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SAMPLING AND ANALYSIS PLAN FOR CHARACTERIZATION OF POTENTIAL WASTE SOURCES AT AUXILIARY REACTOR AREA-1 OPERABLE UNIT 5-07 SITES ARA-02 AND ARA-03

S. L. Pickett (MSE)

EG&G Idaho

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

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Sampling and Analysis Plan for Characterization of Potential Waste Sources at Auxiliary Reactor Area-I Operable Unit 5-07 Sites ARA-02 and ARA-03

S. L. Pickett

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MSE, Inc.
381 Shoup Avenue, Suite 201
Idaho Falls, Idaho 83402

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FINAL

Sampling and Analysis Plan for Characterization of Potential Waste Sources at Auxiliary Reactor Area-I Operable Unit 5-07 Sites ARA-02 and ARA-03

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Approved by

R P Wadkins

R. P. Wadkins
Unit Manager
Waste Area Groups 1,4,5,6,10

5/7/92
Date

Reviewed by

R. J. B

R. J. Bargelt
Manager, Waste Area Group 5
Site Remediation Unit

5/6/92
Date

R H Meservey

R. H. Meservey
Area Landlord, Auxiliary Reactor Area and
Unit Manager, Decontamination and
Decommissioning Program

5-7-92
Date

Alvin J. Nelson for J.P. Shea

J. P. Shea
Chairman
Environmental Restoration Department
Independent Review Committee

5/7/92
Date

ABSTRACT

This Sampling and Analysis Plan (SAP) was prepared for the EG&G Idaho, Inc., Environmental Restoration Department, which is undertaking the sampling and analysis of soils and sanitary septic system materials at the Idaho National Engineering Laboratory (INEL) Auxiliary Reactor Area (ARA)-I Operable Unit (OU) 5-07 for a Track 2 investigation of Sites ARA-02 and ARA-03. A Track 2 investigation involves data collection and information summarization. The information is used by the Remedial Project Managers to determine which of the following outcomes of the Track 2 investigation is appropriate: (1) no further action, (2) interim action, or (3) remedial investigation/feasibility study scoping. A separate decision will be made for each site. Based on the evaluation of existing information, it was decided that additional data collection at Site ARA-03 is not necessary. This SAP addresses site-specific aspects of the Track 2 investigation of OU 5-07, including guidance and instructions for the collection and analysis of samples. This SAP outlines quality assurance and quality control methods for field activities and sampling, analytical, and data management aspects of the OU 5-07 Track 2 investigation. This plan was developed to ensure that all environmental data generated for the project are scientifically valid, defensible, comparable, and of known and acceptable precision and accuracy.

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ACRONYMS

AOC	area of contamination
ARA	Auxiliary Reactor Area
ARDC	Administrative Record and Document Control
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
bgs	beneath ground surface
CAU	Compliance Assurance Unit
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	chain of custody
COCA	Consent Order Compliance Agreement
CRDL	contract required detection limits
CRQL	contract required quantification limits
CSF	CERCLA Storage Facility
CSM	conceptual site model
DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy- Idaho Field Office
DOT	U.S. Department of Transportation
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ERD	Environmental Restoration Department
ERIS	Environmental Restoration Information Systems
ERP	Environmental Restoration Program
FFA/CO	Federal Facilities Agreement/Consent Order
FID	flame ionization detector
FR	Federal Register
FSP	field sampling plan
FTL	field team leader
GC/MS	gas chromatography/mass spectrometry

HDPE	high-density polyethylene
HPIL	Health Physics Instrument Laboratory
HPT	health physics technician
HSO	health and safety officer
HSP	health and safety plan
IDHW	Idaho Department of Health and Welfare
ICP	inductively coupled plasma
ICPP	Idaho Chemical Processing Plant
IDL	instrument detection limit
IDW	investigation derived waste
IEDMS	Integrated Environmental Data Management System
IH	industrial hygienist
INEL	Idaho National Engineering Laboratory
JSS	job site supervisor
L&V	limitations and validation
LCS	laboratory control sample
MDL	method detection limit
MS	matrix spikes
NIST	National Institute of Standards and Technology
NM	narrow-mouth
OMP	Occupational Medical Program
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
OVA	organic vapor analyzer
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PD	Program Directive
PID	photoionization detector
PPE	personal protective equipment
QA	quality assurance
QAPjP	quality assurance project plan
QAO	quality assurance objective

QC	quality control
QE	quality engineer
QPP	quality program plan
RCRA	Resource Conservation and Recovery Act
RE	risk evaluation
RI/FS	remedial investigation/feasibility study
RML	Radiation Measurements Laboratory
ROD	Record of Decision
RPD	relative percent difference
RPM	Remedial Project Manager
RRDL	required radiological detection limit
RSD	relative standard deviation
RWMC	Radioactive Waste Management Complex
SAP	Sampling and Analysis Plan
SC	Site Characterization
SMO	Sample Management Office
SOP	standard operating procedures
SOW	Statement of Work
SRM	standard reference material
SVOC	semivolatile organic compound
TAA	temporary accumulation area
TAL	target analyte list
TBD	to be determined
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TSDF	treatment, storage, and disposal facility
USGS	U.S. Geologic Survey
UST	underground storage tank
VOA	volatile organic analysis
VOC	volatile organic compound
WAG	Waste Area Group

Sampling and Analysis Plan for Characterization of Potential Waste Sources at Auxiliary Reactor Area-I
Operable Unit 5-07
Sites ARA-02 and ARA-03

1. INTRODUCTION

This Sampling and Analysis Plan (SAP) was prepared for the EG&G Idaho, Inc., Environmental Restoration Department (ERD), which is undertaking the sampling and analysis of soils and sanitary septic system materials at the Idaho National Engineering Laboratory (INEL) Auxiliary Reactor Area (ARA)-I Operable Unit (OU) 5-07 for a Track 2 investigation. In accordance with the Action Plan of the INEL Federal Facilities Agreement/Consent Order (FFA/CO), a Track 2 investigation is required for OU 5-07 and will be conducted under guidance established in the INEL FFA/CO Action Plan. The FFA/CO Action Plan established a procedural framework for response actions in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The oversight of this work will be a cooperative effort between the U.S. Department of Energy (DOE), Idaho Field Office (DOE-ID); U.S. Environmental Protection Agency (EPA), Region X; and the State of Idaho, Department of Health and Welfare (IDHW). Under CERCLA and Executive Order 12580, DOE is responsible for the performance of the work, with EPA and State of Idaho oversight. EG&G Idaho, Inc., will perform the work under contract from DOE.

The INEL is divided into 10 Waste Area Groups (WAGs) to facilitate environmental remediation efforts; WAGs 1 through 9 generally correspond to INEL operational facilities. The ARA and the Power Burst Facility have been designated as WAG-5. The WAGs have been further divided into Operable Units (OUs). OU 5-07 consists of two sites: Site ARA-02, a sanitary septic system consisting of three septic tanks, a seepage pit, and associated piping; and Site ARA-03, an area of radiologically-contaminated surface and shallow subsurface soil. A map of the INEL showing the location of the ARA facilities is presented as Figure 1-1. Figure 1-2 is a map showing the location of the ARA-I facility in relation to the other ARA facilities. A diagram of the ARA-I facility showing the ARA-02 sanitary septic system and source buildings and the general location of Site ARA-03 is presented as Figure 1-3.

The objective of a Track 2 investigation is to obtain sufficient valid field data through a sampling program to determine the risks posed by contaminants. This Track 2 investigation will address whether the types and concentrations of contaminants present at Sites ARA-02 and ARA-03 exceed risk-based levels of concern and will better qualify the source terms and potential contaminant pathways. The *Track 2 Guidance Document* (to be prepared) will be used to formalize the existing Track 1 qualitative data evaluation and to conduct a more quantitative risk evaluation. Track 2 investigation results will be incorporated into the OU 5-07 *Track 2 Scoping Summary Report*, presenting the current understanding

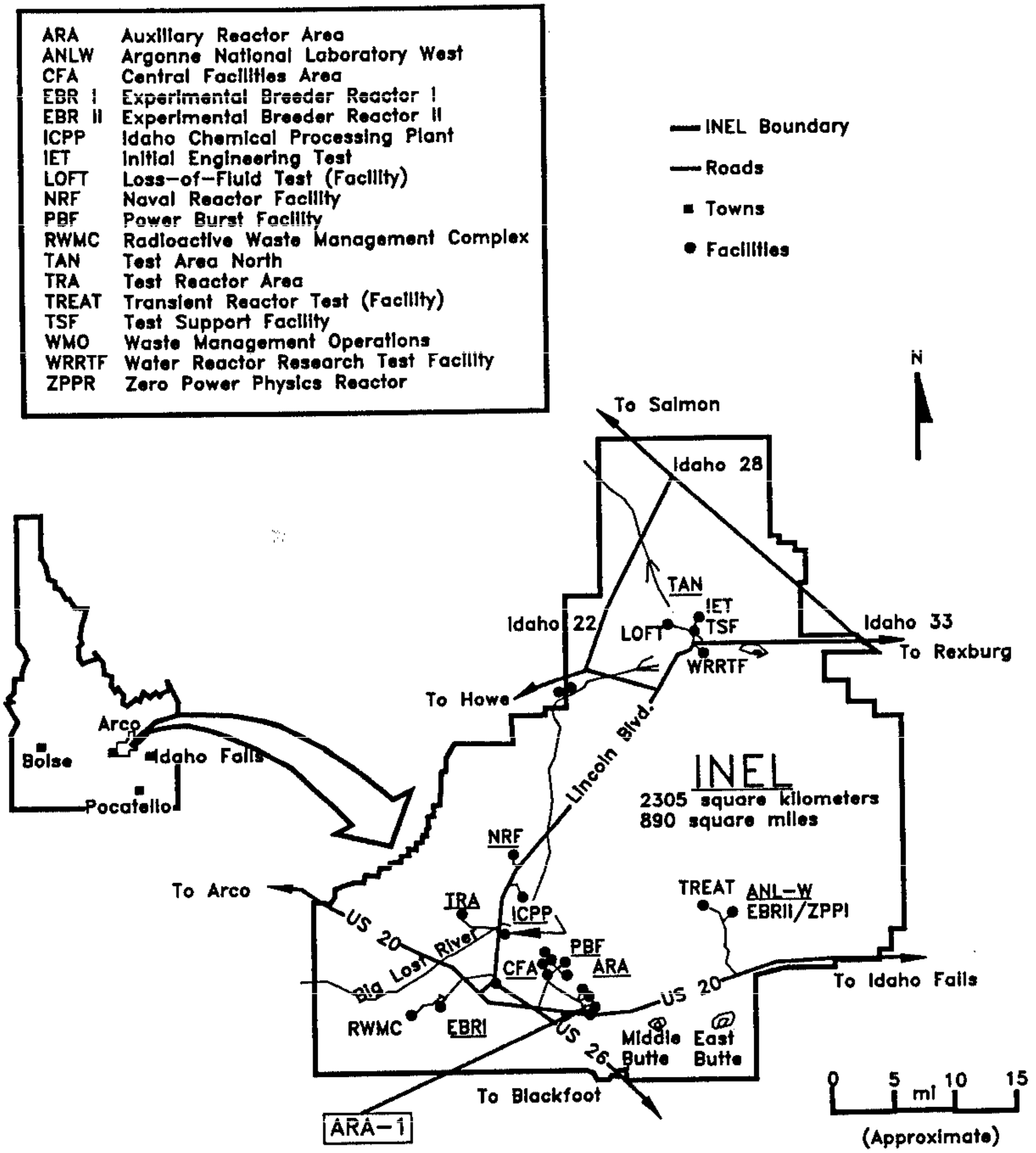

Figure 1-1. Location of the ARA facilities at the INEL.

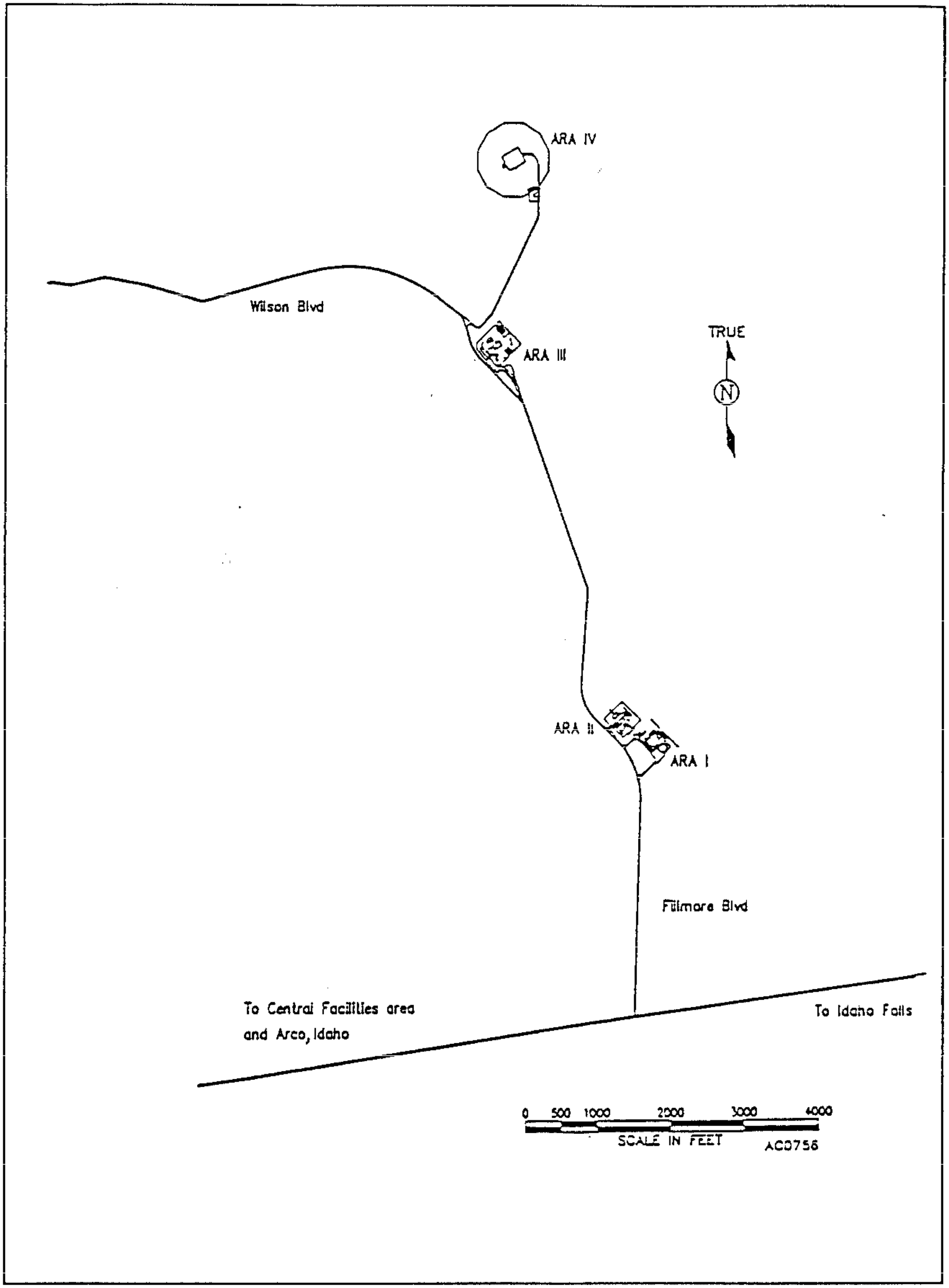

Figure 1-2. Relative locations of the four ARA facilities.

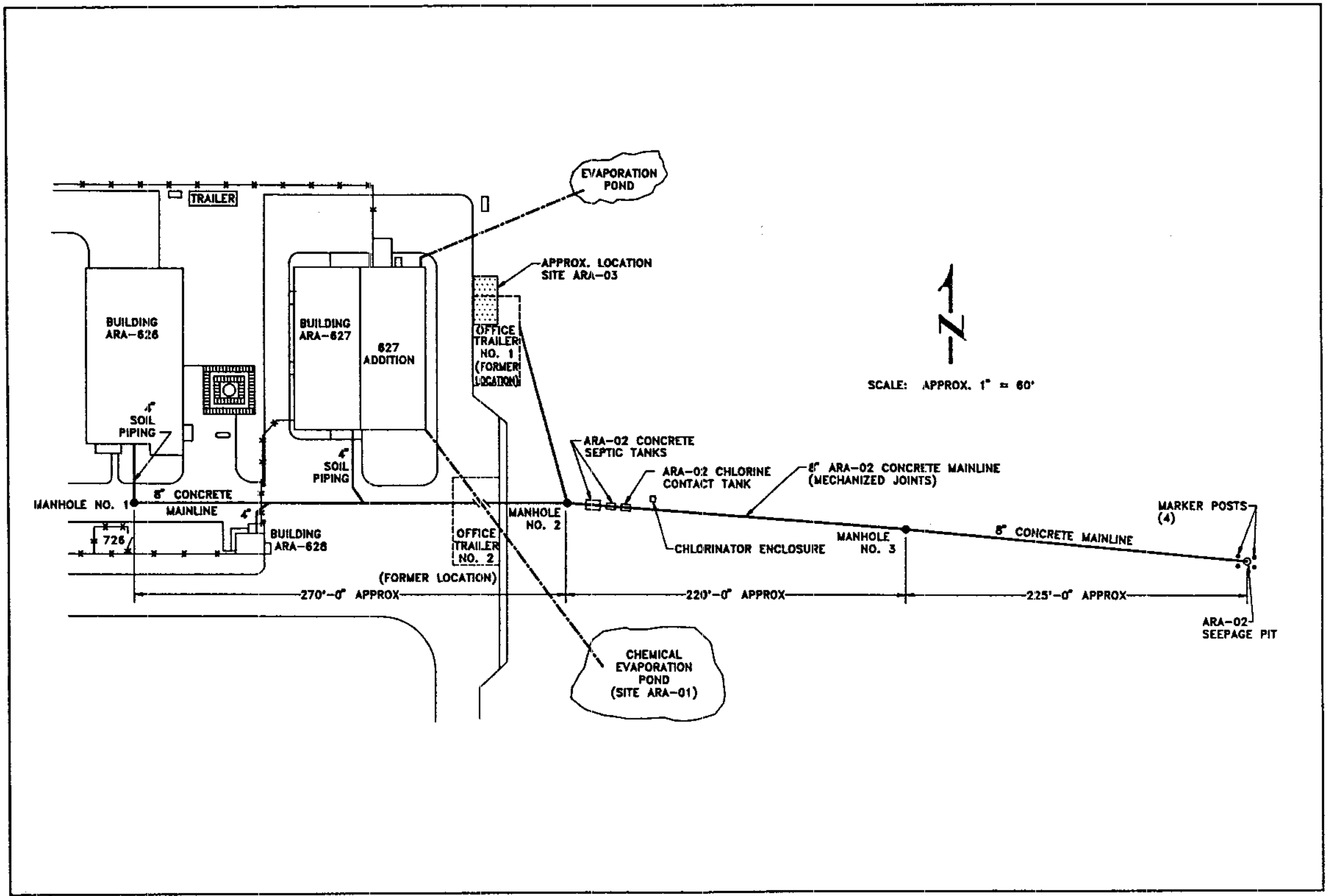

Figure 1-3. Diagram of the ARA-I facility showing the locations of the ARA-02 sanitary septic system, source buildings, and Site ARA-03.

of conditions at OU 5-07. The Remedial Project Managers (RPMs) will then determine whether an unacceptable risk to the public health and welfare, and/or the environment exists. A decision will be made by the RPMs as to which of the following outcomes of the Track 2 investigation is appropriate: (1) recommending that no further action be taken, (2) remediating the site as an interim action, or (3) proceeding through the remedial investigation/feasibility study (RI/FS) process to a final action. A separate decision will be made for each site. If the risk estimate for the assumed exposure scenarios is less than the level of acceptable risk for the OU, no further action will be required. Otherwise, an interim action or RI/FS scoping will be recommended. As a further precaution that contaminants will not remain at either site at levels presenting an unacceptable risk to human health and/or the environment, a WAG-wide RI will be prepared that will effectively act as a "safety net" to allow all earlier decisions to be revisited and reassessed.

The Scope of Work prepared for the ARA-I OU 5-07 Track 2 Investigation is included as Appendix A. As part of the OU 5-07 Track 2 investigation, Site ARA-02 will be sampled under the guidance of this SAP. Additional data collection from Site ARA-03 is not necessary; existing characterization data and process knowledge are sufficient to enable a decision to be made as to the preferred future site action alternative. A quantitative risk evaluation will be conducted and a summary of existing information will be evaluated formally using the methodology from the *Track 2 Guidance Document* (to be published).

This SAP addresses site-specific aspects of the Track 2 investigation of OU 5-07 and was developed to ensure all environmental data generated for the project are scientifically valid, defensible, comparable, and of known and acceptable precision and accuracy. This SAP outlines quality assurance (QA) and quality control (QC) methods for field activities and sampling, analytical, and data management aspects of the investigation. The SAP consists of three parts: an introduction (Section 1), a quality assurance project plan (QAPjP) (Section 2), and a field sampling plan (FSP) (Section 3). The introduction discusses SAP content and the regulatory framework for this project. The QAPjP outlines QA and QC procedures for analytical work and data management. The FSP discusses past characterization efforts of Sites ARA-02 and ARA-03, potential pathways and exposure scenarios, qualitative risk evaluation results as determined using Track 1 guidance, objectives of the Track 2 field investigation, rationale for why and where samples will be collected, numbers of samples, and methodology to be followed during the field program portion of the investigation.

This SAP has been prepared in accordance with the requirements of the INEL FFA/CO Action Plan, CERCLA, and ERD Program Directive (PD) 5.2, "Preparation of Sampling and Analysis Plans." This SAP specifically supports activities to be conducted at ARA-I OU 5-07. It has been prepared in accordance with content requirements of the EPA *Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA* (EPA 1988a) and *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (EPA 1980a).

A *Task Specific Health and Safety Plan: Characterization of Potential Waste Sources at Operable Unit 5-07 Sites ARA-02 and ARA-03* (EG&G 1992a), hereafter referred to as the "Task Specific Health and Safety Plan (HSP)," was prepared as a companion document to this SAP and ensures compliance with Occupational Safety and Health Administration (OSHA), EPA, State of Idaho, and local regulations applicable to the scope of work outlined in this SAP. Apparent hazards and concerns associated with existing waste types, hazard assessment, health and safety considerations, decontamination and disposal procedures, and emergency response procedures are addressed within the HSP. The Task Specific HSP is an addendum to the *Health and Safety Plan for Operations Performed for the Environmental Restoration Program* (Morton 1991).

2. QUALITY ASSURANCE PROJECT PLAN

The QAPjP is written documentation of procedures that ensure the precision, accuracy, representativeness, completeness, and comparability (PARCC) of data generated during this Track 2 investigation of OU 5-07. The QAPjP is used by field, laboratory, and management personnel in all aspects of data collection, management, and control whether onsite or offsite. The QAPjP was prepared using EPA guidelines, including *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (EPA 1980a), and in accordance with the *Quality Program Plan for the Environmental Restoration Department* (EG&G 1991a), hereafter referred to as ERD QPP-149. The QAPjP also addresses requirements set forth in 40 CFR 30, including procedures to ensure the quality of soil, sludge/solid, and liquid samples collected during the OU 5-07 field investigation.

The usability of the data collected during this investigation depends on the data quality. A number of factors relate to the quality of data, and sample collection methods are as important to consider as methods used for sample analysis. Following EPA-approved standard operating procedures (SOPs) for sample collection and analysis reduces sampling and analytical error. Complete chain-of-custody (COC) documentation, adherence to required sample preservation techniques and holding times, and proper shipment methods ensure sample integrity.

Obtaining valid and comparable data also requires adequate QA/QC procedures and documentation, as well as meeting established detection and control limits. QA/QC sample generation, instrument calibration, QA objectives, internal QC checks, audits, preventive maintenance, measurement of PARCC, corrective actions, and QA reporting are also presented in this QAPjP.

It should be noted that analytical laboratories have not yet been contracted to perform analysis of chemical or radiological parameters on OU 5-07 samples. The contracted laboratories shall be selected from a list of ERD-approved laboratories; one or more analytical laboratories may be used. The following must be considered before selection of a laboratory: the data quality objectives (DQOs) of the task, the lab's certification, and the lab's acceptance criteria regarding the radioactive content of the samples. As part of the QA/QC program, each laboratory must be audited and approved by the Sample Management Office (SMO) prior to use to evaluate the laboratory's analytical procedures, calibration, and QA/QC program. The laboratory selected to perform chemical analyses will meet the most recent Contract Laboratory Program (CLP) Statement of Works (SOWs) to produce a data package that, if necessary, can be validated to produce Analytical Level IV data. Similarly, the selected radiological laboratory will deliver a data package sufficient to produce Analytical Level IV data. Analytical levels required by this project are discussed in Section 2.3.9, while data validation is discussed in Section 2.8. The CLP SOWs and the SOW written by the SMO to obtain laboratory services ensure that the selected laboratory will maintain QA documentation and will meet the method detection limits specified in the CLP SOWs, at a minimum. The SOW written to obtain laboratory services for radiological analyses will cover radiological screening requirements prior to shipment of samples to the laboratory. Section 3.6.6

discusses radiological screening of samples and packaging and transportation requirements for samples containing radiological contaminants.

2.1 Project Description

The OU 5-07 Track 2 investigation is being performed in accordance with the INEL FFA/CO Action Plan, as described in Section 1. A Track 2 investigation involves data collection and information summarization. The information is used by the RPMs to make a decision as to which of the following outcomes of the Track 2 investigation is appropriate for each of the sites at OU5-07: (1) no further action, (2) interim action, or (3) RI/FS scoping. A discussion of OU 5-07, including background and history, environmental setting, and past field screening and sampling results is included in Section 3.1. Also presented in Section 3.1 is a discussion on the conceptual model developed for Sites ARA-02 and ARA-03 and Track 1 qualitative risk evaluation results. DQOs for this investigation are discussed in Section 3.2. The rationale behind the data collection program is included as Section 3.3, while sampling methodology, including specific equipment and procedures to be used, is addressed in Section 3.5.

2.2 Project Organization and Responsibility

Table 2-1 is a list of key project personnel and their corresponding responsibilities. Figure 2-1 presents the project organizational chart for the Track 2 investigation of OU 5-07. Figure 2-2 (discussed in Section 2.5) is a flowchart depicting the ERD document control process. Specific training requirements for selected field personnel are presented in the Task Specific HSP (EG&G 1992a). The project team has been selected to provide the specific technical and management capabilities and qualifications required by the task.

2.3 Quality Assurance Objectives for Measurement Data

DQOs are qualitative and quantitative statements developed by data users to specify the quality of data from field and laboratory data collection activities that must be met to achieve project objectives and to support specific decisions or regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used to address the problem being investigated. DQOs and sampling rationale are discussed in Section 3.2 of the FSP.

The objective of this QAPjP is to ensure the information collected for decision-making during the OU 5-07 Track 2 investigation is of adequate quality, statistically accurate, and properly documented. These elements are essential for the enforcement proceedings that may arise from the CERCLA activities. QA is a management system for ensuring that all information, data, and decisions are technically sound and properly documented. QC is the mechanism by which the QA system is put into practice. This will consist of tests of the system whose quality is in question, using known standards. Specific QC procedures related to sampling, analysis, and engineering calculations will ensure that the acquired data

Table 2-1. Key project personnel and corresponding responsibilities.

Responsibility	Personnel
Project Requester	R. J. Bargelt
Project Manager	R. J. Bargelt
Waste Area Group 5 Manager	R. J. Bargelt
ARA Area Landlord	R. H. Meservey
Job Site Supervisor (JSS)	S. L. Pickett (MSE, Inc.)
Field Team Leader (FTL)	S. L. Pickett (MSE, Inc.)
Health Physics Technician (HPT)	Central Facilities Area (CFA) HPT
Radiological Engineer	Compliance Assurance Unit (CAU) Radiological Engineer
Industrial Hygiene (IH)	CAU IH
Health and Safety Officer (HSO)	CAU IH
Sampling Team	MSE, Inc., Butte, MT
Quality Engineer (QE)	V. W. Watson
Occupational Medical Program (OMP)	P. N. Creighton
Laboratory Analysis	ERD-approved contracted laboratory
Radiological Analysis	Radiation Measurements Laboratory (RML) for gamma spectroscopy; ERD-approved contracted laboratory for alpha spectroscopy and Strontium-90 analysis
Data Validation	ERD SMO
Data Evaluation	MSE, Inc., Butte, MT
Data Storage	D. J. Yurman, Environmental Restoration Information Systems (ERIS) database

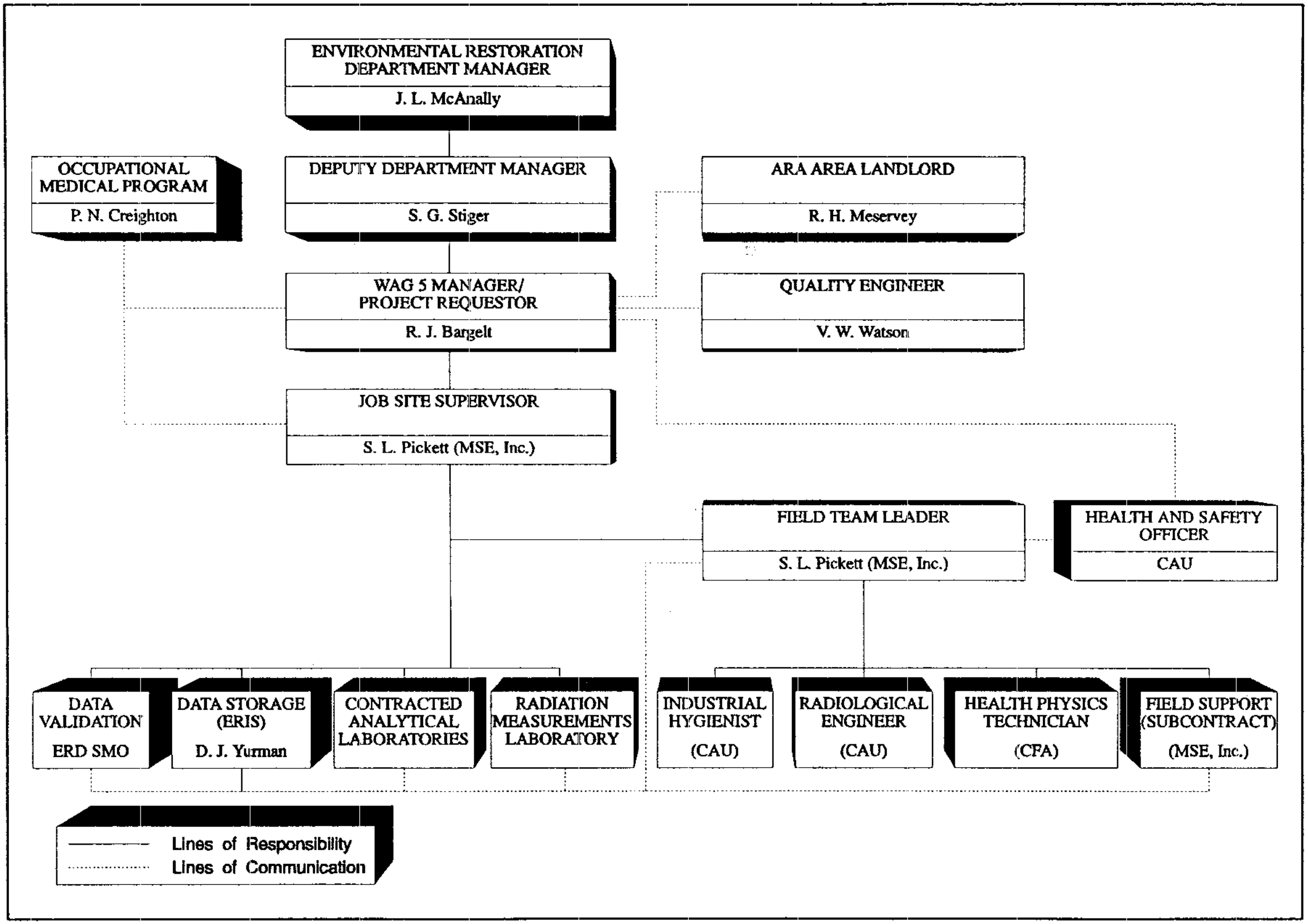

Figure 2-1. OU 5-07 Track 2 investigation organizational chart.

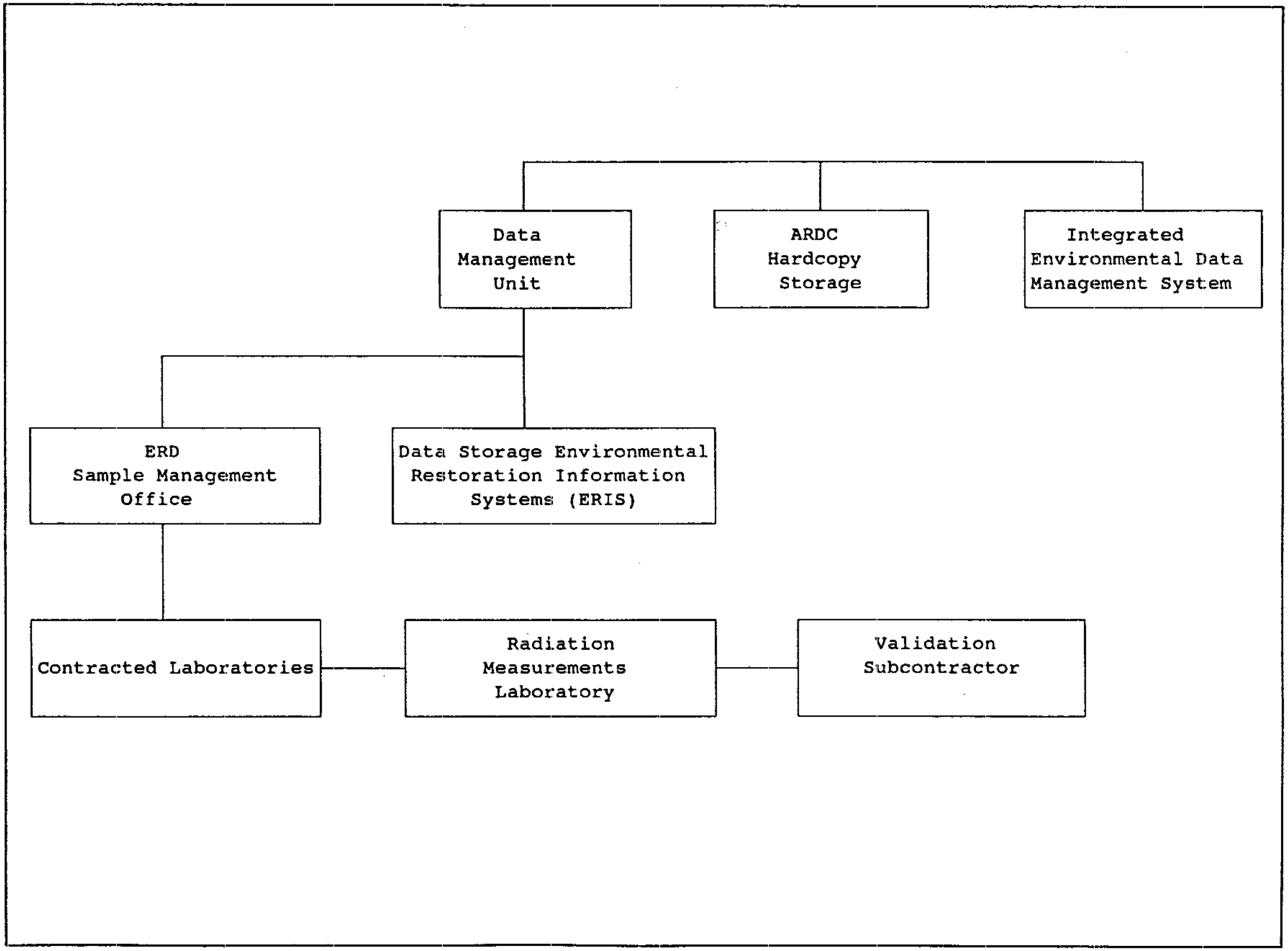

Figure 2-2. Environmental Restoration Department document control process.

is appropriate for Track 2 risk evaluation and decision-making use. The quality assurance objectives (QAOs) and QA/QC requirements for this project follow those detailed in ERD QPP-149 (EG&G 1991a). QAOs are specifications that measurements must meet to achieve project objectives. The technical and statistical quality of these measurements are required to be properly documented. Precision, accuracy, method detection limits, completeness, and sample size must be described qualitatively in terms of representativeness and comparability. QAOs are needed for all critical measurements and for each type of sample matrix. A discussion of whether the DQOs of the project have been met and the impacts on the decision process will be included in the *OU 5-07 Track 2 Scoping Summary Report* (to be prepared upon receipt of validated data).

The quantitative QA parameters are precision, accuracy, detection limit, completeness, and sample size. Precision, accuracy, and method detection limit goals are presented in Table 2-2 (CLP Volatile Organic Target Compound List), Table 2-3 (CLP Semivolatile Organic Target Compound List), Table 2-4 (CLP Pesticide Organic Target Compound List), Table 2-5 (CLP Inorganic Target Analyte List), and Table 2-6 (ERD Radionuclide Target Isotope List). The qualitative QA parameters are comparability and representativeness. Analytical Level III and IV data are required to meet project DQOs. A discussion of quantitative and qualitative QA parameters and analytical levels is presented in the following subsections.

2.3.1 Precision

Precision is a measurement of the reproducibility of a measurement under a given set of conditions. Precision is stated in terms of the relative percent difference (RPD) for two measurements (or observations) or the relative standard deviation (RSD) for three or more measurements (or observations). The formulas for calculating RPD and RSD are presented in Section 2.12.

2.3.1.1 Laboratory Precision. Laboratory precision will be calculated as defined in Section 2.12. For organic analytes, precision will be within the limits set in the CLP *Statement of Work for Organics Analysis — Multi-Media, Multi-Concentration* (EPA 1990a) (commonly known as the "CLP SOW for Organics") and are listed in the RPD columns of Tables 2-2 through 2-4. Precision goals have been established for inorganic analyses in the CLP *Statement of Work for Inorganic Analysis — Multi-Media, Multi-Concentration* (EPA 1990b) (commonly known as the "CLP SOW for Inorganics") and for radiological analyses as specified in the ERD SMO SOP 12.1.2, "Radiological Data Validation." Radiological laboratory precision is discussed further in Section 2.3.3.

2.3.1.2 Field Precision. Field precision is a measure of the variability not due to laboratory or analytical methods, and includes components of within-sample, between-sample, and spatial variability. The between-sample heterogeneity can be evaluated individually using duplicate samples. For purposes of this Track 2 investigation, overall field precision will be calculated. Because of the varied sample media (soil, sludge/solid, and liquid samples) to be collected, no field precision statements will be

Table 2-2. CLP volatile organic target compound list.

