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Los Alamos National Laboratory

Environmental Restoration

A Department of Energy environmental clean-up program

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General

GENERIC QUALITY ASSURANCE PROJECT PLAN FOR RCRA FACILITY INVESTIGATIONS

FOR THE

LOS ALAMOS NATIONAL LABORATORY ENVIRONMENTAL RESTORATION PROGRAM

May 1991

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ENVIRONMENTAL RESTORATION PROGRAM

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LIST OF ACRONYMS

AA	-	Atomic Absorption
AA/ICP	-	Atomic Absorption/Inductively Coupled Plasma
AP	-	Administrative Procedure
ASA	-	American Society of Agronomy, Inc.
ASTM	-	American Society for Testing and Materials
BNA	-	Base/neutral/acid
C	-	Centigrade
CAS	-	Chemical Abstract Service number
CLP	-	Contract Laboratory Program, U.S. Environmental Protection Agency
COE	-	U.S. Army Corp of Engineers
1,3-DNB	-	1,3-Dinitrobenzene
2,4-DNT	-	2,4-Dinitrotoluene
2,6-DNT	-	2,6-Dinitrotoluene
DOE	-	Department of Energy
DOT	-	U.S. Department of Transportation
DQO	-	Data Quality Objective
EPA	-	U.S. Environmental Protection Agency
ER	-	Environmental Restoration
GC	-	Gas Chromatograph
GC/MS	-	Gas Chromatograph/Mass Spectrometer
HPLC	-	High Pressure Liquid Chromatograph
HMX	-	Octahydro-1,3,4,7-tetranitro-1,3,5,7-tetrazocine
HSE	-	Health, Safety and Environment Division
HSWA	-	Hazardous and Solid Waste Amendments
IATA	-	International Air Transportation Association
ICP	-	Inductively Coupled Plasma
LANL	-	Los Alamos National Laboratory
MDL	-	Method Detection Limit
MS	-	Mass Spectrometer
NB	-	Nitrobenzene
NIST	-	National Institute of Standards and Technology
PCB	-	Polychlorinated biphenyl
PEST	-	Pesticide
PID	-	Photoionization Detector
PQL	-	Practical Quantitation Limit
QA	-	Quality Assurance
QAP	-	Quality Assurance Plan
QAPjP	-	Quality Assurance Project Plan
QA/QC	-	Quality Assurance/Quality Control
QC	-	Quality Control
QP	-	Quality Procedure
QPP	-	Quality Program Plan
QPPL	-	Quality Program Project Leader
RCRA	-	Resource Conservation and Recovery Act

LIST OF ACRONYMS (con't)

RDX	-	Hexahydro-1,3,5-trinitro-s-triazine
RMP	-	Records Management Plan
RPD	-	Relative Percent Difference
SMF	-	Sample Management Facility
SOP	-	Standard Operating Procedure
SOW	-	Statement of Work
SSSA	-	Soil Science Society of America, Inc.
SW	-	Solid Waste
TETRYL	-	2,4,6-Trinitrophenylmethylnitramine
1,3,5-TNB	-	1,3,5-trinitrobenzene
2,4,6-TNT	-	2,4,6-Trinitrotoluene
USATHAMA	-	U.S. Army Toxic and Hazardous Materials Agency
VOA	-	Volatile Organic Analysis

3.0. PROJECT DESCRIPTION

3.1. INTRODUCTION

This Quality Assurance Project Plan (QAPjP) is a generic plan that has been prepared to provide instruction to Los Alamos National Laboratory (LANL) and its contractors so that the work performed during the Environmental Restoration (ER) Program will be of the quality desired to satisfy the project objectives and will be responsive to the requirements of the U.S. Environmental Protection Agency (EPA), Region VI. LANL and its contractors are responsible for effecting minimal procedures to ensure that all data are of known quality, well-documented and meet the criteria of precision, accuracy, completeness, representativeness, and comparability as established by each operable unit (OU) QAPjP.

LANL will prepare an OU QAPjP for each task conducted under the ER Program in which data are generated. Data Quality Objectives (DQOs) will be identified for each task to ensure that the OU QAPjP addresses the appropriate data requirements. The intent of the OU QAPjP is to have a document that defines, describes, delineates, and implements the procedures necessary to effectively accomplish the project objectives by assuring that usable, high quality data are produced.

This Generic QAPjP addresses, at a minimum, the 16 essential elements detailed in the EPA document "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" (QAMS-005/80) (EPA 1980). This project plan is tiered to the LANL Quality Program Plan (QPP) for Environmental Restoration Activities (Annex II of the Laboratory's ER Program Installation Work Plan (IWP) (LANL 1990). The QPP meets the requirements of the consensus standard "Quality Assurance Program Requirements for Nuclear facilities" (ANSI/ASME NQA-1) plus the EPA's "Interim Guidelines and Specifications for Preparing Quality Assurance Program Plans" (QAMS-004/80).

During the course of the ER Program, there is the possibility that some of the methods, procedures, detection limits, etc., may change. These modifications will be reviewed and incorporated, and implemented as appropriate using LANL ER Administrative Procedures (APs), "Review and Approval of Environmental Restoration Program Plans and Reports" and " Preparation, Review, and Approval of Standard Operating Procedures".

This Generic QAPjP has been designed to serve as a framework for preparing OU-specific QAPjPs. Thus, only changes to a limited number of the sections plus the addition of necessary Standard Operating Procedures (SOPs) will be required. The boxes that appear in sections of this QAPjP provide guidance and technical information necessary for preparing the OU QAPjP. When a section of this QAPjP is adopted as written in OU QAPjP, no text is required in that section of the OU QAPjP. When information required for an OU QAPjP can be found in the OU RFI work plan, a reference to the section of the work plan is sufficient to include the information in the OU QAPjP. OU QAPjPs are an appendix to the OU RFI work plans.

3.2. FACILITY DESCRIPTION

A facility description of Los Alamos National Laboratory and descriptions of individual areas are presented in Section 2.0 of the LANL ER Program Installation Work Plan (IWP).

3.3. ENVIRONMENTAL RESTORATION PROGRAM

A description of the ER Program is presented in Section 3.0 of the IWP.

3.4. PROJECT DESCRIPTION

This section may be written in the OU QAPjP to define changes or OU-specific information not referenced elsewhere, and is to include the following, as applicable:

1. Comprehensive statement of objectives (purpose).
2. Dates for start and completion of project and sampling activities.
3. Overview of project's scope (activities).
4. Background information.
5. Brief statement of intended data usage(s).

4.0. PROJECT ORGANIZATION AND RESPONSIBILITY

The overall organizational structure of the ER Program is presented in Section 2.0 of the LANL ER Quality Program Plan (QPP). Organizational structures specific to OU work activities will be found in the OU RFI Work Plan. The Sample Management Facility (SMF) is the designated sample custodian.

Key organizations/people should be identified in this section of the OU QAPjP or by reference. Complete information includes the following:

1. Line authority explained or demonstrated by including an organizational chart.
2. Personnel qualifications including training, experience, and resumes.
3. An organizational structure appropriate to accomplish the Quality Assurance (QA) objectives of the project.

4.0. PROJECT ORGANIZATION AND RESPONSIBILITY

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2. Personnel qualifications including training, experience, and resumes.
3. An organizational structure appropriate to accomplish the Quality Assurance (QA) objectives of the project.

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

The precision, accuracy and completeness objectives for LANL ER Program projects are based upon historical precision and accuracy data where available, and upon the completeness needed to accomplish project goals. Where historical information is not available, the published precision and accuracy for the method are the basis for the stated objectives.

The analytical methods that will be used are detailed in the LANL documents LA-10300-M, Volumes 1 and 2, Health and Environmental Chemistry: Analytical Techniques, Data Management, and Quality Assurance. These methods are based on EPA methods when available, or generally recognized and accepted institutions such as the American Public Health Association or American Society for Testing and Materials.

The overall quality assurance objective is to develop and implement procedures that will ensure quality in field sampling, field testing, chain-of-custody, laboratory analysis, and data reporting. Specific procedures for sampling, chain-of-custody, audits, preventive maintenance, and corrective actions are described in other sections of this QAPjP. This section defines the goals for accuracy, precision, completeness, representativeness, and comparability. Quality assurance goals for field measurements are also discussed.

SUMMARY OF PRECISION, ACCURACY AND COMPLETENESS

When changes or additions are made to objectives presented in this Generic QAPjP, the following information is to be included in the operable unit-specific QAPjP in tabular form:

- Measurement parameter
- Method
- Matrix (experimental conditions)
- Precision (as a standard deviation)
- Accuracy
- Completeness if other than 90%

5.1. LEVEL OF QUALITY CONTROL

5.1.1. Field Sampling

Field blanks, reagent blanks, field replicate samples, equipment (rinsate) blanks, and trip blanks will be submitted to the analytical laboratory to provide the means to assess the quality of the data resulting from the field sampling program. Blank samples will be analyzed to check for procedural contamination and ambient conditions at the site that may have caused sample contamination. Replicate samples will be analyzed to check for sampling and analytical reproducibility.

A recommended level of quality control for non-radiological samples is summarized in Table V.1. Additional information is presented in Section 11.1.1 for soil sampling and Section 11.1.2 for water sampling. Two types of field quality control samples will be collected and analyzed for radiological constituents. These are: field duplicates and rinsate blanks. Table X.1 in Section 10.2.2 describes these samples and the acceptance criteria that will be used to evaluate the radiological data obtained from the analysis of these samples. The frequency of field duplicates for soil and water radiological samples will be 1 per 20 samples (5 percent). Rinsate (equipment) blanks for radiological samples will be collected at a frequency of 1 per 20 samples (5 percent) for soil samples and 1 per 10 samples (10 percent) for water samples.

5.1.2. Field Measurements

The quality control level of effort for the field measurement of pH consists of a pre-measurement calibration and a post-measurement verification using two standard reference solutions each time. This procedure will be performed for each water sample tested. Quality control effort for field conductivity measurements will include a daily calibration of the instrument using standard solutions of known conductivity. LANL ER Program SOP, Field Analytical Measurements of Groundwater describes field measurements on ground water samples, including quality control efforts.

5.1.3. Analytical Laboratory

Matrix samples provide information about the effect of the sample matrix on the analytical methodology. All matrix spikes are performed in duplicate. The matrix spike/matrix spike duplicates are not counted in the total number of samples because they are laboratory quality control samples.

A matrix spiked sample will be analyzed with every analytical batch or every 20 investigative samples per sample matrix (soil, surface water, sediment, and groundwater), whichever is more frequent.

The level of laboratory quality control effort for analyses performed by EPA SW (Solid Waste)-846 protocol is specified in the methods for organic and inorganic analyses (EPA 1987). Table V.2 presents a summary of the level of laboratory quality control effort.

5.2. PRECISION, ACCURACY, AND SENSITIVITY OF ANALYSES

The precision, accuracy, and sensitivity of laboratory analytical data must satisfy the quality control acceptance criteria of the analytical protocols. Table V.3 presents the U.S. EPA SW-846 practical quantitation limits (PQLs) for the analysis of volatile organic chemicals in groundwater and low soil/sediment by gas chromatography/mass spectrometry (GC/MS) Method 8240 (EPA 1987). Table V.4 presents the U.S. EPA SW-846 PQLs for the analysis of semivolatile organic chemicals in groundwater and low soil/sediment by GC/MS capillary column technique Method 8270 (EPA 1987). Table V.5 presents the method detection limits (MDLs) for the analysis of organochlorine pesticides and PCBs (polychlorinated biphenyls) by gas chromatography (GC) Method 8080 (EPA 1986a). Table V.6 presents the PQLs for the analysis of organochlorine pesticides and PCBs in groundwater and low level soil by gas chromatography (GC) Method 8080 (EPA 1986a). Table V.7 presents the estimated instrumental detection limits for the analysis of inorganics by inductively coupled plasma-atomic emission spectroscopy Method 6010 (EPA 1987). Table V.8 presents the radionuclide MDLs for water and soil/sediment samples (DOE 1983). Table V.9 presents the MDLs for miscellaneous analytes in water and soil/sediment samples by ion chromatography (EPA 1990). Table V.10 presents the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) high explosive list and MDLs for water and soil samples (USATHAMA n.d.).

5.3. QUALITY ASSURANCE OBJECTIVES FOR PRECISION

Analytical precision is calculated by expressing, as a percentage, the difference between the results of analysis of duplicate samples relative to the average of those results for a given analyte. Precision is expressed as the relative percent difference (RPD). The quality assurance objectives for metals analysis are different from those of organic analysis. The U.S. EPA SW-846 precision

objectives for metals are discussed in Section 5.3.1. Section 5.3.2 discusses the U.S. EPA SW-846 precision objectives for organic analysis.

5.3.1. Metals Analysis (Inorganics)

The quality assurance objective for precision for metals analysis is + or - 20% RPD for sample values greater than 10 times the instrument detection limit. This RPD is for replicate analyses, as specified by Method 6010, Inductively Coupled Plasma-Atomic Emission Spectroscopy in U.S. EPA SW-846 (EPA 1987).

5.3.2. Organic Analysis

Analytical precision for organic analysis (GC/MS) under the criteria of U.S. EPA SW-846 (EPA 1986a; EPA 1987) is measured by comparing the recovery of surrogate compounds in the standard matrix (e.g., blank/blank spike) or by comparing the recovery of a select number of target analytes in duplicate samples or blanks (e.g., matrix spike/matrix spike duplicate). The quality assurance objectives for precision of organic analysis (expressed by the RPD for analysis of matrix spike and matrix spike duplicate samples) are presented in Table V.11. Failure to achieve the RPD values will trigger corrective action as defined in the U.S. EPA SW-846 criteria (EPA 1986a; EPA 1987).

5.4. QUALITY ASSURANCE OBJECTIVE FOR ACCURACY

Analytical accuracy is calculated by expressing, as a percent, the recovery of a standard reference material or an analyte that has been added to the sample (or standard matrix) at a known concentration before analysis. The spiked (fortified) concentration used will be specified by laboratory quality control requirements as detailed in the applicable U.S. EPA SW-846 method (EPA 1986a; EPA 1987).

The quality assurance objectives for accuracy according to U.S. EPA SW-846 criteria are different for organic and inorganic analyses. The accuracy objectives specific to inorganic analyses are presented below in Section 5.4.1. Section 5.4.2 presents the accuracy objectives for organic analysis.

5.4.1. Inorganic Analysis

Analytical accuracy for metals is measured from analysis of a spiked replicate sample and a sample spiked with the analyte of interest (analyte spike). The quality assurance objectives for accuracy in metals analysis, for these quality control samples, are taken from the U.S. EPA SW-846 Method 6010 (EPA 1987) and are summarized below.

Sample	Recovery %
Spiked replicate	80 - 120
Analyte spike	75 - 125

Recovery values outside the quality control limits for spiked replicate samples will trigger corrective action. Recovery values for matrix analyte spike samples that are outside the quality control limits may indicate a matrix effect. If spectral overlap is suspected, use of computerized compensation, an alternate wavelength, or comparison with an alternate method is recommended (EPA 1987). For other inorganic parameters, laboratory control charts and method-specific quality control criteria will be used to define the quality assurance objectives.

5.4.2. Organic Analysis

For organic analysis (gas chromatography (GC) and GC/Mass Spectrometry (MS)), analytical accuracy is obtained from the surrogate recovery measured in each sample and blank or from the analysis of samples or blanks spiked with a select number of target analytes.

