



N00236.001303
ALAMEDA POINT
SSIC NO. 5090.3

**QUALITY ASSURANCE PROJECT PLAN
(FINAL)
SUPPLEMENTARY SOIL INVESTIGATION
FOR ENGINEERING EVALUATION/COST ANALYSIS
SITE 7C FORMER LOCATION OF BUILDING 547**

**NAVAL AIR STATION, ALAMEDA
ALAMEDA, CALIFORNIA
May 22, 1996**

Prepared By:

**Moju Environmental Technologies, Inc.
315 Washington Street, Suite 200
Oakland, CA 94607**

315 Washington Street, Suite 200 • Oakland, California, USA 94607
TEL (510) 874-5400 • Fax (510) 451-MOJU

**ENGINEERING SERVICES FOR VARIOUS ENVIRONMENTAL
ENGINEERING PROJECTS AT NAVAL AIR STATION
ALAMEDA, CALIFORNIA**

Contract No. N62474-94-D-7535

Work Delivery Order No. 0001

Navy Remedial Project Manager: George Kikugawa

Moju Project Manager: Akali Igbene

**QUALITY ASSURANCE PROJECT PLAN
(FINAL)**

**SUPPLEMENTARY SOIL INVESTIGATION FOR
ENGINEERING EVALUATION AND COST ANALYSIS
SITE 7C FORMER LOCATION OF BUILDING 547**

**NAVY AIR STATION, ALAMEDA
ALAMEDA, CALIFORNIA**

Prepared By:

Moju Environmental Technologies, Inc.
315 Washington Street, Suite 200
Oakland, CA 94607

May 22, 1996

**ENGINEERING SERVICES FOR
VARIOUS ENVIRONMENTAL PROJECTS**

**SUPPLEMENTARY FIELD SOIL INVESTIGATION FOR
ENGINEERING EVALUATION AND COST ANALYSIS
SITE 7C FORMER LOCATION OF BUILDING 547**

**NAVY AIR STATION, ALAMEDA
ALAMEDA, CALIFORNIA**

**QUALITY ASSURANCE PROJECT PLAN
(FINAL)**

APPROVED:

MOJU ENVIRONMENTAL
TECHNOLOGIES, INC.

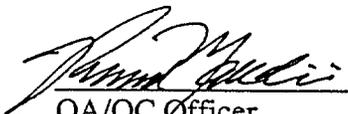
ENGINEERING ACTIVITIES WEST,
NAVAL FACILITIES ENGINEERING
COMMAND

Project Manager
Akali Igbene

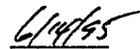
Date

Navy Remedial Project Manager
George Kikugawa

Date



QA/QC Officer
Richard Makdisi



Date

TABLE OF CONTENTS

	page
1.0 PROJECT DESCRIPTION	1
1.1 SITE PHYSICAL DESCRIPTION	1
1.2 SITE HISTORY	2
1.3 PREVIOUS SITE INVESTIGATIONS	2
1.4 SITE GEOLOGY AND HYDROGEOLOGY	3
2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES	3
3.0 QA OBJECTIVES FOR MEASUREMENT	4
3.1 ANALYTICAL LEVEL	5
3.2 PARCC CRITERIA	5
3.2.1 Precision	5
3.2.2 Accuracy	6
3.2.3 Representativeness	7
3.2.4 Completeness	7
3.2.5 Comparability	7
4.0 SAMPLING PROCEDURES	7
5.0 SAMPLE CUSTODY	8
5.1 FIELD CUSTODY PROCEDURES	9
5.1.1 Sample Labels	9
5.1.2 Lithologic Log	9
5.1.3 Field Activities Logbook	9
5.1.4 Chain-of-Custody Record	10
5.2 OFFICE DOCUMENTATION PROCEDURES	10
5.2.1 Project File	10
5.2.2 QA/QC File	11
5.3 LABORATORY CUSTODY PROCEDURES	11
6.0 CALIBRATION PROCEDURES	11
7.0 ANALYTICAL PROCEDURES	12
8.0 DATA REDUCTION, VALIDATION, AND REPORTING	12
8.1 QA/QC EVALUATION AND DATA VALIDATION	13
8.1.1 Blanks	14
8.1.2 Duplicates	14
8.1.3 Spikes	14
8.2 EVALUATION PROCEDURE FOR CONTROL SAMPLES	14
9.0 INTERNAL QUALITY CONTROL	16
9.1 FIELD QUALITY CONTROL SAMPLES	16
9.1.1 Trip Blanks	16
9.1.2 Equipment Rinsates	16
9.1.3 Field Blanks	16
9.1.4 Field Duplicates/Splits	17
9.1.5 QA Sample Analyses Summary	17
9.1.6 Field Measurements	17

TABLE OF CONTENTS

	page
9.2 LABORATORY QUALITY CONTROL SAMPLES	17
9.2.1 Method Blank	17
9.2.2 Duplicates and Spikes	17
9.2.3 Surrogate Compounds	18
9.2.4 Laboratory Control Samples	18
9.2.5 Control Charts	18
10.0 PERFORMANCE AND SYSTEMS AUDITS	18
11.0 PREVENTATIVE MAINTENANCE	18
12.0 DATA ASSESSMENT PROCEDURES	19
13.0 CORRECTIVE ACTION	19
14.0 QUALITY ASSURANCE REPORTS	21
REFERENCES	22
FIGURES	23

LIST OF APPENDICES

APPENDIX A	CURTIS & TOMPKINS QA/QC MANUAL
APPENDIX B	FP-1 GENERAL FIELD PROCEDURES
APPENDIX C	FP-10 GENERAL SAMPLING PROCEDURES
APPENDIX D	FP-10-1 SOIL AND ROCK SAMPLING
APPENDIX E	FP-4 TRENCHING AND TEST PIT PROCEDURES
APPENDIX F	FP-10-5 SOIL GAS SURVEY PROCEDURES

1.0 PROJECT DESCRIPTION

Moju Environmental Technologies (Moju) was awarded Work Delivery Order No. 0001 from the Department of the Navy, Western Division, Naval Facilities Engineering Command, under Engineering Services for Various Environmental Projects at Naval Air Station, Alameda, California Contract No. N62474-94-D-7535. The Navy statement of work dated February 16, 1995 (revised April 25, 1995) directs Moju to perform the following activities in support of the interim removal action Engineering Evaluation/Cost Analysis (EE/CA) for Installation Restoration Site 7C at Naval Air Station, Alameda, California: (1) prepare a quality assurance project plan, a health and safety plan, and a field investigation work plan, (2) collect and analyze soil samples, (3) develop and evaluate potential disposal and treatment alternatives, and prepare a engineering evaluation and cost analysis report, (4) prepare a public notice, action memorandum, implementation workplan, detailed cost estimate, and provide coordination and support for the site, (5) address investigation derived waste management and disposal, and (6) attend project meetings and provide project management.

The Supplementary soil investigation for Site 7C will include collection of soil sample data obtained from surface and borings at selected locations. Selected samples will be submitted for laboratory analysis in accordance with the field investigation work plan. Stratigraphic and relative permeability data will also be collected using the Cone Penetration Test (CPT) technique. These data will be interpreted for development of the EE/CA.

1.1 SITE PHYSICAL DESCRIPTION

Site 7C is a two acre area located within the northeast corner of the Naval Air Station, Alameda (NAS Alameda) which occupies the western end of Alameda Island in Alameda County, California. NAS Alameda is bounded on the north by the Oakland Inner Harbor, by San Francisco Bay to the west and south, and by the City of Alameda to the east. The NAS Alameda complex occupies about 2,635 acres of which about 1,525 acres are useable land and about 1,110 acres are shoreline and marine waters.

Site 7C is generally flat, completely fenced with asphalt paving over much of the area and some mature landscape on the south end. There are two structures existing on the site. One of the structures houses the former car wash facility and the other structure is the overhead canopy at the service island. A third structure previously existed next to the fuel island but is currently only a concrete slab.

Several soil stockpiles exist on the site from the excavation activities associated with the removal of underground storage tanks (USTs). There are four parallel trenches running through the fuel island resulting from the excavation of fuel pipelines. There are trees and bushes a few feet away from the northwest and southeast fence lines of the site. There is an overhead power line that terminates at a power pole located on the southeast portion of the site.