Compound	CAS Number	CRQL			QC Limits			
		Water (μg/L)	Low Soil (μg/kg)	Med Soil (μg/kg)	Water %Rec	Water RPD	Soil %Rec	Soil RPD
Chloromethane	74-87-3	10	10	1200	—	—	—	—
Bromomethane	74-83-9	10	10	1200	—	—	—	—
Vinyl Chloride	75-01-4	10	10	1200	—	—	—	—
Chloroethane	75-00-3	10	10	1200	—	—	—	—
Methylene Chloride	75-09-2	10	10	1200	—	—	—	—
Acetone	67-64-1	10	10	1200	—	—	—	—
Carbon Disulfide	75-15-0	10	10	1200	—	—	—	—
1,1-Dichloroethene	75-35-4	10	10	1200	61-145	14	59-172	22
1,1-Dichloroethane	75-34-3	10	10	1200	—	—	—	—
1,2-Dichloroethene (total)	540-59-0	10	10	1200	—	—	—	—
Chloroform	67-66-3	10	10	1200	—	—	—	—
1,2-Dichloroethane	107-06-2	10	10	1200	—	—	—	—
2-Butanone	78-93-3	10	10	1200	—	—	—	—
1,1,1-Trichloroethane	71-55-6	10	10	1200	—	—	—	—
Carbon Tetrachloride	56-23-5	10	10	1200	—	—	—	—
Bromodichloromethane	75-27-4	10	10	1200	—	—	—	—
1,2-Dichloropropane	78-87-5	10	10	1200	—	—	—	—
cis-1,3-Dichloropropene	10061-01-5	10	10	1200	—	—	—	—
Trichloroethene	79-01-6	10	10	1200	71-120	14	62-137	24
Dibromochloromethane	124-48-1	10	10	1200	—	—	—	—
1,1,2-Trichloroethane	79-00-5	10	10	1200	—	—	—	—
Benzene	71-43-2	10	10	1200	76-127	11	66-142	21
trans-1,3-Dichloropropene	10061-02-6	10	10	1200	—	—	—	—
Bromoform	75-25-2	10	10	1200	—	—	—	—
4,Methyl-2-Pentanone	108-10-1	10	10	1200	—	—	—	—
2-Hexanone	591-78-6	10	10	1200	—	—	—	—
Tetrachloroethene	127-18-4	10	10	1200	—	—	—	—
1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200	—	—	—	—
Toluene	108-88-3	10	10	1200	76-125	13	59-139	21
Chlorobenzene	108-90-7	10	10	1200	75-130	13	60-133	21
Ethylbenzene	100-41-4	10	10	1200	—	—	—	—
Styrene	100-42-5	10	10	1200	—	—	—	—
Xylene (total)	1330-20-7	10	10	1200	—	—	—	—

Table 2-3. CLP semivolatile organic target compound list.

		CRQL			QC Limits			
Compound	CAS Number	Water (µg/L)	Low Soil (µg/kg)	Med Soil (µg/kg)	Water %Rec	Water RPD	Soil %Rec	Soil RPD
Phenol	108-95-2	10	330	10000	12-110	42	26-90	35
bis(2-Chloroethyl)ether	111-44-4	10	330	10000	—	—	—	—
2-Chlorophenol	95-57-8	10	330	10000	27-123	40	25-102	50
1,3-Dichlorobenzene	541-73-1	10	330	10000	—	—	—	—
1,4-Dichlorobenzene	106-46-7	10	330	10000	36-97	28	28-104	27
1,2-Dichlorobenzene	95-50-1	10	330	10000	—	—	—	—
2-Methylphenol	95-48-7	10	330	10000	—	—	—	—
2,2'oxybis(1-Chloropropane)	108-60-1	10	330	10000	—	—	—	—
4-Methylphenol	106-44-5	10	330	10000	—	—	—	—
N-Nitroso-di-n-propylamine	621-64-7	10	330	10000	41-116	38	41-126	38
Hexachloroethane	67-72-1	10	330	10000	—	—	—	—
Nitrobenzene	98-95-3	10	330	10000	—	—	—	—
Isophorone	78-59-1	10	330	10000	—	—	—	—
2-Nitrophenol	88-75-5	10	330	10000	—	—	—	—
2,4-Dimethylphenol	105-67-9	10	330	10000	—	—	—	—
bis(2-Chloroethoxy)methane	111-91-1	10	330	10000	—	—	—	—
2,4-Dichlorophenol	120-83-2	10	330	10000	—	—	—	—
1,2,4-Trichlorobenzene	120-82-1	10	330	10000	39-98	28	38-107	23
Naphthalene	91-20-3	10	330	10000	—	—	—	—
4-Chloroaniline	106-47-8	10	330	10000	—	—	—	—
Hexachlorobutadiene	87-68-3	10	330	10000	—	—	—	—
4-Chloro-3-methylphenol	59-50-7	10	330	10000	23-97	42	26-103	33
2-Methylnaphthalene	91-57-6	10	330	10000	—	—	—	—
Hexachlorocyclopentadiene	77-47-4	10	330	10000	—	—	—	—
2,4,6-Trichlorophenol	88-06-2	10	330	10000	—	—	—	—
2,4,5-Trichlorophenol	95-95-4	50	1700	50000	—	—	—	—
2-Chloronaphthalene	91-58-7	10	330	10000	—	—	—	—
2-Nitroaniline	88-74-4	50	1700	50000	—	—	—	—
Dimethylphthalate	131-11-3	10	330	10000	—	—	—	—
Acenaphthylene	208-96-8	10	330	10000	—	—	—	—
2,6-Dinitrotoluene	606-20-2	10	330	10000	—	—	—	—
3-Nitroaniline	99-09-2	50	1700	50000	—	—	—	—
Acenaphthene	83-32-9	10	330	10000	46-118	31	31-137	19

Table 2-3. (continued).

Compound	CAS Number	CRQL			QC Limits			
		Water (μg/L)	Low Soil (μg/kg)	Med Soil (μg/kg)	Water %Rec	Water RPD	Soil %Rec	Soil RPD
2,4-Dinitrophenol	51-28-5	50	1700	50000	—	—	—	—
4-Nitrophenol	100-02-7	50	1700	50000	10-80	50	11-114	50
Dibenzofuran	132-64-9	10	330	10000	—	—	—	—
2,4-Dinitrotoluene	121-14-2	10	330	10000	24-96	38	28-89	47
Diethylphthalate	84-66-2	10	330	10000	—	—	—	—
4-Chlorophenyl-phenylether	7005-72-3	10	330	10000	—	—	—	—
Fluorene	86-73-7	10	330	10000	—	—	—	—
4-Nitroanaline	100-01-6	50	1700	50000	—	—	—	—
4,6-Dinitro-2-methylphenol	534-52-1	50	1700	50000	—	—	—	—
N-Nitrosodiphenylamine	86-30-6	10	330	10000	—	—	—	—
4-Bromophenyl-phenylether	101-55-3	10	330	10000	—	—	—	—
Hexachlorobenzene	118-74-1	10	330	10000	—	—	—	—
Pentachlorophenol	87-86-5	50	1700	50000	9-103	50	17-109	47
Phenanthrene	85-01-8	10	330	10000	—	—	—	—
Anthracene	120-12-7	10	330	10000	—	—	—	—
Carbazole	86-74-8	10	330	10000	—	—	—	—
Di-n-butylphthalate	84-74-2	10	330	10000	—	—	—	—
Fluoranthene	206-44-0	10	330	10000	—	—	—	—
Pyrene	129-00-0	10	330	10000	26-127	31	35-142	36
Butylbenzylphthalate	85-68-7	10	330	10000	—	—	—	—
3,3'-Dichlorobenzidine	91-94-1	10	330	10000	—	—	—	—
Benzo(a)anthracene	56-55-3	10	330	10000	—	—	—	—
Chrysene	218-01-9	10	330	10000	—	—	—	—
bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10000	—	—	—	—
Di-n-octylphthalate	117-84-0	10	330	10000	—	—	—	—
Benzo(b)fluoranthene	205-99-2	10	330	10000	—	—	—	—
Benzo(k)fluoranthene	207-08-9	10	330	10000	—	—	—	—
Benzo(a)pyrene	50-32-8	10	330	10000	—	—	—	—
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000	—	—	—	—
Dibenz(a,h)anthracene	53-70-3	10	330	10000	—	—	—	—
Benzo(g,h,i)perylene	191-24-2	10	330	10000	—	—	—	—

Table 2-4. CLP pesticide organic target compound list.

Compound	CAS Number	CRQL		QC Limits			
		Water (µg/L)	Soil (µg/kg)	Water %Rec	Water RPD	Soil %Rec	Soil RPD
alpha-BHC	319-84-6	0.05	1.7	—	—	—	—
beta-BHC	319-85-7	0.05	1.7	—	—	—	—
delta-BHC	319-86-8	0.05	1.7	—	—	—	—
gamma-BHC (Lindane)	58-89-9	0.05	1.7	56-123	15	46-127	50
Heptachlor	76-44-8	0.05	1.7	40-131	20	35-130	31
Aldrin	309-00-2	0.05	1.7	40-120	22	34-132	43
Heptachlor epoxide	1024-57-3	0.05	1.7	—	—	—	—
Endosulfan I	959-98-8	0.05	1.7	—	—	—	—
Dieldrin	60-57-1	0.10	3.3	52-126	18	31-134	38
4,4'-DDE	72-55-9	0.10	3.3	—	—	—	—
Endrin	72-20-8	0.10	3.3	56-121	21	42-139	45
Endosulfan II	33213-65-9	0.10	3.3	—	—	—	—
4,4'-DDD	72-54-8	0.10	3.3	—	—	—	—
Endosulfan sulfate	1031-07-8	0.10	3.3	—	—	—	—
4,4'-DDT	50-29-3	0.10	3.3	38-127	27	23-134	50
Methyloxychlor	72-43-5	0.50	17.0	—	—	—	—
Endrin ketone	53494-70-5	0.10	3.3	—	—	—	—
Endrin aldehyde	7421-36-3	0.10	3.3	—	—	—	—
alpha-Chlordane	5103-71-9	0.05	1.7	—	—	—	—
gamma-Chlordane	5103-74-2	0.05	1.7	—	—	—	—
Toxaphene	8001-35-2	5.0	170.0	—	—	—	—
Aroclor-1016	12674-11-2	1.0	33.0	—	—	—	—
Aroclor-1221	11104-28-2	1.0	33.0	—	—	—	—
Aroclor-1232	11141-16-5	2.0	67.0	—	—	—	—
Aroclor-1242	53469-21-6	1.0	33.0	—	—	—	—
Aroclor-1248	12672-29-6	1.0	33.0	—	—	—	—
Aroclor-1254	11097-69-1	1.0	33.0	—	—	—	—
Aroclor-1260	11096-82-5	1.0	33.0	—	—	—	—

Table 2-5. CLP inorganic target analyte list.

Analyte	CAS Number	CRDL (μg/L)
Aluminum	7429-90-5	200
Antimony	7440-36-0	60
Arsenic	7440-38-2	10
Barium	7440-39-3	200
Beryllium	7440-41-7	5
Cadmium	7440-43-9	5
Calcium	7440-70-2	5000
Chromium	7440-50-8	10
Cobalt	7440-48-4	50
Copper	7440-50-8	25
Iron	7439-89-6	100
Lead	7439-92-1	3
Magnesium	7439-95-4	5000
Manganese	7439-96-5	15
Mercury	7439-97-6	0.2
Nickel	7440-02-0	40
Potassium	7440-09-7	5000
Selenium	7782-49-2	5
Silver	7440-22-4	10
Sodium	7440-23-5	5000
Thallium	7440-28-0	10
Vanadium	7440-62-2	50
Zinc	7440-66-6	20
Cyanide	—	10

Table 2-6. ERD radionuclide target isotope list.

Isotope	Emission	Detection Limits	
		Soil	Water
H-3	β	—	400
Mn-54	γ	—	—
Co-60	γ	—	—
Zn-65	γ	—	—
Sr-90	β	0.5	1
Ru-106	γ	—	—
Ag-108m	γ	—	—
Ag-110m	γ	—	—
Sb-125	γ	—	—
Cs-134	γ	—	—
Cs-137[a]	γ	1	10
Ce-144	γ	—	—
Eu-152	γ	—	—
Eu-154	γ	—	—
Th-228	α	0.5	0.05
Th-230	α	0.5	0.05
Th-232	α	0.5	0.05
U-232	α	0.5	0.05
U-235	γ	0.5	0.05
U-238	α	0.5	0.05
Pu-238	α	0.05	0.2
Pu-239/240	α	0.05	0.2
Am-241	α/γ	0.05	0.2
Cm-242	α	—	—
Cm-244	α	—	—
gross α	α	10	4
gross β	β	10	4

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[a] All γ isotopes shall have a detection limit commensurate with its photon yield and energy as related to the Cs-137 detection limit.

produced at this time. Field precision will be evaluated at the end of the project upon receipt of validated data. Field precision will be calculated as the RPD and RSD of field duplicates as defined in Section 2.12 and will be evaluated and compared to EPA minimum acceptable levels.

2.3.2 Accuracy

Accuracy reflects the degree to which the measured value represents the actual or "true" value for a given parameter (the bias in a measurement system); it is difficult to measure for the entire data collection activity. Accuracy of data obtained is a function of the sampling technique and of the laboratory's analytical capabilities. Laboratory QA/QC samples will be analyzed as required by the SMO SOW submitted to obtain analytical services. The formulas for calculating accuracy are presented in Section 2.12.

2.3.2.1 Laboratory Accuracy. Sources of laboratory accuracy error are handling, sample matrix, sample preparation, and analysis techniques. Analytical accuracy may be assessed through the use of percent recovery information on known and/or blind QC samples and matrix spikes (MS). Tables 2-2 through 2-4 reflect the MS percent recovery control limits for organic analyses, as defined by the CLP SOW for Organics (EPA 1990a). The MS recovery (i.e., laboratory accuracy for organic analyses) must be within these control limits. For volatile organic compounds (VOCs), the trip and field blanks will also be used to assess the laboratory accuracy.

Laboratory accuracy for inorganic analyses shall be assessed through the use of laboratory control samples and/or single blind control samples and MS. The established control limits are as follows: spike recovery within 25% and laboratory control sample within 20% or within the certified limits as the case would be with a standard reference material or solid control sample.

For radiological analysis, accuracy shall be assessed through the use of percent recovery data from spiked blanks (laboratory control data) and the uncertainty limits established on a per sample basis as discussed in Section 2.3.3. In radiological analyses, a laboratory control sample (LCS) is used to measure the accuracy of the analysis per ERD SMO SOP 12.1.2, "Radiological Data Validation."

2.3.2.2 Field Accuracy. Field accuracy errors result from the sample preservation and handling, field contamination, and heterogeneities in the sample matrix. Sampling accuracy may be assessed by evaluating the results of field and trip blanks. During sampling for VOCs, some portion of the volatile components may be lost. There is no easy way to measure this loss, although EPA-approved sampling methods will be used to minimize this loss. Contamination of the samples would yield inaccurate results. Equipment (rinsate), trip, and field blanks will be sent to the chemical and radiological laboratories for analysis to evaluate contamination.

2.3.3 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 of 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. Because 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 in the efficiency of the detector or the geometry of the sample. A variety of other uncertainties may be included in efficiency or geometry uncertainties or may be added separately. Because of the 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. Results of radiological analyses are very dependent on the geometry and matrix of the sample. If these are not specified, both the detection limits and range of uncertainties may change in ways that can only be determined by an experienced analyst.

2.3.4 Detection Limit

Detection limits for laboratory instruments will be either contract required quantification limits (CRQL) for organics or contract required detection limits (CRDL) for inorganics as defined in the CLP SOW for Organics (EPA 1990a) and CLP SOW for Inorganics (EPA 1990b) or required radiological detection limits as defined in the *Statement of Work for Radiological Analyses Performed for the Environmental Restoration Department at the INEL*, ERD-SOW-33 (EG&G 1991b). If detection limits lower than those listed in ERD-SOW-33 are required, those detection limits will be described in the laboratory SOW to procure analytical services. Detection limits are shown in Tables 2-2 through 2-6.

2.3.5 Sample Size

Two types of sample size determination were considered; the number of QA/QC samples for estimating precision and accuracy and the number of samples for estimating the mean concentration of contaminants in a sample population. Rationale used to determine the appropriate sample size is discussed in Section 3.3. The total number of samples, including QA/QC samples, to be collected during this investigation is presented in Table 3-4 in the FSP. For projects such as this, in which only one or two samples will be collected from each media type within each of the septic system components, a determination of the coefficient of variation, confidence level, Power, and relative difference to be realized during the project is not possible.

2.3.6 Completeness

To assess potential exposure risks to hazardous substances, the data must be complete (i.e., there must be enough valid data from the analyses to make the assessment). An integral part of obtaining valid data is to design the sampling network in a manner that provides the minimum data necessary for site characterization. The objective for completeness is that the investigation provide enough planned data so the objectives of the data collection can be met.

Completeness for this project will be assessed by comparing the number of samples collected and analyzed (resulting in usable data) to the number of samples planned. Completeness involves an assessment of field and laboratory documentation, whether all samples and analyses specified in the FSP have been processed, and whether the procedures specified in the SAP and laboratory SOPs have been implemented. Field sampling completeness is affected by such factors as equipment and instrument malfunctions and insufficient sample recovery. Analytical completeness is affected if a sample is not analyzed before its holding time is expired; a sample is damaged during handling, shipping, unpacking, or storage; or if the laboratory data cannot be validated and the sample cannot be reanalyzed.

One hundred percent (100%) is the completeness target for all parameters of the OU 5-07 Track 2 investigation. For the project as a whole, a completeness value of 90% will be considered acceptable. However, valid analytical results must be obtained for 100% of the critical samples (see Section 3.3.4). Completeness will be calculated following data validation and reduction (Section 2.8). If the goal is not attained, the impact on the DQOs will be addressed in the *OU 5-07 Track 2 Scoping Summary Report*; additional sampling and analysis may be necessary.

2.3.7 Comparability

Comparability is used to express the confidence with which one set of data can be compared with another set of data. This is a qualitative characteristic that must be ensured in all aspects of the work, from preparation for sampling through reporting. Data comparability will be achieved using standard field and analytical methods and/or written procedures. All data will be reported in units consistent with the conventions used for the given analyte and methods employed. In addition, so that data from subsequent sampling at the same site or facility can be compared, the specific sampling points will be established and documented. To assist in the comparison of data, all analyses will be performed using EPA-accepted methods.

Comparability will be assessed by comparing the following information on each data set:

- Field collection methods
- Field and laboratory QA/QC procedures (in accordance with previously established protocols)

- Laboratory detection limits
- Sample matrices.

2.3.8 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristic of the populations sampled, parameter variations at sampling points, or environmental conditions of concern. Representativeness is a qualitative parameter that addresses the proper design of the sampling program. The representativeness criterion is best satisfied by confirming that sampling locations are selected properly and a sufficient number of samples are collected. Sample locations and number of samples to be collected during this investigation are presented in Section 3.3.

A non-statistical approach was used in the design of the sampling program. Samples collected during this investigation will not produce representative data because of the biased nature of sample location selection. Biased sample locations were selected based on the proximity to the expected contaminant source. Representative data are not required to conduct a Track 2 risk evaluation and make a decision as to the appropriate future site action. Representative data are required for conducting a quantitative risk assessment under an RI/FS scoping, which is a more rigorous procedure. If the RPMs determine that RI/FS scoping is required based on Track 2 investigation results, an additional sampling program will be devised and representative samples will be collected.

2.3.9 Analytical Levels

EPA has established five analytical levels that correspond to data uses. Analytical Levels I, II, and III are appropriate for site characterization, and Analytical Levels III, IV, and V are appropriate for risk assessment. The selected laboratory for chemical analyses will meet the most recent CLP SOWs while the laboratory for radiological analyses will meet ERD SMO-approved radiological methods to produce data packages that, if necessary, can be validated to furnish Analytical Level IV data. Data validation is discussed in Section 2.8.2. The data collected during this investigation will be used for site characterization and to conduct a risk evaluation under Track 2 guidance. Analytical Level III data are appropriate for the intended data use; QA/QC samples and critical samples will be validated to Analytical Level IV. The submittal of a data package by a chemical laboratory using CLP SOWs or radiological laboratory using ERD SMO-approved procedures allows for any sample to be validated to Level IV at a future date if necessary. A discussion of analytical levels is included in ERD QPP-149 (EG&G 1991a). For purposes of this QAPjP, Analytical Levels III and IV are defined by the EPA as follows:

Level III - Analyses performed at a permanent or "fixed laboratory" remote to the site of sampling operations. Analytical methods must be methods approved by the EPA or American Society for Testing and Materials (ASTM) (or equivalent), but not necessarily CLP procedures. Uncertainty in analytical results are quantified on a sample-set basis by the use of duplicates and matrix spikes. Documentation and validation procedures for individual samples are followed, but "CLP type" data packages are not required.

Level IV - Analyses performed at an offsite laboratory following EPA-approved procedures. Analytes may be from the CLP Target Compound List (TCL) for organic compounds or from the CLP Target Analyte List (TAL) for inorganic analytes. The definition does not limit Level IV to the CLP analytes and analytical methods. The definition is based on the amount of data presented in the data deliverable and documentation of the analytical method used. Any analytical package must be accompanied by a complete "CLP type" data package. Uncertainty at the data-set level is quantified by the use of duplicates and matrix spikes. Individual analyses are extensively documented and the entire data analysis process can be validated by independent review of the laboratory data package; thus, uncertainty in individual analyses is minimized.

2.4 Sampling Procedures

The objective of the sampling program is to obtain samples that represent the environment being investigated. Trace levels of contaminants from external sources must be eliminated through the use of experienced field personnel, good sampling techniques, proper sampling equipment, and adequate decontamination.

The rationale used in the development of the sampling strategy is described in Section 3.3 of this SAP, while a detailed discussion of sampling equipment and procedures, including decontamination, is presented in Section 3.5. Field measurements shall be performed in accordance with EPA-accepted procedures. Source materials for developing procedures may be chosen from, but need not be limited to:

- *Compendium of Superfund Field Operations Methods* (EPA 1987)
- *The Environmental Survey Manual* (DOE 1989)
- *Samplers and Sampling Procedures for Hazardous Waste Streams* (EPA 1980b)
- *Test Methods for Evaluating Solid Wastes* (EPA 1986a)
- *User's Guide to the EPA Contract Laboratory Program* (EPA 1986b)
- *EPA Technical Monographs*
    - 15: Purposes and Objectives of Sampling
    - 16: Water Sampling Methods
    - 17: Soil and Sediment Sampling Methods
    - 19: Methods of Collecting Concentrated (Hazardous) Samples
    - 22: Sample Handling, Packaging, and Shipping Procedures.

A Task Specific HSP has been prepared as a companion document to this SAP (EG&G 1992a). The Task Specific HSP ensures compliance with OSHA, EPA, State of Idaho, and local regulations applicable to the scope of work outlined in this SAP. Field sampling team personnel will be trained and perform all work in accordance with the requirements outlined in the Task Specific HSP.

2.4.1 Sample-Type Delineation and Handling

The volumes, containers, preservatives, and holding times required for the samples collected during the Track 2 investigation of OU 5-07 are presented in Table 3-5 of the FSP. Sample preservation, packaging, and transportation are described in Section 3.6. Field personnel will use EPA-recommended container types and adhere to EPA-recommended preservation techniques and holding times for the parameters of concern at OU 5-07.

2.4.2 Field Logbooks

All information pertinent to a field survey and/or sampling will be recorded in the appropriate project field logbook. A discussion of sample documentation and management is presented as Section 3.4.3. Included in the discussion are the specific logbooks to be used during this Track 2 investigation, the type of information to be provided in each of the logbooks, and example logsheets presented as Figures 3-10 through 3-13 in the FSP. Logbooks will be kept in accordance with ERD PD 4.2, "Logbooks."

Field logbooks are legal documents that are the written record of all field data, observations, field equipment calibrations, samples, and COC. The logbooks will be site specific. Logbooks will be bound and contain consecutively numbered pages, firmly attached in the logbooks. All entries will be made in permanent, black, waterproof ink. Any mistakes will be crossed out with a single line and initialed by the person making the correction. At a minimum, entries in the logbook will include the following:

- Identification of sampling crew
- Reference to the procedures used
- Location and description of sampling point
- Types, numbers, and volumes of samples
- Preservatives used
- Date and time of sampling
- Date and time of shipping
- Weather
- Field measurements
- Deviations from procedures
- COC numbers.

2.5 Sample Custody

Sample custody procedures for this project shall be performed in accordance with ERD PD 4.1, "Document Control," and ERD PD 5.7, "Chain of Custody Record," and will be based on EPA-recommended procedures that emphasize careful documentation of sample collection and sample transfer.

2.5.1 Document Control

ERD PD 4.1, "Document Control," establishes a document control process for issuing, distributing, controlling, and revising ERD-assigned documentation. Figure 2-2 depicts the ERD document control process. Additional information on document control and data management is presented in ERD QPP-149 (EG&G 1991a). Control will consist of item identification, secure storage, and documentation distribution of any and all controlled documents. Document control ensures that controlled documents (reports, COC, etc.) will receive review and revisions as needed. They will also define activities affecting quality to ensure the correct documents are used.

The project manager is responsible for properly maintaining active project files. Upon project completion, the project manager will transfer all hardcopy information and documentation developed in the field (project logbooks) and the laboratory (bench logbooks, raw data reports, calculations, and final reports) to the Administrative Record and Document Control (ARDC) for archiving as appropriate. Copies of all analytical data and/or final reports will also be retained in the laboratory files and, at the discretion of the laboratory manager, data will be stored on computer disk for a minimum of 1 yr. Data may be retrieved from ARDC and laboratory archives upon request.

2.5.2 Chain-of-Custody Documentation

Every sampling and analysis program requires the integrity of all samples be maintained from collection to data reporting, which includes the ability to trace possession and handling of all samples from the times of collection through analysis and final disposal. The documentation of the sample's history is referred to as COC. COC procedures are discussed in ERD PD 5.7, "Chain-of-Custody Record," and in Section 3.4.4 of the FSP. Components of the sampling and field COC include field logbooks, sample tags, and custody seals, discussed in detail in Section 3.4.4. Laboratory COC includes a COC record, laboratory records of log-ins and log-outs, laboratory sample storage records, and laboratory sample disposal records.

2.5.3 Chain-of-Custody Record

To establish documentation necessary to trace a sample from time of collection, a COC record will be completed and will accompany every group of samples. The COC record to be used is exhibited in Figure 3-14 in the FSP. The record will be completed in permanent, black, waterproof ink by the sample custodian and shall contain the following information:

- Sample numbers (tied to a sampling location)
- Signatures of collectors
- Dates and times of collection
- Signatures of people involved in the chain-of-possession
- Inclusive dates and times of possession
- Analyses requested
- Number of bottles per sample.

To maintain the COC, each person in custody of the sample will sign the form; samples will not be left unattended unless placed in a secured and sealed container (custody seals) with the COC record inside the container.

2.5.4 Sample Identification

Sample numbers will be designated by a unique 10-character sample identification code affixed to each sample container. The sample numbering system is described in Section 3.4.2.

2.5.4.1. Sample Tags and Labels. All samples are identified by a sample tag and label. The sample tag and label to be used are exhibited in Figures 3-8 and 3-9 in the FSP. All sample tags and labels shall be filled out using permanent, black, waterproof ink. Each sample shall be designated by a unique alphanumeric code that identifies the sample (see Section 3.4.2). Information recorded on the sample tag and label shall include, as appropriate:

- Project name and number
- Field identification sample number
- Type(s) of analysis to be conducted
- Sample collection date/time
- Preservative(s) used
- Sampling person(s) initials.

2.5.5 Custody Seals

Custody seals are used to detect unauthorized tampering with samples before analysis. Gummed paper seals will be used for this purpose. The seal will be attached so it must be broken to open the sample container. Seals will be affixed to containers before the samples leave the custody of sampling personnel.

2.5.6 Document Corrections

Documentation in logbooks, sample tags, custody seals, and other accountable serialized documents will be completed with permanent, black, waterproof ink. None of these documents will be destroyed or thrown away, even if they are illegible or if they contain inaccuracies that require they be replaced. They will be marked "VOID" and maintained in a file. A record of all voided documents will be maintained by the project manager.

If an error is made on an entry into an accountable document, the individual in error will draw a single line through the error, enter the correct information, and initial and date the change. This procedure also applies to words or figures inserted or added to a previously recorded entry.

If a sample tag or COC record is lost in shipment or was never prepared for a sample, or if a properly tagged sample was not transferred with a formal COC record, a written statement will be prepared by the field team leader (FTL) detailing how the sample was collected. A copy of the statement will be sent to the project files.

2.5.7 Photographic Records

A photographic record may be made during this investigation. When photographs are taken, the name of the photographer, date, time, sampling site or laboratory location, description of site or activity being photographed, and weather conditions (if appropriate) will be entered in the photography logbook. Special lenses, film, filter, or other image-enhancement techniques will be noted. Whenever possible, use of such techniques will be avoided because they can affect the admissibility of the photographs as evidence. Once developed, slides or photographic prints will be serially numbered (corresponding to logbook descriptions) and labeled. The project manager will maintain a supply of photograph logbooks and a file of all photographs taken. All photograph logbooks, slides, and prints will be controlled documents.

2.5.8 Laboratory Custody

Laboratory custody will conform to EPA-approved procedures, including those established for the CLP. These procedures include:

- Designation of a sample custodian
- Correct completion by the custodian of the COC record, sample tag, and laboratory request sheet, including documentation of sample condition upon receipt
- Laboratory sample tracking and documentation procedures
- Secure sample storage

The sample will be delivered to the laboratory to ensure requested analyses can be performed within the specified holding times. The sample will be accompanied by the COC record, with an appropriate sample analysis request. The sample will be delivered to the person in the laboratory who is authorized to receive samples (laboratory sample custodian). Samples should be stored at less than 4°C whenever they are not being analyzed. Laboratory internal COC for samples in the laboratory's custody should consist of the following:

- Refrigerator log books
- Sample log-in/log-out documentation
- Documentation of personal custody.

2.6 Calibration Procedures and Frequency

Measuring and testing equipment used in the field shall be controlled by the manufacturer's specifications. Calibration frequencies of field instruments are discussed in Section 3.5.1 of this SAP and in Section A.9.1 of the Task Specific HSP (EG&G 1992a). Specific procedures for monitoring analytical laboratories may be found in ERD SMO SOP 12.2, "Approval and Performance Monitoring of Analytical Laboratories." Guidance found in the CLP SOW for Organics (EPA 1990a) and the CLP SOW for Inorganics (EPA 1990b) shall be followed in determining laboratory instrument calibration procedures and frequency. Measuring and testing equipment calibration may be performed internally using standards traceable to the National Institute of Standards and Technology (NIST), where applicable, or externally by the equipment manufacturer or approved calibration facility. If no nationally recognized standard exists for the equipment to be calibrated, the bases for calibration shall be documented.

Calibration procedures will comply with ERD QPP-149 (EG&G 1991a). The FTL is responsible for ensuring field sampling equipment is calibrated. It is the responsibility of personnel using the equipment to check the calibration status before using it and to ensure the equipment is operational before commencing sampling activities. The health physics technician (HPT) is responsible for maintaining and documenting the calibration of the radiological field instruments and the industrial hygienist (IH) is responsible for maintaining and documenting the calibration of the IH field equipment. Field calibration records will be documented in the appropriate field logbooks (see Section 3.4.3) and will be archived upon project completion. Responsibility for calibration of laboratory equipment rests with the laboratory manager; laboratory calibration records will be maintained and archived at the laboratory.

2.6.1 Calibration Procedures

Approved procedures shall be used to calibrate all measuring and testing equipment. Whenever possible, widely accepted procedures such as those published in *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, third edition, SW-846 (EPA 1986a) (referred to as "EPA SW-846") or procedures provided by the equipment manufacturer shall be used.

2.6.1.1 Field Screening Equipment. Each piece of equipment shall have an individual calibration log and be calibrated/standardized before use or as part of the operational use following the manufacturer's recommended calibration/standardization procedure(s). Measuring and testing equipment shall be calibrated at prescribed intervals and/or before use. Frequency shall be based on the type of equipment, inherent stability, manufacturer's recommendations, intended use, and experience. Records shall be prepared and maintained for each piece of calibrated equipment to indicate that established calibration procedures have been followed. Radiological instrumentation shall be maintained and calibrated in accordance with the *Radiological Controls Manual* (EG&G 1991c) and *Company Procedures Manual*, Section 10.6 (EG&G 1991d).

Equipment that fails calibration or becomes inoperable during use shall be removed from service and segregated to prevent inadvertent use, or shall be tagged to indicate it is out of calibration. Such equipment shall be repaired and/or recalibrated before further use.

2.6.1.2 Analytical Laboratory Instruments. Analytical instruments shall be calibrated periodically using traceable standards in accordance with the specified analytical methods (CLP methods). Calibration procedures, at a minimum, include equipment to be calibrated, the reference standards used for calibration, the calibration techniques and the sequential actions, acceptable performance tolerances, frequency of calibration, and calibration documentation format. Records of standard preparation and instrument calibration shall be maintained by the laboratory and shall be included in the laboratory's QA/QC report (part of the "CLP type" data package). Instrument calibration shall include daily checks using material prepared independently of the calibration standards, and instrument response shall be evaluated against established criteria. The analysis logbook, maintained for each analytical instrument, shall include, at a minimum, the date and time of calibration, the initials of the person performing the calibration, the calibrator reference number, and concentration.

Whenever possible, standards traceable to EPA or NIST standards will be maintained. EPA-traceable standards are available directly from the EPA Quality Assurance Material Bank. NIST standards are available from the National Institute for Standards and Technology. A standard logbook is used to document the preparation of standards and provide a means to trace each solution to the starting materials.

2.7 Analytical Procedures

Analytical methods to be used during the OU 5-07 field investigation are listed in Table 2-7. The rationale for the selection of the parameters and methods used for this project are presented in Section 3.3 of the FSP. Sample analytical methods to be used for chemical analyses are referenced in the CLP SOW for Organics (EPA 1990a) and the CLP SOW for Inorganics (EPA 1990b). Analysis by gamma and alpha spectroscopy and analysis for strontium-90 will be performed in accordance with ERD-SOW-33 (EG&G 1991b). Sample analyses should be completed within the sample holding times for EPA

Table 2-7. Analytical methods to be used for chemical and radiological analyses during the OU 5-07 Track 2 field investigation.

Parameter	Method
CLP volatile organic compounds (VOCs)	CLP methods[a]
CLP semivolatile organic compounds (SVOCs)	CLP methods[a]
CLP polychlorinated biphenyls (PCBs)	CLP methods[a]
CLP metals	CLP methods[b]
Gamma-emitting radionuclides	Gamma spectroscopy[c]
Alpha-emitting radionuclides	Alpha spectroscopy[c]
Beta-emitting radionuclides	Strontium-90[c]

a. CLP SOW for Organics (EPA 1990a).
b. CLP SOW for Inorganics (EPA 1990b).
c. Radiological analyses will be performed in accordance with ERD-SOW-33 (EG&G 1991b).

analytical methods listed in Table 3-5 in the FSP. The FFA/CO requires that raw results be supplied 75 days following sampling and that validated data be supplied within 120 days. Site characterization activities should be organized to provide a turnaround time that meets the project schedule and objectives.

The selected laboratory for chemical analysis will meet the CLP analytical detection limits specified in Tables 2-2 through 2-5, at a minimum; the laboratory for radiological analysis will meet the detection limits defined in Table 2-6. Laboratories will meet the specific calibration procedures and frequencies and internal QC identified in the specific methods.

2.8 Data Reduction, Validation, and Reporting

Data reduction and validation is divided into three components: field, laboratory method, and project (DQO-driven). The field and project levels of reduction and validation are performed in the project office (e.g., statistical analysis to assess data outliers, completeness calculations, field precision analysis, etc.). The laboratories are required to reduce data in accordance with accepted procedures specified in the CLP SOWs. The laboratory data is "method validated" by the SMO.

2.8.1 Data Reduction

The statistical approaches that will be used to evaluate the data are presented in Section 2.3. Data reduction occurs at two points in the data collection and interpretation process: in the laboratory and following the receipt of the data. Data reduction of raw laboratory data will be performed in accordance with procedures described in the laboratory SOW prepared by the SMO to procure a laboratory's services. Data reduction of the analytical data for interpretation, if required, will occur in conjunction with a statistician and will be documented in the *OU 5-07 Track 2 Scoping Summary Report.*

2.8.2 Data Validation

Data validation is the review of measurements and analytical results to confirm that method requirements have been achieved. The primary purpose of data validation is to ensure the legal defensibility of the data. All data to be used in a Track 2 decision should be validated; therefore, the data collected must be capable of being validated. Analyses obtained using a Laboratory SOW prepared by the SMO will be conducted in accordance with the most recent CLP SOWs and a CLP data package will be produced. Data will be validated to Analytical Level III; only critical samples and QA/QC samples will be validated to Analytical Level IV. Analytical Levels III and IV are defined in Section 2.3.9.

The SMO is responsible for method data validation. The data packages delivered by the laboratories will provide sufficient QA/QC information to perform ERD levels A and B validation. Data validation levels correspond to a level of effort at which the data are validated and are described below.

Level A - The maximum effort for chemical analysis data validation (i.e., complete review of the raw data for a given sample analysis, mass spectral confirmation, instrument calibration, calculation checking, etc). Level A validation is recommended on all samples used to make final decisions concerning remediation completeness and risk assessment and should be used for critical samples in site characterization activities.

Level B - Level B validation includes a check of the following; chain of custody, requested versus reported analyses, analysis holding times, method blank analyses, matrix spike/matrix spike duplicate analyses, duplicate analyses, internal standard areas, surrogate recoveries, and any other method specific quality control criteria. Level B validation is appropriate for data that will be used for site characterization or waste characterization (e.g., TCLP data).

One hundred percent of the data collected during this investigation will be validated to level B, except for critical samples, which will be validated to level A. Specific procedures for method data validation, including determining outliers and appropriate qualification flags are described in ERD SMO SOP 12.1.1, "Approval and Performance Monitoring of Analytical Laboratories," ERD SMO SOP 12.2, "Radiological Data Validation," ERD SMO SOP 12.1.3, "Validation of Volatile and Semivolatile Organic Gas Chromatography/Mass Spectrometry Data," ERD SMO SOP 12.1.4, "Validation of Gas Chromatographic Data," and ERD SMO SOP 12.1.5, "Inorganic Data Validation." All validation will be performed in accordance with EPA guidance, including *Laboratory Data Validation Functional*

Guidelines for Evaluating Organics Analyses (EPA 1988b) and *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA 1988c).