The U.S. EPA SW-846 quality assurance objectives for accuracy for organic surrogate spike recovery are summarized in Table V.12 (EPA 1986a; EPA 1987). The U.S. EPA SW-846 quality assurance objectives for precision and accuracy of matrix spike analyses are given in Table V.11. Failure to achieve the recoveries summarized in Tables V.11 and V.12 will trigger corrective action as specified under criteria established in the U.S. EPA SW-846 methods.

5.5. REPRESENTATIVENESS, COMPLETENESS, AND COMPARABILITY

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Data representativeness will be attained through the proper design of the sampling program, including background and/or upgradient samples, which will make certain that sample locations and the number of samples chosen will sufficiently describe the site. The sampling program design will be developed using applicable statistical methods to ensure that an appropriate number of samples are collected and where applicable, will use LANL ER Program SOPs.

Completeness is a measure of the relative number of analytical data points that meet all the acceptance criteria for accuracy, precision, and any other criterion required by the specific analytical methods used. The quality assurance objective for analytical data completeness for the LANL ER Program is 90%. Data completeness is affected by laboratory accidents, insufficient sample volume, or sample breakage during shipment, etc. Additionally, the ability to meet or exceed this objective depends on the nature of the samples submitted for analysis. For example, the application of routine organic analysis methods to non-routine matrices, such as drum samples, wipes, and air samples, may result in poor method performance and, therefore, adversely impact the data completeness goal.

Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be achieved through the use of standard sampling and analytical techniques. Data results will be reported in appropriate units consistent with existing site data and applicable regulatory levels.

5.6. FIELD MEASUREMENTS

Most data derived from ER Program environmental investigations at LANL will be developed in the on-site and off-site analytical laboratories from the samples collected in the field. However, some measurements may be performed in the field at the time of sample collection. Examples of field measurement data include surface water and groundwater sample measurements such as specific conductance, temperature, pH, and alkalinity. If surface water and/or groundwater samples are collected, required measurements will be performed and recorded in the field. The primary quality assurance objectives for all field activities where measurements will be taken are to verify that quality control checks are performed, verify that measurements were obtained to the degree of accuracy

consistent with their intended use, and provide documentation of adherence to the measurement procedures. LANL ER Program SOPs describe in detail the procedures for obtaining accurate and precise measurements in the field. Standard formats for documenting data collection are included in the SOPs. Adherence to the procedures described in the LANL ER Program SOPs will ensure the accuracy, precision, and completeness of the field measurement data.

All surface and subsurface locations sampled during ER Program environmental investigations at LANL will be surveyed. Surveying and preparation of site maps will be conducted to provide a common frame of reference for data reporting and interpretation.

5.7. DATA QUALITY OBJECTIVES

Precision, accuracy, representativeness, completeness, and comparability of data are the terms used to define DQOs.

DQOs are qualitative and quantitative statements that specify the quality of the data required to support specific project decisions. DQOs also specify the level of uncertainty that a decision maker is willing to accept in results derived from environmental data, when the results are used in a regulatory or programmatic decision, such as establishing analytical method requirements, establishing sampling protocols, and revision or development of industry standards.

The development of DQOs shall be the first step in initiating any environmental monitoring data collection activity and shall consist of a three-stage process: the decision shall be defined; the information that is required for the decision shall be identified; and the data collection program shall be designed.

Table V.1. Field Sampling Recommended Level of Quality Control Summary for Non-radiological Samples

Sample Type	Applicable Matrix	Sample Frequency
Field Blank	Soil and Water	1 per 20 samples
Reagent Blank	Soil and Water	1 per 20 samples
Field replicate	Soil Water	1 per 20 samples 1 per 10 samples
Rinsate Blank	Soil Water	1 per 20 samples 1 per 10 samples
Trip Blank	Water	1 per shipping container for VOA analyses only

Table V.2. Laboratory Level of Quality Control Summary for U.S. Environmental Protection Agency Solid Waste (SW) 846 Analyses[a]

Sample Type	Sample Frequency
Matrix Spiked Sample	1 per analytical batch or every 20 samples, whichever is more frequent.
Reagent Blank	1 per analytical batch.
Surrogate Compounds	Every blank, standard, and environmental sample (including duplicates, quality control reference samples, and check standards) will be spiked with surrogate compounds prior to purging or extraction.
Quality Control Reference Sample	1 per analytical batch or every 20 samples, whichever is greater.
Spiked Replicate Sample	At a frequency of 20% for metals analysis.

[a] EPA. 1987.

Table V.3. U.S. Environmental Protection Agency Solid Waste (SW) 846 Volatiles Practical Quantitation Limits for Water and Low Soil/Sediment by Method 8240 Gas Chromatography/Mass Spectrometry[a,b]

		Practical Quantitation Limits[c]	
		Water	Low Level Soil
Volatiles[d]	CAS Number[e]	ug/L	ug/kg
Acetone	67-64-1	100	100
Acetonitrile	75-05-8	100	100
Allyl chloride	107-05-1	5	5
Benzene	71-43-2	5	5
Benzyl chloride	100-44-7	100	100
Bromodichloromethane	75-27-4	5	5
Bromoform	75-25-2	5	5
Bromomethane	74-83-9	10	10
2-butanone	78-93-3	100	100
Carbon disulfide	75-15-0	100	100
Carbon tetrachloride	56-23-5	5	5
Chlorobenzene	108-90-7	5	5
Chlorodibromomethane	124-48-1	5	5
Chloroethane	75-00-3	10	10
2-chloroethyl vinyl ether	110-75-8	10	10
Chloroform	67-66-3	5	5
Chloromethane	74-87-3	10	10
Chloroprene	126-99-8	5	5
1,2-dibromo-3-chloropropane	96-12-8	100	100
1,2-dibromoethane	106-93-4	5	5
Dibromomethane	74-95-3	5	5
1,4-dichloro-2-butene	764-41-0	100	100
Dichlorodifluoromethane	75-71-8	5	5
1,1-dichloroethane	75-34-3	5	5
1,2-dichloroethane	107-06-2	5	5
1,1-dichloroethene	75-35-4	5	5
1,2-trans-dichloroethene	156-60-5	5	5
1,2-dichloropropane	78-87-5	5	5
1,3-cis-dichloropropene	10061-01-5	5	5
1,3-trans-dichloropropene	10061-02-6	5	5
Ethylbenzene	100-41-4	5	5
Ethyl methacrylate	97-63-2	5	5
2-hexanone	591-78-6	50	50
Isobutyl alcohol	78-83-1	100	100
Methacrylonitrile	126-98-7	100	100
Methylene chloride	75-09-2	5	5
Methyl iodide	74-88-4	5	5

Table V.3. Continued

Volatiles[d]	CAS Number[e]	Practical Quantitation Limits[c] Water ug/L	Practical Quantitation Limits[c] Low Level Soil ug/kg
Methyl methacrylate	80-62-6	5	50
4-methyl-2-pentanone	108-10-1	50	50
Pentachloroethane	76-01-7	10	10
Propionitrile	107-12-0	100	100
Styrene	100-42-5	5	5
1,1,1,2-tetrachloroethane	630-20-6	5	5
1,1,2,2-tetrachloroethane	79-34-5	5	5
Tetrachloroethene	127-18-4	5	5
Toluene	108-88-3	5	5
1,1,1-trichloroethane	71-55-6	5	5
1,1,2-trichloroethane	79-00-5	5	5
Trichloroethene	79-01-6	5	5
1,2,3-trichloropropane	96-18-4	5	5
Vinyl acetate	108-05-4	50	50
Vinyl chloride	75-01-4	10	10
Xylene (total)	1330-20-7	5	5

[a] EPA. 1987.

[b] Sample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable. See the following information for further guidance on matrix-dependent PQLs (EPA 1987).

[c] PQLs listed for soil/sediment are based on wet weight. Normally data is reported on a dry weight basis; therefore, PQLs will be higher, based on the percent moisture in each sample (EPA 1987).

[d] Compounds listed are from EPA SW-846 Method 8240 (EPA 1987).

[e] CAS Number - Chemical Abstract Service Number.

Table V.4. U.S. Environmental Protection Agency Solid Waste (SW) 846 Semivolatiles Practical Quantitation Limits for Water and Low Soil/Sediment by Method 8270 Gas Chromatography/Mass Spectrometry Capillary Column Technique[a,b]

		Practical Quantitation Limits[c]	
		Water	Low Level Soil
Semivolatiles[d]	CAS Number[e]	ug/L	ug/kg
Acenaphthene	83-32-9	10	660
Acenaphthylene	208-96-8	10	660
Acetophenone	98-86-2	10	ND
2-acetylaminofluorene	53-96-3	20	ND
1-acetyl-2-thiourea	591-08-2	1000	ND
2-aminoanthraquinone	117-79-3	20	ND
Aminoazobenzene	60-09-3	10	ND
4-aminobiphenyl	92-67-1	20	ND
Anilazine	101-05-3	100	ND
o-anisidine	90-04-0	10	ND
Anthracene	120-12-7	10	660
Aramite	140-57-8	20	ND
Azinphos-methyl	86-50-0	100	ND
Barban	101-27-9	200	ND
Benzoic acid	65-85-0	50	3300
Benz(a)anthracene	56-55-3	10	660
Benzo(b)fluoranthene	205-99-2	10	660
Benzo(k)fluoranthene	207-08-9	10	660
Benzo(g,h,i)perylene	191-24-2	10	660
Benzo(a)pyrene	50-32-8	10	660
p-benzoquinone	106-51-4	10	ND
Benzyl alcohol	100-51-6	20	1300
bis(2-chloroethoxy)methane	111-91-1	10	660
bis(2-chloroethyl)ether	111-44-4	10	660
bis(2-chloroisopropyl)ether	39638-32-9	10	660
bis(2-ethylhexyl)phthalate	117-81-7	10	660
4-bromophenyl phenyl ether	101-55-3	10	660
Bromoxynil	1689-84-5	10	ND
Butyl benzyl phthalate	85-68-7	10	660
Captafol	2425-06-1	20	ND
Captan	133-06-2	50	ND
Carbaryl	63-25-2	10	ND
Carbofuran	1563-66-2	10	ND
Carbophenothion	786-19-6	10	ND
Chlorfenvinphos	470-90-6	20	ND
4-chloroaniline	106-47-8	20	1300
Chlorobenzilate	510-15-6	10	ND

Table V.4. Continued

Semivolatiles[d]	CAS Number[e]	Practical Quantitation Limits[c] Water ug/L	Low Level Soil ug/kg
5-chloro-2-methylaniline	95-79-4	10	ND
4-chloro-3-methylphenol	59-50-7	20	1300
3-(chloromethyl)pyridine hydrochloride	6959-48-4	100	ND
2-chloronaphthalene	91-58-7	10	660
2-chlorophenol	95-57-8	10	660
4-chlorophenyl phenyl ether	7005-72-3	10	660
Chrysene	218-01-9	10	660
Coumaphos	56-72-4	40	ND
p-cresidine	120-71-8	10	ND
Crotoxyphos	7700-17-6	20	ND
2-Cyclohexyl-4,6-dinitro-phenol	131-89-5	100	ND
Demeton-o	298-03-3	10	ND
Demeton-s	126-75-0	10	ND
Diallate (cis or trans)	2303-16-4	10	ND
Diallate (trans or cis)	2303-16-4	10	ND
2,4-diaminotoluene	95-80-7	20	ND
Dibenz(a,j)acridine	224-42-0	10	ND
Dibenz(a,h)anthracene	53-70-3	10	660
Dibenzofuran	132-64-9	10	660
Dibenzo(a,e)pyrene	192-65-4	10	ND
Di-n-butylphthalate	84-74-2	10	ND
Dichlone	117-80-6	NA	ND
1,2-dichlorobenzene	95-50-1	10	660
1,3-dichlorobenzene	541-73-1	10	660
1,4-dichlorobenzene	106-46-7	10	660
3,3'-dichlorobenzidine	91-94-1	20	1300
2,4-dichlorophenol	120-83-2	10	660
2,6-dichlorophenol	87-65-0	10	ND
Dichlorovos	62-73-7	10	ND
Dicrotophos	141-66-2	10	ND
Diethyl phthalate	84-66-2	10	660
Diethyl stilbesterol	56-53-1	20	ND
Diethyl sulfate	64-67-5	100	ND
Dimethoate	60-51-5	20	ND
3,3'-dimethoxybenzidine	119-90-4	100	ND
Dimethylaminoazobenzene	60-11-7	10	ND
7,12-dimethylbenz(a)-anthracene	57-97-6	10	ND

Table V.4. Continued

Semivolatiles[d]	CAS Number[e]	Practical Quantitation Limits[c] Water ug/L	Low Level Soil ug/kg
3,3'-dimethylbenzidine	119-93-7	10	ND
a,a-dimethylphenethylamine	122-09-8	ND	ND
2,4-dimethylphenol	105-67-9	10	660
Dimethyl phthalate	131-11-3	10	660
1,2-dinitrobenzene	99-65-0	40	ND
1,3-dinitrobenzene	528-29-0	20	ND
1,4-dinitrobenzene	100-25-4	40	ND
4,6-dinitro-2-methylphenol	534-52-1	50	3300
2,4-dinitrophenol	51-28-5	50	3300
2,4-dinitrotoluene	121-14-2	10	660
2,6-dinitrotoluene	606-20-2	10	660
Dinocap	39300-45-3	100	ND
Dinoseb	88-85-7	20	ND
5,5-diphenylhydantoin	57-41-0	20	ND
Di-n-octylphthalate	117-84-0	10	660
Disulfoton	298-04-4	10	ND
EPN	2104-64-5	10	ND
Ethion	563-12-2	10	ND
Ethyl carbamate	51-79-6	50	ND
Ethyl methanesulfonate	62-50-0	20	ND
Famphur	52-85-7	20	ND
Fensulfothion	115-90-2	40	ND
Fenthion	55-38-9	10	ND
Fluchloralin	33245-39-5	20	ND
Fluoranthene	206-44-0	10	660
Fluorene	86-73-7	10	660
Hexachlorobenzene	118-74-1	10	660
Hexachlorobutadiene	87-68-3	10	660
Hexachlorocyclopentadiene	77-47-4	10	660
Hexachloroethane	67-72-1	10	660
Hexachlorophene	70-30-4	50	ND
Hexachloropropene	1888-71-7	10	ND
Hexamethyl phosphoramide	680-31-9	20	ND
Hydroquinone	123-31-9	ND	ND
Indeno(1,2,3-cd)pyrene	193-39-5	10	660
Isodrin	465-73-6	20	ND
Isophorone	78-59-1	10	660
Isosafrole	120-58-1	10	ND
Kepone	143-50-0	20	ND
Leptophos	21609-90-5	10	ND