1.2 SITE HISTORY

Site 7C was a fuel station from 1971 to 1988 and is currently not being used. Building 547, an on-base annex service station, previously occupied the site. The service station was located between Eleventh and Main Streets. The two acre site contained three 12,000-gallon underground fiberglass fuel tanks, and reportedly contained one 10,000-gallon stainless steel waste oil tank and one 5,000-gallon underground stainless steel waste oil tank (PRC/Montgomery Watson, 1993). However, the Base Survey does not indicate the presence of the waste oil tanks. Additionally, the report of a remedial investigation performed in 1990 states that the waste oil tanks were above ground (Canonie, 1990c). The three 12,000-gallon fuel tanks were located in the northwest corner of the property. The underground tanks were reported to have been installed in 1971. A car wash facility also existed on the site.

In 1980 one of the 12,000-gallon fiberglass fuel tanks was reportedly punctured by a tank measuring stick rod dropped into the bottom of the tank. The tank was reported to have been drained and repaired between 1980 and 1987 (Canonie, 1990c). The 1987 tank test survey by Environmental Resources Management revealed that feed lines to the same tank were leaking. The lines were subsequently removed and replaced. Following a failed precision tightness test in a 1988 tank testing survey, fuel was removed from the tank. The three 12,000-gallon fuel tanks were reportedly excavated and removed in 1995.

1.3 PREVIOUS SITE INVESTIGATIONS

Previous investigations performed at Site 7C include (1) a tank testing survey performed in 1987 by Environmental Resources Management, (2) a tank testing survey conducted in 1988, (3) a remedial investigation accomplished by Canonie in 1990, (4) a follow-on investigation conducted by PRC/Montgomery Watson in 1994, and (5) tank and piping excavation in early 1995.

Two previous field investigations were performed at the site. Canonie performed a soil gas survey, soil drilling and sampling, construction of monitoring wells, and groundwater sampling. PRC performed a similar, follow-up investigation but did not collect soil vapor samples.

During these investigations, samples of soil-vapor, soil, and groundwater were collected and selected samples were analyzed. During the recent excavation of three USTs (12,000 gallon, fiberglass construction) and removal of associated piping, backfill and contaminated soil was stockpiled on the site. Soil sampling and analysis of the UST excavation base, sidewalls, and piping trenches were also performed.

In preparation of this document, Moju conducted a document review, including data reported by Canonie and PRC, and the NAS Alameda Public Works utility maps.

Review of the previous data indicates that the primary chemicals detected at elevated concentrations are benzene, toluene, ethylbenzene, and xylene (BTEX), gasoline range hydrocarbons, polyaromatic hydrocarbons (PAHs) typically present in gasoline (naphthalene

and methylnaphthalene), heavier petroleum hydrocarbons reported as JP-5 jet fuel and diesel. There are also areas with localized motor oil range hydrocarbons, PAHs, and lead concentrations of concern.

BTEX were found in soil above 1,000 ppm and gasoline range hydrocarbons above 10,000 ppm (up to 66,900 ppm) in soil just above the water table at a depth of about 5 feet. Heavier fuel hydrocarbons are also encountered in this approximate depth range but at a concentration less than 5000 ppm. Motor oil range hydrocarbons appear to be present primarily as isolated hot-spots at or near the surface at concentrations above 1,000 ppm. Also reported were localized lead above 1,000 ppm and naphthalene (PAH) above 100 ppm.

The Soil Gas Survey data indicate that BTEX vapor is widely distributed across the western part of the site. The sources appear to be the former locations of the USTs and the service island, with the vapor apparently migrating in the southerly direction.

These data suggest that the highest concentrations of petroleum products and vapor are along the alignment of the subsurface utilities where the permeable backfill (typically placed around underground utilities) may have contributed substantially to the migration of BTEX and petroleum products.

1.4 SITE GEOLOGY AND HYDROGEOLOGY

The site is underlain by hydraulic fill to depths ranging from 7 feet to 12.5 feet below ground surface (bgs). The fill consists of intermixed sandy clay, silty sand, clayey sand and sand. The sand is generally fine grained. The fill is underlain to the depths explored (about 15 feet bgs) by native materials described as silty sand of the Merritt Sand formation.

Groundwater has been encountered between about 5.5 feet and 7 feet bgs during the 1990 field investigation by Canonic. Groundwater level measurements in 1995 reported by others indicate that the average groundwater depth is about 5 feet bgs. Groundwater is reported to flow to the southeast with an estimated gradient of 0.008 foot/foot.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The Moju Team (Team) organization for this project is shown in Figure 1. The Project Manager has responsibility for overall control of the project and uses the Team Quality Circle (TQC) approach to ensure that adequate qualified technical and management resources are devoted to the project tasks.

The Team project management approach is to have Task Leaders be responsible for the project operations. Task leaders are the bridge between management and technical personnel for a project. In addition, since the Task Leaders are experienced project managers, they will support the Project Manager through the TQC, which is an ad-hoc committee. Task Leaders are appointed to control the technical efforts that contribute to task accomplishment, since tasks often require the contribution of several members of the participating organizations. Task leaders ensure that the sum of the efforts of technical staff achieve the

desired goal.

The responsibilities of the project manager will include:

- Provide adequate resources to effectively support the QA requirements applicable to the project
- Maintain awareness of QA issues and problems and effect resolutions
- Assure that technical personnel are qualified by experience and training to perform assigned work and comply with applicable technical and QA requirements for the work being performed
- Approve all QA implementing procedures
- Select Task Leaders for each task
- Select the Peer Reviewer for each task
- Schedule and conduct TQC meetings

The Project Manager will designate one of the Task Leaders on the TQC as the project Peer Reviewer for each task. The Peer Reviewer will provide peer review of the technical activities coordinated by the project Task Leaders. The Peer reviewer will have at least comparable professional experience with the Task Leader for the task. The responsibilities of the Peer Reviewer will include:

- Review of all documents prepared for the Task Leader
- Provide professional assistance to the Task Leader
- Serve as a TQC member

The TQC concept dominates the relationship between the Project Manager and subcontractors that are participating in the project, subordinating boundaries between organizations to obtain more efficient utilization of project resources.

The Alternate Project Manager assists the Project Manager in coordinating the efforts of the Task Leaders of the TQC to ensure that tasks are completed on-time and maintain the required quality goals. Schedules are produced to ensure that interfaces between tasks are adequate and timely.

3.0 QA OBJECTIVES FOR MEASUREMENT

The data quality objectives (DQOs) are qualitative and quantitative statements developed by data users to specify the types and quality of data needed from a particular data collection activity to support specific decisions or regulatory actions. The three-stage process for developing DQOs, described in U.S. Environmental Protection Agency (EPA) guidance, is based on the following:

- Identifying project objectives
- Specifying the data necessary to meet the project objectives
- Describing the methods that will yield data of acceptable quality and quantity to support the required decisions

The objectives of this supplementary soil investigation are to:

- Obtain more complete data to define the vertical and lateral distribution of fuel hydrocarbon in the site soil
- Determine the residual concentration of fuel hydrocarbon in the suspect source areas
- Assess the degree to which the underground utility line backfill acts as a migration pathway for gasoline and BTEX
- Verify the extent to which lead is a contaminant of concern. The issue of lead is a particular DQO because it is potentially a false positive result, having been reported above 1000 ppm in only one of 40 samples in the previous site investigation data.
- Identify the nature and vertical distribution of petroleum hydrocarbons reported as motor oil
- Stratigraphic data to assess relative permeability of the fuel affected soil area

This QAPP describes controls for field and analytical activities to ensure that data of acceptable quality and quantity are obtained to support the required decisions. It details the analytical level and methods, and measurement objectives for precision, accuracy, representativeness, completeness, and comparability (PARCC). Field techniques are described in the Field Investigation Work Plan (FIWP).

3.1 ANALYTICAL LEVEL

The laboratory analytical reporting level for all data will be Navy Level C and Navy Level D for lead. The higher analytical level D for lead is justified by its potential to be a false positive contaminant. Curtis & Tompkins, Ltd., the selected laboratory, has the capability to generate the necessary Navy reporting levels.

Field measurements will follow two levels: A and B. Level A is characterized by the use of portable instruments that provide data for optimum sampling points and for health and safety support. Level B is used for field analyses where both qualitative and quantitative data can be obtained, as with the use of the photoionization detector (PID).