Sample data, for both solid and liquid matrices, will be evaluated according to the following:

- Holding times
- GC/MS tuning (organic analysis only)
- Instrument calibration (verification)
- Blank analysis
- Laboratory control sample (inorganic)
- Surrogate recovery (organic)
- Duplicate analysis (inorganic)
- Matrix spike/matrix spike duplicate (organic)
- Internal standard performance (organic)
- Inductively coupled plasma (ICP) interference check sample (inorganic)
- graphite-furnace atomic absorption QC and ICP serial dilution (inorganic)
- Sample verification
- System performance
- Overall assessment of data for the case.

2.8.3 Data Reporting

Data reporting requirements during the data collection, transfer, storage, recovery, and processing steps, including laboratory and field QC, and the organizations responsible, are documented in ERD PD 2.4, "Characterization Process in the Environmental Restoration Department," and presented in Figure 2-2. Reporting requirements for the laboratory, including data and sample storage requirements, are specified in the CLP SOWs and the laboratory SOW prepared by the SMO.

2.9 Internal Quality Control Checks

Internal QC checks are established for both field and laboratory methods. The internal QC check samples will be analyzed along with field samples. The QA objectives discussed in Section 2.3 describe the statistical evaluation of the project. The calculation of the QC indicators is presented in Section 2.12. Internal QC checks will be performed in accordance with ERD-QPP-149, Section 11 (EG&G 1991a).

2.9.1 Laboratory Quality Control

The internal laboratory QC checks, including the type and frequency of QC samples and calculation of data quality indicators, are described in the laboratory SOW prepared by the SMO. All laboratory services will be obtained following ERD-approved procedures as outline in ERD PD 5.5, "Obtaining Laboratory Services," and ERD PD 5.6, "Conducting Audits of Laboratories."

Internal QC focuses on ensuring each chemical measurement has the highest probability of exceeding method protocol in terms of precision and accuracy. Laboratory results of spiked samples and duplicate/split sample analyses shall be provided in a manner that will allow complete assessment of accuracy and precision. Adequate statistical procedures will be used to monitor and document performance and to implement an effective program to resolve testing problems (e.g., instrument maintenance and operator training).

2.9.2 Field Quality Control

Several types of field QA/QC checks will be used. These include, but are not limited to:

- Rinsates (equipment blanks)
- Trip blanks—one per cooler containing volatile organics
- Ambient conditions blanks (field blanks)
- Laboratory spikes—for analytes of specific interest suspected or known to be present or randomly selected
- Duplicate samples.

The total number of each type of QA/QC sample to be collected and analyses methods for each sample are specified in Table 3-4 within the FSP. Section 3.3.6 defines and explains the types of field QA/QC samples to be submitted during this investigation. The QA/QC samples will either be collected in the field or generated by EG&G Idaho in the laboratory and sent to the field, then shipped to the performing laboratories with other samples according to COC procedures. The numbering system for QA/QC samples will follow the general numbering scheme outlined in Section 3.4.2. Duplicate samples will be labeled as normal field samples so they cannot be identified as QA/QC samples by laboratory personnel. The field activities will be audited by a quality engineer (QE) to ensure activities are conducted according to approved plans as outlined in ERD PD 5.14, "Quality Monitoring and Surveillance."

2.10 Performance and System Audits

An audit is a systematic check to determine whether project personnel are adhering to requirements outlined and referenced in this QAPjP, the FSP, and in ERD QPP-149 (EG&G 1991a). Two types of audits will be performed: systems audits and performance audits. All assessment activities will be performed in accordance with the assessment requirements of ERD QPP-149, Section 12 (EG&G 1991a). Detailed operating procedures for field and laboratory audits, including example checklists and reporting requirements, can be found in the National Enforcement Investigations Center procedures manual and Section 12 of ERD QPP-149 (EG&G 1991a). Checklists are to include review of necessary items and results of the audit.

2.10.1 Systems Audits

The system audits include onsite reviews of both field and laboratory systems and facilities. The system audit ensures the QA/QC system planned for the project is in place and functioning.

The field system audit(s) ensures the sample documentation, collection, preparation, storage, and transfer procedures are in place before sampling begins. One field system audit will be conducted by the ERD QE during this investigation, preferably before or shortly after systems are operational. The project manager or FTL will notify the QE of the start date of the sampling activities at least two weeks in advance so the assessment can be scheduled and a checklist can be prepared. The audit will verify that the QA organization is operational; correct sampling methodologies have been chosen; written procedures for sampling are available and being followed; and specified equipment is available, calibrated, and in proper working order.

During and after the audit, the auditor(s) will discuss findings with individuals audited and suggest corrective actions. Minor administrative findings that can be resolved to the satisfaction of the auditors during an audit will not be noted on the audit checklist. Time-critical field events and short-term activities must receive immediate corrective-action attention. The deficiency must be corrected well before task completion to ensure data acceptability.

A systems audit will also be conducted for laboratory operations. These qualitative audits are typically conducted before approval of a contract. The laboratory audit will include inspection of analytical and support instrumentation maintenance and calibration logs; inspection of the sampling tracking system; and other inspections outlined in ERD QPP-149 (EG&G 1991a), ERD PD 5.5, "Obtaining Laboratory Services," and ERD PD 5.6, "Conducting Audits of Laboratories."

2.10.2 Performance Audits

The performance audits consist of field surveillance audits and audits of laboratory performance, documentation and reporting. These activities occur after the data production systems are operational and are generating data.

The field audits are conducted to determine the status of the sampling operations. Field audits are discussed in ERD PD 5.14, "Quality Monitoring and Surveillance." The laboratory operations audits will be conducted on a routine basis by the laboratory QA manager and the laboratory QE. The laboratory audit, which will be conducted annually, at a minimum, will include verification of written procedures and analyst's understanding, verification, and documentation of procedures and other verifications as outlined in ERD QPP-149 (EG&G 1991a).

2.10.3 Data Management Audits

An audit of the data management system, to be performed by the QA officer, will trace the flow of specific samples through the system. Specifically, the ability of the system to correctly identify a sample at any stage of sampling and analysis should be checked.

2.10.4 Quality Engineer

The QE designs and/or performs QA performance and systems audits. Since QA audits represent, by definition, independent assessments of a system and associated data quality, the auditor must be functionally independent of the effort to ensure objectivity. However, the auditor must be familiar enough with the objectives, principles, and procedures to be able to perform a thorough and effective evaluation of the system. Especially important is the auditor's ability to identify components of the system that are critical to overall data quality so that the audit focuses heavily upon these elements. The auditor's technical background and experience should also provide a basis for appropriate audit standards selection, audit design, and data interpretation.

2.10.5 Reports

Post audit or surveillance reports will be completed by the QE following an audit or surveillance. A copy of the audit report(s) will be sent by the project QE to the project manager. This report will detail the date of the audit or surveillance, identification of the audit or surveillance participants, description of items requiring corrective actions, and other information as appropriate. If an audit reveals that major or long-term corrective actions are needed, the responsible project manager will obtain a commitment from persons involved to implement necessary actions.

2.11 Preventative Maintenance

The primary objective of a preventative maintenance program is to help ensure the timely and effective completion of a measurement effort by minimizing the down time of crucial sampling and/or analytical equipment because of expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas: maintenance responsibilities, maintenance schedules, and adequate inventory of critical spare parts and equipment. Preventative maintenance of field survey and sampling equipment will be performed according to the manufacturer's operating and maintenance manual for each piece of equipment used. Preventative maintenance of HP and IH field instruments will be the responsibility of the HPT and the IH, respectively. All maintenance will be recorded in the appropriate calibration/standardization logbooks as required by ERD PD 4.2, "Logbooks." The maintenance schedules for the laboratories are provided in the laboratories' quality assurance plan.

2.12 Data Assessment Procedures

The data quality indicators of precision, accuracy, and completeness are addressed in Section 2.3, Quality Assurance Objectives. The equations that will be used to calculate and report these data quality indicators will be described in this section. Data quality indicators that will be calculated for this Track 2 investigation include precision, accuracy, and completeness.

2.12.1 Precision

The calculated RPD or RSD will be used to assess various measurements for precision. The RPD or RSD is calculated for every contaminant for which field or laboratory duplicates and/or splits exist.

The RPD is used when there are two observed values (i.e., field collocated duplicates, laboratory duplicates, laboratory matrix spike/matrix spike duplicates). The RSD is used when there are more than two observed values. The RPD for duplicate or split samples is calculated by:

$$RPD = \frac{|Y_1 - Y_2|}{(Y_1 + Y_2) / 2} x\ 100$$

where

RPD = relative percent difference
Y_1 = larger of the two observed values
Y_2 = smaller of the two observed values.

The RSD for three or more observed values is calculated as follows:

$$RSD = \frac{SD}{\overline{X}} x\ 100$$

where

RSD = relative standard deviation
SD = standard deviation
$\overline{X}$ = mean value of observations.

The laboratory precision statement will be developed from laboratory duplicate analysis (split samples, split extractants/digestants, duplicate analyses, etc.).

2.12.2 Accuracy

Accuracy will be monitored with the use of field blanks, laboratory spikes, and reference samples. Accuracy shall be measured by the percent bias or percent recovery. Two calculations will be used to assess laboratory accuracy: percent recovery (% Rec) of the MS and % Rec of known and/or blind LCS.

The % Rec of the MS is calculated by:

$$\% \ Rec = \frac{C_i - C_o}{C_t} \times 100\%$$

where

% Rec = percent recovery
C_i = concentration of spiked aliquot
C_o = concentration of unspiked aliquot
C_t = actual concentration of the spike added.

The % Rec of a known and/or blind LCS or a standard reference material (SRM) is calculated as:

$$\% \ Rec = \frac{C_m}{C_{srm}} \times 100\%$$

where

% Rec = percent recovery
C_m = measured concentration of the SRM of the LCS
C_{srm} = actual or certified amount of analyte in the sample.

2.12.3 Completeness

One calculation will be used to assess completeness:

$$\% \ C = \frac{S_a}{S_t} \times 100\%$$

where

$\% C$ = percent completeness
S_a = number of samples for which acceptable data are generated
S_t = total number of samples.

2.13 Corrective Action Procedures

Corrective action procedures are implemented when samples do not meet QA/QC established standards. A discussion of field and laboratory corrective action procedures is presented in ERD QPP-149, Section 15 (EG&G 1991a), ERD PD 5.13 "Corrective Action," and in the following subsections.

2.13.1 Laboratory Corrective Action

Laboratory analytical protocols, under the EPA CLP, dictate the corrective action procedures required when laboratory analyses exceed method QAOs. These corrective measures are the responsibility of the laboratory and their QA officer. The laboratory corrective action plan will be detailed in the laboratory QAPjP which will be submitted to EG&G Idaho upon selection of an analytical laboratory. The need for corrective action may come from several sources: equipment malfunctions, failure of internal QC checks, method blank contamination, failure of performance or system assessments, and noncompliance with QA requirements. The SOW prepared by the SMO to obtain laboratory services outlines ERD requirements for laboratory QA/QC and reporting requirements.

2.13.2 Field Corrective Actions

Field corrective actions will be in accordance with ERD QPP-149 (EG&G 1991a). The initial responsibility for monitoring the quality of field measurements lies with the field personnel. The FTL is responsible for verifying that all QA procedures, such as assessing the field methods and their ability to meet QA objectives, are followed and for making a subjective assessment of the impact a procedure has on field objectives and subsequent data quality. If a problem occurs that might jeopardize the integrity of the project, cause a QA objective to not be met, or impact data quality, the manager of the task and/or the QE will notify the WAG 5 Manager (R. J. Bargelt) and corrective actions will be decided upon and implemented. The FTL will document the situation, field objectives affected, corrective action taken, and results of the corrective action. Copies of the documentation will be provided to the project manager and the project QE. The evaluation of corrective action options for field samples exceeding control limits (provided by NIST or EPA) is the responsibility of the project QE or designee. In either case, all corrective action procedures are the responsibility of the project QE, project manager, and FTL.

Corrective action procedures that might be implemented from unacceptable audit results will be developed on a case-by-case basis. Such actions may include altering procedures in the field, resampling, reanalyzing, using different sample containers, or recommending an audit of laboratory procedures. Data will be validated as described in the data management plan. Data that cannot be validated using procedures outlined in the data management plan will be reviewed in detail in an attempt to evaluate each measurement. Corrective actions addressing QA/QC exceedances and their situation and impacts on the DQO's of the project will be described in the *OU 5-07 Track 2 Scoping Summary Report.*

2.14 Quality Assurance Reports

Effective management of a field sampling and analytical effort requires timely assessment and review of field and laboratory activities. This will require effective interaction and feedback between the field team members, project manager, laboratories, and project QE.

A performance report of the QA program will be prepared at the end of the project by the project QE. When appropriate, analytical laboratory QA/QC reports will be included. At task completion, and after data verification and validation, all QC data will be archived to become part of the program files. The *OU 5-07 Track 2 Scoping Summary Report* will summarize and/or reference all documentation which impacts the DQO's of the project.

QA reports will include:

- Deviations from the FSP and/or QAPjP
- Results of any systems and performance audits conducted during the period
- Copies of field reports and forms, including logbooks, copies of COCs, copies of sample analysis results, copies of laboratory validation reports, and copies of validated data
- Assessment of accuracy, precision, completeness, representativeness, and comparability of data collected during the period
- Nonconformance reports issued during the period, related corrective actions undertaken, and an assessment of action results
- Significant QA problems and recommended solutions
- Discussion of whether QA objectives were met
- Limitations on the use of the data.

3. FIELD SAMPLING PLAN

This section of the SAP discusses background information and past characterization efforts of Sites ARA-02 and ARA-03; the conceptual model developed for Sites ARA-02 and ARA-03, including potential pathways and exposure scenarios, qualitative risk evaluation results as determined using Track 1 guidance, objectives of the Track 2 field investigation, rationale for why and where samples will be collected, numbers of samples, and methodology to be followed during the Track 2 field program portion of the investigation. Procedures and equipment to be used for sampling septic system materials and surface and subsurface soils during field characterization activities are discussed.

3.1 Site Background

This section presents information regarding the background of the ARA-I facility and OU 5-07. A comprehensive discussion of the geographic setting, history, geology, hydrogeology, meteorology, and ecology of the INEL is found in the *INEL Environmental Characterization Report* (EG&G 1984). Specific information regarding the ARA-I facility is detailed in the *Installation Assessment Report for EG&G Idaho, Inc., Operations at the Idaho National Engineering Laboratory* (EG&G 1986) and in the following subsections.

3.1.1 ARA-I Operable Unit 5-07 (Sites ARA-02 and ARA-03)

ARA-I is a surplus facility that has been used in the past as a nuclear research reactor area with laboratories and various operations related to examination or storage of radioactively contaminated materials. ARA-I is located in the south central portion of the INEL (see Figure 1-1). OU 5-07 consists of two sites at the ARA-I facility, former Consent Order and Compliance Agreement Units ARA-02 and ARA-03.

3.1.1.1 Site ARA-02. The ARA-02 site consists of a sanitary septic system, which serviced ARA-I Buildings 626, 627, 628 and Office Trailer No. 1. The system was built in 1960 and was used until 1988, at which time the facility was inactivated. Drawings produced from as-built blueprints (Site Engineering Drawing No. 102709) of the sanitary septic system show the locations of the septic tanks, seepage pit, and associated piping, including three manholes. A diagram of the source buildings and septic system is presented as Figure 1-3. A cross-section profile of the septic system is shown in Figure 3-1. As-built drawings presented in Figures 3-2 and 3-3 show construction details of the three septic tanks and seepage pit, respectively. Site ARA-02 is defined as the entire septic system, including the three septic tanks, the seepage pit, and all associated piping (both 4-in. and 8-in.), as well as any soil surrounding the components that has been contaminated from system materials (not currently delineated).

Building ARA-626 was a hot cell building that began operation in 1957. The building was later used to support materials research. It also contained a small laboratory area for sample preparation and

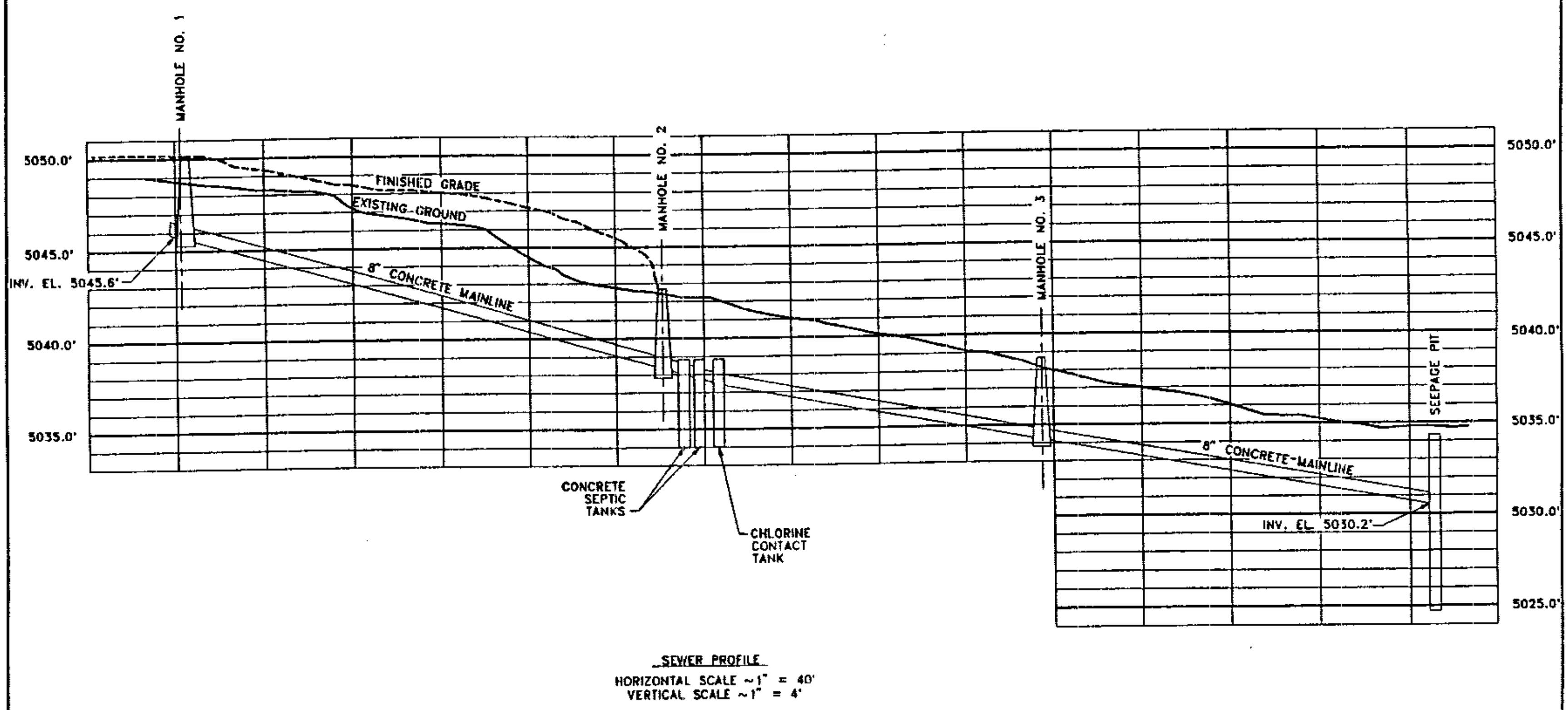

Figure 3-1. Cross-section profile of the ARA-02 sanitary septic system.

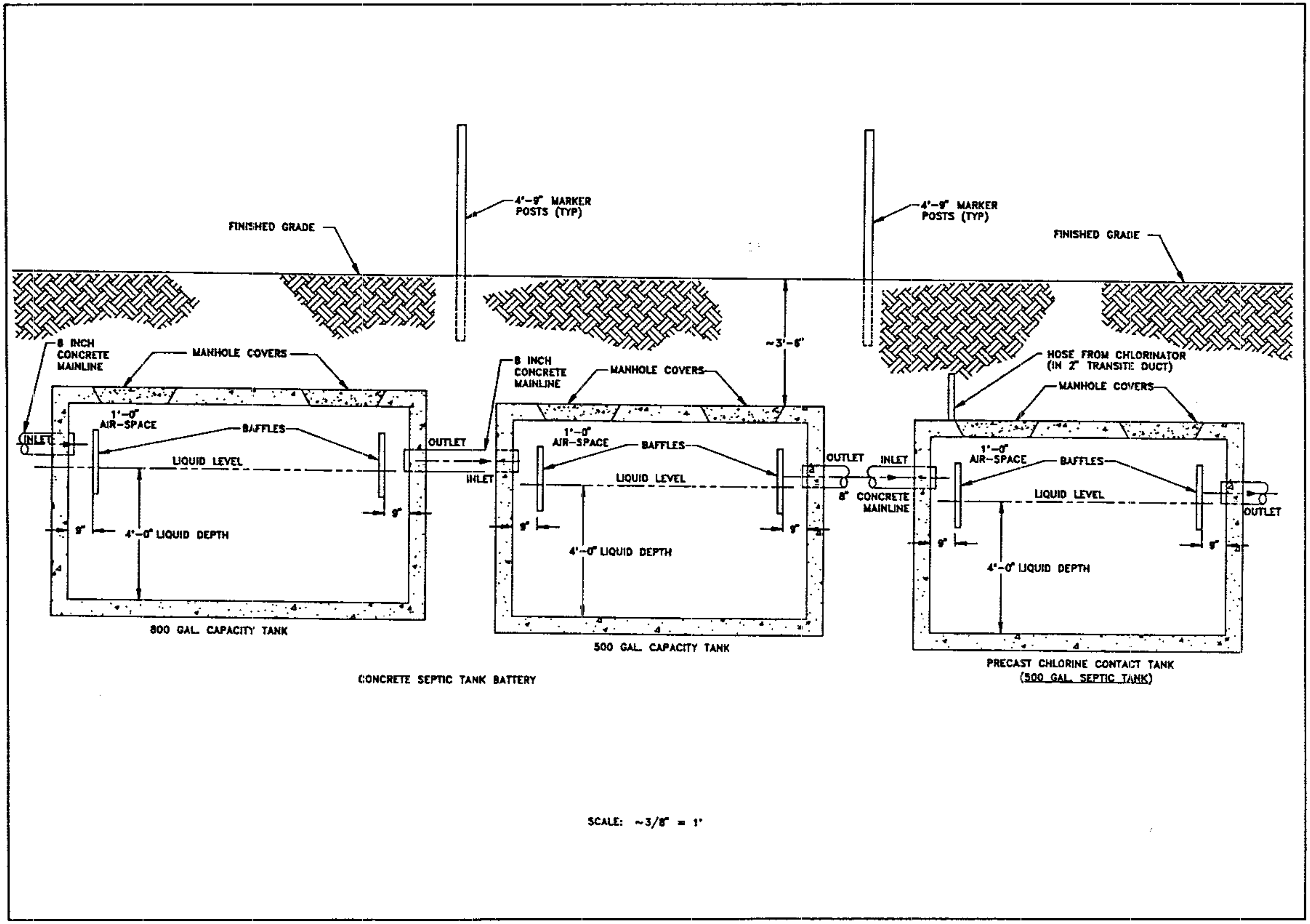

Figure 3-2. Construction details of the three ARA-02 septic tanks.

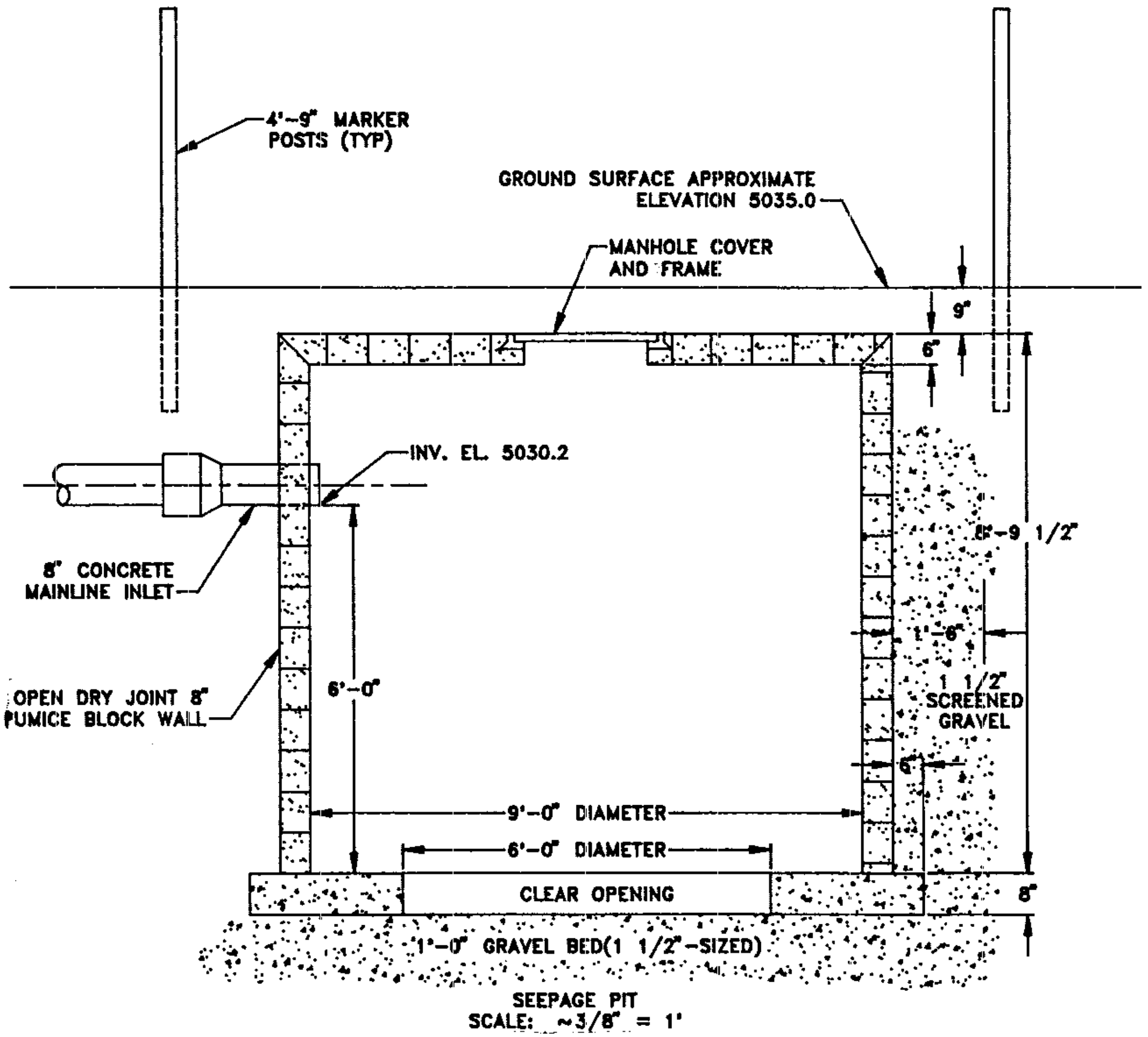

Figure 3-3. Construction details of the ARA-02 sanitary septic system seepage pit.

inspection. The hazardous chemicals used at the hot cell were limited to small quantities of solvents and acids. When organic solvents were used, either methanol or acetone was used because of their high vapor pressures. Occasionally, nitric acid was used in the hot cell laboratory. The effluents generated during hot cell operations were passed through a hot sewer to a radioactive holding tank. Periodically, this tank was emptied and the contents shipped to the Idaho Chemical Processing Plant (ICPP) for processing and disposal; hot cell wastes should not have been disposed of in the sanitary septic system (EG&G 1986).

Building ARA-627 was a print shop from 1955 to 1971 that generated small amounts (approximately 300 lb/yr) of rags that were occasionally wetted with acetone/printing fluids. These wastes were disposed of in an unspecified INEL landfill. The building was expanded in 1970 and modified to serve as a research laboratory for materials development and testing. From 1970 to 1984, small amounts of organic solvents (acetone and methanol) and mineral acids (mainly nitric acid) were used in operations on a routine basis. When large amounts of acids and solvents were used on a specific project, they were retained and sent to the Test Reactor Area or ICPP for disposal. The small amounts of acids and solvents which were used on a more routine basis (metal etching, cleaning, etc.) were disposed of in the following manner. Radioactively contaminated wastes (acids from metal etching operations) were put into the radioactive waste sewer and retained in the radioactive waste tank (the same tank used by Building ARA-626). These wastes were subsequently treated and disposed of at ICPP. Nonradioactively contaminated acids and solvents were disposed of in the ARA-I Chemical Evaporation Pond (Site ARA-01), sometimes referred to as the ARA-I chemical leach field. The materials research and testing operations were moved from Building ARA-627 in 1984 (EG&G 1986).

In 1980 the building was further modified to incorporate a radiochemistry laboratory. The 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% 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 1×10^{-12} Ci/mL) and the organic solvents used in the extraction process (xylene, heptane, 2-ethyl hexanol, and methanol) were sent to the ARA-01 Chemical Evaporation Pond. The radiochemistry laboratory continued operations until 1988; the remainder of the building was vacated in 1984 (EG&G 1986).

Building ARA-628 housed the ARA-I guardhouse. Office Trailers No. 1 and No. 2 were emplaced at the ARA-I facility from 1980 until 1986, at which time the trailers were removed from the facility. No hazardous wastes were known to be generated from these buildings, although it is possible that radionuclides were utilized within the confines of the trailer.

Although procedures for the disposal of routinely generated radioactive and hazardous waste were seemingly in place during operations at Buildings ARA-626 and ARA-627, incidental disposal in the sanitary septic system evidently occurred based on sample results discussed in Section 3.1.3.1.

The ARA-02 sanitary septic system includes 4-in. piping leading from each of the aforementioned buildings into an 8-in. concrete main with mechanical joints, three septic tanks, and an associated seepage pit discharge point. Three manholes allow access to the 8-in. concrete main. The first manhole is located at the point where the 4-in. pipe from Building ARA-626 enters the 8-in. mainline, while a second manhole is located near the discharge point of the mainline into the first of three in-series septic tanks. The 8-in. main continues eastward, away from the septic tanks and other ARA-I facilities, to the seepage pit. A third manhole accesses the mainline pipe approximately halfway between the second manhole and the seepage pit. As indicated in Figure 3-1, the 8-in. mainline lies approximately 3.5 to 4.0 ft beneath ground surface (bgs) along its entire length.

Based on Figure 3-1, the septic tanks lie approximately 3.5 ft bgs, the first in the series being a distance of approximately 285 ft east of the first manhole (south of Building ARA-626). The first settling tank is constructed of concrete, is 5 ft deep, and has an 800-gal capacity (see Figure 3-2). The tank construction allows for a maximum accumulation of 4-ft of liquids and sludges, with a 1-ft air space above the 8-in. mainline inlet and outlets. Contents of the septic tanks have not been examined because of the tanks' inaccessibility, but it is presumed that both sludges and liquids are present in the tanks, with proportionally fewer solids in the second and third tanks. The second concrete tank lies approximately 2 ft further east and is a 500-gal capacity tank, 5 ft deep, with a maximum 4-ft liquid/sludge depth. The third tank is a 500-gal capacity precast chlorine contact tank, also 5 ft deep. It is not known if any sludges are present in this tank. After the 3.5-ft depth of overburden soil has been removed, each of the tanks can be accessed and sampled by means of two manholes located above the entrance and exit points.

The 8-in. mainline piping continues eastward from the chlorine contact tank to the third manhole, a distance of 220 ft from the second manhole; the seepage pit is located an additional 225 ft east of the third manhole. The seepage pit is accessed via a manhole approximately 0.75 ft bgs (see Figure 3-3). The 8-in. mainline pipe inlet to the seepage pit lies approximately 4.75 ft bgs. The seepage pit is constructed of 8-in. open dry joint pumice blocks lying on concrete pilings 6 ft below the mainline inlet. Screened gravel (1.5-in. in size), 1.5 ft deep, surrounds the seepage pit below the mainline inlet, while a 1-ft thick gravel bed lies below the open base of the pit. An inspection of the seepage pit has not been conducted, but liquids are not expected to be present within the pit because of the construction design of the pit and the relatively high permeability of the surrounding soils (see Section 3.1.2).

No remedial response actions have been taken at Site ARA-02. Previous ARA-02 field screening and sample results are presented in Section 3.1.3.1. Information regarding types, locations, and frequency of samples to be collected during this Track 2 field investigation is found in Section 3.3. Analytical methods to be used for chemical and radiological analyses are presented in Table 2-7. Potential health and safety concerns associated with the sampling of Site ARA-02 manholes, septic tanks, and seepage pit are discussed in the Task Specific HSP (EG&G 1992a).

3.1.1.2 Site ARA-03. The ARA-03 site is located east of Building ARA-627 at the former location of Office Trailer No. 1 (see Figure 1-3). The site consists of a 900-ft^2 (30- x 30-ft) area that remains roped off and posted as a radiological contamination control zone (Zone I). The roped off area constitutes the boundaries of the site. A portion of the area was covered with lead sheeting to provide shielding from radioactivity detected in the surface soil. The source of contamination existing at Site ARA-03 is not known, but is thought to have originated from a spill related to the radiochemistry laboratory in Building ARA-627 or from a radioactive tank truck parked in the area. The lead sheeting was removed in January 1991 and the area was sampled in April 1991; previous field screening and sample results are presented in Section 3.1.3.2. There have been no previous remedial response actions taken at Site ARA-03. Additional sample collection is not necessary (information supporting this conclusion is presented in Section 3.1.3.2).

3.1.2 Environmental Setting

Soils in the vicinity of the ARA-I facility are shallow and poorly developed, as is typical of soils in the southern portion of the INEL. During the 1990 field sampling of the nearby ARA-01 Chemical Evaporation Pond (see Figure 1-3), a maximum soil depth of 1 m (3.5 ft) was found. The soils at the ARA-01 Chemical Evaporation Pond are composed of windblown sediments (loess) with a sandy loam or loamy texture. Precise soil depths and soil textures at Site ARA-02 will be determined during the sampling program.

Very little site-specific information is available that describes the geology at ARA-I. Some information is available from the driller's log for a production well located 183 m (600 ft) northwest of the ARA-01 Chemical Evaporation Pond. A complete geophysical log is not available. The geologic descriptions from the drillers' logs are poor but can be used to assemble a limited picture of the subsurface geology. The log indicates ARA-I is underlain by more than 183 m (600 ft) of relatively thin basalt flows interbedded periodically with fine-grained sedimentary materials. A generalized lithology produced from the driller's log for the production well is presented in Figure 3-4. Measured depth to groundwater was approximately 184 m (604 ft).

3.1.3 Existing Information and Characterization Data

3.1.3.1 Site ARA-02. Process knowledge and as-built blueprints of the septic system indicate that ARA-02 was a sanitary septic system; however, the system is known to be contaminated with radioactive materials based on existing field screening and sampling data. In January 1992, field screening instruments (Ludlum 14C) detected maximum readings of 0.7 and 40 mR/hr beta-gamma on contact within the first and second manholes, respectively, accessing the 8-in. mainline. Field strengths at the manhole coverings were < 1.0 mR/hr beta-gamma on contact, while readings at ground surface above the system components did not exceed background levels. Field screening surveys for alpha contamination or organic vapors were not conducted. Samples were collected from the first and second

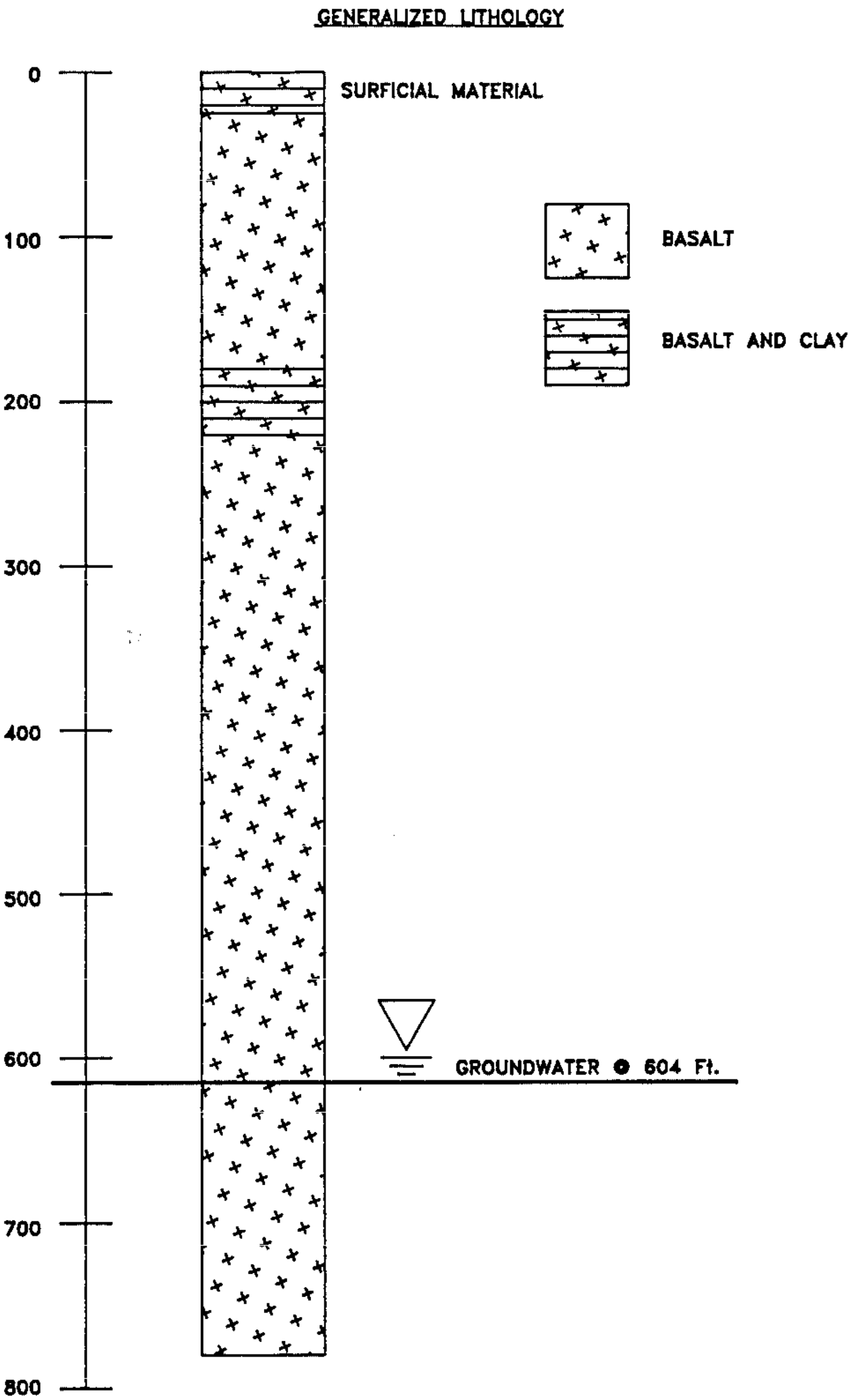

Figure 3-4. Driller's log for a production well northwest of ARA-01 Chemical Evaporation Pond.

manholes on the same date; the samples consisted largely of dry soil and gravel-sized rocks. These samples were analyzed by gamma spectroscopy and found to contain the radionuclides cesium-137 at 9.2E+01 pCi/g and cobalt-60 at 1.4E+03 pCi/g (first manhole), and cesium-137 at 3.8E+02 pCi/g, cobalt-60 at 6.0E+03 pCi/g, and uranium-235 at 1.0E+02 pCi/g (second manhole). No hazardous constituents are known to have been released to the unit. Additional samples will be collected and analyzed as described in Section 3.3.2.

