965, all activities in support of the Army's program were curtailed at ARA, and activities in the hot cell were dedicated to other programs at INEL. In 1970, the operation of the hot cell was dedicated to fuels and material research, but this has no significant impact on the quantity or type of work at the hot cell. The hazardous chemicals used at the hot cell were limited to small quantities of solvents and acids.

Typically, because of personnel hazards associated with solvents and acids in a hot cell environment, soap and water were used as cleaning agents. When organic solvents were used, either methanol or acetone were chosen because of their high vapor pressures (100 percent volatility). Occasionally, nitric acid was used in the hot cell laboratory. The effluents generated during these operations were passed through a sewer for radioactive wastes to a radioactive materials holding tank. Periodically, the radioactive materials holding tank was emptied, and the contents were shipped to the Idaho Chemical Processing Plant (ICPP) for processing and subsequent disposal. These waste streams were not sent to the Chemical Evaporation Pond.

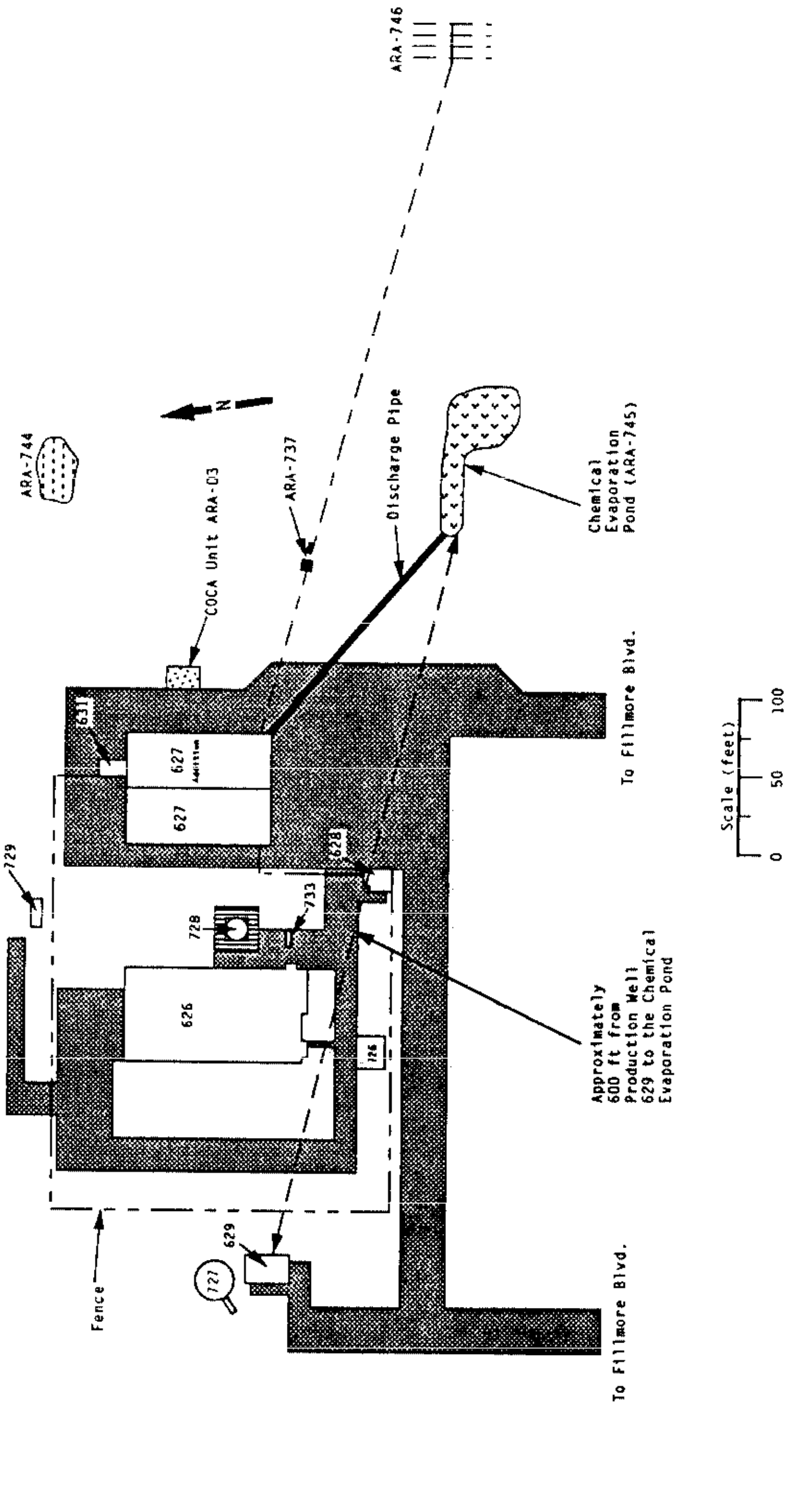

Figure 1-6 Plot Plan for ARA-I

Building 627 was originally a print shop that generated small amounts (approximately 300 lb/yr) of rags, which were occasionally wetted with acetone/printing fluids. These rags were disposed of in an INEL landfill.

During 1970, Building 627 was modified, expanded and subsequently used for materials research and testing. From 1970 to 1984, small amounts of organic solvents and mineral acids were used in operations in Building 627. Infrequently, when large amounts of acids or solvents were used on a specific project, they were retained and sent to TRA or ICPP. The small amounts of acids and solvents that were used on a more routine basis (metal etching, cleaning, etc.) were disposed in the following manner. Radioactively contaminated (from metal etching operations) acids were put into the radioactive waste sewer and retained in the radioactive waste tank (the same tank used by Building 626). The tank was periodically emptied, and the wastes were treated at the ICPP. Nonradioactively contaminated acids and solvents were often disposed of at the Chemical Evaporation Pond located southeast of Building 627.

In 1980, minor modifications were again made to Building 627 to provide space for a radiochemistry laboratory. This laboratory performed extractions to determine potential leaching of radionuclides from waste forms and other inorganic media. By the nature of the work performed, approximately 95 to 99 percent of the low-level radioactivity contained in the analytical samples was retained on filter paper, and periodically sent to the Radioactive Waste Management Complex (RWMC). The minor amounts of radioactivity that were not captured during extraction operations (approximately $1x10^{-12}$ Ci/mL) and the organic solvents used in the extraction process (xylene, heptane, 2-ethyl hexanol, and methanol) were sent to the Chemical Evaporation Pond. In 1984, the materials research and testing operations were moved from Building 627. The buildings are now vacant and their future use is uncertain.

1.2 Objectives of the Sampling Effort

The ARA-I Chemical Evaporation Pond has not been properly characterized to evaluate the presence and type of chemical and/or radioactive contamination. The purpose of the proposed sampling is to determine the presence, extent, and concentrations of chemical and radioactive constituents in the surface and shallow subsurface soil at the ARA-I Chemical Evaporation Pond. This data will be used to characterize the Evaporation Pond contamination so a closure plan can be constructed.

The sampling plan design will focus on the detection of chemical and radioactive constituents in the pond and immediately adjacent to the pond. Compounds detected in the laboratory analysis will be compared to action levels to determine contamination status.

The objectives of the proposed sampling and analysis are to:

characterize the presence and areal extent of pond contaminants using biased, systematic and random samples;

determine the presence and areal extent of contaminants in previously unsampled areas: Areas with potential for contamination include the discharge pipe and overflow areas adjacent to the pond;

assess the extent of subsurface contaminant movement;

delineate areas that may require soil removal to achieve closure under RCRA; and

collect background samples to set action levels for metal and sulfide contamination.

The objectives were established based on the requirements of the COCA, Appendix 1 requirements (EPA 1987) and the EG&G Strategy Plan (EG&G 1989). Decisions to be based on those data are shown in a decision tree in Figure 1-7.

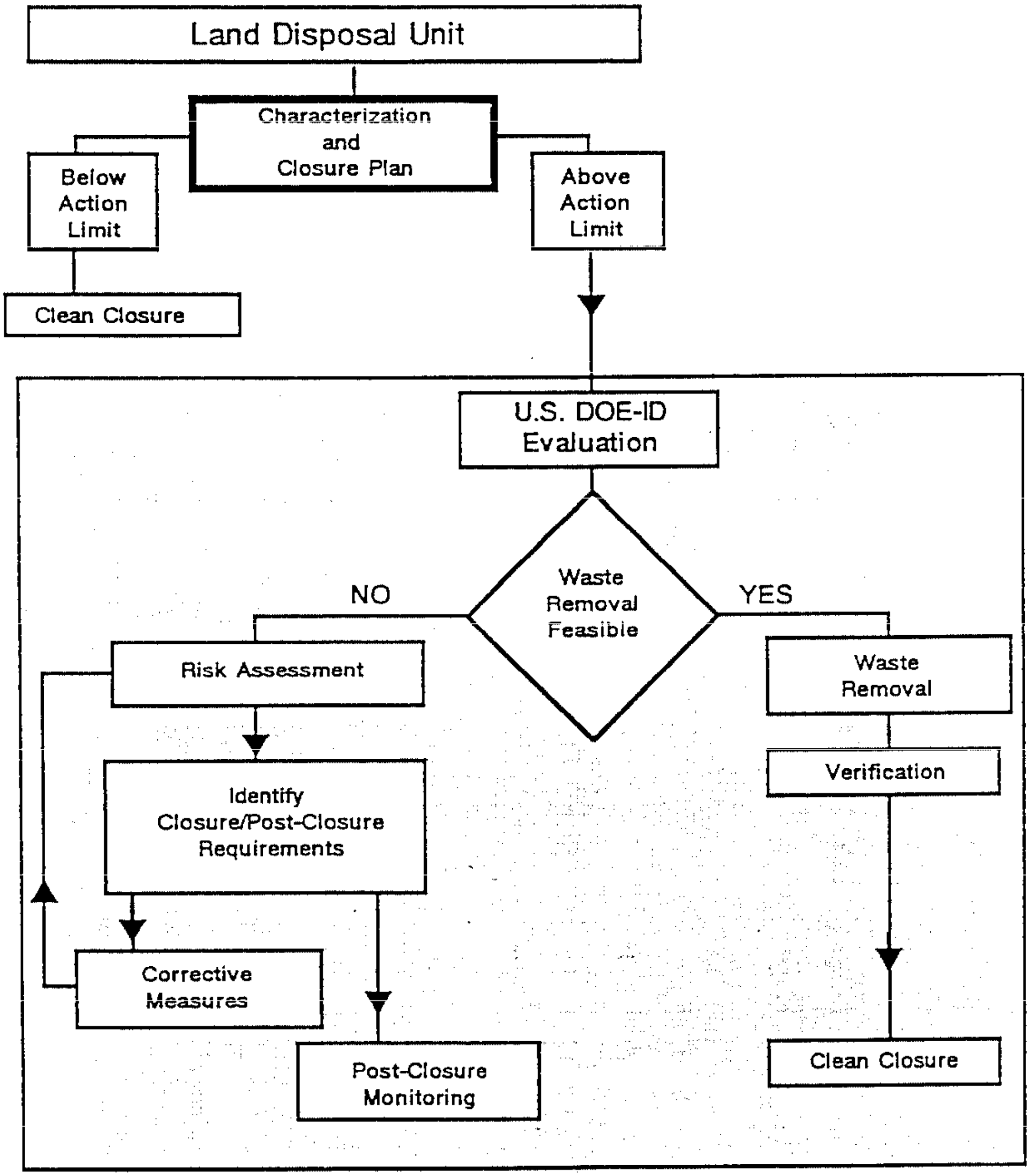

Figure 1-7 Decision tree for clean closure of the ARA Chemical Evaporation Pond.

2. PROJECT DESCRIPTION

2.1 Analysis of Existing Data

Previous sampling efforts at the ARA-I Evaporation Pond have been limited to the collection of a single composite sediment sample in 1982 (EG&G 1986), slightly over one year of quarterly sampling of the ARA-I waste stream effluent in 1987 and 1988, and a recent surface radiation survey in 1989 (Wright 1989).

In August and September of 1982, a single composite sediment sample, consisting of three subsamples, was collected from the ARA Chemical Evaporation Pond and analyzed for priority pollutants by Cal Analytical in Sacramento, California. The subsamples were collected from surficial materials with decontaminated, stainless steel trowels. The exact location of the subsamples is unknown, other than being within the perimeter of the primary pond. The sample was chilled and shipped in coolers by overnight delivery to the analytical laboratory per chain-of-custody procedures.

Organic constituents were not detected at concentrations greater than the method detection limit in the sediment sample. Metals were not detected in concentrations outside the range of expected background concentrations in the sediment sample. Although background concentrations of metals in soils at this particular location have not been established, comparison to background concentrations at nearby INEL locations is acceptable for this preliminary data. A summary of the analytical results from previous sampling is presented in Appendix B. Background metal concentration resulting from two separate studies are presented in Appendix C.

Effluent monitoring at the ARA Chemical Evaporation Pond was performed on a limited basis in 1987. The only effluent monitoring data from the waste stream discharging into the ARA Chemical Evaporation Pond was collected in 1987. The 1987 samples were analyzed for metals to Contract Laboratory

Program detection limits, anions were determined using EPA Method 300.0, and total organic carbon was determined using EPA Method 415.1. In addition, field measurements for temperature, conductivity, and pH were taken.

The monitoring did not detect significant concentrations of any of the analytes. However, the usefulness of these data is limited because of the small number of samples collected and the limited analytical parameters. Results of the 1987 effluent monitoring are presented in Appendix D.

The quantity of radionuclides released to the pond was reported to be negligible; however, a recent (June 26, 1989) surface radiation survey detected radiation above ambient background at three areas (Wright 1989). Figure 2-1 shows the location of these areas and the associated readings. Readings were taken at contact and three feet above ground surface. The highest reading (location 2) was located 3.7 m (12 ft) away from the effluent stream drain opening. The readings were 1.85 mR/hr at contact and 0.27 mR/hr at 0.9 m (3 ft) above the surface. The ambient background level for this area was 0.009 mR/hr.

Information detailing the composition of waste streams to the ARA-I pond and the magnitude of sediment contamination within and adjacent to the pond is inadequate. Records for quantifying waste stream constituents were not kept and monitoring results for effluent discharges are sparse and incomplete. Contaminant characterization is inadequate for the ARA-I site because sediment sampling within the pond is insufficient and overflow areas have not been sampled. Background soils data are also needed for developing action levels for evaluating metals and sulfide contamination.

2.2 Data Quality Objectives

The ARA-I Evaporation Pond Sampling and Analysis Plan is based upon Data Quality Objectives developed as outlined below.

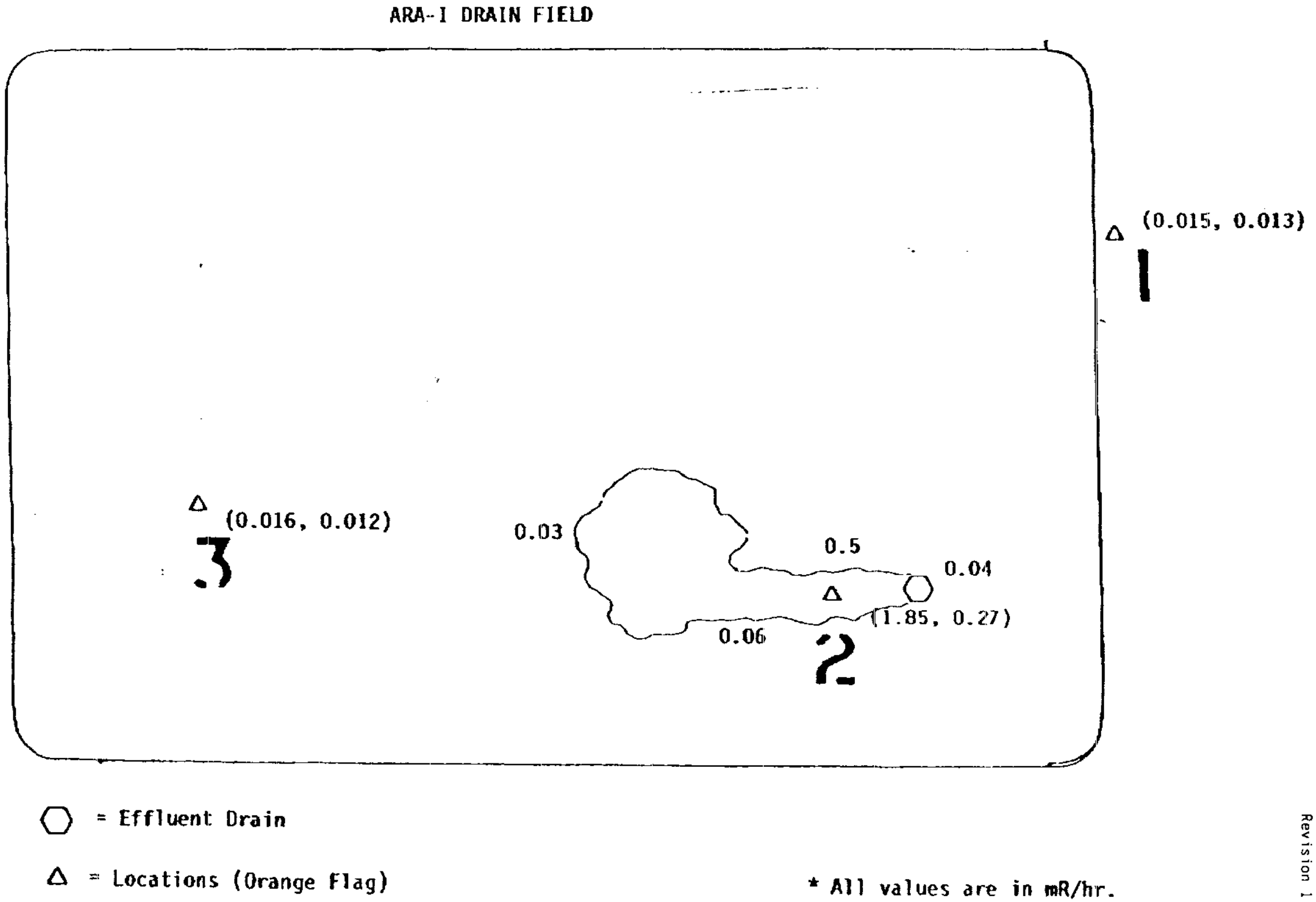

Figure 2-1. Above background radiation measurements at ARA-1.

2.2.1 Decisions to be Made

The Environmental Technology Unit (ETU) and Environmental Restoration Program Managers (ERP), with concurrence from EPA Region 10 and the Idaho Hazardous Waste Bureau, will determine if the ARA-I Evaporation Pond and adjacent overflow areas can achieve clean closure without remedial actions after review of results from this sampling and analysis effort, and previous efforts. If the evaporation pond can not be clean closed, a number of closure scenarios are possible. The pond can be closed as a landfill, or if waste removal is determined to be feasible, affected material will be removed, and the ARA-I Chemical Evaporation Pond will be clean closed. Other closure scenarios are possible depending on the results of sampling and analysis.

2.2.2 Information Required to Make Decisions

The closure decision for the ARA-I Chemical Evaporation Pond will be based on the presence or absence of contaminants in the pond sediments. The sediments may contain metals, organics, or radionuclides. The information required will include contaminant levels of a sufficient analytical level in sediment samples and the concentrations of those contaminants in background soil samples. If contaminants are present, subsequent decisions on proposed closure options must be made. Decisions will require information on the presence and concentration of environmental contaminants, and the contaminants spatial distribution at the ARA-I Chemical Evaporation Pond.

2.2.3 Potential Consequences of Inadequate Environmental Data

Environmental data that are not truly representative of background soils, evaporation pond sediments, or sediments beneath the discharge pipe could lead to incorrect site closure decisions. Data that indicate the presence of sediment contamination when none actually exists (false positives) could trigger unnecessary sediment removal and disposal of materials which are not hazardous. The result would be an over-expenditure of available human and financial resources. Conversely, data indicating a lack of contamination, when contaminants are present, (false negatives) would result in the premature clean closure of the evaporation pond and a failure to address an existing contamination problem.

2.2.4 Specific Environmental Data Required

2.2.4.1 Background Levels of Potential Contaminants in Soils. To identify action levels for metal and sulfide contaminants, the mean and standard deviation of metal and sulfide concentrations in local (ARA-I vicinity) surface soils will be determined. Those data will be compared with metal and sulfide concentrations in sediments from the evaporation pond (see Section 4.6) to determine the presence of contaminants.

2.2.4.2 Contaminant Levels in Site Sediments. Defensible results from soils/sediments sampling must be produced to determine contaminant concentrations. Concentrations of contaminants are compared to action levels to demonstrate the presence or absence of contamination.

Specific analyses of the soils and sediments will consist of: metals by inductively coupled plasma (ICP), volatile organic analysis (VOA), 40 CFR 264 Appendix IX analytes, and gamma-emitting radioisotopes by gamma spectroscopy.

2.2.5 Domain of Decision

The Sampling Plan specifically addresses the ARA-I Chemical Evaporation Pond, discharge pipe, and overflow area. Actions resulting from the evaluation of sampling and analysis data will impact the evaporation pond area, adjacent overflow area, and the corridor along the discharge pipe. Disturbance may result from removal of that soil and other remedial actions if data from the sampling effort indicates contaminants are present.

2.2.6 Information to be Derived from Environmental Data

Laboratory data resulting from the sampling and analysis effort will be evaluated to determine if metals, organics, or radionuclide contaminants exceed action levels and to estimate the spatial distribution of contamination. The information will be used to select site closure options.

2.2.7 Need for New Environmental Data

Insufficient information exists regarding the composition of waste streams released and prior data collection for evaluation of sediment contamination in the ARA-I Chemical Evaporation Pond and associated overflow area. Only one composite sample has been collected and analyzed to evaluate contamination in the pond sediments. Furthermore, the locations and depths of the three subsamples for this single composite sample are unknown. Additional sampling is necessary to assess the spatial distribution of sediment contamination in the pond and overflow area. This is achieved by taking samples from the surface and shallow subsurface (3-m or above basalt/sediment interface) across the entire length of the pond and overflow area. Sample collection is proposed in the surface 3-m of sediment because excavation and removal of contaminated sediments is only practical for contaminants concentrated above the basalt/sediment interface.

In addition, sampling has not been performed to determine if leakage has occurred along the discharge pipe. Samples will be taken to assess the integrity of the discharge pipe and to determine if contaminants were released from this structure.

Background soil samples will be collected and analyzed for metal and sulfide concentrations. Background analyses will be used to identify appropriate action levels for metals and sulfides found in samples collected in the various waste units.

2.2.8 Summary

Table 2-1 summarizes the Data Quality Objectives (DQOs) for this sampling and analysis effort.

2.2.8.1 Decisions to be Made. Does the ARA-I Chemical Evaporation Pond qualify for clean closure without additional sampling and analysis or remedial action. If contamination is found, is it in concentrations above stated action levels? Then, does the ARA-I Chemical Evaporation Pond qualify for clean closure using soil removal methods and verification sampling or closure as a landfill?

2.2.8.2 Resources Available for Data Collection. Availability of financial resources is not considered to be a limiting factor.

2.2.8.3 Domain of Decision. The ARA-I Chemical Evaporation Pond, overflow area, and the corridor of the discharge pipe will be impacted by the decision regarding qualification for clean closure.

2.2.8.4 Data Analysis. The sediments will be considered contaminated with metals if statistically reliable data indicate metals are present in the sediments at levels above those found in background soils. Action levels for radionuclides will be based upon requirements specified in DOE Order 5820.2A (DOE, 1988). Action levels for organic compounds in soils will be set at twice the method detection limit (See Section 4.6).

TABLE 2-1. ARA-I CHEMICAL EVAPORATION POND DATA QUALITY OBJECTIVES

SAMPLE LOCATION:	Discharge Pipe	Background Samples	and Overflow Area
ACTIVITY	Obtain biased grab samples of sediments beneath the discharge pipe for analysis of metals, VOCs, and radionuclides.	Obtain biased, composite surface soil samples from selected background soil locations near the ARA-I facility and analyze the samples for total metals.	Obtain biased and random surface and subsurface sediment samples from the primary and secondary pond and the overflow area. These samples will be analyzed for total metals, VOCs, and radionuclides.
OBJECTIVE	Assess the integrity of the discharge pipe and determine if leakage has occurred.	Determine background levels of metals for comparison with potentially contaminated sediments and soils.	Determine the areal and vertical extent of sediment contamination in the pond and overflow area.
PRIORITIZED DATA USE	Evaluate RCRA closure options.	Provide basis for evaluating contamination in evaporation pond sediments, overflow area soils, and soils beneath the discharge pipe.	Evaluate RCRA closure options, and locate potential area for soil removal.
APPROPRIATE ANALYTICAL LEVEL	Level III[a]	Level III	Level III
CONTAMINANTS OF CONCERN	Metals, organics, radionuclides	Metals	Metals, organics, radionuclides.
LEVEL OF CONCERN	METALS: 99% one-sided upper tolerance interval for background samples. ORGANICS: 3 X MDL or PQL, whichever is higher. RADIONUCLIDES: Consistent with DOE Order 5820.2A BRC[c] classification.	N/A	METALS: 99% one-sided upper tolerance interval for background samples. ORGANICS: 3 X MDL or PQL, whichever is higher. RADIONUCLIDES: Consistent with DOE Order 5820.2A BRC[c] classification.
REQUIRED DETECTION LIMIT[b]	METALS: MDL ORGANICS: MDL RADIONUCLIDES: MDL	METALS: MDL	METALS: MDL ORGANICS: MDL RADIONUCLIDES: MDL
IMPORTANT SAMPLES	samples at the outfall	minimum of two	subsurface sediment samples

a. Analytical Level III is defined in *Data Quality Objectives for Remedial Response Activities: Development Process* (EPA, 1987).
b. The method detection limit (MDL) for each analysis specified in Section 8 will be used per agreements with EPA Region X and State of Idaho.
c. BRC = below regulatory concern.

3. PROJECT ORGANIZATION AND RESPONSIBILITY

Several organizations will be directly involved in the performance and review of this project. The project documentation receives internal review that is outlined in the Environmental Restoration Program (ERP), Program Directive for the Preparation of Sampling and Analysis Plans (EG&G 1989). An organization chart for sampling and analysis activities at the ARA-I Chemical Evaporation Pond and overflow areas is shown in Figure 3-1.

The key personnel designated to prepare all plans and conduct work required for this project include:

S. N. Stanisich will be the Task Project Manager during sampling and analysis and subsequent RCRA closure efforts at the ARA-I Chemical Evaporation Pond. He will be responsible for directing the project team, reviewing and editing project documentation, and for communicating with the Decontamination and Decommissioning Program, Environmental Restoration Program, Data Integrity Review Committee (DIRC), DOE-ID, EPA Region X, and the contract laboratory on technical and administrative matters.

R. Rice, P. Permann, and C. Hardy, along with other personnel, will serve as field team members. They will assist in all phases of field sampling. Additionally, a field team composed of personnel from MSE, Inc., in Butte, Montana, may be assigned to this task.

Data Management responsibilities belong to O. Hester, who will manage the movement of data from field logbooks, analytical labs, to data analysis, and to the final reports. He will be responsible for getting verified and validated data into the final reports.

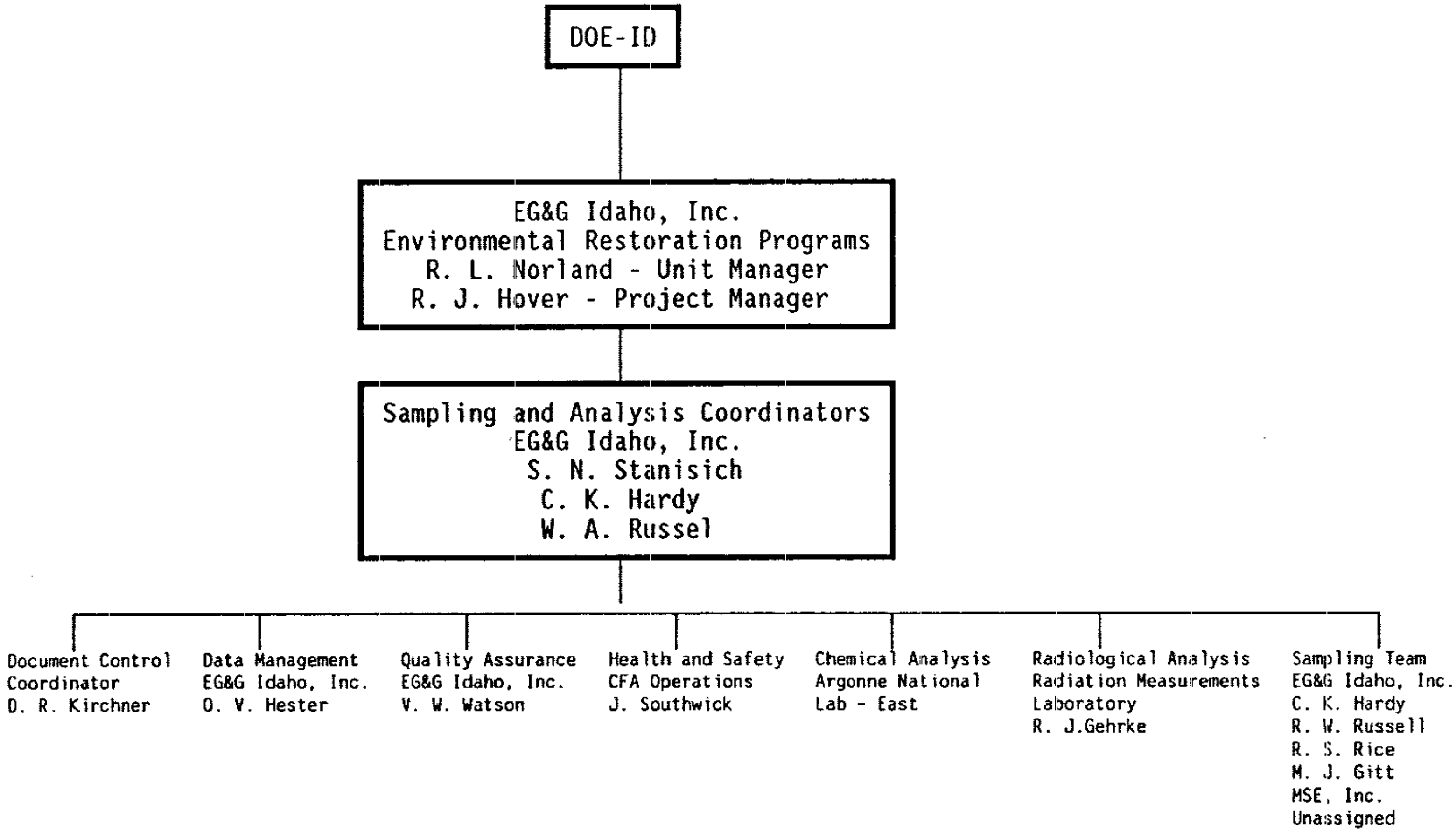

Figure 3-1. Organization Chart for ARA-I Chemical Evaporation Pond Sampling and Analysis.