3.2 PARCC CRITERIA

Critical indicators of project data quality are precision, accuracy, representativeness, completeness, and comparability. PARCC objectives for those indicator parameters were developed for this project based on past experience and on the objectives of this task. Both field and laboratory analytical method controls will be used to meet these objectives.

3.2.1 Precision

Precision refers to the reproducibility of measurements of the same characteristic, usually under a given set of conditions. For duplicate measurements, precision is expressed as the relative percent difference (RPD) of the pair and is calculated using the following equation:

$$RPD = \frac{|D_1 - D_2|}{\frac{1}{2}(D_1 + D_2)} \times 100$$

Where

D_1 = concentration of analyte in a field sample

D_2 = concentration of analyte in a duplicate/replicate sample

The precision of field measurements (such as photoionization detector (PID) response) will be evaluated based on the results of duplicate measurements (two measurements taken with the same instrument). For field samples, at least 10 percent of the field measurements will be obtained in duplicate. Duplicate PID results will be compared to the established acceptance criteria of ± 25 percent.

Precision control limits for the analysis of samples for lead are initially established at 40% or less.

The precision of chemical analyses for parameters other than lead will be assessed through the analysis of field duplicate samples, and matrix spike/matrix spike duplicate (MS/MSD) samples.

General precision acceptance criteria for duplicate and MS/MSD samples are presented in the Curtis & Tompkins laboratory QA/QC Manual. When analytes are present in samples either near the method detection limit or substantially above the detection limit, these objectives may not be met. If precision objectives are not met, an anomaly will be noted, and other QC data will be evaluated to determine the validity of the data.

3.2.2 Accuracy

Accuracy refers to the degree of agreement of a measurement to the true value. The accuracy of a measurement system is impacted by errors introduced through the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques. Sampling accuracy will be evaluated based on the results of the analysis of field blanks, VOC trip blanks, and equipment rinse samples. Analytical accuracy will be evaluated on the basis of matrix spike samples, reference standards such as internal and surrogate standards, and method blank samples.

Accuracy is expressed in terms of percent recovery calculated by the following equation:

$$\% \text{ recovery} = \frac{\text{measured spike value} - \text{unspiked value}}{\text{known spike value}} \times 100$$

The results of blank samples will provide information on positive bias. The method blanks must be below the reported method reporting limit (MRL) for every analyte in the analytical procedure, with the exception of common laboratory and field contaminants including methylene chloride, acetone, toluene, 2-butanone, and phthalate esters. For these five potential contaminants, the results are qualified when the reported sample concentration is less than 10 times the blank sample concentration. The results of spiked

samples and reference standards will be expressed as percent recovery and will provide information on positive and negative bias. Objectives for matrix spike samples and surrogate compounds, expressed in percent recovery, are presented in the Curtis & Tompkins laboratory QA/QC Manual. Objectives for reference standards will be based on the type analyzed.

Accuracy of the measurement of lead in samples will be assessed by obtaining the laboratory results for calibration and laboratory control samples.

3.2.3 Representativeness

Representativeness is a qualitative expression of the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is maximized by ensuring that the number and location of sampling points and sample collection and analysis techniques are appropriate and will provide information that reflects "true" site conditions.

Representativeness of lead samples will be ensured by selecting a comparatively large number of sampling locations.

3.2.4 Completeness

Completeness is defined as the percentage of measurements that are judged valid compared to the number of samples needed for the project. The project completeness goal for field samples is 90 %. The project completeness value will be determined at the conclusion of the data validation phase and will be calculated by dividing the number of complete, valid sample results by the total number of samples planned for analyses listed in the FIWP. Complete results are defined as results that meet all QC criteria, such as sample holding times and acceptable surrogate recoveries. Samples without complete QC criteria are listed as incomplete. Incomplete results may be used as part of the investigation; however, these data will be considered questionable.

3.2.5 Comparability

Comparability is a qualitative parameter that expresses the confidence that one data set may be compared to another. This goal is achieved through the use of standardized techniques to collect and analyze samples and appropriate units to report analytical results. These techniques are described in the FIWP and this QAPP.

4.0 SAMPLING PROCEDURES

Sampling activities at Site 7C will include soil sampling from borings using a hollow stem drill rig and a split-barrel sampler at approximately 20 locations and surface soil

sampling at 10 locations. The collection of samples will be controlled by procedure FP-10-1, Soil and Rock Sampling, APPENDIX D

Analyses of the samples will be conducted at Curtis & Tompkins, Ltd. Samples will be handled in a manner appropriate for the intended analyses. A summary of sample containers, holding times, and preservative requirements for all parameters is presented in Table 1.

Table 1
PROJECT SAMPLES

Analyte	Method	Container	Preservative	Holding Time	No. of Samples	QC Samples				
						Field Blank	Trip Blank	Dup. Split	Matrix Split	Total QC (4 days)
TPH(g) + BTEX	8015	brass tube	Cool 4 °C	14 days	50	1/day	1/day	7	0	15
TEPH + JP-5	8015	brass tube	same	14 days	58	1/day	1/day	7	0	15
Lead	6010	4 oz wide-mouth glass	none	6 months	9	1	0	1	1	3

The FIWP contains details on the sampling design including the following:

- Site sampling rationale
- Sampling techniques and equipment
- Sample selection criteria
- Sampling equipment preparation and decontamination

Field equipment will be decontaminated before and between sampling events using procedure FP-1, General Field Procedures.

5.0 SAMPLE CUSTODY

In order to link each reported datum with its associated sample, sample custody and documentation procedures have been established. The sample custody pathway for this project is summarized in Figure 2. Three separate, interlinking documentation and custody procedures (field, office, and laboratory) are described. The Chain-Of-Custody (COC) Records, which are central to these procedures, will be attached to all samples and their associated data throughout the tracking process.

5.1 FIELD CUSTODY PROCEDURES

Field documentation will include sample labels, lithologic logs, a field activities logbook, and COC Records. These documents will be completed using indelible ink. Any corrections to the document will be made by drawing a line through the error and entering the correct value without obliterating the original entry. Persons correcting the original document will initial any changes made.

Field documents are described in detail in the following section.

5.1.1 Sample Labels

The Curtis & Tompkins labels will be used to identify samples. The label is made of a waterproof material backed with a water-resistant adhesive. This sample label, to be completed using waterproof ink, contains the following information: Sampler's name; sample number; date; time; location; and preservative used.

5.1.2 Lithologic Log

All sediments encountered during drilling will be examined and described by the site geologist or engineer, who will maintain a complete record of these descriptions. Sediments will be described in accordance with the Unified Soil Classification System.

5.1.3 Field Activities Logbook

A field log will be used to record daily field activities. The field geologist is responsible for making sure that a copy of the field log is sent to the project file as soon as each sampling round is completed. Field log entries will include the following:

- field worker's name
- field log number
- date and time data are entered
- location of activity
- personnel present on-site
- climatic and other field conditions
- sampling and measurement methods
- total number of samples collected
- sample numbers
- sample distribution (laboratory)
- field observations, comments

5.1.4 Chain-of-Custody Record

The COC Record is prepared for groups of samples collected at a given location on a given day. A COC Record will be completed in quadruplicate and will accompany every shipment of samples to the respective analytical laboratories. The COC Record is shown in Figure 3.

Two of the four copies (white and green) will accompany the samples to the analytical laboratory. The yellow copy is kept in Moju's QA/QC file, while the pink copy is retained for the sampler's record. The COC Record makes provision for documenting sample integrity and the identity of any persons involved in sample transfer. Other information entered on the COC Record includes:

- project name and number
- field logbook number
- COC serial number
- project location
- sample numbers
- sampler/recorder's signature
- date and time of collection
- collection location
- sample type
- analyses requested
- inclusive dates of possession
- name of person receiving the sample
- laboratory sample number
- date of sample receipt
- address of analytical laboratory

5.2 OFFICE DOCUMENTATION PROCEDURES

Samples and data will be tracked and archived in Moju's office. Moju's QA/QC Officer is responsible for ensuring that correct management practices are followed for proper documentation and for linking all samples with data. The two files used in data tracking and documentation are the QA/QA file and the project file, discussed below.

5.2.1 Project File

This contains several documents, including work delivery orders, cost proposals, field investigation workplans, assessment reports, correspondence, the field log, COC Record, and sampling information form. This provides a common location for all information that will be required in data evaluation and interpretation and report preparation. The file is organized for easy retrieval and long-term storage of information for a minimum of four years. The Project Coordinator manages the project file.