3.1.3.2 Site ARA-03. The ARA-03 area was surveyed by health physics technicians (HPT) in January 1991 after the lead sheeting was removed. An area of surficial soils in the center of the area was noted to show radiation levels of up to 4 mR/hr beta-gamma on contact.

Site ARA-03 was sampled for radiological and Resource Conservation and Recovery Act (RCRA) characteristic waste in April 1991. The data were collected following the approach outlined in the *Abbreviated Sampling and Analysis Plan for the Initial Characterization of Potential Waste Sources at ARA-I and ARA-II* (EG&G 1991e). Complete sample results can be found in *Summary Report for the Initial Characterization of Potential Waste Sources at ARA-I and ARA-II* (EG&G 1992b); a summary of the new results is presented in Sections 3.1.3.2.1 and 3.1.3.2.2.

A geophysical survey was employed to determine if an underground storage tank (UST) or piping existed within the ARA-03 site; results determined that no UST or piping is buried within the ARA-03 area as currently demarcated[a]. A Ludlum 2A and an HNu photoionization detector (PID) were employed to assess the vertical extent of contamination. Field screening results indicated that there were no organic vapors present and that radioactivity decreased significantly toward the periphery of the site and below 18 in. The vertical decrease in radioactivity correlated with a decrease in soil grain size. The surface of Site ARA-03 is composed largely of a gravelly, loamy sand, while a denser, sandy clay layer was encountered at approximately 18 in. The clay layer appears to have absorbed a large amount of contamination in the first few inches of the horizon. Samples collected from a depth of 0.5 to 1.0 ft below the top of the clay layer show little if any chemical or radiological contamination. A Ludlum 2A indicated that the 0- to 6-in. depth had 1,000 to 8,000 counts per minute (cpm) of radioactivity above background, the 12- to 18-in. depth had 16,000-20,000 cpm of radioactivity above background and below 18 in., there was less then 100 cpm of radioactivity above background. Based on these results, a decision was made in the field to collect soil samples at two separate depths at each of six selected sample locations: one at 0-6 in. and a second from just below the zone of highest radioactivity (generally concentrated between 18 and 24 inches). The six soil sample locations were spaced evenly across the site area as shown in Figure 3-5.

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[a] Personal Communication from S. T. Marts to T. J. Meyer, EG&G Idaho, Inc., Idaho Falls, Idaho, April 19, 1991.

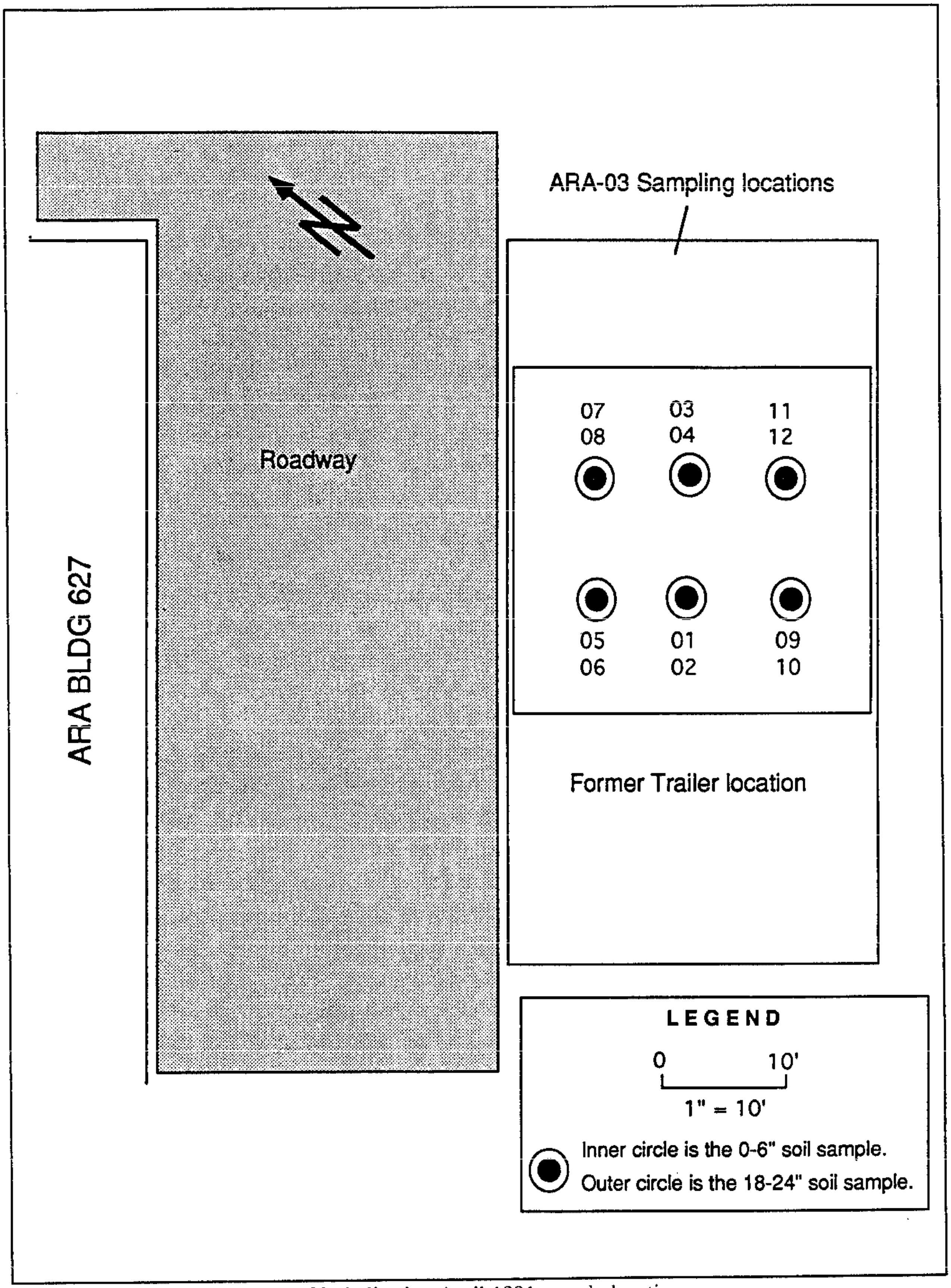

Figure 3-5. Map of Site ARA-03, indicating April 1991 sample locations.

3.1.3.2.1 Chemical Analyses Results— Samples were analyzed for reactivity, corrosivity, ignitability, F-listed waste, and Toxicity Characteristic Leaching Procedure (TCLP) constituents to determine if the materials exhibited characteristics of a hazardous waste. Samples were analyzed for TCLP VOCs (including water soluble F-listed compounds) by EPA SW-846 Method 1311 (extraction)/8240, TCLP methanol by SW-846 Method 1311/8015-modified, TCLP semivolatile organic compounds by SW-846 Method 1311/8270, TCLP Pesticides by SW-846 Method 1311/8080, TCLP Herbicides by SW-846 Method 1311/8150, and TCLP metals by SW-846 Methods 1311/6010 and 7000 series. None of the samples exceeded regulatory levels established for TCLP and F-listed constituents.

Samples were also analyzed for total organic halides using EPA SW-846 Method 9020; concentrations ranged from 8 to 90 ppm. Total organic halides is not regulated in soils, but was used as an indicator of hazardous waste. Discarded material containing greater than 1,000 ppm are considered hazardous waste. Samples analyzed for reactivity were prepared using the procedures described in Section 7.3 of EPA SW-846 and were then analyzed for sulfide and cyanide. Reactivity for sulfide in the twelve soil samples ranged from <25 to 293.5 ppm and was <250 ppm for cyanide (not reactive). Corrosivity was determined by EPA SW-846 Methods 9040 or 9045 (pH) and ranged from 7.0 to 9.8 pH (not corrosive). Ignitability was determined using Method 1010 Pensky Martins Closed Cup Flashpoint. No samples exhibited ignitability criteria.

3.1.3.2.2 Radiological Analytical Results—Samples were collected for gamma spectroscopy, gross alpha, and gross beta analysis. As predicted by the field screening, the highest levels of radioactivity were in the center region of the site and within the first 18 inches of soil. Maximum concentrations of 9.0E-01 pCi/g cobalt-60 and 6.98E+03 pCi/g cesium-137 were detected in the shallow (0-6 in.) soils. Below 18 in., the concentration of cesium-137 ranged from non-detection to 7.6E+01 pCi/g; no Co-60 was detected. None of the samples contained alpha activity that was statistically positive[b]. The area remains roped off and posted for radioactive contamination and radiation levels.

Based on the conceptual model developed for the site (see Section 3.1.4), the Track 1 qualitative risk evaluation results (see Section 3.1.5), and existing field characterization data (presented above), additional data collection at Site ARA-03 is not necessary. Although the data for lead and other potential inorganic contaminants are not sufficient to determine if any CERCLA hazardous substances were present in concentrations requiring consideration of cleanup action, radiological contaminants likely drive the risk at this site. Track 1 qualitative risk evaluation results for Site ARA-03 are discussed in Section 3.5.1.2. The radiological contaminants have been quantified as to the specific radionuclides and concentrations present at the site. The spatial extent of contamination has been adequately bound using radiological survey instruments (areal and vertical extent) and data results from samples collected from an 18- to

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[b] Personal Communication from D. S. Sill to T. J. Meyer, "Results of Gross Spectrometric Alpha Analyses," Letter #DSS-12-91, EG&G Idaho, Inc., Idaho Falls, Idaho, July 9, 1991.

24-in. depth (vertical extent). A quantitative risk evaluation will be conducted and a summary of existing information will be formally evaluated using the methodology from the *Track 2 Guidance Document* (to be published). The information derived from this Track 2 investigation will be incorporated into the OU 5-07 *Track 2 Scoping Summary Report*. A decision will then be made by the RPMs as to which one of the following alternatives is appropriate for the site: (1) no further action, (2) interim action, or (3) RI/FS scoping.

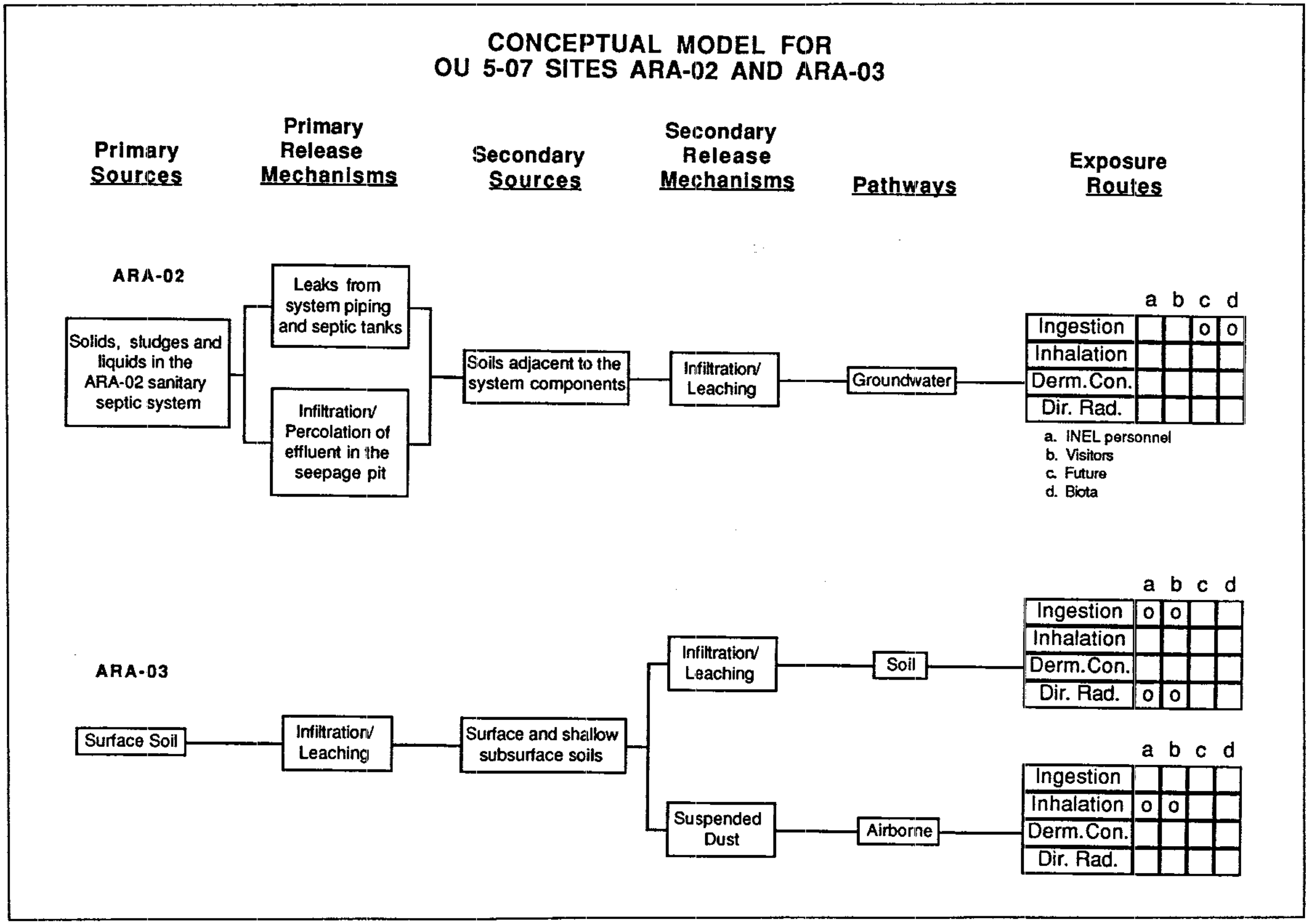
Based on existing data, it is expected that a small volume of contaminated soil will be removed from Site ARA-03. Following the removal action, verification samples may be collected and analyzed for radiological and inorganic constituents to ensure that contaminants are not left at the site at concentrations posing an unacceptable risk to human health and/or the environment.

3.1.4 Conceptual Site Model

The conceptual site model (CSM) is presented as Figure 3-6 and was developed to support the requirements for conducting a Track 2 site investigation according to FFA/CO guidelines. Figure 3-6 depicts the possible sources, potential release mechanisms, transport pathways, exposure routes, and receptors for the contaminants of concern at OU 5-07 Sites ARA-02 and ARA-03. The utilization of this information allows a conceptual evaluation of the potential risks to human health and the environment. The CSM was developed based on the limited historical information that is available from record searches, namely the *Installation Assessment Report for EG&G Idaho, Inc., Operations at the Idaho National Engineering Laboratory* (EG&G 1986); the physical setting of Sites ARA-02 and ARA-03; and previous field screening and sampling results. The following subsections describe the CSM components in greater detail.

3.1.4.1 Primary Contaminant Sources and Release Mechanisms. **ARA-02—** The primary sources of contamination at Site ARA-02 are the waste materials present within the three septic tanks, the seepage pit, and the system piping that, together, make up the ARA-02 sanitary septic system. The waste sources may be present as solids, sludges, and liquids. During the 28-year service life of the ARA-02 sanitary septic system (1960-1988), the waste stream mainly consisted of liquid and solid sanitary wastes discharged directly from buildings ARA-626, ARA-627, ARA-628, and Office Trailer No. 1, although the system is known to contain radioactive contaminants from an unknown source (see Section 3.1.3.1). The integrity of the septic system components is not known; the mainline and septic tanks may have leaked small amounts of wastes. The primary release mechanisms of the waste sources are (1) leaks from the mainline and/or septic tanks into surrounding soils and (2) infiltration/percolation of effluent reaching the seepage pit into adjacent soils.

ARA-03— Background information on Site ARA-03 is provided in Section 3.1.1.2. The primary source of contamination at Site ARA-03 is an area affected by a spill or leak of radioactive material of an unknown origin that was subsequently covered with lead sheeting to reduce the radiation field. The



ARA-02, Groundwater:

	a	b	c	d
Ingestion			o	o
Inhalation				
Derm.Con.				
Dir. Rad.				

ARA-03, Soil:

	a	b	c	d
Ingestion	o	o		
Inhalation				
Derm.Con.				
Dir. Rad.	o	o		

ARA-03, Airborne:

	a	b	c	d
Ingestion				
Inhalation	o	o		
Derm.Con.				
Dir. Rad.				

Figure 3-6. Conceptual model for OU 5-07 Sites ARA-02 and ARA-03.

primary release mechanisms of the waste source are infiltration/leaching of the radioactive contaminants and possibly lead into the shallow subsurface soils.

3.1.4.2 Secondary Contaminant Sources and Release Mechanisms. **ARA-02—** The secondary sources of contamination at Site ARA-02 are the potentially contaminated soils adjacent to the septic system components. There has been no characterization sampling conducted to determine the presence or absence of contamination resulting from leaks (if any) or the general extent of infiltration of liquids from the seepage pit into the surrounding soils. The secondary release mechanism of the waste source is infiltration/leaching of wastes into subsurface sediments, with the potential to contaminate groundwater.

ARA-03— The secondary source of contamination at Site ARA-03 is the small volume of soil that is known to be radiologically contaminated (see Section 3.1.3.2). The secondary release mechanisms of the waste source are (1) infiltration/leaching of contaminants into subsurface sediments with the potential to contaminate groundwater and soil, and (2) suspended dust.

3.1.4.3 Contaminant Exposure Pathways. An exposure pathway is the route a contaminant takes from a source to a receptor. The major pathway potentially affecting Site ARA-02 is the groundwater pathway, while the major pathways potentially affecting Site ARA-03 are the soil and airborne pathways.

ARA-02— Exposure to contaminants via the soil, airborne, surface water, and game animal transport pathways is not considered relevant at Site ARA-02 as there is no surface exposure of the waste sources (the 8-in. concrete mainline and the tops of the three septic tanks lie a minimum of 3.0 ft bgs; the seepage pit lies from 0.75 to 10.0 ft bgs). Exposure via these pathways would be possible under a future residential/agricultural/recreational exposure scenario, however, such a scenario is not considered applicable for reasons discussed in Section 3.1.4.4. External exposure to direct ionizing radiation is not of concern because of the shielding effect of the overlying soil as evidenced by the negligible present day field strengths above the site (see Section 3.1.3.1). Although the migration of volatiles from a leaking system is possible, the high volatility of many organic compounds and the long period of time since the system was active suggests that the presence of volatile organics and the resulting potential for the inhalation of volatiles is extremely unlikely.

Calculations were performed to determine if the groundwater pathway is of potential concern at Site ARA-02. Given the estimated discharge rates (approximately 1,000 gal per day from 1960 to 1988), it can be assumed that wastes have migrated into the subsurface around the seepage pit and leaking components (if present) and have the potential to contaminate groundwater. The modeling program GWSCREEN was run to calculate the maximum soil concentration of a particular contaminant allowable in a source term such that regulatory contaminant levels in groundwater are not exceeded. Instructions for running the program and a discussion of the output and limitations of GWSCREEN are presented in

GWSCREEN: A Semi-analytical Model for Assessment of the Groundwater Pathway from Surface or Buried Contamination: Theory and User's Manual (EG&G 1992c). GWSCREEN calculations are presented as Appendix B and are discussed in Section 3.1.5.

Additional calculations were performed to determine the time required for contaminants released from the ARA-02 sanitary septic system to reach groundwater beneath the site; a discussion of the rationale behind the calculations, as well as the results, are included as Appendix C. The calculations indicate that two perched water zones would have been present beneath Site ARA-02 while the system was operational. However, the water retention potential of Zone 2 far exceeds the infiltration into the zone, and effluent (and contaminants) discharged to the septic system has not infiltrated past the second zone.

Although the rationale and calculations presented in Appendices B and C indicate that the groundwater pathway does not appear to be of concern, the groundwater pathway cannot be excluded from consideration. Additional sampling is required to better characterize the source terms present in each of the septic system components. At present, only concentrations of radionuclides within Manholes No. 1 and No. 2 have been quantified. Furthermore, the development of the rationale presented in Appendix C was hampered by a shortage of suitable data on the subsurface geology at ARA-I; the validity of the calculations and conclusions is therefore somewhat tempered.

ARA-03— Because of the exposure of contaminants at the surface of Site ARA-03, the airborne and soil pathways must be considered. The groundwater pathway is not considered relevant at Site ARA-03 since little or no contamination is present beneath a depth of 18 in. as evidenced by field screening and sample results (see Section 3.1.3.2). Moreover, based on the calculations presented in Appendix C, none of the contaminants present at Site ARA-03 would be expected to reach groundwater, particularly when the minimal infiltration of liquids at Site ARA-03 as compared to Site ARA-02 (1,000 gal per day) is considered. The presence of volatile contaminants (inhalation of volatiles via the airborne pathway) has not been indicated by field screening or sample results. Other pathways, such as surface water transport and transport via game animals, are not applicable. There are no surface water features located near the site; localized runoff from spring snowmelt and precipitation events is minimal. There is very little vegetation at Site ARA-03; consequently, it is unlikely that significant human exposure via the food chain would occur.

3.1.4.4 Exposure Routes and Receptors. *Receptors* are humans and terrestrial and aquatic biota that may be exposed to contaminants via the identified pathways. There are two general exposure scenarios under which persons or biota can be affected; a current occupational scenario and a future hypothetical residential scenario for human receptors. The potential receptors at OU 5-07 are employees of and visitors to the INEL, future residents of the area, and terrestrial biota that inhabit or use the INEL. Receptors may be exposed by a number of exposure routes including ingestion of potentially contaminated soil or groundwater, inhalation of vapors or contaminated particulates, dermal contact with potentially contaminated soil or groundwater, and external exposure to direct ionizing radiation.

Occupational Scenario— The occupational scenario considers exposures to workers who would work under current environmental conditions. This scenario is conservative since ARA-I is currently an inactive facility and there are no permanent workers at the site. Visitors to the facility spend less than 40 h/wk, and usually less than 8 h/day, at the site. Although it is assumed that temporary workers and visitors will not be exposed to everyday occupational scenarios, risk-based levels of concern have been calculated for soil ingestion, inhalation of fugitive dust, and external exposure under an occupational scenario for Site ARA-03 (see Section 3.1.5). Exposure to members of the public, under present circumstances, is considered to be unlikely given the strict security maintained at the INEL. Exposure to the nearest permanent residents [Atomic City — 14 km (9 mi)], persons travelling on U.S. Highway 20 (1 mile away), or employees at the nearest active INEL facility [Power Burst Facility — 3 km (2 mi)] would be negligible because of the small volume of exposed waste (Site ARA-03 only) and relatively low concentrations of contaminants in the exposed waste source.

Calculations for the soil ingestion, inhalation of fugitive dust, and external exposure routes at Site ARA-02 are not relevant for the reasons presented in Section 3.1.4.3. The groundwater pathway at Site ARA-02 is not relevant under an occupational scenario because no water used by the INEL is derived from wells in the vicinity of ARA.

Residential Scenario— The residential exposure scenario considers exposures to individuals who would live at the sites under contaminant conditions that would exist in 100 years. This future residential scenario has been developed in accordance with the current DOE Order 5820.2A, "Radioactive Waste Management," which allows for 100 years of active institutional control. The scenario that the area encompassed by OU 5-07 could be used for residential, agricultural, and/or recreational purposes after the INEL is closed and vacated (100-year estimate) has been evaluated, but is not considered relevant for the following reasons. It is generally suggested that, at a minimum, a 10-ft depth of removable materials be present for proper installation of a foundation for a residential house with a basement. The area around ARA-I is characterized by shallow soils (less than 10 ft) and numerous basalt outcrops. As discussed in Section 3.1.2, the maximum soil depth found at the ARA-01 Chemical Evaporation Pond was 3.5 ft. Exact soil depths within and around Sites ARA-02 and ARA-03 are not known, but are assumed to be similar to the remainder of the ARA-I soils. It is, therefore, not reasonable to expect that residences would be built at any time in the future at either site. Agricultural uses of the land would also be extremely limited by the shallow soil, basalt outcrops, and dry conditions. Finally, there are no exceptional or novel features or nearby bodies of water that would indicate that OU 5-07 would make an appealing recreational area. The groundwater pathway potentially remains open under a future residential scenario as groundwater may migrate a short distance offsite.

In addition to human exposures, various organisms in the surrounding ecosystem could be exposed to contaminants at OU 5-07. OU 5-07 lacks the components of an aquatic ecosystem, but the site is located adjacent to undisturbed rangeland with terrestrial organisms that could be exposed to contaminants at Sites ARA-02 and ARA-03. Terrestrial biota include desert mammals and birds, reptiles and amphibians, as well as terrestrial vegetation. For the purposes of the Track 1 qualitative risk evaluation (see Section 3.1.5), humans are regarded as a sensitive indicator species for the ecosystem as a whole.

3.1.5 Track 1 Qualitative Risk Evaluation

A qualitative risk evaluation was performed for Sites ARA-02 and ARA-03 using the methodology from *Track 1 Sites: Guidance for Assessing Low Probability Hazard Sites at INEL* (DOE-ID 1991a). Limiting soil concentrations (risk-based levels of concern) for the groundwater pathway were calculated using the GWSCREEN modeling program (EG&G 1992c). Risk-based soil screening concentrations were calculated for all relevant pathways for occupational and residential scenarios for the contaminants of concern at each site. Risk-based soil screening concentrations calculated for the pathways and contaminants of concern at Sites ARA-02 and ARA-03 and actual concentrations within the source terms are summarized in Tables 3-1a and 3-1b, respectively. Risk-based soil screening concentrations are compared to actual concentrations to determine if cleanup actions could be required.

3.1.5.1 Site ARA-02. The ARA-02 sanitary septic system has not been previously sampled for chemical constituents. Contaminants of concern such as mercury, barium, chromium^{+3}, and

Table 3-1a. Summary table of risk-based soil screening concentrations for Site ARA-02 (residential scenario, groundwater ingestion pathway).

Contaminant	Soil screening concentration	Manhole No. 1 concentration	Manhole No. 2 concentration
Cs-137	2.01E+233 pCi/g	9.2E+01 pCi/g	3.8E+02 pCi/g
Co-60	3.47E+223 pCi/g	1.4E+03 pCi/g	6.0E+03 pCi/g
U-235	7.61E+004 pCi/g	ND[a]	1.0E+02 pCi/g
Barium	1.66E+007 mg/kg	—	—
Mercury	1.98E+005 mg/kg	—	—
Chromium^{+3}	2.65E+008 mg/kg	—	—
Chromium^{+6}	7.09E+004 mg/kg	—	—

---

a. ND = No detections.

Table 3-1b. Summary table of risk-based soil screening concentrations for Site ARA-03 (occupational scenario).

	Soil screening concentration (pCi/g)			Actual concentration (pCi/g)	
Contaminant	Soil ingestion	Inhalation of fugitive dust	External exposure	0-6" depth	18-24" depth
Cs-137	1.32E+01	4.10E+04	—	6.98E+03	7.6E+01
Ba-137	1.54E+05	1.30E+09	2.94E-03	—	—
Co-60	2.44E+01	4.80E+03	7.69E-04	9.00E-01	ND[a]

a. ND = No detections.

chromium^{+6} were selected as constituents known to be common to many septic tank systems. Also considered for evaluation because of their known presence within the septic system were the radionuclides cobalt-60, uranium-235, and cesium-137 (see Section 3.1.3.1). Lead, although a potential concern, could not be evaluated because of the absence of a published slope factor.

Because the ARA-02 sanitary septic system is fully contained (not withstanding unknown leaks) and buried a minimum of 3.0 ft bgs, as shown in Figure 3-2, no pathways were considered relevant under an occupational scenario (see Sections 3.1.4.3 and 3.1.4.4); calculating risk-based soil screening concentrations for Site ARA-02 contaminants under an occupational scenario is, therefore, not appropriate. To determine if the groundwater pathway and ingestion of groundwater are potentially of concern under a future residential scenario, the GWSCREEN modeling program was run to calculate the limiting risk-based soil concentrations for each of the contaminants of concern (cesium-137, cobalt-60, uranium-235, barium, mercury, chromium^{+3} and chromium^{+6}); calculations and conclusions are presented in Appendix B. A summary of the limiting risk-based soil screening concentrations derived for the groundwater pathway using GWSCREEN is presented in Table 3-1a. Limiting soil concentrations for lead can not be calculated because of the lack of a published slope factor. Although risk-based soil screening concentrations far exceed actual concentrations of radionuclides in the mainline, additional sampling is required to better characterize contaminants in the remainder of the source terms.

3.1.5.2 Site ARA-03. The major contaminants of concern at Site ARA-03 are the radionuclides previously detected (see Section 3.1.3.2) and possibly lead. Based on previous field screening and sample results, most of the contaminants present at ARA-03 are concentrated in the surficial and shallow subsurface soils (0- to 18-in. depth). The radionuclides cobalt-60, cesium-137, and the daughter product of cesium-137, barium-137m ("m" denotes metastable), were evaluated for the relevant pathways and corresponding exposure routes under an occupational scenario. The relevant pathways are the airborne (inhalation of fugitive dust) and soil (direct ingestion and direct radiation) pathways (see Section 3.1.4.3). Risk-based soil screening concentrations are presented in Table 3-1b.

Because of the absence of published slope factors, lead could not be evaluated. The groundwater pathway and future residential scenario were not considered relevant for reasons discussed in Sections 3.1.4.3 and 3.1.4.4, respectively. Actual concentrations of cesium-137 present at Site ARA-03 exceed risk-based soil screening concentrations for soil ingestion, indicating that some form of remedial action is warranted at this site.

3.2 Sampling Objectives

This section discusses data requirements for characterization of waste sources potentially present at OU 5-07 Site ARA-02.

3.2.1 Currently Existing Data Gaps

Site ARA-02. The following information regarding contamination at Site ARA-02 is not known:

- The types and concentrations of contaminants present within the primary and secondary waste sources
- The determination as to whether contaminants are leaking from the system septic tanks and/or mainline piping and the general extent of migration of contaminants from the seepage pit.
- Specific knowledge about subsurface geology and hydrogeology.

The Track 2 investigation of Site ARA-02 will consist of three phases:

Phase 1- Define types and concentrations of contaminants within and outside of each source area through a sampling program (locations of the ARA-02 septic system components and samples exterior to the system are shown in Figure 3-7):

- Two sets of biased composite samples will be collected from just beneath the gravel base of the seepage pit (1-1.5 ft); biased composite samples will be collected at two locations outside of the seepage pit at a depth of 10.0-11.0 ft (see note)

- Two biased composite samples will be collected from the sludge and one sample will be collected from each liquid phase from each of the three septic tanks; biased composite samples will be collected at two locations outside of the septic tanks at a depth of 8.0-9.0 ft (see note)

- Three biased composite samples will be collected from the 8-in. mainline (one from within each of the three manholes); systematic random composite samples will be collected at three locations alongside the mainline at a depth of 3.5-4.5 ft (see note).

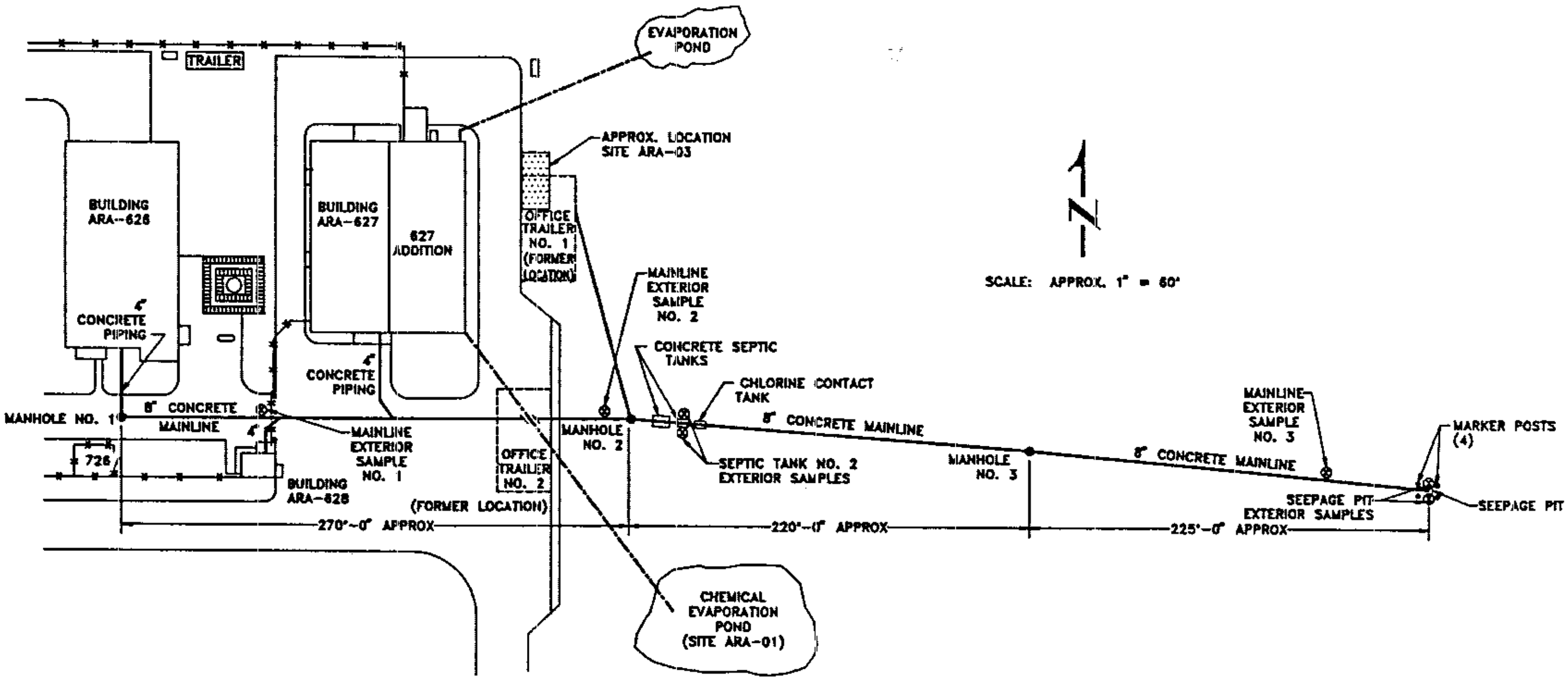


Figure 3-7. Locations of samples exterior to the ARA-02 septic system.

Note: Based on field screening results for radiological and organic constituents, additional samples may be collected from greater depths at each of the soil boring locations exterior to the system components. Additional information on the methodology to be used to determine if additional sample collection is necessary is proffered in Section 3.3.2.

Phase 2- Re-appraise all historical and process data and evaluate Track 2 environmental sample data.

Phase 3- Perform Track 2 Risk Evaluation/Prepare OU 5-07 *Track 2 Scoping Summary Report.*

Table 3-2 summarizes the types and number of samples to be collected from Site ARA-02, including QA/QC samples to be collected as part of this Track 2 investigation. All samples will be analyzed for CLP metals, CLP VOCs, CLP SVOCs, and CLP PCBs, and gamma-, alpha-, and beta-emitting radionuclides by gamma spectroscopy, alpha spectroscopy, and Strontium-90 analysis, respectively. The data types required and the measures to be taken in filling these data gaps are addressed in the remainder of Section 3.2, while Section 3.3 details the sampling program, including locations and numbers of samples to be collected during this investigation.

Site ARA-03. The Track 2 investigation of Site ARA-02 will consist of three phases:

Phase 1- Additional data collection is not necessary.

Phase 2- Re-evaluate all historical and process data and existing environmental sample data.

Phase 3- Perform Track 2 Risk Evaluation/Prepare OU 5-07 *Track 2 Scoping Summary Report.*

3.2.2 Data Quality Objectives

DQOs are qualitative and quantitative statements that are specified to ensure that data of known and appropriate quality are obtained to support decisions regarding remedial response actions. DQOs address data requirements for various stages of the Track 2 investigative process, including site characterization, risk evaluation, and the evaluation of future site action alternatives. A summary of DQOs for the Track 2 field investigation of Site ARA-02 is presented as Table 3-3. The DQO development process can be divided into three stages, as follows:

Table 3-2. Sample and analysis plan table for OU 5-07 Site ARA-02 samples.

SAP Number: OU5-07
SAP Table No. 1
Date: 04/24/92 Revision: 1.0

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: CHARACTERIZATION AT ARA-I (SITE ARA-02) - OU 5-07

Page 1 of 4

Project Manager: R. J. BARGELT

Form No: SAP11B

SAMPLE DESCRIPTION						SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
										AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	C1	CV	PS	R4	SA															
AI2001	REG	SOLID MATERIAL	COMB	BIASD	05/01/92	ARA-02	INT. MANHOLE 1	8" MAINLINE	N/A	1	1	1	1	1															
AI2002	REG	SOLID MATERIAL	COMB	BIASD	05/01/92	ARA-02	INT. MANHOLE 2	8" MAINLINE	N/A	1	1	1	1	1															
AI2003	REG	SOLID MATERIAL	COMB	BIASD	05/01/92	ARA-02	INT. MANHOLE 3	8" MAINLINE	N/A	1	1	1	1	1															
AI2004	REG	SOIL	COMB	SYRND	05/01/92	ARA-02	EXTERIOR - 1	8" MAINLINE	3.5-4.5	1	1	1	1	1															
AI2005	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 1	8" MAINLINE	8.5-9.5	1	1	1	1	1															
AI2006	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 1	8" MAINLINE	13.5-14.5	1	1	1	1	1															
AI2007	REG	SOIL	COMB	SYRND	05/01/92	ARA-02	EXTERIOR - 2	8" MAINLINE	3.5-4.5	1	1	1	1	1															
AI2008	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 2	8" MAINLINE	8.5-9.5	1	1	1	1	1															
AI2009	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 2	8" MAINLINE	13.5-14.5	1	1	1	1	1															
AI2010	REG	SOIL	COMB	SYRND	05/01/92	ARA-02	EXTERIOR - 3	8" MAINLINE	3.5-4.5	1	1	1	1	1															
AI2011	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 3	8" MAINLINE	8.5-9.5	1	1	1	1	1															
AI2012	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 3	8" MAINLINE	13.5-14.5	1	1	1	1	1															
AI2013	REG	LIQUID-PHASE I	COMB	BIASD	05/01/92	ARA-02	INT. TANK 1 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2014	REG	LIQUID-PHASE II	COMB	BIASD	05/01/92	ARA-02	INT. TANK 1 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2015	REG	SLUDGE	COMB	BIASD	05/01/92	ARA-02	INT. TANK 1 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

AT1: CLP Metals
AT2: CLP Volatiles
AT3: CLP Semivolatiles/PCBs
AT4: Gamma Spectroscopy
AT5: Alpha Spectroscopy/Strontium-90
AT6:
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

COMMENTS

COMB = Combination of COMPOSITE and GRAB samples. COMPOSITE samples will be collected for CLP Metals, CLP Semivolatiles/PCBs, Gamma Spectroscopy, and Alpha Spectroscopy/Strontium-90. GRAB samples will be collected for CLP Volatiles.