Table V.4. Continued

Semivolatiles[d]	CAS Number[e]	Practical Quantitation Limits[c] Water ug/L	Practical Quantitation Limits[c] Low Level Soil ug/kg
Malathion	121-75-5	50	ND
Maleic anhydride	108-31-6	NA	ND
Mestranol	72-33-3	20	ND
Methapyrilene	91-80-5	100	ND
Methoxychlor	72-43-5	10	ND
3-methylcholanthrene	56-49-5	10	ND
4,4'-methylenebis(2-chloraniline)	101-14-4	NA	ND
Methylmethanesulfonate	66-27-3	10	ND
2-methylnaphthalene	91-57-6	10	660
Methyl parathion	298-00-0	10	ND
2-methylphenol	95-48-7	10	660
3-methylphenol	108-39-4	10	ND
4-methylphenol	106-44-5	10	660
Mevinphos	7786-34-7	10	ND
Mexacarbate	315-18-4	20	ND
Mirex	2385-85-5	10	ND
Monocrotophos	6923-22-4	40	ND
Naled	300-76-5	20	ND
Naphthalene	91-20-3	10	660
1,4-naphthoquinone	130-15-4	10	ND
1-naphthylamine	134-32-7	10	ND
2-naphthylamine	91-59-8	10	ND
Nicotine	54-11-5	20	ND
5-nitroacenaphthene	602-87-9	10	ND
2-nitroaniline	88-74-4	50	3300
3-nitroaniline	99-09-2	50	3300
4-nitroaniline	100-01-6	20	ND
5-nitro-o-anisidine	99-59-2	10	ND
Nitrobenzene	98-95-3	10	660
4-nitrobiphenyl	92-93-3	10	ND
Nitrofen	1836-75-5	20	ND
2-nitrophenol	88-75-5	10	660
4-nitrophenol	100-02-7	50	3300
5-nitro-o-toluidine	99-55-8	10	ND
4-nitroquinoline-1-oxide	56-57-5	40	ND
N-nitrosodibutylamine	924-16-3	10	ND
N-nitrosodiethylamine	55-18-5	20	ND
N-nitrosodiphenylamine	86-30-6	10	660
N-nitroso-di-n-propylamine	621-64-7	10	660

Table V.4. Continued

Semivolatiles[d]	CAS Number[e]	Practical Quantitation Limits[c] Water ug/L	Low Level Soil ug/kg
N-nitrosopiperidine	100-75-4	20	ND
N-nitrosopyrrolidine	930-55-2	40	ND
Octamethyl pyrophosphoramide	152-16-9	200	ND
4,4'-oxydianiline	101-80-4	20	ND
Parathion	56-38-2	10	ND
Pentachlorobenzene	608-93-5	10	ND
Pentachloronitrobenzene	82-68-8	20	ND
Pentachlorophenol	87-86-5	50	3300
Phenacetin	62-44-2	20	ND
Phenanthrene	85-01-8	10	660
Phenobarbital	50-06-6	10	ND
Phenol	108-95-2	10	660
1,4-phenylenediamine	106-50-3	10	ND
Phorate	298-02-2	10	ND
Phosalone	2310-17-0	100	ND
Phosmet	732-11-6	40	ND
Phosphamidon	13171-21-6	100	ND
Phthalic anhydride	85-44-9	100	ND
2-picoline	109-06-8	ND	ND
Piperonyl sulfoxide	120-62-7	100	ND
Pronamide	23950-58-5	10	ND
Propylthiouracil	51-52-5	100	ND
Pyrene	129-00-0	10	660
Pyridine	110-86-1	ND	ND
Resorcinol	108-46-3	100	ND
Safrole	94-59-7	10	ND
Strychnine	57-24-9	40	ND
Sulfallate	95-06-7	10	ND
Terbufos	13071-79-9	20	ND
1,2,4,5-tetrachlorobenzene	95-94-3	10	ND
2,3,4,6-tetrachlorophenol	58-90-2	10	ND
Tetrachlorvinphos	961-11-5	20	ND
Tetraethyl pyrophosphate	107-49-3	40	ND
Thionazine	297-97-2	20	ND
Thiophenol (benzenethiol)	108-98-5	20	ND
Toluene diisocyanate	584-84-9	100	ND
o-toluidine	95-53-4	10	ND
1,2,4-trichlorobenzene	120-82-1	10	660
2,4,5-trichlorophenol	95-95-4	10	660

Table V.4. Continued

Semivolatiles[d]	CAS Number[e]	Practical Quantitation Limits[c] Water ug/L	Practical Quantitation Limits[c] Low Level Soil ug/kg
2,4,6-trichlorophenol	88-06-2	10	660
Trifluralin	1582-09-8	10	ND
2,4,5-trimethylaniline	137-17-7	10	ND
Trimethyl phosphate	512-56-1	10	ND
1,3,5-trinitrobenzene	99-35-4	10	ND
Tris-(2,3-dibromopropyl) phosphate	126-72-7	200	ND
Tri-p-tolyl phosphate	78-32-0	10	ND
0,0,0-triethyl phosphorothioate	126-68-1	NT	ND

[a] EPA. 1987.

[b] Practical quantitation limits (PQLs) listed for soil/sediment are based on wet weight. Normally data is reported on a dry weight basis, therefore, PQLs will be higher, based on the percent moisture in each sample. This is based on a 30-g sample and gel permeation chromatography cleanup (EPA 1987).

[c] Sample PQLs are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable (EPA 1987).

[d] Compounds listed are from EPA SW-846 Method 8270 (EPA 1987).

[e] CAS Number - Chemical Abstract Service Number.

ND = Not determined.

NA = Not applicable.

NT = Not tested.

Table V.5. U.S. Environmental Protection Agency Solid Waste (SW) 846 Organochlorine Pesticides and PCBs Method Detection Limits by Method 8080 Gas Chromatography[a]

Compound[b]	CAS Number[c]	Method Detection Limit (ug/L)
Aldrin	309-00-2	0.004
alpha-BHC	319-84-6	0.003
beta-BHC	319-85-7	0.006
delta-BHC	319-86-8	0.009
gamma-BHC (lindane)	58-89-9	0.004
Chlordane (technical)	57-74-	0.014
4,4'-DDD	72-54-8	0.011
4,4'-DDE	72-55-9	0.004
4,4'-DDT	50-29-3	0.012
Dieldrin	60-57-1	0.002
Endosulfan I	959-98-8	0.014
Endosulfan II	33213-65-9	0.004
Endosulfan sulfate	1031-07-8	0.066
Endrin	72-20-8	0.006
Endrin aldehyde	7421-93-4	0.023
Heptachlor	76-44-8	0.003
Heptachlor epoxide	1024-57-3	0.083
Methoxychlor	72-43-5	0.176
Toxaphene	8001-35-2	0.240
Aroclor-1016	12674-11-2	ND
Aroclor-1221	11104-28-2	ND
Aroclor-1232	11141-16-5	ND
Aroclor-1242	53469-21-9	0.065
Aroclor-1248	12672-29-6	ND
Aroclor-1254	11097-69-1	ND
Aroclor-1260	11096-82-5	ND

a EPA. 1986a.

b Compounds listed are from EPA SW-846 Method 8080 (EPA 1986a).

c CAS Number - Chemical Abstract Service Number.

ND = Not determined.

Table V.6. U.S. Environmental Protection Agency Solid Waste (SW) 846 Organochlorine Pesticides and PCBs Practical Quantitation Limits by Gas Chromatography by Method 8080 for Water and Low-Level Soil[a]

		Practical Quantitation Limits[b]	
		Water[c]	Low Level Soil[d]
Compound[e]	CAS Number[f]	ug/L	ug/kg
Aldrin	309-00-2	0.04	2.68
alpha-BHC	319-84-6	0.03	2.01
beta-BHC	319-85-7	0.06	4.02
delta-BHC	319-86-8	0.09	6.03
gamma-BHC (lindane)	58-89-9	0.04	2.68
Chlordane (technical) 57-74-9	0.14	9.38	
4,4'-DDD	72-54-8	0.11	7.37
4,4'-DDE	72-55-9	0.04	2.68
4,4'-DDT	50-29-3	0.12	8.04
Dieldrin	60-57-1	0.02	1.34
Endosulfan I	959-98-8	0.14	9.38
Endosulfan II	33213-65-9	0.04	2.68
Endosulfan sulfate	1031-07-8	0.66	44.22
Endrin	72-20-8	0.06	4.02
Endrin aldehyde	7421-93-4	0.23	15.41
Heptachlor	76-44-8	0.03	2.01
Heptachlor epoxide	1024-57-3	0.83	55.61
Methoxychlor	72-43-5	1.76	117.92
Toxaphene	8001-35-2	2.40	160.80
Aroclor-1016	12674-11-2	ND	ND
Aroclor-1221	11104-28-2	ND	ND
Aroclor-1232	11141-16-5	ND	ND
Aroclor-1242	53469-21-9	0.65	43.55
Aroclor-1248	12672-29-6	ND	ND
Aroclor-1254	11097-69-1	ND	ND
Aroclor-1260	11096-82-5	ND	ND

[a] EPA. 1986a.

[b] Sample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable (EPA 1986a).

[c] The PQLs for groundwater consist of the individual compound Method Detection Limit X a factor of 10 (EPA 1986a).

[d] The PQLs for low-level soil consist of the individual compound Method Detection Limit X a factor of 670. These PQLs are for low-level soil by sonication with gel permeation chromatography (GPC) cleanup (EPA 1986a).

[e] Compounds listed are from EPA SW-846 Method 8080 (EPA 1986a).

[f] CAS Number - Chemical Abstract Service Number.

ND = Not determined.

Table V.7. U.S. Environmental Protection Agency Solid Waste (SW) 846 Estimated Instrumental Detection Limits for Inorganics by Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy[a]

Element	CAS Number[b]	Estimated Detection Limit[c] (ug/L)
Aluminum	7429-90-5	45.
Antimony	7440-36-0	32.
Arsenic	7440-38-2	53.
Barium	7440-39-3	2.
Beryllium	7440-41-7	0.3
Cadmium	7440-43-9	4.
Calcium	7440-70-2	10.
Chromium	7440-47-3	7.
Cobalt	7440-48-4	7.
Copper	7440-50-8	6.
Iron	7439-89-6	7.
Lead	7439-92-1	42.
Lithium	7439-93-2	5.
Magnesium	7439-95-4	30.
Manganese	7439-96-5	2.
Molybdenum	7439-98-7	8.
Nickel	7440-02-0	15.
Phosphorus	7723-14-0	51.
Potassium	7440-09-7	d
Selenium	7782-49-2	75.
Silver	7440-22-4	7.
Sodium	7440-23-5	29.
Strontium	7440-24-6	0.3
Thallium	7440-28-0	40.
Vanadium	7440-62-2	8.
Zinc	7440-66-6	2.

[a] EPA. 1987.

[b] CAS No. - Chemical Abstract Service Number.

[c] The estimated instrumental detection limits shown are given as a guide for an instrumental limit. The actual method detection limits are sample dependent and may vary as the sample matrix varies (EPA 1987).

[d] Highly dependent on operating conditions and plasma position (EPA 1987).

Table V.8. Radionuclide Method Detection Limits for Water and Soil/Sediment[a]

Radionuclide	Method Detection Limit Water	Method Detection Limit Soil/Sediment[a]
Americium-241	3.0 pCi/g	
Americium-241	0.04 pCi/L[b]	0.002 pCi/g[b]
Cesium-137	20.0 pCi/L[d]	0.1 pCi/g[d]
Gamma spectroscopy	15.0-300 pCi/L[d]	0.1-2.0 pCi/g[d]
Gross alpha	3.0-5.0 pCi/L[e]	4.0-10. pCi/g
Gross beta	3.0-6.0 pCi/L[e]	5.0-12.0 pCi/g
Isotopic plutonium (Pu-238, -239, -240)	0.04 pCi/L[b]	0.005 pCi/g[b]
Isotopic thorium (Th-228, -230, -232)	0.1 pCi/L	0.01 pCi/g
Total Uranium	2.0 ug/g[c]	0.5 ug/g[c]
Isotopic uranium		
U-234, -238	0.2 pCi/L	0.01 pCi/g
U-235	0.2 pCi/L	0.05 pCi/L
Radium-226	0.5 pCi/L	0.5 pCi/g[d]
Strontium/Yttrium-90	3.0 pCi/L	2.0 pCi/g
Tritium	400 pCi/L	400 pCi/L

[a] This footnote applies to all analytes in this table except those given footnotes b or c below. Methods are specified in Section 9. Method reference: DOE 1983. The detection limits listed are the method detection limits. Lower detection limits can be achieved with larger sample aliquots, additional chemistry, and extended counting times.

[b] Methods are specified in Section 9. Method reference: LANL methods manual LA-10300-M. The detection limits listed are the method detection limits. Lower detection limits can be achieved with larger sample aliquots, additional chemistry, and extended counting times.

[c] Methods are specified in Section 9. Method reference: LANL methods manual LA-10300-M. The detection limits listed are the method detection limits.

[d] The detection limit is dependent upon the mixture of isotopes in the sample.

[e] The detection limit listed is achievable providing the concentration of dissolved solids is equal to or less than 200 parts per million.

Table V.9. Method Detection Limits for Miscellaneous Analytes in Water and Soil/Sediments[a]

Analyte	Method Detection Limit Water	Method Detection Limit Soil/Sediment
Boron	0.1 mg/L	0.005 mg/L
Chloride	1.0 mg/L	1.0-10.0 mg/kg[b]
Fluoride	1.0 mg/L	1.0-10.0 mg/kg[b]
Nitrate	1.0 mg/L	1.0-10.0 mg/kg[b]
Nitrate & nitrite	0.04 mg/L	
Nitrite	0.02 mg/L	
Sulfate	1.0 mg/L	1.0-10.0 mg/kg[b]
Sulfide	0.1 mg/L	
Bromide	2.0 mg/L	
Carbonate	0. mg/L	
Phosphate	0.04 mg/L	
Ammonia/Nitrogen	0.01 mg/L	
Silica	5. mg/L	
Cyanide (total)	0.01 mg/L	5. mg/L
Mercury	0.02 ug/L	0.2 ug/L
Chromium (+6)	0.02 mg/L	0.5 mg/L
TOC	0.01 mg/L	
TSS	1. mg/L	

[a] EPA. 1990.

[b] The detection limit for soil/sediment samples varies depending upon the amount of sample used and the extraction procedure (EPA 1990).

Table V.10. USATHAMA Method Detection Limits for High Explosives in Water and Soil[a]

		Method Detection Limits	
		Water	Low Level Soild
Compounds[b]	CAS Number[c]	ug/L	ug/kg
HMX	2691-41-0	1.30	1.27
RDX	121-82-4	0.63	0.98
NB	98-95-3	1.13	0.42
1,3-DNB	99-65-01	0.61	0.59
1,3,5-TNB	99-35-4	0.56	2.09
2,4-DNT	121-14-2	0.60	0.42
2,6-DNT	606-20-2	0.55	0.40
2,4,6-TNT	118-96-7	0.78	1.92
TETRYL	35572-78-2	0.66	0.25

[a] U.S. Army Toxic and Hazardous Materials Agency, n.d.

[b]

HMX	Octahydro-1,3,4,7-tetranitro-1,3,5,7-tetrazocine
RDX	Hexahydro-1,3,5-trinitro-s-triazine
NB	Nitrobenzene
1,3-DNB	1,3-Dinitrobenzene
1,3,5-TNB	1,3,5-trinitrobenzene
2,4-DNT	2,4-Dinitrotoluene
2,6-DNT	2,6-Dinitrotoluene
2,4,6-TNT	2,4,6-Trinitrotoluene
TETRYL	2,4,6-Trinitrophenylmethylnitramine

[c] CAS Number - Chemical Abstract Service Number.