5.2.2 QA/QC File

This is a temporary file used during the period of field work to track samples and link samples with data. It is also used in the QA/QC assessment of chemical data, as explained in Section 14.0. The COC will be compared with reported data to ascertain whether the correct samples were analyzed using the analysis methods requested. If necessary, analytical laboratories will be contacted to obtain results and resolve quality control concerns. On completion of the project, all information in this file will be transferred to the project file. The QA/QC Officer manages the QA/QC file.

5.3 LABORATORY CUSTODY PROCEDURES

Laboratory custody procedures are described in the Curtis & Tompkins laboratory QA/QC Manual, Appendix A. Curtis & Tompkins laboratory has designated a sample custodian who will accept custody of the shipped samples and check that the information on the sample label matches that on the COC form(s). The custodian will then enter the appropriate data into the laboratory sample tracking system. The laboratory custodian will use the sample number on the sample label or will assign a unique laboratory number to each sample. As a record of sample receipt, the analytical laboratory will mail a copy of the COC form, with the assigned laboratory numbers, to the sampler. The custodian will then transfer the sample(s) to the proper analyst(s) or store the sample(s) under refrigeration until they are extracted and analyzed.

Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or disposed of. Material remaining after completion of the requested analyses will be stored for a minimum of 30 days before disposal. Disposal of unused samples must comply with all applicable Federal, state and local environmental regulations. All data sheets and laboratory records are retained as part of the permanent documentation.

6.0 CALIBRATION PROCEDURES

The photoionization detector used for field measurements in conformance with the project Health and Safety Plan will be calibrated according to the manufacturer's specifications. Laboratory equipment used for sample analyses also have prescribed calibration procedures. The procedures detail the frequency of calibration in accordance with the referenced analytical method.

The actions required for instruments that are found not to be within acceptable limits after sample analyses are performed are prescribed in the Curtis & Tompkins laboratory QA/QC Manual. The project sampling coordinator will be informed in these cases and the procedure for nonconformance will be used.

7.0 ANALYTICAL PROCEDURES

Modified EPA method 8015 using a gas chromatograph with FID and PID detectors will be used for TPH(gasoline) and BTEX, respectively. Modified EPA Method 8015 will be used for TEPH + JP-5. EPA Method 6010 will be used to analyze for lead by inductively coupled plasma (ICP). For ICP analyses, matrices will be digested using Method 3050. Chromalab, the subcontracting analytical laboratory in Pleasanton, California, describes the EPA methods in the Curtis & Tompkins laboratory QA/QC Manual in APPENDIX A.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

The analytical laboratory will perform initial data reduction, validation and reporting as prescribed in the Curtis & Tompkins laboratory QA/QC Manual, APPENDIX A, and internal procedures. The analyst is responsible for identifying process errors or malfunctions of equipment that may contribute to invalid raw data. The analyst verifies that the run of a sample batch is in control by reviewing internal quality control checks.

Manual calculations performed by the analyst are recorded in the bench workbook and are available for verification. Automated calculations are documented in summary reports and are subject to periodic performance verification. A review and certification of the validated data is performed by the Lab Director before the final report is released to the client organization.

Analytical data will be reported to meet Navy Level "C" analytical level and Navy Level "D" analytical level for lead. The laboratory data reporting format will be established by Chromalab and must include:

- The final data presentation will be checked in accordance with data verification requirements, approved and certified by the laboratory manager.
- Data will be presented in a tabular format whenever possible.
- Each page of data will be identified with the project number and name, date of issue, and client name.
- Reported data will include the submitter's sample identification number, laboratory sample identification number, analytical method, associated QC reported value, unit of measure, and quantification limits.
- Field QC results will be reported in the same format as real samples.
- Footnotes will be reference to specific data if required to explain reported values.
- The laboratory will report case narratives that include any problems that occurred at the laboratory in reference to the samples.

Moju performs an extensive review of the reduction, validation and reporting before the data is used in evaluations and reports. The process is illustrated in Figure 4. All data that undergoes a manual transcription process will be verified by a quality control

checker before the data is used in evaluations or reports.

Moju's QA/QC Officer will evaluate chemical data using quantitative statistical tests, qualitative assessment, and professional judgement to ensure that the data received are representative of actual field conditions. The analytical results will first be checked for completeness, including the analytical method sensitivity (reported detection limit) from one sampling round to another and for an entire sampling plan. Thereafter, blanks, duplicates, and spikes (quality control samples) will be evaluated for contamination, data precision, and data accuracy, respectively (see Figure 4).

Using a database management system, sample results will be compiled and summarized for relevant compounds and those found at concentrations above their detection limits. Where direct electronic data transfer is not used in data compilation, hard copies of the summarized data will be checked for errors following data keying.

Data completeness is tracked and checked with an analyses completion form. The completion of all analyses requested in the COC Record and additional analyses request forms will be checked by tracking the status of each sample being analyzed. Tracking will be maintained until all samples have been analyzed and the results have been reported by the analytical laboratory and reviewed by Moju's QA Officer. In addition, the detection limits reported for all data will be screened for possible unacceptably high limits and comparability from one sampling round to another.

Laboratory data will be reduced and summarized on a database system at Moju's office. Compounds reported as present at concentrations above detection limits will be summarized in an historical data table. This table will also contain the following information: Laboratory name; sample number; laboratory number; sampling date; field measurement; and quality control samples analytical data.

8.1 QA/QC EVALUATION AND DATA VALIDATION

Both the field and laboratory quality control samples will be evaluated to assess the representativeness of soil chemistry analysis results for the sampling region. Blank samples will be used to determine if and where any field samples may have been contaminated and the significance of any such contamination. Duplicate samples will be used to assess the precision of the analytical procedure as well as the inherent variability within the sampling region. Spiked samples will be used to determine the effect of matrix solutions and analytical preparation solutions on the analyte, and whether degradation, decay, or transformation have compromised sample integrity. Simple statistical parameters and qualitative indicators will be used in validating data.

The following types of control samples will be used to evaluate the quality of data from laboratory analyses:

8.1.1 Blanks

Blanks are good indicators of possible sample contamination. Samples can be contaminated before, during, and after field sampling. Often this results from sample container or sampling equipment contamination. After field sampling, samples may be contaminated during shipping and sample custody prior to analysis and during laboratory chemical analysis. To be able to isolate the stage at which sample contamination may have occurred, up to three types of blank samples may be collected; namely trip blank, field blank and laboratory blank (method or VOA blank). Trip blanks consist of purged distilled water in sample containers prepared either by the laboratory or the sampler before sampling in the field. Field blanks are rinsate water from steam-cleaning of equipment before sampling soil. Laboratory blanks, otherwise called method blanks, are distilled water used in preparing the analyte.

8.1.2 Duplicates

Duplicates are samples used to estimate data precision and the variability within the sampling region. There are two types: field duplicates and laboratory splits. Field duplicates are samples collected from the same sampling location, following the same sampling protocol, one after the other. Duplicate samples may be submitted to one laboratory so long as they are blindly labeled for intra-laboratory comparison, or one of the duplicate samples may be sent to a designated quality control laboratory for inter-laboratory comparison. Laboratory splits are samples divided into two halves by the laboratory prior to their analysis.

8.1.3 Spikes

Spike sample results allow the accuracy of the analytical methodologies to be assessed. Laboratory spikes may be conducted on matrix solutions and/or laboratory blanks. Laboratory results of the internal spike samples analyzed will be summarized and reported at the end of every phase of work.

8.2 EVALUATION PROCEDURE FOR CONTROL SAMPLES

Quality Control sample data will be comprehensively evaluated for contamination, accuracy, and precision.

Blank results will be evaluated qualitatively. Any compound detected in any of the blank samples will also be checked for in trip blanks and field blanks which were prepared during the same sampling event, or which were analyzed using the same equipment and on the same day as the method (laboratory) blanks were analyzed. The extent of any possible sample contamination based on the amount of compound detected in blank samples will be computed as follows:

$$\text{Probable Percent Contamination} = \frac{\text{concentration in blank}}{\text{concentration in relevant sample}} \times 100$$

Samples will be flagged when the probable percent contamination is 10 percent or greater and qualified as suspect if it is greater than 50 percent. However, under no circumstances will sample results be deleted or removed from the database.