SYRND = Systematic Random

Exterior samples at depths 8.5-9.5', 13.5-14.5' (8" Mainline), 13-14', 18-19' (Septic Tanks), and 15-16', 20-21' (Seepage Pit) will be collected only if contamination is detected using field screening instruments.

Table 3-2. (continued).

SAP Number: OU5-07
SAP Table No. 1
Date: 04/24/92 Revision: 1.0

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: CHARACTERIZATION AT ARA-I (SITE ARA-02) - OU 5-07

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Form No: SAP118

SAMPLE DESCRIPTION						SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										C1	CV	PS	R4	SA															
AI2016	REG	SLUDGE	COMB	BIASD	05/01/92	ARA-02	INT. TANK 1 - 2	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2017	REG	LIQUID-PHASE I	COMB	BIASD	05/01/92	ARA-02	INT. TANK 2 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2018	REG	LIQUID-PHASE II	COMB	BIASD	05/01/92	ARA-02	INT. TANK 2 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2019	REG	SLUDGE	COMB	BIASD	05/01/92	ARA-02	INT. TANK 2 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2020	REG	SLUDGE	COMB	BIASD	05/01/92	ARA-02	INT. TANK 2 - 2	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2021	REG	LIQUID-PHASE I	COMB	BIASD	05/01/92	ARA-02	INT. TANK 3 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2022	REG	LIQUID-PHASE II	COMB	BIASD	05/01/92	ARA-02	INT. TANK 3 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2023	REG	SLUDGE	COMB	BIASD	05/01/92	ARA-02	INT. TANK 3 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2024	REG	SLUDGE	COMB	BIASD	05/01/92	ARA-02	INT. TANK 3 - 2	SEPTIC TANKS	N/A	1	1	1	1	1															
AI2025	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 1	SEPTIC TANKS	8-9	1	1	1	1	1															
AI2026	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 1	SEPTIC TANKS	13-14	1	1	1	1	1															
AI2027	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 1	SEPTIC TANKS	18-19	1	1	1	1	1															
AI2028	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 2	SEPTIC TANKS	8-9	1	1	1	1	1															
AI2029	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 2	SEPTIC TANKS	13-14	1	1	1	1	1															
AI2030	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 2	SEPTIC TANKS	18-19	1	1	1	1	1															

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
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AT6:
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

C O M M E N T S

COMB = Combination of COMPOSITE and GRAB samples. COMPOSITE samples will be collected for CLP Metals, CLP Semivolatiles/PCBs, Gamma Spectroscopy, and Alpha Spectroscopy/Strontium-90. GRAB samples will be collected for CLP Volatiles.

SYRND = Systematic Random

Exterior samples at depths 8.5-9.5', 13.5-14.5' (8" Mainline), 13-14', 18-19' (Septic Tanks), and 15-16', 20-21' (Seepage Pit) will be collected only if contamination is detected using field screening instruments.

Table 3-2. (continued).

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SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: CHARACTERIZATION AT ARA-I (SITE ARA-02) - OU 5-07

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Form No: SAP118

SAMPLE DESCRIPTION					PLANNED DATE	SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD		AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										C1	CV	PS	R4	SA															
A12031	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	INTERIOR - 1	SEEPAGE PIT	1-1.5	1	1	1	1	1															
A12032	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	INTERIOR - 2	SEEPAGE PIT	1-1.5	1	1	1	1	1															
A12033	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 1	SEEPAGE PIT	10-11	1	1	1	1	1															
A12034	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 1	SEEPAGE PIT	15-16	1	1	1	1	1															
A12035	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 1	SEEPAGE PIT	20-21	1	1	1	1	1															
A12036	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 2	SEEPAGE PIT	10-11	1	1	1	1	1															
A12037	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 2	SEEPAGE PIT	15-16	1	1	1	1	1															
A12038	REG	SOIL	COMB	BIASD	05/01/92	ARA-02	EXTERIOR - 2	SEEPAGE PIT	20-21	1	1	1	1	1															
A12039	REG	LIQUID WASTE	GRAB	BIASD	05/01/92	ARA-02	DECONTAMINATION	WASTE WATER	N/A	1	1	1	1	1															
A12040	QC	SOLID MATERIAL	DUP		05/01/92	ARA-02	INT. MANHOLE 2	8" MAINLINE	N/A	1	1	1	1	1															
A12041	QC	LIQUID-PHASE I	DUP		05/01/92	ARA-02	INT. TANK 1 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
A12042	QC	LIQUID-PHASE II	DUP		05/01/92	ARA-02	INT. TANK 1 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
A12043	QC	SLUDGE	DUP		05/01/92	ARA-02	INT. TANK 1 - 1	SEPTIC TANKS	N/A	1	1	1	1	1															
A12044	QC	SOIL	DUP		05/01/92	ARA-02	INTERIOR - 1	SEEPAGE PIT	1-1.5	1	1	1	1	1															
A12045	QC	WATER	RNST		05/01/92	ARA-02	QC	RINSATE	N/A	3	3	3	3	3															

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
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AT6:
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

COMMENTS

COMB = Combination of COMPOSITE and GRAB samples. COMPOSITE samples will be collected for CLP Metals, CLP Semivolatiles/PCBs, Gamma Spectroscopy, and Alpha Spectroscopy/Strontium-90. GRAB samples will be collected for CLP Volatiles.

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Table 3-2. (continued).

SAP Number: OU5-07
SAP Table No. 1
Date: 04/24/92 Revision: 1.0

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: CHARACTERIZATION AT ARA-1 (SITE ARA-02) - OU 5-07

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Project Manager: R. J. BARGELT

Form No: SAP11B

SAMPLE DESCRIPTION						SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										C1	CV	PS	R4	SA															
A12046	QC	WATER	TBLK		05/01/92	ARA-02	QC	TRIP BLANK	N/A		3																		
A12047	QC	WATER	FBLK		05/01/92	ARA-02	QC	FIELD BLANK	N/A	1	1	1	1	1															

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

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AT4: Gamma Spectroscopy
AT5: Alpha Spectroscopy/Strontium-90
AT6:
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

COMMENTS

COMB = Combination of COMPOSITE and GRAB samples. COMPOSITE samples will be collected for CLP Metals, CLP Semivolatiles/PCBs, Gamma Spectroscopy, and Alpha Spectroscopy/Strontium-90. GRAB samples will be collected for CLP Volatiles.

SYRND = Systematic Random

Exterior samples at depths 8.5-9.5', 13.5-14.5' (8" Mainline), 13-14', 18-19' (Septic Tanks), and 15-16', 20-21' (Seepage Pit) will be collected only if contamination is detected using field screening instruments.

Table 3-3. Data Quality Objectives for Track 2 Investigation of OU 5-07 Site ARA-02.

Data Quality Objective Elements	INEL WAG 5 OPERABLE UNIT 07		
	ARA-02 Septic Tanks	ARA-02 Seepage Pit	ARA-02 Piping
Objective(s)	- Identify types and concentrations of contaminants within and exterior to the three tanks - Conduct risk evaluation	- Identify types and concentrations of contaminants within and exterior to the seepage pit - Conduct risk evaluation	- Identify types and concentrations of contaminants within and exterior to the concrete mainline - Conduct risk evaluation
Data Quality Factors			
Prioritized Data Use(s)	Site characterization, risk evaluation	Site characterization, risk evaluation	Site characterization, risk evaluation
Contaminants of Concern	Metals, VOCs, SVOCs, PCBs; gamma-, beta-, and alpha-emitting radionuclides	Metals, VOCs, SVOCs, PCBs; gamma-, beta-, and alpha-emitting radionuclides	Metals, VOCs, SVOCs, PCBs; gamma-, beta-, and alpha-emitting radionuclides
Risk-based Level of Concern			
Lead Mercury Barium Chromium^{+3}/$^{+6}$ Cesium-137 Cobalt-60 Uranium-235	(Hazard Index > 1, carcinogenic risk > 1E-04 to 1E-06) (see Table 3-1a)	(Hazard Index > 1, carcinogenic risk > 1E-04 to 1E-06) (see Table 3-1a)	(Hazard Index > 1, carcinogenic risk > 1E-04 to 1E-06) (see Table 3-1a)
Reporting Limits			
Lead Mercury Barium Chromium^{+3}/$^{+6}$ Cesium-137 Cobalt-60 Uranium-235	3 ug/L 0.2 ug/L 200 ug/L 10 ug/L 1.0 pCi/g - 0.5 pCi/g	3 ug/L 0.2 ug/L 200 ug/L 10 ug/L 1.0 pCi/g - 0.5 pCi/g	3 ug/L 0.2 ug/L 200 ug/L 10 ug/L 1.0 pCi/g - 0.5 pCi/g
Appropriate Analytical Levels	Site characterization and risk assessment: III and IV QA/QC and critical samples: IV	Site characterization and risk assessment: III and IV QA/QC and critical samples: IV	Site characterization and risk assessment: III and IV QA/QC and critical samples: IV
Critical Samples	One set of samples/phase from first tank; one set of samples exterior to second septic tank	One set of samples from pit base; one set of samples exterior to pit	One set of samples from the second manhole; one set of samples exterior to mainline (near manhole No. 2)
Data Quality Needs			
Sample/Analysis Procedures 1. Sample collection 2. Sample analysis	1. Use approved SOPs for liquid and sludge sampling 2. CLP TCL for VOCs, SVOCs, & PCBs; CLP TAL for metals; ERD-SOW-33 for gamma-, beta-, alpha-emitting radionuclides	1. Use approved SOPs for soil sampling 2. CLP TCL for VOCs, SVOCs, & PCBs; CLP TAL for metals; ERD-SOW-33 for gamma-, beta-, and alpha- emitting radionuclides	1. Use approved SOPs for sludge/solid sampling 2. CLP TCL for VOCs, SVOCs, & PCBs; CLP TAL for metals; ERD-SOW-3 for gamma-, beta-, and alpha- emitting radionuclides
Level I - Field Screening	Screen for VOCs using HNu PID or FID and radiological contamination; Used for Health and Safety	Screen for VOCs using HNu PID or FID and radiological contamination; Used for Health and Safety	Screen for VOCs using HNu PID or FID and radiological contamination; Used for Health and Safety

I. **Identification of decision types**, including the identification of data users and the determination of objectives in the site characterization process gaps

II. **Identification of data uses and needs**, including required data types for the different media of concern and the various data quality and quantity needs

III. **Design of a data collection program**, which is detailed in the FSP.

Individual components of the Stage I and Stage II DQO development process are addressed in the following subsections.

3.2.3 Stage I: Identification of Decision Types

3.2.3.1 Identification of Data Users. Data users can be subdivided into two general categories: primary and secondary users. Primary users are those organizations and individuals that are directly involved in Track 2 activities. Primary users of Track 2 information for OU 5-07 include:

- Waste Area Group 5 Manager
- U.S. Environmental Protection Agency
- Idaho Department of Health and Welfare
- Idaho National Engineering Laboratory.

Secondary data users are those individuals or organizations who rely mainly on outputs from the RI/FS studies to support their activities. Secondary users include the general public and special interest groups.

3.2.3.2 Track 2 Investigation Objectives and Decisions. The overall objectives of the OU 5-07 Track 2 investigation are to collect a sufficient amount of valid field data to determine the nature of waste sources potentially released to the environment at Sites ARA-02 and ARA-03 and to determine the risks present and future conditions pose to human health and the environment.

3.2.4 Stage II: Identification of Data Uses and Needs

Data uses and needs during the OU 5-07 Track 2 investigation fall into the following general purpose categories:

- **Site Characterization (SC)** - Data will be acquired to supplement existing data so that the nature of contamination at Site ARA-02 can be better defined. The currently existing data gaps have been identified in Section 3.2.1. These data gaps will be addressed through additional sampling.

- **Risk Evaluation (RE)** - Data will be acquired in order to evaluate the threat posed by contaminants at Site ARA-02 to human populations and environment. Risk evaluation data will be specifically required by the RPMs to determine which one of the following future site action alternatives is appropriate for each of the sites: (1) no further action, (2) interim action, or (3) RI/FS scoping.

The potential consequences (relative to actual site conditions) of incorrectly deciding the site is or is not a problem must be addressed. The main consequence of erroneously determining that either of the sites are not a problem is the potential for contamination to remain at concentrations which present an unacceptable risk to human health and/or the environment. This false negative could be mitigated by removing the contamination at some point in the future. The major concern associated with erroneously determining sites to be problems is the unnecessary expenditure of funds.

3.2.4.1 Data Types. The data types of interest for Site ARA-02 are presented in Table 3-4. Also provided in Table 3-4 are methods of determination for the data types, the intended uses of the data, and the analytical levels appropriate to the data uses.

3.2.5 Data Quality Needs

The various tasks and phases of a remedial investigation require different levels of data quality. Analytical quality levels applicable to the data needs at OU 5-07 are provided in Table 3-4. The five Analytical Levels III and IV are defined in Section 2.3.9. The assignment of analytical levels to the various data types are based on the intended use of the data and the QA/QC protocols available for the test methods being considered.

3.2.6 Data Quantity Needs

The DQOs for this investigation are of sufficient quality and quantity to accomplish the following:

- Detect the presence or absence and concentrations of potential contaminants at Site ARA-02: CLP VOCs, CLP SVOCs, CLP PCBs, CLP metals, and gamma-, beta-, and alpha-emitting radionuclides.
- Determine concentrations of contaminants in each of the ARA-02 septic system source terms to compare to the risk-based soil screening concentrations determined using Track 1 guidance (see Section 3.1.5).
- Produce data of sufficient quality to conduct a quantitative risk evaluation using methodology from *Track 2 Guidance Document* (to be published). A more complete discussion of the Track 2 risk evaluation and a summary of existing information will be included in the OU 5-07 *Track 2 Scoping Summary Report* (to be prepared upon receipt of validated data).

Table 3-4. Required data types for OU 5-07 Site ARA-02 samples.

Parameter (Data Type)	Method	Analytical Levels	Data Use[a]
CLP VOCs	CLP Methods[b]	III or IV[c]	SC, RE
CLP Metals	CLP Methods[d]	III or IV[c]	SC, RE
CLP SVOCs	CLP Methods[b]	III or IV[c]	SC, RE
CLP PCBs	CLP Methods[b]	III or IV[c]	SC, RE
Gamma-emitting radionuclides	Gamma spectroscopy[e]	IV	SC, RE
Beta-emitting radionuclides	Strontium-90[e]	IV	SC, RE
Alpha-emitting radionuclides	Alpha spectroscopy[e]	IV	SC, RE

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a. The acronyms used are defined below:
SC = Site characterization (Identify presence or absence and types and concentrations of contaminants; determine general vertical extent of contamination).
RE = Risk evaluation (baseline).

b. CLP SOW for Organics (EPA 1990a).

c. Critical and QA/QC samples will be validated to Analytical Level IV

d. CLP SOW for Inorganics (EPA 1990b).

e. Radiological analyses will be performed in accordance with ERP-SOW-33 (EG&G 1991b).

- Examine probable contaminant pathways to the degree required to support a decision on the future site action alternative.

In addition, the procedures presented are designed to ensure that:

- All sample and field measurements are consistent with project objectives.
- Samples are identified, preserved, and transported in such a manner as to ensure the integrity and validity of samples.
- Field measurements are collected in a manner to allow for comparison between existing and newly collected data to provide an adequate data base for achieving the objectives of the Track 2 investigation.

3.3 Sampling Location and Frequency

This section details the rationale behind the data collection program proposed for Site ARA-02 and the specifics of the proposed investigation process.

3.3.1 Introduction

The sampling design has been selected to meet the DQOs and scheduling requirements of the project. The sampling design may be amended after field screening results are evaluated and/or as visual evidence warrants. Generally, the OU 5-07 Track 2 investigation will focus on the determination of the types and concentrations of contaminants within the waste sources at Site ARA-02.

Activities to be conducted under the proposed field investigation program include the following:

- Field screening of the areas to be sampled within Site ARA-02 using industrial hygiene and radiological field instruments.
- Characterization of material within the 8-in. concrete mainline leading from the source buildings to the septic tanks and from the septic tanks to the seepage pit (see note).
- Characterization of sludge and liquid material within each of the three septic tanks (see note).
- Characterization of soil (or sludge if present) at the base of the seepage pit (see note).
- Characterization of soil adjacent to the mainline and septic tanks to determine if septic system materials have leaked from the structures (see note).
- Characterization of soil adjacent to the seepage pit (see note).

Note: Samples collected at Site ARA-02 as part of the Track 2 investigation of OU 5-07 will not produce representative data because of the biased nature of sample location selection. The intended uses of the data collected from this investigation, namely to conduct a baseline Track 2 quantitative risk evaluation and to support a Track 2 decision as to the appropriate future site action, do not require representative data. Representative data are required for conducting a quantitative risk assessment as part of an RI/FS (additional samples will be collected if an RI/FS is the outcome of this Track 2 investigation). Biased sample locations were selected based on the proximity to the expected contaminant source.

The sampling strategy was devised largely because of the expected heterogeneity between and within the septic system components. As certain constituent of the waste materials settle out or are precipitated as they pass through the system, there should be a general trend towards a reduction in the levels of contamination. Analysis of waste materials both between and within each system component is required to better characterize the source terms present.

Samples will be collected from four sample media types: (1) surface and subsurface soils contiguous to the ARA-02 septic system components; (2) solid material in the ARA-02 septic system piping consisting of soil and gravel, (3) sludges in the septic tanks and seepage pit (if present), and (4) liquids in the ARA-02 septic tanks. Potential pathways for release of contaminants at OU 5-07 are limited by site conditions such as isolation, topography, climate, depth to groundwater (see Section 3.1.2), absence of a hydraulic gradient, amount of disposed wastes, and location of potential or detected contaminants. Consequently, no samples will be taken below the soil/basalt interface. Waste water produced during sampling and decontamination activities will be containerized and analyzed to ensure proper handling and disposal of waste generated during this characterization effort.

Table 3-4 provides a detailed DQO summary table of data types, analytical/measurement methods, required analytical levels, and data uses for samples to be collected from Site ARA-02 during this investigation. The types, locations, and number of samples to be collected have been selected based on existing field screening and sample results, the limited historical information available, and engineering judgement. Table 3-2 summarizes the sample collection strategy for Site ARA-02. A sufficient number of QA/QC samples, consisting of duplicates, equipment rinsate blanks (rinsates), trip blanks, and field blanks will be included to satisfy the QA/QC requirements for the field investigation. ERD-approved analytical laboratories will analyze all samples. The sample numbering system to be used during this investigation is discussed in Section 3.4.2.

3.3.2 Site ARA-02 Sampling Strategy

Samples collected for gamma spectroscopy analysis from the ARA-02 sanitary septic system 8-in. mainline contained the radionuclides Cesium-137, Cobalt-60, and Uranium-235 (see Section 3.1.3.1); no other sampling of the system has occurred. Additional sample data is required to enable risks to human health and the environment to be assessed. In order to fill the data gaps, samples will be collected from the concrete mainline pipe, each of the three septic tanks, the seepage pit, and soils surrounding the system components. Figure 3-7 shows the locations of samples to be collected exterior to the septic system components. Samples collected along the exterior of the mainline piping and outside of the septic tanks will be used to evaluate the integrity of the system. The project HPT and IH will conduct field screening for radiological contamination and organic vapors, respectively, throughout sampling activities. Samples will be analyzed for CLP metals, CLP VOCs, CLP SVOCs, and CLP PCBs, and for gamma-, alpha-, and beta-emitting radionuclides by gamma spectroscopy, alpha spectroscopy, and strontium-90 analysis, respectively (see Table 3-2).

One set of composite samples will be collected from the 8-in. mainline at each of the three manhole access locations. Locations of the three samples to be collected along the exterior of the mainline were selected using systematic random techniques and are shown in Figure 3-7. The entire length of the mainline (approximately 720 ft) was divided into three sections of equal length (approximately 240 ft). Each of the three 240-ft sections were then divided into 80 subsections, each 3 ft in length. A random number generator was used to select a number from 0 to 80, the selected number being commensurate with the subsection to be sampled within each of the 240-ft mainline sections. A unique random number was generated for each of the three sections. One set of composite samples will be collected at each of the three exterior mainline sample locations at a depth approximating the depth of the bottom of the piping (3.5-4.5 ft bgs).

Additional samples may be collected below the specified depths at each of the soil borings located exterior to the mainline, septic tanks, and seepage pit. Soil samples will be observed for abnormal discoloration and unusual odors, and will be screened for organic vapor headspace concentrations and radiological contamination using field screening instruments. If no radiation or organic vapors are detected in the material collected from the first specified depth (commensurate with the approximate depth of the bottom of each system component), no additional samples will be collected for analysis. However, if contamination is detected in the sample material, the boring will be extended as an initial attempt to determine the vertical extent of contamination. Continuous field screening readings will be taken during borehole drilling. Additional samples will be collected for analysis from each borehole (a) every 5 ft below the initial sample depth until no further contamination is detected using field screening instruments or bedrock is encountered, or (b) at the point no further contamination is detected or bedrock is reached (when less than 5 ft below initial specified sample depth). At a minimum, the samples collected at the depths specified in Table 3-2 will be submitted for analysis.

Sampling of the septic tanks will occur through two manholes accessing each tank. Liquid samples will be collected first to prevent mixing of the liquid and sludge layers. One set of composite samples will be collected from each phase of liquid present in each of the septic tanks (it is not known if vertical separation has occurred). The liquid within each of the tanks is expected to be more homogeneous than the sludge and the collection of one composite sample from each phase present in each tank will be sufficient to characterize the liquid source term. Two sets of composite samples will be collected from the sludge present in each of the septic tanks because of the potential heterogeneity of sludge both within and between the tanks. The collection of two sets of sludge samples per septic tank will increase confidence in the results, although actual confidence intervals cannot be calculated with only two data sets. One set of analyses will be taken from sludge near the mainline inlet and the other from near the outlet. Sample locations outside of the septic tanks will be biased in regard to proximity to a potential contamination source area and will therefore be placed 2 ft from the outside of the second septic tank, one on either side of the tank (see Figure 3-7). Sample depths for these samples will approximate the depth of the base of the septic tanks (8.0-9.0 ft bgs). Additional soil samples may be collected below this depth based on field screening and/or visual or olfactory observations according to the methodology described above for the mainline exterior samples.

Two sets of composite samples will be collected from the soil just beneath the 1 ft depth of gravel bed material constituting the base of the seepage pit. Sampling logistics do not allow for the collection of additional samples within the seepage pit from a greater depth. The construction of the seepage pit (see Figure 3-3) is such that the screened gravel surrounding the structure acts as a lateral and vertical conduit for system effluent. Samples collected from two soil borings located approximately 2 ft distant from the seepage pit walls, one on either side of the pit (see Figure 3-7), consequently be typical of seepage pit contamination. Composite samples will be collected from a 10.0 to 11.0 ft depth at each of these two sample locations. This sample depth approximates the depth of the base of the seepage pit. Additional soil samples may be collected at greater depths from the exterior soil borings following the methodology previously described. The sampling strategy described above will evaluate the general lateral and vertical extent of contamination resulting from infiltration of system effluent reaching the seepage pit.

Specific sampling equipment and procedures to be used for collecting subsurface soils, sludge, and liquid samples from Site ARA-02 are discussed in Section 3.5.

3.3.3 Background Sample Collection

Background sample data to be used will be those background data collected during 1990 sampling of the ARA-I Chemical Evaporation Pond (Site ARA-01). These background samples were collected from an area approximately 500 to 800 ft southeast of the pond. The ARA-01 Chemical Evaporation Pond is located approximately 110 ft south of the ARA-02 septic tanks, 425 ft southwest of the ARA-02 seepage pit, and 225 ft southeast of Site ARA-03.

3.3.4 Critical Sample Collection

Critical samples collected from Site ARA-02 will include, as a minimum:

- One set of samples collected at 3.5-4.5 ft depth exterior to the mainline piping (sample location nearest Manhole No. 2)
- One set of samples collected at 8.0-9.0 ft depth exterior to the second septic tank

- One set of samples collected at 10.0-11.0 ft depth exterior to the seepage pit
- Samples collected from the second manhole
- One set of samples from the sludge and from each liquid phase in the first septic tank
- One set of samples collected from the base of the seepage pit.

Completeness for critical samples must be 100%.

3.3.5 Management of Investigation-Derived Waste

Investigation-derived wastes (IDW) produced during this project will include the following:

- Decontamination fluids
- Miscellaneous trash, including personal protective clothing and sampling supplies
- Excess sample materials not used or archived for laboratory analysis (including samples returned from laboratories after analysis.

Waste minimization practices will be employed during this investigation through a reduction of waste containing a radiological or hazardous waste component, and recycling.

IDW falls into one or more of the following categories:

- Clean (non-radioactive and non-hazardous)
- RCRA hazardous waste (characteristic or listed)
- Waste contaminated with CERCLA hazardous substances
- Waste contaminated with CERCLA hazardous substances and radionuclides
- Mixed (radioactive and hazardous waste)
- Radioactive
- Unknown.

Any site where contaminants are suspected will require some characterization activities. Field screening mechanisms, process knowledge, or past analytical data will be utilized to determine if radiological, hazardous substances, or hazardous waste are expected. Preliminary characterization of IDW will be conducted by field screening and applying process or historical knowledge.

The FFA/CO supersedes the COCA and brings all sites listed in the agreement under CERCLA jurisdiction. One of the most significant modifications includes transfer of the investigation and cleanup of releases at the INEL from the authority of RCRA to CERCLA. This applies only to historical releases to the environment. Current or new releases at the INEL are subject to RCRA corrective actions. IDW shall generally be managed in accordance with CERCLA requirements, although the IAG determines what is controlled by CERCLA and what is controlled by RCRA. IDW shall be temporarily stored in

CERCLA Storage Facilities (CSFs) (rather than temporary accumulation areas) pending the requisition of validated sample results and subsequent determination as to the type of IDW. It is currently proposed that each Waste Area Group (WAG) be designated as an area of contamination (AOC). One CSF per WAG would subsequently be established to manage all IDW produced during CERCLA activities at each of the OUs within a particular WAG. During site characterization activities, IDW should remain within the designated AOC, otherwise, the exemption to the 90-day temporary storage under RCRA does not apply.

The distinctive category of the IDW determines the applicable methodologies for management of the waste material. Analyses types and methods for the determination of hazardous waste have been selected based on guidance presented in 40 CFR Part 261, Hazardous Waste Management System; Identification and Listing of Hazardous Waste; and Toxicity Characteristics Revision; Final Rule (Federal Register 1990). The various types of IDW to be produced during this investigation and procedures to be followed for managing the waste are discussed in the following subsections.

3.3.5.1 Decontamination Fluids. Containment vessels (5-gal poly carboys or other approved, leak-proof container) will be available to collect decontamination water and any other waste water generated during this investigation (i.e., wash water). Containers will be labeled to indicate the site, contents, and date of sample collection. The water in each carboy (if more than one is required) will be composited and a single set of samples collected for analysis for CLP metals, CLP VOCs, CLP SVOCs, CLP PCBs, and alpha-, beta-, and gamma-emitting radionuclides (see Table 3-2). Equipment and procedures for sample collection of waste water are discussed in Section 3.5.2.4. Samples collected from waste water will be grab samples collected by pouring water directly from the carboy into the required sample container. The containers will be sealed and transported to the WAG 5 CSF pending receipt of sample analysis results. Decontamination fluids will be managed according to the type of hazardous and/or radioactive waste it contains as determined by sample analysis results.

3.3.5.2 Miscellaneous Wastes. All disposable protective clothing and sampling supplies (i.e., rags, paper and plastic bags, aluminum foil, etc.) will be presumed hazardous and will be placed in a DOT 17C 55-gal drum(s). Drums will be sealed and transported to the WAG 5 CSF where the materials will be stored pending receipt of sample analysis results. Miscellaneous wastes will be managed according to the type of hazardous and/or radioactive waste it contains as determined by sample analysis results.

3.3.5.3 Excess Sample Material. The SOW prepared to procure laboratory services should contain a discussion that all samples other than those that are radioactively contaminated (or mixed waste) are to be disposed of by the laboratory conducting the analysis. The ERD will accept and manage all samples containing radioactivity. Samples that are determined to be nonhazardous as a result of analysis may be returned to the place of origin (i.e., corresponding soil boring or septic system component).

3.3.6 Quality Assurance/Quality Control Samples

Field QC checks are established by submitting QC samples to the analytical laboratory. Table 3-4 provides a summary of the types and numbers of QA/QC samples to be collected during this investigation. The types and frequency of collection for field QA/QC samples are provided below:

- **Field duplicates.** Field duplicates are defined as two independent samples collected in such a manner that they are equally representative of the variables of interest at a given point in space and time. Duplicate samples provide an estimate of sampling precision. Duplicates will be collected only when the amount of sample material present is sufficient to collect two sets of analyses. Samples collected for CLP VOC analysis will not be homogenized because this increases volatilization. The total number of field duplicates will be at least 5% of each analysis type and 10% of the total number of field samples. Duplicate samples will be collected from the interior of Manhole No. 2, the sludge and each liquid phase present in the first septic tank, and the base of the seepage pit (see Table 3-2). Duplicate samples will be analyzed for the same analytes as the corresponding sample and will be identified as normal field samples to disguise them from the laboratory.

- **Rinsates (equipment blanks).** Rinsate is defined as the final analyte-free water rinse collected from equipment decontaminated during a sampling event. Equipment blanks are made of ASTM Type II reagent water that has been poured through the sampling device, transferred into the sample bottle, and then transported to the laboratory for analysis. The total number of rinsate samples will be at least 5% of the total number of field samples. A minimum of one set of equipment blanks will be collected whenever there is a change in sample collection procedures, sample decontamination procedures, sampling equipment, or sample collection personnel. Approximately three sets of rinsates will be collected from sampling equipment and will be analyzed for all analyses included for the particular sample collected with that equipment (see Table 3-2). The results of the rinsate analyses will be used to evaluate the decontamination process, the final rinse water, and the sample containers for contamination.

- **Trip blank.** Trip blanks are defined as samples that originated from analyte-free water from the laboratory taken to the sample site (in a VOA vial) and returned to the laboratory with the samples to be analyzed for CLP VOCs. One trip blank shall accompany each cooler containing VOC samples. The results of the trip blank analyses will help determine the level of contamination, if any, introduced to the sample during shipping, handling, and storage. The exact number of trip blanks will depend on the number of sample shipments required during the project.

- **Field blanks (ambient conditions blanks).** Field blanks are defined as samples collected in the field by pouring ASTM Type II reagent water into sample containers. These blanks are handled as samples and then sent to the laboratory for analysis. One ambient conditions blank will be collected per day during sampling, with a minimum of one collected at each site. Field blanks will be analyzed for CLP VOCs, SVOCs, metals, and PCBs, and by gamma spectroscopy, alpha spectroscopy, and strontium-90 analysis. The total number of field blank samples will be at least 5% of the total number of field samples.

3.4 Sample Designation, Sample Documentation, and Sample Custody

3.4.1 Introduction

The following sections summarize sample designation and required sample documentation and custody practices. Sample designation is the numbering system used to identify each sample uniquely. Documentation includes all field documents used to record field data and document sampling procedures. Sampling documents include sample container tags and labels, and COC forms. Sample integrity is maintained through proper COC procedures.

3.4.2 Sample Designation

A systematic ten character field sample identification code will be used to uniquely identify each sample. The uniqueness of the sample number to the individual sample is a key field in all environmental data bases and is crucial for maintaining consistency and ensuring that no two samples are assigned the same identification code. The sample identification code used in this investigation has been cleared with the Integrated Environmental Data Management System Unit, which is chartered by the ERD as the organization responsible for ensuring unique sample identification. The identification code will not reflect that a sample is a QA/QC sample.

The first three characters of the sample number designate the general sampling activity (OU 5-07 Track 2 investigation), while the next three characters designate differences in physical sample locations (e.g., mainline pipe samples vs. septic tank samples). The seventh and eighth characters designate the sequence of sample collection, while the final two characters identify the analysis type for the sample. Table 3-2 identifies only the sample number root (first six characters) instead of all ten characters in order to simplify the use of this table by the field sampling team. Table 3-2 is used to compile a sampling and analysis plan database, which is then used to generate preprinted tags and labels containing the entire ten-character sample number.

Additional fields included in the sampling and analysis plan table (Table 3-2) are sample type (regular, QC, split, etc.), sample media (soil, sludge, liquid, etc.), collection type (grab, composite, trip blank, rinsate, etc.), and collection method. Also identified in the table are general and specific sample collection locations, sample depths, analysis types requested, and the planned date of collection.

Each sample number will be recorded in the sample logbook, shipping logbook, and on a COC form. The sampler's initials, date, and time the sample was obtained will be written on the sample label and tag. After collection, identification, and required preservation, the sample will be maintained under COC procedures (discussed in Section 3.4.4).

3.4.3 Sample Documentation and Management

The FTL is responsible for controlling and maintaining all field documents and records and for ensuring that all required documents are submitted to the Administrative Record and Document Control (ARDC) at the conclusion of the project. Sample documentation and custody procedures for this project are based on EPA-recommended procedures that emphasize careful documentation of sample collection and sample transfer. To ensure that all of the important information pertaining to each sample is recorded, the following documentation procedures will be executed.

All original data recorded in field logbooks, on sample labels and tags, or in custody records, as well as other data sheet entries, will be written with permanent, black, waterproof ink. If an error (e.g., incorrect date or sample depth) is made on the document, corrections will be made by crossing a line through the error (in such a manner that the original entry can still be read) and entering the correct information. All corrections will be initialed and dated. The serial or identification number and disposition of all controlled documents (e.g., COC forms) will be recorded in the FTL's daily logbook. If any documents are lost, a new document will be completed. The loss of the document and an explanation of how the loss was rectified will be recorded in the document control logbook. The serial or identification number and disposition of all damaged or destroyed field documents will also be recorded. All voided and completed documents will be maintained in appropriate ARDC files.

3.4.3.1 Sample Container Labels and Tags. Waterproof, gummed labels and tags for samples to be analyzed by an analytical laboratory will be supplied by EG&G Idaho. Labels containing information concerning the name of the project, the sample identification number, and the analysis type will be used. Information concerning sample date, time, preservation used, field measurements or hazards, and the sampler's initials will be filled out during field sampling. Clear plastic tape will be placed over the label to protect it from damage. Figure 3-8 is an example of a sample container label. A tag will be attached in the field to each sample container using rubber bands. The tag will contain the same information as the labels. The date and time of sampling will be recorded in the field. Figure 3-9 is an example of a sample container tag. Labels and tags will be distributed as needed and will remain in the custody of the FTL when not in use.

3.4.3.2 Field Logbooks. All information pertinent to field screening and/or sampling will be recorded in appropriate field logbooks. Logbooks to be used by the field sampling team during the OU 5-07 Track 2 investigation will be supplied by the ARDC and will consist of FTL's logbooks (daily, sample, sample shipping, and field instrument calibration/standardization). In addition, the project HPT and IH are required to maintain a health physics and industrial hygiene logbook, respectively. Logbooks will be kept in accordance with ERD PD 4.2, "Logbooks." Field logbooks will be waterproof, bound books with consecutively numbered pages.

Field logbooks will be used to record information necessary to interpret analytical data. All field information pertaining to sampling team activities will be entered in the logbooks. Entries will be dated and signed by the individual making the entry. All logbooks will be QC checked daily for accuracy and completeness by the FTL or an appointed designee. The person responsible for QC checks will sign their name in the appropriate space, indicating the above information is true and correct. Entries in the logbooks will include the following general information:

- Names and affiliations of personnel on site
- General description of each day's field activities
- Documentation of weather conditions during sampling
- Location of sampling (station number as description)
- Name and address of field contact (on cover of logbook).

3.4.3.2.1 Field Team Leader's Daily Logbook— A project logbook will be maintained by the FTL. This logbook will contain a daily summary of all the team activities, problems encountered, deviations from the SAP, visitor log, and list of site contacts. For relatively small field activities, this information may be included in the sample logbook.

3.4.3.2.2 Sample Logbook— Sample logbooks will be used by the field teams. Each sample logbook will contain copies of the team activity log sheet (Figure 3-10) to maintain a chronological record of the team's daily activities. This logbook will contain logsheets (Figure 3-11) to

ARA-I OU 5-07, Site ARA-02	
SAMPLE ID NUMBER:	TIME:
DATE (ddmmyy):	SAMPLER:
ANALYSIS:	
FIELD MEASUREMENT/HAZARDS:	

Figure 3-8. Sample container label.

record a description of specific sample locations, depths, analysis types, sample jars and preservation methods used, and any changes in sampling method. Additional information to be recorded in sample logbooks includes:

- Type of sample matrix (e.g., soil, sludge, liquid, etc.)
- Date and time of collection, including QA/QC samples
- Chronological sequence of collection
- Observations of sample or collection environment, if needed
- Any field measurements made, such as field screening, etc.
- Sampler's name
- Sample type (composite, duplicate, etc.).

All QA/QC samples (field duplicates, equipment rinsate blanks, trip blanks, and field blanks) will be recorded in the sample logbook. A record of decontamination activities will also be included in this logbook, and will include information such as date, time, equipment decontaminated, samples collected immediately before and after decontamination, and any associated equipment rinsate blanks collected.

3.4.3.2.3 Sample Shipping Logbook— This logbook will be used to record the sample identification number, collection date, shipping date, cooler identification number, destination, date shipped, COC number, sample shipping classification, name of shipper, and QA check (see Figure 3-12).

3.4.3.2.4 Field Instrument Calibration/Standardization Logbook— Each piece of field equipment operated by the sampling team requiring periodic calibration or standardization will be recorded in a logbook for equipment calibration data. This logbook will contain logsheets to record the date, time, method of calibration, and instrument identification number (Figure 3-13).

3.4.3.2.5 Health Physics Logbook— All radiological measurements, data and time of measurement, instrumentation used, and results will be recorded by the HPT.

3.4.3.2.6 Industrial Hygiene Logbook— IH data, including all measurements required by the Task Specific HSP (EG&G 1992) will be logged.

ARA-I OU 5-07, Site ARA-02		
AREA: ARA-I OU 5-07, Site ARA-02		
ANALYSIS	DATE (ddmmyy):	TIME:
SAMPLE ID NUMBER:		

Figure 3-9. Sample container tag.

SAMPLE LOGBOOK

RECORDED BY: ________________ QA CHECK BY: ________________

Figure 3-10. Sampling team activity log sheet.