Table V.11. U.S. Environmental Protection Agency Solid Waste (SW) 846 Quality Assurance Objectives for Precision and Accuracy of Matrix Spike Analyses[a,b]

Matrix Spike		Percent Recovery Limit		Percent RPD Limits	
Fraction	Compound	Water	Soil/Sediment	Water	Soil/Sediment
VOA	1,1-dichloroethene	61-145	59-172	14	22
VOA	Trichloroethene	71-120	62-137	14	24
VOA	Benzene	76-127	66-142	11	21
VOA	Toluene	76-125	59-139	13	21
VOA	Chlorobenzene	75-130	60-133	13	21
BNA	Phenol	12-89	26-90	42	35
BNA	2-chlorophenol	27-123	25-102	40	50
BNA	1,4-dichlorobenzene	36-97	28-104	28	27
BNA	N-nitroso-di-n-propylamine	41-116	41-126	38	38
BNA	1,2,4-trichlorobenzene	39-98	38-107	28	23
BNA	4-chloro-3-methyl-phenol	23-97	26-103	42	33
BNA	Acenaphthene	46-118	31-137	31	19
BNA	4-nitrophenol	10-80	11-114	50	50
BNA	2,4-dinitrotoluene	24-96	28-89	38	47
BNA	Pentachlorophenol	9-103	17-109	50	47
BNA	Pyrene	26-127	35-142	31	36
Pest	Lindane	56-123	46-127	15	50
Pest	Heptachlor	40-131	35-130	20	31
Pest	Aldrin	40-120	34-132	22	43
Pest	Dieldrin	52-126	31-134	18	38
Pest	Endrin	56-121	42-139	21	45
Pest	4,4-DDT	38-127	23-134	27	50

[a] EPA. 1987

[b] EPA. 1986a

RPD - Relative Percent Difference.

VOA - Volatile organic analysis by Method 8240.

BNA - Base/neutral/acid by Method 8270.

PEST - Pesticide by Method 8080.

Table V.12. U.S. Environmental Protection Agency Solid Waste (SW) 846 Quality Assurance Objectives for Accuracy of Organic Surrogate Spike Analyses[a,b]

Fraction	Surrogate Compound	Percent Recovery Low/Medium Water	Percent Recovery Low/Medium Soil/Sediment
VOA	Toluene-d_8	88-110	81-117
VOA	4-bromofluorobenzene	86-115	74-121
VOA	1,2-dichloroethane-d_4	76-114	70-121
BNA	Nitrobenzene-d_5	35-114	23-120
BNA	2-fluorobiphenyl	43-116	30-115
BNA	p-terphenyl-d_{14}	33-141	18-137
BNA	Phenol-d_6	10-94	24-113
BNA	2-fluorophenol	21-100	25-121
BNA	2,4,6-tribromophenol	10-123	19-122
PEST	Dibutylchlorendate	24-154	24-150[c]

[a] EPA. 1987.

[b] EPA. 1986a.

[c] These percent recovery are advisory (EPA 1987).

VOA - Volatile organic analysis by Method 8240.

BNA - Base/neutral/acid by Method 8270.

PEST - Pesticide by Method 8080.

6.0. SAMPLING PROCEDURES

QAPjPs for specific operable units will contain or reference detailed and specific SOPs for the various sampling media that will be found at LANL. If an EPA-accepted SOP is used, it only needs to be referenced. If a unique procedure is needed, then a detailed step-by-step SOP must be written and referenced in the operable unit-specific QAPjP.

In most cases, procedures for collecting soil and aqueous samples will be selected, as appropriate, from already prepared LANL ER Program SOPs. Air sampling, other than that performed for health and safety monitoring, may potentially be performed. If air sampling is performed, U.S. EPA protocols such as TO-14 (EPA 1984a) will be used. The exact procedure(s) to be used for each sampling event, as are the guidelines for selection of sampling sites, are defined in the LANL operable unit field sampling plans.

All samples will be collected and containerized in properly cleaned sample containers. Sample containers will vary according to the matrix and nature of the sample to be collected. The LANL ER Program SOP, Containers, Sampling and Preservation contains information on the selection of the correct containers, container cleaning, required sample volumes, preservation criteria, and holding times. This information is for routine analytical measurements, such as physical properties, metals, organics, semivolatile organics, inorganics, PCBs, pesticides, and radiological samples. Non-routine analytical measurements, such as physicochemical tests, have specialized requirements.

These requirements, as appropriate, can be detailed in the operable unit-specific QAPjP.

6.1 Quality Control Samples

Quality control samples will be collected as part of all LANL ER Program sampling. Specific quality control samples are identified for surface water and groundwater sampling, and soil sampling activities. Table V.1 in Section 5.1.1 presents a summary of the field sampling level of quality control for non-radiological samples. Additional information for non-radiological quality control samples is presented in Section 11.1.1 for soil samples and Section 11.1.2 for water samples. The quality control level of effort for radiological samples is presented in Table X.1 in Section 10.2.2.

6.2. SAMPLE PRESERVATION DURING SHIPMENT

All samples will be labeled when collected and stored as required by the appropriate standard operating procedudre. Chain-of-custody documentation for all samples will be maintained. A chain-of-custody document will accompany the samples to the analytical laboratory. In addition, chain-of-custody documents should be sealed in plastic bags to ensure protection from melt water during shipment to the analytical laboratory.

6.3. EQUIPMENT DECONTAMINATION

All LANL ER Program samples will be collected with properly decontaminated equipment. Equipment decontamination is an integral part of the data collection and quality assurance process. The implementation of proper decontamination practices and procedures will begin in the field prior to the use of sample collection equipment. Equipment contamination procedures are described in LANL ER Program SOP, General Equipment Decontamination. The use of each type of sampling equipment is described in a LANL SOP. Each SOP used should also be reviewed for additional information regarding specific decontamination procedures. Wash water and other fluids created during decontamination should be handled in accordance with the ER Program Procedure for RFI-Generated Waste Management (SOP-01.06).

Sampling of some LANL environments, such as surface water systems, outfall pipes, waste streams, or containerized materials will be performed with the use of hand-held equipment. Due to the small number of these samples expected to be collected, and the inaccessibility of the sample locations, it is likely that expendable sampling equipment would be justified. All expendable sampling equipment will be certified clean prior to use. The use of expendable sampling equipment would provide the highest level of quality data by eliminating the possibility of cross-contamination between samples. Also, expendable sampling equipment would not require decontamination between samples which would generate solutions that may be potentially contaminated and require costly disposal.

6.4. SAMPLE DESIGNATION

Samples will be assigned a unique alphanumeric identifier to provide chain-of-custody control during the transfer of samples from the time of collection through analysis and reporting. The LANL procedure for Sample Control and Documentation describes the ER Program sample numbering system. This procedure presents details of the chain-of-custody procedures, and field documentation requirements.

7.0. SAMPLE CUSTODY

7.1. OVERVIEW

Strict chain-of-custody procedures shall be used to ensure the proper handling of samples during collection and analysis. Sample custody procedures require that the possession and handling of the sample from the moment of its collection through analysis be documented by written record. The chain-of-custody records will be initiated at the time of sample collection and remain in effect until the sample is disposed of. The chain-of-custody record lists the sample identifier, sampling date, sample matrix, number of containers, analysis requested and turn-around time required. Individuals receiving and relinquishing custody of the samples will sign and date the form using indelible blue or black ink. Record-keeping documentation for the samples includes the following:

- Field logbook or appropriate forms to document sampling activities in the field,
- Waterproof labels to identify individual samples,
- Chain-of-custody record sheets for documenting transfer and possession of samples, and
- Laboratory analysis request sheet for documenting analyses to be performed.

LANL ER Program SOP, Sample Control and Documentation, describes the chain-of-custody procedures.

7.2. FIELD DOCUMENTATION

7.2.1. Sample Identification

A numbering system has been developed to identify each boring location; monitor well; and sample collected during surface water, groundwater, sediment, waste stream, soil and air sampling programs. This numbering system provides a tracking procedure to all data retrieval. Sample identification numbers will be assigned in accordance with the LANL ER SOP-01.04, Sample Control and Documentation. Familiarity with the sample numbering system among the key LANL program staff will ensure that the numbering system is universally applied to samples collected during the project.

7.2.2. Field Logs

All data collection activities performed at a site will be documented, using indelible blue or black ink, either in a field notebook or on LANL ER Program forms. Field notebooks will be bound books and will be assigned to individual field personnel for the duration of their assignment. Entries will be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory.

7.2.3. Data Collection Forms

As the primary means of assuring the collection of accurate field and sampling information, standardized data collection forms will be used. LANL ER Program forms have been developed and will be used to record data in a consistent format that limits individual interpretations or preferences. By explicitly outlining reporting methods, identifying appropriate units of measure, and specifying alternative test procedures, these forms provide a measure of quality control and quality assurance in the data collection process.

The standard data collection forms prepared for the LANL ER Program SOPs group data and information according to problem-solving needs. They are a means of preventing the collection of invalid or redundant data and eliminating critical data gaps. Each data collection form precisely defines what data are necessary to accurately characterize a particular property or relationship. This reduces the likelihood of initiating field sampling or laboratory analyses, only to discover that key pieces of information have not been collected and that further field sampling is required.

Each SOP for a data collection activity provides an example of all forms required for the accurate recording of the procedure. A blank form will be used for each new location or sample, as specified by the SOP. During a LANL ER Program field investigation, each form will be completed as accurately and completely as possible, as indicated by the example and instructions contained in the SOP. Before submittal to the LANL ER Records Processing Facility, all data collection forms will be reviewed by the appropriate LANL ER Program field team leader or other applicable technical reviewer. The review will ensure completeness and accuracy in both form completion, as well as data integrity. The reviewer will then sign, date and record the time on each form.

7.2.4. Corrections to Documentation

Incorrect entries will be crossed out with a single line and signed and dated by the person originating the entry, and the appropriate LANL ER Program technical field team leader. The correct information will be entered and the correction signed and dated by the person making the correction. There will be no erasures or deletions from any type of data document record.

7.3. SAMPLE MANAGEMENT FACILITY

All samples will initially be transported by the field team to the LANL ER Program Sample Management Facility (SMF). The LANL SMF will coordinate the ER Program sample collection activities and analytical chemical analysis. The SMF is staffed and operated by the Health and Environmental Chemistry Group (HSE-9) in LANL's Health, Safety and Environment (HSE) Division. The following ER Program activities are coordinated by the SMF:

- Project Sampling Plan Review,
- Delivery of Samples,
- Sample Validation,
- Sample Packaging and Shipment, to contract laboratories, and
- Disposition of Samples

Appendix O, Sample Coordination Facility, in the LANL ER Program Installation Work Plan contains the details of the above listed activities which are coordinated by the LANL SMF.

7.4. LABORATORY DOCUMENTATION

The following subsections describe laboratory custody procedures associated with sample receipt, storage, preparation, analysis and general security. The custody procedures described herein, and procedures described in the analytical laboratory quality assurance manuals of each of the participating laboratories, will be adhered to for all analyses.

7.4.1. Sample Receipt

Each laboratory participating in analysis of LANL ER Program samples will telephone LANL's SMF to acknowledge the receipt of each shipment of samples.

- The laboratory sample custodian will inspect all sample containers for integrity. The presence of leaking or broken containers will be noted on the chain-of-custody record. The sample custodian will also identify any discrepancies in the chain-of-custody documentation. The sample custodian will sign the chain-of-custody record (with date and time of receipt), thus assuming custody of the samples.

- The information of the chain-of-custody record will be compared with that on sample tags and labels to verify sample identity. The laboratory sample custodian will notify the LANL SMF Coordinator of all discrepancies in the chain-of-custody record. Any inconsistencies will be resolved with the LANL SMF Coordinator before sample analysis proceeds. If needed, LANL's SMF Coordinator will initiate and document all necessary corrective actions.

- Samples will be placed in storage prior to analysis. The storage location will be recorded on the chain of custody record.

- The sample custodian will alert the appropriate section managers and analysts of any analyses requiring immediate attention because of short holding times.

7.4.2. Sample Storage

Where appropriate, samples will be maintained in storage in one of the locked storage refrigerators prior to sample preparation and analysis. The storage refrigerators are maintained at 4 degrees + or - 2 degrees C. Analytical laboratory personnel will request samples for preparation and analysis from the sample custodian. The sample custodian and analyst will sign using indelible blue or black ink, date and record the time on the chain-of-custody record to acknowledge transfer of custody to the analyst.

7.4.3. Sample Tracking - Organic Analysis

When samples are extracted or digested for analysis, all pertinent data are recorded in a bound laboratory notebook. Extraction or digestion data are entered, when appropriate, in to the laboratory information management system by the person performing the extraction or digestion. Extracts or digestions are maintained in the appropriate storage until analyzed.

7.4.4. Record-Keeping

Data related to all sample preparation and analysis procedures and observations by laboratory analysts are recorded in bound and numbered laboratory notebooks that are issued by the laboratory quality assurance coordinator. Laboratory notebook entries are signed and dated using indelible blue or black ink. Corrections to notebook entries are made by drawing a single line through the erroneous entry and by writing the correct entry next to the one crossed out. All corrections are signed (or initialed) and dated by the analyst.

7.5. SAMPLE HANDLING, PACKAGING, AND SHIPPING

All samples shipped off-site will be shipped, by courier such as Federal Express, to the appropriate participating analytical laboratory. Only samples that contain a material listed in the Hazardous Material Table (49 CFR 172.101) should be handled, packaged, and shipped as hazardous material. The U.S. Department of Transportation (DOT) (CFR 49 1985) and the International Air Transport Association (IATA) (IATA 1988) have established specific regulations governing the packaging of hazardous samples for shipment. LANL ER Program SOP, Guide to Handling, Packaging and Shipping of Samples, and Appendix O, Sample Management Facility, in the ER Program Installation Work Plan provide information and references that must be reviewed prior to selection of appropriate packaging materials, shipping containers, and shipping labels.

7.6. FINAL EVIDENCE FILE DOCUMENTATION

All LANL ER Program RFI project participants will maintain records to document the quality assurance/quality control activities and to provide support for possible evidential proceedings. All records generated for the ER Program are the property of the LANL ER Program Office. Records which provide documentary evidence of quality shall be specified, prepared and maintained in accordance with appropriate LANL ER Program Administrative Procedures (APs).

The LANL Records Management Plan (RMP) provides requirements on the identification, classification, and management of project records. A detailed description of the LANL RMP and its coordination with other aspects of the ER Program is presented in Annex IV of the LANL Installation Work Plan (LANL 1990). Additional information is presented in Section 17 of the LANL ER Program Quality Program Plan.

8.0. CALIBRATION PROCEDURES AND FREQUENCY

8.1. OVERVIEW

Measuring and test equipment used in the field and laboratory are controlled by formal calibration programs. The programs provide equipment of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results. Routine calibration services are provided by the LANL Metrology Group, MEC-9.

Devices are calibrated and adjusted at specified, predetermined intervals using equipment and material having known valid relationships to National Institute of Standards and Technology (NIST) standards, other recognized standards, or accepted values of natural physical constants. If national standards do not exist, the basis of calibration is documented. Documentation of all calibration activities are maintained and performed in accordance with written SOPs. Calibration is based on the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience.

Routine calibration procedures are required to ensure proper operation of equipment and instruments. Established procedures and frequency are necessary to produce and document the quality of data required for task objectives.

8.2. FIELD EQUIPMENT

A list of analytical and health and safety screening procedures that may be used in the field during environmental investigations is presented in Appendix M of the LANL Installation Work Plan. Specific information regarding calibration procedures and frequency of calibration for field equipment is presented in the applicable LANL ER Program SOPs.

The instruments will be calibrated according to manufacturer's specifications before and after each field use, or as otherwise described in the LANL ER Program SOPs. Where necessary, instruments will be calibrated each day during field use.

Records for each field instrument used as part of environmental investigations at LANL will be maintained to assure its capability of providing accurate and precise measurements. Records will be maintained on instrument maintenance and calibration. Tracking of instrument records will be accomplished by assigning unique numbers to each instrument which will correspond to its record file.

8.3. LABORATORY EQUIPMENT

Before any instrument is used as a measuring device, the instrument response to known reference materials must be determined. The manner in which various instruments are calibrated is dependent on the particular type of instrument and its intended use. All sample measurements will be made within the calibrated range of the instrument.