The field operations QA Officer (QAO) or Project QA Officer will monitor the performance of field operations, and detect and report any deviation from QA protocol to ensure the quality of the sampling and data collection programs

The ARA operations landlord will be responsible for implementing the Health and Safety Plan for sampling at the ARA Chemical Waste Pond. This includes providing Health Physicists staff, as necessary, to support the sampling activities.

The samples for gamma spectroscopy will be sent to the Radiation Measurements Laboratory (RML) at INEL. R. Gehrke of RML will be responsible for overseeing the sample analysis and data reporting. Gehrke will work with Watson and Hester to generate the required information.

Nonradiological analytical samples may be sent to assigned laboratories approved by the ERP. S. N. Stanisich will be responsible for identifying responsible task coordinators from each laboratory, who will be responsible for sample analysis and data reporting. At the laboratories, assigned personnel will work with Watson and Hester to generate the requested data.

Data acquired through this SAP will undergo independent verification by the Data integrity Review Committee (DIRC). The DIRC will evaluate the data for its ability to meet the objectives and requirements detailed in this plan.

4. SAMPLING AND ANALYSIS STRATEGY

4.1 Purpose and Sampling Approach

In the past, specific waste streams at the ARA-I site were discharged to an unlined pond called the ARA-I Chemical Evaporation Pond. The presence and extent of sediment contamination within and adjacent to the pond is unknown because the types and quantities of waste released to the pond were not recorded. The waste streams probably consisted of volatile organic compounds, metals, and low levels of radionuclides. A combination of biased, systematic and random sampling will be employed to investigate the presence or absence of contamination and the horizontal and vertical extent of contamination at the ARA-I Chemical Evaporation Pond.

The sampling plan for detection of chemical and radioactive constituents is based on (1) the limited quantities of materials discharged over a long period of time, (2) the assumption that waste streams were composed primarily of waste solvents and laboratory waste acids, and (3) the defined limits of ponded contaminant effluent. Field screening for gamma and beta emitting radionuclides will be used to bias sample collection. The Ludlum 2A, or a similar type radiation detection instrument, will be used to screen for Beta-Gamma contamination.

4.2 Description of Sampling Units

For the purpose of sampling, the ARA-I Chemical Evaporation Pond contains four discrete units as illustrated in Figure 4-1. The four units are (1) the primary pond, (2) secondary pond, (3) overflow area, and (4) the corridor beneath the discharge pipe. A fifth sampling unit is defined for local background soil samples for metal, cyanide and sulfide analysis.

Division of the pond into primary and secondary sections was based on vegetational changes and the probability that a second discharge pipe may have been located in the secondary pond. The primary pond, directly downstream of

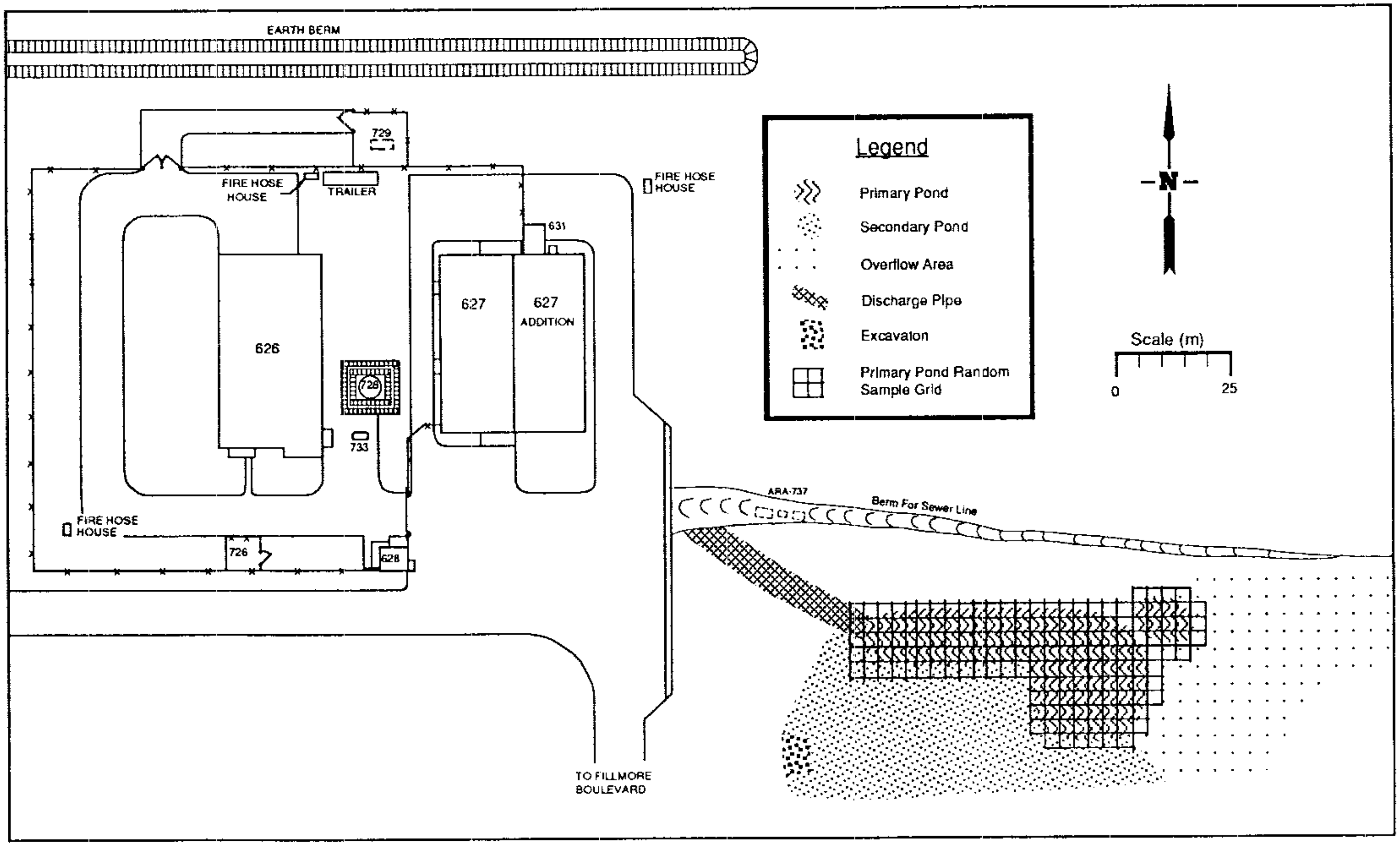

Figure 4-1. ARA-1 Chemical Evaporation Pond sampling locations.

the discharge, is covered with emergent vegetation, which indicated the general outline of the water level which existed when the pond was in use. The suspected secondary discharge area is adjacent to and upgradient from the primary pond. The area has sparse vegetation with surface material from zero to a few feet thick covering basalt. This is an area of concern, since there is evidence that at some time in the past a discharge pipe was located there; however, there is no evidence of this discharge point at the present time and historical information does not support the presence of a discharge pipe. Evidence for the secondary pond discharge point is based on the presence of an excavation located on the western margin of this sampling unit. For the purposes of this sampling and analysis plan, it will be assumed a discharge point was located in the secondary pond even though there is no historical evidence to support this. This excavation may also be the remains of a building foundation. The overflow area east of the pond may have received water during pond overtopping events. Overtopping events may have occurred due to an increase in the rate of discharge to the pond or intense precipitation events. The sediment beneath the discharge pipe is being investigated to screen for contaminated effluent which may have migrated to underlying soils.

The primary pond can be separated into two general sections based on the presence of dominant vegetation (see Figure 4-1). At the drain pipe discharge point, effluent flowed through a shallow sloping ditch with dimensions of approximately 10 x 32 m. The dominant vegetation in the ditch, when the pond was in use, was composed primarily of willows (Salix spp.) with a small area of cattails (Typha spp.) located at the discharge point. This ditch flowed into an area where the effluent ponded. The area where ponding occurred is roughly circular in shape with a diameter of approximately 25 m. The dominant vegetation in the ponded area, when the pond was in use, was composed primarily of cattails (Typha spp.). Immediately to the northeast of the cattail section of the primary pond is a noticeable shallow depression which contained ponded effluent. This depression is separated from the cattail section of the primary pond by a basalt outdropping. For the purposes of sampling, this depression will be considered part of the primary pond.

Presently, cattails and willows no longer occupy the site, which is being colonized by species characteristic of the adjacent range.

Detectable levels of radioactivity, as determined by portable radiation detection instruments, can only be found in the willow section of the primary pond. A site investigation, using Ludlum 2A, revealed that beta-gamma radiation levels were greatest at the pont of discharge to the pond and decreased to background levels at the eastern margin of the willow section of the primary pond. The highest reading (1,600 cpm) was found approximately 2 m below the discharge point. Activity was not detected in the cattail section of the primary pond.

4.3 Description of Sampling

Separate sampling approaches are proposed for each unit based on the definition of the sampling units. Approaches were based on the dual goals of obtaining data to determine the presence or absence of contaminants and to provide sufficient data for evaluating closure options if contaminants are found. The sample sizes used should produce representative information, although the absence of preliminary information precludes a quantitative sample size determination. Table 4-1 summarizes the type, location, and number of field samples to be collected from each unit.

4.3.1 Background Metals

Ten background surface soil samples will be collected, as control samples, for comparison with samples collected from the pond area. Biased sample locations will be selected at the discretion of the Field Team Leader. Locations will be selected so samples are representative of local background conditions. Selected areas will avoid surface disturbances and minimize the potential for windblown contamination. Background soil samples will be collected upgradient of the ponds but within 100 yd of the ponds. Each plot location will be marked with a sufficiently permanent marker to allow for surveying of the location.

4.3.2 Discharge Pipe

To screen for contaminants released due to pipe leakage, three subsurface samples will be collected at a depth of 0.6 m below the discharge pipe and will be analyzed by ICP for metals, for volatile organic compounds, and for gamma-emitting radionuclides. If contaminant leakage from the pipe has occurred, it is most likely to be concentrated just below the pipe. Based on visual observation of the evaporation pond or through radioactive field screening, sample locations will be selected. If areas of obvious staining of the soil surface are present or radiation is detected, then biased samples will be taken in these locations. Otherwise, locations will be selected by the field team leader. All sampled locations will be marked to allow post-sampling surveying.

TABLE 4-1. SUMMARY OF NUMBER, LOCATION, AND TYPES OF ANALYSES TO BE PERFORMED ON FIELD SAMPLES COLLECTED FROM THE ARA-I CHEMICAL EVAPORATION POND.

Location	Depth	Number	Type	6010 ICP	8240/8260 VOC's	Appendix IX					Spectroscopy
I - Chem jar size				250 ml	250 ml	250 ml[a]	500 ml[b]	500 ml[c]	500 ml[d]	500 ml[e]	500 ml Squats[f]
Background	Surface	10	Biased					10			
Discharge Pipe	.6 m	3	Biased	3	3						3
Primary Pond	Surface	15	Random	15							15
	Interface	15	Random	15	15						15
	Surface	3	Biased	3							3
	Interface	3	Biased			3	3	3	3	3	3
Secondary Pond	Surface	4	Biased	4							4
	Interface	4	Biased	4	4						4
Overflow Area	Surface	4	Biased	4							4
	Interface	4	Biased	4	4						4
TOTAL FIELD SAMPLES		65		52	26	3	3	13	3	3	55

a. Analytical parameters: Volatile organic compounds (SW-846 method 8240 or 8260)
b. Analytical parameters: Semivolatiles (SW-846 method 8270)
c. Analytical parameters: ICP metals/As/Se/Pb/Hg/Tl/Sn/Sulfide/CN (SW-846 methods: 6010, 7060, 7740, 7421, 7470 or 7471, 7841 and 7870 respectively, sulfide is analyzed by the method stated in Chapter 7, Section 7.3.4.1 of SW-846. Cyanide according to USEPA SOW No. 788)
d. Analytical parameters: PCBs/Organochlorine Pesticides (SW-846 method 8080)
e. Analytical parameters: Organophosphorus Pesticides/Chlorinated Herbicides (SW-846 methods 8140 and 8150 respectively)
f. Gamma Spectroscopy analysis will adhere to procedures detailed in SOPs for the RML.

4.3.3 Primary Pond

Suface and interface samples will be collected at fifteen locations from a 3 x 3 m sample grid placed within the coundaries of the primary pond. The margin of the sample grid will extend at least 3 m beyond the area thought to be affected by discharges to the pond. The affected area can be delimited by the distinct fegetational boundary present at the primary pond. Fifteen grid nodes will be randomly selected for sampling. At each of the randomly selected sample locations, a furface sample and an interface sample will be collected. The surface composite sample will be collected as described for the background samples. Each sampling location will be marked to allow post-sampling surveying of all sampled location. All surface samples from within the primary pond will be analyzed for metals by ICP (EPA Method 6010), and by gamma spectroscopy and the interface samples will be analyzed by the above methods and for bolatile organic compounds (EPA Method 8240 or 8260).

Soils in the primary pond may be of insufficient depth to collect both surface and interface samples. If the soil depth to basalt is less than 1.5 feet, only one sample will be collected from each location. This decision will be made by the field team leader or an alternate.

4.3.4 Secondary Pond

Based on the judgement of the field team leader, four biased sample locations will be selected from the secondary pond area. These samples will be collected to determine if contamination is present outside the margins of the primary pond and to determine if contamination is associated with the assumed secondary discharge. One of these biased samples will be collected at the assumed secondary discharge point. A surface and interface sample will be collected at each biased location. If the soil depth above basalt is less than 1.5 feet, only the surface sample will be collected. The surface sample will be analyzed bu ICP for metals and for gamma-emitting radionuclides by gamma spectroscopy, the interface samples will be analyzed by ICP for metals, for gamma-emitting radionuclide by gamma spectroscopy and by GC/ms for VOC's.

Surface and interface samples will be collected using procedures described in Section 5.

4.3.5 Overflow Area

Four biased sample sites will be located in the overflow area. Two of the biased samples will be collected from the drainage which would accept overflow water from the primary pond to screen for contaminants which may have been deposited during pond overtopping events. The remaining two biased samples will be collected along the eastern boundary of the primary pond to bound the margins of contamination. The surface samples will be analyzed by ICP for metals and for gamma-emitting radionuclides by gamma spectroscopy. The interface samples will be analyzed by ICP for metals, for gamma-emitting radionuclides by gamma spectroscopy and by GC/ms for VOC's. Surface and interface samples will be collected using procedures described in Section 5.

The soils in the overflow area may be of insufficient depth to collect both surface and interface samples. If the soil depth to basalt is less than 1.5 feet, interface samples will not be collected. This decision will be made by the field team leader.

4.3.6 Primary Pond Appendix IX Biased Sample Locations

Samples will be collected from three biased sample locations within the primary pond. Surface samples will be analyzed by ICP for metals and by gamma spectroscopy for gamma-emitting radionuclides. The interface samples will be analyzed for 40 CFR Part 264 Appendix IX constituents and by gamma spectroscopy. One of these biased samples will be collected from the cattail section of the primary pond where discharge water ponded. The remaining two sample locations will be collected from the willow section of the primary pond. These two locations will be determined in the field based on field indications of beta-gamma radioactivity. The two locations with the highest activity, as determined by Ludlum 2A, or similar radiation detection instruments, will be sampled at the surface and interface. Surface and interface samples will be collected using procedures described in Section 5.

Soils in the primary pond may be of insufficient depth to collect both surface and interface samples. If the soil depth to basalt in less than 1.5 feet, only interface Appendix IX samples will be collected. This decision will be made by the field team leader or an alternate.

4.4 Sample Analysis

All surface field samples collected (except background samples) will be analyzed by ICP for metals (EPA method 6010) and for gamma-emitting radionuclides by gamma spectroscopy. A brief description of gamma-spectroscopy analytical methods is given in Section 8. All interface field samples (except for those to be analyzed for Appendix IX constituents) will be analyzed by ICP for metals (EPA method 6010), for gamma-emitting radionuclides by gamma spectroscopy and by GC/MS for volatile organic compounds (EPA method 8240 or 8260). Analysis for volatile organic compounds will not be performed on the surface soils. Surface soils are directly exposed to weathering and should not contain VOC's in appreciable quantities. The biased interface Appendix IX samples will be analyzed by the methods specified in Section 8 of this SAP.

Background field samples will receive analyses for a number of metals, cyanide and sulfide. Metals in background samples will receive the following analyses by reference to an approved EPA method; metals by ICP (EPA method 6010), antimony (EPA method 7041), arsenic (EPA method 7060), lead (EPA method 7421), mercury (EPA method 7471), selenium (EPA method 7740), thallium (EPA method 7841) and tin (EPA method 7870). Cyanide in background samples will be analyzed by the method specified in the EPA Statement of Work (SOW) for inorganics analyses, SOW No. 788. Finally, releasable sulfides will be analyzed by the mehtod stated in Chapter 7, Section 7.3.4.1 of SW-846.

4.5 Quality Control Samples

Quality Control (QC) samples will also be collected during the ARA-I Chemical Evaporation Pond field activities. A summary of the number and locations, and the analyses to be performed on QC samples is shown in Table 4-2. Field replicates, rinsates (equipment blanks), field blanks, trip blanks and field standards will be collected.

Field replicates will be collected at three locations (1) one from the biased Appendix IX samples collected from the willow section of the primary pond (2) and two from the random interface samples collected from the primary pond. Those locations were chosen as most critical for site characterization. The biased Appendix IX field replicate collected from the willow section of the primary pond will be analyzed for Appendix IX constituents and by gamma spectroscopy. The remaining field replicates will be analyzed for metals by ICP, for gamma- emitting radionuclides by gamma spectroscopy and by GC/MS for volatile organic compounds.

Rinsates (equipment blanks) and field blanks will receive similar analyses. These samples will be analyzed for metals by ICP, for volatile organic compounds and for gamma-emitting radionuclides by gamma spectroscopy. Trip blanks will be analyzed only for volatile organic compounds by GC/MS.

Rinsates (equipment blanks) and field blanks will receive similar analyses. The samples will be analyzed for metals by ICP, for volatile organic compounds and for gamma-emitting radionuclides by gamma spectroscopy. Trip blanks will be analyzed for volatile organic compounds by GC/MS.

Field standards will be analyzed for the same constituents as the background samples with the exception of cyanide and sulfide. The specific analyses for field standards by EPA method number are as follows; metals by ICP (EPA method 6010), antimony (EPA method 7041), arsenic (EPA method 7060), lead (EPA method 7421), mercury (EPA method 7471), selenium (EPA method 7740), thallium (EPA method 7841) and tin (EPA method 7870). Sections 10 and 11 describe project QC samples in greater detail.

TABLE 4-2. SUMMARY OF NUMBER, LOCATION, AND TYPE OF ANALYSES TO BE PERFORMED ON QC SAMPLES COLLECTED FROM THE ARA-I EVAPORATION POND.

Location	Number	Type	6010 ICP	8240/8260 VOC's	Appendix IX					Spectroscopy
I - Chem jar size			250 ml	250 ml	250 ml[a]	500 ml[b]	500 ml[c]	500 ml[d]	500 ml[e]	500 ml Squats[f]
Replicates:										
High Radiation Level Area	1	QC Soil			1	1	1	1	1	1
Primary Pond Random Interface	1	QC Soil	1	1						1
Primary Pond Random Interface	1	QC Soil	1	1						1
Rinsates	4	QC Water	4[i]	4[h]						4[j]
Trip Blanks	4	QC Water		4[h]						
Field Blanks	4	QC Water	4[i]	4[h]						4[j]
Field Standards	3	QC Soil					4[g]			
TOTAL QC SAMPLES	19		10	14	1	1	5	1	1	11
TOTAL SAMPLES INCL. QC SAMPLES	**85**		**62**	**40**	**4**	**4**	**18**	**4**	**4**	**66**

a. Analytical parameters: Volatile organic compounds (SW-846 method 8240 or 8260)
b. Analytical parameters: Semivolatiles (SW-846 method 8270)
c. Analytical parameters: ICP metals/As/Se/Pb/Hg/Tl/Sn/Sulfide/CN (SW-846 methods: 6010, 7060, 7740, 7421, 7470 or 7471, 7841 and 7870 respectively, sulfide is analyzed by the method stated in Chapter 7, Section 7.3.4.1 of SW-846. Cyanide according to USEPA SOW No. 788)
d. Analytical parameters: PCBs/Organochlorine Pesticides (SW-846 method 8080)
e. Analytical parameters: Organophosphorus Pesticides/Chlorinated Herbicides (SW-846 methods 8140 and 8150 respectively)
f. Gamma Spectroscopy analysis will adhere to procedures detailed in SOPs for the RML.
g. Analytical parameters for field standards: ICP metals/As/Se/Pb/Hg/Tl/Sn (SW-846 methods: 6010, 7060, 7740, 7421, 7470 or 7471, 7841 and 7870 respectively)
h. Aqueous VOA Samples placed in 3 - 40 ml glass vials.
i. Aqueous samples analyzed by SW-846 method 6010 placed in 500 ml (NM) HDPE containers.
j. Aqueous samples analyzed for gamma emitting radionuclides placed in 540 ml (NM) HDPE containers.

4.6 Action Levels

Action levels for contaminants in the surface and subsurface soils at the ARA Chemical Evaporation Pond determine specific cleanup criteria for organic compounds, metals, cyanide, and radionuclides.

4.6.1 Action Levels for Radionuclides

Action limits for radionuclides in soils can be established by using "Radiological Release Criteria for Soils" as presented in the Development of Criteria for Release of Idaho National Engineering Laboratory Sites Following Decontamination and Decommissioning (EG&G, 1986). A performance objective of 10 mrem/yr effective dose equivalent will be used for the cleanup of residual radioactive contamination. This is 1/10 of the 0 to 100-mrem range suggested for release of INEL sites following decontamination and decommissioning (EG&G, 1986). This is a conservative value, considering the conservative agriculture exposure scenario used for the dose calculation, the period of control (> 100 yr) for the INEL sites, and that residual contamination would be further redueced by radioactive decay during this period of control. The release criteria are consistent with current international (International Commission on Radiological Protection) and national (National Commission on Radiological Protection) standards for radiation.

Table 4-3 presents the ERP target radionuclide list that delineates radionuclides produced or used during research activities at the INEL. These radionuclides have the potential to be released to the environment as a result of site activities.

4.6.2 Action Levels for Metals and Cyanide

To perform action level comparisons for metals and cyanide valid tolerance limits must be determined. The action level for metals and sulfides will be defined as the one-sided upper tolerance limit corresponding to the 99^{th} percentile of the background population with 99% confidence. This means

TABLE 4-3. ERP TARGET RADIONUCLIDE LIST.

Radionuclide	Half-Life
Actinium-228	6.13 h
Americium-241	458 y
Antimony-125	2.7 y
Bismuth-212	60.6 min
Bismuth-214	19.8 min
Cerium-144	284 d
Cesium-134	2.05 y
Cesium-137	30.2 y
Cobalt-60	5.27 y
Europium-152	12 y
Europium-154	16 y
Europium-155	1.81 y
Lead-212	10.6 h
Lead-214	26.8 min
Manganese-54	303 d
Plutonium-238[a]	87.7 y
Plutonium-239[a]	24,000 y
Plutonium-240[a]	6580 y
Protactinium-234	6.7 h
Radium-226	1600 y
Silver-110	253 d
Strontium-90[a]	28.8 y
Thallium-208	3 min
Thorium-234	24.1 d
Uranium-234[a]	2.5×10^5 y
Uranium-238[a]	4.5×10^9 y
Zinc-65	245 d

a. To be determined by radiochemical techniques and methods. All others listed are determined by gamma spectrometric techniques.

Note: Thorium-234, Protactinium-234, Uranium-234, Radium-226, Lead-214, and Bismuth-214 are decay products (daughters) of the natural Uranium series decay chain. Actinium-228, Lead-212, Bismuth-212, and Thallium-208 are decay products (daughters) of the natural thorium series decay chain. The long half-lives of the parent activity should be considered when examining the half-lives of the daughter activities.

that the calculated action level will be greater than 99% of the values in the background population with 99% confidence. This limit, U, is calculated from the mean, x, and the standard deviation, s, of the background samples as $U = x + ks$, where k is the tabled value corresponding to the 99^{th} percentile with 99% confidence. A loose interpretation of this statistic is that if a sample value exceeds the value of U then there is less than a 1% chance that the sample is from background, and hence, likely to be contaminated.

If inorganic constituents detected during evaporation pond sampling and analysis are found to be below the one-sided upper tolerance limit, then the site will be considered uncontaminated for the particular analyte. Detections found to be above these action limits indicate that RCRA cleanup activities may be necessary or additional sampling to improve site characterization may be required.

4.6.3 Action Levels for Organic Compounds

The cleanup action limit for organic compounds will be set at the larger of three times the PQL as specified in EPA SW-846, or the MDL as determined by the analytical laboratory. The three times the MDL/PQL action limit has been mandated by EPA Region X and the State of Idaho.

5. SAMPLING PROCEDURES

5.1 Sample Collection

Sampling procedures have been developed to insure representative data, collection and to guide potential site remediation. Collection methods differ for the surface and subsurface samples. Sampling device descriptions and procedures for their use are described in Characterization of Hazardous Waste Sites--A Method Manual: Volume II, Available Sampling Methods (EPA, 1983). All soil samples will be collected using a stainless steel hand auger. The hand auger consists of a series of drill rods, a "T" handle, and a thin-wall tube corer or auger bit. The bit is used to bore a hole to the desired sampling depth and is then withdrawn. The sample material is then recovered directly from the auger.

5.1.1 Surface Samples

The surface samples will be spatial composites of 5 subsamples collected from a 1-m by 1-m square plot to a depth of 15 cm. Subsamples will be collected at the four corners and the center of the plot using the hand auger. Each subsample will be sieved using a stainless steel spoon through a 2-mm mesh stainless steel screen into a disposable aluminum pan. This procedure will be conducted at each of the five subsample points. The soil in the aluminum pan will be thoroughly mixed with the stainless steel spoon following the collection of all subsamples. Sample bottles will be filled using the stainless steel spoon from the composited mixture. This method of compositing will be employed to help reduce the short-range spatial variability typically present in soil properties.

5.1.2 Interface/Subsurface Samples

Interface and subsurface samples will be collected using similar procedures. Subsurface samples will be collected adjacent to the discharge pipe. Interface samples will be collected from all other sampling units at the evaporation Pond. Interface and subsurface samples will be collected from a single core hole using a hand auger. Sample material from each auger lift will be screened through a 2-mm mesh stainless steel screen into an aluminum pan. After screening the sample material, a stainless steel spoon will be used to thoroughly homogenize the sediments. The stainless steel spoon will then be used to placed the sediments into sample containers. For interface samples, a grab for volatile organic analysis will be collected directly from the stainless steel hand auger from sediments located immediately above the basalt. Volatile organic samples are collected as grabs to avoid the loss of organics which may occur during screening and homogenization of the sediments. Interface sample to be analyzed for metals, volatile organic compounds and gamma-emitting radionuclides will require a core length of approximately 0.3 m (1 ft). Interface samples to be analyzed for Appendix IX constituents and gamma-emitting radionuclides will require a core length of approximately 0.7 m (2.5 ft). For the subsurface samples, a core length of approximately 0.3 m will be necessary to fill the required sample containers. The volatile organic sample will be collected as a grab from the last auger lift.

5.2 Decontamination Procedures

To prevent cross contamination of samples from onsite sampling equipment, all sampling equipment will be decontaminated. Decontamination will be performed throughout the work day as equipment is used and clean supplies are depleted. Sampling equipment decontamination will follow the procedures used in the DOE Environmental survey (DOE, 1989) and involve:

- washing and scrubbing equipment with nonphosphate detergent,
- rinsing with tap water,
- rinsing with ASTM-Type II water or equivalent,
- rinsing with pesticide grade methanol,
- air drying (if possible), and
- wrapping in aluminum foil.

6. SAMPLE CONTROL AND DOCUMENT MANAGEMENT

The following sections summarize sample control and document management. The section on documentation addresses all field documents used to record data collected in the field and to document sampling procedures. Documents include sample container tags, labels, and field logbooks. The use of sample identification codes is also explained. The section on sample handling procedures outlines the sample containers and preservatives that will be used and discusses chain of custody, screening for radioactivity, and packaging and transportation of samples to the laboratory.

6.1 Documentation

The field document control coordinator is responsible for the control and maintenance of all field documents and records, and assuring that all required documents are submitted to ERP Administrative Records and Document Control (ARDC) (see Section 9.0). The project manager will appoint a member of the field team as field document control coordinator. All entries will be made in permanent black ink. Any errors will be corrected by drawing a single line through the error and then the correct information will be entered. All corrections will be initialed and dated. The serial number or ID number and disposition of all controlled documents (e.g., sample container tags and chain-of-custody forms) will be recorded in the document control logbook. If any documents are lost, a new document will be completed. The loss of a document and an explanation of how the loss was rectified will be recorded in the document control logbook. The serial number and disposition of all damaged or destroyed field documents will also be recorded. All voided and completed documents will be maintained in a file.

6.1.1 Sample Container Label

Waterproof, gummed labels containing preprinted information concerning the sample ID number, the name of the project area, and type of analysis will be used. I-Chem container labels, included with the sample container, will not be used. The preprinted sample ID number will serve as a unique label identifier. Tags and labels will be distributed to the field team leader at the start of the field period, and when not in use, they will be in the custody of the field team leader. Information concerning date and time of sampling and field measurements of hazards will be filled out in the field. Before collecting the sample, labels will be completed and placed on the containers in the field. Clear plastic tape will be placed over the label to protect it from damage. Refer to Figure 6-1 for an example of a correctly completed label.

6.1.2 Sample Container Tag

In the field, a tag will be attached to each sample container using rubber bands. Preprinted information found on the sample tags includes the name of the project area, a three character code referencing the project area, the analysis type, and the sample ID number. Information on the date and time of sampling is recorded during field sampling. Figure 6-2 is an example of a correctly completed tag.

6.1.3 ARA-I Chemical Evaporation Pond Sample Numbering

A systematic eight or nine-character code will be used to number sample aliquots at the ARA-I Chemical Evaporation Pond (Table 6-1). The first three characters of the code, "ARA," denotes the facility name. The next two characters are specific to each sampling location or the type of quality control sample. The following two characters refer to the number of aliquots collected for each particular analysis. The final one or two characters refer to a particular class of analysis, "M" for metals (EPA method 6010), "V" for volatile organic compounds (EPA method 8240 or 8260) and "G" for gamma spectroscopy. Appendix IX aliquots are labeled as follows: "AV" for VOAs, "AM" for metals, "AS" for semivolatiles, "AP" for organophosphorus pesticides and chlorinated herbicides, and "AB" for PCBs and organochlorine pesticides.