SAMPLE LOGBOOK

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

RECORDED BY: ______________________ QA CHECK BY: ________________

Figure 3-11. Sample log sheet (page 1).

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

SAMPLE DESCRIPTION: CODE (_____)

SOIL/ROCK
(00) Surf. Soil
(01) Sub. Surf. Soil
(02) Basalt
(03) Sediment Interbed
(04) Other

SEDIMENT/SLUDGE
(05) Pond/Impoundment
(06) Drum/Tank
(07) Other

AIR/GAS
(15) Soil Gas
(16) Other

LIQUIDS
(08) Pond/Impoundment
(09) Drum/Tank
(10) Plant Discharge
(11) Spring/Seep
(12) Perched Aquifer
(13) Regional Aquifer
(14) Other

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 3-11. Sample log sheet (page 2).

SAMPLE LOGBOOK

SAMPLE ID NUMBER	CONTAINER		ANALYSIS	PRESERVATIVE
	VOLUME	TYPE		TYPE/VOLUME

RECORDED BY: ______________________ QA CHECK BY: ______________

Figure 3-11. Sample log sheet (page 3).

SAMLE IDENTIFICATION NUMBER	DATE COLLECTED	LAB OR STORAGE AREA SHIPPED TO	DATE SHIPPED (COOLER NO.)	CHAIN-OF-CUSTODY NUMBER	COMMENTS AND SAMPLE SHIPPING CLASSIFICATION

SHIPPED BY: ______________________ (Signature) QA CHECK BY: ______________________ (Signature)

Figure 3-12. Logsheet from sample shipping logbook.

FIELD INSTRUMENT CALIBRATION/STANDARDIZATION LOG

Instrument Property or Serial Number: ________________________________

EG&G Calibration Class: __ EG&G Calib. Date: __/__/__ Expires: __/__/__

DATE	TIME	METHOD OF STANDARDIZATION/CALIBRATION AND SIGNATURE OF CALIBRATOR

Figure 3-13. Logsheet from field instrument calibration/standardization logbook.

3.4.3.2.7 Photograph Logbook— Photographs may be taken during this investigation. If taken, a photographic record will be documented in a photograph logbook. Information to be recorded includes:

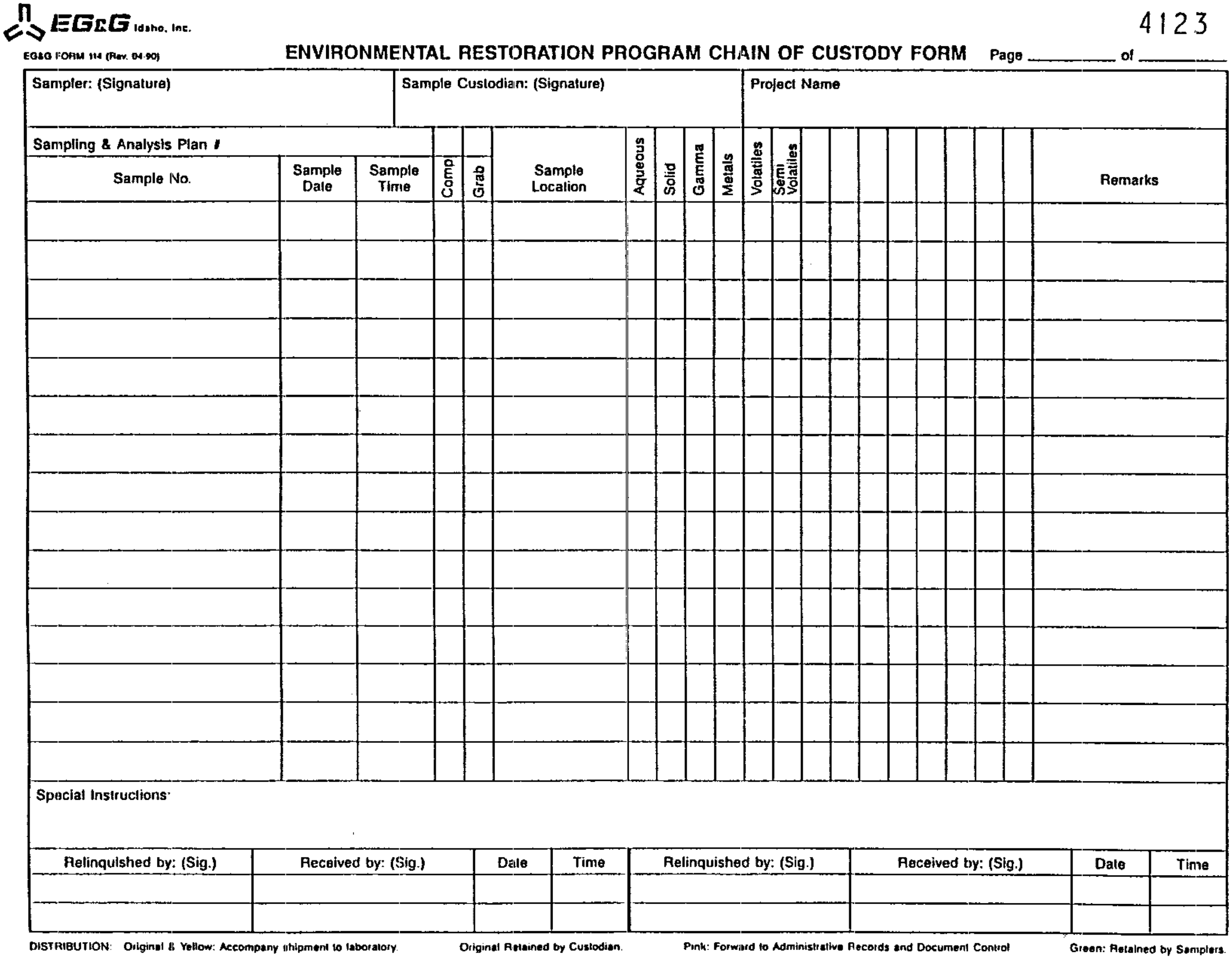
- Roll and frame number
- Time
- Photographer
- Location (e.g., Site ARA-02 septic tank #2)
- Subject (e.g., sludge sampling)
- Significant features
- Special image enhancement techniques (if used)
- Names of any personnel included in the photograph.

3.4.4 Chain-of-Custody Requirements

To maintain and document sample possession, COC procedures discussed in ERD PD 5.7, "Chain-of-Custody Record" will be followed. The purpose of COC is to document the identity of a sample and its handling from the point of collection until laboratory analysis is complete and the sample is disposed of. The custody record is completed by the individual designated by the project manager as being responsible for sample shipment and must be completed at the sampling site. The COC record will be a multiple-copy form that serves as a written record of the handling of the sample. An example of a COC form is included as Figure 3-14. The completed original COC form should be returned promptly to ARDC by the laboratory personnel upon initial receipt of the samples and completion of the form. The original form shall be a permanent part of the project records.

To maintain and document sample custody, the following general COC procedures will be followed:

- A minimal number of persons will handle the samples. The appropriate sample identification documents will be completed before or immediately following sample collection. Each of these documents will contain the sample's identification number.
- Parafilm will be wrapped around the lid and neck of the container.
- A COC form, and when needed, a sample analysis request sheet will accompany the samples.
- Samples will be transported in an ice-filled cooler and classified, packaged, and transported according to Department of Transportation (DOT) regulations (see Section 3.6).
- The use of any preservatives that become an integral part of the sample will be documented on the sample label, COC, and sample analysis request sheet.
- If, at any time, the COC is broken, the last person on the COC record will be contacted to identify and rectify the problem.
- COC seals will be used on all shipping containers.



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ENVIRONMENTAL RESTORATION PROGRAM CHAIN OF CUSTODY FORM Page ________ of ________

Sampler: (Signature)	Sample Custodian: (Signature)	Project Name

Sampling & Analysis Plan #																				
Sample No.	Sample Date	Sample Time	Comp	Grab	Sample Location	Aqueous	Solid	Gamma	Metals	Volatiles	Semi Volatiles									Remarks

Special Instructions:

Relinquished by: (Sig.)	Received by: (Sig.)	Date	Time	Relinquished by: (Sig.)	Received by: (Sig.)	Date	Time

DISTRIBUTION: Original & Yellow: Accompany shipment to laboratory. Original Retained by Custodian. Pink: Forward to Administrative Records and Document Control Green: Retained by Samplers.

Figure 3-14. Chain-of-custody form.

COC procedures will begin immediately after sample collection. The secureness of the lids on the containers will be checked before shipping the container to the analytical laboratory. Parafilm will be wrapped around the neck and lid of the container to secure the lid. The completed COC forms will be placed inside the coolers, and then the coolers will be taped shut. At least two custody seals will be placed on the coolers. Clear plastic tape will be placed over the seals to ensure the seals are not accidentally broken during shipment.

3.4.4.1 Transfer of Custody. When a sample changes custody, the person(s) relinquishing and receiving the sample will sign a COC record. Each change of possession will be documented. Thus, a written record of tracking sample handling will be established. A sample is considered to be under custody if it is in:

- Actual possession of the responsible person
- View, following physical possession
- Possession of a responsible person and is locked or sealed to prevent tampering
- A secure area.

Field personnel initially taking the sample are responsible for the care and custody of the sample(s) until it is properly transferred or delivered to laboratory personnel. All samples will be accompanied by a COC record. When transferring the possession of samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the record. The company from which the sample is relinquished and to which it is delivered and the reason for transfer will be noted. This record documents the transfer of samples from the custody of the sampler to that of another person or the permanent laboratory.

The relinquishing individual will record specific shipping data (airway bill number, office, time, and date) on the original and duplicate custody records. It is the project manager's responsibility to ensure that all shipping data are consistent and that they are made part of the permanent job file.

If sent by mail, the package will be sent by registered mail, with a return receipt requested. If sent by common carrier, a bill of lading will be used. Freight bills, postal service receipts, and bills of lading will be retained as part of the permanent documentation.

3.5 Equipment and Procedures

This section describes the equipment and general procedures for field screening and the collection of samples from the ARA-02 sanitary septic system. Sampling methods follow procedures described in *The Environmental Survey Manual* (DOE 1989) and *A Compendium of Superfund Field Operations Methods* (EPA 1987). All sampling methods and related field activities will conform to Federal, State, local, and other applicable regulatory agency requirements.

3.5.1 Field Measurements

Properties of soil, sludge, liquid, and atmospheric samples will be measured during OU 5-07 field activities. Areas to be sampled will be screened for radiological contamination and organic vapor concentrations prior to commencement of any sample collection activities. Samples collected during this investigation will be screened for radiological contamination at the time of collection and before shipment of samples. Radiological contamination will be determined by screening a portion of the sample material using radiological field instruments. Sample headspace may be measured for total organic vapor compound concentrations using an organic vapor analyzer (OVA) or photoionization detector (PID). Organic vapor headspace concentrations will be determined by filling a glass sample jar or plastic ziplock bag approximately half full of sample material. The sample will be allowed to warm at room temperature for approximately 15 minutes, at which time organic vapor headspace concentrations will be measured using an OVA or PID.

Ambient air will be monitored during all sampling activities. Ambient air monitoring during sampling will be conducted by an IH or qualified field sampling personnel. An OVA will be used to monitor concentrations of total organic vapors in the breathing space at worker chest level and within the septic tanks, seepage pit, and septic system piping. If concentrations of organic vapors in ambient air exceed levels specified in the Task Specific HSP (EG&G 1992), sampling will be stopped and action will be taken according to the HSP. Limited periodic personal air sampling may be performed in addition to ambient air monitoring.

Field screening equipment, its calibration and maintenance are discussed in the Task Specific HSP (EG&G 1992) and briefly in the following subsections. A discussion of field corrective actions is included in Section 3.5.1.3. Proper maintenance, calibration, and operation of each instrument will be the responsibility of the field personnel and the instrument technicians assigned to the project. All instruments and equipment used during the investigation will be maintained, calibrated, and operated according to the manufacturers' guidelines and recommendations. At a minimum, all instruments will be inspected and calibrated upon receipt from a vendor or from another office. A photocopy of each manufacturer's operation and calibration recommendation will be available to the FTL and equipment operator. All instruments are to be stored, transported, and handled with care to preserve equipment accuracy. Damaged instruments will be taken out of service immediately and not used again until a qualified technician repairs and recalibrates the instruments.

3.5.1.1 Equipment Calibration. Field equipment will be calibrated before use in the field as appropriate. The calibration procedures will follow standard manufacturers' instructions to ensure that the equipment is functioning within tolerances established by the manufacturer and required by the project. Copies of the instrument manuals will be available to the FTL and equipment operator. A record of field calibration of analytical instruments used by the field sampling team will be maintained in the Field Instrument Calibration/Standardization logbook by field personnel. These records will be subject to QA audit. In addition, any notes on unusual results, changing of standards, battery charging, and operation and maintenance will be included in the logbook. A routine schedule and record of instrument calibration will be maintained throughout the duration of the study.

Calibration of health physics instruments are performed every six months by Health Physics Instrument Laboratory (HPIL) personnel following approved procedures. The HPT performs a source check weekly and an operational check before each use and records these in the HP instrument calibration logbook. The manager of the HPIL maintains records of all instrument calibrations performed at the laboratory. Information about calibration of IH field instruments can be obtained from the calibration stickers on each piece of equipment and from the HPT instrument logbooks maintained at the CFA HP office. Calibration of the instruments used by industrial hygienists are performed annually. Routine standardization to known standards is performed by the IH before use. The standardization is documented in the IH logbook along with the calibration information from the manufacturer.

3.5.1.2 Equipment Maintenance. Maintenance responsibilities for field equipment are coordinated through an instrument technician who has, as his or her primary duty, responsibility for ensuring that available equipment and instrumentation are ready for use, and that returned equipment is checked out, serviced, and returned to available inventory in a timely manner. Maintenance during use is the responsibility of the project FTL. HPTs perform minor repairs and general maintenance of radiological screening instruments. For more laborious repairs, HP field instruments are returned to the HPIL for repairs and/or recalibration. Calibration/maintenance logbooks contain information on instrument maintenance, calibration, and repair. Backup equipment, spare parts, and other supplies will be brought to the field to every extent possible. In addition to spare parts and supplies inventories, INEL non-assigned equipment represents an extensive in-house source of backup equipment and instrumentation.

3.5.1.3 Corrective Action (Field Activities). During the course of the OU 5-07 Track 2 investigation, it will be the responsibility of the project manager and sampling team members to see that all procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event a problem arises, it is imperative that prompt action be taken to correct the problem. Corrective action is discussed in ERD QPP-149, Section 15, "Corrective Action" (EG&G 1991), ERD PD 5.13, "Corrective Action," and Section 2.13 of the QAPjP.

3.5.2 Sample Collection

The following sections provide general guidance on appropriate sampling equipment and procedures, although site-specific characteristics may require significant modifications to the suggested sampling strategies. Soil samples at Site ARA-02 will be collected using hand augers. A powered auger may be used to reach the desired sampling depth. Collection equipment and procedures used to collect sludge samples from septic tanks and solid material from the mainline pipe will be dependent upon the characteristics of the material to be sampled. Liquid samples will be collected by means of a peristaltic pump or by the container immersion method. The methods described are expected to be appropriate for most conditions encountered in the field. To prevent disturbance and mixing, liquid samples from the ARA-02 septic tanks will be collected before the sludge samples.

The containers and preservatives specified in Table 3-5 will be used for sample collection. Sample containers will be packaged according to the procedures outlined in Section 3.6.4. Samples requiring preservation will be immediately cooled to 4°C by placing them in a cooler filled with Blue Ice.

3.5.2.1 Soil Sample Collection Techniques. Soil samples will be collected using stainless steel hand augers. A description of and procedure for the use of hand augers is presented in DOE procedure E5.2.3 of the *Environmental Survey Manual* (DOE 1989). If hand augering is hindered by the presence of cobble and gravel in the soil, a powered auger may be used to reach the desired depth, at which point a hand auger will be used for sample collection. If the desired sampling depth cannot be reached, the sampling location will be moved approximately 2 ft from the initial location and another attempt will be made. The top few centimeters of soil contained in the hand auger will be discarded to prevent sample contamination from sloughing and/or powered auger cuttings.

Soil samples for analyses other than volatile organic analysis (VOA) will be depth composite samples. Depth composites are obtained when two or more consecutive auger subsamples are collected and composited in order to obtain a volume of sample sufficient for the selected analyses. Each subsample will be sieved (except those specified for CLP VOC analysis) through a 2-mm mesh stainless steel screen into a stainless steel, aluminum, or glass mixing pan. Following collection of all subsamples, the soil in the mixing pan will be thoroughly mixed with a stainless steel spoon, surveyed with an OVA or PID and radiological survey instruments, and placed into the appropriate sample containers (see Table 3-5). Radiological field screening of samples is discussed in Section 3.6.6.1. Excess sample material will be returned to the sample boring from which it was collected.

Samples for VOA require special handling and will, therefore, not be collected from the composited material used for the other analyses. To minimize the loss of volatile compounds, CLP VOC samples will be grab samples that are removed directly from the stainless steel hand auger and placed immediately into the appropriate sample container (see Table 3-5). Soil samples collected for CLP VOC analysis will be grabs collected from the first auger of soil obtained at the specified collection depths at

Table 3-5. Sample container, preservative, and holding time requirements.

Analysis (EPA Method)	Sample Type	Volume Requirement	Container Type	Holding Time	Preservative(s)
Soil/sludge samples					
CLP VOCs	Grab	125 mL	Wide-mouth (WM) glass jar	14 days	Cool to 4°C
CLP metals	Composite	250 mL	WM glass jar	6 months	Cool to 4°C
CLP SVOCs/PCBs	Composite	250 mL	WM glass jar	14 days	Cool to 4°C
Gamma spectroscopy	Composite	16 oz	plastic squat	1 year	None
Alpha spectroscopy/ Strontium-90	Composite	16 oz	plastic squat	1 year	None
Liquid samples					
CLP VOCs	Grab	3 x 40 mL	Glass VOA vial	14 days	Cool to 4°C
CLP metals	Composite	1 L	HDPE[a] bottle	6 months	Cool to 4°C, HNO_3 to pH < 2
CLP SVOCs/PCBs	Composite	2360 mL	Narrow-mouth amber glass jar	7 days/ext. 40 days/analysis	Cool to 4°C
Gamma spectroscopy	Composite	540 mL	plastic	1 year	HNO_3 to pH < 2
Alpha spectroscopy/ Strontium-90	Composite	1 L	HDPE[a]	1 year	HNO_3 to pH < 2

---

a. High-density polyethylene (HDPE)

each sample location.

3.5.2.2 Liquid Sample Collection Technique. Liquid samples for analyses other than volatile organic analysis will be composite samples collected using a peristaltic pump. Liquid samples for CLP VOC analysis will be grab samples obtained by the container immersion technique. Samples will be collected by accessing the two manholes present in each septic tank.

The thickness of the sludge and liquid layers present in the septic tanks is not known. Using a wooden stick, stainless steel tube, or the teflon tubing for the peristaltic pump, the thickness of the liquid layer will be determined. To collect the sample for CLP VOC analysis, a sample bottle will be attached to a stainless steel pole using stainless steel wire or non-volatile tape. The sample bottle will be submerged, taking care to not disturb the sludge, and the container will be allowed to fill. The container will be removed, preserved, and capped tightly. Liquid samples may be pre-preserved if the sample containers are not allowed to overflow during collection. The sample for CLP VOC analysis will require preservation after sample collection.

The peristaltic pump collection system consists of a pump capable of achieving a pump rate of 1 to 3 L/min. and an assortment of Teflon tubing to extend the suction intake. To have improved control of the Teflon tubing, a portion of the tubing will be attached to a stainless steel pole using wire or non-volatile tape. The tubing will be marked to indicate the measured thickness of the liquid layer in the particular tank. A representative composite sample will be collected by moving the tube from side to side and from the surface of the liquid to a point just above the sludge as samples are being collected. If possible, several liters of sample will be allowed to pass through the system before actual sample collection (this purge volume will be collected and returned to the source tank following sample collection). The appropriate sample containers (see Table 3-5) will be filled by allowing the continuous pump discharge to flow gently down the side of the bottle.

3.5.2.3 Sludge Sample Collection Technique. In general, sludge is defined as semi-dry material ranging from de-watered solids to high-viscosity liquids. Depending on the consistency of the sludge and the depth of water above the sludge, sludge samples may be collected using a stainless steel scoop, tube sampler, or mud auger.

The samples obtained from the 8-in. mainline pipe will be a composite of material scraped from the sides and bottom of the pipe accessed at each of the three manholes. Mainline samples will most likely be collected using stainless steel scoops or spoons used as scrapers. Because the manhole entrance is approximately 4.5-5.0 ft above the bottom of the mainline pipe, the selected sampling device will be attached to a long-handled stainless steel pipe or wooden stick. The sample for CLP VOC analysis will be a grab sample (more than one grab may be required to obtain the necessary sample volume) collected with as little disturbance of the sample material as possible. The material for the remainder of the analyses will be a composite sample consisting of subsamples that have been placed into a mixing pan and thoroughly mixed. The sample material will be surveyed with an OVA or PID and radiological survey instruments before placement into appropriate sample containers (see Table 3-5).

Sludge samples from the ARA-02 septic tanks will most likely be collected using long-handled stainless steel tube samplers or mud augers. To minimize the loss of volatile compounds, CLP VOC samples will be grab samples that are removed directly from the tube sampler or mud auger and placed immediately into the appropriate sample container. Other analyses will be collected from a composite sample of sludge. A sufficient number of subsamples to fill the required sample containers will be collected in a mixing pan, thoroughly mixed, and screened for volatile organics and radiological contaminants using field screening instruments before placement into the appropriate sample containers. Radiological field screening surveys of samples is discussed in Section 3.6.6.1. Excess sample material will be returned to the sample boring from which it was collected.

3.5.2.4 Sample Collection of Waste Water. The water produced during decontamination and sampling activities will be stored in 5-gal carboys and will be sampled and analyzed prior to disposal to ensure that hazardous constituents are not present. Samples collected from waste water will be grab samples collected by the pouring liquid from the carboys directly into the appropriate sample containers. The samples will be preserved immediately after collection.

3.5.3 Equipment Decontamination

To prevent contamination of samples, sampling equipment will be thoroughly decontaminated before and after sampling. Decontaminated sampling equipment will be surveyed for radiological contamination before collection of any samples, including rinsates. The sampling team will use only unused or previously decontaminated equipment; decontamination will be performed as equipment is used and clean equipment supplies are depleted. The field sampling team will be responsible for properly decontaminating the sampling equipment. A central decontamination area will be designated by the project manager.

Sampling equipment decontamination solutions will be containerized in 5-gal plastic carboys. Equipment blank samples (rinsates) will be collected by INEL personnel before starting field activities and after each decontamination event. Upon project completion, the decontamination solutions will be stored and disposed of as discussed in Section 3.3.5.1. Rinsate samples will be analyzed for the constituents shown in Table 3-4.

Sampling equipment that is not readily decontaminated will be discarded after each use. Discarded materials will be placed into appropriate receptacles and stored and disposed of as discussed in Section 3.3.5.2.

3.5.3.1 Soil and Sludge/Solid Sampling Equipment Decontamination. Decontamination procedures for sample equipment used to collect soil, sludge, or other solid samples are as follows:

- Wash and scrub equipment with a nonphosphate detergent
- Rinse with tap water
- Rinse with deionized water
- Air dry all equipment on a clean, nonplastic surface
- Wrap cleaned equipment in aluminum foil.

(No solvents will be used during equipment decontamination in an effort to minimize waste generation at the site).

3.5.3.2 Liquid Sampling Equipment Decontamination. The peristaltic pump used to collect liquid samples from the septic tanks will be thoroughly decontaminated before use and between sample locations to avoid cross-contamination. The pump will be decontaminated by flushing/pumping nonphosphate detergent solution and then potable water through the tubing and internal components. The exterior of the tubing will be wiped down with damp cloths.

3.6 Sample Handling and Analysis

This section on sample handling and analysis procedures outlines analysis methods to be used and the sample containers and preservatives required by the analytical laboratory. Also discussed are sample packaging and sample transportation requirements for sample shipment to the analytical laboratories.

3.6.1 Chemical Analyses Methods for Soil, Sludge, Liquid, and QA/QC Samples

Table 3-4 presents all chemical analyses methods to be performed during the ARA-I OU 5-07 Track 2 investigation. Standard EPA-approved analytical methods to be used for the analyses are referenced in CLP SOW for Organics (EPA 1990a) and CLP SOW for Inorganics (EPA 1990b). Radiological analyses will be performed in accordance with ERD-SOW-33.

3.6.2 Sample Jar Requirements

All samples will be contained in precleaned and certified bottles (I-Chem or equivalent) provided by the laboratory and prepared in accordance with EPA bottle-washing procedures. Table 3-5 outlines specific requirements for containers, sample volumes, preservation methods, and holding times for solid and liquid samples as identified in EPA guidance documents. Sample bottles for organic analysis will be filled with minimal headspace. The 40-mL VOA vials for liquids will be filled completely, with absolutely no headspace or air bubbles.

3.6.3 Sample Preservation

Preservation of samples is required to retain integrity. The most common preservation techniques include pH adjustment and temperature control. Field personnel will adhere to EPA and analytical laboratory recommended preservation techniques and holding times for the parameters of concern. Sample bottles from the analytical laboratory will contain the required types and amounts of preservatives. For samples not pre-preserved, preservation will be performed immediately upon sample collection. Specific preservation methods to be employed during sampling activities are presented in Table 3-5. The temperature will be checked periodically and recorded before shipment to ensure adequate preservation for those samples requiring a temperatures of 4°C for preservation.

Ice chests (coolers) containing frozen Blue Ice will be used to chill samples, if required, in the field after sample collection. A refrigerator or cooler will be provided on site for samples requiring overnight refrigeration. A log of refrigerator or cooler temperature will be kept by the FTL and recorded daily in the sample logbook.

3.6.4 Sample Packaging for Shipment

All samples will be packaged in accordance with EG&G Idaho *Company Procedures Manual* (EG&G 1991d), the EG&G Idaho *Hazardous Materials Transportation Manual* (EG&G 1991f), and EPA recommended procedures. Packaging procedures will vary depending on the suspected sample concentrations and DOT hazard class. At a minimum, samples will be packaged in a manner that will protect the integrity of the samples, as well as protect them against detrimental effects from possible leakage. All samples will be screened for radionuclide activity as discussed in Section 3.6.6.1 and classified before they are packaged and transported. Sample packaging of radioactive samples is discussed in Section 3.6.6.2.1.

All samples will be packaged carefully to avoid breakage or contamination, and will be shipped to the laboratory at proper temperatures. The following sample packaging requirements will be followed:

- Sample bottle lids will not be mixed. All sample lids will stay with the original containers.
- Sample containers will be packed in insulated and shock-resistant coolers. Individual sample bottles may be wrapped in bubble pack or other protective material before their placement in plastic bags to minimize the potential for contamination and breakage during shipment. The coolers will then be filled with Blue Ice.
- Empty space in the cooler will be filled in with inert packing material. Under no circumstances will locally obtained material (sawdust, sand, etc.) be used.
- All samples will be cooled unless "no cooling" has been specified.
- The COC record will be placed in a plastic bag and taped to the bottom of the cooler lid.

- All shipping containers will be taped and custody sealed for shipment to the laboratory. Filament tape will be wrapped around the cooler at least twice, and signed and dated custody seals will be applied to both front and back of the cooler. Clear cellophane tape will be placed over the custody seal to prevent accidental damage to the seal. Appropriate labels (e.g., analytical laboratory and return addresses, this side up, fragile, environmental samples, etc.) should be placed on the outside of the cooler. Remove all extraneous labels to avoid confusion.
- The FTL will call the laboratory before shipment to alert them of any shipments and to confirm that personnel will be available to receive and process samples. The FTL will also call after the expected receipt of samples to check upon their condition, holding times, cooling, etc.

The temperature of each batch of coolers (i.e., those arriving at the same time) will be checked upon receipt by the analytical laboratory. 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. The laboratory will communicate these temperatures to the FTL to ensure adequate coolant is used to cool the samples during shipment.

3.6.5 Sample Custody

COC procedures are discussed in Section 3.4.4 and will follow ERD PD 5.7, "Chain-of-Custody Record."

3.6.6 Transportation of Samples

All samples will be transported in accordance with EG&G Idaho *Company Procedures Manual* (EG&G 1991d), the EG&G Idaho *Hazardous Materials Transportation Manual* (EG&G 1991f), regulations issued by the DOT (49 CFR 171 through 178), and EPA sample handling, packaging, and shipping methods (40 CFR 261.C.3C.3). All samples for offsite analysis will be transported "priority one/overnight" via commercial air transport delivery services.

3.6.6.1 Radiological Screening of Samples. A radiation screening survey for shipping purposes will be performed in the field by a certified HPT. Screening will help determine whether the sample must be shipped as a radioactive shipment, how it should be packaged, and to which laboratory it can be shipped to for analysis. The HPT will first measure the external surface contact radiation level of the sample material in the homogenization pan or directly from the sample equipment for alpha, beta, and gamma radiation using direct reading instrumentation. The HPT will also survey each packaged sample before shipment. A contact, beta-gamma survey will be performed on the outside of the sample container, with readings taken on all sides. Samples with detectable radioactivity greater than 100 cpm above background will be sent to the RML for analysis of gamma-emitting radionuclides by gamma spectroscopy. Samples showing elevated radiation levels will be handled according to the EG&G *Radiological Controls Manual* (EG&G 1991c).

3.6.6.2 Identification and Classification of Sample Material. Project managers are responsible for determining, to the best of their knowledge, whether samples planned for collection are environmental, hazardous, and/or radioactive samples. After collection, and prior to packaging and shipping, each sample will undergo an identification and classification process. A review of the field sampling logbook [specifically, any recorded field measurements (radiation levels, organic vapor concentration, etc.)] and other relevant information concerning the material within the sample container will be conducted by the shipper and the project manager.

3.6.6.2.1 Radioactive Materials— According to DOT regulations, a radioactive sample is one that contains a specific activity greater than 2 x 10^3 pCi/g or 2 x 10^6 pCi/L. Based on the radiological screening results for alpha-, beta-, and gamma-emitting radionuclides (obtained from RML, Radiochemistry Unit, and field survey instruments), any samples that exceed either of these values will be packaged by an EG&G Idaho certified shipper (Course No. HZ110/111 or equivalent) in accordance with 49 CFR parts 173.401 through 173.478. The sections that will apply will vary according to the radioactive isotopes involved, the quantity of each isotope, the type of sample (liquid, sludge, soil), etc. Samples will be packaged in steel-belted coolers and checked by the HPT to ensure less than 0.5 mR/h on contact.

Limited quantity radioactive material is defined as any material whose activity per package does not exceed the limits specified in 49 CFR 173.423, using the appropriate A2 value for the sample from 49 CFR 173.435. If the identity of the radionuclides cannot be determined, the A2 value of 0.002 curies (or 0.4 curies when alpha-emitters are known to be absent) (49 CFR 173.433) will be used. Most radioactive samples will meet the definition of limited quantity radioactive material and are, therefore, exempt from the more stringent DOT requirements for greater activities of radioactive material.

3.6.6.2.2 Nonhazardous/Environmental Samples— Low concentration samples (the contaminant of highest concentration is present at less than 10 ppm) are defined as environmental samples and are packaged and shipped as described in Section 6.4.3.1 of *A Compendium of Superfund Field Operations Methods*, OSWER Directive 9355.0-14 (EPA 1987).

3.6.6.2.3 Hazardous Samples— Medium- and high-concentration samples are defined as hazardous (EPA 1987) and include the following:

- **Medium-concentration sample:** The contaminant of highest concentration is present at a level greater than 10 ppm and less than 15% (150,000 ppm).

- **High-concentration sample:** At least one contaminant is present at a level greater than 15%. Samples from drums and tanks are assumed to be high concentration unless information indicates otherwise.

3.6.6.3 Approvals Needed for Onsite Transportation of Samples. Transportation of radioactive and hazardous samples both onsite and offsite will be coordinated with the EG&G Idaho radioactive shipping coordinator.

3.6.6.4 Onsite Shipment of Samples. An onsite shipment is any transfer of materials within the perimeter of the 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.

3.6.6.5 Offsite Shipment of Samples. Sample shipping to offsite analytical laboratories via ground and air transport will be coordinated through EG&G Idaho Shipping/Receiving at CFA.

3.6.6.6 Analytical Laboratory Sample Acceptance Criteria. The analytical laboratories selected for chemical and radiological analyses will meet the acceptance criteria for this project so as to be capable of receiving and analyzing samples collected during the ARA-02 Track 2 investigation. The selected laboratory evaluate samples on a case by case basis.

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Federal Register, 1990, 55 FR 11827, "40 CFR Part 261 et al., Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," March 29.

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APPENDIX A

APPENDIX A

SCOPE OF WORK FOR
ARA-I OU 5-07 TRACK 2 INVESTIGATION

1. Site History and Description

ARA-02 Sanitary Septic System. The ARA-02 site consists of a sanitary septic system which serviced buildings 626, 627, 628 and Office trailer No.1 at ARA-I. This system has been inactive since 1988. The system includes 4" piping leading from the each of the source buildings into an 8" concrete main, three septic tanks, and an associated seepage pit discharge point. Process knowledge and as-built blueprints of the septic system and source buildings indicate that ARA-02 was a sanitary septic system; however, the system is known to be contaminated with radioactive materials based on existing field screening and sampling data. Field screening readings of 0.7 mR/hr and 40 mR/hr beta-gamma on contact were detected within the first and second manholes accessing the 8" mainline in January 1992. No alpha contamination was detected with field instrumentation in either manhole. Samples collected from the first and second manholes on the same date were analyzed by gamma and alpha spectroscopy and found to contain the radionuclides Cesium-137 at 9.2E-05 uCi/g and Cobalt-60 at 1.4E-03 uCi/g (first manhole) and Cesium-137 at 3.8E-04 uCi/g, Cobalt-60 at 6E-03 uCi/g and Uranium-235 at 1E-04 uCi/g (second manhole). No hazardous constituents are known to have been disposed of to the unit.

Site ARA-03. The ARA-03 site is located southeast of Building 627 at the former location of Office Trailer No. 1 and consists of a 900 ft^2 (30 x 30 ft) area, a portion of which was once covered with lead sheeting to provide shielding from radioactivity detected in the surface soil. The source of contamination is not known, but may have originated from a spill from Office Trailer No. 1, which temporarily housed a radiochemistry laboratory. The lead sheeting was removed in January 1991 and an area of surficial soils in the center of the area had radiation levels of up to 4 mR/hr beta-gamma on contact. Previous sampling was conducted at this site in April 1991. Twelve samples were collected and analyzed using the Toxicity Characteristic Leaching Procedure (TCLP) to determine if the soil contains RCRA hazardous constituents. Unvalidated results indicate that no hazardous waste is present. Samples were also collected for gamma spectroscopy, gross alpha, and gross beta analysis. Maximum concentrations of 0.9 pCi/g Co-60 and 6980 pCi/g Cs-137 were detected in the shallow (0-6 in.) soils. Below 18-in., the concentration of Cs-137 ranged from non-detection to 76 pCi/g; no Co-60 was detected. No alpha was detected and beta radiation detected was strongly correlated to Cs-137. The area remains roped off and posted for radioactive contamination and radiation levels.

2. Initial WAG Managers Evaluation

ARA-02. Based on the evaluation of existing information, it was decided that additional data for Contract Laboratory Program (CLP) metals, VOCs, SVOCs, and PCBs, and gamma-, alpha-, and beta-emitting radionuclides by gamma spectroscopy, alpha spectroscopy, and Strontium-90 analysis are required. Existing information regarding radioactive contamination will be reevaluated. If a risk evaluation determines that metal or organic contaminants pose a risk of less than a Hazard Index of 1 for non-carcinogenic contaminants and a cancer risk of less than 5×10^{-4} for carcinogenic contaminants and radiological contaminants pose a cancer risk of less than 5×10^{-4} for the scenarios presented in the conceptual model, then no further sampling will be recommended for this site. Otherwise, the site would undergo an interim action or be included in the WAG-5 comprehensive RI/FS.

ARA-03. Based on the evaluation of existing information, it was decided that additional data collection is not necessary. Process knowledge and previous sampling results will be reevaluated. A Track 1 investigation will be performed, and a decision will be made concerning the site. The basis for this determination will be documented further in the OU5-07 Track 2 Summary Report.

3. Scope for OU 5-07

ARA-02. The investigation of Site ARA-02 will consist of three phases:

Phase 1- Define types and concentrations of contaminants in the ARA-02 sanitary septic system through sampling program:

- Two biased composite samples will be collected from the gravel base of the seepage pit (0-6 in.); biased composite samples will be collected at two locations outside of the seepage pit at two depths (7.0-8.0 ft and 10.0-11.0 ft).

- Two biased composite samples will be collected from each phase (sludge and liquid) from each of the three septic tanks; biased composite samples will be collected at two locations outside of the septic tanks at a depth of 8.0-9.0 ft.

- Three biased composite samples will be collected from the 8-in. mainline (one from each of the three manholes); random composite samples will be collected at three locations alongside the mainline at a depth of 3.5-4.5 ft.