Routine calibration standards will be used in the analytical laboratory to demonstrate that the performance of an instrument does not cause unnecessary error in the analysis. This calibration will indicate instrument stability and sensitivity. The methods for verification and documentation of instrument conditions prior to and during testing shall be detailed by each participating laboratory in specific laboratory procedures.

Laboratory instrument calibrations typically consist of two types, initial calibration and continuing calibration. Initial and continuing calibration criteria must meet the method acceptance criteria before sample analysis can begin. Initial calibration procedures establish the calibration range of the instrument and determine instrument response over that range. Typically, three to five analyte concentrations are used to establish instrument response over a concentration range. The instrument response over that range is expressed as a correlation coefficient (e.g., for atomic absorption, inductively coupled plasma, UV-visible/infrared spectrophotometry, ion chromatography) or by a response factor, amount/response (e.g., for gas chromatography (GC), gas chromatograph/mass spectrometer (GC/MS), high performance liquid chromatography (HPLC)).

Continuing calibration usually includes measurement of the instrument response to one or more calibration standards and requires instrument response to compare within certain limits (e.g., + or - 10 percent) of the initial measured instrument response. Continuing calibration is performed at least once per operating shift for all analyses.

Calibration criteria for each sampling event, beyond that given in the analytical methods, will be specified in operable unit sampling and analysis plans. Specific instrument calibration procedures for various analytical instruments are described in detail in the Quality Assurance Plan (QAP) of each participating laboratory or their procedure.

9.0. ANALYTICAL PROCEDURES

9.1. OVERVIEW

Analytical procedures must be established in a data measurement program. These procedures will enable participants in the sampling program to determine the data quality that is to be expected. Each measurement parameter, in the field and laboratory, will follow LANL ER Program SOPs to ensure that correct measurements are taken.

9.2. FIELD TESTING AND SCREENING

As part of the analytical protocol for all surface and groundwater samples, several parameters will be measured in the field during LANL ER Program environmental investigations. All aqueous samples will be tested for specific conductance, temperature, pH, and alkalinity. LANL ER Program SOP, Field Analytical Measurements of Groundwater will be used for field determination of these parameters.

9.3. LABORATORY METHODS

Groundwater, surface water, and soil samples collected during LANL ER Program environmental investigations will be analyzed using EPA SW-846 (EPA 1986a; EPA 1986b; EPA 1987) and other analytical methods specified in Tables IX.1 and IX.2. Radionuclides, miscellaneous analytes and high explosives in aqueous and solid matrices will be analyzed according to methods referenced in Tables IX.1 and IX.2, respectively. Physicochemical tests on soil samples will be performed according to methods referenced in Table IX.2. In addition, new methods will be used once approved for use.

Tables V.3 through V.7 contain, for specific analytical methods, a list of parameters to be determined and, as appropriate, the practical quantitation limits or method detection limits for each parameter, as currently required by the EPA SW-846 analytical protocols (EPA 1986a; EPA 1986b; EPA 1987). Radionuclide method detection limits are listed in Table V.8 (DOE 1983). Method detection limits for miscellaneous analytes (in aqueous and solid matrices) are listed in Table V.9 (EPA 1990). USATHAMA method detection limits for high explosives in water and soil samples are presented in Table V.10 (USATHAMA n.d.).

The operable unit-specific sampling plans will specify parameters and analyses for sampling activities. Where more than one method is given for a parameter or parameter group, the sampling plan will indicate the appropriate method. In general, methods that provide the most qualitative information will be used during the characterization phases of the project. For example, GC/MS methods may be used to determine the specific method parameters as well as to identify other compounds present that may be of interest. After all compounds of concern are known, other more specific methods may be used wherever available. Where EPA methods are not available, methods from generally recognized and accepted institutions such as the American Public Health Association or American Society for Testing and Materials will be employed.

For special or unusual analytical methodologies (e.g., explosives), SOPs will be developed as necessary. The methods will describe in detail the exact procedures and materials required to analyze the samples. Data will be included, if appropriate, to support the limitations and the applicability of the method.

All analytical methods are to be used as written. All changes and modifications to SOPs will be documented thoroughly in the narrative summary for the data package. All parameters specified by the analytical methods will be determined. Compounds may be added to subsequent analyses if they are identified and judged to be of concern.

All laboratory analyses will be performed by an analytical laboratory with demonstrated proficiency for each parameter.

TABLE IX.1. ANALYSIS PLAN FOR AQUEOUS SAMPLES

Analyte	Method
Volatile organics	EPA SW-846 Method 8240[a,b]
Semivolatile organics	EPA SW-846 Method 8270[a,c]
Organochlorine Pesticides and PCBs	EPA SW-846 Method 8080[def]
Inorganics (metals)	EPA SW-846 Method 6010[a,g]
<u>Radionuclides</u>	
Americium-241	Radiochemical separation and alpha spectrometer[n,o]
Cesium-137	Gamma spectrometry[h,i]
Gamma spectroscopy (all peaks reported)	Gamma spectrometry[h,i]
Gross alpha	Gas flow proportional counter[h,i]
Gross beta	Gas flow proportional counter[h,i]
Isotopic plutonium (plutonium-238, -239, -240)	Radiochemical separation and alpha spectrometer[n,o]
Isotopic thorium (thorium-228, -230, -232)	Radiochemical separation and alpha spectrometer[h,i]
Total uranium	Inductively Coupled Plasma Mass Spectroscopy (ICP MS)[n,o]
Isotopic uranium (uranium-234, -235, -238)	Radiochemical separation and alpha spectrometer[h,i]
Radium-226	Radiochemical separation and alpha scintillation counter[h,i]
Strontium/Yttrium-90	Gas flow proportional counter[h,i]
Tritium	Distillation and liquid scintillation[h,i]
<u>Miscellaneous</u>	
Boron	LANL Method WI-220, Colorimetry[n,o]
Chloride	EPA Method 300.0 by Ion Chromatography[j,k]
Fluoride	EPA Method 300.0 by Ion Chromatography[j,k]
Nitrate	EPA Method 300.0 by Ion Chromatography[j,k]
Nitrate & nitrite	LANL Method WI-280, Flow Injection Colorimetry[n,o]
Nitrite	LANL Method WI-310, Flow Injection Colorimetry[n,o]
Sulfate	EPA Method 300.0 by Ion Chromatography[j,k]
Sulfide	EPA Method 376.2, Colorimetry[p,q]
Bromide	EPA Method 320.1, Titrimetric[p,q]
Carbonate	EPA Method 310.1, Titrimetric[p,q]
Phosphate	EPA Method 365.4, Colorimetric[p,q]
Ammonia/Nitrogen	LANL Method WI-210, Automated Colorimetry[n,o]
Silica	LANL Method WI-340, Flow Injection Colorimetry[n,o]
Cyanide (total)	EPA Method 335.3, Colorimetric, Automated UV[p,q]
Mercury	EPA Method 245.1, Manual Cold Vapor Technique[p,q]
Chromium (Hexavalent)	LANL Method WI-260, Flow Injection Colorimetry[n,o]
TOC	EPA Method 415.1, Combustion or Oxidation[p,q]
TSS	EPA Method 160.2, Gravimetric, dried at 103-105 C[p,q]

TABLE IX.1. (CONTINUED) ANALYSIS PLAN FOR AQUEOUS SAMPLES

Analyte	Method
High Explosives	
HMX	USATHAMA by High Performance Liquid Chromatography[l,m]
RDX	USATHAMA by High Performance Liquid Chromatography[l,m]
NB	USATHAMA by High Performance Liquid Chromatography[l,m]
1,3-DNB	USATHAMA by High Performance Liquid Chromatography[l,m]
1,3,5-TNB	USATHAMA by High Performance Liquid Chromatography[l,m]
2,4-DNT	USATHAMA by High Performance Liquid Chromatography[l,m]
2,6-DNT	USATHAMA by High Performance Liquid Chromatography[l,m]
2,4,6-TNT	USATHAMA by High Performance Liquid Chromatography[l,m]
TETRYL	USATHAMA by High Performance Liquid Chromatography[l,m]

SW - Solid Waste

USATHAMA - U.S. Army Toxic and Hazardous Materials Agency

HMX - Octahydro-1,3,4,7-tetranitro-1,3,5,7-tetrazocine

RDX - Hexahydro-1,3,5-trinitro-s-triazine

NB - Nitrobenzene

1,3-DNB - 1,3-Dinitrobenzene

1,3,5-TNB - 1,3,5-trinitrobenzene

2,4-DNT - 2,4-Dinitrotoluene

2,6-DNT - 2,6-Dinitrotoluene

2,4,6-TNT - 2,4,6-Trinitrotoluene

TETRYL - 2,4,6-Trinitrophenylmethylnitramine

[a] EPA. 1987.

[b] See Table V.3 for EPA practical quantitation limits.

[c] See Table V.4 for EPA practical quantitation limits.

[d] EPA. 1986a.

[e] See Table V.5 for EPA method detection limits.

[f] See Table V.6 for EPA practical quantitation limits.

[g] See Table V.7 for EPA estimated instrumental detection limits.

TABLE IX.1. (CONTINUED) ANALYSIS PLAN FOR AQUEOUS SAMPLES

Analyte	Method

[h] DOE. 1983.

[i] See Table V.8 for DOE method detection limits.

[j] EPA. 1990.

[k] See Table V.9 for EPA method detection limits.

[l] U.S. Army Toxic and Hazardous Materials Agency, n.d.

[m] See Table V.10 for USATHAMA method detection limits.

[n] LANL methods manual LA-10300-M.

[o] See Table V.8 for LANL method detection limit.

[p] EPA 1983

[q] See Table V.9 for EPA method detection limits.

TABLE IX.2. ANALYSIS PLAN FOR SOIL/SEDIMENT SAMPLES

Analyte	Method
Volatile organics	EPA SW-846 Method 8240[a,b]
Semivolatile organics	EPA SW-846 Method 8270[a,c]
Organochlorine Pesticides and PCBs	EPA SW-846 Method 8080[def]
Inorganics (metals)	EPA SW-846 Method 6010[a,g]
Radionuclides	
Americium-241	Radiochemical separation and alpha spectrometer[n,o]
Americium-241	Gamma spectrometry[h,i]
Cesium-137	Gamma spectrometry[h,i]
Gamma spectroscopy (all peaks reported)	Gamma spectrometry[h,i]
Gross alpha	Gas flow proportional counter[h,i]
Gross beta	Gas flow proportional counter[h,i]
Isotopic plutonium (plutonium-238, -239, -240)	Radiochemicalseparation and alpha spectrometer[n,o]
Isotopic thorium (thorium-228, -230, -232)	Radiochemical separation and alpha spectrometer[n,o]
Total uranium	Inductively Coupled Plasma Mass Spectroscopy (ICPMS) or Delayed Neutron Assay[n,o]
Isotopic uranium (uranium-234, -235, -238)	Radiochemical separation and alpha spectrometer[h,i]
Radium-226	Radiochemical separation and alpha scintillation counter[h,i]
Strontium/Yttrium-90	Gas flow proportional counter[h,i]
Tritium	Distillation and liquid scintillation[h,i]
Miscellaneous	
Boron	LANL Method WI-220, Colrimetry[r,s]
Chloride	EPA Method 300.0 by Ion Chromatography[j,k]
Fluoride	EPA Method 300.0 by Ion Chromatography[j,k]
Nitrate	EPA Method 300.0 by Ion Chromatography[j,k]
Sulfate	EPA Method 300.0 by Ion Chromatography[j,k]
Cyanide (total)	EPA Method 9010, Colorimetry[a,k]
Mercury	EPA Method 7470, Cold Vapor[a,k]
Chromium (hexavalent)	EPA Method 7196, Colorimetry[a,k]
Tests	
Triaxial permeability	COE Laboratory Soil Testing EM1110-2-1906[l]
Moisture content	ASTM D2216 (1980)[m,n]
Density	ASTM D698 (1978)[m,n]
Porosity	ASTM D4645 (1987)[m,n]
Clay mineralogy	ASTM D4647 (1987)[m,n]
Percent organic	ASTM D2974 (1987)[m,n]
Capillary-moisture	ASTM D2325 (1986)[m,n]

TABLE IX.2. (CONTINUED) ANALYSIS PLAN FOR SOIL/SEDIMENT SAMPLES

Analyte	Method
Grain size	ASTM D421 (1985)[m,n,] ASTM D422 (1963)[m,n, and] ASTM D1140 (1954)[m,n]
Attenberg limits	ASTM D4318 (1984)[m,n]
Air permeability	ASTM D4525 (1985)[m,n]
Total organic carbon	ASA and SSSA Method 29-2.2.5.1[o]
<u>High Explosives</u>	
HMX	USATHAMA by High Performance Liquid Chromatography[p,q]
RDX	USATHAMA by High Performance Liquid Chromatography[p,q]
NB	USATHAMA by High Performance Liquid Chromatography[p,q]
1,3-DNB	USATHAMA by High Performance Liquid Chromatography[p,q]
1,3,5-TNB	USATHAMA by High Performance Liquid Chromatography[p,q]
2,4-DNT	USATHAMA by High Performance Liquid Chromatography[p,q]
2,6-DNT	USATHAMA by High Performance Liquid Chromatography[p,q]
2,4,6-TNT	USATHAMA by High Performance Liquid Chromatographyp,q
TETRYL	USATHAMA by High Performance Liquid Chromatography[p,q]

SW - Solid Waste

COE - U.S. Army Corps of Engineers

ASTM - American Society for Testing and Materials

ASA - American Society of Agronomy, Inc.

SSSA - Soil Science Society of America, Inc.

USATHAMA - U.S. Army Toxic and Hazardous Materials Agency

HMX - Octahydro-1,3,4,7-tetranitro-1,3,5,7-tetrazocine

NB - Nitrobenzene

1,3-DNB - 1,3-Dinitrobenzene

1,3,5-TNB - 1,3,5-trinitrobenzene

2,4-DNT - 2,4-Dinitrotoluene

2,6-DNT - 2,6-Dinitrotoluene

2,4,6-TNT - 2,4,6-Trinitrotoluene

TETRYL - 2,4,6-Trinitrophenylmethylnitramine

TABLE IX.2. (CONTINUED) ANALYSIS PLAN FOR SOIL/SEDIMENT SAMPLES

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[a] EPA. 1987.

[b] See Table V.3 for EPA practical quantitation limits.

[c] See Table V.4 for EPA practical quantitation limits.

[d] EPA. 1986a.

[e] See Table V.5 for EPA method detection limits.

[f] See Table V.6 for EPA practical quantitation limits.

[g] See Table V.7 for EPA estimated instrumental detection limits.

[h] DOE. 1983.

[i] See Table V.8 for DOE method detection limits.

[j] EPA. 1990.

[k] See Table V.9 for EPA method detection limits.

[l] COE. 1970.

[m] ASTM. 1988.

[n] The year the current edition of the ASTM method was approved, in parentheses.

[o] ASA and SSSA. 1982.

[p] U.S. Army Toxic and Hazardous Materials Agency, n.d.

[q] See Table V.10 for USATHAMA method detection limits.

[r] LANL methods manual LA-10300-M.

[s] See Table V.9 for LANL method detection limit.

10.0. DATA REDUCTION, VALIDATION AND REPORTING

Data generation from sampling activities is usually a four step process: data collection, data reduction, data validation, and data reporting. All these activities are governed by standard operating procedures, and routine reviews which include checking for errors in calculations, data entry, data transmission, and transcription. In addition, the field and/or laboratory analytical data have internal quality control checks such as method blanks, field blanks, spiked blanks, matrix spikes, internal standards, surrogates, and calibration standards with established method acceptance criteria.