ARA-01 CHEMICAL POND SAMPLING		
AREA: ARA-01		
ANALYSIS: Metals	DATE(ddmmmyy):	TIME:
SAMPLE ID NUMBER: ARA0101M		

Figure 6-1. Sample container tag.

ARA-01 CHEMICAL POND SAMPLING	
SAMPLE ID NUMBER: ARA0101M	TIME:
DATE(ddmmmyy):	SAMPLER:
ANALYSIS: Metals	
FIELD MEASUREMENT/HAZARDS:	

Figure 6-2. Sample container label.

TABLE 6-1. SAMPLE NUMBERS AT THE ARA-1 CHEMICAL EVAPORATION POND

Location	Depth	Type	Analyses by EPA Methods Number: 6010 ICP	Analyses by EPA Methods Number: 8240 VOAS	Appendix IX[a]	Gamma Spectroscopy
Background	Surface	Biased			ARA0101AM - ARA0110AM	
Discharge Pipe	.6 m	Biased	ARA0201M - ARA0203M	ARA0201V - ARA0203V		ARA0201G - ARA0203G
Primary Pond	Surface	Random	ARA0301M - ARA0315M			ARA0301G - ARA0315G
	Interface	Random	ARA0401M - ARA0415M	ARA0401V - ARA0415V		ARA0401G - ARA0415G
	Surface	Biased	ARA1101M - ARA1103M			ARA1101G - ARA1103G
	Interface	Biased			ARA1201-ARA1203AV,AM,AS,AP,AB	ARA1201G - ARA1203G
Secondary Pond	Surface	Biased	ARA0701M - ARA0704M			ARA0701G - ARA0704G
	Interface	Biased	ARA0801M - ARA0804M	ARA0801V - ARA0804V		ARA0801G - ARA0804G
Overflow Area	Surface	Biased	ARA1701M - ARA1704M			ARA1701G - ARA1704G
	Interface	Biased	ARA1801M - ARA1804M	ARA1801V - ARA1804V		ARA1801G - ARA1804G
Replicates:						
Radiation Area	Interface	QC Soil			ARA1301AV,AM,AS,AP,AB	ARA1301G
Primary Pond	Interface	QC Soil	ARA1401M	ARA1401V		ARA1401G
Primary Pond	Interface	QC Soil	ARA1501M	ARA1501V		ARA1501G
Rinsates		QC Water	ARA1601MR - ARA1604MR	ARA1601-ARA1604AR,BR,CR[b]		ARA1601GR - ARA1603GR
Trip Blanks		QC Water		ARA2001 - ARA2004TA,TB,TC		
Field Blanks		QC Water	ARA2101MF - ARA2104MF	ARA2101 - ARA2104FA,FB,FC		ARA2101GF-ARA2104GF
Field Standards		QC Soil			ARA1901AM - ARA1904AM	

a. Appendix IX aliquots are labeled as follows: AV-VOAs, AM-metals, AS-semivolatiles, AP-pesticides, AB-PCBs.
b. Aqueous VOA samples consist of 3 40-ml aliquots labeled A, B, and C.

6.1.4 Field Guide Forms

Field guide forms are used to facilitate sample container documentation and organization of field activities. Field guide forms contain information on the sample request number, sample ID numbers, sample locations, aliquot ID, analysis type, container size and type, and sample preservation. An example of a field guide form for sampling at the ARA-I Chemical Evaporation Pond is shown in Figure 6-3.

6.1.5 Field Logbooks

Field logbooks will be used to record information necessary to interpret the analytical data. All field information pertaining to the sampling teams' activities will be entered in logbooks. Entries will be dated and signed by the individual making the entry. All logbooks will be checked daily for accuracy and completeness by the field document control coordinator.

6.1.5.1 Sample Logbook.

Sample logbooks will be used by soils task teams. Each logbook will contain copies of a media team activity log sheet, including a chronological record of the team's activities throughout the day and a sample log sheet to record specific information about the samples collected. Figures 6-4 and 6-5 are examples of a correctly completed media team activity log sheet and sample log sheet. The cover of the logbook will display the titles "INEL RCRA/CERCLA INVESTIGATIONS" and "Sample Logbook," as well as the starting and ending sampling dates, site name, logbook number, and name of the person to whom the logbook was assigned.

6.1.5.2 Special Logbooks

In situ measurements where no physical samples are collected (such as geophysical or field radiation surveys) will be recorded in a special logbook. A complete description of the location, instruments used, calibrations performed, and data collected, will be included in this logbook. The cover of

ENVIRONMENTAL PROBLEM NUMBER:

OBJECTIVE:

Sampling Team:

Sample Request: ARA04

Sample Number(s): ARA0401_ through ARA0408_: M V G
ARA0409__: A_ G

Media: Sediment

Sample Type:

Suspected Sampling Hazard:

Sample Location(s): Primary Pond Interface

ANALYSES

RAD: Gamma Spectroscopy

NON-RAD: ICP Metals, VOCs, Appendix IX

FIELD:

Sample Containers, Volumes, and Preservatives:

Aliquot ID (8^{th}, 9^{th} char.)	Analytical Parameter	Container Volume or Type	Preservative
M	ICP metals	250 ml WM glass	Ice
V	VOAs	250 ml WM glass	Ice
AV	App.IX: VOAs	250 ml WM glass	Ice
AS	Semivol.	500 ml WM glass	Ice
AM	Metals	500 ml WM glass	Ice
AB	PCBs/Pest.	500 ml WM glass	Ice
AP	Pest./Herb.	500 ml WM glass	Ice
G	Gamma Spectroscopy	500 ml squats	None

Figure 6-3. Example of a field guide form used at the ARA-1 Chemical Evaporation Pond.

SAMPLE LOGBOOK

Date (mm/dd/yy): __ __/__ __/__ __

Field Team Members:

________________________ ________________________

________________________ ________________________

________________________ ________________________

________________________ ________________________

________________________ ________________________

SAMPLE

Weather: ____

____

Narrative (description of field sampling activities with time and location, description of sampling point, and samples collected.):

____

____

____

____

____

____

____

____

____

____

____

____

____

RECORDED BY: ____________ (Signature) QA CHECK BY: ____________(Signature)

Figure 6-4. Sample logbook activity logsheet for the ARA-I Chemical Evaporation Pond.

SAMPLE LOGBOOK

DATE(MM/DD/YY): __ __/__ __/__ __   LOCATION: ______________________________

SAMPLE TYPE: (0) Normal (1) Equip. Blank (PRIOR) (2) Trip Blank (3) Replicate (4) Split
(5) Equip. Blank (POST) (6) Spike (7) Other ____________________

ID NO.	CODE	POINT (LOCATION)	DEPTH FROM ____	TO ____ (UNITS) BELOW SURFACE

SAMPLE

SAMPLE METHOD: CODE: (_____)
(0) Grab (1) Spatial Comp. (2) Time Comp. (3) Other __________

SAMPLE DESCRIPTION: CODE (_____)

SOIL/ROCK	SEDIMENT/SLUDGE	LIQUIDS
(00) Surf. Soil	(05) Pond/Impoundment	(08) Pond/Impoundment
(01) Sub. Surf. Soil	(06) Drum/Tank	(09) Drum/Tank
(02) Basalt	(07) Other	(10) Plant Discharge
(03) Sediment Interbed	AIR/GAS	(11) Spring/Seep
(04) Other	(15) Soil Gas	(12) Perched Aquifer
	(16) Other	(13) Regional Aquifer
Other: ______________________		(14) Other

FIELD MEASUREMENTS: (list field measurements of the samples)

ID No.	Measurement	Units	Instr. Make/Model	Instr. No.

SAMPLING AND ANALYSIS PLAN FOLLOWED: NO (___) YES (___) IF NO EXPLAIN DEVIATIONS:

RECORDED BY: ______________________________ QA CHECK BY: __________________

Figure 6-5. Sample logbook logsheet for the ARA-I Chemical Evaporation Pond (page 1).

SAMPLE LOGBOOK

SAMPLE ID NUMBER	CONTAINER		ANALYSIS	PRESERVATIVE
	VOLUME	TYPE		TYPE/VOLUME

RECORDED BY: ____________________ QA CHECK BY: ____________________

Figure 6-5. Sample logbook logsheet for the ARA-I Chemical Evaporation Pond (page 2).

SAMPLE LOGBOOK
MAP OF SAMPLING LOCATION: (include location of sampling points and reference points) SAMPLE

RECORDED BY: ______________________ QA CHECK BY: ______________________

Figure 6-5. Sample logbook logsheet for the ARA-I Chemical Evaporation Pond (page 3).

the logbook will display the title ARA-I Chemical Evaporation Pond, as well as the site, sampling organization (Environmental Technology Unit), and a two-digit logbook number.

6.1.5.3 Field Team Leader's Daily Logbook

A project logbook will be maintained by the sampling team leader. That logbook will contain a daily summary of activities of the team, problems encountered, and site contacts. An inventory of all logbooks and documents will be kept by the ERP document control coordinator.

6.1.5.4 Equipment Calibration and Decontamination Logbook

Each piece of equipment will have a logbook to record equipment calibration data. The logbook will also contain logsheets to record the date and decontamination procedure for each piece of equipment. The date, time, sample ID number, and method used to collect all QA samples will be recorded on the decontamination logsheets of these logbooks. The samples include trip blanks, preservation blanks, and equipment decontamination rinsates.

6.2 Sample Handling

Tables 6-2 and 6-3 outline the generic requirements for containers, preservation methods, sample volumes, and holding times for solid and aqueous samples. However, should it become necessary, soil/sediments and aqueous liquids will be analyzed for those constituents previously discussed; ICP metals, VOAs, Appendix IX and gamma spectroscopy. All containers will be precleaned and obtained from I-Chem, an EPA-approved supplier for Superfund sites.

Sample bottles for liquid inorganic and radionuclide analyses will be filled to 90 percent capacity, allowing for expansion of the contents. Sample bottles containing material to be analyzed for organic compounds will be filled with minimum headspace. The 40-mL glass VOA vials will be filled

Table 6-2. TYPICAL SAMPLE REQUIREMENTS - SOILS/SEDIMENTS/SLUDGE/BIOTA

Analytical Parameter	Container Size	Container Type	Preservative	Holding Time[a]	Sample Volume
Oil and Grease	1000 mL	(WM) Glass Jar	H_2SO_4 to pH<2	28 days	1000 mL
Volatile Organics/Hydrocarbons	125 mL	(WM) Glass Jar	4°C	14 days	50 g (minimum headspace)
Semivolatile Organic/Anions/ TCLP Semivols/PCB/Pesticide	250 mL	(WM) Glass Jar	4°C	Ext. Org.-14 days TCLP-28 days Sulfides-7 days Pest-7 days	150 g
High Explosives	250 mL	(WM) Glass Jar	4°C	NA	200 g
CLP Metals/ICP Metals/Cations/ Cyanide/TCLP Metals/ Pb/Hg/Cr/Cr^{+6}/As/Tl/Sn	250 mL	(WM) Glass Jar	4°C	6 months Cyanide-28 days	75 g
Gamma Analysis/Gross A&B Analysis Total Pu/H/Total U/Th/Sr-90/Am/ Ra-226/Cs137	16 oz	Plastic Squat Jar	None	1 year	fill to top
Environmental Asbestos/Bulk Asbestos	500 mL	Glass (WM)	4°C	None	500 ml
Soil gas		Canister	4°C	6 weeks	variable

a. Holding times are from the date of collection as referred to in Federal Register Vol. 49, No. 209, October 26, 1984.

Table 6-3. TYPICAL SAMPLE REQUIREMENTS - AQUEOUS SAMPLES.

Analytical Parameter	Container		Preservative	Holding Time[a]	Sample Volume
	Size	Type			
Volatile Organics	40 mL	Glass Vial	4°C	14 days	120 mL/3-40 ml vials
Semivolatile Organics/TCLP Semivol Org. or PCBs/Pesticides	4-1 gal.	Amber Glass Jugs	4°C	Extract 7 days analyze 40 days	4 gallons
Anions	125 mL	HDPE (NM)	4°C	48 hours-- NO_3, PO_4, All others 28 days	100 mL
ICP Metals/Cations/Hg/Pb/TCLP metals	500 mL	HDPE (NM)	pH<2, HNO_3	6 months	500 mL
High Explosives	2360 mL	Amber Glass	4°C	NA	2 L
Cyanide	500 mL	HDPE (NM)	pH>12, NaOH	14 days	500 mL
Gross alpha, beta screen	125 mL	HDPE (NM)	pH<2 HNO_3	Screen immediately	100 mL
Gamma Analysis or Screen	540 mL	Plastic	pH<2 HNO_3	1 year	500 mL
Rad. Analysis/Total U	2-1/2 gal	Plastic collapsible	pH<2 HNO_3	1 year	2-1/2 gallons
Suspended Particles	250 mL	HDPE (WM)	4°C	14 days	250 mL
Environmental Asbestos	500 mL	HDPE (NM)	None	--	--
Sr-90	1000 mL	HDPE (NM)	pH<2 HNO_3	--	1000 mL
Tritium (HT)	125 mL	HDPE (NM)	None	1 year	100 mL

a. Holding times are from the date of collection as referred to in Federal Register Vol. 49, No. 209, October 26, 1984.

completely with absolutely no headspace or air bubbles. Soil samples collected in 250- and 500-mL jars will be filled to capacity.

Chain-of-custody (COC) procedures for sample bottles will begin when the sample is collected. Bottles will be stored in the field in a secured area accessible only to the field team members. Before mobilization of the sampling team, sample bottles will be stored in a secured room with custody seals placed on the outside of each box of containers. COC procedures will be followed as outlined in A Compendium of Superfund Field Operations Methods (EPA 540 P-87 001). Refer to Figure 6-6 for an example of a COC form to be used during field operations at the ARA-I Chemical Evaporation Pond. Sample container information will be recorded on the Chain-of-custody forms the day the sample is collected. Parafilm will be wrapped around the neck and lid of the container to secure the lid. The secureness of the lids on the containers will be checked in the field at least 15 minutes after the sample is collected, and/or before the container is shipped to the analytical laboratory.

6.2.1 Sample Preservation

Preservation of all environmental samples will be performed immediately upon sample collection.

The pH and/or temperature of the final sample will be checked before shipping to ensure adequate preservation. Each field task team will be equipped with field sample preservation kits required for sampling, which may include nitric acid, sulfuric acid, hydrochloric acid, and sodium hydroxide, as well as pH indicator paper.

Ice chests will be used to cool samples during field sampling, packaging, and transportation. A refrigerator or ice chest will be provided in the site office for samples requiring overnight refrigeration. A refrigerator temperature log will be kept by the sampling team leader and recorded in the

EG&G CHEMICAL SCIENCES
CHAIN OF CUSTODY FORM

SAMPLER *(Signature)*	PROJECT NAME

SAMPLE NO FIELD	SAMPLE NO LAB	SAMPLING DATE	SAMPLING TIME	COMP	GRAB	SAMPLE LOCATION	AQUEOUS	SOLID	OTHER	REMARKS	RECEIVED BY ANALYST	DATE/TIME

SAMPLE

Relinquished by *(Signature)*	Date/Time	Received by *(Signature)*	Relinquished by *(Signature)*	Date/Time	Received by *(Signature)*
Relinquished by *(Signature)*	Date/Time	Received by. *(Signature)*	Relinquished by *(Signature)*	Date/Time	Received by *(Signature)*

DISTRIBUTION Original and Pink copies accompany sample shipment to laboratory Original copy retained by custodian Pink copy retained by laboratory Yellow copy retained by samplers

Figure 6-6. Example of a chain-of-custody form to be used during sampling activities at the ARA-1 Chemical Evaporation Pond.

project logbook. Thermometers will be placed in the ice chests that are used to transport samples from the field to the shipping area; the temperature will be checked periodically and recorded in the logbook.

6.2.2 Transportation of Samples

All short holding-time samples will be transported priority one/overnight via Federal Express through the Federal Express Office, in accordance with the regulations issued by the Department of Transportation (DOT) (49 CFR Parts 171 through 178), and EPA sample handling, packaging, and shipping methods (40 CFR 261.C.3C.3). Additionally, Sampling and packaging procedures will adhere to ERP Program Directive entitled "Sample Packaging and Shipping Procedures" (EG&G, 1989e).

All samples will be packaged and transported in a manner that will protect the integrity of the sample, as well as protect against any detrimental effects from possible leakage. Depending on the suspected sample concentrations and DOT hazard class, packaging procedures will vary; however, all samples will be screened for radionuclide activity and classified before they are packaged and transported. Figure 6-7 depicts a properly packaged and labeled cooler for shipment to the analytical laboratory. The temperature of each batch of coolers arriving at the laboratory will be checked. [A batch is all the coolers arriving at the same time.] One cooler per batch will be opened, a thermometer will be placed inside and allowed to equilibrate, and the temperature will be recorded in a logbook by personnel at the analytical laboratory.

6.2.3 Custody Seals

Custody seals will be placed on all coolers containing samples to be transported. Clear, plastic tape will be placed over the seals to ensure the seals are not accidentally broken during shipment.

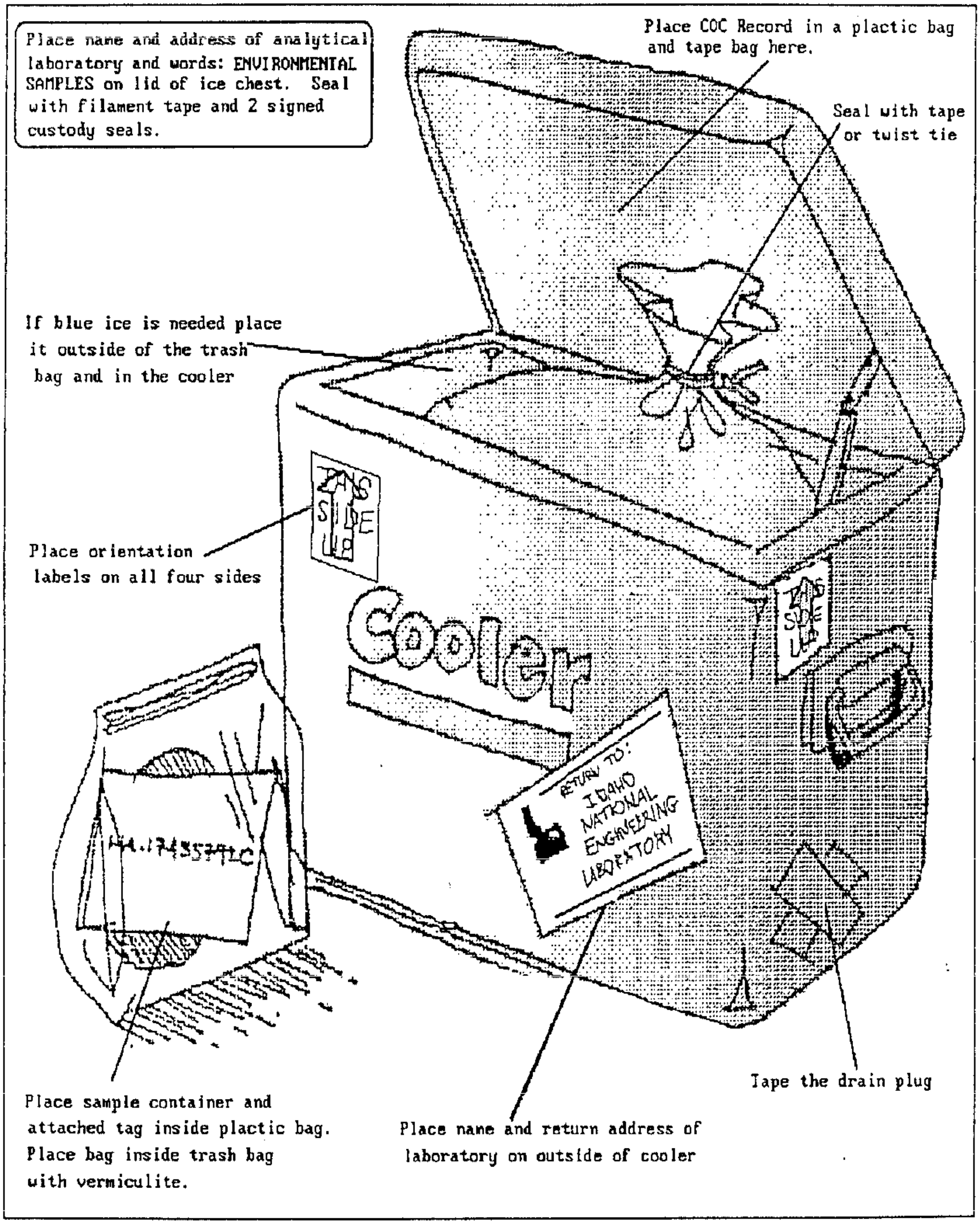

Figure 6-7. Packaging of environmental samples for transport to the analytical laboratory.

6.2.4 Field Radiation Screening Procedures

Radiation screening for transport purposes will be performed in the field by qualified EG&G Idaho personnel. Screening will help determine whether the sample must be transported as a radioactive shipment, how it should be packaged, and to which laboratory it will be sent for analysis.

The first step in field radiation screening consists of surveying uncontainerized soil in screening and homogenization pans (or directly from the auger, in the case of volatiles) for alpha, beta, and gamma radiation.

The second step in field radiation screening consists of surveying each sample, using hand-held survey instruments. Hand-held instruments will be used by qualified/trained personnel and will be calibrated before field use. First, a contact, beta-gamma survey will be performed on the outside of the sample container. If there is a possibility the sample is not homogeneous (e.g., soil or sludge samples), readings will be taken on all sides of the container. A contact reading will be taken on the bottom of all liquid samples, because particles may have settled to the bottom of the sample bottle. All results will be recorded in a radiation screening logbook.

Samples with detectable radioactivity greater than background will be sent to the EG&G Radiation Measurement Laboratory for analysis of gamma emitting radionuclides by gamma spectroscopy. Samples showing elevated radiation levels will be handled according to the EG&G Radiation Controls Manual (EG&G 1989).

6.2.5 Onsite Shipping

An onsite shipment is any transfer of material within the perimeter of INEL. Site-specific and site shipping/receiving department requirements for transportation of samples within site boundaries will be followed. Shipments within INEL boundaries will conform to DOT requirements, as stated in 49 CFR.

6.2.6 Packaging of Radioactive Materials

According to DOT regulations, a radioactive sample is one that contains a specific activity greater than $2x10^3$ pCi/g or $2x10^6$ pCi/L. Radioactive samples will be packaged to prevent hazards to the health and safety of personnel and the public; consequently, samples will be packaged in steelbelted coolers and checked by onsite Health Physics personnel to ensure less than 0.5 mR/h is read at contact. Figure 6-8 depicts a properly packaged and labeled cooler containing limited quantity radioactive samples.

6.2.7 Approvals Needed for Onsite Transportation of Samples

Transportation of radioactive and hazardous samples both onsite and offsite will be coordinated with EG&G Idaho shipping personnel. These arrangements will be made prior to the onset of field sampling activities.

6.2.8 Shipping to Analytical Laboratories

The temperature of each batch of ice chests arriving at an analytical laboratory will be checked and recorded in a logbook. If cooler temperatures do not meet preservation requirements for the samples transport, sampling and/or shipping personnel will be notified. This procedure is required to ensure that adequate coolant is used during sample transport.

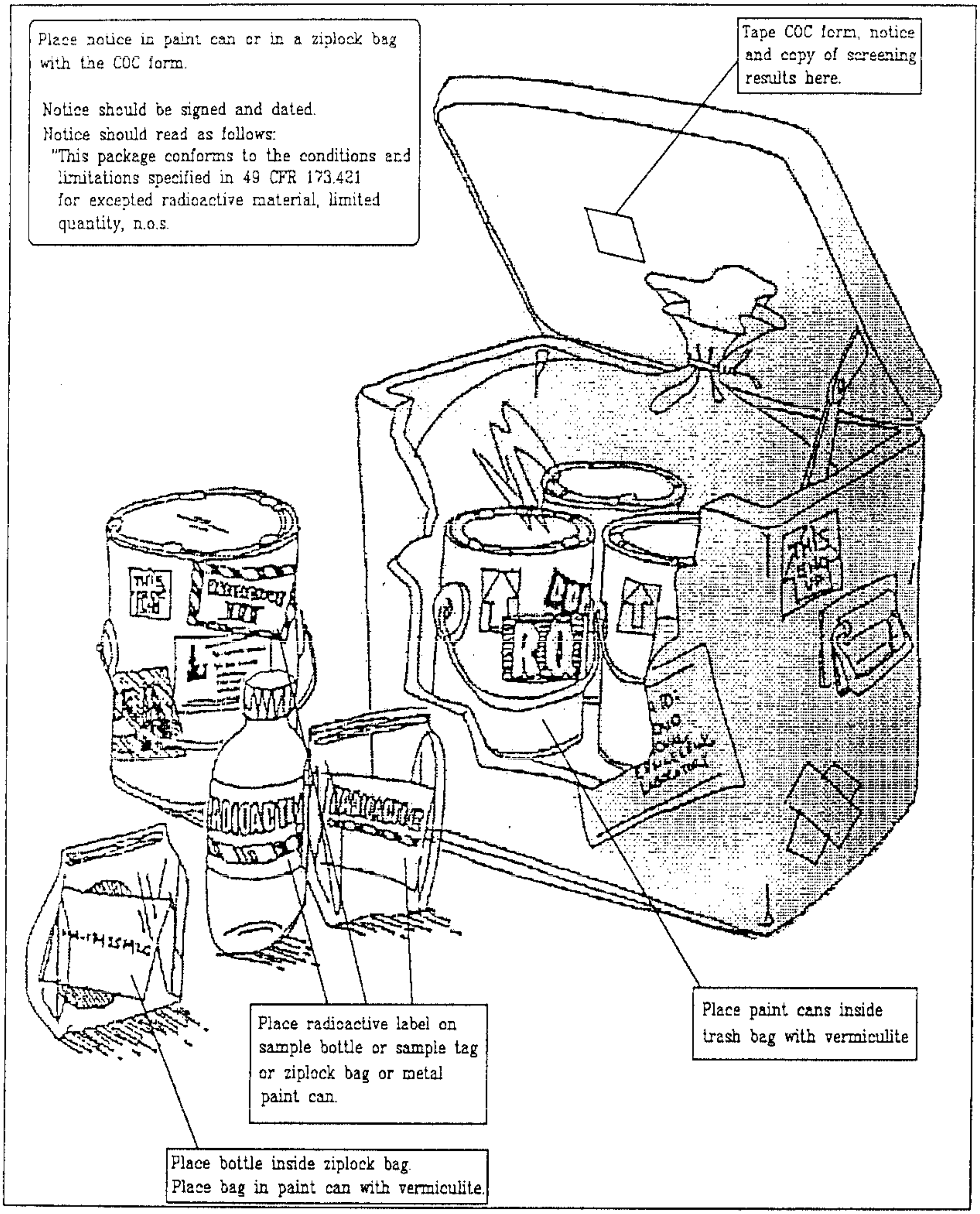

Figure 6-8. Packaging of limited quantity radioactive samples for transport to the analytical laboratory.

7. EQUIPMENT

7.1 Maintenance and Operation

Equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be serviced in accordance with specified recommendations of the manufacturers and the written procedures developed by the operators.

7.2 Calibration

All instruments in both field and laboratories will be calibrated as per manufacturer's instructions and SOPs. Calibration frequency of each instrument will be as specified in the Health Physics Instrument Laboratory Operating Procedure Manual (EG&G, unpublished data). A logbook of instrument and equipment calibration and maintenance will be kept by the sampling team and controlled by the field document control coordinator.

7.3 Field Equipment

Calibration of portable radiation detection instruments will follow procedures outlined in the EG&G Radiological Controls Manual (EG&G, 1989a). Portable radiation detection instruments shall be calibrated before initial use, after modification or adjustment, and following any modification or alteration that may affect instrument response, or at intervals that do not exceed six months. Changing instrument batteries and/or probe cords is not considered maintenance.

Portable radiological instrumentation shall have satisfactorily passed a source check performed within the week preceding its use for surveys. The instruments ability to respond to a known source will be examined, rather than merely verifying that radiation causes the indicator to move. Instrument response shall be within 20% of the expected reference reading. Results of this weekly operational check shall be recorded and kept with the instruments.

Additional periodic instrument checks shall be made before each use:

1. Check battery
2. Check the calibration label on the instrument to verify that calibration has been performed within 6 months
3. Check the physical condition of the instrument
4. Check instrument response.

Field screening of VOCs will be performed with a portable photoionization detector (PID) equipped with a 11.7 eV probe. Instrument calibration, operation, and maintenance will follow the manufacturer's instructions. Calibration information will be recorded in the "Field Instrument Calibration/Standardization Logbook."

7.4 Laboratory Equipment

Calibration of laboratory instruments will follow procedures outlined in Test Methods for Evaluating Solid Waste (SW-846), and procedures outlined in SOPs for gamma spectroscopy analysis for the RML.

All calibration standards, including internal standards and surrogate standards, are obtained from chemical suppliers with certification of high purity and concentration. The standards are routinely checked by the laboratory for traceability to National Institute of Standards and Technology (NIST). Standard Reference Materials (SRMs) are used as stock standards. Working standards are made to cover the linear range of the calibration curve. The working standards are used for initial calibration curves, continuing calibration checks, and preparation of analyte spiking solutions.

Radiation standards used by the RML are obtained from suppliers that certify their quality. Use and procurement of radiation standards are controlled by the RML QA/QC manual (EG&G, 1989b).

7.5 Decontamination

Procedures will be followed which will prevent or minimize contamination. The procedures will enhance the integrity and quality of the samples. Decontamination procedures are discussed in greater detail in Section 5.2.

8. ANALYTICAL PROCEDURES

EPA published methods will be used as the basis for all analyses for which such methods exist. The EPA methods to be followed are contained in Test Methods for Evaluation of Solid Waste, SW-846, 3rd edition (EPA, 1986). Procedures for the analysis of gamma-emitting radionuclides are detailed in the SOPs for the RML.