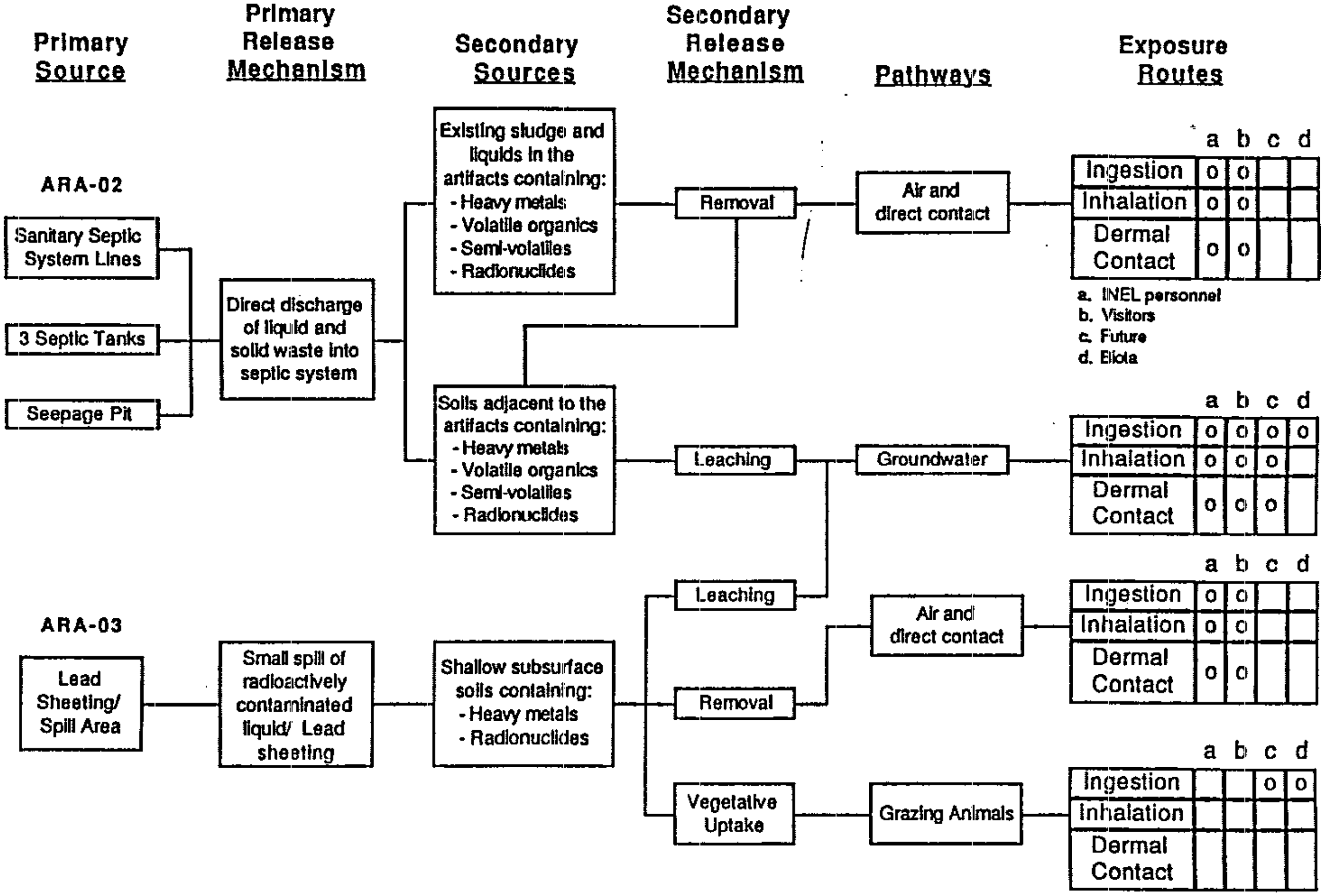
All samples will be analyzed for CLP metals, VOCs, SVOCs, and PCBs, and gamma-, alpha-, and beta-emitting radionuclides by gamma spectroscopy, alpha spectroscopy, and Strontium-90 analysis.

Phase 2- Evaluate all historical and process data and Track 2 environmental sample data.

Phase 3- Perform Baseline Risk Assessment/Evaluate Remedial Action objectives.

ARA-03. Additional data collection is not necessary. A Track 1 Assessment will be done, with the final information presented in the Track 2 OU5-07 Summary Report.

CONCEPTUAL MODEL FOR
OU5-07 SITES ARA-02 AND ARA-03



4. Data Quality Objectives Summary for OU5-07

Data Quality Objective Elements	INEL WAG 5 OPERABLE UNIT 07		
	ARA-02 Septic Tanks	ARA-02 Seepage Pit	ARA-02 Piping
Objective(s)	- Identify types and concentrations of contaminants within and exterior to the three tanks - Conduct risk evaluation	- Identify types and concentrations of contaminants within and exterior to the seepage pit - Conduct risk evaluation	- Identify types and concentrations of contaminants within and exterior to the concrete mainline - Conduct risk evaluation
Data Quality Factors			
Prioritized Data Use(s)	Site characterization, risk assessment	Site characterization, risk assessment	Site characterization, risk assessment
Contaminants of Concern	Metals, VOCs, SVOCs, PCBs; gamma-, beta-, and alpha-emitting radionuclides	Metals, VOCs, SVOCs, PCBs; gamma-, beta-, and alpha-emitting radionuclides	Metals, VOCs, SVOCs, PCBs; gamma-, beta-, and alpha-emitting radionuclides
Risk-based Level of Concern			
Lead Mercury Barium Chromium^{+3}/$^{+6}$ Cesium-137 Cobalt-60 Uranium-235	(Hazard Index > 1, carcinogenic risk > 5E^{-4})	(Hazard Index > 1, carcinogenic risk > 5E^{-4})	(Hazard Index > 1, carcinogenic risk > 5E^{-4})
Reporting Limits			
Lead	200 ug/L	200 ug/L	200 ug/L
Mercury	0.2 ug/L	0.2 ug/L	0.2 ug/L
Barium	200 ug/L	200 ug/L	200 ug/L
Chromium^{+3}/$^{+6}$	10 ug/L	10 ug/L	10 ug/L
Cesium-137	0.3pCi/g	0.3pCi/g	0.3pCi/g
Cobalt-60	0.3pCi/g	0.3pCi/g	0.3pCi/g
Uranium-235	NA	NA	NA
Appropriate Analytical Levels	Site characterization: III and V Risk assessment: IV and V	Site characterization: III and V Risk assessment: IV and V	Site characterization: III and V Risk assessment: IV and V
Critical Samples	One sample/phase/tank/analysis; exterior samples	One sample from pit base; exterior samples	One sample/manhole/location/analysis; exterior samples
Data Quality Needs			
Sample/Analysis Procedures 1. Sample collection 2. Sample analysis	1. Use approved SOPs for liquid and sludge and sampling 2. CLP TCL for VOCs, SVOCs, & PCBs; CLP TAL for metals; ERD-SOP-33 for gamma-, beta-, and alpha- emitting radionuclides	1. Use approved SOPs for soil sampling 2. CLP TCL for VOCs, SVOCs, & PCBs; CLP TAL for metals; ERD-SOP-33 for gamma-, beta-, and alpha- emitting radionuclides	1. Use approved SOPs for sludge sampling 2. CLP TCL for VOCs, SVOCs, & PCBs; CLP TAL for metals; ERD-SOP-33 for gamma-, beta-, and alpha- emitting radionuclides
Level I - Field Screening	Screen for VOCs using HNu PID or FID and radiological contamination; Used for Health and Safety	Screen for VOCs using HNu PID or FID and radiological contamination; Used for Health and Safety	Screen for VOCs using HNu PID or FID and radiological contamination; Used for Health and Safety

5. Deliverables and Corresponding Schedule

1.	Draft Scope of Work to EPA/IDHW	02-07-92
2.	EPA/IDHW comments on draft SOW to DOE	02-26-92
3.	Draft FSP to EPA/IDHW	03-20-92
4.	EPA/IDHW comments on draft FSP to DOE	04-03-92
5.	Revised Final FSP that incorporates EPA/IDHW comments approved by DOE	04-07-92
6.	Draft Summary Report to EPA/IDHW	12-01-92
7.	EPA/IDHW comments on Summary Report to DOE	12-30-92
8.	Revised Summary Report that incorporates EPA/IDHW comments	01-28-93

6. Signature of WAG/RPM

DOE WAG/RPM ______________________ Date __________

EPA WAG/RPM ______________________ Date __________

STATE WAG/RPM ______________________ Date __________

APPENDIX B

APPENDIX B

GWSCREEN CALCULATIONS AND CONCLUSIONS

The following discussion was obtained from *GWSCREEN: A Semi-analytical Model for Assessment of the Groundwater Pathway from Surface or Buried Contamination: Theory and User's Manual* (EG&G 1992).

GWSCREEN was developed for assessment of the groundwater pathway from leaching of radioactive and non radioactive substances from surface or buried sources. The code was designed for implementation in the Track I and Track II assessment of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites identified as low probability hazard at the Idaho National Engineering Laboratory (INEL).

The code calculates the limiting soil concentrations such that regulatory contaminant levels in groundwater are not exceeded. Groundwater concentration as a function of time may also be calculated. The model only considers drinking water consumption and does not include contaminant transfer to food products resulting from irrigation with contaminated water. Both radiological and non-radiological contaminants are considered in this code. Non-radiological assessment includes both carcinogenic and non-carcinogenic criteria. Carcinogenic assessment is based on a user input risk value. Non-carcinogen criteria is based on the reference dose (RfD). Radiological assessments are based on an annual effective dose equivalent limit for drinking water ingestion.

The code uses a mass conservation approach to model three processes: Contaminant release from a source volume, contaminant transport in the unsaturated zone, and contaminant transport in the saturated zone. The source model considers the sorptive properties and solubility of the contaminant. Transport in the unsaturated zone is described by a plug flow model. Transport in the saturated zone is calculated with a semi-analytical solution to the advection dispersion equation for transient mass flux input. The modeling approach used in GWSCREEN has its roots in the methodology proposed by the Nuclear Regulatory Commission. This methodology has also been employed in a number of other assessment codes including the Remedial Action Priority System and DECHEM.

One of the limitations of this code is that it does not deal with radioactive progeny. Radioactive progeny were ignored because very few of the sites identified for assessment contained radionuclides with long decay chains that would have significant ingrowth of decay progeny.

GWSCREEN has shown comparable results when compared against other codes using similar algorithms and has also been shown to provide bounding estimates of groundwater concentrations when compared to results from complex numerical codes. This code was designed for assessment and screening of the groundwater pathway when field data is limited. This model was not intended to be a predictive tool. Rather, it was intended to provide a bounding estimate of limiting soil concentrations that, after leaching, would not result in groundwater concentrations that exceed regulatory criteria limits (EG&G 1992).

GWSCREEN was run as part of the Track 2 investigation of Operable Unit 5-07 Site ARA-02 Sanitary Septic System. The contaminants of concern at Site ARA-02 are cesium-137, cobalt-60, uranium-235, barium, mercury, chromium^{+3}, and chromium^{+6}. Risk-based soil screening concentrations were calculated for the groundwater ingestion exposure route under a theoretical future residential scenario. For purposes of this report, it is assumed that a residence could be constructed in the vicinity of ARA-I after a period of institutional control of at least 30 years; however, a more likely scenario would be 100 yrs.

Soil screening concentrations are compared to known or estimated contaminant concentrations present in a source term. If known or estimated concentrations exceed the limiting soil concentration calculated using GWSCREEN, unacceptable risks to human health and/or the environment may exist and remedial action may be warranted. Calculated risk-based soil screening concentrations and actual concentrations present in Manholes No. 1 and 2 are summarized in Table B-1.

Table B-1. Summary table of risk-based soil screening concentrations for Site ARA-02 (residential scenario, groundwater ingestion pathway).

Contaminant	Soil screening concentration	Manhole No. 1 concentration	Manhole No. 2 concentration
Cs-137	2.01E+233 pCi/g	9.2E+01 pCi/g	3.8E+02 pCi/g
Co-60	3.47E+223 pCi/g	1.4E+03 pCi/g	6.0E+03 pCi/g
U-235	7.61E+004 pCi/g	ND[a]	1.0E+02 pCi/g
Barium	1.66E+007 mg/kg	—	—
Mercury	1.98E+005 mg/kg	—	—
Chromium^{+3}	2.65E+008 mg/kg	—	—
Chromium^{+6}	7.09E+004 mg/kg	—	—

a. ND = No detections.

GWSCREEN model runs showing input parameter values and results of calculations for the contaminants of concern at Site ARA-02 are provided in this Appendix. Input parameters for each of the contaminants were obtained from a variety of sources identified below.

- Integration time - default
- Length of source parallel to groundwater (GW) flow - site specific
- Width of source perpendicular to GW flow - site specific
- Thickness of source - site specific estimate
- Percolation rate - Track 1 Guidance Document
- Volumetric water content in source - GWSCREEN Manual (EG&G 1992)
- Volumetric water content in unsaturated zone - GWSCREEN Manual (EG&G 1992)
- Bulk density at source - default
- Sorption coefficient at source - Appendix F of Track 1 Guidance Document
- Bulk density in unsaturated zone - default
- Sorption coefficient in unsaturated zone - Appendix F of Track 1 Guidance Document
- Half-life of contaminant - contaminant specific
- Initial mass or activity - default
- Molecular weight - contaminant specific
- Solubility limit - default
- Bulk density of aquifer - default
- Porosity of aquifer - site specific
- Sorption coefficient in aquifer - Appendix F of Track 1 Guidance Document
- Dispersivity: x direction - default
- Dispersivity: y direction - default
- Pore velocity - site specific
- Well screen thickness - default
- Distance to aquifer below contamination - site specific
- Distance to receptor along (x) axis - default
- Distance to receptor along (y) axis -default
- Radiological dose conversion factor - contaminant specific

GWSCREEN output values include the following:

- Peak time--the time in years required for the highest concentration of contaminant to reach the groundwater
- Peak concentration--the maximum concentration of contaminant predicted to reach the groundwater
- Limiting soil concentration--the maximum concentration of a contaminant in the source term that, after leaching, would not result in groundwater concentrations that exceed regulatory criteria limits (concentrations in Table B-1 have been converted into pCi/g)

The results for cesium-137 (calculation provides for the daughter product of cesium-137, barium-137m), cobalt-60, and uranium-235 (see Table B-1) indicate that actual concentrations of these radionuclides within the manholes are at least two orders of magnitude less than the concentration required to exceed regulatory contaminant levels in groundwater. Actual concentrations of barium, mercury, and chromium$^{+3,+6}$ in the source term(s) are not known, though it is not likely that they are present at the risk-based soil screening concentrations presented in Table B-1.

GWSCREEN results indicate that contaminants are not present within the ARA-02 septic system components at concentrations posing an unacceptable risk to human health and/or the environment. However, adequate data do not exist on the subsurface geology at ARA-I and contaminants present in the remainder of the source terms (other than the mainline material) to completely rule out the groundwater pathway as being a concern; additional sampling is therefore required.

Cesium-137

```
TIME OF RUN 18:36:10.70
DATE OF RUN 05/04/92
INPUT FILE NAME: ara02cs.in
OUTPUT FILE NAME: ara02cs.out
   ***************************************************
   *                                                 *
   *     This output was produced by the model:      *
   *                                                 *
   *                    GWSCREEN                     *
   *        Version Control Copy,  Version 1.3       *
   *    A semi-analytical model for the assessment   *
   *    of the groundwater pathway from the leaching *
   *    of surficial and buried contamination.       *
   *                                                 *
   *                 Arthur S. Rood                  *
   *        Idaho National Engineering Laboratory    *
   *                 EG&G Idaho Inc.                 *
   *     Subsurface and Environmental Modeling Unit  *
   *                  PO Box 1625                    *
   *             Idaho Falls, Idaho 83415            *
   ***************************************************
  >>> TITLE OF PROJECT:
  ARA-02 SANITARY SEPTIC SYSTEM LIMITING SOIL CONCENTRATION CS-137
  ------------------------------------------------------------

  WARNING:  VARIABLE INTIME SHOULD BE EQUAL TO 1 YEAR
            FOR RADIOLOGICAL DOSE CALCULATION

  >>> INPUT DATA
  ***********************************************************
  INTEGRATION TIME (years)                        30
  LENGTH OF SOURCE PARALLEL TO GW FLOW (m)        2.00E+00
  WIDTH OF SOURCE PERPENDICULAR TO GW FLOW (m)    2.00E+00
  THICKNESS OF SOURCE (m)                         1.00E+00
  PERCOLATION RATE (darcy vel m/y)                1.00E-01
  VOLUMETRIC WATER CONTENT IN SOURCE              3.40E-01
  VOLUMETRIC WATER CONTENT IN UNSATURATED ZONE    6.80E-02
  BULK DENSITY AT SOURCE  (g/cm**3)               1.80E+00
  SORPTION COEFFICIENT AT SOURCE (ml/g)           0.00E+00
  BULK DENSITY IN UNSAT ZONE (g/cm**3)            2.00E+00
  SORPTION COEFFICIENT IN UNSAT ZONE (ml/g)       5.00E+02
  HALF LIFE OF CONTAMINANT (y)                    3.00E+01
  INITIAL MASS OR ACTIVITY (mg or Ci)             1.00E+00
  MOLECULAR WEIGHT (g/mole)                       1.33E+02
  SOLUBILITY LIMIT (mg/L)                         1.00E+06
  BULK DENSITY OF AQUIFER (g/cm**3)               2.00E+00
  POROSITY OF AQUIFER                             1.00E-01
  SORPTION COEFFICIENT IN AQUIFER (ml/g)          5.00E+02

  DISPERSIVITY X DIRECTION (m)                    9.00E+00
  DISPERSIVITY Y DIRECTION (m)                    5.00E+00
  PORE VELOCITY  (m/y)                            9.30E+02
  WELL SCREEN THICKNESS (m)                       5.00E+00
  DISTANCE TO AQUIFER BELOW CONTAMINATION (m)     1.84E+02
  DISTANCE TO RECEPTOR ALONG X AXIS       (m)     5.00E+01
  DISTANCE TO RECEPTOR ALONG Y AXIS       (m)     0.00E+00
  RADIOLOGICAL DOSE CONVERSION FACTOR (rem/Ci)    4.99E+04
  UNITS OF CONTAMINANT                            Ci

  INPUT DATA FILE CREATED BY:____________________ DATE   /  /
```

```
INPUT DATA CHECKED BY:     ____________________ DATE  /  /

----------------------------------------------------------

LIMITING SOIL CONCENTRATION CALCULATION
INITIAL SOURCE RESET TO 1.0 Ci
>>> INITIAL ACTIVITY CONVERTED TO MASS (mg)   1.12E+01
>>> VALUES CALCULATED IN SOURCE SUBROUTINE
******************************************************
LEACH RATE CONSTANT (1/y)                      2.9412E-01
UNSATURATED PORE VELOCITY (m/y)                1.4706E+00
DECAY CONSTANT (1/y)                           2.3105E-02
RETARDATION FACTOR (SATURATED)                 1.0001E+04
RETARDATION FACTOR (UNSATURATED)               1.4707E+04
SOLUBILITY LIMITED MASS (mg)                   1.3600E+09
SOLUBILITY LIMITED ACTIVITY (Ci)               1.2195E+08
TRANSIT TIME IN UNSAT ZONE (years)             1.8401E+06
FRACTION DECAYED DURING UNSAT TRANSPORT        1.0000E+00
------------------------------------------------------
>>> EXPOSURE DATA FOR LIMITING SOIL CONCENTRATION
******************************************************
BODY WEIGHT (kg)                   7.000E+01
AVERAGING TIME (days)              2.555E+04
WATER INTAKE RATE (L/d)            2.000E+00
EXPOSURE FREQUENCY (days/year)     3.500E+02
EXPOSURE DURATION (years)          3.000E+01
RADIOLOGICAL DOSE LIMIT (rem/y)    4.000E-03
CARCINOGENIC RISK CRITERIA         1.000E-06
HAZARD QUOTIENT                    1.000E+00
------------------------------------------------------
>>> RESULTS OF CALCULATIONS
******************************************************
PEAK TIME (y) = 1.840125E+06
PEAK CONC (Ci/m**3) = 0.0000E+00
AVERAGE INTEGRATED CONCENTRATION (Ci/m**3) = 7.8985-236
LIMITING SOIL CONCENTRATION (Ci/m**3) = 3.62+227
LIMITING SOIL CONCENTRATION (Ci/kg) = 2.01+224
LIMITING SOIL AMOUNT (Ci) = 1.45+228
LIMITING SOIL AMOUNT (mg) = 1.62+229
WARNING !!! THE LIMITING SOIL MASS OF  1.62+229 mg
EXCEEDS THE SOLUBILITY LIMITED SOURCE MASS OF  1.36E+09
```

Cobalt-60

```
TIME OF RUN 08:17:42.66
DATE OF RUN 05/05/92
INPUT FILE NAME: ara02co.in
OUTPUT FILE NAME: ara02co.out
   **************************************************
   *                                                *
   *     This output was produced by the model:     *
   *                                                *
   *                    GWSCREEN                    *
   *        Version Control Copy,  Version 1.3      *
   *    A semi-analytical model for the assessment  *
   *    of the groundwater pathway from the leaching *
   *    of surficial and buried contamination.      *
   *                                                *
   *                 Arthur S. Rood                 *
   *        Idaho National Engineering Laboratory   *
   *                 EG&G Idaho Inc.                *
   *     Subsurface and Environmental Modeling Unit *
   *                  PO Box 1625                   *
   *              Idaho Falls, Idaho 83415          *
   **************************************************
  >>> TITLE OF PROJECT:
  ARA-02 SANITARY SEPTIC SYSTEM LIMITING SOIL CONCENTRATION C0-60
  ----------------------------------------------------------------

  WARNING:  VARIABLE INTIME SHOULD BE EQUAL TO 1 YEAR
            FOR RADIOLOGICAL DOSE CALCULATION

  >>> INPUT DATA
  ***********************************************************
  INTEGRATION TIME (years)                             30
  LENGTH OF SOURCE PARALLEL TO GW FLOW (m)             2.00E+00
  WIDTH OF SOURCE PERPENDICULAR TO GW FLOW (m)         2.00E+00
  THICKNESS OF SOURCE (m)                              1.00E+00
  PERCOLATION RATE (darcy vel m/y)                     1.00E-01
  VOLUMETRIC WATER CONTENT IN SOURCE                   3.40E-01
  VOLUMETRIC WATER CONTENT IN UNSATURATED ZONE         6.80E-02
  BULK DENSITY AT SOURCE  (g/cm**3)                    1.80E+00
  SORPTION COEFFICIENT AT SOURCE (ml/g)                1.00E+01
  BULK DENSITY IN UNSAT ZONE (g/cm**3)                 2.00E+00
  SORPTION COEFFICIENT IN UNSAT ZONE (ml/g)            1.00E+01
  HALF LIFE OF CONTAMINANT (y)                         5.25E+00
  INITIAL MASS OR ACTIVITY (mg or Ci)                  1.00E+00
  MOLECULAR WEIGHT (g/mole)                            2.40E+02
  SOLUBILITY LIMIT (mg/L)                              0.00E+00
  BULK DENSITY OF AQUIFER (g/cm**3)                    2.00E+00
  POROSITY OF AQUIFER                                  1.00E-01
  SORPTION COEFFICIENT IN AQUIFER (ml/g)               1.00E+01

  DISPERSIVITY X DIRECTION (m)                         9.00E+00
  DISPERSIVITY Y DIRECTION (m)                         5.00E+00
  PORE VELOCITY  (m/y)                                 9.30E+02
  WELL SCREEN THICKNESS (m)                            5.00E+00
  DISTANCE TO AQUIFER BELOW CONTAMINATION (m)          1.84E+02
  DISTANCE TO RECEPTOR ALONG X AXIS       (m)          5.00E+01
  DISTANCE TO RECEPTOR ALONG Y AXIS       (m)          0.00E+00
  RADIOLOGICAL DOSE CONVERSION FACTOR (rem/Ci)         2.70E+04
  UNITS OF CONTAMINANT                                 Ci

  INPUT DATA FILE CREATED BY:____________________ DATE   /   /
```

```
INPUT DATA CHECKED BY:      _____________________ DATE  /  /

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

LIMITING SOIL CONCENTRATION CALCULATION
INITIAL SOURCE RESET TO 1.0 Ci
>>> INITIAL ACTIVITY CONVERTED TO MASS (mg)   3.52E+00
>>> VALUES CALCULATED IN SOURCE SUBROUTINE
*****************************************************
LEACH RATE CONSTANT (1/y)                        5.4526E-03
UNSATURATED PORE VELOCITY (m/y)                  1.4706E+00
DECAY CONSTANT (1/y)                             1.3203E-01
RETARDATION FACTOR (SATURATED)                   2.0100E+02
RETARDATION FACTOR (UNSATURATED)                 2.9512E+02
SOLUBILITY LIMITED MASS (mg)                     0.0000E+00
SOLUBILITY LIMITED ACTIVITY (Ci)                 0.0000E+00
TRANSIT TIME IN UNSAT ZONE (years)               3.6925E+04
FRACTION DECAYED DURING UNSAT TRANSPORT          1.0000E+00
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
>>> EXPOSURE DATA FOR LIMITING SOIL CONCENTRATION
*****************************************************
BODY WEIGHT (kg)                     7.000E+01
AVERAGING TIME (days)                2.555E+04
WATER INTAKE RATE (L/d)              2.000E+00
EXPOSURE FREQUENCY (days/year)       3.500E+02
EXPOSURE DURATION (years)            3.000E+01
RADIOLOGICAL DOSE LIMIT (rem/y)      4.000E-03
CARCINOGENIC RISK CRITERIA           1.000E-06
HAZARD QUOTIENT                      1.000E+00
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
>>> RESULTS OF CALCULATIONS
*****************************************************
PEAK TIME (y) = 3.693570E+04
PEAK CONC (Ci/m**3) = 1.6897-225
AVERAGE INTEGRATED CONCENTRATION (Ci/m**3) = 8.4774-226
LIMITING SOIL CONCENTRATION (Ci/m**3) = 6.24+217
LIMITING SOIL CONCENTRATION (Ci/kg) = 3.47+214
LIMITING SOIL AMOUNT (Ci) = 2.50+218
LIMITING SOIL AMOUNT (mg) = 8.79+218
WARNING !!! THE LIMITING SOIL MASS OF  8.79+218 mg
EXCEEDS THE SOLUBILITY LIMITED SOURCE MASS OF  0.00E+00
```

Uranium-235

```
TIME OF RUN 08:22:47.82
DATE OF RUN 05/05/92
INPUT FILE NAME: ara02unc.in
OUTPUT FILE NAME: ara02unc.out
   ***************************************************
   *                                                 *
   *     This output was produced by the model:      *
   *                                                 *
   *                    GWSCREEN                     *
   *        Version Control Copy,  Version 1.3       *
   *    A semi-analytical model for the assessment   *
   *    of the groundwater pathway from the leaching *
   *    of surficial and buried contamination.       *
   *                                                 *
   *                  Arthur S. Rood                 *
   *        Idaho National Engineering Laboratory    *
   *                  EG&G Idaho Inc.                *
   *     Subsurface and Environmental Modeling Unit  *
   *                   PO Box 1625                   *
   *              Idaho Falls, Idaho 83415           *
   ***************************************************
  >>> TITLE OF PROJECT:
  ARA-02 SANITARY SEPTIC SYSTEM LIMITING SOIL CONCENTRATION U-NONCARC
  ----------------------------------------------------------
  >>> INPUT DATA
  ***********************************************************
  INTEGRATION TIME (years)                             30
  LENGTH OF SOURCE PARALLEL TO GW FLOW (m)             2.00E+00
  WIDTH OF SOURCE PERPENDICULAR TO GW FLOW (m)         2.00E+00
  THICKNESS OF SOURCE (m)                              1.00E+00
  PERCOLATION RATE (darcy vel m/y)                     1.00E-01
  VOLUMETRIC WATER CONTENT IN SOURCE                   3.40E-01
  VOLUMETRIC WATER CONTENT IN UNSATURATED ZONE         6.80E-02
  BULK DENSITY AT SOURCE  (g/cm**3)                    1.80E+00
  SORPTION COEFFICIENT AT SOURCE (ml/g)                3.50E+01
  BULK DENSITY IN UNSAT ZONE (g/cm**3)                 2.00E+00
  SORPTION COEFFICIENT IN UNSAT ZONE (ml/g)            6.00E+00
  HALF LIFE OF CONTAMINANT (y)                         7.12E+08
  INITIAL MASS OR ACTIVITY (mg or Ci)                  1.00E+00
  MOLECULAR WEIGHT (g/mole)                            2.70E+02
  SOLUBILITY LIMIT (mg/L)                              0.00E+00
  BULK DENSITY OF AQUIFER (g/cm**3)                    2.00E+00
  POROSITY OF AQUIFER                                  1.00E-01
  SORPTION COEFFICIENT IN AQUIFER (ml/g)               6.00E+00

  DISPERSIVITY X DIRECTION (m)                         9.00E+00
  DISPERSIVITY Y DIRECTION (m)                         5.00E+00
  PORE VELOCITY  (m/y)                                 9.30E+02
  WELL SCREEN THICKNESS (m)                            5.00E+00
  DISTANCE TO AQUIFER BELOW CONTAMINATION (m)          1.84E+02
  DISTANCE TO RECEPTOR ALONG X AXIS       (m)          5.00E+01
  DISTANCE TO RECEPTOR ALONG Y AXIS       (m)          0.00E+00
  LIMITING RADIONUCLIDE GW CONCENTRATION (Ci/L)        3.00E-11
  UNITS OF CONTAMINANT                                 Ci

  INPUT DATA FILE CREATED BY:____________________ DATE  /  /

  INPUT DATA CHECKED BY:     ____________________ DATE  /  /

  ----------------------------------------------------------
```

```
LIMITING SOIL CONCENTRATION CALCULATION
INITIAL SOURCE RESET TO 1.0 Ci
>>> INITIAL ACTIVITY CONVERTED TO MASS (mg)   5.37E+08
>>> VALUES CALCULATED IN SOURCE SUBROUTINE
******************************************************
LEACH RATE CONSTANT (1/y)                         1.5788E-03
UNSATURATED PORE VELOCITY (m/y)                   1.4706E+00
DECAY CONSTANT (1/y)                              9.7352E-10
RETARDATION FACTOR (SATURATED)                    1.2100E+02
RETARDATION FACTOR (UNSATURATED)                  1.7747E+02
SOLUBILITY LIMITED MASS (mg)                      0.0000E+00
SOLUBILITY LIMITED ACTIVITY (Ci)                  0.0000E+00
TRANSIT TIME IN UNSAT ZONE (years)                2.2205E+04
FRACTION DECAYED DURING UNSAT TRANSPORT           2.1617E-05
------------------------------------------------------
>>> EXPOSURE DATA FOR LIMITING SOIL CONCENTRATION
******************************************************
BODY WEIGHT (kg)                    7.000E+01
AVERAGING TIME (days)               2.555E+04
WATER INTAKE RATE (L/d)             2.000E+00
EXPOSURE FREQUENCY (days/year)      3.500E+02
EXPOSURE DURATION (years)           3.000E+01
RADIOLOGICAL DOSE LIMIT (rem/y)     4.000E-03
CARCINOGENIC RISK CRITERIA          1.000E-06
HAZARD QUOTIENT                     1.000E+00
------------------------------------------------------
>>> RESULTS OF CALCULATIONS
******************************************************
PEAK TIME (y) = 2.222999E+04
PEAK CONC (Ci/m**3) = 5.6368E-08
AVERAGE INTEGRATED CONCENTRATION (Ci/m**3) = 5.4774E-08
LIMITING SOIL CONCENTRATION (Ci/m**3) = 1.37E-01
LIMITING SOIL CONCENTRATION (Ci/kg) = 7.61E-05
LIMITING SOIL AMOUNT (Ci) = 5.48E-01
LIMITING SOIL AMOUNT (mg) = 2.94E+08
WARNING !!! THE LIMITING SOIL MASS OF  2.94E+08 mg
EXCEEDS THE SOLUBILITY LIMITED SOURCE MASS OF  0.00E+00
```

Mercury

```
TIME OF RUN 08:24:03.51
DATE OF RUN 05/05/92
INPUT FILE NAME: ara2hgnc.in
OUTPUT FILE NAME: ara2hgnc.out
   ***************************************************
   *                                                 *
   *     This output was produced by the model:      *
   *                                                 *
   *                    GWSCREEN                     *
   *        Version Control Copy,  Version 1.3       *
   *    A semi-analytical model for the assessment   *
   *    of the groundwater pathway from the leaching *
   *    of surficial and buried contamination.       *
   *                                                 *
   *                  Arthur S. Rood                 *
   *        Idaho National Engineering Laboratory    *
   *                  EG&G Idaho Inc.                *
   *     Subsurface and Environmental Modeling Unit  *
   *                   PO Box 1625                   *
   *             Idaho Falls, Idaho 83415            *
   ***************************************************
  >>> TITLE OF PROJECT:
  ARA-02 SANITARY SEPTIC SYSTEM LIMITING SOIL CONCENTRATION HG-NONCARC
  ----------------------------------------------------------------
  >>> INPUT DATA
  ******************************************************************
  INTEGRATION TIME (years)                             30
  LENGTH OF SOURCE PARALLEL TO GW FLOW (m)             2.00E+00
  WIDTH OF SOURCE PERPENDICULAR TO GW FLOW (m)         2.00E+00
  THICKNESS OF SOURCE (m)                              1.00E+00
  PERCOLATION RATE (darcy vel m/y)                     1.00E-01
  VOLUMETRIC WATER CONTENT IN SOURCE                   3.40E-01
  VOLUMETRIC WATER CONTENT IN UNSATURATED ZONE         6.80E-02
  BULK DENSITY AT SOURCE  (g/cm**3)                    1.80E+00
  SORPTION COEFFICIENT AT SOURCE (ml/g)                1.00E+02
  BULK DENSITY IN UNSAT ZONE (g/cm**3)                 2.00E+00
  SORPTION COEFFICIENT IN UNSAT ZONE (ml/g)            1.00E+02
  HALF LIFE OF CONTAMINANT (y)                         1.00E+38
  INITIAL MASS OR ACTIVITY (mg or Ci)                  1.00E+00
  MOLECULAR WEIGHT (g/mole)                            4.61E+02
  SOLUBILITY LIMIT (mg/L)                              4.50E-02
  BULK DENSITY OF AQUIFER (g/cm**3)                    2.00E+00
  POROSITY OF AQUIFER                                  1.00E-01
  SORPTION COEFFICIENT IN AQUIFER (ml/g)               1.00E+02

  DISPERSIVITY X DIRECTION (m)                         9.00E+00
  DISPERSIVITY Y DIRECTION (m)                         5.00E+00
  PORE VELOCITY  (m/y)                                 9.30E+02
  WELL SCREEN THICKNESS (m)                            5.00E+00
  DISTANCE TO AQUIFER BELOW CONTAMINATION (m)          1.84E+02
  DISTANCE TO RECEPTOR ALONG X AXIS        (m)         5.00E+01
  DISTANCE TO RECEPTOR ALONG Y AXIS        (m)         0.00E+00
  NON-CARCINOGENIC REFERENCE DOSE RfD (mg/kg/d)        3.00E-04
  UNITS OF CONTAMINANT                                 mg

  INPUT DATA FILE CREATED BY:____________________ DATE  /  /

  INPUT DATA CHECKED BY:     ____________________ DATE  /  /

  ----------------------------------------------------------------
```

```
LIMITING SOIL CONCENTRATION CALCULATION
INITIAL SOURCE RESET TO 1.0 mg
>>> VALUES CALCULATED IN SOURCE SUBROUTINE
******************************************************
LEACH RATE CONSTANT (1/y)                             5.5451E-04
UNSATURATED PORE VELOCITY (m/y)                       1.4706E+00
DECAY CONSTANT (1/y)                                  0.0000E+00
RETARDATION FACTOR (SATURATED)                        2.0010E+03
RETARDATION FACTOR (UNSATURATED)                      2.9422E+03
SOLUBILITY LIMITED MASS (mg)                          3.2461E+04
SOLUBILITY LIMITED ACTIVITY (Ci)                      0.0000E+00
TRANSIT TIME IN UNSAT ZONE (years)                    3.6813E+05
FRACTION DECAYED DURING UNSAT TRANSPORT               0.0000E+00
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
>>> EXPOSURE DATA FOR LIMITING SOIL CONCENTRATION
******************************************************
BODY WEIGHT (kg)                   7.000E+01
AVERAGING TIME (days)              2.555E+04
WATER INTAKE RATE (L/d)            2.000E+00
EXPOSURE FREQUENCY (days/year)     3.500E+02
EXPOSURE DURATION (years)          3.000E+01
RADIOLOGICAL DOSE LIMIT (rem/y)    4.000E-03
CARCINOGENIC RISK CRITERIA         1.000E-06
HAZARD QUOTIENT                    1.000E+00
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
>>> RESULTS OF CALCULATIONS
******************************************************
PEAK TIME (y) = 3.684275E+05
PEAK CONC (mg/m**3) = 1.7932E-08
AVERAGE INTEGRATED CONCENTRATION (mg/m**3) = 1.7900E-08
LIMITING SOIL CONCENTRATION (mg/m**3) = 3.57E+08
LIMITING SOIL CONCENTRATION (mg/kg) = 1.98E+05
LIMITING SOIL AMOUNT (mg) = 1.43E+09
WARNING !!! THE LIMITING SOIL MASS OF  1.43E+09 mg
EXCEEDS THE SOLUBILITY LIMITED SOURCE MASS OF  3.25E+04
```

Barium

```
TIME OF RUN 08:20:54.24
DATE OF RUN 05/05/92
INPUT FILE NAME: ara2banc.in
OUTPUT FILE NAME: ara2banc.out
   **************************************************
   *                                                *
   *     This output was produced by the model:     *
   *                                                *
   *                    GWSCREEN                    *
   *        Version Control Copy,  Version 1.3      *
   *    A semi-analytical model for the assessment  *
   *    of the groundwater pathway from the leaching *
   *    of surficial and buried contamination.      *
   *                                                *
   *                 Arthur S. Rood                 *
   *        Idaho National Engineering Laboratory   *
   *                 EG&G Idaho Inc.                *
   *     Subsurface and Environmental Modeling Unit *
   *                  PO Box 1625                   *
   *             Idaho Falls, Idaho 83415           *
   **************************************************
  >>> TITLE OF PROJECT:
  ARA-02 SANITARY SEPTIC SYSTEM LIMITING SOIL CONCENTRATION BARIUM
  ----------------------------------------------------------
  >>> INPUT DATA
  **********************************************************
  INTEGRATION TIME (years)                             30
  LENGTH OF SOURCE PARALLEL TO GW FLOW (m)             2.00E+00
  WIDTH OF SOURCE PERPENDICULAR TO GW FLOW (m)         2.00E+00
  THICKNESS OF SOURCE (m)                              1.00E+00
  PERCOLATION RATE (darcy vel m/y)                     1.00E-01
  VOLUMETRIC WATER CONTENT IN SOURCE                   3.40E-01
  VOLUMETRIC WATER CONTENT IN UNSATURATED ZONE         6.80E-02
  BULK DENSITY AT SOURCE  (g/cm**3)                    1.80E+00
  SORPTION COEFFICIENT AT SOURCE (ml/g)                5.00E+01
  BULK DENSITY IN UNSAT ZONE (g/cm**3)                 2.00E+00
  SORPTION COEFFICIENT IN UNSAT ZONE (ml/g)            5.00E+01
  HALF LIFE OF CONTAMINANT (y)                         1.00E+38
  INITIAL MASS OR ACTIVITY (mg or Ci)                  1.00E+00
  MOLECULAR WEIGHT (g/mole)                            1.97E+02
  SOLUBILITY LIMIT (mg/L)                              2.00E+01
  BULK DENSITY OF AQUIFER (g/cm**3)                    2.00E+00
  POROSITY OF AQUIFER                                  1.00E-01
  SORPTION COEFFICIENT IN AQUIFER (ml/g)               5.00E+01

  DISPERSIVITY X DIRECTION (m)                         9.00E+00
  DISPERSIVITY Y DIRECTION (m)                         5.00E+00
  PORE VELOCITY  (m/y)                                 9.30E+02
  WELL SCREEN THICKNESS (m)                            5.00E+00
  DISTANCE TO AQUIFER BELOW CONTAMINATION (m)          1.84E+02
  DISTANCE TO RECEPTOR ALONG X AXIS        (m)         5.00E+01
  DISTANCE TO RECEPTOR ALONG Y AXIS        (m)         0.00E+00
  NON-CARCINOGENIC REFERENCE DOSE RfD (mg/kg/d)        5.00E-02
  UNITS OF CONTAMINANT                                 mg

  INPUT DATA FILE CREATED BY:____________________ DATE  /  /

  INPUT DATA CHECKED BY:      ____________________ DATE  /  /

  ----------------------------------------------------------
```

```
LIMITING SOIL CONCENTRATION CALCULATION
INITIAL SOURCE RESET TO 1.0 mg
>>> VALUES CALCULATED IN SOURCE SUBROUTINE
*****************************************************
LEACH RATE CONSTANT (1/y)                               1.1069E-03
UNSATURATED PORE VELOCITY (m/y)                         1.4706E+00
DECAY CONSTANT (1/y)                                    0.0000E+00
RETARDATION FACTOR (SATURATED)                          1.0010E+03
RETARDATION FACTOR (UNSATURATED)                        1.4716E+03
SOLUBILITY LIMITED MASS (mg)                            7.2272E+06
SOLUBILITY LIMITED ACTIVITY (Ci)                        0.0000E+00
TRANSIT TIME IN UNSAT ZONE (years)                      1.8413E+05
FRACTION DECAYED DURING UNSAT TRANSPORT                 0.0000E+00
-----------------------------------------------------
>>> EXPOSURE DATA FOR LIMITING SOIL CONCENTRATION
*****************************************************
BODY WEIGHT (kg)                     7.000E+01
AVERAGING TIME (days)                2.555E+04
WATER INTAKE RATE (L/d)              2.000E+00
EXPOSURE FREQUENCY (days/year)       3.500E+02
EXPOSURE DURATION (years)            3.000E+01
RADIOLOGICAL DOSE LIMIT (rem/y)      4.000E-03
CARCINOGENIC RISK CRITERIA           1.000E-06
HAZARD QUOTIENT                      1.000E+00
-----------------------------------------------------
>>> RESULTS OF CALCULATIONS
*****************************************************
PEAK TIME (y) = 1.842764E+05
PEAK CONC (mg/m**3) = 3.5802E-08
AVERAGE INTEGRATED CONCENTRATION (mg/m**3) = 3.5690E-08
LIMITING SOIL CONCENTRATION (mg/m**3) = 2.98E+10
LIMITING SOIL CONCENTRATION (mg/kg) = 1.66E+07
LIMITING SOIL AMOUNT (mg) = 1.19E+11
WARNING !!! THE LIMITING SOIL MASS OF  1.19E+11 mg
EXCEEDS THE SOLUBILITY LIMITED SOURCE MASS OF  7.23E+06
```