Duplicate spikes or spikes results will be evaluated for accuracy and expressed as spiked percent recovery (SPR) for each spike compound. The SPR is the difference in concentration between the total concentration in the spike sample and the original concentration in the sample, divided by the actual spike concentration added to the sample. The standard deviation will be computed on a compound-by-compound basis for spiked sample data expressed as SPR. Other steps for the data validation procedure are explained below.

Duplicate results will be statistically evaluated for data precision, using the relative percent difference (RPD) values computed from the raw data reported. RPD is the difference in concentration between field duplicates and laboratory splits, divided by their average concentration, expressed as a percentage. The standard deviation for groups of duplicate data will be computed. One of the following statistical testing and acceptance criteria will be selected and applied:

1. Pre-selected upper warning and control limits (UWL and UCL, respectively) and lower warning and control limit (LWL and LCL) will be used to assess data when historical control data for the site under investigation are insufficient. The warning limits are cautionary indicators that results should be closely evaluated prior to data validation. Control limits indicate poor data quality. These preselected UWL and UCL are based on those imposed for the EPA contract laboratory program. For duplicate results expressed as RPD, the only applicable limits, the UWL and UCL, are set at 50 percent and 100 percent respectively, except when compounds are detected near the reporting limit. For surrogate or spike percent recovery, the UWL and UCL are set at 125 percent and 150 percent, respectively. Hence, the LWL and LCL are 75 percent and 50 percent, respectively.
2. The UWL, UCL, LWL, and LCL are computed from the historical quality control duplicate and spike data. The control limits (CLs) are ideally at the 95 percent confidence interval for a one-tailed normal distribution for duplicate results expressed as RPD and for a two-tailed normal distribution for spike results expressed as SPR. The CL value for half of a bell-shaped curve is 2.77 times the standard deviation or standard error, depending on the applicable parameter. It will, however, be approximated as three times the standard deviation for statistical testing. The warning limits (WLs) are two-thirds of the UCL, hence twice the standard deviation.

3. Other tests for statistical significance, such as Student's t-test, F-test, or Chi-test will be selected and applied as appropriate.

9.0 INTERNAL QUALITY CONTROL

To check the quality of field data, QC samples are collected both for laboratory and field analysis.

9.1 FIELD QUALITY CONTROL SAMPLES

Although the number of QC samples changes, the types of field QC samples remain the same, regardless of the level of QC implemented. The percentage of field QC samples will be specified by level for each sample matrix per event. A sampling event is considered to be from the time the sampling personnel arrive at the site until these personnel leave for more than 24 hours. An event may span more than 1 day.

9.1.1 Trip Blanks

Trip blanks are defined as samples that originate from ASTM Type II water placed in sample vials in the laboratory, taken from the laboratory to the sampling site, and returned to the laboratory with the volatile organic samples. Trip blanks are not to be opened in the field. One set of trip blanks should accompany each cooler containing volatile organics (VOCs), should be stored at the laboratory with the samples, and analyzed with the sample set. Trip blanks are only analyzed for VOCs.

9.1.2 Equipment Rinsates

Equipment rinsates are the final ASTM Type II water rinse from equipment cleaning and are collected and analyzed at a rate of one per day per matrix during a sampling event. For well drilling and sampling, the equipment rinsates will be sent with the samples to the laboratory. The results from the field blanks will be used to qualify the levels of analytes in the samples. This qualification is made during data performance review. The rinsates are analyzed for the same analytes as the samples which are collected that day.

9.1.3 Field Blanks

Field blanks, also known as source water samples, are the water used in decontamination and steam cleaning. One sample will be collected for each event and each source of water and analyzed for each parameter. These will be collected in the appropriate container for the required analysis.

9.1.4 Field Duplicates/Splits

Duplicates or splits are collected as described in FP-10, APPENDIX C. For soil samples sent to the subcontract laboratory for lead analysis, 10 % duplicates will be collected.

9.1.5 QA Sample Analyses Summary

Table 1 summarizes the number of QA/QC samples for the analytical program. Included in the tables are analytical methods, total number of environmental samples, number of trip blanks, equipment rinsate blanks (field blanks), duplicates/replicates, and total number of analyses for the entire project for each analytical method and medium.

9.1.6 Field Measurements

Field parameters to be measured for this program include field portable PID measurements for organic vapors. Moju will adhere to the manufacture's procedure for operation of the instrument.

9.2 LABORATORY QUALITY CONTROL SAMPLES

The analytical laboratory will meet or exceed the QC requirements specified for Navy Level "C" for petroleum analysis and Navy Level "D" QC for lead analysis. The Chromalab QA/QC Manual is included as APPENDIX A to this QAPP.

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 a normal work shift. Samples in each batch should be of similar matrix. The maximum size of an analytical batch is 20 samples.

9.2.1 Method Blank

A method blank is an artificial, matrixless sample used to monitor the system for interferences and contamination from glassware, reagents, etc. The method blank is taken through the entire sample preparation process, and is included with each batch of extractions/digestions prepared or with each 20 samples analyzed, whichever is more frequent.

9.2.2 Duplicates and Spikes

Matrix spikes and matrix spike duplicates (MS/MSD) are used in each batch with

a frequency of 5 percent with each different sample matrix for all GC methods. Acceptance criteria and spiking compounds are listed in the Chromalab QA/QC Manual. Spiked samples that do not meet established precision criteria will be further evaluated under the laboratory data validation protocol.

9.2.3 Surrogate Compounds

For GC analyses, the analytical process includes the addition, subsequent detection, and recovery calculations of surrogate spiking compounds. Surrogate compounds are added to every sample at the beginning of the sample preparation, and the surrogate recovery is used to monitor matrix effects and sample preparation. The compounds and the expected surrogate recoveries are listed in APPENDIX A.

9.2.4 Laboratory Control Samples

Laboratory control samples (LCS) are blank reagent water or blank sand or laboratory soil, spiked with a known amount of analyte from a source different than that used for the calibration standards and included with every batch of samples. The LCS measures method performance under interference-free conditions. LCS results, together with matrix spike results, can establish the presence of any matrix effects. LCS recovery must meet the acceptance criteria listed in APPENDIX A.

9.2.5 Control Charts

Recoveries for laboratory control samples will be plotted on control charts. This will aid in giving a true picture of laboratory performance.

10.0 PERFORMANCE AND SYSTEMS AUDITS

Systems audits will be used to verify adherence to QA policies and SOPs. These may include on-site reviews of measurement systems, including facilities, equipment, and personnel by the Moju QA/QC Officer. Procedures for measurement, quality control, and documentation will be reviewed and accepted prior to start of project work.

11.0 PREVENTATIVE MAINTENANCE

A description of specific preventative maintenance procedures for laboratory equipment is contained in the Curtis & Tompkins laboratory QA/QC Manual and in written SOPs maintained by the laboratory. These documents identify the personnel responsible for major, preventative, and daily maintenance; the frequency and type of maintenance and documentation procedures.

12.0 DATA ASSESSMENT PROCEDURES

The caliber of data for achieving well-founded decisions rests upon the scientific validity and integrity of the data. The degree of validity is based on the comparison of the analytical and QC results to the DQOs for the project. The integrity of the data is maintained by observing procedures designed to prevent errors and loss of data during manipulation and transfer. Upon receipt of the data collected from the field, including laboratory analytical data, Moju will review and validate data and then enter it into the database for storage, further manipulation, and retrieval.

Upon receipt of the analytical data package from the laboratory, project personnel will check for the following:

- Data package includes all requested deliverables
- Samples were analyzed as requested
- Sample holding times were not exceeded
- QC sample results are within established control limits
- Appropriate detection limits were obtained
- Completeness

Data review will be performed by the Moju QA/QC Officer. Once verification is accomplished, the data will be compiled and reported in the field investigation report. All summary tables and figures produced will be checked for errors with the original data reports prior to including them in the final report.

After review and validation of the field and laboratory data reports, the data will be entered into the database system.

13.0 CORRECTIVE ACTION

An effective QA program requires prompt and thorough correction of nonconformances affecting quality. Rapid and effective corrective action minimizes the possibility of questionable data or documentation.

Two types of corrective action exist: immediate and long term. Immediate corrective action includes the correction of documentation deficiencies or errors, the repair or calibration of inaccurate instrumentation, or the correction of inadequate procedures. Often, the source of the problem is obvious and can be corrected quickly. Long-term corrective action is designed to eliminate the source of problems. Examples of long-term corrective action includes the correction of systematic errors in sampling or analysis, or the correction of procedures producing questionable results. Corrections can be made through additional personnel training, instrument replacement, and/or procedural improvements.