When analysis for Appendix IX compounds is requested, the analytical methods used will be a portion of those listed in SW-846. The methods used for Appendix IX analysis are listed below:

6010	Metals by inductively coupled plasma, atomic emission spectroscopy (CLP target analyte list).
7041	Antimony by graphite furnace atomic absorption spectroscopy (GFAA)
7060	Arsenic by GFAA
7421	Lead by furnace GFAA
7470/7471	Mercury by cold vapor atomic absorption spectroscopy
7740	Selenium by GFAA
7841	Thallium by GFAA
7870	Tin by direct aspiration atomic absorption spectroscopy
8080	Organochlorine pesticides/PCBs by GC/ECD
8140	Organophosphorus pesticides
8150	Chlorinated herbicides
8240/8260	Gas chromatography/mass spectrometry (GC/MS) for volatile organics
8270	GC/MS semivolatile analysis
9010-9012	Total cyanide (USEPA Statement of Work for Inorganics analysis, SOW No. 788)
9030	Releasable sulfides by the method stated in Chapter 7, Section 7.3.4.1 of SW-846.

Concentrations of the gamma-emitting radionuclides will be measured in surface soil using standard gamma-ray spectroscopy methods. These methods allow for the nondestructive determination of low-level concentrations of all gamma-emitting radionuclides present in the samples. A detailed description of analysis methods and techniques can be found in documented and approved RML procedures. Standard Operating Procedures (SOPs) for soil/sediments are numbered: RML-3 (Rev. 11/22/89), DM-9 (Rev. 7/13/89) and DM-1 (Rev. 4/19/89), and SOPs for aqueous samples are numbered: RML-6 (Rev. 11/22/89), DM-11 (Rev. 7/13/89) and DM-1 (Rev. 4/19/89). The RML QA/QC procedures are reviewed annually and are described in the Quality Assurance/Quality Control Program of the Radiation Measurements Laboratory for Gamma Spectroscopy and Direct Gross Alpha/Beta Counting, ST-CS-013-89, (EG&G, 1989b). The RML will analyze for the gamma-emitting radionuclides on the ERP Target List (Table 4-4).

Analysis of gamma-emitting radionuclides by gamma spectroscopy provides adequate information for this investigation. The history of the ARA-I evaporation pond indicates that alpha-emitting radionuclides do not exist in concentrations greater than background. In addition, detection of americium-241 by gamma spectroscopy is a good indication of other transuranics. Concentrations of beta-emitters may be estimated or inferred from detections of gamma-emitters which are found in similar proportions in mixed fission products (i.e., cesium-137 and strontium-90).

Detection limits for gamma emitting radionuclides are below Release Criteria described in Section 4.6.1, with the exception of ^{234}U. Detection limits for ^{234}U in surface soils by gamma spectroscopy are near the Release Criteria (370 pC/g detection limit and 400 pC/g Release Criteria). If the upper uncertainties associated with the ^{234}U analysis by gamma spectroscopy exceed the Release Criteria, wet chemistry methods will be used to determine concentrations of ^{234}U in subsurface soils. Detection limits of ^{234}U in subsurface soils are below release criteria.

9. DATA REDUCTION, VALIDATION, AND REPORTING

9.1 Data Reduction and Reporting

Data Reduction refers to computations and calculations performed on the data, as defined by the Buried Waste Program Data Collection Quality Assurance Plan (EG&G 1988). Data reduction includes computing summary statistics, standard errors, confidence limits, tests of hypothesis relative to the parameters, and model validation. Standard equations and statistically acceptable procedures will be used. When appropriate, data will be reported with statistically supported limits of uncertainty to indicate limitations on the use of the data. All data will be rounded to the number of significant figures consistent with the confidence limits. Confidence limits will be justified by the accuracy and precision of the sampling measurement and the analytical method.

Reduction of laboratory data will be addressed in the ARA-I Chemical Evaporation Pond Analytical Statement of Work (SOW) issued to the analytical laboratories. All bench chemists will document sample preparation activities in a bound laboratory notebook, which will serve as the primary record for subsequent reduction of data. Final reduction of analyses performed will be the responsibility of the individuals compiling the final report. Samples will be analyzed at Argonne National Laboratory - East. The Laboratory Manager (Pete Lindahl) and the QA Coordinator (Fred Martino) are responsible for compiling the final report. Any applicable state or federal regulatory limits will be presented with the analytical data.

Reporting procedures and formats for field data are specified in Section 6 in this SAP. Reporting of laboratory data will follow the procedures and format specified in the ARA-I Chemical Evaporation Pond analytical Statement of Work (SOW). Results and QC data for each analysis will be transcribed onto analytical reporting forms specific to the particular analysis. Forms will be provided in the analytical SOW. All data will be checked for accuracy and precision at the bench and instrument operator/analyst level and the laboratory manager's level before submitting the data package to EG&G Idaho.

9.2 Data Validation

Data Validation is the process by which a sample measurement, method, or piece of data is deemed useful for a specified purpose (EG&G, 1988). The ARA-I Chemical Evaporation Pond Analytical SOW will specify information and guidance specific to the samples being analyzed and data reporting forms used. Separate SOW's for chemical and radiological analyses are prepared and have separate reporting requirements.

The data flow process is illustrated in Figure 9-1. Figure 9-2 depicts a separate flow process for radiological data. The process begins when a database from a Sampling and Analysis Plan (SAP) is developed. Sample labels and tags are generated by data management personnel using this database. Selected field data will be used by data management for producing summary tables of field and analytical results.

After data management receives a data package from the analytical laboratories, a number of processes are followed to ensure proper handling of the data. First, analytical results are prepared for data entry via computer programs. This is followed by entry of the analytical results into the computer, with automated error checks of the data. The data management staff decides if the package has sufficient completeness and accuracy for entry into the Data Management System (DMS) and reports to the project manager. The process commonly results in a need to procure additional data or clarification from the lab that performed the analyses, prior to entering the data. For example, a data package cannot be entered if sample numbers are used inconsistently. Once the package is deemed adequate, it is then entered into the DMS.

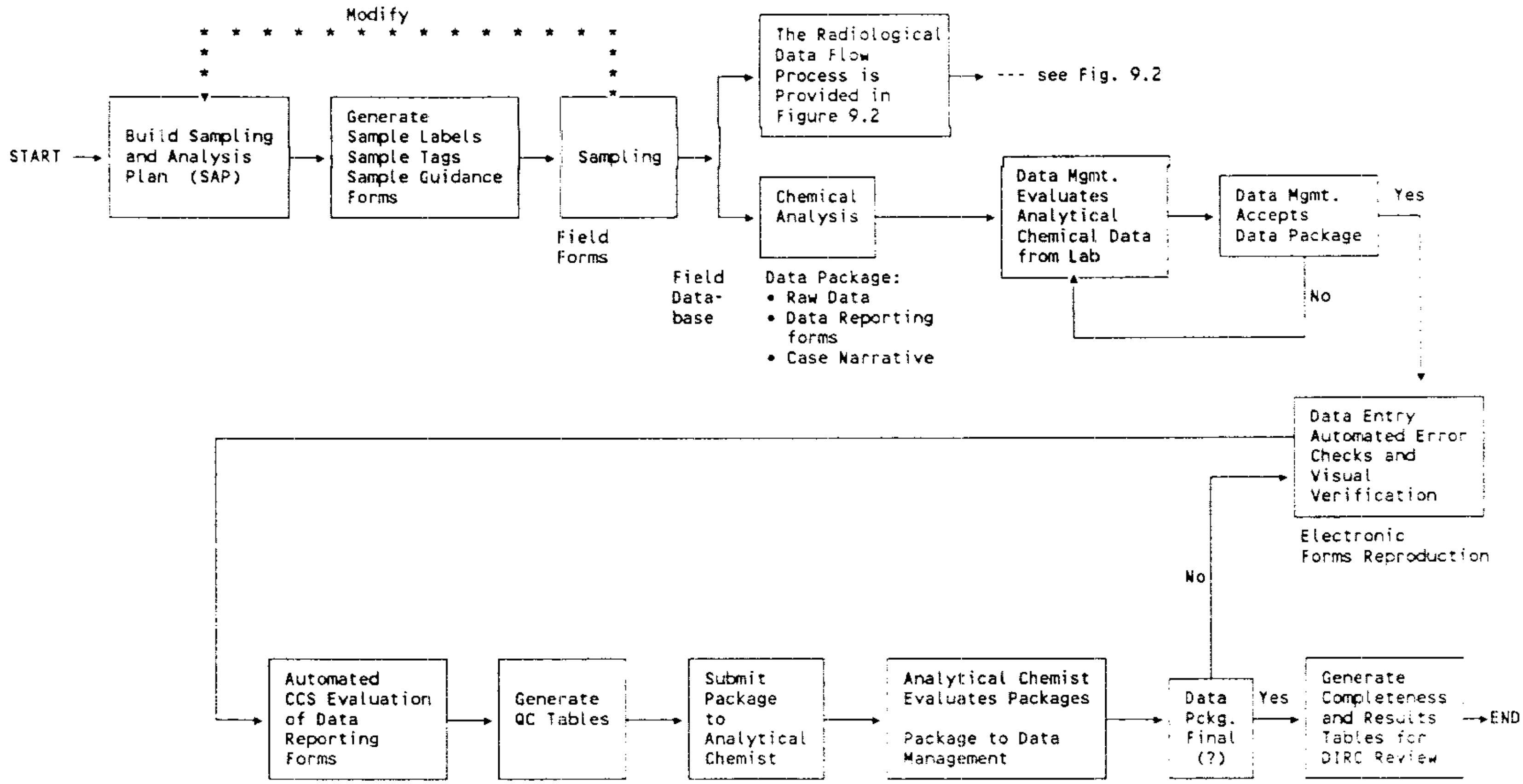

Figure 9-1. Integrated chemical data flow process for analytical results received by EG&G Data Management.

Concurrent with data entry, an automated routine is invoked that performs a set of checks on the data as part of the data verification and validation (V/V) process. A listing of suspect data entries (errors) is

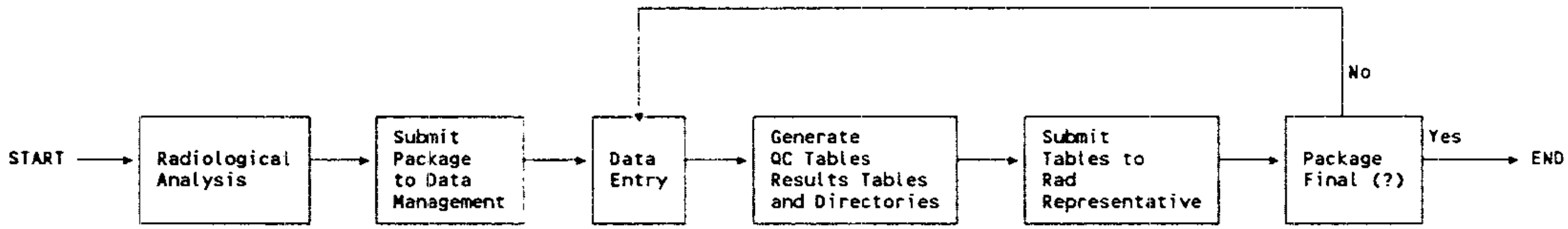

Figure 9-2. Integrated radiological data flow process for analytical results received by EG&G Data Management.

printed to an output file. Then an attempt is made to resolve each error. First, a check is made to determine if the error resulted from data entry. Other attempts are made to resolve the errors and, when the effort is successful, the data forms and databases are modified to reflect any changes. A listing of the residual set of errors is made, and each error is highlighted on the applicable data form. The data entry clerk visually verifies the data through comparison of data on the original data forms and data on electronically produced forms, the latter originating from the database created in the data entry process. The next step in the V/V process is generating QC tables. The QC tables provide an efficient, easily readable tabular presentation of all data included on the complete set of data forms. The QC table is part of a package of information that is then forwarded to an analytical chemist to perform the next step of the data V/V. The package includes the following:

1. Raw analytical data
2. Original data forms
3. Electronically reproduced data forms
4. Error file output
5. Contract Compliance Screening (CCS) output
6. QC table.

The chemist continues the data quality assessment using the set of information identified above. The chemist attempts to resolve deficiencies identified in the error file listing. Concurrently, the chemist reviews the raw data to assess whether the analysis was performed per the specifications for the underlying analytical method and that data on the reporting forms is consistent with the raw data. All laboratory data will be cross-referenced to the appropriate trip blank, field blank, rinsate (equipment blank), method blank, field duplicate or replicate, matrix spike, and matrix spike duplicate. In addition, all pertinent data (data collected, received by the laboratory, and analyzed) for each laboratory analysis will be compared to hold times.

After the chemist's evaluation, the modified data forms are resubmitted to the data management staff. The forms will detail any required changes to the database, with each change dated and initialed by the chemist to maintain the traceability for all modifications made to the database. A report of the quality assessment of the data package will be generated by the analytical chemist and submitted to the Data Integrity Review Committee (DIRC). The DIRC will make a final assessment of the quality of data.

9.3 List of Required Data

The following is a list of information that is required on all samples to complete a Data Qualification Package. The listed information is described in the ERP Data Qualification Manual (EG&G, 1989d). Three copies of the analytical data produced for the requested analyses should be reported to the Document Control Coordinator, Administrative Records and Document Control (ARDC) of the Environmental Restoration Program (ERP). ARDC will forward a copy to the project manager and others as appropriate.

9.3.1 Chemical Analysis Data

Level III Organic Analyses

Organic analyses will be performed for volatiles (EPA method 8240 or 8260) and Appendix IX volatiles, semivolatiles, and pesticides/PCBs for water and soil/sediment samples. General guidance requirements are defined in the User's Guide to the Contract Laboratory Program of EPA. Each organic data qualification package will include the following:

- Data Quality Objectives
- Sampling Information
  - SAP reference
  - DOP and/or SOP reference
  - Logbook reference or copies of applicable pages

- Copies of calibration logs
- Sample number(s)
- Sample location
- Sample date and time
- Field duplicates
- Field spikes
- Field blanks
- Copies of QC reports
- Chain-of-custody
- Storage and shipping requirements

Contract Requirements and EG&G Statement of Work or Reference

Analytical Information

- Analytical summary
  - lab name
  - date and time samples were analyzed
  - analytical method or procedure reference
  - type of instrumentation used
  - description of analytical problems encountered and internal decisions applied
  - summary of sample preparation procedure (lab notebook reproduction or bench sheets) including addition of surrogate and/or matrix
  - percent recovery information
- Copies of sample Traffic Reports
- Quality control summary
  - surrogate recoveries
  - reagent blank analyses
  - matrix spike and matrix spike duplicate recoveries
  - instrument tuning and performance information
- Sample data
  - sample size (aqueous samples in ml, others in grams)
  - matrix (water, soil or others)
  - tabulated results of all required organic compounds
  - assigned data qualifiers

- established method detection limits
- reported concentration in µg/L (water) or µg/kg (soil, sludge, or other)

Raw sample analytical data
- sample chromatographs
- sample spectra
  - standard spectra for positive qualitative sample results
- quantization reports
- calculations

Standards data package
- standards chromatographic
- data system printouts
- initial calibration summary forms
- continuing calibration summary forms

QC data package
- GC/MS instrument tunes for both volatile and semivolatile compound analyses (spectra and tables of m/z vs. relative abundance)
- addition of surrogate compounds to each sample and blank for determining percent recovery information
- matrix spike and matrix spike duplicate analyses (including all information required for sample data and raw sample analytical data)

Data review
- analytical chemist reviews report
- computerized QC checks
- established uncertainties
- DIRC report

Level III Inorganic Analyses

Level III analyses for inorganic compounds will be for metals, cyanides, and sulfides in water and soil/sediment samples. General requirements are obtained from the User's Guide to the Contract Laboratory Program of EPA for inorganic routine analytical services. The EPA summary forms for inorganic compounds will not be required but may be used to summarize the laboratory analysis. The following information will be included in the data qualification package:

- Data Quality Objectives
- Sampling Information
  - SAP reference
  - DOP and/or SOP reference
  - Logbook reference or copies of applicable pages
  - Copies of calibration logs
  - Sample number(s)
  - Sample location
  - Sample date and time
  - Field duplicates
  - Field spikes
  - Field blanks
  - Copies of QC reports
  - Chain-of-custody
  - Storage and shipping requirements
- Contract requirements or reference
- Analytical information
  - Analytical summary
    - lab name
    - date and time samples were analyzed
    - analytical method or procedure reference
    - type of instrumentation used
  - Cover letter
    - listing of samples
    - comments describing problems encountered in analysis
  - Tabulated results
    - inorganic compounds identified and quantified
    - reported in μg/L or mg/kg

QC samples
- initial calibration verification
- continuing calibration verification
- ICP interference check sample analysis
- preparation blank analysis
- matrix spike analysis
- duplicate sample analysis
- laboratory control sample analysis

Raw data system printouts
- calibration standards
- calibration blanks
- preparation blanks
- samples and any atypical dilution
- duplicates
- spikes
- interference checks
- instrument adjustments

9.3.2 Radiological Data

Chain-of-Custody
- Field COC form
- Lab COC form

Request for Analysis Form

Lab Data Package
- Case narrative or cover sheet
  - lab name
  - contract, work request or SAP number
  - analytical method and equipment used
  - summary of any quality control, sample, shipment and/or analytical problems encountered in a specific case
  - background spectra IDs and duration of count
  - the samples that make up the analytical batch or sample delivery

group (SDG); a listing of sample external or field ID numbers with internal or lab ID numbers that were analyzed.

Summary report
- sample ID
- date of analysis
- instrument ID and model number
- analytical method or procedure number
- sample matrix
- reported radionuclides (ERP Target List)
- activity reported in pCi/g
- uncertainties in one sigma reported in pCi/g

QA/QC summary
- documentation indicating the lab was in control
  - QA/QC program summary sheet
  - energy calibration verification
  - control charts
    - detection efficiency check - monthly
    - instrument background - monthly
- any applicable QA/QC documentation

9.4 Uncertainty Analysis

Uncertainty measurements will be assigned to all chemical/radiological contaminant concentration data. For chemical analysis under SW-846, historical precision and accuracy measures for the water matrix will be used as uncertainties.

The uncertainty measure assigned to each concentration will be given by +/-U where

$$U = B^2 + 4S^2$$

and

$$B = \% \text{ Bias} = \% \text{ Recovery} - 100$$

$$S = \% \text{ RSD}$$

The calculation of % Recovery and % RSD is discussed in Section 12. For the standard analysis techniques (i.e., those done under SW-846), historical values will be used if the laboratory is in control. For radiological analysis, the % Recovery and % RSD will be calculated from the sample analysis results, as discussed in Section 11.

10. QUALITY ASSURANCE

10.1 Field Quality Control Samples

Internal quality control (QC) checks are established by submitting quality control samples to the analytical laboratory. The number of quality control samples will be approximately 5% of the total number of field samples collected. The types and frequency of collection for field quality control samples are provided below:

- Trip Blank - Trip blanks apply to volatile organic samples only. Trip blanks are prepared during the sampling event and are kept with the investigative samples. Trip blanks consist of HPLC grade (organic free) water placed in 40 ml VOA vials. Three vials are required for each sample. Trip blanks are then transported to the analytical laboratory with samples requiring analysis for volatile organic compounds. Trip blanks are stored at the laboratory with samples and analyzed only for VOCs (EPA method 8240 or 8260). Results of the analyses will be used to determine the level of contamination introduced to the sample during shipping, handling, and storage.

- Rinsates (equipment blanks) - defined as analyte-free water (HPLC grade) poured over sample collection equipment after the equipment has been through the decontamination process. The analyte free water which has been poured over the sampling equipment is placed in appropriate sample containers for analysis. The samples will be used to determine if the decontamination procedures have been sufficient and if contaminants are present in the final rinse water or the sample containers. The total number of rinsate samples will be no less than 5% of the total number of field samples.

- Field Blanks - Field blanks are collected using the same HPLC grade water used for final rinsing of equipment blanks (rinsates). The source water for field blanks does not come in contact with decontaminated sampling equipment, as is the case with rinsates. Instead, the HPLC grade water is poured directly into the sample containers. Results of the analysis will be used to determine the level of contamination introduced into the sample due to sampling technique, container contamination and assess the purity of the source water. The total number of field blanks will be no less than 5% of the total number of field samples.

- Field Replicates - Are independent samples collected in such a manner that they are equally representative of the parameters of interest at a given point in space and time. Field replicates will be collected from side-by-side interface/subsurface soil cores or side-by-side surface spatial composite plots. Field replicates, when collected processed, and analyzed by the same analytical laboratory will provide intralaboratory precision information for the entire measurement system including sample acquisition, homogeneity, handling, shipping storage, preparation and analysis. The total number of field replicates will be no less than 5% of total number of field samples.

Field Standards - Field standards will be submitted as blind samples to the analytical laboratory. The standards will consist of a standard soil obtained from the National Institute of Standards and Technology (NIST). The same analyses to be run on background soil samples (i.e., Appendix IX inorganic analytes, except cyanide and sulfide) will be run on the standards to provide a QC check (accuracy) on Appendix IX metals analyses.

10.2 Laboratory QA/QC

The quality of analytical data generated in the contracted analytical laboratories is controlled by the implementation of an Analytical Laboratory Quality Assurance Plan. Only laboratories approved by the audit process of the Environmental Restoration Program will be permitted to perform the required analyses. The types of internal quality control checks are described below:

- Method Blanks: Method blanks usually consist of laboratory reagent-grade water treated in the same manner as the sample (i.e., digested, extracted, distilled, etc.). The method bland is analyzed and reported as a standard sample would be.

- Method Blank Spike: A method blank spike is a sample of laboratory reagent-grade water fortified (spiked) with the analytes of interest which is prepared and analyzed with the associated sample batch. Method blank spikes are not included with volatiles analyses, since the same function is served by the calibration blank.

- Laboratory Control Sample for Inorganics: This is a standard solution with a certified concentration which is analyzed as a sample and is used to monitor analytical accuracy (equivalent to a method blank spike).

- Matrix Spikes: A matrix spike is an aliquot of an investigative sample which is fortified (spiked) with the analytes of interest and analyzed with an associated sample batch. This is performed to monitor the effects of the investigative sample matrix (matrix effects) on the analytical method. Matrix spikes are only used with specific analytical protocols. Matrix spikes will be performed on 5 percent of the samples (1 in 20) or one per batch of samples, whichever is greater.

- Laboratory Duplicate Samples: Duplicate samples are obtained by splitting a field sample into two separate aliquots and performing two separate analyses on the aliquots. The analysis of laboratory duplicates monitors sample precision; however, it may be affected by heterogeneity of the sample, particularly in the case of nonaqueous samples. Duplicates are performed only in association with selected protocols. Laboratory duplicates are performed on 5 percent of the samples (1 in 20) or one per batch of samples, whichever is greater.

- Known QC Check Sample: This is a QC sample of known concentration obtained from the U.S. EPA, the NIST or a commercial source. This QC sample checks the accuracy of an analytical procedure. It is particularly applicable when a revision or adjustment has been made to an analytical procedure or instrument.

Laboratory QA/QC for gamma spectroscopy analysis is described in the QA plan for the RML (EG&G, 1989b).

10.3 Audits

Evaluating the performance of activities in accordance with the Quality Assurance Project Plan (QAPP) will be the responsibility of the project manager, field team leaders and analytical managers, in conjunction with the appropriate QA Coordinators. Quality-related activities will be routinely inspected to ensure compliance with the QAPP. Internal inspections will be performed routinely and for specific activities. Significant deviations from the QA plan will be discussed with the project manager, QA coordinators, and affected personnel, as appropriate.

The first phase of an auditing program should be the preparation of checklists that identify the methods and techniques necessary to perform all aspects of the required audit. The checklists must be adequate to perform sampling (collection, field, and data management) audits. The second phase will then be the actual conduct of the required field audit. Audits are conducted at a frequency determined by the project manager. The final phase will be the preparation of the QA Audit Report by the field and laboratory QA officers. The final QA report will be made a part of the overall report to DOE-ID and EPA.

10.3.1 System Audit

The system audit is an overall evaluation of the sampling project and it is performed to:

1. Verify that the sampling methodology is being performed in accordance with program requirements

2. Check on the use of appropriate QA/QC measures

3. Check methods of sample handling (i.e., packaging, labeling, preserving, transporting, and archiving), in accordance with program requirements

4. Identify any existing quality problems

5. Check program documentation (i.e., records, site description, chain-of-custody collection and analytical tags, field and sample bank logbooks and field work sheets)

6. Initiate corrective action if a problem is identified

7. Assess personnel experience and qualifications, if required

8. Follow-up on any corrective action previously implemented

9. Provide debriefings for sampling team and sample bank personnel

10. Provide a written evaluation of the sampling and sample bank program.

The purpose of the system audit is to ensure that the QA/QC system planned for the project is in place and functioning properly.

The auditor first must review work plans, protocols, test plans, the QA/QC project plan, and all program reports. A discussion with the project manager of the current status of the project and the identity of any problems encountered is suggested before conducting the onsite sampling audit. Sample chain-of-custody procedures and raw data are checked, as appropriate. Spot checks of sampling methods and techniques, sampling and analysis calculations, and data transcription are performed.

10.3.2 Sample Collection Audits

An audit of the overall QA/QC plan for sample documentation, collection, preparation, storage, and transfer procedures will be performed just before sampling starts. The intent of this audit is to critically review the entire sampling operation to determine the need for any corrective action early in the program. Additional total program or partial audits can be conducted at various times throughout the sampling program.

It is recommended that a QA officer (QAO) perform unannounced site inspections to monitor the sampling team's activities, provide technical and corrective action suggestions to the sampling teams, and supplement sampling performance audits. The QAO will be notified at least two weeks prior to start of the field work so an audit schedule can be produced.

10.3.3 Field Audits

The primary objective of field audits is to determine the status of sampling operations. Emphasis is placed on the following activities:

1. Verify that operational aspects and procedures are in accordance with the protocols and the SAP

2. Verify the collection of all samples, including field replicates and field blanks

3. Verify that documentation is in order and sufficient to establish the collection location of any sample collected

4. Determine discrepancies that exist and initiate corrective action, as appropriate

5. Allow the QAO to direct the collection of independent samples.

The purpose of the onsite field audit is to inspect sample records and equipment. Records inspected include the following:

1. Chain-of-custody forms
2. Sample tags
3. Sample labels
4. Logbooks.

The operational procedures inspected should include the following:

1. Sampling procedures
2. Equipment
3. Techniques
4. Decontamination
5. Collection of duplicate and field blank samples
6. Security
7. Sample storage and transportation
8. Containers
9. Contaminated waste storage and disposal

10.3.4 Data Management Audits

An audit should be performed on the data management system by tracing the flow of specific samples through the system. In particular, the system should be checked for its ability to allow correct identification of a sample from any stage of sampling and analysis. The data management process is described in more detail in Sections 9.1, 9.2 and 12.

10.4 Quality Assurance Reports to Management

Quality Assurance reports to project management will be prepared for each sampling site. Reports on the performance of the quality assurance program will be prepared by the QAO and presented to the Program Manager. These reports will cover data quality assessment and results of internal performance inspections, with corrective action recommendations and status, as necessary.

11. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

The quality assurance objective for measurement data is to ensure that site characterization data are of known and acceptable quality. Data from laboratory analysis of site samples will be used for site assessments and hazard determination at the ARA-I Chemical Evaporation Pond.

Quality assurance objectives for analytical data from the environmental samples collected will include the following, and are described in greater detail in the Data Collection Quality Assurance Plan (DCQAP) for the Buried Waste Program (EG&G, 1988) and by the sampling and analysis plan for the ARA-I Chemical Evaporation Pond.

Descriptions for precision, accuracy, representativeness, comparability and completeness are given below.

11.1 Precision

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is assessed by means of laboratory duplicate/field replicate sample analysis. The laboratory objective for precision is to equal or exceed the precision demonstrated for similar samples, and shall be within the established control limits for the methods, as published by the EPA (SW-846).

11.1.1 Field Precision

The field precision will be calculated using results of field replicate samples as both the standard deviation and the percent relative standard deviation (%RSD). The standard deviation, s, is calculated from the variance, s^2, as

$$s^2 = \frac{\Sigma(x_i - \bar{x})^2}{n-1}$$

and

$$s = \sqrt{s^2}$$

The %RSD is then

$$\%RSD = s/\bar{x}$$

The standard deviation and %RSD are calculated for every contaminant measured.

11.1.2 Laboratory Precision

Precision of the chemical laboratory data will be measured through the use of the matrix spike/matrix spike duplicate (MS/MSD) samples and will be calculated as the %RSD.

11.2 Accuracy

Accuracy means the nearness of a result, or the mean of a set of results, to the true value. Accuracy is assessed by means of reference samples and percent recoveries. The laboratory objective for accuracy is to equal or exceed the accuracy demonstrated for these analytical methods on similar samples, and shall be within the established control limits for the methods as published by EPA (SW-846). Historical ranges for percent recoveries, for each analytical method, are stated in SW-846.

11.2.1 Field Accuracy

Determining whether a sample will yield results which accurately reflect the true concentration of a contaminant in the soil, sediment, or groundwater cannot be quantitatively assessed. However, the sampling locations and methods described in the SAP have been chosen such that the resultant samples are believed to be representative of the media being sampled.

Contamination of the samples would yield inaccurate results. Hence, rinsates, field blanks, and trip blanks will be sent to the chemical and radiological laboratories for analysis. Sections 4 and 10 discuss QA/QC samples in greater detail.

11.2.2 Laboratory Accuracy

The QAPP and SOPs of radiological and analytical laboratories will describe procedures to evaluate accuracy. However, the actual techniques used will depend upon the type of laboratory, radiological or chemical. Accuracy will be used to help determine if the laboratory is in control and accuracy is used to assign the uncertainties to the radiological data, as discussed in Section 9.4.

Accuracy of the chemical laboratory data will be assessed through the calculation of percent recovery from MS/MSD analysis and any certified standards that the laboratory analyzes as part of its ongoing QA/QC program. The %Recovery is calculated as

$$\%\ Recovery = \frac{SSR - SR}{SA} \times 100\%\ ,$$

where SSR is the spiked sample result, SR is the sample result, and SA is the spike added. The laboratory is also required to run a sufficient number and type of blanks to detect laboratory contamination.

11.3 Radiological Laboratory Precision and Accuracy

For radiological analyses, uncertainties traditionally have not been broken down into precision and accuracy components. Instead, either a statistical uncertainty, based on Poisson statistics or radioactive emissions, and/or a total uncertainty, in which other error components are combined with the statistical uncertainty by adding in quadrature, is reported. The statistical component is a function of the number of counts in the peak; since the decay of radioactive elements is subject to Poisson statistics, the statistical uncertainty is equal to the square root of the number of counts in the peak. For gamma spectrometry, where peak-fitting programs are used to quantify the peak area, the statistical uncertainty is dependent on the peak-fitting routine. Other components added may be uncertainties due to the chemical procedure, if any, or uncertainties in the efficiency of the detector or geometry of the sample. A variety of other uncertainties may be included in efficiency or geometry uncertainties, or may be added separately. Because of cascade summing effects of some gamma decays, uncertainties may be higher for samples containing more than one radionuclide or for samples not in the exact geometry for which the detector has been calibrated.