10.1. DATA REDUCTION

Data reduction is defined as those activities involving conversion of raw data to reportable units, transfer of data between recording media, and computation of summary statistics, standard errors, confidence intervals, tests of hypotheses relative to the parameters, and model validation. Statistically-acceptable data analysis procedures will be implemented for all data reduction steps.

10.1.1. Field Technical Data Reduction

Field technical data (i.e., non-laboratory generated) collected during ER Program environmental investigations can generally be characterized as either objective or subjective data. Objective data include all direct measurements such as field screening, field analyses, and water level measurements. Subjective data include descriptions and observations. Some activities, for example, test boring and well logs, include both types of data in that the data recorded in the field are descriptive but can be reduced using the standardized lithologic coding system.

As described in Section 7.0, all field data will be recorded by field personnel on ER Program forms. For example, during drilling activities, the field team member supervising a drill rig will keep a chronological log of drilling activities, a vertical descriptive log of lithologies encountered, other pertinent drill information (e.g., staining, odors, field screening, working conditions, water levels, and geotechnical data), and a labor and materials account in the project's bound logbook. At the completion of a task, copies of all field logs, and ER Program forms will be presented to the Operable Unit Project Leader. After checking the field data and the ER Program forms, the data are

reduced to tabular form wherever possible, by entering the data into database files. Where appropriate, the database files will be set up for direct input into the project database system. Subjective data will be filed as hard copies for incorporation into technical reports as appropriate.

10.1.2. Laboratory Data Reduction

Data are initially collected, converted to standard reporting units, and recorded in standard formats by the project analysts. The project analysts will conduct preliminary data analyses using a variety of methods and procedures. Because many analytical instruments are microprocessor-controlled, some of the analyses can be performed directly in the instrument's operating or outputting mode. Those instruments interfaced to stand-alone computers or microprocessors often permit data analysis programs to be written and modified to produce data formats specially suited to end user requirements. Data requiring manual recording, integration and/or analysis must be converted to a more appropriate format prior to subsequent analyses.

The associated quality control data (e.g., blanks, blank spikes, duplicates, and continuing calibration checks) will be entered onto quality control charts and verified to be within control limits. Quality control data outside control limits will be reported with a qualifier. During all stages and aspects of data processing, the data are double-checked for translation or transcription errors and initialed by both the recorder and the checker.

The data will be entered into the laboratory computer system, and the data summaries (including raw data) will be submitted for review to the laboratory Quality Control (QC) reviewer. The laboratory data manager will be notified when the data are ready to be reported. The completed analyses will be removed from the laboratory backlog and a hardcopy report will be generated. The laboratory data manager generates a hard-copy data summary that is reviewed and is signed by the laboratory section manager, the laboratory manager, and the QA officer.

10.2. DATA VALIDATION

Data validation, an after-the-fact review of data, is the process whereby data are determined to be of acceptable or unacceptable quality based on a set of predefined criteria. These criteria depend upon the type(s) of data involved and the purpose for which data are collected.

10.2.1. Field Technical Data Validation

Validation of objective field and technical data will be performed at two different levels. On the first level, data will be validated at the time of collection by following standard procedures and quality control checks. At the second level, data will be validated by the Operable Unit Project Leader, who will review the data to ensure that the correct codes and units have been included. After data reduction into tables or arrays, the Operable Unit Project Leader will review data sets for anomalous values. Any inconsistencies or anomalies discovered by the Operable Unit Project Leader will be resolved immediately, if possible, by seeking clarification from the field personnel responsible for collecting the data.

Subjective field and technical data will be validated by the Operable Unit Project Leader, who will review field reports for reasonableness and completeness. In addition, random checks of sampling and field conditions will be made to confirm the recorded observations. Whenever possible, peer review will also be incorporated into the data validation process, particularly for subjective data, to maximize consistency among field personnel. For example, during drilling activities, the Operable Unit Project Leader will schedule periodic reviews of archived lithologic samples to ensure that the appropriate lithologic descriptions and codes are being consistently applied by all field personnel. In addition, for field analyses and tests, an independent review of the applicable items listed in Section 10.2.2, Laboratory Data Validation, will be conducted (e.g., calibration methods, control limits, instrument checks, etc.).

10.2.2. Laboratory Data Validation

Non-Radiological Analytical Data

In general, the criteria to be reviewed in the data validation process will depend on criteria unique to the analysis parameters (i.e., organic, inorganic, radiological, and physical testing), instrument limitations, and regulatory requirements. At a minimum, the following items will be reviewed during the validation process of non-radiological analytes:

- Sample holding times,
- Documentation that the analytical results are within control limits,
- Documentation that data and calculations were checked by the supervisor who was not involved in the sample analysis or data reduction,

- Documentation that a final review of the data was made by the laboratory manager for correctness and validity of the data,
- Calibration of methods and instruments,
- Routine instrument checks (noise levels, drift, linearity, etc.),
- Documentation of traceability of instrument standards, samples, and data,
- Documentation af analytical methodology and QC methodology,
- The control for interference contaminants in analytical methods (use of reference blanks and check standard for method accuracy and precision),
- Documentation of sample preservation and transport,
- Preparation and analysis of the appropriate number and type of laboratory quality control samples,
- Complete data packages, and
- For the field and laboratory quality control samples, conformance with established acceptance criteria.

Radiological Data

Data validation criteria, such as EPA Contract Laboratory Program (CLP) or other EPA analytical methodologies, generally do not apply to radiological data. Therefore, ER Program environmental investigations will use the criteria described in this section to evaluate the acceptability of radiological data. These criteria should be evaluated with the approval of the analytical laboratory selected to perform the analyses. In addition, if analyte-specific requirements are necessary, these issues should also be identified and evaluated prior to sample collection.

The evaluation of the radiological data will consist of the following components:

- Were the appropriate procedures followed during sample collection?
- Were the samples containerized and handled as described in the field sampling plan and procedures?
- Were the appropriate number and type of field quality control samples collected?
- Were the appropriate number and type of laboratory quality control samples prepared and analyzed?

- Are the data packages complete (Section 10.3.2)?
- Did the field and laboratory quality control samples meet established acceptance criteria?

The following sections describe the field and laboratory quality control samples that will be collected/prepared and analyzed in order to evaluate the acceptability of the radiological data.

Field Quality Control Samples

Two types of field quality control samples will be collected and analyzed for radiological constituents. These are: field duplicates and rinsate blanks. Table X.1 describes these samples and the acceptance criteria that will be used to evaluate the radiological data obtained from the analysis of these samples.

Laboratory Quality Control Samples

Table X.2 describes the laboratory quality control samples and their purpose and frequency. Table X.3 describes the laboratory radiological quality control acceptance criteria. If the data are acceptable against these criteria, the data are approved and a report is generated. If the data are rejected, the laboratory will notify the recipient (Operable Unit Project Leader) of the data package and/or re-analysis will be initiated, as appropriate.

10.3. DATA REPORTING

Data will be reported on magnetic media; in hard copy data reports; and by using the quality assurance verification, tabular output, and archiving capabilities of the project database.

10.3.1. Non-radiological Analytical Laboratory

The standard commercial laboratory data reports for non-radiological data will consist of a transmittal letter and the following for organic analyses:

- cover page describing data qualifiers, sample collection, sample receipt, extraction and analysis dates, and a description of any technical problems encountered with the analyses,
- copies of the chain-of-custody forms,
- copies of the analytical forms,

- spreadsheet sample analytical results and quality control summaries,
- instrument tuning results and mass spectra,
- calibration results,
- mass spectra and chromatogram for each sample,
- calculated recoveries for all quality control samples, method duplicate or duplicate spike and method blank results,
- all laboratory quality control data including method blank, method blank spike, matrix spike, laboratory duplicate or spike duplicate, and surrogate recovery data,
- method quantitation limits for all parameters and dilutions,
- calibration ranges and all raw data for all analyses, as appropriate, and
- five-peak library search report for GC/MS volatiles and semivolatiles.

Organic analytical results (volatiles, semivolatiles and pesticides/PCBs) will be reported in ug/L for aqueous samples and in ug/kg for soil/sediment samples. Inorganic (metals) analytical results will be reported in ug/L. Miscellaneous analyte parameters will be reported in mg/L for aqueous samples and in mg/kg for soil/sediment samples.

The standard commercial laboratory data reports for non-radiological data will consist of a transmittal letter and the following for inorganic analyses:

- cover page describing data qualifiers, sample collection, sample receipt, digestion and analysis dates, and a description of any technical problems encountered with the analyses,
- copies of the chain-of-custody forms,
- analytical results and quality control summaries which include laboratory blanks,
- quality control summary report on laboratory quality control samples (accuracy).

The following will be archived by HSE-9:

- instrument standardization and calibration results,
- method quantitation limits for all parameters and dilutions,
- calibration ranges and all raw data for all analyses, as appropriate,

10.3.2. Radiological Analytical Laboratory Data Reporting

Radiochemical analyses are not part of established EPA data reporting packages, such as EPA CLP. Data packages for radiochemical analyses will consist of the following elements:

- cover page describing data qualifiers, sample collection, sample receipt, preparation and analysis dates and a description of any technical problems encountered with the analyses,
- copies of the chain-of-custody forms,
- instrument calibration information (date, time, technician),
- all laboratory radiochemical quality control data (see Tables X.2 and X.3) including reagent blank, method blank, blind repeat, laboratory duplicate (replicate), spiked samples (matrix spikes), standard reference materials, and blind replicate standard,

The following will be archived by HSE-9:

- results of standards, including instrument blanks and calibration standards,
- raw data, including counting time and number of disintegrations per sample;
- calculated activity, per unit mass or liquid volume, with the following associated statistics:
    - relative counting error at the 95% confidence level,
    - lower detection limit,
    - average bias, and
    - average relative precision.

Radiochemical analytical results will be reported in pCi/L for aqueous samples and in pCi/g for soil samples.

10.3.3. Non-analytical Data Reporting

Non-analytical data will consist of results of physicochemical tests performed on soil core samples (Table IX.2). The results of these tests will be reported in the units specified in the specific American Society for Testing and Materials (ASTM) or U.S. Army Corps of Engineers (COE) method. SOPs will be written and approved as needed.

TABLE X.1. FIELD RADIOLOGICAL QUALITY CONTROL SAMPLES

Type	Purpose of Sample	Frequency	Acceptance Criteria
Field duplicate	To evaluate the reproducibility of the sampling technique	1 out of 20 samples or less	RPD less than or equal to 20% (similar to CLP inorganics)
Rinsate blank	To evaluate decontamination procedures	1 out of 20 samples or less (if a dedicated sampling tool is not used)*	If radiological constituents are detected, the data will be evaluated in order to determine probable source and impact on sampling results.

* - Rinsate blank frequency for soil samples is 5%. The frequency for water samples is 10%.

RPD - relative percent difference

CLP - Contract Laboratory Program, U.S. EPA

TABLE X.2. LABORATORY RADIOLOGICAL QUALITY CONTROL

Sample Type	Purpose of Sample	Frequency
Reagent blank	Determine the background of each reagent/solvent to be used in an analysis. Must use identical conditions to actual analysis including detection system. Background must not interfere with intended analysis.	With each new batch of reagents/ solvents.
Method blank	The analysis is performed using only the reagents and solvents used in the method. Determines cumulative interference. If cumulative interference cannot be eliminated, it must be taken into account when computations are done.	With each group of samples, 1 out of 20 samples, or daily, which-ever is more frequent.
Blind repeat	An aliquot of a sample, unknown to analyst at time of sample log in, is introduced by QC Coordinator (known to QC Coordinator).	1 out of 100 or at least once a month.
Replicate	An aliquot of a sample known to analyst. Calculate relative percent difference.	1 out of 20 samples.
Spiked samples (matrix spikes)	A known concentration of a specific parameter is added to an aliquot of a sample with the matrix of interest. Percent recovery is determined and spike is compared against an unspiked aliquot.	1 out of 20 samples.

TABLE X.2. LABORATORY RADIOLOGICAL QUALITY CONTROL SAMPLES

Type	Purpose of Sample	Frequency
Standard reference materials	Standards prepared by recognized external agency (e.g., NIST) and used to determine performance of entire system instrumentation and analysis.	Scheduled periodic basis per specific lab procedure.
Blind replicate standard	A replicate standard of fixed concentration added by QC Coordinator, unknown to analyst.	Monthly.

QC - Quality Control.

NIST - National Institute of Standards and Technology.

TABLE X.3. LABORATORY RADIOLOGICAL QUALITY CONTROL ACCEPTANCE CRITERIA

Type	Accuracy and Precision Application	Introduced by	Acceptance Criteria
Reagent Blank	No	Analyst	Reagent values acceptable[a]
Method Blank	Yes	Analyst	Blank values acceptable[a]
Blind Repaet	Yes	QC Coordinator	+ or - 3 sigma of original sample (+ or - 2 sigma = warning limit).
Replicate	Yes	Analyst	+ or - 3 sigma of original sample (+ or - 2 sigma = warning limit).
Spiked samples (matrix spikes)	Accuracy only	Analyst	+ or - 3 sigma (+ or - 2 sigma = warning limit).
Standard reference materials	Accuracy only	Analyst or QC Coordinator	+ or - 3 sigma (+ or - 2 sigma = warning limit).
Blind replicate standard	Yes	QC Coordinator	+ or - 3 sigma of original sample (+ or - 2 sigma = warning limit).

QC - Quality Control.

[a] If high blank or reagent background is observed, laboratory glassware and reagents will be checked for contamination and the analysis halted until the system is brought under control. (High background is defined as contamination sufficient to result in a difference in sample value greater than or equal to the smallest significant digit known to be true.)

11.0. INTERNAL QUALITY CONTROL CHECKS

Internal quality control checks will allow evaluation the consistency and validity of generated data. Confidence in generated data in the form of internal quality control checks will allow task personnel to work efficiently.

As appropriate, internal quality control samples will be analyzed to establish and document the consistency and validity of the sample data. The quality control checks may include:

- Field duplicates,
- Laboratory duplicates,
- Spiked blank samples,
- Spiked site matrix samples,
- Field bottle or equipment blanks,
- Method blanks,
- Internal standards,
- Surrogate spikes,
- Reagent blanks,
- Calibration standards,
- Sample duplicates,
- Laboratory control samples,
- Standard reference materials, and
- Calibration check samples.

11.1. FIELD SAMPLING QUALITY CONTROL CHECKS

Quality control checks for field sampling provides a means of evaluating the integrity of a sample from the time of collection through analysis at an approved laboratory.

Specific field sampling quality control checks apply to both soil samples and water samples as described below.

11.1.1. Soil Sampling

Quality control checks for field soil sampling activities will follow guidance provided in the Soil Sampling Quality Assurance User's Guide (EPA 1984b). Table V.1 presents the recommended level of quality control for soil sampling activities.

Field replicate soil samples will be given a unique alphanumeric identifier and submitted to the laboratory blind, (i.e., without indicating the location). These samples will serve as blind field splits and will be used to evaluate laboratory reproducibility and field reproducibility. Field duplicate soil samples will be identified on the appropriate LANL ER Program forms.

Trip blanks and equipment (rinsate) blanks are not suggested Quality Assurance/Quality Control (QA/QC) procedures for soil samples according to the U.S. EPA Soil Sampling Quality Assurance User's Guide (EPA 1984b). Therefore, trip blanks will not be part of field QA/QC programs for soil sampling activities.

Equipment blanks, however, will be included as part of the field QA/QC program for soil sampling activities. Since radiological contamination may be encountered at many LANL locations, the addition of equipment blanks will serve as a check on the sampling device cleanliness.