All QA problems and corrective action will be documented to provide a complete record of QA activities and help identify needed long-term corrective action. Defined responsibilities are required for scheduling, performing, documenting, and assuring the effectiveness of the corrective action. This section describes the corrective action procedures to be followed in the field and laboratory.

The definition of field nonconformances as well as the corrective action procedures that will be used to eliminate any nonconformances are presented in the following sections.

Field Nonconformances are defined as occurrences or measurements that are (1) either unexpected or do not meet established acceptance criteria and (2) will impact data quality if corrective action is not implemented. Nonconformances may include the following:

- Incorrect use of field equipment
- Improper sample collection, preservation, and shipment procedures
- Incomplete field documentation, including chain-of-custody records
- Incorrect decontamination procedures
- Incorrect collection of QC samples

Field Corrective Action procedures will depend on the severity of the nonconformance. In cases where immediate and complete corrective action may be implemented by field personnel, corrective action will be specifically recorded in the field log book and summarized in the daily field progress report and site log book.

Nonconformances identified during an audit that have a substantial impact on data quality require the completion of a corrective action request form. This form may be filled out by an auditor or any individual who suspects that any aspect of data integrity is being affected by a field nonconformance. Each form is limited to a single nonconformance.

Copies of the corrective action request form will be distributed to the Project Manager, the Field Team Leader, the project QA officer, and the project file. The project QA officer will forward forms to the program manager and the QA program Manager as appropriate. Key personnel will meet to determine the corrective action. At a minimum the following will be considered:

- Determination of when the problem developed
- Assignment of responsibility for problem investigation and documentation
- Determination of the corrective action needed to eliminate the problem, including resampling or submission of duplicate samples for analysis
- Development of a schedule for completion of the corrective action
- Assignment of responsibility for implementing the corrective action
- Documentation and verification that the corrective action has eliminated the problem
- Determination of whether the Navy should be notified

Laboratory nonconformances may include:

- Unacceptable blank contamination results
- Unacceptable matrix spike results
- Unacceptable reported detection limits for samples from over-dilution
- Unacceptable duplicate results

Corrective actions may include:

- Review of gas chromatograph raw data and QC reports
- Re-analysis of extract if within holding time
- Reanalysis of duplicate samples
- Reanalysis of duplicate samples by a designated QC laboratory

The internal laboratory corrective action procedure and a description of out-of-control situations requiring corrective action are contained in the laboratory QA plan. At a minimum, corrective action will be implemented when control chart warning or control limits are exceeded, method QC requirements are not met, or sample holding times are exceeded. Out-of-control situations will be reported to the project analytical coordinator within 2 working days of identification. In addition, a corrective action report, signed by the laboratory director or project managers and the laboratory QC coordinator, will be provided to the project QA coordinator.

14.0 QUALITY ASSURANCE REPORTS

Reports will be prepared describing the results of the field investigation and resulting data and evaluation. Special laboratory QC reports may be required if corrective actions were taken. All reports will be subject to review and approval prior to delivery to the client organization. The review will be documented and retained in the project files.

REFERENCES

Canonie, 1990. Sampling Plan, Remedial Investigation/Feasibility Study (RI/FS), Navy Air Station (NAS) Alameda, California, Vol. 1. Prepared for NAVY-WESTDIV, February, 12, 1990.

PRC/Montgomery Watson, 1993. Data Summary Report, RI/FS Phases 1 and 2A, NAS Alameda, Final. Prepared for Navy-WESTDIV, August 1993.