Tables 11-1 and 11-2 list radionuclides selected for their probability of occurring in buried waste at INEL; Table 11-1 lists radionuclides that may be found in soil samples and Table 11-2 lists those that may be found in water samples. These radionuclides are sufficiently long-lived, and may still be present in environmental samples after many years and have occasionally been found in samples taken from the RWMC and other sites at INEL. A number of these radionuclides occur naturally in the soil and are decay products of uranium and thorium (Table 11-3). Potassium-40 is also found as a natural component in soil and rock samples.

Column 2 of Tables 11-1 and 11-2 lists the half-life of each radionuclide. However, the natural radionuclides listed are analyzed not by using half-life of the individual decay product given in the table, but by using the half-life of the parent of the natural decay chain in which they occur. Column 4 lists the detection limit of each radionuclide in the geometry specified in the table. Detection limits are calculated according to the definition of L.A. Curie:

$$D = (2.71 = 4.66B^{1/2})/[(t)(E)(Y)(P)(3.7 \times 10^{-2})]$$

where D is the detection limit in picoCuries (pCi), B is the number of counts in the background, t is the counting time in seconds, E is the counting efficiency expressed as a decimal, P is the gamma emission probability, Y is

TABLE 11-1. RADIONUCLIDES LIKELY TO BE FOUND IN SOIL SAMPLES AS A RESULT OF PAST WASTE DISPOSAL ACTIVITIES AT INEL.

RADIO-NUCLIDE	HALF-LIFE	NOTE	ESTIMATED DETECTION LIMIT (pCi/g)	ESTIMATED ANALYTICAL UNCERTAINTY (%)
^{54}Mn	312.5 d	b	0.3	7-13
^{60}Co	5.27 y	b	0.3	7-13
^{65}Zn	244.1 d	b	0.6	7-13
^{90}Sr	28.8 y	a	0.3	5-100
^{110}Ag	252 d	b	0.3	7-25
^{125}Sb	2.7 y	b	0.6	7-20
^{134}Cs	2.06 y	b	0.3	7-20
^{137}Cs	30.2 y	b	0.3	7-16
^{144}Cs	284 d	b	1.5	7-15
^{152}Eu	13 y	b	1.5	7-20
^{154}Eu	8.5 y	b	0.6	7-18
^{155}Eu	4.9 y	b	2.0	7-21
^{212}Bi	60.6 m	b	c	c
^{214}Bi	19.7 m	b	c	c
^{212}Pb	10.64 h	b	c	c
^{214}Pb	26.8 m	b	c	c
^{226}Ra	1600 y	b	c	c
^{228}Ac	6.13 h	b	c	c
^{234}Pa	6.7 h	b	c	c
^{234}Th	24.1 d	b	c	c
^{234}U	2.45E5 y	b	c	c
^{238}U	4.5E9 y	a	c	c
^{238}Pu	87.7 y	a	.003	3-100
^{239}Pu	24100 y	a	.003	3-100
^{241}Am	433 y	a	.003	3-100
Tritium	12.33 y		na	na
gross α		e	5.0E-5	5-100
gross β		e	2.5E-4	5-100

a. determined by radiochemistry.
b. In 500-ml squat jars counted by gamma spectroscopy for 2 hr. Different geometries or different count times will change detection limits and uncertainties. Each radionuclide is assumed to be the only significant gamma-emitter in the sample. More complex mixtures will have different detection limits.
c. Since these may occur in significant quantities in soils and rocks naturally, a detection limit is difficult to define.
e. 60 mg solid from 1000 ml, counted 2 hr.

TABLE 11-2. RADIONUCLIDES LIKELY TO BE FOUND IN WATER SAMPLES AS A RESULT OF PAST WASTE DISPOSAL ACTIVITIES AT INEL.

RADIO-NUCLIDE	HALF-LIFE	NOTE	ESTIMATED DETECTION LIMIT (pCi/g)	ESTIMATED ANALYTICAL UNCERTAINTY (%)
^{54}Mn	312.5 d	b	0.3	7-13
^{60}Co	5.27 y	b	0.3	7-13
^{65}Zn	244.1 d	b	0.6	7-13
^{90}Sr	28.8 y	a	0.3	5-100
^{110m}Ag	252 d	b	0.3	7-25
^{125}Sb	2.7 y	b	0.6	7-20
^{134}Cs	2.06 y	b	0.3	7-20
^{137}Cs	30.2 y	b	0.3	7-16
^{144}Cs	284 d	b	1.5	7-15
^{152}Eu	13 y	b	1.5	7-20
^{154}Eu	8.5 y	b	0.6	7-18
^{155}Eu	4.9 y	b	2.0	7-21
^{238}U	4.5E9 y	a	c	c
^{238}Pu	87.7 y	a	.003	3-100
^{239}Pu	24100 y	a	.003	3-100
^{241}Am	433 y	a	.003	3-100
Tritium	12.33 y		na	na
gross α		e	5.0E-5	5-100
gross β		e	2.5E-4	5-100

a. determined by radiochemistry.
b. In 4-L Marinelli beakers counted by gamma spectroscopy for 16 hr. Different geometries or different count times will change detection limits and uncertainties. Each radionuclide is assumed to be the only significant gamma-emitter in the sample. More complex mixtures will have different detection limits.
c. Since ^{238}U may occur in significant quantities in ground water naturally, a detection limit is difficult to define.
d. 10 mL counted for 2 hr.
e. 60 mg solid from 1000 ml, counted 2 hr.

TABLE 11-3. NATURALLY OCCURRING RADIONUCLIDES IN SOILS AT INEL.

RML CODE	ISOTOPE	SERIES (CHAIN)
RAB 214	^{214}Bi	Uranium (^{226}Ra)
RAP 214	^{214}Pb	Uranium (^{226}Ra)
THT 208	^{208}Tl	Thorium (^{232}Th)
THB 212	^{212}Bi	Thorium (^{232}Th)
THP 212	^{212}Pb	Thorium (^{232}Th)
RA 226	^{226}Ra	Uranium (^{238}U)
THA 228	^{228}Ac	Thorium (^{232}Th)
THM 234	^{234}Th	Uranium (^{238}U)
PAM 234	^{234}Pa	Uranium (^{238}U)

the chemical yield if a chemical procedure is included in the counting process, and 3.7×10^{-2} is the number of disintegrations per second in a pCi. These detection limits were calculated in 1985, and will be updated in the near future.

Column 5 of each table gives an estimation of the range of total uncertainty, expressed as one standard deviation, which may be expected for each radionuclide if the sample is in the geometry as defined in each table. For gamma emitters, the range of uncertainties is that seen in samples of water and soil taken at the RWMC over several years. The high end of the range may be seen when quantities are 1.5 to 3 times the detection limit; as the activities approach the detection limit, uncertainties will be higher, up to 100% or more. The low end of the uncertainty range is the lowest possible uncertainty, and may be seen when the activity is well above the detection limit, when no interferences exist, and when the geometry is exactly the same as that for which the detector is calibrated.

Results of radiological analyses are very dependent on the geometry and matrix of the sample. If these are not as specified, both the detection limits and range of uncertainties may change in ways that can only be determined by an experienced analyst. An experienced analyst should always be consulted for each individual analysis to resolve these and other questions.

11.4 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter. The representativeness criterion is best satisfied by making certain that sampling locations are selected properly and a sufficient number of samples are collected. A well designed sampling and analysis program should produce representative samples.

11.5 Comparability

All data will be reported in units consistent with the conventions used for the given analyte and methods employed. The results of analyses can be compared with analyses by other laboratories because of the following project comparability objectives:

- Use standard methodology;
- Report results from similar matrices in consistent units;
- Apply appropriate levels of quality control within the context of the Laboratory Quality Assurance Program.

11.6 Overall Precision and Completeness

11.6.1 Precision

The best estimate of the overall precision is the standard deviation or %RSD calculated from the field replicates, as discussed in Section 11.1.1. The field precision calculated from the field replicates actually does contain a component of variation due to the laboratory. However, the laboratory variability is expected to be small compared to the field variation.

11.6.2 Completeness

The completeness of the data is the amount of valid data obtained from the measurement system or laboratory analysis versus the amount of data planned to be collected from the field. The specific objective for completeness of this project is 90 percent.

12. DATA MANAGEMENT

Data management is being addressed by the ERP data management staff. Presently, the Data Management System (DMS) is in varying stages of development. The DMS is being developed using guidance of standard data management practices to ensure the overall integrity of the data it captures.

The DMS is designed cognizant of the need to capture large volumes of data from several ERP programs. The DMS is also designed to produce reliable, consistent, and effective flow, treatment, storage, and retrieval of all data. The DMS captures Sampling and Analysis Plan (SAP) data, field sampling data, and analytical data. Additional data types will be incorporated into the DMS as the needs arise.

As stated above, parts of the DMS are currently under development. However, the portion that captures SAP, field, and analytical data for chemical analysis samples is in place and functional. The flow process for these data is depicted in Figures 9-1 and 9-2. The data are all channeled through the ARDC to ensure that a consistent flow path is maintained for all data. Discussions on the reduction, reporting, and validation of these data are presented in Sections 9.1 and 9.2. A flow process similar to that shown in Figures 9-1 and 9-2 will be developed for other data types.

The DMS will include software for database management, data analysis, and report generation with a well-defined set of files with standardized record structures for maintaining the data and for archival purposes. This uniformity of data storage makes possible the integration of data from different ERP programs and maintenance of a global DMS for all ERP data.

Data entry, retrieval, manipulation, and report production capabilities either exist or will be developed for all data sets. The DMS will include several levels of automated verification and validation to ensure the highest level of reliability, accuracy, and quality in the data captured by the system.

13. SAFETY AND TRAINING

The Health and Safety Plan establishes the procedures and provides general guidelines for worker and public safety to be used by EG&G Idaho, Inc., and during characterization of the project area. A site specific Health and Safety Plan is presented in Appendix E.

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APPENDIX A

DRILLERS LOG

DRILLER'S LOG OF ARA PROD. WELL NO. 1

CONTRACTOR: STRASSER DRILLING CO.

DRILLER: H. R. ISAAK

FORMATION	DEPTH (FT)	THICK-NESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				10-24-56	
					SET UP RIG ON ARA ROCK PILE. CONDUCTED SEARCH FOR CREVASSES IN WHICH TO PLACE STAKES. STRUNG UP TOOLS.
				10-25-56	
CLAY AND SMALL ROCKS	2			7:00A	
HARD PAN AND BOULDERS	4				
LAVA, GREY	10			6:00P	TOOLS KICKING OFF.
				10-26-56	
ON IRON				6:45A	
			2	7:00A	
	15				DRY HOLE
RED LOOSE LAVA	20		3	6:00P	
				6:15P	END OF SHIFT.
				10-27-56	
LOOSE ROCK MAKING LARGE HOLE	20			7:00A	HARD FORMATION, BUT SO MUCH MATERIAL COMING IN DRILLIN[G] IS SLOW
	24			6:30P	END OF SHIFT.
				10-28-56	
HARD SOLID	24			7:00A	SO MUCH LOOSE MATERIAL COMI[NG] IN TOOLS HIT SOLID ONLY 10% OF THE TIME. PULLED OUT & HOLE BACK FILLED 10 FEET.
	26			3:00P	END OF SHIFT.
				11-6-56	
				12:00N	WENT TO ETR FOR WINCH TRUCK. TRANSFERRED PIPE & HAULED SOME TO ARA. SET UP WATER TANK & COMMENCED WORK ON SH[OE]
	26			6:00P	END OF SHIFT
				11-7-56	Finished shoe & welded casin[g]
Formation seems to be pretty hard in bottom.				6:45a	together worked casing down
Boulders still giving trouble.	27			6:00p	commenced drilling.

Driller's log of ARA Prod. Well no. 1

Formation	Depth (ft)	Thick- ness (ft)	Sample No.	Date & time	Remarks
				11-8-56	
				7:00p	Tools kicking around &
	27				running rough.
Red rock turning to grey	30		4	1:00p	Using some iron. 2 hrs.
Getting harder.					welding bit.
	34			6:00p	End of shift
				11-9-56	
Grey lava	35		5	8:00a	½ hr. welding bit.
Hard formation					Bit batters slightly on out-
					side edges. 1 hr. welding b
Grey lava	40		6	5:30p	
	41			6:45p	End of shift.
				11-10-56	
				6:45a	Down 1 hr. to put on jars.
Grey lava	45		7	1:30p	1 hr. welding bit. Cut off 16" of starter pipe leaving 24' 1" in hole.
	49			3:45p	End of shift.
				11-13-56	
Grey lava	50		8	8:00a	Medium hard. Red tinge.
Grey lava	55		9	1:00p	Formation turning harder.
Grey lava			10	7:00p	Tools running rough.
	60				End of shift.
				11-14-56	
Grey lava	60			7:00a	Hard & rough. Rig down 2½ hrs. to retie knot in rope socket & to change bits. Put on fabricated one way b
Grey lava, red tinge	65		11	2:00p	Tools running rough.
Grey lava	70		12	7:00p	
				11-15-56	
Lava, extremely hard	73			7:00a	
Grey lava	75		13	2:00p	Very hard rough formation. Bit batters.
	78			7:00p	End of shift.

Driller's log of ARA Prod. Well no. 1

Formation	Depth (ft)	Thick-ness (ft)	Sample No.	Date & time	Remarks
				11-16-56	
	78			7:00A	
Grey lava, extremely hard	80		14	1:00P	Bit batters & mushrooms. 2 hrs welding bit on bottom. Had to trim off outside lip as bit
Grey lava	85		15	6:00P	was swaging out of gauge.
				7:00P	End of shift.
				11-17-56	
	86			7:00A	2 hrs. helping driller at MTR
Grey lava	90		16	1:00P	change knot & haul wood.
Grey lava	95		17	7:00P	End of shift.
				11-18-56	
				7:00P	Two helpers on job hauling & unloading 16" casing for ARA well.
Grey lava, hard	100		18	2:00P	1 hr. welding on bit.
	102			7:00P	End of shift
				11-19-56	
				7:30A	Worked on water truck 2 hrs.
Grey lava	105		19	3:00P	1 hr welding bit. Down ½ hr. go for parts.
	108			8:00P	End of shift
				11-20-56	
				7:15A	
Grey lava	110		20	10:00A	Welded bit 1 hr.
Grey and red lava	115		21	2:00P	Down 1 hr for bit welding. 1½
Grey and red lava	120		22	5:30P	hrs. to go to Idaho Falls for
	123			8:45P	parts. End of shift
				11-21-56	
				7:00A	
Red lava, cindery in nature	125		23		Hole will not hold water. Using Bentonite.
Grey and red lava, solid	130		24	2:00P	Out of water.
	131			3:00P	End of shift.

DRILLER'S LOG OF ARA PROD. WELL NO. 1

Formation	Depth (ft)	Thick-ness (ft)	Sample No.	Date & time	Remarks
				11-24-56	
	131			8:00A	Drilling rough. Iron added to hole. Drilling harder at
Red lava, hard	135			2:00P	Rig down 1 hr to weld bit. Tools running exceptionall rough
	137			6:00P	End of shift.
				11-26-56	
				11:00A	
Grey and red lava	140		25	1:30P	Tools running rough.
	144			6:00P	End of shift.
				11-27-56	
				6:45A	
Grey and red lava	145		26	11:00A	Tied new knot. 2 hrs weldin on bit.
Grey and red lava	150		27	4:30P	
	154			6:45P	End of shift.
				11-28-56	
				6:45A	
Grey lava (some red)	155		28	7:30A	
Grey lava	160		29	12:00N	
Grey lava	165		30	4:30P	
	167			7:00P	End of shift
				11-29-56	
Grey lava, hard, rather dense	167			7:00a	
Grey lava	170		31	9:00A	2 hrs. hauling water & woo 2 hrs. welding on bit.
Grey lava	175		32	4:30P	Dense formation. Cuttings heavy. Tools running rougl last 3'.
	179			7:00P	End of shift.

Driller's log of ARA Prod. Well no. 1

Formation	Depth (ft)	Thick- ness (ft)	Sample No.	Date & time	Remarks
				11-30-56	
				7:00A	
Grey lava	180		33	8:00A	
Grey lava	185		34	11:30A	Shut down rig to get driller from MTR to help change knot as rope started to strand at rope socket. Rig down 2 hrs.
Grey lava	190		35	5:30P	Cut off 10' ft of line.
	192			7:00P	End of shift
				12-1-56	
				7:00A	
Grey lava and clay	195		36	9:30A	✓
Clay	200		37	10:00A	
Clay	205		38	12:00N	Rig down 1:00P to 4:00P to help driller at MTR. change knot & haul water.
Gray lava	210		39	5:00P	
	212			7:00P	End of shift.
				12-2-56	
				2:00P	
Grey lava	215		40	4:00P	
Grey lava	220		41	7:00P	End of shift
				12-3-56	
	222			7:00A	
Grey lava	225		42	9:30A	
Grey lava	230		43	2:00P	Tools running very rough.
Grey lava	235		44	5:30P	On iron. Down 45 minutes to weld bit (iron won't hold up
	237			7:30P	tools. End of shift.
				12-4-56	
				7:00A	
Grey lava	240		45	9:00A	
Dry hole. Lost mud & water.	241				Rig down 1 hr. to haul water
Still dry hole	245				from CFA. Hole started to blow very hard. Necessary to run stream of water in hole to
Still dry	250				make any footage. Drilling
Broken formation					large hole.
Black lava	255		46	7:00P	Tools wallowing. End of shift.

Driller's Log of ARA Prod. Well no. 1

Formation	Depth (ft)	Thick- ness (ft)	Sample No.	Date & time	Remarks
				12-5-56	
				7:00A	
Black lava	260		47	2:00P	Rig down $\frac{1}{2}$ hr. to haul rock f backfill dumped load of roc in hole. Backfilled same to 256. Drilled out in $\frac{1}{2}$ hr. Di no good. Shut down to see about dynamite or cement.
	260			5:00P	End of shift.
				12-6-56	
				7:30A	Rig down. 1 hr to clean out hole. 2 hrs to locate safet man for blasting permit. $\frac{1}{2}$ blasting preparations.
				12:00N	Shot hole. Rock bridged over 240. Hole backfilled to 25_ Hole sucking air so bad tha it takes large amount to reach bottom. Hole is dry & large. Great difficulty is encountered in drilling back
	255			7:30P	to bottom. End of shift
				12-7-56	
				7:00A	Continued drilling out backfi from shot. Hole in good con dition again. Making new ho Running slow in an attempt narrow down hole diameter. Much time wasted letting wa down hole in baiter.
	263			4:00P	End of shift.
				12-10-56	
				7:00A	Tools runnong rough & wallowi badly. Also afraid to run fa as it would be very easy to snap off a pin or joint. Rig down for 2 hrs to retie knot & put on new jars. Helper
Grey lava	265		47	2:00P	hauled water.
	266			7:15P	End of shift.

Driller's log of AEA Prod. Well No. 1

Formation	Depth (ft)	Thick-ness (ft)	Sample No.	Date & time	Remarks
				12-11-56	
Gray lava	266			7:30a	Still bailing out 4 times a much mud as drilling make Must be in a cavern & catching all the cutting lost above. Rig down 2 hrs. to weld bit.
Gray lava	270		48	6:00p	
	271			7:30p	End of shift.
				12-12-56	
Gray lava				7:00a	Hole seems to be narrowing down some. Still bailing 4 times too many cutting Tools running rough.
Gray lava	275		49	2:00p	Ironed hole heavy. Dropped into another crevasse. L stranded. Lost thing 11
	277			7:30p	ft from end. End of shi
				12-13-56	
				8:00a	Went to ETR to get helper. Cut off line & turned sa end for end. Tied new k
				1:00p	Resumed drilling. Rig dow 1 hr for bit welding. 1 hr for preparations -
	278				blasting of hole. Shot hole. Tools still runni rough. May have to blas again.
	279			7:00p	End of shift.
				7:30p ?	Finished running 6" pipe & strung up 3 3/4 tools on calf line. Small tools hit & slide past the roc No sun or light to see where pipe hangs.
				5:00p	End of shift.

Driller's log of APA Prod. Well No. 1

Formation	Depth (ft)	Thick-ness (ft)	Sample No.	Date & time	Remarks
				12-14-56	
				8:00a	Tools hung up at 9:00a. Rock on side of tools. Tools up the hole 10 ft. Jarred up for 2 hrs. Went to MTR picked up tools for side drilling 6" pipe. Manufactured misc. items for running pipe. Start running 6"
				6:00p	pipe. End of shift.
				12-16-56	
				8:00a	Tried banking rock with small tools inside 6" pi Tools & pipe keep slidir past rock. Pulled pipe. Preparing to run large tools for side drilling.
				1:00p	End of shift.
				12-17-56	
				7:00a	Went to American Falls for tools for fishing operation. Picked up more tools at STR & OMRE & strung up. Drilled up approximately 1 ft of
				7:00p	boulder. End of shift.
				12-18-56	
				7:45a	Resumed side drilling & drilled up 1 more foot c boulder before tools com free enough to work tool
				9:30a	out of hole. Removed second string of tools & reset joint on bit on ma
				11:00a	string of tools. Resume drilling. Intermittent boulder caving all day.
				5:00p	Jarred loose 3 times.
				6:00p	Hung up. Jarred, very hard
	283			7:15p	to get loose by 7:00p. End of shift. Running exceptionally rough.

DRILLER'S LOG OF ARA PROD. WELL NO. 1

FORMATION	DEPTH (FEET)	THICK-NESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				12-19-56	
	283			7:30A	DRILLING ROUGH. SOME CAVING.
				10:00A	TOOLS HUNG UP. HOLE STILL JAR
				10:45A	LOCKED. WENT TO OMRE FOR HELPER. RESTRUNG SIDE DRILL TOOLS & COMMENCED WORKING O BOULDER. TOOLS OUT AT 3:00P. RESUMED DRILLING. TOOLS WIL NOT RUN WITH ANY MOTION WHATEVER. HAVE NEVER SEEN TOOLS RUN IN THIS FASHION be
	285			7:00P	END OF SHIFT.
				12-20-56	
				7:00A	RIG DOWN 1 HR TO WELD BIT.
GREY LAVA	285		51	8:30A	TOOLS RUNNING VERY ROUGH.
				12:00N	SHOT HOLE. RIG DOWN 1 HR FO TRIP TO BUMKER & SHOT
	287				PREPARATIONS.
GREY LAVA	290		52	3:30P	HOLE IS ROUGH AGAIN.
	293			7:00P	END OF SHIFT.
				12-21-56	
				7:00A	1 HR. WELDING BIT.
GREY LAVA	295		53	11:00A	HOLE ROUGH. ON IRON.
GREY LAVA	300		54	3:00P	
	302			4:30P	END OF SHIFT.
				12-22-56	
				7:00A	
RED LAVA	305		55	9:30A	HARD FORMATION. STILL ON IRO RIG DOWN FOR BIT WELDING, 1½ HRS.
RED LAVA	310		56	7:00P	LOST ALL CUTTINGS LAST THING END OF SHIFT.
				12-23-56	
				1:00P	DRY HOLE IN A CREVASSE. WENT TO ETR FOR BENTONITE. TOOL KICKING BADLY. STILL IN
	314			6:00	CREVASSE. END OF SHIFT.

DRILLER'S LOG OF ARA PROD. WELL NO. 1

FORMATION	DEPTH (FT)	THICK-NESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				12-24-56	
				7:00A	
GREY AND RED LAVA	315		57	9:00A	ON IRON. RIG DOWN 1½ HRS TO HAUL WATER (TROUBLE AT STAND PIPE DUE TO ICE ACCUMULATED UNDERNEATH) SPUDDER BEARING IS HEATING & CAUSING TROUBLE. HOLE STILL VERY ROUGH. RIG DOWN
GREY AND RED LAVA	320		58	4:00P	1 HR. TO WELD BIT. ON IRON
	322			5:30P	END OF SHIFT. ON IRON
				12-26-56	
RED AND GREY SOLID FORMATION				7:00A	ON IRON
GREY AND RED LAVA	325		59	11:00A	ON IRON. RIG DOWN 1 HR. TO WELD BIT. 1 HR TO HAUL WAT SECURITY REFUSED TO ALLOW DYNAMITE ON WATER TRUCK. SO EXTRA TRIP TO CF AREA WA NECESSARY. 1 HR FOR SHOT
	329				PREPARATIONS. SHOT HOLE HE
				7:00P	END OF SHIFT.
				12-27-56	
				7:15A	
GREY AND RED LAVA	330		60	8:00A	RETIED KNOT IN ROPE SOCKET 1 HR. TOOLS RUNNING VERY ROUGH.
GREY LAVA	335		61	2:00P	RIG DOWN 1 HR. FOR SHOT PREPARATIONS & 1 HR WAITI ON SECURITY TO GET DYNAMI FROM BUNKER. SHOT HOLE
	335				HEAVY.
	338			7:15P.	END OF SHIFT.
				12-28-56	
				7:00A	
GREY LAVA	340			9:30A	
GREY LAVA	345		63	4:30P	SOLID FORMATION. TOOLS STI RUNNING ROUGH.
	347			6:30P.	END OF SHIFT.

DRILLER'S LOG OF ARA PROD. WELL NO. 1

FORMATION	DEPTH (FT)	THICK-NESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				12-31-56	
				7:00A	RIG DOWN 1 HR TO WELD BIT. 1 HR TO GO TO OMRE.
GREY LAVA	350		64	1:00P	ON IRON.
	354			7:00P	END OF SHIFT.
				1-2-57	
				7:00A	
GREY LAVA	355		65	9:00A	DISCOVERED CRACK IN STEM. SHUT DOWN PENDING EMPLOYER' DECISION.
RED AND GREY LAVA	360		66	12:30N	RIG DOWN TILL 3:30P FOR PRE-HEATING, SCARFING, WELDING & ANNEALLING OF CRACK IN STEM. HOLE MOSTLY DRY LAST 4 FT. TOOLS RUNNING ROUGH.
RED & GREY LAVA	365		67	7:00P	END OF SHIFT.
				1-3-57	
				7:00A	HOLE SUCKING & TAKING AN ABNORMAL AMOUNT OF WATER.
RED LAVA	370		68	11:30A	LOOSE MATERIAL MAKING LARGE HOLE.
RED LAVA	375		69	6:00P	HARDER FORMATIONS LAST FOOT.
	376			7:30p	TOOLS RUNNING ROUGH. End of shift.
				1-4-57	
				7:00A	RETIED KNOT IN ROPE SOCKET. RIG DOWN 1½ HRS.
RED LAVA, HARD.	380		70	1:00P	RIG DOWN 3 HRS. TO REPAIR CRACK IN STEM.
	384			7:30P	END OF SHIFT.
				1-5-57	
				8:30A	
RED LAVA	385		71	10:00A	
RED & GREY LAVA	390		72	2:00P	GOING INTO HARD SOLID FORMATION
GREY LAVA	395		73	6:30P	END OF SHIFT.

Driller's log of ARA Prod. Well no. 1

Formation	Depth (ft)	Thick-ness (ft)	Sample No.	Date & Time	Remarks
				12-6-57	
	395			10:30A	Hard dense formation. Very heavy cuttings. Rig down 2 hrs. to weld bit. Had to spud through ice in top of hole.
Grey lava	400		74	6:00P	End of shift.
				12-7-57	
				6:30A	Shut down rig at 10:00A to haul water & weld bit.
				12:30P	Resumed drilling.
Grey lava	405		75	1:00P	Samples show increase in silicone content.
Grey lava	410		76	5:30P	Still same dense heavy formation.
				7:30P	End of shift.
				1-8-57	
				7:30P	
Lava, hard dense	415		77	11:00A	Still same dense hard lava
Grey lava	420		78	3:00P	
Grey brown lava	422				Formation changing
Dark grey lava	425		79	6:15P	
	426			7:00P	End of shift.
				1-9-57	
				7:00P	Rig down 1 hr. to weld bit
Red and grey lava	430		80	11:00A	
	435			4:00P	End of shift.
				1-10-57	
				9:00A	Went to Rupert with pump shaft & oil tubing from AIW well to be repaired. Brought back 16" perforat casing for ARA well. Also 24" casing to be used for dummy.
				9:00P	End of shift.

Driller's Log of ARA Prod. Well No. 1

Formation	Depth (ft)	Thick-ness (ft)	Sample No.	Date & Time	Remarks
				1-11-57	
				8:00A	Helped driller at MTR. Change sand lines. Hauled same to location 3 hrs. Unloaded truck here & went to MTR for tools to run dummy. Broke down 2 strings fishing tools
				6:30P	End of shift.
				1-12-57	
				7:00A	Trimmed pipe for dummy & rigged up for same. Ran dumm Charles Morby inspector. Present. Restrung tools. Ready to resume drilling.
				5:30P	End of shift.
				1-14-57	
				7:00A	
Grey and red lava	435		81	8:00A	
Grey and red lava	440		82	1:00P	Rig down 1 hr for bit welding
Grey and red lava	445		83	5:00P	
	448			7:15P	End of shift.
				1-15-57	
				7:00A	
Grey and red lava	450		84	9:00A	
Grey lava	455		85	1:00P	Rig down 1 hr for bit welding Formation becoming hard & rough.
	460			6:00P	End of shift.
				1-16-57	
				7:30A	Rig down 1 hr heating oil for diesel fuel.
Grey lava			85	8:30A	
Grey lava	465		86	3:30P	
	466			4:30P	End of shift.

DRILLER'S LOG OF ARA PROD. WELL NO. 1

FORMATION	DEPTH (FT)	THICK-NESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				1-17-57	
				7:30A	1½ HRS FIGHTING JELLED DIESEL FUEL.
GREY LAVA	470		88	1:00P	
RED AND GREY LAVA (CONSIDERABLE RED PIGMENTS)	472				DOWN 1 HR FOR BIT WELDING
GREY AND RED LAVA	475		89	5:00P	
GREY AND RED LAVA	480		90	7:00P	END OF SHIFT.
				1-18-57	
GREY AND RED LAVA TAPERING TO SEMISOLID GREY				7:30A	
GREY LAVA	485		91	11:00A	SLIGHTLY POROUS.
GREY LAVA, SLIGHTLY POROUS	490		92	3:00P	DOWN 1 HR FOR BIT WELDING.
GREY LAVA (POROUS)	495		93	7:00P	
				7:05P	END OF SHIFT.
				1-19-57	
				7:00A	
BLACK LAVA	500		94	10.30A	DOWN 1 HR FOR BIT DRESSING.
GREY LAVA	505		95	3:00P	ON IRON LAST 4'.
	509			6:30P	END OF SHIFT.
				1-21-57	
				7:30A	1 HR DRESSING BIT.
GREY LAVA	510		96	10:00A	ON IRON. DOWN 1 HR FOR BIT WELDING. 1 HR FOR RETYING ROPE SOCKET KNOT.
GREY LAVA	515		97	5:00P	
				7:00P	END OF SHIFT.
				1-22-57	
GREY LAVA, HARD ROUGH FORMATION	517			7:15A	ON IRON. ½ HR SPUDDING UP THROUGH ICE UPPER 70' OF HOL
GREY LAVA					
VERY HARD LIGHT COLORED ROCK	520		98	12:00N	DOWN 2 HRS WELDING ON BIT. ½ HR SBUDDING UP THROUGH ICE UPPER 70' OF HOLE.
GREY AND RED LAVA	525		99	5:00P	
	527			6:45P	END OF SHIFT.