11.1.2. Water Sampling

Quality control checks for field surface water and groundwater sampling activities will include the recommended types of samples presented in Table V.1.

Field duplicate water samples will be given a unique alphanumeric identifier and submitted to the laboratory blind, (i.e., without indicating the location). These samples will serve as blind field splits and will be used to evaluate laboratory reproducibility and field reproducibility. Field duplicate water samples will be identified on the appropriate LANL ER Program forms.

11.2. LABORATORY ANALYTICAL ACTIVITIES

A summary of laboratory-based quality control samples and frequency is presented in Table V.2. The information in Table V.2 is based on criteria in the U.S. EPA SW-846 methods. At a minimum, 1 laboratory matrix spike and replicate per 20 environmental samples or analytical batch, whichever is more frequent, will be used. Reagent blanks will be at a frequency of 1 per analytical batch. Spike replicate samples for inorganic (metals) analysis will be at a frequency of 10 percent. Specific types of laboratory quality control samples are described in the following subsections.

11.2.1. Laboratory Standards

Three types of laboratory standards will be utilized:

1) calibration standards,
2) check standards, and
3) quality control reference sample.

Calibration standards are prepared by diluting the stock analyte solution in graduated amounts which cover the expected range of the samples being analyzed. Calibration standards must be prepared using the same type of acid or solvent and at the same concentration as will result in the samples following sample preparation. These criteria are applicable to organic and inorganic chemical analyses. Results obtained from analysis of standards are used to generate a standard curve which plots concentrations of known analyte standards versus the instrument response to the analyte. The standard curve is used to quantitate the compound in an environmental sample. A minimum of three calibration standards will be used to generate a standard curve for all inorganic analyses and a five-point calibration curve will be used for organic analyses.

A check standard is a material of known composition that is analyzed concurrently with test samples to evaluate a measurement process. One check standard should be analyzed with each analytical batch or every 20 samples, whichever is greater. The check standard is prepared by the analyst to monitor and verify instrument performance on a daily basis.

A quality control reference samples is prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. An independent standard is defined as a standard composed of the analyte(s) of interest from a different source that used in the preparation of standards for use in preparing the standard curve. The quality control reference sample serves as an independent check of technique, methodology, and standards. A quality control reference sample will be analyzed with every analytical batch or every 20 samples, whichever is greater. This applies to organic and inorganic analyses.

11.2.2. Laboratory Replicates

Laboratory replicate samples are two aliquots taken from the same container and analyzed independently. In the case of volatile organic samples, duplicate samples are obtained in the field for replicate analysis rather than obtaining replicates in the laboratory.

11.2.3. Laboratory Spike Samples

Two types of laboratory spikes will be used for quality control evaluation purposes:

1) Matrix spikes, and

2) Surrogate spikes.

A matrix spike analysis is performed by adding a pre-determined quantity of stock solutions of certain analytes to a sample matrix prior to sample extraction/digestion and analysis. Matrix spikes provide a measure of accuracy for the method used in a given matrix. The concentration of the spike should be at the regulatory standard level, or the practical quantitation limit for the method. Precision and accuracy criteria of matrix spike analyses (percent recovery limits and relative percent difference) are presented in Table V.11.

Surrogate spikes are organic compounds similar to analytes of interest in chemical composition, extraction, and chromatography; but which are not normally found in environmental samples. Surrogate spikes simulate the background and interferences found in actual samples. Surrogate

compounds are spiked into all blanks, calibration and check standards, samples (including duplicates and quality control reference samples) and spiked samples prior to analysis. Percent recoveries are calculated for each surrogate spike compound and are a measure of the accuracy of the total analytical method. The accuracy criteria for surrogate spike analyses, measured as percent recoveries, are presented in Table V.12.

11.2.4. Laboratory Blank Samples

Two types of laboratory blanks will be analyzed:

1) calibration blanks, and
2) reagent blanks.

Calibration blanks are usually an organic or aqueous solution that is as free of analyte as possible. Calibration blanks are prepared with the same volume of chemical reagents used in the preparation of the calibration standards and diluted to the appropriate volume with the same solvent (water or organic) used in the preparation of the calibration standard. The calibration blank is used to give the null reading (baseline) for the instrument response versus concentration calibration curve. One calibration blank will be analyzed with analytical batch or every 20 samples, whichever is greater.

Reagent blanks are usually an organic or aqueous solution that is as free of analyte as possible. The reagent blank contains all the reagents in the same volume as used in the processing of the environmental samples. The reagent blank must be carried through the complete sample preparation procedure and contains the same reagent concentrations in the final solution as in the sample solution used for analysis. The purpose of the reagent blank is to correct for possible contamination resulting from the preparation or processing of the environmental samples. One reagent blank will be analyzed with each analytical batch or every 20 samples, whichever is greater.

Narratives and documentation on the performance of these laboratory quality controls will be provided as part of the data package submitted by the participating laboratory. Frequency and methods used in performing these quality controls will be in accordance with LANL standards. Activities that do not meet LANL requirements will require corrective action by the laboratory. Such corrective action will also be in accordance with LANL standards.

The following should be addressed in each operable unit QAPjP or document included by reference:

1. Does the plan describe procedures for both field and laboratory?
2. Are the protocols used (spikes, surrogates, blanks, etc.) described for each parameter and matrix?
3. Are the acceptance or control limits specified for each?
4. Is the frequency of the checks described?
5. Is it clear whether the intent is to measure total error/variability or component (sampling/lab) error/variability?

12.0. PERFORMANCE AND SYSTEM AUDITS

Performance and system audits are addressed in two LANL ER Program Quality Procedures. The process for conducting performance audits is described in LANL-ER-QP-01.1Q, Audits. The term utilized for a performance audit with the ER Program is survey. The process for conducting surveys (i.e., performance audits) is described in LANL-ER-QP-01.2Q, Surveys. These procedures are derived from the requirements presented in Section 18, Audits and Surveys, of the LANL ER Quality Program Plan.

13.0. PREVENTIVE MAINTENANCE

Proper preventive maintenance of field and laboratory equipment is a necessary element for achieving equipment reliability. All field and laboratory instruments and equipment will be maintained to manufacturer's recommendations and specifications. System checks and service will be performed on a schedule specified by the manufacturer. Maintenance will be performed when the instrument will not adequately tune or calibrate. The professional judgement of the equipment operator or lead analyst will determine when maintenance is necessary.

Section 12 of the LANL ER Program Quality Program Plan provides additional discussion of control of measuring and test equipment. This section provides information on equipment identification, maintenance and calibration.

13.1. FIELD EQUIPMENT

Field equipment will be properly calibrated, charged, and in good general working condition before the beginning of each working day. LANL ER Program SOPs define the required equipment checks and calibration requirements for each type of field equipment. Field equipment which does not meet the calibration requirements will be taken out of service until acceptable performance can be verified. Non-operational field equipment will also be removed from service and returned to the supplier, and a replacement will be obtained. Maintenance records will be maintained for each field instrument according to a unique number affixed to the instrument. These records will be reviewed prior to their use in the field to assure that instrument maintenance and calibration are up to date.

All field instruments will be properly protected against inclement weather conditions during environmental investigations. At the end of each working day, all field equipment (except self-propelled equipment) will be taken out of the field and placed in appropriate storage.

All self-propelled field equipment (e.g., drill rigs, water trucks and support vehicles) will arrive at the site in proper working condition each day. All lubricating, hydraulic, and motor oils will be checked before the start of each work day to make certain all fluid reservoirs are full and there are no leaks. If a leak is detected, the equipment will be removed from service for repair or replacement.

13.2. LABORATORY EQUIPMENT

The ability to generate valid data requires that all analytical instrumentation be properly maintained. Service contracts may provide routine preventive maintenance and emergency repair service. The elements of preventive maintenance programs for each participating analytical laboratory are discussed in their respective laboratory Quality Assurance Plans.

13.2.1. Instrument Maintenance Logbooks

Requirements for instrument maintenance logbooks are described in Section 12 of the LANL ER Quality Program Plan.

13.2.2. Instrument Calibration and Maintenance

Requirements for analytical instrument calibration and maintenance are described in Section 12 of the LANL ER Quality Program Plan.

Major analytical instruments have specific preventive maintenance and calibration schedules. Preventive maintenance and calibration is generally performed by the manufacturer's service representatives on a routine basis. Each participating analytical laboratory Quality Program Plan should provide maintenance frequency information which should be reviewed for each operable unit QAPjP.

13.2.3. Spare Parts

Each participating analytical laboratory will maintain an inventory of routinely required spare parts relevant to the services provided (i.e., sources, vacuum pumps, and filaments for GC/MS; torches and burner heads for AA/ICP).

14.0. SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, REPRESENTATIVENESS, AND COMPLETENESS

Precision, accuracy, and completeness are means of evaluating the consistency of generated data. These procedures have been identified to inform task personnel of the standards against which data is to be evaluated. Procedures for calculating precision and accuracy must comply with the criteria contained in the most recent editions and updates of U.S. EPA SW-846 Chapter 1, when analytical activities are in support of RCRA compliance. Analytical precision and accuracy will be calculated and reported by the laboratory for every data set. The LANL personnel will calculate field duplicate sample precision during the data validation process, because these samples were submitted blind to the laboratory.

14.1. PRECISION

Analytical precision is calculated by expressing, as a percentage, the difference between the results of analysis of standard reference materials or duplicate samples relative to the average of those results for a given analyte. Precision is expressed as the Relative Percent Difference (RPD) and is calculated as follows (EPA 1987):

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

where:

RPD = relative percent difference.

D1 = first sample value.

D2 = second sample value (replicate).

14.2. ACCURACY

Analytical accuracy is calculated by expressing, as a percent, the recovery of a standard reference material or an analyte that has been added to the sample (or standard matrix) at a known concentration before analysis and is expressed by the following formula (EPA 1987):

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

where:

SSR = spiked sample result,

SR = sample result, and

SA = spike added.

The spiked (fortified) concentration used will be specified by laboratory quality control requirements as detailed in the applicable U.S. EPA SW-846 method (EPA 1986a; EPA 1987).

14.3. SAMPLE REPRESENTATIVENESS

Data obtained during environmental investigations at LANL should characterize the site conditions. Obtaining representative data requires strict adherence to the procedures for sample collection and analysis that are presented in the QAPjP. In addition, the samples will be carefully selected to ensure that they are representative of the site location that they are intended to characterize. The details on the types, locations and number of samples to be collected are listed in the individual sampling and analysis plan for each operable unit. The following points serve as guidelines for ensuring representativeness of the samples:

- Where sample composition may vary with location (e.g., in sampling from soil or from waste treatment piles), a sufficient number of samples will be collected so that the entire area can be characterized. A statistically based sampling scheme may be used to choose the sampling locations, where appropriate.

- Where sample composition may vary with time (e.g., in sampling of groundwater, surface water or process streams), samples will be collected over a sufficient period of time so that the variation with time can be described.

Composite samples may be collected to represent the average of several individual samples. Site-specific objectives will determine the choice of sample collection (i.e., individual samples or composite samples).

14.4. COMPLETENESS

Completeness is a measure of the relative number of analytical data points that meet all the acceptance criteria for accuracy, precision, and any other criterion required by the specific analytical methods used. The percent completeness for analytical data can be expressed by the following formula:

$$\% \text{ Completeness} = \frac{V}{T} \times 100,$$

where:

V = valid data, and

T = total analyses.

The initial responsibility to monitor the quality of an analytical system lies with the analyst. The analyst will verify that all quality control procedures are followed and that results of analysis of quality control samples are within acceptance criteria. If acceptance criteria limits are exceeded, this must be described in the analytical report case narrative. This requires that the analyst assess the correctness of the following items, as appropriate:

- initial calibration,
- calibration verification,
- method blank result,
- duplicate analysis,
- laboratory control standard, and
- fortified sample result.

15.0. CORRECTIVE ACTION

The ER QP, Deficiency Reporting, applies to both field and laboratory activities. Corrective action is initiated when the following situations arise:

- Specific requirements of the analysis method or SOPs are not met.
- Data quality objectives for precision, accuracy and completeness are not achieved.
- Lab or field data review indicates that data are incomplete or that improper calculation, methodology or technique was employed, or that an instrument malfunction has occurred.

15.1. OVERVIEW

The LANL ER Program process for deficiency reporting is presented in quality procedure, Deficiency Reporting. This procedure describes the methods by which deficiencies are identified and corrected.

Where deficiencies are found, the LANL ER Program QPPL and Operable Unit Project Leader will determine if the data in question are essential to the project and what corrective action will be taken. Corrective action may include one or more of the following:

- Additional information or recalculations are supplied.
- Instrument operation and calibration are checked. Calibration standards are checked and new standards obtained if necessary. Instrument malfunctions are corrected.
- Personnel repeat the task using the same procedure.
- A different individual repeats the task using the same procedure.
- Samples are re-analyzed (if holding time permits).
- Sampling and/or analytical procedures are evaluated and amended.

- Personnel repeat the task using a validated new or modified procedure.

- If practical, a new sample is collected and analyzed.

If the anomaly is not resolved after the above steps are taken, the data are reported with qualifying statements. In some cases, depending on the nature and degree of deviation, no data may be reported.

15.2. FIELD CORRECTIVE ACTION

The initial responsibility for monitoring the quality of field measurements and observations lies with the field personnel. The field Technical Team Leader is responsible for verifying that all quality control procedures are followed. This requires that the field Technical Team Leader assess the correctness of field methods and the ability to meet quality assurance objectives. If a deficiency occurs that might jeopardize the integrity of the project or cause some specific quality assurance objective not to be met, it is the responsibility of all field project staff to report it. Field project staff must report all such suspected deficiencies according to the process defined in LANL ER Program quality procedure for Deficiency Reporting.

15.3. LABORATORY CORRECTIVE ACTION

The initial responsibility for monitoring the quality of an analytical system lies with the analyst. In this pursuit, the analyst will verify that all quality control procedures are followed and that the results of analysis of quality samples are within acceptance criteria. This requires that the analyst assess the correctness of all of the following items, as appropriate:

- sample preparation procedures,
- initial calibration,
- calibration verification,
- method blank result, and
- laboratory control standard.

If the assessment by the analyst reveals that any of the quality control acceptance criteria, as defined by the most recent edition and updates of the analytical method are not met, the analyst must immediately assess the analytical system to correct the deficiency. The analyst must notify the LANL laboratory analytical unit leader and the LANL laboratory quality assurance coordinator of the deficiency and, if possible, identify potential causes and corrective action.

The nature of the corrective action obviously depends on the nature of the deficiency. For example, if a continuing calibration verification is determined to be out of control, the corrective action may require re-calibration of the analytical system and re-analysis of all samples since the last acceptable continuing calibration standard.

Quality control samples (e.g., matrix spikes and matrix spike duplicates) provide an indication of matrix effects on analyses. Failure to achieve method specific performance on quality control samples will trigger corrective action or additional re-analysis as appropriate.

When the appropriate corrective action measures have been defined and the analytical system is determined to be "in control", the analyst documents the problem, the corrective action, and the data, demonstrating that the analytical system is in control. Copies of this documentation will be provided to the LANL laboratory analytical unit leader and the LANL laboratory quality assurance coordinator.

All personnel are responsible for identifying the need for corrective action. The LANL ER Program QPPL and the originator of the Deficiency Report must approve all proposed corrective actions.