Chromium^{+3}

```
TIME OF RUN 08:19:28.11
DATE OF RUN 05/05/92
INPUT FILE NAME: a2cr3nc.in
OUTPUT FILE NAME: a2cr3nc.out
   **************************************************
   *                                                *
   *     This output was produced by the model:     *
   *                                                *
   *                    GWSCREEN                    *
   *        Version Control Copy,  Version 1.3      *
   *    A semi-analytical model for the assessment  *
   *    of the groundwater pathway from the leaching *
   *    of surficial and buried contamination.      *
   *                                                *
   *                 Arthur S. Rood                 *
   *        Idaho National Engineering Laboratory   *
   *                 EG&G Idaho Inc.                *
   *     Subsurface and Environmental Modeling Unit *
   *                  PO Box 1625                   *
   *             Idaho Falls, Idaho 83415           *
   **************************************************
  >>> TITLE OF PROJECT:
  ARA-02 SANITARY SEPTIC SYSTEM LIMITING SOIL CONCENTRATION CR3-NONCAR
  ---------------------------------------------------------
  >>> INPUT DATA
  **********************************************************
  INTEGRATION TIME (years)                          30
  LENGTH OF SOURCE PARALLEL TO GW FLOW (m)          2.00E+00
  WIDTH OF SOURCE PERPENDICULAR TO GW FLOW (m)      2.00E+00
  THICKNESS OF SOURCE (m)                           1.00E+00
  PERCOLATION RATE (darcy vel m/y)                  1.00E-01
  VOLUMETRIC WATER CONTENT IN SOURCE                3.40E-01
  VOLUMETRIC WATER CONTENT IN UNSATURATED ZONE      6.80E-02
  BULK DENSITY AT SOURCE  (g/cm**3)                 1.80E+00
  SORPTION COEFFICIENT AT SOURCE (ml/g)             4.00E+01
  BULK DENSITY IN UNSAT ZONE (g/cm**3)              2.00E+00
  SORPTION COEFFICIENT IN UNSAT ZONE (ml/g)         4.00E+01
  HALF LIFE OF CONTAMINANT (y)                      1.00E+38
  INITIAL MASS OR ACTIVITY (mg or Ci)               1.00E+00
  MOLECULAR WEIGHT (g/mole)                         1.52E+02
  SOLUBILITY LIMIT (mg/L)                           0.00E+00
  BULK DENSITY OF AQUIFER (g/cm**3)                 2.00E+00
  POROSITY OF AQUIFER                               1.00E-01
  SORPTION COEFFICIENT IN AQUIFER (ml/g)            4.00E+01

  DISPERSIVITY X DIRECTION (m)                      9.00E+00
  DISPERSIVITY Y DIRECTION (m)                      5.00E+00
  PORE VELOCITY  (m/y)                              9.30E+02
  WELL SCREEN THICKNESS (m)                         5.00E+00
  DISTANCE TO AQUIFER BELOW CONTAMINATION (m)       1.84E+02
  DISTANCE TO RECEPTOR ALONG X AXIS       (m)       5.00E+01
  DISTANCE TO RECEPTOR ALONG Y AXIS       (m)       0.00E+00
  NON-CARCINOGENIC REFERENCE DOSE RfD (mg/kg/d)     1.00E+00
  UNITS OF CONTAMINANT                              mg

  INPUT DATA FILE CREATED BY:____________________ DATE  /  /

  INPUT DATA CHECKED BY:     ____________________ DATE  /  /

  ---------------------------------------------------------
```

```
LIMITING SOIL CONCENTRATION CALCULATION
INITIAL SOURCE RESET TO 1.0 mg
>>> VALUES CALCULATED IN SOURCE SUBROUTINE
******************************************************
LEACH RATE CONSTANT (1/y)                         1.3824E-03
UNSATURATED PORE VELOCITY (m/y)                   1.4706E+00
DECAY CONSTANT (1/y)                              0.0000E+00
RETARDATION FACTOR (SATURATED)                    8.0100E+02
RETARDATION FACTOR (UNSATURATED)                  1.1775E+03
SOLUBILITY LIMITED MASS (mg)                      0.0000E+00
SOLUBILITY LIMITED ACTIVITY (Ci)                  0.0000E+00
TRANSIT TIME IN UNSAT ZONE (years)                1.4733E+05
FRACTION DECAYED DURING UNSAT TRANSPORT           0.0000E+00
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
>>> EXPOSURE DATA FOR LIMITING SOIL CONCENTRATION
******************************************************
BODY WEIGHT (kg)                     7.000E+01
AVERAGING TIME (days)                2.555E+04
WATER INTAKE RATE (L/d)              2.000E+00
EXPOSURE FREQUENCY (days/year)       3.500E+02
EXPOSURE DURATION (years)            3.000E+01
RADIOLOGICAL DOSE LIMIT (rem/y)      4.000E-03
CARCINOGENIC RISK CRITERIA           1.000E-06
HAZARD QUOTIENT                      1.000E+00
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
>>> RESULTS OF CALCULATIONS
******************************************************
PEAK TIME (y) = 1.474462E+05
PEAK CONC (mg/m**3) = 4.4714E-08
AVERAGE INTEGRATED CONCENTRATION (mg/m**3) = 4.4555E-08
LIMITING SOIL CONCENTRATION (mg/m**3) = 4.78E+11
LIMITING SOIL CONCENTRATION (mg/kg) = 2.65E+08
LIMITING SOIL AMOUNT (mg) = 1.91E+12
WARNING !!! THE LIMITING SOIL MASS OF  1.91E+12 mg
EXCEEDS THE SOLUBILITY LIMITED SOURCE MASS OF  0.00E+00
```

Chromium^{+6}

```
TIME OF RUN 08:08:21.65
DATE OF RUN 05/05/92
INPUT FILE NAME: ara2crnc.in
OUTPUT FILE NAME: ara2crnc.out
   ***************************************************
   *                                                 *
   *     This output was produced by the model:      *
   *                                                 *
   *                    GWSCREEN                     *
   *        Version Control Copy,  Version 1.3       *
   *    A semi-analytical model for the assessment   *
   *    of the groundwater pathway from the leaching *
   *    of surficial and buried contamination.       *
   *                                                 *
   *                 Arthur S. Rood                  *
   *        Idaho National Engineering Laboratory    *
   *                 EG&G Idaho Inc.                 *
   *     Subsurface and Environmental Modeling Unit  *
   *                   PO Box 1625                   *
   *              Idaho Falls, Idaho 83415           *
   ***************************************************
  >>> TITLE OF PROJECT:
  ARA-02 SANITARY SEPTIC SYSTEM LIMITING SOIL CONCENTRATION CR6-NONCAR
  ----------------------------------------------------------
  >>> INPUT DATA
  **********************************************************
  INTEGRATION TIME (years)                           30
  LENGTH OF SOURCE PARALLEL TO GW FLOW (m)           2.00E+00
  WIDTH OF SOURCE PERPENDICULAR TO GW FLOW (m)       2.00E+00
  THICKNESS OF SOURCE (m)                            1.00E+00
  PERCOLATION RATE (darcy vel m/y)                   1.00E-01
  VOLUMETRIC WATER CONTENT IN SOURCE                 3.40E-01
  VOLUMETRIC WATER CONTENT IN UNSATURATED ZONE       6.80E-02
  BULK DENSITY AT SOURCE  (g/cm**3)                  1.80E+00
  SORPTION COEFFICIENT AT SOURCE (ml/g)              1.20E+00
  BULK DENSITY IN UNSAT ZONE (g/cm**3)               2.00E+00
  SORPTION COEFFICIENT IN UNSAT ZONE (ml/g)          1.20E+00
  HALF LIFE OF CONTAMINANT (y)                       1.00E+38
  INITIAL MASS OR ACTIVITY (mg or Ci)                1.00E+00
  MOLECULAR WEIGHT (g/mole)                          5.20E+01
  SOLUBILITY LIMIT (mg/L)                            1.00E+06
  BULK DENSITY OF AQUIFER (g/cm**3)                  2.00E+00
  POROSITY OF AQUIFER                                1.00E-01
  SORPTION COEFFICIENT IN AQUIFER (ml/g)             1.20E+00

  DISPERSIVITY X DIRECTION (m)                       9.00E+00
  DISPERSIVITY Y DIRECTION (m)                       5.00E+00
  PORE VELOCITY  (m/y)                               9.30E+02
  WELL SCREEN THICKNESS (m)                          5.00E+00
  DISTANCE TO AQUIFER BELOW CONTAMINATION (m)        1.84E+02
  DISTANCE TO RECEPTOR ALONG X AXIS        (m)       5.00E+01
  DISTANCE TO RECEPTOR ALONG Y AXIS        (m)       0.00E+00
  NON-CARCINOGENIC REFERENCE DOSE RfD (mg/kg/d)      5.00E-03
  UNITS OF CONTAMINANT                               mg

  INPUT DATA FILE CREATED BY:____________________ DATE  /  /

  INPUT DATA CHECKED BY:     ____________________ DATE  /  /

  ----------------------------------------------------------
```

```
LIMITING SOIL CONCENTRATION CALCULATION
INITIAL SOURCE RESET TO 1.0 mg
>>> VALUES CALCULATED IN SOURCE SUBROUTINE
******************************************************
LEACH RATE CONSTANT (1/y)                      4.0000E-02
UNSATURATED PORE VELOCITY (m/y)                1.4706E+00
DECAY CONSTANT (1/y)                           0.0000E+00
RETARDATION FACTOR (SATURATED)                 2.5000E+01
RETARDATION FACTOR (UNSATURATED)               3.6294E+01
SOLUBILITY LIMITED MASS (mg)                   1.0000E+10
SOLUBILITY LIMITED ACTIVITY (Ci)               0.0000E+00
TRANSIT TIME IN UNSAT ZONE (years)             4.5411E+03
FRACTION DECAYED DURING UNSAT TRANSPORT        0.0000E+00
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
>>> EXPOSURE DATA FOR LIMITING SOIL CONCENTRATION
******************************************************
BODY WEIGHT (kg)                   7.000E+01
AVERAGING TIME (days)              2.555E+04
WATER INTAKE RATE (L/d)            2.000E+00
EXPOSURE FREQUENCY (days/year)     3.500E+02
EXPOSURE DURATION (years)          3.000E+01
RADIOLOGICAL DOSE LIMIT (rem/y)    4.000E-03
CARCINOGENIC RISK CRITERIA         1.000E-06
HAZARD QUOTIENT                    1.000E+00
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
>>> RESULTS OF CALCULATIONS
******************************************************
PEAK TIME (y) = 4.544919E+03
PEAK CONC (mg/m**3) = 1.3066E-06
AVERAGE INTEGRATED CONCENTRATION (mg/m**3) = 8.3439E-07
LIMITING SOIL CONCENTRATION (mg/m**3) = 1.28E+08
LIMITING SOIL CONCENTRATION (mg/kg) = 7.09E+04
LIMITING SOIL AMOUNT (mg) = 5.10E+08
```

APPENDIX C

APPENDIX C

AUXILIARY REACTOR AREA SITE ARA-02 SANITARY SEPTIC SYSTEM GROUNDWATER CALCULATIONS

Given the estimated discharge rates (approximately 1,000 gal per day from 1960 to 1988), it can be assumed that wastes have migrated into the subsurface around the seepage pit and have the potential to contaminate groundwater. The length of time required for the wastes to reach groundwater is dependent on the characteristics of the unsaturated zone between the surface and the Snake River Plain aquifer. Recharge rates through the unsaturated zone at the INEL are affected by the sedimentary layers that occur between basalt sequences. These layers generally have low permeabilities and can impede vertical flow, resulting in the formation of perching layers. Typically, water spreads laterally along perching layers until equilibrium is reached. Eventually, the wetting front passes through the perching layer and continues to migrate to the aquifer or the next low-permeability layer. Depending on the number of sedimentary layers, their physical characteristics, and the overall depth to groundwater, water can take from a few years to a few hundred years to reach the aquifer.

Geologic cross-section maps and drillers' logs were reviewed to determine the subsurface strata (zones) at the Auxiliary Reactor Area (ARA). The geologic descriptions from the drillers' log are poor but can be used to assemble a limited picture of the subsurface geology. The log indicates ARA is underlain by more than 183 m (600 ft) of basalt flows interbedded in places with fine-grained sedimentary materials. A generalized lithology produced from the drillers' log for the production well is presented in Figure C-1 and Table C-1. The southern section of the Idaho National Engineering Laboratory (INEL), along with the location of geologic cross section A-A', is shown in Figure C-2. Geologic cross section A-A', showing the general area from Central Facilities Area (CFA) to a point north of ARA, is presented in Figure C-3. This cross section was taken from the *Evaluation of a Predictive Groundwater Solute-Transport Model at the Idaho National Engineering Laboratory* (IDP-22062, 1982).

Hydraulic conductivity (K) (the rate which water will flow through a geologic medium per unit of head) and porosity (n) (the percentage of void space in a geologic medium) for interbeds were estimated by averaging the results of previous K tests conducted on similar zones located at Test Reactor Area (TRA), CFA, and Radioactive Waste Management Complex (RWMC) (Table C-2) (Doornbos et.al, 1991; Wood, 1989; Wood et.al, 1989). The K and n of the basalt used in the calculations were derived from tests performed at TRA (Doornbos et.al, 1991).

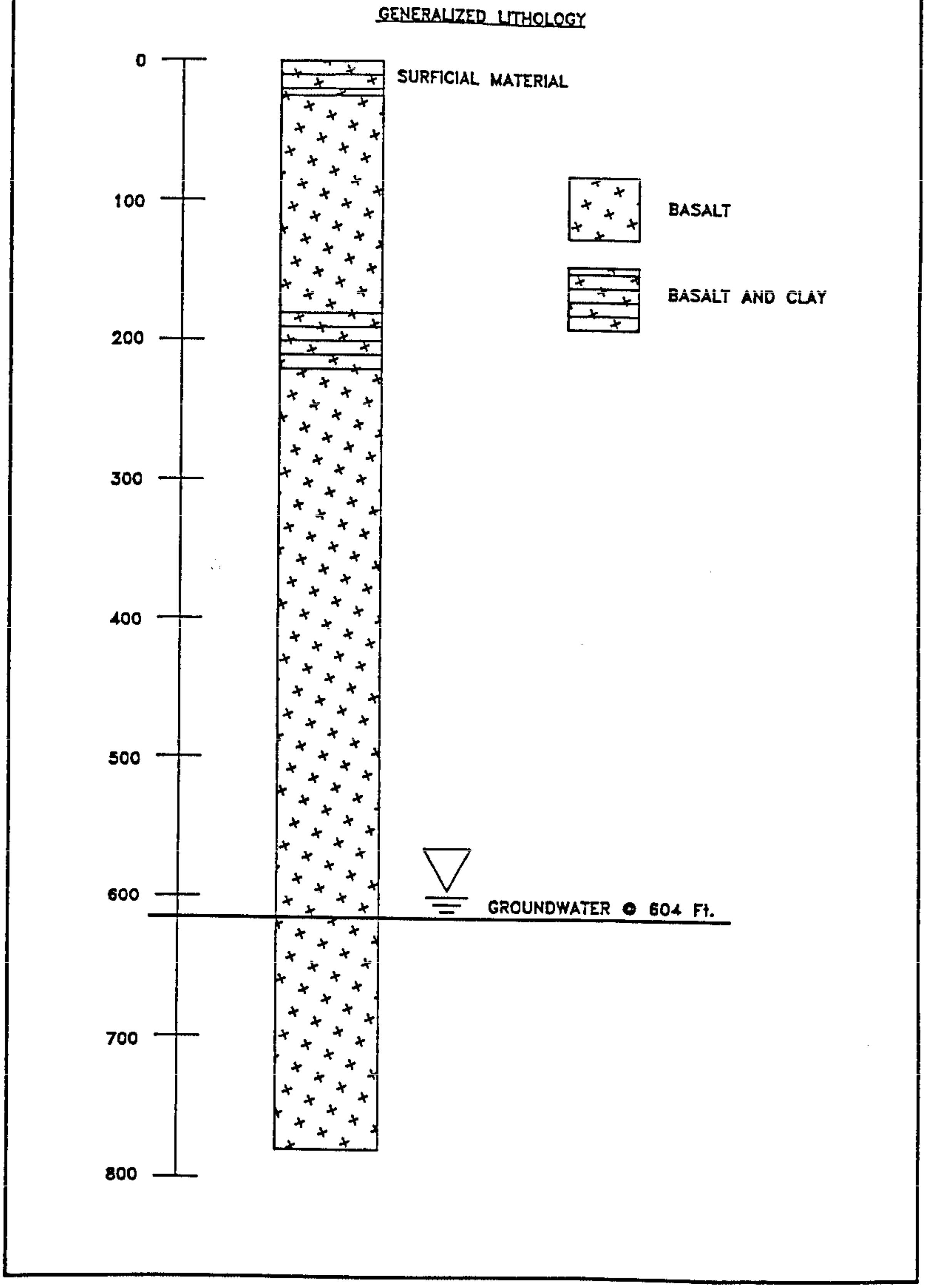


Figure C-1. Generalized lithology of the Auxiliary Reactor Area.

ARA SEPTIC SYSTEM CHARACTERIZATION DATA

	ZONE	INTERVAL FT	INTERVAL THICKNESS FT	DESCRIPTION	ESTIMATED SATURATED HYDRAULIC CONDUCTIVITY (K) FT / DAY
	1	0 - 15	15	unconsolidated alluvial sand silt and gravel	1.83E+00
	2	15 - 125	110	basalt	2.24E-02
	3	125 - 130	5	interbed (sand, silt, and clay)	4.34E-04
	4	130 - 195	65	basalt	2.24E-02
	5	195 - 210	15	basalt & clay	4.34E-04
	6	210 - 225	15	siltstone & basalt	1.73E-01
	7	225 - 470	245	basalt	2.24E-02
	8	470 - 490	20	basalt & clay	4.34E-04
	9	490 - 604	114	basalt	2.24E-02
	10	604		water table	

Table C-1. Site ARA-02 septic system characterization data.

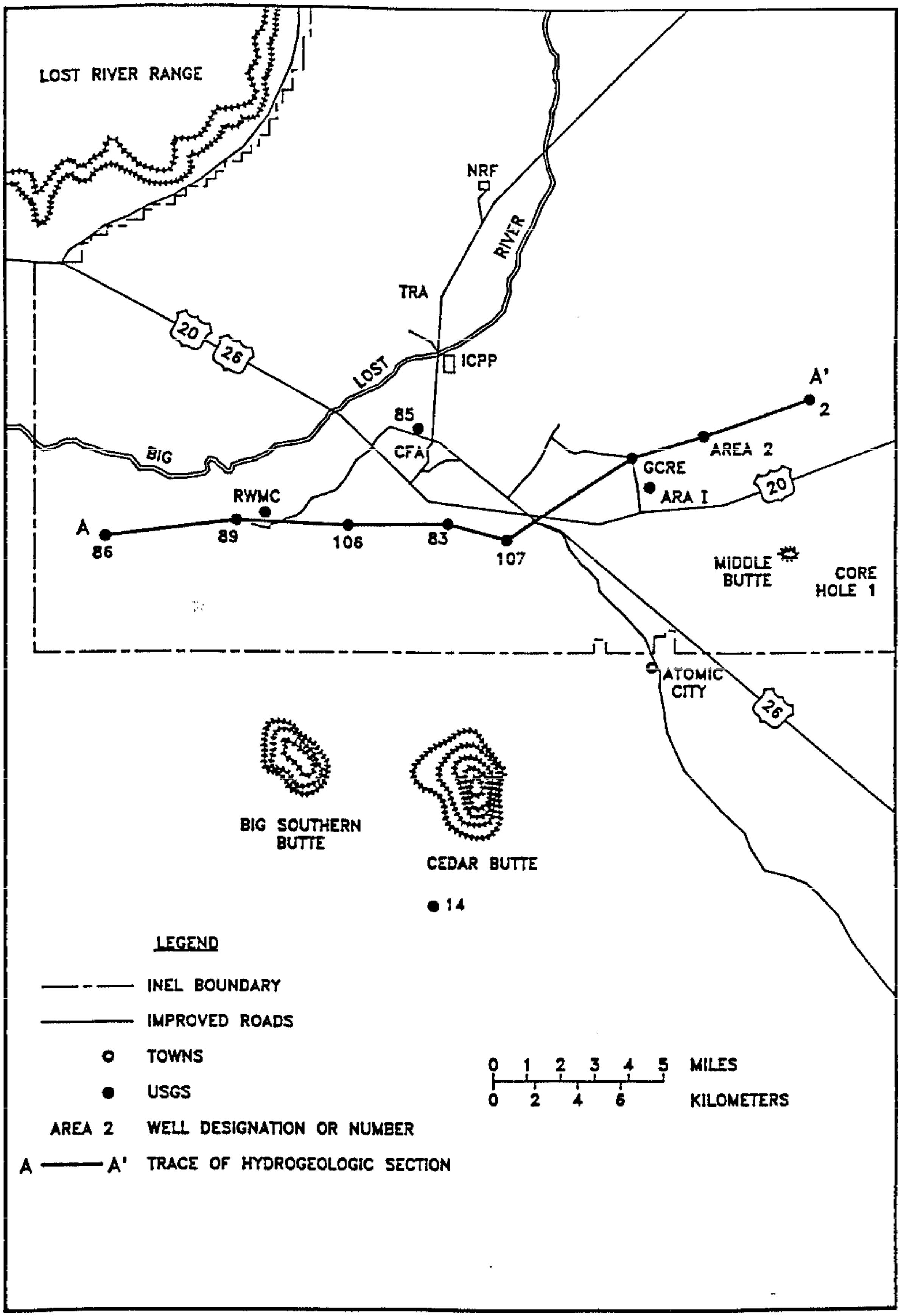


Figure C-2. Southern area of INEL with location of cross-section A-A'.

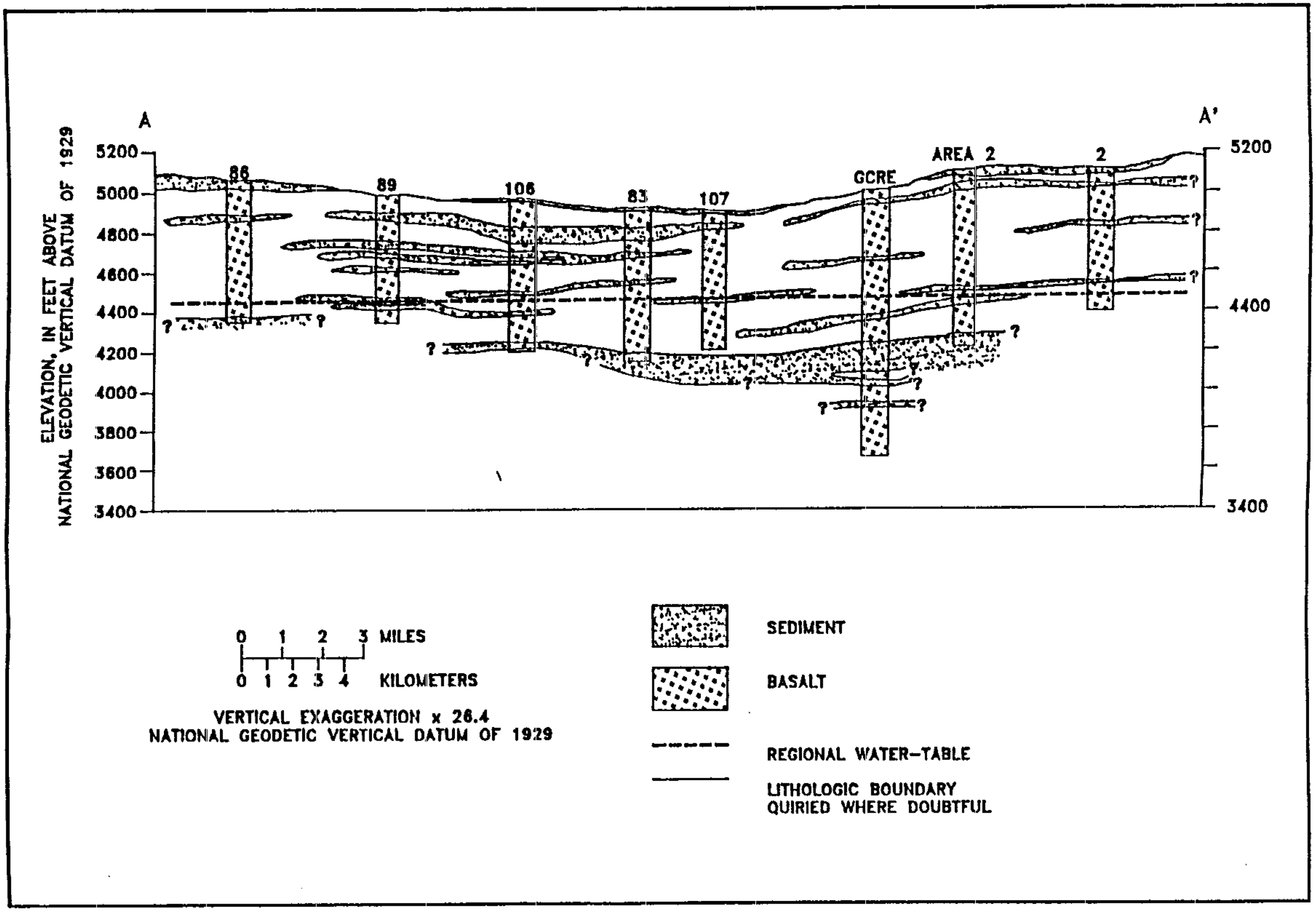


Figure C-3. Geologic cross-section A-A'.

Table C-2. Hydraulic conductivity estimation.

	Hydraulic Conductivity Estimation			
		Sample Number	Well	Saturated Hydraulic Conductivity (ft / day)
	1	2Q0060205A	TRA-06	9.35E-05
	2	2Q0060205B	TRA-06	1.11E-03
	3	2Q0060205C	TRA-06	4.82E-05
	4	2Q0060205D	TRA-06	1.11E-04
	5	2Q0060205E	TRA-06	5.67E-05
	6	2Q0070205C	TRA-07	4.82E-04
	7	2Q0070205D	TRA-07	7.09E-04
	8	2Q0070205E	TRA-07	2.44E-04
	9	2Q0070205F	TRA-07	1.16E-04
	10	2Q0070205G	TRA-07	1.33E-03
	11	2Q0070205H	TRA-07	6.52E-04
	12	2Q0070205I	TRA-07	1.22E-04
	13	2Q0070205J	TRA-07	2.66E-04
	14	2Q0050105	TRA-08	7.37E-04
	Average Hydraulic Conductivity =			4.34E-4 ft / day
				or 1.53E-5 cm/sec

A conservative approach was taken to determine the potential for a perched water zone to accumulate below the ARA-02 Sanitary Septic System. The yearly infiltration (I) to the strata below the system was determined by estimating the daily discharge (1000 gal/day). As a result, there are 260,000 gallons of water with the potential of traveling to the water table. Saturated flow, homogeneity within each zone, and constant head conditions were assumed.

Travel time through each zone was determined by the volume of water entering the zone and the K.

$t(\text{day}) = h(\text{ft}) / K(\text{ft/day})$

$t(\text{day}) = \text{time}$

The maximum volume of water that can infiltrate through each zone per unit time was estimated by:

$I(\text{ft}^3/\text{day}) = K(\text{ft/day}) * A(\text{ft}^2)$

where:

$A(\text{ft}^2)$ = surface area

$K(\text{ft/day})$ = hydraulic conductivity

If the volume of water entering the zone is greater than the potential for infiltration, excess water will accumulate in the upper zone (perched zone) and spreading will occur. Calculations indicate that this is the case for Zone 1. Since the area at the bottom (A_2) of Zone 1 is larger than the top surface (A_1), the shape of the zone will approximate that of a conic section (Figure C-4). The region below the septic system (Zone 1) has been modeled as a conic section, where the conic volume and areas were estimated using the equation:

$V_t(\text{ft}^3) = h/3\ [A_1 + A_2 + (A_1 + A_2)^{1/2}]$

where:

$V_t(\text{ft}^3)$ = Total volume (water, solids, and voids)

$V_w(\text{ft}^3)$ = Volume of water entering the zones upper boundary

$A_1(\text{ft}^3)$ = Upper surface area of Zone 1

$A_2(\text{ft}^3)$ = Lower surface area of Zone 1

$h_1(\text{ft})$ = Thickness of Zone 1

Once water is no longer discharged to the septic system, constant head conditions will no longer exist, drainage will occur, and unsaturated conditions will exist. Each zone has the potential to retain a volume of water (θ). The amount of water retained is dependent on the pressure head, the available

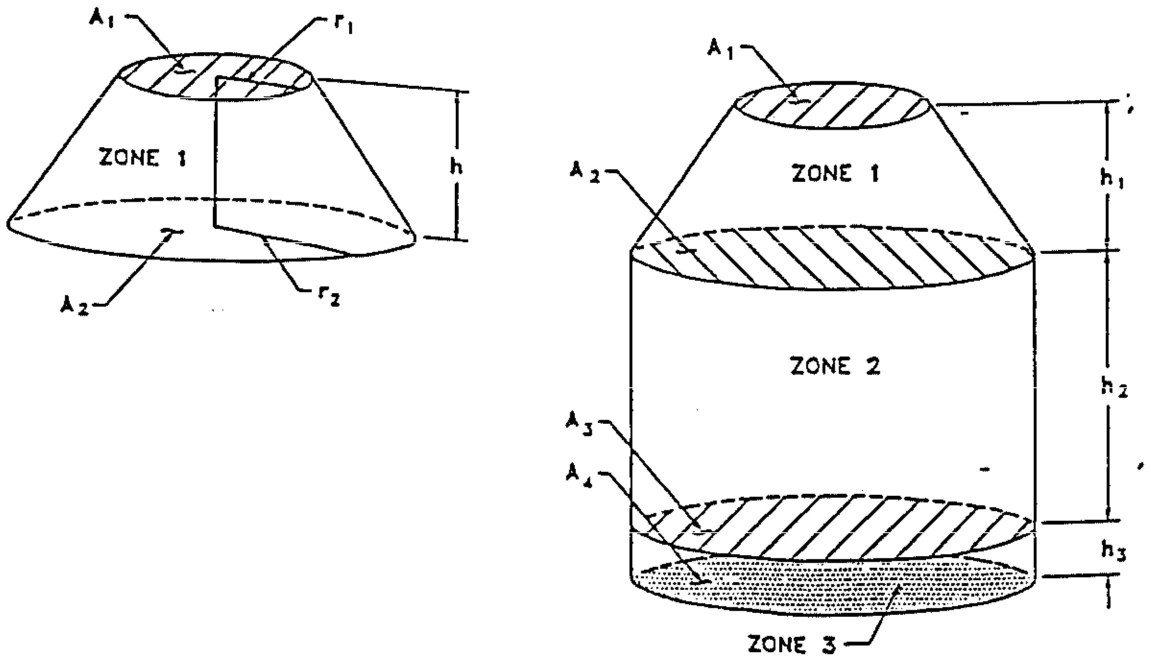


Figure C-4. Zone models.

water, the effective porosity, and the pore size. It has been assumed that prior to discharging water to the system, each zone retained a volume of water below field capacity (the maximum volume of water a geologic medium can retain, without drainage occurring, under unsaturated conditions). The θ used in the calculations represents this additional water retention potential.

If the infiltration into a zone is less than the potential for water retention, all water entering the zone will be retained in the zone, and no perched water or spreading will occur.

The approach used to determine the volume of water retained in each zone assumes that a percentage of the total volume (V_t) (geologic medium, void space, and water) will retain water.

$$R = V_t * \theta$$

where:

$R(ft^3)$ = Water retained

θ = Water Retention Potential

Zone 2 was conservatively modeled as cylinders, where the volume and areas were determined by:

$$V_t = A * h$$

where:

$A_2 = \pi r^2$ = Zone surface area

r = radius of the surface

h = Zone thickness

Since the space water can occupy is determined by the effective porosity of the zone, the total volume of zone was estimated using the following equation.

$$V_t(ft^3) = V_w/n_e$$

where:

n_{ei} = Effective porosity (dimensionless) of the i^{th} zone

Calculations:

Given:

A_1 = 28.3 ft^2 (Surface area of the septic system seepage pit)
r_1 = 3 ft h_1 = 5 ft
n_{e1} = 20% (Sediments) h_2 = 110 ft
n_{e2} = 15% (Basalt) h_3 = 5 ft
n_{e3} = 40% (Interbed) K_1 = 1.83 ft/day
θ_1 = 6% K_2 = $2.24*10^{-2}$ ft/day
θ_2 = 4% K_3 = $4.34*10^{-4}$ ft/day
θ_3 = 15% V_w = 8,060,000 gal/31 yrs
= 1,077,540 ft^3/31 yrs

Q_1 = 1000 gal/day (water discharged to the septic system)

Assumption:

Water was discharged to the septic system for 260 days per year for 31 years.

Zone Excess (Z_i) $= [A_i(ft^2) * K_i(ft/day) * 7.48(gal/ft^3)] - Q_i$

$Z_2 = [28.3\ ft^2 * 2.24*10^{-2}\ ft/day * 7.48\ gal/ft^3] - 1{,}000\ gal/day = -995\ gal/day$

The negative result (-995 gal/day) indicates that there are 995 gal/day that did not infiltrate into Zone 2. This excess water will accumulate in Zone 1 and a perched zone will form. The total volume for Zone 1 (V_{t1}), which consists of soil, water, and void space, was estimated as follows:

$V_{t1} = [-Z_2(gal/day) * t(days/yr) * t(yrs)] \div (7.48\ gal/ft^3 * n_{e1})$

$V_{t1} = (995\ gal/day * 260\ day/yr * 31\ yrs) \div (7.48\ gal/ft^3 * .2) = 5{,}360{,}762\ ft^3$

$V_{t1} = 5{,}360{,}762\ ft^3 = 5\ ft/3\ [28.3\ ft^2 + A_2 + (28.3\ ft^2 + A_2)^{1/2}]$

$A_2 = 3{,}214{,}636\ ft^2$ $r_2 = 1{,}016\ ft$

Potential Water Retained in Zone 1 (R_1)

$R_1 = V_{t1} * \theta_1 = 5{,}360{,}762\ ft^3 * .06 = 321{,}646\ ft^3$

Volume of Water Available for Infiltration Into Zone 2 (I_2)

V_w = Discharge to the septic system
$= (1000\ gal/day * 260\ day/yr * 31\ yr) \div 7.48\ gal/ft^3 = 1{,}077{,}540\ ft^3$

$I_2 = V_w - R_1 = 1{,}077{,}540\ ft^3 - 321{,}646\ ft^3 = 755{,}894\ ft^3$

Volume of Zone 2

Spreading effects in Zone 2 are conservatively neglected, as a result, these zone has been modeled as a cylinder (V_{t2}) where:

$V_{ti} = A_i * h_i$

Assume: $A_2 = A_3 = A_4$

$V_{t2} = A_2 * h_2 = 3{,}214{,}636\ ft^2 * 110\ ft = 353{,}609{,}960\ ft^3$

Potential Water Retained in Zone 2 (R_2)
$R_2 = V_{t2} * \theta_2 = 353{,}609.960\ ft^3 * 0.04 = 14{,}144{,}398\ ft^3$

Travel Time Through Zone 2 (t_2)
$t_2 = h_2 \div K_2 = 110\ ft \div 2.24*10^{-2}\ ft/day = 4{,}911\ days = 13.4$ Years.

Volume of Water Available for Infiltration Into Zone 3 (I_3)
$I_3 = I_2 - R_2 = 755{,}894\ ft^3 - 14{,}144{,}398\ ft^3 = -13{,}388{,}504\ ft^3$

Zone 1 Perched Water Decay Time (T_{D1})

$$T_{D1} = I_2 \div (A_2 * K_2)$$

$$= 755{,}894 \text{ ft}^3 \div (3{,}214{,}636 \text{ ft}^2 * 2.24*10^{-2} \text{ ft/day}) = 10.5 \text{ days}$$

Result : 10.5 days after water is no longer discharged to the septic system, the water perched in Zone 1 will have infiltrated into Zone 2. Since the water retention potential of Zone 2 far exceeds the infiltration into the zone, water discharged to the septic system has not infiltrated past the second zone.