Driller's Log of ARA Prod. Well No. 1

Formation	Depth (ft)	Thick-ness (ft)	Sample No.	Date & Time	Remarks
				1-23-57	
				7:30A	Hole partially dry.
Grey and red lava	530		100	12:00N	Course cuttings. Trouble w settling. 1½ hrs welding b
Grey and red lava	535		101	4:00P	Going into harder formatio
				7:00P	End of shift.
				1-24-57	
				7:30A	
Grey lava, hard	540		102	11:00A	Tools running very rough.
Grey lava	545		103	4:00P	Hard & rough. 1½ hrs weldi on bit.
				6:30P	End of shift.
				1-25-57	
Very hard grey dense lava	546			8:00A	2 hrs welding on bit.
Grey lava	550		104	4:00P	
				6:00P	End of shift.
				1-28-57	
	551			7:30A	1½ hrs starting deisel un 2 hrs welding bit.
Grey lava	555		105	4:00P	Still same hard grey.
	557			6:30P	End of shift.
				1-29-57	
				8:00A	
Grey lava	560		106	12:00N	Reset rope socket. Down 2 ½ hr welding bit. 1 hr spudding out through ice
Grey lava	565		107	7:00P	End of shift.
				1-30-57	
				8:00A	Diesel fuel jelled up. Ri down 1 hr. Each time tool pulled, they must be spu out through ice. The top 70' top of hole. This of takes ½ hr or better.
Grey lava	570		108	3:30P	Hard solid formation. Tool running erratic 35 minut Pulling tools last thing
	572			7:30P	End of shift.

Driller's Log of ARA Prod. Well No. 1

Formation	Depth (ft)	Thick- ness (ft)	Sample No.	Date & time	Remarks
				1-31-57	
	572			8:00A	1 hr welding bit first thing.
Grey and red lava	575		109	11:00A	
Grey and red lava	580		110	5:00P	$\frac{1}{2}$ hr welding bit.
				6:45P	End of shift.
				2-1-57	
				8:00A	Still same formation. Tools running erratic
Red and grey lava	585		111	2:30P	Shut down due to worn drilli[illegible] line. Driller deems it unsa[illegible] to go any deeper with prese[illegible] line. Helped crew at MTR pu[illegible] on new line.
				5:00P	End of shift.
				2-2-57	
				9:00A	Went to MTR for cable reel & axle. Changed drilling line[illegible] Put on 1200' of 1" line.
				2:30P	Resumed drilling operations.
Grey and red lava	588				Lots of life in new line.
				6:30P	End of shift.
				2-3-57	
				10:00A	Hole appears to be losing so[illegible] of the water added.
Greyish red lava, heavy cuttings					Bailing required every 2'or3 tools running very sluggish. Out of water.
	590			3:00P	End of shift
				2-4-57	
[illegible]			[illegible]	8:00A	
Grey lava			112	8:30A	Rig down $1\frac{1}{2}$ hrs for blasting & preparations for same. Shot hole at 593 heavy.
Grey lava	595		113	5:30P	
	596			6:30P	End of shift.

DRILLER'S LOG OF ARA PROD. WELL NO. 1

FORMATION	DEPTH (FT)	THICK-NESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				2-5-57	
				7:30A	WELDED BIT 1 HR.
GREY AND RED LAVA	600		114	11:30A	PICKING UP SOME SEEPAGE WATER. STATIC WILL PROBABLY BE AROUND 590.
GREY AND RED LAVA	605		115	6:00P	DOWN 1 HR WELDING BIT.
	606			6:45P	END OF SHIFT.
				2-6-57	
				7:30A	RED PIGMENT IN WATER DISAPPEARED OVER NIGHT.
GREY LAVA, MEDIUM HARD	610		116	10:00A	CONSIDERABLE TROUBLE WITH BAILING PROCEDURES. CHANGED BAILERS. CUTTING SETTLE QUICKLY AND SET U
GREY LAVA	615		117	4:00P	FORMATION IS TURNING HARD FINER CUTTINGS
	617			6:30P	END OF SHIFT.
				2-7-57	
				7:30A	
GREY LAVA, MEDIUM HARD	620		118	10:00A	USGS MEASURED WATER LEVEL AT 606' ALSO CORRECTED LINE MEASUREMENT ON TOTA DEPTH 10' MORE HOLE THAN DRILLER HAD CREDITED. TH 620 BECAME 630'. RIG DOW 1 HR TO GET AIR HAMMER FROM OMRE WELL SITE.
GREY LAVA, RED TRACES	635		119	4:00P	MAY BE SOME WATER FROM 636 TO 640.
GREY LAVA	640		120	5:30P	END OF SHIFT.
				2-8-57	
	641			8:30A	WELDED BIT. RIG DOWN 1 H
GREY LAVA, HARD	645		121	12:30P	TOOLS RUNNING ROUGH. HAR SOLID FORMATION.
GREY LAVA, HARD	650		122	4:00P	MAKING HEAVY MUD.
	652			5:30P	END OF SHIFT.

Driller's Log of ARA Prod. Well No. 1

Formation	Depth (ft)	Thickness (ft)	Sample No.	Date & Time	Remarks
				2-9-57	
	651			9:00A	Worked on air hammer. Spud Welded bit. Drilled 1 hr. Weather bad. 40 mph gusts.
	652			2:00P	End of shift
				2-11-57	
				7:45A	
Grey lava	655		123	11:00A	Trouble picking up mud. It sets up too quick to get much. Reset knot in rope
				2:00P	socket. Rig down 1½ hrs.
Grey lava	660		124	3:00P	Welded bit 2 hrs last thing Need sand pump.
	661			6:30P	End of shift.
				2-12-57	
				8:15A	Welding bit 1 hr. Cuttings are very heavy & settle quickly.
Grey lava	665		125		Cannot pick up cuttings wit bailer. Tools running roug Fault in rock. May produce small amount of water. Welding on bailer 1 hr.
	669			7:00P	End of shift.
				2-13-57	
				8:00A	
Grey lava	670		126	10:00A	Tools running rough. Shot h
				3:00P	at 672 heavy. Very dense r Heavy cuttings. Formation turning lighter in color. Rig down 3 hrs for blastin transporting of explosives
	674			7:00P	End of shift.
				2-16-57	
				1:00P	Rigged up for dummy & ran s Did not touch anything. Inspector present—Crosthwa
				5:00P	End of shift. Diesel fuel p leaking badly.

DRILLER'S LOG OF ARA PROD. WELL NO. 1

FORMATION	DEPTH (FT)	THICKNESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				2-17-57	
				10:30A	RIG DOWN 1 HR TO WORK ON POW UNIT--FUEL SYSTEM. 1½ WELD ON BIT.
GREY LAVA	675		127	2:00P	HARD FORMATION. TOOLS RUNNI SMOOTHER.
	679			4:30P	END OF SHIFT
				2-18-57	
				7:30A	
GREY LAVA	680		128	9:00A	SAME HARD DENSE FORMATION. CHEWING BIT UP BAD.
GREY AND RED LAVA	683				FORMATION CHANGE.
GREY AND RED LAVA	685		129	3:00P	SHOULD YIELD SOME WATER.
GREY LAVA & BROWN CLAY (SEDIMENTARY-NATURE)	687				
DO	690		130	4:30P	SOLID FORMATION 690½. WATE HAS NOT CLEARED UP TO ANY EXTENT.
GREY AND RED LAVA	695		131	6:30P	
				6:45P	END OF SHIFT.
				2-19-57	
				8:00A	
GREY LAVA	700		132	11:00A	SOME SEDIMENTS IN PORES & POCKETS. FUEL PUMP HAS RESUMED LEAKING. WATER STI VERY MUDDY DUE PARTLY TO SEDIMENTS PRESENT.
GREY LAVA, POROUS	705		133	3:00P	FORMATION BECOMING MORE POR FOUND CRACK IN STEM. SHUT
	706			4:30P	DOWN. END OF SHIFT.
				2-20-57	
				9:00A	BROKE DOWN TOOLS. LAID DOWN STEM & GROUND & DRILLED OU CRACK TO CHECK FOR DEPTH C CRACK. TOO DEEP TO BE WELD
				2:00P	END OF SHIFT.
				2-25-57	
				8:00A	MADE UP TOOLS & RESET KNOT ROPE SOCKET. 2 HRS.
				12:00n	Resumed drilling. Welding : bit 2 hrs.

Driller's log of ARA Prod. Well no. 1

Formation	Depth (ft)	Thick-ness (ft)	Sample no.	Date & time	Remarks
				2-25-57 -- Continued	
Grey lava	710		134	2:00p	
Grey lava	715		135	4:00p	Water still dirty.
				5:45p	End of shift.
				2-26-57	
				8:00a	
Grey and red lava	720		136	9:00a	Possible water indications?
	724				Back to solid grey material
Grey lava	725		137	11:30a	Rig down ½ hr to work on power unit fuel system.
Grey lava	730		138	3:00p	More solid formation last 10'.
Grey lava	735		139	5:30p	End of shift.
				2-27-57	
				8:00a	
Grey lava, some red	740		140	11:00a	Losing 25 to 50% of the cutting Water has cleared up some. Sti dirty black.
Red lava (hard to medium hard)	745		141	2:00p	Water has turned red last 5 fee
Red lava	750		142	4:30p	Hard solid formation. Going from medium hard to very hard.
	753			6:30p	Water still reddish. End of shif
				2-28-57	
				8:00a	
Red lava	755		143	10:00a	Went to OMRE for extra sand line Discovered cracks in stem at 1:00p. Scarfed out cracks in st after preheating. Welded some & allowed annealing to take place Rig down total of 4 hours.
	757			4:30p	End of shift
				3-1-57	
				8:00a	
Reddish grey lava	760		144	10:30a	Formation is turning back to gr and not so hard.
Grey lava	765		145	1:00p	
	766				Tools running very sluggish & Rough. Very heavy cuttings. No much stuff in hole. Water stil dirty. Pulled tools & welded bit. (down 45 min.) Tools running smoother last ½ hr.

DRILLER'S LOG OF ARA PROD. WELL NO. 1

FORMATION	DEPTH (FT)	THICK-NESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				3-1-57 — CONTINUED	
					APPEARS TO BE CHANGING FORMATION. MAY BE GOING TO POROU[S] RED.
GREY LAVA (RED TRACES)	770		146	6:30P	END OF SHIFT.
				3-2-57	
				8:00A	
GREY LAVA	775		147	10:45A	WATER VERY DIRTY. HOLE HAS A TENDENCY TO MAKE MUD IN VER[Y] BOTTOM. CUTTINGS ARE COARS[E] & STILL HEAVY
GREY LAVA	780		148	2:00P	DIRTY HEAVY CUTTINGS. TRIED T[O] CHECK FOR DRAWDOWN WITH BAILER. CLEANED OUT HOLE. INSPECTOR SAID TO STOP DRIL[LING] TO CLEAN OUT HOLE & LET SET OVER NIGHT & CONDUCT BAILIN[G] TEST TOMORROW.
				3:00P	END OF SHIFT.
				3-3-57	
				8:00A	CONSTRUCTED GASKET FOR BAIL[ER] TO PREVENT LEAKING. NO SUCCESS, DISCARDED SAME. COMMENCED BAILING. TOOK S[...] WATER SAMPLES. COULD NOT S[EE] ANY NOTICEABLE DRAWDOWN AT 105 GALS. EVERY 2 MINUTES.
				11:00A	WATER WAS SOME CLEARER IN LOWER PORTION OF HOLE. TH[IS] MAY BE DUE TO SLIGHTLY LE[AK]ING BAILER, WASHING WATER DOWN SIDES OF THE HOLE. WA[S] CLEARING UP GRADUALLY LAST HALF HOUR. STILL A LITTLE RILEY.
				12:30P	END OF SHIFT.
				3-4-57	
				8:00A	WENT TO MICHAUD FLATS PRO[J]. FOR BULLDOZER & HEAVY TR[...] WENT TO ETR FOR BEAMS & PARAPHANALIA TO USE IN INSTALLING CASING. SMOOT[HED] OFF AREA OF MUD DITCH. [...] DOWN DRILLING TOOLS.
				6:30P	END OF SHIFT.

DRILLER'S LOG OF ARA PROD. WELL NO. 1.

FORMATION	DEPTH (FT)	THICKNESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				3-5-57	
				8:00A	GOT RID OF LAST OF TOOLS. WEN TO ETR FOR BEAMS & PARAPHENE MADE SHOE & RING AND WELDED SAME ON FIRST JOINT OF PIPE. FABRICATED 1¼" BOLTS FOR 16' CLAMPS. FINISHED PREPARATIO FOR RUNNING PIPE. G.S. MEASURED DEPTH AT 787.0 WATER TABLE AT 606
	787			5:30P	END OF SHIFT.
				3-6-57	
				7:30A.	RAN 143' CASING AS PER INSPECTOR'S DIAGRAM.
				6:15P.	END OF SHIFT.
				3-7-57	
				7:30A	RAN CASING JOINTS NO. 7 THR 12. SHUT DOWN BECAUSE OF STRONG WINDS. WENT TO ETR RIG TO BORROW BLOCK F RIGGING MORE LINES TO HAN INCREASED WEIGHT.
				5:00P	END OF SHIFT.
				3-8-57	
				7:30A	RAN CASING JOINTS 13 THROUGH 17.
				11:00A	RIGGING BIG BLOCK & FIGHT ING TWIST IN OLD DRILL LINE BEING USED FOR HOIS ING LINE.
				7:00P	END OF SHIFT.
				3-9-57	
				8:00A	WENT TO ETR & OMRE FOR BOOSTER BATTERIES TO STA RIG. 2 HRS. STARTING. RAN CASING JOINTS 18 THROUGH 22 INC.
				6:00P	END OF SHIFT.

Driller's Log of ARA Prod. Well no. 1

Formation	Depth (ft)	Thickness (ft)	Sample No.	Date & Time	Recharge
				3-10-57	
				9:00A	Ran joint of casing. Wind blowing 40 mph & gusts.
				11:30A	End of shift.
				3-11-57	
				7:00A	Ran pipe joints 24 thro 26 in[illegible] Shut down 2:00 p.m. due to wind.
				3-13-57	
				9:00A to 11:30A	Ran casing 27 thro 30 joint 1 hr putting timbers under platform for increased weight of pipe. End of sh[illegible]
				12:30P to 7:30P	
				3-14-57	
				6:45A	Ran pipe joints no. 32 thru 36. Hauled wood for fire fr CF area. Reset 2 stakes.
				7:00P	End of shift.
				3-15-57	
				7:00A	Finished running casing 787. total to top of starter pip Cut off last pipe joint. S[illegible] cement & picked up pipe to allow same to run around f[illegible] plate.
				2:30P	End of shift.
				3-18-57	
				7:00A	Changed sand lines. Ran 380' conductor line ($2\frac{1}{2}$"). Rigge[illegible] swabbing tools, put in 5 yds gravel. Swabbed hole 2 hrs.
				6:30P	End of shift.
				3-19-57	
				6:30A	Ran 393' 6" of 1" air line [illegible] in 5 yds of gravel. Swabbed 4 hrs.
				6:45P	End of shift.

DRILLER'S LOG OF ARA PROD. WELL NO. 1

FORMATION	DEPTH (FT)	THICK-NESS (FT)	SAMPLE NO.	DATE & TIME	REMARKS
				3-20-57	
				7:00A	MADE NEW SWAB DISCS & PUT ON SAME. PUT IN 6 YDS GRAVEL. SWABBED HOLE 1½ HRS. HOLE FILLS UP 33' PER 6 YDS OF GRAVEL. PUT IN 6 YDS GRAVEL. SWABBED HOLE 1½ HRS. HOLE FILLED IN TO 660.
				5:30P	END OF SHIFT.
				3-21-57	
				7:00A	SWABBED HOLE 1 HR. FIRST THI PUT IN 12 YDS GRAVEL. SWABB INTERMITTENTLY ABOUT 3 HRS. DOWN ½ HR TO GO TO OMRE TO
				4:15P	SEE EMPLOYER. SWABBED AGAIN
				TO 6:30P	NOT BRINGING IN MUCH OFF ANY THING LAST 2 HRS. END OF SHI
				3-22-57	
				7:00A	COMMENCED SWABBING. SWABBED TO 4:30 P. BAILED OUT 1 FT STUFF ALL THAT WAS SWABBED
				4:35P	COMMENCED BAILING HOLE
				TO 6:00P	WATER NOT VERY DIRTY AT STAR RUSTY LOOKING. CLEANED UP NOTICEABLY IN 1½ HRS BAILIN END OF SHIFT.
				3-23-57	
				7:30A	BAILED HOLE 1 HR FIRST THING. INSPECTOR STOPPED THE BAILIN WATER CLEAR ENOUGH. PUT IN APPROX. 2 YDS CEMENT ON GRAV PULLED OUT CONVEYOR PIPE.
				3:00P	END OF SHIFT.

APPENDIX B

ANALYTICAL RESULTS OF PREVIOUS SAMPLING

APPENDIX B

ANALYTICAL RESULTS OF PREVIOUS SAMPLING

The following pages contain copies of the analytical results from ARA-I sampling. The analyses were performed by California Analytical Laboratories, Inc.

INORGANIC ANALYSES IN SOIL FOR EG&G-IDAHO

CAL LAB No: 15132-10
EGG Sample ID No: 210 ARA-1

ELEMENT	sample dilution	concentration in solution	microgram per gram	detection limit
Aluminum	0.12 g/ml	110000	880.00	0.80
Chromium	0.12 g/ml	350	2.91	0.16
Barium	0.12 g/ml	5600	46.66	0.83
Berylium	0.12 g/ml	1	8.33e-03	8.00e-03
Cadmium	0.12 g/ml	320	2.66	0.20
Cobalt	0.12 g/ml	190	1.58	0.41
Copper	0.12 g/ml	780	6.50	0.41
Iron	0.12 g/ml	140000	1166.66	0.41
Lead	0.12 g/ml	1200	10.00	0.33
Nickel	0.12 g/ml	556	4.63	0.33
Manganese	0.12 g/ml	12000	100.00	0.12
Zinc	0.12 g/ml	6500	54.16	0.16
Boron	0.12 g/ml	5000	41.66	0.83
Vanadium	0.12 g/ml	100	0.83	0.83
Mercury	0.12 g/ml	4	0.03	0.03
Thallium	0.12 g/ml	75	0.62	0.63
Arsenic	0.12 g/ml	100	0.83	0.83
Selenium	0.12 g/ml	100	0.83	0.83
Antimony	0.12 g/ml	100	0.83	0.83

PAUL A. TAYLOR, Ph.D.
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VICE PRESIDENT

ANTHONY S. WONG, Ph
VICE PRESIDENT

RUBY A. ULRICH
SECRETARY/TREASURE

California Analytical Laboratories, Inc.

5895 POWER INN ROAD
SACRAMENTO, CALIFORNIA 95824
(916) 381-5105

CLIENT: E.G.& G.

CAL LAB NO: 15132-10

CLIENT I.D.: 210 ARA-1

PP#	CAS #	ACID COMPOUNDS	ug/kg
21A	88-06-2	2,4,6-trichlorophenol	ND
22A	59-50-7	p-chloro-m-cresol	ND
24A	95-57-8	2-chlorophenol	ND
31A	120-83-2	2,4-dichlorophenol	ND
34A	105-67-9	2,4-dimethylphenol	ND
57A	88-75-5	2-nitrophenol	ND
58A	100-02-7	4-nitrophenol	ND
59A	51-28-5	2,4-dinitrophenol	ND
60A	534-52-1	4,6-dinitrophenol	ND
64A	87-86-5	pentachlorophenol	ND
65A	108-95-2	phenol	ND

PP#	CAS #	BASE/NEUTRAL COMPOUNDS	ug/kg
1B	83-32-9	acenaphthene	ND
5B	92-87-5	benzidine	ND
8B	120-82-1	1,2,4-trichlorobenzene	ND
9B	118-74-1	hexachlorobenzene	ND
12B	67-72-1	hexachloroethane	ND
18B	111-44-4	bis(2-chloroethyl)ether	ND
20B	91-58-7	2-chloronaphthalene	ND
25B	95-50-1	1,2-dichlorobenzene	ND
26B	541-73-1	1,3-dichlorobenzene	ND
27B	106-46-7	1,4-dichlorobenzene	ND
28B	91-94-1	3,3'-dichlorobenzidine	ND
35B	121-14-2	2,4-dinitrotoluene	ND
36B	606-20-2	2,6-dinitrotoluene	ND
37B	122-66-7	1,2-diphenylhydrazine	ND
39B	206-44-0	fluoranthene	ND
40B	7005-72-3	4-chlorophenyl phenyl ether	ND

PP#	CAS #	BASE/NEUTRAL COMPOUNDS	ug
41B	101-55-3	4-bromophenyl phenyl ether	
42B	39638-32-9	bis(2-chloroisopropyl)ether	
43B	111-91-1	bis(2-chloroethoxy)methane	
52B	87-68-3	hexachlorobutadiene	
53B	77-47-4	hexachlorocyclopentadiene	
54B	78-59-1	isophorone	
55B	91-20-5	naphthalene	
56B	98-95-3	nitrobenzene	
61B	62-75-9	N-nitrosodimethylamine	
62B	86-30-6	N-nitrosodiphenylamine	
63B	621-64-7	N-nitrosodipropylamine	
66B	117-81-7	bis(2-ethylhexyl)phthalate	
67B	85-68-7	benzyl butyl phthalate	
68B	84-74-2	di-n-butyl phthalate	
69B	117-84-0	di-n-octyl phthalate	
70B	84-66-2	diethyl phthalate	
71B	131-11-3	dimethyl phthalate	
72B	56-55-3	benzo(a)anthracene	
73B	50-32-8	benzo(a)pyrene	
74B	205-99-2	benzo(b)fluoranthene	
75B	207-08-9	benzo(k)fluoranthene	
76B	218-01-9	chrysene	
77B	208-96-8	acenaphthylene	
78B	120-12-7	anthracene	
79B	191-24-2	benzo(ghi)perylene	
80B	86-73-7	fluorene	
81B	85-01-8	phenanthrene	
82B	53-70-3	dibenzo(a,h)anthracene	
83B	193-39-5	indeno(1,2,3-cd)pyrene	
84B	129-00-0	pyrene	

ND-Not detected *-detected below a detection limit of 200 ug/kg

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California Analytical Laboratories, Inc.

5896 POWER INN ROAD
SACRAMENTO, CALIFORNIA 95824
(916) 381-5106

CLIENT: E.G. & G. CAL LAB NO: 15132-10

CLIENT I.D.: 210 AKA-1

PP#	CAS #	VOLATILES	ug/kg
2V	107-02-8	acrolein	ND
3V	107-13-1	acrylonitrile	ND
4V	71-43-2	benzene	ND
6V	56-23-5	carbon tetrachloride	ND
7V	108-90-7	chlorobenzene	ND
10V	107-06-2	1,2-dichloroethane	ND
11V	71-55-6	1,1,1-trichloroethane	ND
13V	75-34-3	1,1-dichloroethane	ND
14V	79-00-5	1,1,2-trichloroethane	ND
15V	79-34-5	1,1,2,2-tetrachloroethane	ND
16V	75-00-3	chloroethane	ND
19V	110-75-8	2-chloroethylvinyl ether	ND
23V	67-66-3	chloroform	ND
29V	75-35-4	1,1-dichloroethene	ND
30V	156-60-5	trans-1,2-dichloroethene	ND
32V	78-87-5	1,2-dichloropropane	ND
33V	10061-02-6	trans-1,3-dichloropropene	ND
	10061-01-5	cis-1,3-dichloropropene	ND
38V	100-41-4	ethylbenzene	ND
44V	75-09-2	methylene chloride	ND
45V	74-87-3	chloromethane	ND
46V	74-83-9	bromomethane	ND
47V	75-25-2	bromoform	ND
48V	75-27-4	bromodichloromethane	ND
49V	75-69-4	fluorotrichloromethane	ND
50V	75-71-8	dichlorodifluoromethane	ND
51V	124-48-1	chlorodibromomethane	ND
85V	127-18-4	tetrachloroethene	ND
86V	108-88-3	toluene	ND
87V	79-01-6	trichloroethene	ND
88V	75-01-4	vinyl chloride	ND

PP#	CAS #	PESTICIDES	ug/kg
89P	309-00-2	aldrin	ND
90P	60-57-1	dieldrin	ND
91P	57-74-9	chlordane	ND
92P	50-29-3	4,4'-DDT	ND
93P	72-55-9	4,4'-DDE	ND
94P	72-54-8	4,4'-DDD	ND
95P	115-29-7	a-endosulfan	ND
96P	115-29-7	b-endosulfan	ND
97P	1031-07-8	endosulfan sulfate	ND
98P	72-20-8	endrin	ND
99P	7421-93-4	endrin aldehyde	ND
100P	76-44-8	heptachlor	ND
101P	1024-57-3	heptachlor epoxide	ND
102P	319-84-6	a-BHC	ND
103P	319-85-7	b-BHC	ND
104P	319-86-8	d-BHC	ND
105P	58-89-9	g-BHC (lindane)	ND
106P	53469-21-9	PCB-1242	ND
107P	11097-69-1	PCB-1254	ND
108P	11104-28-2	PCB-1221	ND
109P	11141-16-5	PCB-1232	ND
110P	12672-29-6	PCB-1248	ND
111P	11096-82-5	PCB-1260	ND
112P	12674-11-2	PCB-1016	ND
113P	8001-35-2	toxaphene	ND

PP#	CAS #	DIOXINS	ug/kg
129B	1746-01-6	2,3,7,8-tetrachloro-dibenzo-p-dioxin	ND

ND-Not detected *-below detection limit of 10 ug/kg for volatiles

APPENDIX C

BACKGROUND CONCENTRATIONS OF METALS

APPENDIX C
BACKGROUND CONCENTRATIONS OF METALS

This appendix contains analytical data on the background concentrations of metal in soil samples collected for two separate studies at the INEL. Additional background samples will be collected for the specific area near the ARA-I Chemical Evaporation Pond. These additional samples will be used for comparisons to background.

Forty-eight samples were collected and analyzed from various undisturbed locations of the INEL (Rope, 1988). Table C.1 contains the data reported as dry weight.

Table C.2 is a listing of background concentrations of metals in soil, as reported as part of a soil assessment of the Radioactive Waste Management Complex (RWMC). These analysis were performed using the same analytical methods used for analyzing the samples obtained from the ARA-I Chemical Evaporation Pond.

Table C.1. Background Concentrations of Metals--Dry Weight (ppm).

Metal	Arithmetic Mean	Geometric Mean	95% Confidence Interval on Geometric Mean
Al	1,500	14,300	13,100-15,600
B	10.1	9.8	8.4-11.4
Ba	244	238	222-255
Ca	9,900	8,460	7,270-9,900
Cr	18.9	18.0	15.0-21.6
Cu	18.3	18.0	17.0-19.1
Fe	15,100	16,200	14,800-17,800
Mn	401	379	345-417
Ni	18.4	18.0	16.8-20.5
Pb	14.0	13.7	12.4-15.2
Zn	100	96.7	89.7-104

Table C.2. Background Concentrations of Metals--Wet Weight (ppm).

Metal	Sample I	Sample II
B	25	25
Ba	250	92
Ca	1.1	0.36
Co	4.8	2.0
Cr	5.8	7.9
Cu	11	4.3
Mn	230	160
Ni	8.3	4.0
Pb	11	7.8
Zn	38	20

APPENDIX D

1987 EFFLUENT MONITORING OF ARA-I CHEMICAL EVAPORATION POND WASTE STREAM

Stream 006 - ARA I effluent to ARA leach pond

Parameter	Field Data: °C	pH	Conductivity (µS)	Concentration - ppm (parts per million, mg/l): TDS	TSS	TOC	F^-	Cl^-	NO_3^-	PO_4^{-3}	SO_4^{-2}	Br^-	CN^-
Quarter 1 Mean	15	7.4	335	NR	NR	1	0.74	21	4.1	X	22	NR	NR
Quarter 2 Mean	9	8.1	330	NR	NR	1	0.46	19	4.3	X	19	NR	NR
Quarter 3 Mean	14	8.3	321	NR	NR	3	0.41	20	4.5	X	20	NR	NR
Quarter 4 Mean	27	8.1	382	NR	NR	1	0.38	18	4.5	X	18	NR	NR
FY-87 Mean	16	8.0	342	NR	NR	2	0.50	20	4.3	ID	20	NR	NR
Level 1 Control Limit	NR	7.2 L 8.8 U	394	NR	NR	6	0.86	24	4.9	ID	25	NR	NR
Level 2 Control Limit	NR	6.9 L 9.0 U	418	NR	NR	8	1.0	26	5.1	ID	27	NR	NR
Regulatory Comparison Guideline	NR	6.5 L 8.5 U	NA	NA	NA	NA	4.0	250	10	NA	250	NR	NR

NR = Not required.

NA = Not available.

X = Less than instrument detection level.

ID = Insufficient data to calculate a meaningful value for this parameter.

. = No data generated.

Stream 006 - ARA I effluent to ARA leach pond

	Field Data			Concentration - ppm (parts per million, mg/l)										
Parameter	°C	pH	Conductivity (µS)	TDS	TSS	TOC	F^-	Cl^-	NO_3^-	PO_4^{-3}	SO_4^{-2}	Br^-	CN^-
Quarter 1 Mean	15	7.4	335	NR	NR	1	0.74	21	4.1	X	22	NR	NR
Quarter 2 Mean	9	8.1	330	NR	NR	1	0.46	19	4.3	X	19	NR	NR
Quarter 3 Mean	14	8.3	321	NR	NR	3	0.41	20	4.5	X	20	NR	NR
Quarter 4 Mean	27	8.1	382	NR	NR	1	0.38	18	4.5	X	18	NR	NR
FY-87 Mean	16	8.0	342	NR	NR	2	0.50	20	4.3	ID	20	NR	NR
Level 1 Control Limit	NR	7.2 L 8.8 U	394	NR	NR	6	0.86	24	4.9	ID	25	NR	NR
Level 2 Control Limit	NR	6.9 L 9.0 U	418	NR	NR	8	1.0	26	5.1	ID	27	NR	NR
Regulatory Comparison Guideline	NR	6.5 L 8.5 U	NA	NA	NA	NA	4.0	250	10	NA	250	NR	NR

NR = Not required.