16.0. QUALITY ASSURANCE REPORTS TO MANAGEMENT

16.1. FIELD QUALITY ASSURANCE REPORTS TO MANAGEMENT

The Operable Unit Project Leader will provide a monthly field progress status report to the LANL ER Program Manager. This report will include a copy of all field data sets compiled, a description of the activities performed, a description of unusual occurrences or situations encountered, a discussion of any deviations from established procedures, and documentation of any nonconformances.

16.2. LABORATORY QUALITY ASSURANCE REPORTS TO MANAGEMENT

The laboratory quality assurance coordinator will provide monthly, quarterly, and annual reports to the LANL ER Program QPPL. These reports summarize quality assurance activities for the reporting period including the following items:

- results of performance audits (external and internal),
- results of system audits (external and internal),
- summaries of corrective action to remedy nonconforming activities, and
- recommendations for revisions of laboratory procedures to improve the analytical systems.

All final reports will contain QA sections.

The laboratory quality assurance coordinator will immediately notify the LANL ER Program QPPL when laboratory quality assurance situations occur which require immediate corrective action.

16.3. INTERNAL MANAGEMENT QUALITY ASSURANCE REPORTS

Monthly QA reports will be prepared for the ER Program Manager. Each report will summarize the status with regard to overall precision, accuracy, and completeness results obtained to date. Additionally, each monthly QA report as a matter of record will discuss the following items:

- audit findings and any deficiencies noted,

- corrective actions taken and the effectiveness of the corrective action,
- any deviations from the established procedures, and
- a discussion of the methods and protocols utilized for the field and laboratory activities as set forth in this QAPjP.

If any of the above listed monthly QA report items have not occurred since the previous reporting period, this fact will be so noted in the report.

The LANL ER Program Manager will prepare a monthly project summary report for the LANL ER Program Project Director (HSE Deputy Division Leader). The purpose of the monthly project summary is to provide continued communication among the project management and technical personnel in order to ensure that problems are remedied and solutions documented in a timely manner.

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APPENDIX A - DATA QUALITY OBJECTIVE - EXAMPLE SCENARIO

This section will be rewritten to define the specific project description.

Groundwater Monitoring for Land Disposal Facilities under RCRA.

The primary goal of the sampling and analytical activities of the program is to determine if the groundwater at a facility is contaminated. The data generated will provide a "snapshot" of the condition of the groundwater at the time of sampling. Data will not be generated over an extended period of time to show variations due to seasonal or other factors. Thus, the data collected from the study will be used to support the need for additional data collection activities and/or be used in conjunction with existing monitoring data to make decisions regarding needed actions.

The goal for the reliability of Program data will be at the 95% confidence level. A goal of + or - 20% is proposed for sampling precision. Sampling precision will be evaluated using duplicate field samples. Duplicate sample results will help to establish precision among different samples collected from the same site. Splits of the same sample will provide a measure of precision within that sample (sample homogeneity). Duplicate samples will be collected for volatile organic analysis at all wells. Duplicated samples for semivolatile and inorganic analytes and indicator parameters will be collected from at least 5% of the monitoring wells or at least two duplicates per site.

The DQO for this Program will be developed in two phases. The DQO presented above defines goals for Phase I of the Program. Using data generated from Phase I, more definitive DQO will be developed for Phase II of the Program.

The following information needs to be considered in developing Quality Data Objectives, as apporpriate:

- A clear qualitative statement of the decision to be made or the problem under evaluation;
- A statement of why environmental data are needed and how the data will specifically be used;
- Schedule and budget constraints on data collection;
- A description of the data to be collected or measurements to be made;

- Specifications regarding the domain (i.e., that portion of the environmental or physical system from which samples will be collected); and
- The calculations, statistical or otherwise, that will be performed on the data to arrive at a result.

Do the Quality Assurance objectives and Data Quality Objectives address the following:

1. Is there a comprehensive statement of intended data usage?
2. Are secondary data usages discussed?
3. Do the DQOs reflect the administrative process (dialogue between technical staff and decision maker or between producers of the data and users) and tie the DQO to the decision to be made or the use of the data?
   a. Is the person(s) responsible for formatting DQOs identified?
   b. Have the following been considered in the development of the DQOs: intended use, measurement process, available resources and cost?
4. Are DQOs quantitatively stated for precision and accuracy (bias)?
   a. Have the following been defined for each matrix and parameter:
      1) Level of QA effort (frequency of QA, etc.)?
      2) Accuracy (matrix spikes, surrogate spikes, reference samples, etc.)?
      3) Precision (replicate samples)?

4) Sensitivity or Method Detection Limit?

5) Statistical reporting units?

b. Are quantitative limits established for each?

c. Are both field and lab covered?

d. Is it clear that a distinction has been defined to "total" system availability and bias vs. only looking at the laboratory?

e. Are objectives/requirements properly expressed (e.g., not confused with capabilities)?

5. If appropriate, are completeness objectives quantitatively stated?

6. Are representativeness and comparability appropriately addressed?

QUALITY ASSURANCE/QUALITY CONTROL DEFINITIONS

Accuracy - The degree of agreement of a measurement (or an average of measurements of the same thing), X, with an accepted reference or true value, T, usually expressed as the difference between the two values X-T, or the difference as a percentage of the reference or true value, 100 (X-T)/T, and sometimes expressed as a ratio, X/T. Accuracy is a measure of the bias in a system. Accuracy is assessed by means of reference samples and percent recoveries.

Analytical Batch - The basic unit for analytical quality control is the analytical batch. The analytical batch is defined as samples which are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch should be of similar composition (e.g., groundwater, sludge, ash, etc.).

Audit - A systematic check to determine the quality of operation of some function or activity. Audits may be two basic types: (1) performance audits in which quantitative data are independently obtained for comparison with routinely obtained data in a measurement system, or (2) system audits of a qualitative nature that consist of an on-site review of a laboratory's quality assurance system and physical facilities for sampling, calibration, and measurement.

Bias - A systematic displacement of all the observations in a sample from the true or accepted value, or a systematic and consistent error in test results.

Blank or Sample Blank - A sample of a carrying agent (gas, liquid, or solid) normally used to selectively capture a material of interest. The blank or sample is subjected to the usual analytical or measurement process to establish a zero baseline or background value and is used to adjust or correct routine analytical results.

Calibration - Establishment of a relationship between various calibration standards and the measurements of them obtained by a measurement system or portions of the system. The levels of the calibration standards should bracket the range of levels obtained when actual measurements are to be made.

Calibration Standard - A standard used to quantitate the relationship between the output of a sensor and a property to be measured. Calibration standards should be traceable to standard reference materials, certified reference materials, or a primary standard.

Certified Reference Materials - A material produced in quantity when certain properties have been certified to the extent possible to satisfy its intended use by the National Institute of Standards and Technology or other agencies.

Chain-of-Custody - Inventory control information that, when documented, attests to the integrity of data (sample[s]) collected.

Check Standard - A material of known composition that is analyzed concurrently with test samples to evaluate a measurement process. An analytical standard that is analyzed to verify the calibration of the analytical system. One check standard should be analyzed with each analytical batch or every 20 samples, whichever is greater.

Comparability - Expresses the confidence with which one data set can be compared to another.

Completeness - A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions.

Data Quality - The totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are: accuracy, precision, completeness, representativeness, and comparability.

Data Quality Objectives - Qualitative and quantitative statements specified to ensure that data of known and appropriate quality are obtained to support specific decisions or regulatory actions.

Data Validation - A systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use. Data validation consists of data editing, screening, checking, auditing, verification, certification, and review.

Defensibility - Ability to defend, through documented objective evidence, the origin, chain-of-custody, matrix of scientifically-acceptable operations performed, reduction and transcription of data, so that limitations, representativeness, and applicability are clearly known.

Environmental Samples - An environmental sample or field sample is a representative sample of any material (aqueous, non-aqueous, or multi-media) collected from any source for which determination of composition or contamination is requested or required. For the purposes of this investigation, environmental samples shall be classified as follows:

Surface Water and Groundwater;

Drinking Water -- delivered water (treated or untreated) designated as potable water;

Water/Wastewater -- raw source waters for public drinking water supplies, ground waters, municipal influents/effluents, and industrial influents/effluents;

Sludge -- municipal sludges and industrial sludges;

Waste -- aqueous and non-aqueous liquid wastes, chemical solids, contaminated soils, and industrial liquid and solid wastes.

Environmentally Related Measurements - A term used to describe essentially all field and laboratory investigations that generate data involving (1) the measurement of chemical, physical, or biological parameters in the environment, (2) the determination of the presence or absence of criteria or priority pollutants in waste streams, (3) assessment of health and ecological effect studies, (4) conduct of clinical and epidemiological investigations, (5) performance of engineering and process evaluations, (6) study of laboratory simulation of environmental events, and (7) study or measurement on pollutant transport and fate, including diffusion models.

Equipment (Rinsate) Blank - Usually an organic or aqueous solution that is as free of analyte as possible and is transported to the site, opened in the field, and poured over or through the sample collection device, collected in a sample container, and returned to the laboratory. This serves as a check on the sampling device cleanliness. One equipment blank should be analyzed with each analytical batch or every 20 samples, whichever is greater.

Field Blank - Usually an organic or aqueous solution that is as free of analyte as possible and is transferred from one vessel to another at the sampling site and preserved with the appropriate reagents. This serves as a check on reagent and environmental contamination. One field blank should be analyzed with each analytical batch or every 20 samples, whichever is greater.

Field Duplicate Samples - Duplicate samples are two separate samples taken from the same source (i.e. in separate containers and analyzed independently). Independent samples collected in such a manner that they are co-located samples equally representative of the sample matrix at a given location and time. Field duplicates will be indistinguishable from other analytical samples so that the personnel performing the analyses are not able to determine which samples are duplicates. Field duplicates determine total random error.

Grab Sample - A discrete aliquot which is representative of a specific location at specific time.

Internal Quality Control - The routine activities and checks, such as periodic calibrations, duplicate analyses, and the use of spiked samples, that are included in normal internal procedures to control the accuracy and precision of a measurement process.

Laboratory (Reagent) Blank - A sample which is prepared and analyzed by the laboratory, prior to and during analysis of each sample batch, to demonstrate that identified compound concentrations do not reflect laboratory contamination.

Laboratory Duplicates - Two aliquots taken in the laboratory from the same sample container with one of the aliquots identified as the duplicate and the other aliquot the original sample. Each aliquot is treated identically through the laboratory analytical procedure.

Matrix Spike - A matrix spike is employed to provide a measure of accuracy for the method used in a given matrix. A matrix spike analysis is performed by adding a predetermined quantity of stock solutions of certain analytes to a sample matrix prior to sample extraction/digestion and analysis. The concentration of the spike should be at the regulatory standard level or the practical quantitation limit (PQL) for the method. When the concentration of the analyte in the sample is greater than 0.1%, no spike of the analyte is necessary.

Method Detection Limit (MDL) - The method detection limit is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

Minimum Detectable Level (Limit of Detection) - The limit of detection for an analytical method is the minimum concentration of the constituent or species of interest that can be observed by the instrument and distinguished from instrument noise with a specified degree of probability.

Performance Audits - (See Audit).

Practical Quantitation Limit (PQL) - The practical quantitation limit is the lowest limit that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Precision - A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is the agreement between a set of replicate measurements without assumption or knowledge of the true value. Precision is assessed by means of duplicate/replicate sample analysis. Precision is best expressed in terms of the standard deviation. Various measures of precision exist depending upon the "prescribed similar conditions."

Quality Assurance - The total integrated program for assuring the reliability of monitoring and measurement data. A system for integrating the quality planning, quality assessment, and quality improvement efforts to meet user requirements.

Quality Assurance Program Plan (QAPP) - An orderly assembly of management policies, objectives, principles and general procedures by which an organization outlines how it intends to produce quality data.

Quality Assurance Project Plan (QAPjP) - An orderly assembly of detailed and specific procedures by which an organization delineates how it produces quality data for a specific project or measurement method.

Quality Control - The routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process.

Quality Control Reference Sample - A sample prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. An independent standard is defined as a standard composed of the analyte(s) of interest from a

different source than that used in the preparation of standards for use in the standard curve. A quality control reference sample is intended as an independent check of technique, methodology, and standards and should be run with every analytical batch or every 20 samples, whichever is greater. This is applicable to all organic and inorganic analyses.

Quality Control Samples - A planned check of the operation of a measurement system to obtain a measure of the quality of the data generated. Examples of Quality Control sample types are:

- Blank samples,
- Duplicate samples,
- Split (replicate) samples, and
- Matrix spike samples.

Reagent Blank - Usually an organic or aqueous solution that is as free of analyte as possible and contains all the reagents in the same volume as used in the processing of the samples. The reagent blank must be carried through the complete sample preparation procedure and contains the same reagent concentrations in the final solution as in the sample solution used for analysis. The reagent blank is used to correct for possible contamination resulting from the preparation or processing of the sample. One reagent blank should be prepared for every analytical batch or for every 20 samples, whichever is greater.

Reagent Grade - Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents which conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.

Replicate Analysis - Repeated, but independent, determinations of the same sample by the same analyst, at essentially the same time and under the same conditions.

Replicate Samples - Replicate samples are two aliquots taken from the same sample container and analyzed independently. In cases where aliquoting is impossible, as in the case of volatiles, duplicate samples must be taken for the replicate analysis.

Representativeness - Expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Reproducibility - The precision, usually expressed as a standard deviation, measuring the variability among results of a measurement of the same sample at different laboratories.

Sensitivity - The degree by which an instrument (or method) can detect a particular compound.

Spiked Sample - A normal sample of material (gas, liquid, or solid) to which is added a known amount of some substance of interest. The extent of the spiking is unknown to those analyzing the sample. Spiked samples are used to check on the performance of a routine analysis or the recovery efficiency of a method.

Standard Curve - A standard curve is a curve which plots concentrations of known analyte standards versus the instrument response to the analyte. Calibration standards are prepared by diluting the stock analyte solution in graduated amounts which cover the expected range of the samples being analyzed. Standards should be prepared at the frequency specified in the appropriate method. The calibration standards must be prepared using the same type of acid or solvent and at the same concentration as will result in the samples following sample preparation. This is applicable to organic and inorganic chemical analyses.

Standard Operating Procedures (SOP) - A written document which details operation, analysis, or action whose mechanisms are thoroughly prescribed and which is commonly accepted as the method for performing certain routine or repetitive tasks.

Surrogate - Surrogates are organic compounds which are similar to analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, calibration and check standards, samples (including duplicates and quality control reference samples) and spiked samples prior to analysis. Percent recoveries are calculated for each surrogate.

Survey - (See Systems Audit).

System Audit - A review of the Quality Control system to ensure that a comprehensive set of Quality Control methods, procedures, reviews, and sign-off approvals are established or in place. Such audits may be either planned or unannounced.

Traceability - A documented chain of comparisons connecting a working standard to a national standard, such as a standard maintained by the National Institute of Standards and Technology.

Trip Blank - Usually an organic or aqueous solution that is as free of analyte as possible and is transported to the sampling site and returned to the laboratory without being opened. A trip blank consists of a sample that is prepared by the laboratory prior to the sampling event. The trip blank is contained in the actual sample containers and is kept with the investigative samples throughout the sampling event. Trip blanks are handled and packaged for shipment in the same manner as other investigative samples. This serves as a check on sample contamination originating from sample transport, shipping, and from the site conditions. One trip blank should be analyzed with each analytical batch or every 20 samples, whichever is greater. Trip blanks are generally used only in volatile organic sampling and shipping activities.

Water - Any reference to water in the EPA SW-846 Method refers to American Society for Testing and Materials (ASTM) Type II reagent water (unless otherwise specified) which is free of contaminants that may interfere with the analytical test in question.