FIGURES

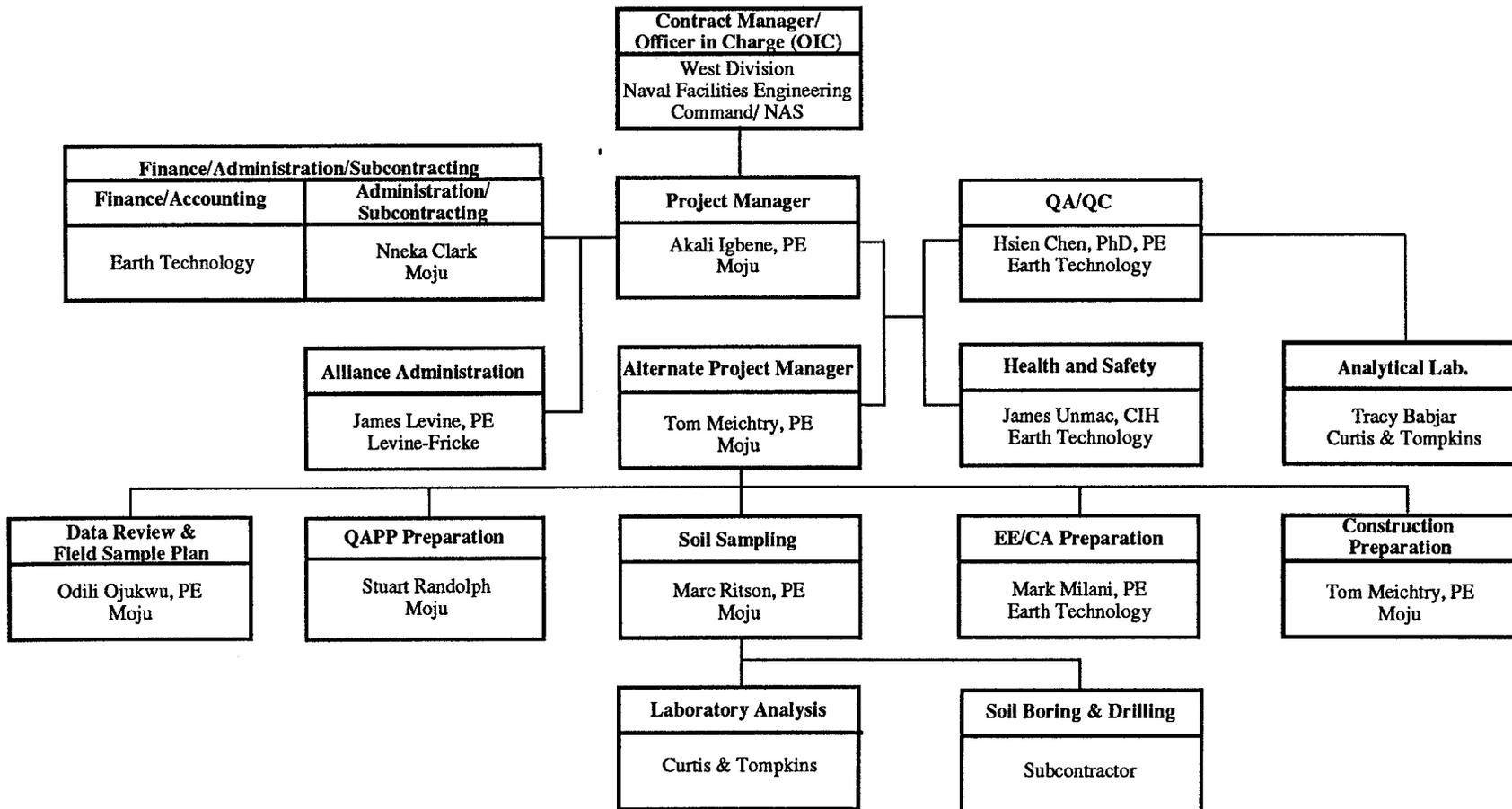


Figure 1
PROJECT ORGANIZATION

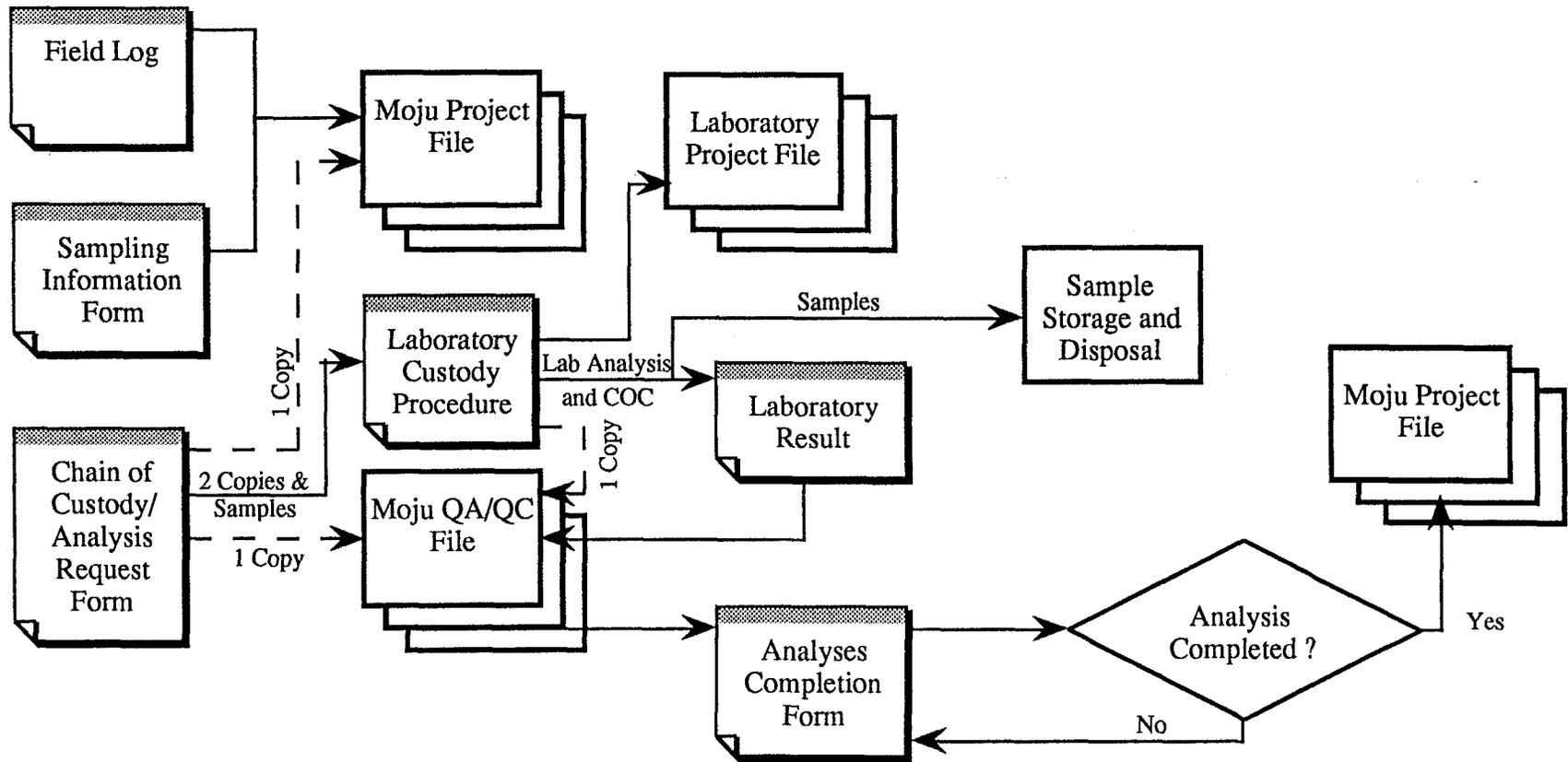


Figure 2
 SAMPLE CUSTODY DOCUMENTATION

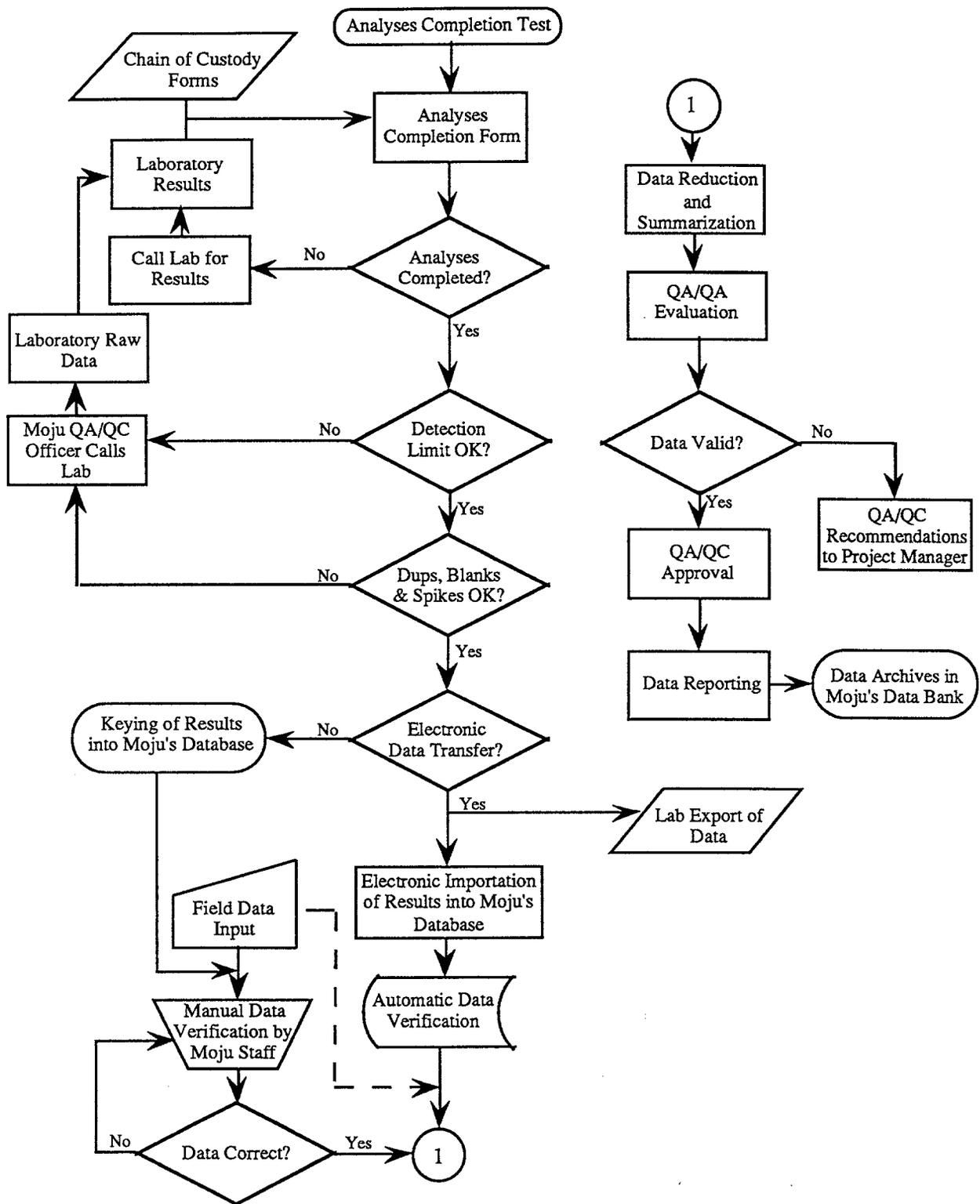


Figure 4
DATA VERIFICATION, VALIDATION, REDUCTION AND REPORTING

APPENDIX A

CURTIS & TOMPKINS, Ltd.

QUALITY ASSURANCE/QUALITY CONTROL MANUAL

Curtis & Tompkins, Ltd.

Laboratory Quality Assurance Manual (QAM)

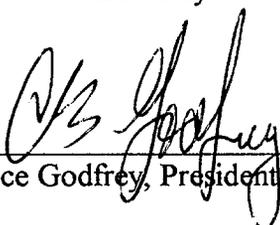
Version 3.1
March 15, 1995

A manual detailing the policies, practices, and procedures for insuring the quality of laboratory measurement data at the Berkeley and Irvine Laboratories of C&T.

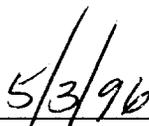
This manual is the property of Curtis and Tompkins Ltd.. Any reproduction in whole, or in part, for any reason is specifically forbidden. This QAM may be superceded by new revisions at any time. Please call either laboratory if there is a need to verify the status of this revision.