NA = Not available.

X = Less than instrument detection level.

ID = Insufficient data to calculate a meaningful value for this parameter.

. = No data generated.

Stream 006 - ARA I to ARA leach pond

Parameter	As	Ba	Cd	Cr	Cr(IV)	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn
	Concentration - ppb (parts per billion, μg/l)												
Quarter 1 Mean	70	50	5	10	NR	22	X	0.54[b]	X	X	7	X	31
Quarter 2 Mean	X[a]	39	5	11	NR	21	360	0.38[b]	X	X[a]	8	X	20
Quarter 3 Mean	X[a]	34	5	9	NR	11	7.9[a]	1.5[b]	X	X[a]	X	X[a]	28
Quarter 4 Mean	11[a]	35	X	10	NR	X	25[a]	0.48	X	5.9[a]	22	X[a]	27
FY-87 Mean	ID	39	5	10	NR	20	49	0.68	ID	ID	ID	ID	26
Level 1 Control Limit	ID	54	7	14	NR	30	245	2.0	ID	ID	ID	ID	37
Level 2 Control Limit	ID	62	8	16	NR	35	348	2.6	ID	ID	ID	ID	43
Regulatory Comparison Guideline	50	1,000	10	50	NR	1000	50	2	NA	10	50	NA	5000

NR = Not required.

NA = Not available.

X = Less than instrument detection level.

ID = Insufficient data to calculate a meaningful value for this parameter.

. = No data generated.

a = GFAAS.

b = Cold vapor AA.

Stream 006 • ARA I to ARA leach pond

Parameter	As	Ba	Cd	Cr	Cr(IV)	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn
	Concentration - ppb (parts per billion, µg/l)												
Quarter 1 Mean	70	50	5	10	NR	22	X	0.54[b]	X	X	7	X	31
Quarter 2 Mean	X[a]	39	5	11	NR	21	360	0.38[b]	X	X[a]	8	X	20
Quarter 3 Mean	X[a]	34	5	9	NR	11	7.9[a]	1.5[b]	X	X[a]	X	X[a]	28
Quarter 4 Mean	11[a]	35	X	10	NR	X	25[a]	0.48	X	5.9[a]	22	X[a]	27
FY-87 Mean	ID	39	5	10	NR	20	49	0.68	ID	ID	ID	ID	26
Level 1 Control Limit	ID	54	7	14	NR	30	245	2.0	ID	ID	ID	ID	37
Level 2 Control Limit	ID	62	8	16	NR	35	348	2.6	ID	ID	ID	ID	43
Regulatory Comparison Guideline	50	1,000	10	50	NR	1000	50	2	NA	10	50	NA	5000

NR = Not required.

NA = Not available.

X = Less than instrument detection level.

ID = Insufficient data to calculate a meaningful value for this parameter.

. = No data generated.

a = GFAAS.

b = Cold vapor AA.

APPENDIX E

HEALTH AND SAFETY PLAN
FOR THE
ARA CHEMICAL LEACH POND
(COCA UNIT ARA-01)

Idaho National Engineering Laboratory
EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Idaho Operations Office
Under DOE Contract No. DE-AC07-76ID01570

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CONTENTS

APPENDIX E

HEALTH AND SAFETY PLAN

Figures

HEALTH AND SAFETY PLAN

1. INTRODUCTION

The Health and Safety Plan establishes the procedures and provides general guidelines for worker and public safety to be used by EG&G Idaho, Inc. (EG&G) during the Soil Sampling of the ARA-1 Chemical Leach Pond (COCA Unit ARA-01) at the Idaho National Engineering Laboratory (INEL). The sampling and analysis strategy is stated in Section 4 of the Sampling Plan.

The Health and Safety Plan will be made available and is intended to apply to EG&G employees, subcontractors to EG&G, and employees of other firms working under the technical direction of EG&G at the site of the investigation. It has been prepared in recognition of and is consistent with the U.S. Environmental Protection Agency (EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Section 2.3.3, "Health and Safety Plan," dated October 1988; NIOSH/OSHA/USCG/EPA Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, October 1985; the EG&G Safety Manual; and the U.S. EPA Standard Operating Safety Guides, November 1984.

It is recognized that this Health and Safety Plan must be flexible to fit the existing conditions. Modifications to the Plan may be implemented with concurrence from the Industrial Hygienist (IH), the Project Manager (PM) and the Principal Investigator (PI). Changes or additions to the Plan, along with rationale for the change, will be recorded in the Daily Activity Log and communicated to the team members by the PI.

1.1 Policy Statement

It is the policy of EG&G to take every practical precaution to protect the health of its employees, the employees of its subcontractors, the surrounding community, and official visitors from any adverse effect that might result from activities at a hazardous waste site. The safety and health precautions in this plan should allow these investigative activities to be accomplished safely without placing an excessive burden of equipment and procedures on the personnel performing the work, thus allowing the project to be performed effectively and expeditiously.

Activities conducted in accordance with this policy will be in compliance with OSHA and EPA regulations governing hazardous waste operations. All EG&G employees who conduct, supervise, and/or manage hazardous waste operations are responsible for carrying out activities in compliance with the provisions of this policy.

1.2 Site Description

The Auxiliary Reactor Area (ARA) is located 7.5 miles east of the Central Facilities Area and encompasses four satellite areas: ARA-I, ARA-II, ARA-III, and ARA-IV. These facilities were constructed in 1957 to test U.S. Army portable power reactors. Additional information on the site is given in Section 1 of the Sampling and Analysis Plan (SAP).

1.3 Work Description

The work to be performed will assist EG&G in their investigation of whether environmental contamination has resulted from waste disposal practices at the ARA Chemical Leach Pond at the INEL and, if contamination is found, in their determination of the magnitude and extent of the contamination.

Field activities in support of the EG&G investigation consist of:

- Collecting composite surface soil samples
- Collecting grab samples to bedrock using hand augers
- Drilling boreholes to collect subsurface samples

The field activities that will be conducted may involve exposure to hazardous materials or wastes resulting from direct contact with contaminated soil, rock, and groundwater during sampling operations. The maintenance of good health and provision for the safety of onsite personnel will be of major concern during the field activities at the investigation site. To this end, EG&G has identified a number of subjects to be addressed that will afford onsite personnel and the nearby facilities with protection. Ten major areas to be addressed for protection of workers and the facility are as follows:

- Health and safety responsibilities
- Medical surveillance program
- Personnel training
- Hazard evaluation
- Levels of protection and personal protective equipment
- Safe work practices
- Establishment of work zones and site entry and security procedures
- Environmental monitoring and recordkeeping requirements
- Decontamination procedures
- Emergency information.

Each of these areas is detailed with respect to the proposed ARA Chemical Leach Pond activities in the following sections.

2. HEALTH AND SAFETY RESPONSIBILITIES

The implementation of this Health and Safety Plan (HSP) will be the responsibility of the Environmental Restoration Project Manager (PM), the Principal Investigator (PI), or an alternate, and every other member of the site team. It is imperative that open communications and responsiveness exist among field team members to ensure the safe completion of the project. Figure E-1 shows the overall project organizational structure and key personnel staff for the program.

2.1 Project Manager (PM)

The Project Manager (PM) has ultimate responsibility for the safe and successful completion of the sampling activities and for all phases of safety at the work location. Should a health and safety issue develop, the PM upon notification by the Principle Investigator will halt sampling activities until consultations with an industrial hygienist, the ARA Landlord, and the Environmental Restoration Program Manager have resulted in a reasonable and safe solution to the problem. In addition, he/she must remain responsive to any health and safety issues pointed out by any field team member.

2.2 Principal Investigator (PI)

The Principle Investigator (PI), or an appointed alternate, will conduct an orientation meeting before the beginning of field activities to review and discuss the Health and Safety Plan with all team members. This orientation should be repeated when new team members arrive at the site. At the beginning of each work day, he/she will meet with the team to discuss the day's activities and address any safety issues that may have arisen.

The PI will have access to a permanent file of signed Health and Safety Certification Forms from each member, OSHA training certifications for all team members, all personal and air monitoring data results (if applicable), and any accident or illness report forms.

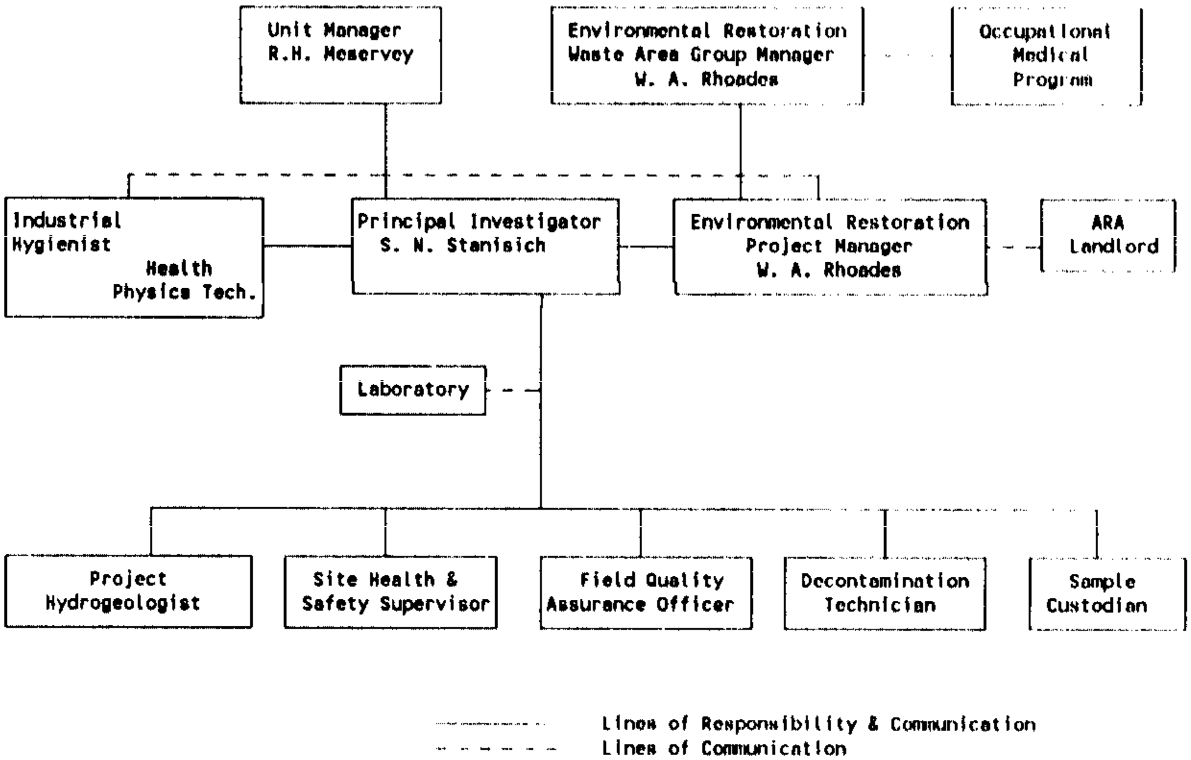

Figure E-1. Organization chart.

The PI is responsible for ensuring compliance with and executing the safety procedures described in this plan, as well as maintaining technical responsibility for the successful completion of the activities.

The PI is responsible for sounding an alarm in the case of an emergency evacuation and notification of emergency personnel (fire, explosion, ambulance).

2.3 Additional Responsibilities of the PI (or an Alternate)

Additional responsibilities of the PI include the following:

Locate the support facilities in an uncontaminated area.

Initiate contact with the local emergency response agencies (security, fire, medical), establish reporting requirements (Section 11), and test the emergency phone numbers to ensure their accuracy. (These numbers along with a map and directions to the medical facility are included at the back of this plan and will be posted at each sampling site.)

Implement the safety training as described in this plan (Section 3).

Observe site activities to ensure the proper uses of personal protective equipment (Section 6).

Ensure that safety equipment is located on the site and maintained properly, e.g., monitoring equipment is checked for proper operation, batteries are fully charged, and unused respirators (if necessary) are supplied and stored in a single layer. (Each team member should know the location of this equipment.)

Conduct periodic safety review sessions for the field team (Section 3).

Ensure that all personnel, material, equipment, and samples are surveyed by Health Physics prior to leaving the sample area.

Ensure that Health Physics coverage is scheduled by Friday of the week prior to the planned sampling date and notify ARA (CFA) Safety.

Ensure that daily work schedules are appropriate for types of work, levels of effort, and outside temperature and weather conditions each day (Sections 5 and 7).

Ensure that the field team observes the work zone and decontamination procedures as described in this plan (Sections 8 and 10).

Initiate corrective action for observed safety violations and report unsuccessful attempts to correct a violation to the PM.

Appoint an alternate.

Both the PI and the PM also share the responsibility and authority to halt or modify any working condition or remove personnel from the site if they consider conditions to be unsafe. The PI will be the main contact in any onsite emergency situation. Both are responsible for ensuring that all onsite personnel understand and comply with all safety requirements. Except in an emergency, modification of this plan can be made only after consultation with an industrial hygienist. The resulting changes must then be communicated to the ARA Landlord and the PM.

2.4 Industrial Hygienist (IH)

The Industrial Hygienist (IH) will be a primary source of information regarding health and safety issues at the site. He/she is responsible for operating, daily cleaning, and calibrating all monitoring equipment (except for radiological equipment) as well as maintaining a daily logbook of monitoring activities. However, due to the fact that trained personnel are necessary to assess readout data to avoid misinterpretations of the hazards present, the IH will retain the responsibility to advise the PM and PI on any protective equipment changes and on site evacuation and re-entry. The IH will periodically monitor the area during the sampling activities and determine frequency of monitoring.

When the use of organic vapor monitoring badges is necessary, the IH will interface with the analytical lab(s) concerning analyses of the filter media and will make provisions with the lab for a maximum 48-h turnaround for analysis in the event of an accidental acute exposure. In addition, the IH will see that chemical type and concentration samples are delivered to the Occupational Medical Program (OMP) as soon as possible after a spill or other accident involving personnel exposure.

2.5 Health Physics Technician (HP)

The Health Physics Technician (HP) will be the primary source of information and guidance for monitoring radiological hazards. The HP may be present at the site during all sampling activities; otherwise he/she will be on call and accessible by "F" net radio. The HP is responsible for identifying radiological hazards and can stop sampling activities as required. The HP may also require that material and equipment be surveyed to removal from the sampling area.

2.6 ARA-1 Landlord

The CFA Landlord (Ken Tuck) has jurisdiction over sampling activities at the ARA-1 Facility, and therefore also functions as the ARA Landlord. The ARA Landlord will be kept informed on all activities and will serve as advisor to the sampling crew with regard to ARA. In case of an emergency, the ARA Landlord will be notified and will act as coordinator of the situation in regards to the ARA facilities and facility personnel actions.

2.7 Site Safety and Health Supervisor (SS)

The Site Safety and Health Supervisor (SS), or appointed alternate, is responsible for the development and implementation of this plan, as well as to verify compliance and effectiveness. The SS is designated by the PI or IH and will be present during all sampling activities.

2.8 Field Quality Assurance Officer (QAO)

The Field Quality Assurance Officer (QAO) is responsible for monitoring the activities of the site, verifying that the applicable sampling procedures have been followed, and certifying that all procedural and documentation requirements have been met. The Field QAO will normally remain outside of the general activities of the field team.

2.9 Decontamination Technician

The Decontamination Technician will be responsible for decontaminating all of the instrumentation and equipment used in collecting hazardous waste samples. Decontamination will be in accordance with the respective DOE Environmental Survey Manual, January 1989. This technician will also assist individual team members in removing their personal protective gear after they have exited from the exclusion area by use of a designated doffing area. The decontamination technician will a) obtain and maintain the necessary decontamination agents, and b) assist in preventing contamination spread to the clean area.

2.10 Sample Custodian

The Sample Custodian is responsible for the documentation, handling, packaging, preserving, and shipping of samples. This individual will document all sample descriptions and activities in a field logbook and fulfill the chain-of-custody procedures as described in the Quality Assurance Project Plan.

2.11 Field Staff

All field staff, including EG&G subcontractor personnel, are responsible for understanding and complying with all requirements of the Health and Safety Plan. Field staff will be briefed during a morning meeting before the start of each day's activities to bring all perceived unsafe site conditions to the attention of the PI. In addition, the field staff will inform the PI or SS of any signs and symptoms of overexposure.

2.12 Visitors

To protect site visitors from any adverse health effects that may result from site activities, all visitors will be required to follow the rules as set forth in this plan:

No visitors will be allowed in any of the zoned work areas of the site unless they have received 40 hours of OSHA training, plus respirator-fit testing.

Visitors will be required to prearrange their visit in advance with the PI. The PI will inform them of the required protective equipment.

Upon arrival, the PI will instruct the visitors concerning the safety precautions in effect.

Only visitors who have official business with the field team and who have notified the PI in advance will be allowed near the site locations.

3. OCCUPATIONAL MEDICAL PROGRAM

The INEL Occupational Medical Program (OMP) provides medical advice and service to all INEL employees and employers. The INEL Occupational Medical Program resides in the Health and Medical program organization of EG&G and their activities are required and authorized by DOE Order 5480.8. The Occupational Medical Program helps to ensure compliance with OSHA and other regulations. These regulations require medical surveillance of workers exposed above threshold limit values (TLVs) 30+ days per year, those wearing respiratory protection 30+ days per year, those injured/overexposed due to emergency incidents, and other personnel involved in the handling of hazardous materials (HAZMAT). Medical services are provided at one decontamination facility, two facilities staffed by physicians and nurses, and four dispensaries staffed by nurses. The major medical facility at CFA is open during all shifts, every day of the year.

The Occupational Medical Program has responsibilities in the following areas:

1. Treatment of illness and injuries in or arising out of the source of work.

2. Assistance in the documentation and investigation of work-related illness or injury.

3. Providing medical opinions about the ability of employees to perform the assigned work.

4. Advice on medical treatment and transportation.

5. The maintenance and operation of a radiological and chemical decontamination facility at CFA.

6. Providing medical surveillance programs for workers who are properly identified by a qualified industrial hygienist as exposed, or at risk to become exposed over action limits to specific toxic substances.

A baseline physical examination must be on file with the INEL OMP for all employees identified as hazardous material handlers (see EG&G Idaho Resource Manual, Section 8).

The following information is also to be provided by the IH prior to beginning work:

1. Substances to which the employee is likely to be exposed, expected frequency and duration of exposure.

2. Time, place, and extent of previous exposure to these substances above TLV.

3. Type of personal protective equipment (PPE) to be used by the employee, when and what training on its use has been given.

4. The estimated number of days per month the worker is to use PPE, especially respirators, in the coming year.

5. The estimated length of time the employee is expected to continue as a HAZMAT worker.

4. PERSONNEL TRAINING

The PI, or an alternate, will ensure that all personnel will have received a minimum of 40 hours of OSHA training. Supervisors will have an additional 8 h of special training. This training complies with the OSHA Interim Final Standard, 29 CFR Part 1910, Docket #S-760, December 19, 1986, and will be augmented by fit-testing of respiratory protectors and 3 days field experience before work begins on the project site. The PI or an alternate will ensure that all personnel understand the hazards associated with site operations and will design and implement a site-specific training program to include:

Site safety and health personnel and alternates
Hazards present onsite
Use of personal protective equipment
Work practices to minimize risk
Safe use of engineering controls
Medical surveillance requirements
Importance of informing employer of signs and symptoms of overexposure.

In addition, at least two workers at the ARA Chemical Leach Pond will have current First Aid and CPR certification.

4.1 Personnel Training Outline

The following outline is to be used by the PI or SS for orienting and informing personnel who will be working on the project site.

4.1.1 Work Plan

This sampling effort involves the collection of surface and subsurface soil samples in a low hazard environment. The training will familiarize personnel with overall objectives and specific tasks to accomplish the work.

4.1.2 General Field Safety

Responsibilities (Section 2)
Medical program (Section 3)
Site work zones (Section 8)
Vehicle operation and parking
Site air monitoring (Section 9)
Personal monitoring equipment (Section 9)
Potential hazardous contaminants present at the project site and chemical hazards at specific sites (toxicity and symptomology) (Section 5)
Contingency plans and responses (Section 11)
Use of field equipment and supplies

- Work tools
- Sampling equipment
- Monitoring equipment (site and personal), calibration and cleaning procedures
- Site analysis equipment

Site control and security (Section 8)
Buddy system and hand signals (Section 11)
Work limitations (Sections 5, 7, and 9)

- Weather
- Fatigue
- Heat stress
- Cold stress
- Hours of work
- Lightning.

4.1.3 Personal Protective Equipment and Clothing

General (Section 6)
Availability (Section 6)
Hearing protection devices (Section 6)

Personal protective equipment and clothing for Level D operations, including limitations of protection (Section 6)

- Work clothing
- Eye protection
- Foot protection
- Hand protection
- Head protection
- Hearing protection

Personal protective equipment and clothing for Level C operations including limitations of protection (Section 6)

- Respiratory protection
- Work clothing
- Eye protection
- Foot protection
- Hand protection
- Head protection
- Hearing protection

Decontamination of clothing and equipment (Section 10)

Disposal of contaminated clothing and equipment (Section 10)

4.1.4 Emergency Assistance

Availability of emergency services and location of telephone numbers (Section 11)

Transportation of emergency cases (Sections 10 and 11) and accompanying medical monitoring procedures

First aid/cardiopulmonary resuscitation (Sections 10 and 11)

Onsite emergency assistance and review of hand signals (Section 11)

5. HAZARD EVALUATION

Review of documents and records indicate that hazardous materials have been disposed of at the ARA-01 Chemical Leach Pond. Section 1 of the Sampling and Analysis Plan describes the materials discharged to these areas.

5.1 Chemical Hazards

Chemical hazards to the field team exist when gaseous, liquid, or solid samples from the investigation sites contact human tissue. Every effort will be made to avoid direct contact with the subsurface materials at the site.

5.1.1 Routes of Chemical Exposure

The field activities team may be exposed to contaminated soils and groundwater through inhalation, ingestion, and/or skin and eye contact.

Respiratory system contact with contaminated materials can occur due to lack of or improper use of respiratory equipment.

Gastrointestinal system contact with samples can occur when workers do not pay attention to personal hygiene rules designed to reduce the chance of ingesting site contaminants; e.g., washing hands thoroughly before smoking, eating, or drinking after leaving the site.

NOTE: Although ingestion should be the least significant route of exposure at a site, it is important to be aware of how this type of exposure can occur. Deliberate ingestion of chemicals is unlikely; however, personal habits such as chewing gum or tobacco, drinking, eating, smoking cigarettes, and applying cosmetics on site may provide a route of entry for chemicals. No smoking, eating, drinking, or chewing is allowed while on the site. Consumption of fluids or food will have to be done in an approved eating area.

Skin contact with solid- or liquid-contaminated samples can occur when a worker does not wear proper protective clothing during drilling and sampling activities or when sample preparation and packing is performed carelessly.

Eye contact with solid- or liquid-contaminated samples can occur when a worker does not wear safety glasses during excavating and sampling activities or when dirty hands are used to scratch an eye.

5.1.2 Indicators of Chemical Exposure

Observable by others

- Changes in complexion, skin discoloration
- Lack of coordination
- Changes in demeanor
- Excessive salivation, pupillary response
- Changes in speech pattern

Nonobservable by others

- Headaches
- Dizziness
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory tract.

5.2 Physical Hazards

The field team can be exposed to a number of physical hazards during this project. Physical hazards that may be encountered are:

- Fire and explosion
- Ionizing radiation
- Biological hazards
- Industrial safety hazards
- Electrical hazards
- Heat stress
- Cold exposure
- Noise
- Decontamination activities
- Work stress
- Lightning.

General considerations are discussed below, followed by specific comments in the following section.

5.2.1 Fire and Explosion

There are many potential causes of explosions and fires at hazardous waste sites. Explosions and fires may arise spontaneously. However, they more commonly result from site activities such as moving drums, accidentally mixing incompatible chemicals, introducing an ignition source into an explosive or flammable environment, or refueling excavation equipment. Intense heat, open flame, smoke inhalation, flying objects, and the release of toxic chemicals into the environment can result.

Fuel and decontamination fluid (methanol) may generate fumes that can be ignited by the pilot flame on the steam cleaner. Keep the storage areas for these fluids 50 ft away from the steam cleaner.

5.2.2 Ionizing Radiation

Field surveys and gamma spectroscopy of soil samples have indicated radioactivity to be at ambient background levels. A field survey for detection of radioactivity will be completed prior to the beginning of field activities. The HP assigned by the ARA Landlord will determine the need for additional surveys.

5.2.3 Biological Hazards

Normal tetanus bacteria live in soil. All field team members should have updated tetanus immunizations. The field team will be made aware that site activities may disturb the local wildlife population. Snakes, insects, and other animals can and will bite if disturbed. Avoidance is the best solution, but field personnel will be briefed regarding the potential for encountering wildlife and prompt first-aid measures should they be necessary.

5.2.4 Industrial Safety Hazards

Hazardous waste sites may contain numerous safety hazards such as:

- Existing hazardous objects and terrain
- High work areas
- Lifting heavy objects
- Moving equipment and falling objects
- Personal protective equipment.

Personal protective equipment can restrict visibility and movement. This increases the risk of falling over objects, striking objects, or being struck by them. Personal protective equipment can also elevate the risk of heat stress.

5.2.4.1 Existing Objects or Terrain. Existing objects and terrain can present safety hazards in the form of:

Holes and ditches
Precariously positioned objects such as drums or boards that may fall
Sharp objects such as nails, metal shards, and broken glass
Slippery surfaces
Steep grades
Uneven terrain
Unstable surfaces such as walls that may collapse or flooring that may give way.

5.2.4.2 Lifting Heavy Objects. Field team members may be exposed to injury caused by lifting heavy objects because drilling operations involve manual movement of heavy drilling casing, auger flights, and various other pieces of equipment. All field team members should be trained in the proper method of lifting heavy equipment and cautioned against lifting objects that are too heavy for one person. Mechanical and hydraulic assists will be utilized whenever possible to minimize lifting dangers.

5.2.4.3 Moving Machinery and Falling Objects. The field team may be subject to lacerations and contusions (cuts and bruises) because excavating/sampling activities usually involve contact with moving machinery and possible falling objects. This will be minimized by wearing protective clothing, steel-toed boots, and using mechanical assists whenever possible. Hard hats will be worn in the area of influence of any operating heavy machinery. Loose clothing or neck chains for security badges should not be worn around heavy equipment.

5.2.4.4 Personal Protective Equipment. Wearing personal protective equipment reduces a worker's ability to move freely and hear directions and noise that might indicate a hazard. Protective equipment can impair a worker's agility, hearing, and vision, which can result in an increased risk of an accident. All workers wearing personal protective equipment will be made aware of the potential increase in risk of physical hazards. Site personnel should constantly look for potential safety hazards and immediately inform their supervisors of any new hazards so that corrective action can be taken.

5.2.5 Electrical Hazards

Overhead power lines, downed electrical wires, and buried cables all pose a danger of shock or electrocution if workers contact or sever them during site operations. Electrical equipment used on site may also pose a hazard to workers. The appropriate INEL operating group will be contacted for underground utility clearances before sampling operations. EG&G requirements will be adhered to for work permits and clearances for operations near power lines.

5.2.6 Heat Stress

During the project, workers may be required to wear protective clothing that insulates the body and could result in adverse health effects if not correctly managed. High ambient temperatures can result in various symptoms including heat fatigue and physical discomfort, all stemming from the increase of body temperature. The PI must be alert for the signs and symptoms of heat stress and act accordingly to preserve the alert and safe-work practices necessary for this operation.

Field team members will be observed for the following signs and symptoms of heat stress:

- Dizziness
- Profuse sweating
- Skin color change
- Vision problems
- Confusion.

Any team member who exhibits any of these symptoms will be removed immediately from field work and allowed to rest. The team member shall be taken to a Medical Facility if the symptoms persist, or when required in the opinion of an appropriate responsible official or person always present.

Many methods are available to minimize the effects of heat stress besides the establishment of a work rest regimen. The work is scheduled to begin early in the day to minimize the effect of radiant heat generally encountered in the afternoon. During break, each worker will be at rest and able to drink cool drinks (water or commercial drink mixes such as Gatorade™ or Quik Kick™). Protective clothing will be removed and breaks taken in the shade, when possible.

5.2.7 Cold Exposure

Cold exposure may be a factor, if winds are high, and/or if unpredictable weather occurs. Adequate protective clothing to ensure warmth will be necessary, but extra care must be taken while working in this environment; heavy clothing impairs movement and hearing. Observation is required of co-workers' facial extremities (ears and nose) for signs of frostbite (whitening of the skin surface), and of workers mental coherence and body movements to avoid hypothermia. The SS will monitor wind chill and notify personnel of exposure danger.

5.2.8 Noise

The field team may be exposed to excessive noise levels from equipment and other sources during this project. The IH will identify field team members who require enrollment in the INEL Hearing Protection Program. This information will be given to the OMP along with the allowable time team members in the Hearing Protection Program can be around an excavation operation. Hearing protection will be provided to any and all personnel working in environments of excess noise.

5.2.9 Decontamination

The decontamination of tools, equipment, and personnel to remove contamination generated by the activities identified in this document has the potential for spreading contamination and increasing the exposure to personnel if care is not exercised when the decontamination activities are taking place. High pressure hot water and steam used in the process can also present a hazard if blasts of either rebound into the face or on the body of the decontamination technician or nearby workers.

5.2.10 Work Stress

Hazardous activities that rely on a high degree of personal alertness shall be performed under controlled conditions of job performance outlined by Section 20, Part 2.2 and Appendix C of the EG&G Idaho Safety Manual. The PI and IH assume the responsibility to use good judgment in the assignment of personnel fatigued by excessive hours of work in psychologically and possibly physiologically stressful environments. A work week in excess of 48 hours requires approval of a Level 2 or 3 manager or the General Manager.

6. LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment selection is based on the recommendations contained in the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (NIOSH, 10/85). Personal protective equipment will be required during the course of the project and selection will be based primarily on hazard assessment data and work task requirements. Every attempt will be made, when possible, to use engineering controls to alleviate the use of personal protective equipment. Before entry, each work location may be monitored for potentially hazardous contaminants using an HNu photoionization detector, a combustible gas indicator, and a radiological scan by an HP.

Due to the site history, the types of known contaminants, and the likelihood of unknown contaminants being present, the recommended level of personal protective equipment (PPE) is Level D as described in Section 6.2. This requirement may be changed with concurrence from the IH, the SS, and the PI. Modifications to the Health and Safety Plan, along with rationale, will be noted in the Daily Activity Log maintained by the PI. The IH will evaluate the effectiveness of the program protection.

It is known that wearing PPEs will increase the effects of work and heat stress on personnel, especially when ambient temperatures rise above 65°F. If the HNu photoionization detector reads 5.0 ppm above background, but less than 10 ppm in the breathing zone for five continuous minutes, then Level C PPE (Section 6.3) will be worn by personnel in the Exclusion Zone (Levine and Martin, 1985).

The person reading the HNu should be aware that the HNu readings can be affected by engine exhaust, temperature, dust particles, wind, moisture, and the response of the chemicals measured.

HNu Response Criteria	
5.0 ppm*	Don Level C PPE
10.0 ppm*	Elevate PPE to Level B as defined by NIOSH, 1985.

* Air concentration, above background, measured at breathing zone for five continuous minutes.

6.1 Provisions for Site Evacuation

If Combustible Gas Indicator readings exceed 10% of the lower explosive limit (LEL), site activities will be suspended. Before resuming site work, the PI in conjunction with the IH will develop safe procedures for continuing operations.

If HNu photoionization detector readings are in excess of 5 ppm above background levels for more than five continuous minutes in the breathing zone, then an evacuated canister sample will be taken at the site to determine the constituents present; the IH will continue to monitor the fluctuation of vapor levels with the Combustible Gas Indicator (CGI) and HNu. If the elevated vapor levels do not dissipate, the IH, SS, and PI will jointly determine a course of action that will allow safe operations. If HNu concentrations in the breathing zone ever exceed 1000 ppm, sampling operations will be discontinued (Levine and Martin, 1985).

Any personnel re-entering the exclusion zone to collect gas samples, take HNu readings, or perform other operations after elevated vapor levels have been detected, will enter only the affected area wearing a minimum of Level B personal protective equipment.

6.2 Level D Personal Protective Equipment

Personnel working in an Exclusion Zone, as defined above, shall wear as a minimum:

Coveralls
Safety shoes with steel toe and shank
Hard hat (as required by the IH)
Gloves of a material appropriate to the task
Hearing protection (as required by the IH)
Eye protection where needed.

6.3 Level C Personal Protective Equipment

The Level C clothing described below must be worn, as a minimum, by all personnel working within the Exclusion Zone when the HNu readings are in excess of 5.0 ppm:

Full-face with appropriate eye protection; air-purifying respirator with appropriate filters (NIOSH-approved) as required by INEL Health Physics and IH recommendations
Disposable chemical-resistant coveralls
Chemical-resistant safety shoes with steel toe and shank
Hard hat (as required by IH)
Chemical-resistant gloves
Hearing protection (as required by IH)
Eye protection where needed.

6.4 Level B Personal Protective Equipment

Level B is the same as Level C clothing except the respiratory protection is upgraded to full-face air line respirators with escape self-contained breathing apparatus (SCBA). Level B clothing, as described below, must be worn, as a minimum, by all personnel within the Exclusion Zone, as instructed by the IH:

Pressure-demand, full-face SCBA or pressure-demand supplied-air respirator with escape SCBA
Disposable chemical-resistant coveralls
Chemical-resistant safety shoes with steel toe and shank
Hard hat (as required by IH)
Chemical-resistant gloves
Hearing protection (as required by IH)
Eye protection where needed.

6.5 Respirators

MSA respirators supplied by EG&G will be used exclusively. Respirators can be reused from day to day. The respirators should be kept in a sealed container and stored in a single layer when not in use. The respirators shall be cleaned per IH instructions.

The lifetime of charcoal filters is short; consequently, all used canisters should be replaced daily.

6.5.1 Inspection Procedure

The respirators shall be inspected for the following deficiencies:

Look for breaks or tears in the headband material. Stretch the bands to ensure sufficient elasticity.

Ensure that all headbands, fasteners, and adjusters are in place and not bent.

Check the facepiece for dirt, cracks, tears, or holes. Ensure that the rubber is flexible, not stiff.

Check the shape of the facepiece for possible distortion that may occur if the respirator is not properly stored.

Check the exhalation valve located near the chin between the cartridge holders by:

- Unsnapping the cover
- Lifting the flexible rubber valve and the valve seat to check for cracks, tears, dirt, and distortion
- After replacing the cover, ensuring that it spins freely.

Check both inhalation valves, located under the respirator cartridges for the same items listed above.

Check the cartridge holders to ensure that they are clean, necessary gaskets are in place, threads are not worn, and there are no cracks or other visible signs of damage; ensure that they are the correct type of filter required for the job.

Check cartridges, especially the threaded portions, for dents or other damage.

6.5.2 Repair and Replacement

Respirators should not be repaired by unqualified personnel. Unless personnel in the field have received formal instruction on the maintenance of respiratory protection devices, damaged respirators should be sent to Jim Wetzel, CF 617, for maintenance (phone 6-6380).

7. SAFE WORK PRACTICES

A Safe Work Permit will be required for the sampling operations at the ARA Chemical Leach Pond.

Several factors may affect the safe working environment at the work site: inclement weather, extended working schedules, work in heavy personal protective equipment, and work done under artificial illumination. In addition, these factors could compromise the integrity of the samples and the efficiency of the team work.

Cold temperatures, high winds, heavy rainfall, and hot temperatures could reduce the abilities of the field team to accomplish their work safely and efficiently. The PI, in conjunction with the PM, is responsible for continuing or discontinuing work due to weather conditions. Their first consideration should be personnel safety, and second the integrity of the sampling operations. Field team members should, however, prepare to work in cold, windy, wet, and hot weather with appropriate clothing.

Work schedules may be extended to expedite the project. Section 20 in the EG&G Safety Manual offers guidelines and managerial approval needed for personnel working more than a 48 hour week. The PI is always responsible for the safety of the field crew; however, when work weeks are in excess of 48 h, he/she must realize that physiological and psychological stresses reduce the safety and efficiency of the field operations and that ultimate responsibility rests on his/her judgment.

Work performed in heavy personal protective equipment, such as Level C or B, creates additional stresses that severely limit the ability of the crew to work long shifts. If personnel are wearing Level C or B equipment, it is recommended that the work schedules be altered according to guidelines in The American Conference of Government Industrial Hygienists' (ACGIH) "TLVs and Biological Exposure Indices, 1988-89".

If hot and/or windy conditions exist during the regular work shift, the schedule may need to be changed to perform the work at night. The use of artificial illumination, although a necessity, can create a hazardous environment for the workers due to reduced visibility. Workers in this environment will need to be especially alert and cautious as they maneuver around in the work areas.

The following are general safe work practices that will be adhered to on this project:

Contact lenses are not recommended to be worn by personnel working in the Exclusion Zone.

Smoking, eating, drinking, and chewing are prohibited in the Exclusion and Decontamination Zones.

Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, etc. Avoid kneeling, leaning, or sitting on equipment or the ground.

All field team members should use all of their senses to alert themselves to potentially dangerous situations; e.g., the presence of strong, irritating, and/or nauseating odors.

Prevent spillages to the extent possible and, if spillage occurs, contain it, report it, and immediately clean it up.

Prevent splashing of contaminated materials.

Field crew members will familiarize themselves with the physical characteristics of the sites of investigation including, but not limited to:

- Wind direction
- Accessibility to fellow workers, equipment, and vehicles
- Safe work distances
- Communications at and near the site
- Hot zones (areas of known or suspected contamination)
- Site access
- Nearest water sources
- Nearest emergency assistance.

No less than two workers should be in the Exclusion Zone when there is a potential for airborne contamination.

Keep an eye on your co-worker. Look for signs of exhaustion, heat or cold stress, or exposure to harmful vapors. Ask regularly if they are okay. Talk to them.

All wastes generated during the site investigation will be placed in containers provided by EG&G and stored onsite. The Project Manager will be responsible for proper disposal.

Adhere to strict personal hygiene practices such as washing face, neck, and hands before eating, drinking, smoking, or using the restroom. Keep hands away from mouth and eyes when working in the Exclusion Zone or after handling samples or sample containers.

8. WORK ZONES AND SITE ENTRY AND SECURITY

Based on the expected levels of contamination and work activity, two work zones will be established at each site (Figure E-2). Site entry will be strictly controlled to minimize the number of personnel onsite consistent with effective operations. Unnecessary personnel will be excluded and visitors will be required to have clearance from the PI before being allowed access to the investigation sites.

Three work zones will be required for Level D, C, or B work activities:

Exclusion Zone: zone of maximum hazard

Contamination Reduction Zone: where personnel and equipment, in contact with the exclusions zone, will be decontaminated and prepared for entry into the Support Zone

Support Zone: zone of no hazard.

8.1 Exclusion Zone

The Exclusion Zone includes that area of the work site where active sampling activities will be undertaken. Workers in this zone may be subject to contact with hazardous gases, liquids, and solids during sampling operations. The minimum number of personnel necessary to safely perform sampling operations will be allowed in the Exclusion Zone.

8.2 Contamination Reduction Zone

The Contamination Reduction Zone will consist of an area set up for decontamination of personnel and equipment that have been in contact with the Exclusion Zone. The Contaminant Reduction Zone should be established 50 ft upwind of the exclusion zone. It is anticipated that necessary personnel and small-equipment decontamination will take place here.

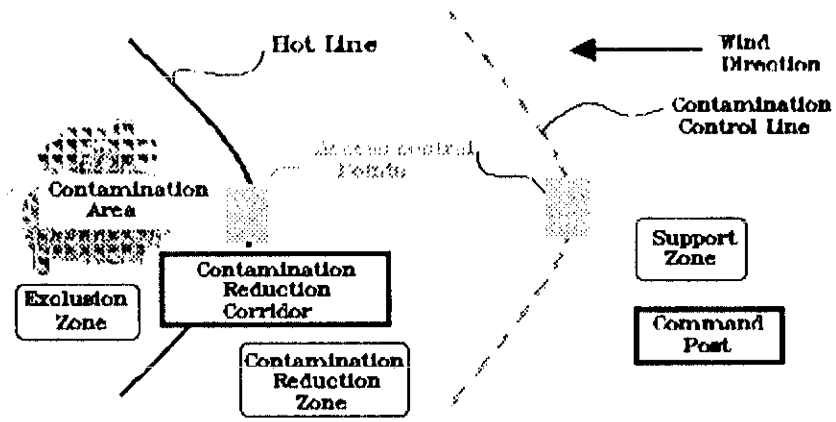

Figure E-2. Diagram of typical Level C work zones at Idaho National Engineering Laboratory (INEL).

8.3 Support Zone

The Support Zone will consist of the area within the safety perimeter around the work site but outside the Contamination Reduction Zone and will include the field office and an area for staging vehicles and safety equipment during site operations. The zone should be at least 50 ft upwind from the site operations and should remain clean and free of potentially contaminated soil and equipment.

9. ENVIRONMENTAL MONITORING AND INDUSTRIAL HYGIENE

Employee exposure to site contaminants and physical hazards may be monitored during the site activities using a combination of techniques. The following monitoring for contaminants may be performed.

Organic vapor measurements using a photoionization detector (HNu) with a 11.7 eV probe or a Photovac TIP II (TIP II) with a 11.7 eV probe

Combustible gas measurements using a combustible gas indicator

Heat or cold stress using field measurements and observations and, if necessary, body temperature measurements

Radiation measurements using equipment provided and operated by a health physicist at times previously stated in Section 2.6 or at the discretion of the HP

Personal exposure to organic vapors, particulate contamination (heavy metals) using personal monitoring pumps and appropriate filters collection media (active sampling)

Harmful noise levels using a sound-level meter

Organic vapors using vapor-monitoring badges (passive sampling)

Observation of working practices and the work sites.

Before the start of field activities, a designated member of the field team will be instructed by the IH in the operation, cleaning, and calibration of the HNu. Personal sampling pumps are not expected to be used at this project site. If conditions should warrant personal sampling pump use, the IH will be contacted. These requirements are enacted as a safety precaution. If the IH is not present at the project site, sampling crew members will be familiar with the use of monitoring equipment.

9.1 Chemical Exposure Monitoring

Each work area may be monitored for organic vapors in the breathing zone (chest or face level). Volatile organic compounds have not been detected in previous sampling efforts. Therefore, monitoring with an HNu will be at the discretion of the PI. Negative readings on the HNu should never be interpreted as a complete absence of airborne toxic substances. If readings exceed 5 ppm above background for 5 min, an evacuated canister sample should be taken to determine the constituents present in the air. The IH will continue to monitor vapor levels with the HNu and the Combustible Gas Indicator (CGI). If the readings on the HNu (photoionization detector) ever rise to 1000 ppm above background, work at the site must be halted and personnel evacuated from the area. From the analysis results, the IH will advise on an appropriate plan of action. Personnel will not re-enter the site until the PI has been assured of its safety.

Personal monitoring pumps may be used to gather data on organic vapors and particulate concentrations in the breathing zone. Collection media, sampling intervals, and which workers will wear the pumps will be recommended by the IH.

9.2 Combustible Gas Monitoring

The work site will be monitored for combustible gases every 15 to 30 min (or at the recommendation of the IH). Elevated readings on the HNu might be an indicator of the presence of combustible gases. If the Lower Explosive Limit (LEL) is greater than 10%, work at the site will stop until the levels drop.

9.3 Heat and Cold Stress Control and Monitoring

The PI and the SS will set work and break schedules depending upon the ambient weather conditions in coordination with the IH and will monitor field staff to ensure that they adhere to the work and break schedule, are adequately replacing body fluids, and are keeping body temperatures in a normal range.

The monitoring program will involve the measurement of the Wet Bulb Globe Temperature (WBGT), as described by the ACGIH. The results of the monitoring will be used to establish the initial work-rest regime.

The work schedule for the first day will be established as follows:

WORK / REST SCHEDULE DICTATED BY WET BULB GLOBE TEMPERATURE

Work/Rest Regime	WBGT °F	WBGT °C
120 min work, 15 min rest	80	26
90 min work, 30 min rest	82	28
60 min work, 60 min rest	85	29
30 min work, 90 min rest	88	31

The guidelines established by the ACGIH are not able to account for the acclimatization of the workers and are conservative as a result.

The PI, SS, and IH will adjust the schedule after it is determined that the rest breaks are effective and the workers are adequately acclimated. Workers will be interviewed periodically to ensure that the controls are effective and no excessive exposures are occurring. Workers will be encouraged to monitor their own body symptoms and to take a break before a negative effect is observed.

Workers suspected of a heat-stress-related exposure will be removed from the Exclusion Zone to the rest area. No worker shall be returned to the Exclusion Zone if the oral temperature exceeds 100.6°F.

Rest breaks shall include the following preventive measures:

Adequate liquids
Cool, shaded rest area
Protective clothing removed to allow evaporative cooling
Perform no other work assignments during the break.

9.4 Noise-Level Monitoring

Field personnel exposures to noise will be monitored at the start of drilling using sound-level meters. If noise levels are detected at or above recommended exposure levels (80 to 85 dBA for 8 to 16 h, 1987-88 TLV) for continuous or intermittent noise, all personnel potentially exposed will be required to wear hearing protection as directed by SS or IH. (Recommended: "E-A-R" Hearing Protectors, Noise Reduction Rating 35 dB.)

9.5 Physical Hazard Control and Monitoring

The PI will have the primary responsibility for ensuring the project work area is maintained in a safe condition by requiring correction of unsafe conditions and keeping the site clean of debris and garbage.

Individuals working on the project have a specific responsibility to use safe work techniques, report unsafe working conditions, and keep the work area in a clean condition.

9.6 Recordkeeping Requirements

The PI is required to keep the following information in the program file indefinitely:

Copies of the ARA Chemical Leach Pond Project Management Plan, Health and Safety Plan, Sampling and Analysis Plan, and Quality Assurance Project Plan

Any accident or illness report forms

Any monitoring results

Personal sampling results

Standard Operating Procedures

The IH is required to maintain a log book of all air-monitoring results, personnel sampling results, times of sampling intervals, calibration of instruments, and personnel equipment usage. In addition, he/she is to coordinate with the analytical labs concerning analysis turnaround time and will be in charge of transporting the personal sample media to the labs.

10. DECONTAMINATION PROCEDURES

Establishment of decontamination procedures for personnel and equipment is necessary to control contamination and to protect field personnel. All decontamination procedures are to be monitored by the SS. If equipment or personnel are radiologically contaminated, decontamination procedures will be specified by the HP. When hazardous-constituent decontamination is necessary, it will consist of the following procedures.

10.1 Level D Decontamination Procedures

Equipment in the Exclusion Zone will be decontaminated before transport to the Support Zone. Should routine decontamination procedures be impractical, then visual contamination and loose soil will be superficially removed, the equipment isolated by placement in a bag, box, or tray before transporting to the Support Zone and/or other area where thorough decontamination can be achieved. Personnel leaving the Exclusion Zone will perform a step-off decontamination at the "hotline" (see Figure E-2). This process entails removal of chemical-resistant coveralls, chemical-resistant gloves, respirator, then surgical undergloves, in that order. All personnel will wash their hands, forearms, and faces thoroughly with soap and water before eating, drinking, smoking, applying cosmetics, or using the bathroom.

At the end of the work day, a full-body shower, including a complete soap down using a wash cloth, is recommended. Pay particular attention to areas of the body that are typically overlooked, such as behind the ears or between the toes.

10.2 Level C and B Decontamination Procedures

Decontamination procedures for Level C will be established by the IH based upon the types of contaminants encountered. The basic decontamination procedure will be as stated above, with the addition of a Contamination

Reduction Zone between the Exclusion Zone and the Support Zone. The order of removing personal protective equipment will be chemical-resistant coveralls, overboots or chemical-resistant boots (or thorough decontamination of chemical-resistant boots), chemical-resistant gloves, respirator/SCBA, then surgical undergloves.

10.3 Equipment Decontamination and Disposal of Contaminated Materials

All equipment and contaminated clothing must be decontaminated or the contamination isolated before leaving the work area. Equipment that may require decontamination includes soil- and water-sampling devices, and certain protective equipment. In the event a worker's impermeable clothing becomes wetted with hazardous substances, he/she will remove the clothing and shower. The contaminated clothing will then be disposed of or decontaminated before it is removed from the work zone. Sampling tools and protective equipment will be decontaminated using soap and water followed by rinsing with deionized water, then methanol, and another rinse with deionized water. Unauthorized employees shall not remove protective clothing or equipment from change rooms. If necessary, the commercial laundries will be informed of the effects of exposure to hazardous substances.

All materials and equipment used for decontamination must be disposed of properly. Disposable clothing, tools, buckets, brushes, and other contaminated equipment will be secured in containers to be provided by EG&G and stored in a suitable location for disposal by EG&G. It is the responsibility of the Project Manager to ensure proper disposal of all material. Unexpended contaminated equipment that can be used later on the project will be placed in plastic bags and stored onsite.

Soil cuttings and fluids generated during sampling and decontamination operations will be containerized, treated as hazardous waste, and stored as directed by EG&G. EG&G shall have the responsibility for final disposition of the wastes until determined to be nonhazardous.

10.4 Decontamination During Medical Emergencies

If prompt, life-saving first aid and/or medical treatment is required, decontamination procedures can be omitted or postponed to a more appropriate time. Onsite personnel should accompany contaminated victims to the medical facility to advise on the type of contamination. The IH is responsible to see that chemical-type and concentration samples are delivered to Medical as soon as possible in the event of a spill or other accident involving personnel exposure. The medical radiation and chemical decontamination unit is located at the INEL Medical Facility (CF-603) at the Central Facilities Area.

Life-saving care will be instituted immediately without considering decontamination. Outer garments can be removed if they do not cause delay or interfere with treatment or aggravate medical problems. Respiratory equipment must always be removed. Chemical-resistant clothing can be cut away. If the outer contaminated garments cannot be removed, the victim should be wrapped in plastic, rubber, or cloth to help prevent contamination of transporting vehicles or medical personnel. Outer garments can then be removed at the medical facility. The transport vehicle and medical facility may have to be decontaminated.

11. EMERGENCY PROCEDURES, EQUIPMENT, AND INFORMATION

The nature of work at hazardous waste sites makes emergencies a continual possibility, no matter how infrequently they may occur. Emergencies happen quickly and unexpectedly and require immediate response. The following sections describe the procedures to be used during emergency situations, equipment that will be available onsite for emergency situations, and the agencies, facilities, and offsite personnel who will be notified in case of emergency. This emergency response plan will be reviewed periodically to ensure its effectiveness. Locations and telephone numbers of emergency personnel, facilities, and offsite personnel will be posted at the sampling site. The PI will notify emergency facilities by phone and inform emergency personnel that work has commenced at the sampling site, before initial start of activities.

The buddy system is an effective way of ensuring a workers mental and physical well being is monitored during the work day. The buddy system is designed to minimize the possibility of personnel becoming ill or injured and not being noticed. This is particularly crucial for workers in the Exclusion Zone. Pair up workers to check regularly on one another during the day's activities with attention to their alertness, motor functions, and coherence.

11.1 Emergency Procedures

The following standard emergency procedures will be used by onsite personnel. The PI will be notified of any onsite emergencies and will be responsible for ensuring that the appropriate procedures are followed, including a response critique, follow-up, and incident evaluation. All injuries, regardless of how minor, will be reported and recorded in a field log book. All injuries or illnesses deemed reportable, vehicle accidents resulting in damage or losses above $500.00, and property damage occurrences resulting in losses of $1,000.00 or more will be reported on DOE Form 5484X.

The form will be completed and transmitted to EG&G Environment, Safety and Quality Department on or before the 10th of the month following the date of the accident. The SS will conduct an emergency response rehearsal, and will instruct all team members on the use of the employee alarm system and evacuation accounting procedure (see Section 11.1.1).

Emergency procedure outlines below are designed to give the field team instruction in handling medical emergencies. Medical problems that can occur onsite need to be handled competently and quickly. Each team member must be aware of the following instructions and information:

The telephone number of the CFA Medical Dispensary, (6-2356) and the Ambulance, (6-2211).

Seek immediate professional attention for personnel that are bleeding severally, not breathing, experience intense pain, or are unconscious.

If a team member gets anything (chemical or dust) in his/her eyes, flood them with water for 15 minutes: do not remove objects that are stuck in the eye; always seek medical attention for the eye injuries.

Stop bleeding with direct pressure. Place a bandage over the wound and apply pressure. Use a tourniquet only in extreme cases.

Areas of direct contact with contaminants must be rinsed immediately with water. The affected area must then be washed with soap and water as soon as possible.

11.1.1 Personnel Injury in the Exclusion Zone

Upon notification of an injury in the Exclusion Zone, a continuous blast on a vehicle horn or self-contained air horn will be sounded. All equipment within the Exclusion Zone, if not necessary to respond to the emergency, will be shut down, onsite personnel will transport the injured person to the boundary between the Exclusion Zone and the Support Zone, and all other personnel will assemble at the decontamination line. The PI and/or the IH will evaluate the nature of the injury and the affected person will be decontaminated to the extent possible, in keeping with the instructions in Section 10.4, before movement to the Support Zone. Appropriate first aid will be initiated and, if necessary, contact will be made with the INEL Warning Communication Center by radio for emergency transportation and medical aid. No persons will re-enter the Exclusion Zone until the cause of the injury or symptoms is determined.

11.1.2 Personnel Injury in the Support Zone

Upon notification of an injury in the Support Zone, the PI and/or IH will assess the nature of the injury. If the cause of the injury or loss of the injured person does not affect the performance of site personnel, operations will continue with the administration of appropriate first aid and necessary follow-up, as discussed previously. If the injury increases the risk to other onsite workers, nonessential equipment will be shut down, and all site personnel will move to the decontamination line for further instructions. Activities at the site will not start up again until the added risk is removed or minimized.

11.1.3 Transportation and Follow-Up of Injury

If an injured worker is transported to the medical facility, he/she will be accompanied by at least one other site worker to inform medical personnel of the level of decontamination performed before leaving the work site and to provide specific details as to the nature of the injury.

In the event of contaminant exposure, the same procedures will be followed and affected personnel monitoring devices will be immediately transported to the analytical lab to aid in the appropriate testing and treatment of the injured worker.

11.1.4 Fire/Explosion

In the event of a fire or explosion, evacuate all personnel from the site immediately and notify fire and explosive experts by radio. Keep personnel at a safe distance from the involved area until the situation is remedied and risks have been eliminated.

11.1.5 Personal Protective Equipment Failure

If any site worker experiences a failure or alteration of protective equipment that affects the protection factor, that person and his/her buddy will immediately leave the Exclusion Zone. Re-entry will not be permitted until the equipment has been repaired or replaced.

11.1.6 Other Equipment Failure or Hazardous Material Spill

If any other equipment onsite fails to operate properly, the PI and SS will be notified and they will determine the effect of this failure on continuing operations onsite. If the failure affects the safety of personnel or prevents completion of Technical Work Plan tasks, all personnel will leave the Exclusion Zone until the situation is evaluated and appropriate actions are taken.

In the event of a spill of a hazardous or potentially hazardous material over 2.5 gal, refer to CFA Emergency Action Manual, Spill

Prevention and Control Countermeasures, and report the spill to the ARA Landlord office. This includes spillage of petroleum products, decontamination solutions, calibration material, and equipment fuels.

11.1.7 Hand Signals

Hand signals and the buddy system will be used if an emergency situation should arise and normal communication becomes impossible or unsafe. The following hand signals will be used in an emergency:

Hand gripping throat - out of air, can't breathe

Grip partner's wrist or both hands around waist - leave area immediately

Hands on top of head - need assistance

Thumbs up - okay, I'm alright, I understand

Thumbs down - no, negative.

11.1.8 Emergency Escape

In cases of life-threatening emergencies such as fire or explosion, personnel should leave the vicinity using the shortest possible route without regard for decontamination at that time. When the situation has stabilized, personnel will take necessary steps to decontaminate themselves, equipment, and other affected areas.

11.1.9 Operations Shutdown

Operations may be suspended for several reasons:

When an increase of 1000 ppm above background is measured in the breathing zone. High HNu readings may also indicate displacement of oxygen or the presence of a combustible gas. Reevaluation of the situation will be made in conjunction with the IH before reentering the site.

When radiation levels hazardous to personnel are identified by the HP survey at the sampling site.

In addition, sampling, instrumentation, and other weather-sensitive activities may stop during consistent winds greater than 20 mph, gusts of blowing dust, electrical storms, or temperatures below 0°F.

11.1.10 Exclusion Zone Re-entry

In all situations, when an onsite emergency results in evacuation of the Exclusion Zone, personnel will not reenter until:

1. The hazards have been reassessed by the IH and the HP if the hazards are radiological.

2. The conditions resulting in the emergency have been corrected.

3. The Health and Safety Plan has been reviewed.

4. Site personnel have been briefed on any changes in the Health and Safety Plan.

Re-entry into an evacuated zone to monitor or collect potentially hazardous vapors requires minimum Level B protective clothing.

11.2 Emergency Equipment

All emergency equipment will be inspected by the IH for certification and reliability before sampling each day. The following emergency equipment will be available at the work site during field operations:

Fire Extinguishers: Because of the potential threat of fire at hazardous waste sites, at least one 20-lb (minimum) ABC fire extinguisher will be readily available and at hand throughout the sampling activities. The fire extinguisher will be kept with the field team during any subsurface activity.

First-Aid Kits: An industrial first-aid kit with sufficient supplies for five people will be kept in the support area. At least two individuals at the sampling site will be trained and certified in First Aid and CPR.

Eyewash: Two eyewashes and sufficient potable water for copious flushing will be readily available and at hand throughout the investigation. The eyewash units will be kept in the Exclusion Zone at the decontamination station.

Communications: Emergency telephone numbers are included in this plan and will be readily available to any of the field team members. Emergency communication will be discussed in the safety training before initiation of site investigation activities.

Personal Hygiene: A sufficient supply of clean, potable water and hand soap will be provided at the site for the personal hygiene of field team members.

Chemical Spill: Acid and base spill kit material will be available in the event of a chemical spill.

12.0 REFERENCES

EG&G Idaho Inc., Radiation Controls Manual.

EG&G Idaho Inc., EG&G Safety Manual, October 1989.

Levine S. P. and Martin W. F. *Protecting Personnel at Hazardous Waste Sites*. Butterworth Publishers, 1985.

National Institute of Occupational Safety and Health (NIOSH), *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, U.S. Department of Health and Human Services, October 1985.

Science Application International Corporation, "Health and Safety Plan, Task Order No. 7", *Hydrogeologic Characterization Study for CFA Landfills II and III, Idaho National Engineering Laboratory*, December 4, 1987.

Threshold Limit Values and Biological Exposure Indices for 1988-89, American Conference of Governmental Industrial Hygienists, 1988.

U.S. EPA, *Standard Operating Safety Guides*, November 1984.

U.S. EPA, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, October 1988.

U.S. DOE, *The Environmental Survey Manual*, Appendix G, January, 1989.

EMERGENCY AND INFORMATION NUMBERS

EMERGENCY	Office
• Warning Communication Center (WCC)	526-1515
• Medical Advice & Treatment - INEL Bldg. CFA 604 (Kansas Avenue) Dr. Judith Constantino	526-2356
• CFA Dispensary	526-2356
• Ambulance - INEL Bldg. CFA 666 (Nevada Street)	526-2211
• Fire - INEL Bldg. CFA 666 (Nevada Street)	526-2211
• Spills - INEL Bldg. CFA 607	526-2374
• Security - Site Security	526-2321
• Safety Engineering Support:	
- Industrial Hygiene	526-4369
- Explosives Expert Richard Green	526-2702
• HP Office at CFA	526-2284

• Environment, Safety and Quality Jim Snoddy	526-2452
• Environmental Restoration Unit Manager Richard Meservey	526-0513
• Environmental Restoration Waste Area Group Manager W. A. Rhoades	526-8066
• Principal Investigator S. N. Stanisich	526-1256
• ARA Landlord Ken Tuck	526-6056

HEALTH AND SAFETY CERTIFICATION FORM

Project Title: ARA-01 Chemical Pond Sampling and Analysis

Environmental Restoration
Project Manager: W. A. Rhoades

Principal Investigator: S. N. Stanisich

Safety Engineer: J. H. Southwick

I certify that I have been given a copy of the Health and Safety Plan for the ARA-01 Chemical Leach Pond Sampling Project, and agree to comply with the procedures described therein. I further certify that I understand the potential health and safety hazards of the program (as outlined in the Health and Safety Plan) and have been trained in the use of the personal protection equipment selected for this project.

Employee: ____

(Print) (Signature) (Date)

Company of Employment: ______________________________