Berkeley 510-486-0900

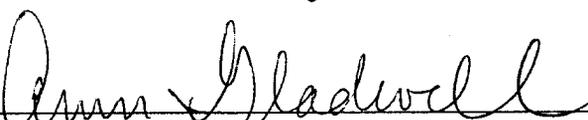
Irvine 714-252-9700



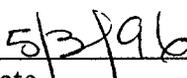
Dr. Bruce Godfrey, President, Curtis & Tompkins, Ltd



Date



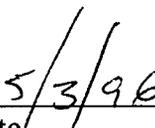
Ms. Ann Gladwell, Irvine Laboratory Director



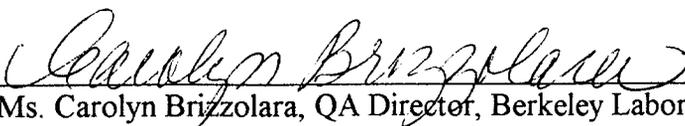
Date



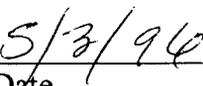
Mr. Chris Duncan, QA Director, Irvine Laboratory



Date



Ms. Carolyn Brizzolara, QA Director, Berkeley Laboratory



Date

Table of Content

1.0 INTRODUCTION	5
1.1 Mission Statement	5
1.2 Basic Policies	5
1.3 Communication & Interaction at C&T: "Rules of the Game"	6
2.0 SCOPE AND PURPOSE OF THE QA PROGRAM	7
2.1 Content	7
2.2 Purpose	8
2.3 Objectives and Scope	8
3.0 ORGANIZATION AND RESPONSIBILITIES	9
3.1 Organization	9
3.2 Responsibilities and Authority	9
3.2.1 QA Directors'	9
3.2.2 Group Leaders	9
3.2.3 Project Managers	10
3.2.4 Chemists and Analysts	11
Figure 3.1 Curtis & Tompkins Corporate Management Organization Chart	12
Figure 3.2 Berkeley Organization Chart	13
Figure 3.3 Irvine Organization Chart	14
4.0 PERSONNEL QUALIFICATIONS	15
4.1 Qualifications for Lab & QA Directors	15
4.2 Group Leader Qualifications	15
4.3 Chemist & Analyst Qualifications	16
4.4 Classroom Training	16
4.5 Functional Skills Training & Proficiency Demonstration	17
4.6 Other Training	17
5.0 FACILITIES, EQUIPMENT AND SUPPLIES	17
5.1 Laboratory Design	17
5.2 Facilities	17
5.3 Equipment	18
5.4 Data Management Systems	19
5.4.1 QA for Laboratory Information & Data Management Systems	19
5.5 Supplies	20
5.6 Preventative Maintenance	21

Table of Content

6.0 SAMPLE CUSTODY PROCEDURES	21
6.1 Sampling Procedures	21
6.2 Sample Custody	21
6.2.1 Sample Receipt	22
6.2.2 Sample Verification and Log-in	22
6.2.3 Sample Storage and Tracking	23
6.2.4 Sample Disposal	23
7.0 ANALYTICAL PROCEDURES & METHODS	24
7.1 Adherence to Accepted Methods	24
7.2 Method Selection	25
7.3 Calibration of Lab Equipment	25
7.4 Source & Working Standards: LIMS Standards Utility	25
7.5 Recording & Documenting Events & Activities in Lab Benchbooks	26
7.5.1 LIMS Logging of Benchbooks	26
7.5.2 Auditing Benchbooks	27
7.5.3 Types of, and uses for Benchbooks	27
7.5.4 Archiving Benchbooks	28
8.0 DATA QUALITY CONTROL & ASSESSMENT	28
8.1 Quality Control Limits & Acceptance Criteria	28
8.2 Instrument Calibration Criteria	28
8.2.1 Initial Instrument Calibration Criteria	29
8.2.2 Continuing Instrument Calibration	29
8.3 Batch QC	30 29
8.3.1 Batch QC Acceptance Matrix	31
8.3.2 Method Blank Acceptance Flowchart	32
8.4 Sample Quality Control	33
8.5 Audits and Scheduled Quality Assessments	33
8.5.1 Performance Evaluation Samples	33
8.5.2 Internal Audits	33
8.5.3 External Audits	33
8.6 Comparability, Representativeness and Completeness	34
8.7 Method Validation & Performance	34
8.7.1 Method Detection Limit Studies	34
8.7.2 Instrument Detection Limit Studies	34
8.7.3 Reporting Limits	35
8.7.4 Quantitation Limits	35



Table of Content

9.0 DATA REVIEW 35

 9.1 Peer Review Process 35

 9.2 Analytical Data Review 36

 9.2.1 Semi-Volatiles and Volatiles 37

 9.2.2 Metals and General Chemistry 37

 9.3 Peer Qualifications 38

 9.4 Group Leader Data Review, Reporting and Verification 38

 9.5 Data Entry 39

 9.6 Project Management Review 39

10.0 DATA STORAGE & DOCUMENT CONTROL 40

 10.1 Data Storage 40

 10.2 Data Security & fraud 40

 10.2.1 Integration Procedures: Controls for "Peak Shaving" 40

 10.2.1 "Time Travel" Controls 41

 10.3 Document Control Procedures 42

11.0 THE CORRECTIVE ACTION PROCESS 43

 11.1 Corrective Actions for Sample Analyses and Related Activities 43

 11.1.1 Sample Analysis QC Outside of Criteria/Not within Specified Range ... 43

 11.1.2 RTQC and Automated Exception Reporting: 44

 11.2 Corrective Action Notices 44

 11.3 When Sample Analyses Cannot Meet Acceptance Criteria 44

 11.4 Corrective Action for Systemic Errors 44

 11.5 Filing & Tracking Corrective Actions 45

 11.6 Auditing Corrective Actions 45

12.0 QUALITY ASSURANCE REPORTING & RECORDS 46

 12.1 Reports to Lab Directors & the President 46

 12.2 QA Directors' Planning and Review Reports 46

 12.3 President's and Lab Directors Performance Reviews of QA Directors 46

 12.4 QA Recordkeeping 47

Appendix 1: List of All C&T Standard Operating Procedures

 Table of Content..... 1

 SOP Catalog..... 4/15



1.0 INTRODUCTION

This is Curtis & Tompkins Quality Assurance Manual. Here we describe procedures, practices and philosophies for insuring data and product quality. The equally important aspect of client service quality is implicit in the text, but not explicitly stated here in terms of practices and procedures. We can only exist at the pleasure of our clientele. Satisfying their requirements for timeliness and professionalism in every aspect of their interaction with our organization is an essential part of our existence.

We, at C&T, are committed to a process of continuous quality improvement through employee participation. As a client driven organization, we strive to provide clients with a high quality product at a reasonable price. This manual outlines, for both clients and C&T employees, the measures taken to ensure and document data quality, monitor and assess quality activities, and the mechanisms which promote quality improvement.

The foundation of C&T's quality program is our employees and their participation in developing and improving data quality and productivity in light of ever changing client needs. C&T's organization is based on the concept of management participation in laboratory work and employee participation in management. Group leaders in all laboratory areas routinely perform analysis and employees are encouraged to participate on work teams formed throughout the laboratory in order to develop new products, resolve production or quality issues, and design and implement corrective actions, as required.

The following text outlines the core principles of our organization from which we have built a thriving business of more than 118 years duration.

1.1 Mission Statement

We are professionals in the chemical measurements business, for profit, and the satisfaction of our clients and staff. We strive to exceed our clients expectations while reporting results without bias. People are our greatest asset. We are committed to developing their capabilities in a challenging environment of personal and professional growth.

1.2 Basic Policies

We at Curtis & Tompkins will conduct our activities in accordance with the Mission Statement and:

1. We will conform to all laws and statutes of the communities in which we do business, and act with integrity and social responsibility in dealing with our employees, clients, suppliers, and the public.



2. We will provide employees with satisfying work, with performance judged objectively and reviewed at least once a year. We pay salaries equivalent to comparable market rates and promote from within wherever possible.
3. We expect a high ethical standard from our employees. We do not tolerate discrimination, sexism, or racism in any form or appearance.
4. We will maintain a stringent safety program for the protection of our employees and the public.
5. We will establish a professional management system with appropriate delegation, accountability, communication, and control.
6. We will maintain written corporate policies and procedures for adherence by all employees.

1.3 Communication & Interaction at C&T: "Rules of the Game"

High quality work begins with, and relies upon, good communication. Accordingly, to aid the quality improvement process C&T has developed and implemented the following rules for staff interaction. They are central to the success of the quality program.

1. Be willing to support our mission, vision, values, and policies.
2. Speak with good purpose. Listen actively and often.
3. Be open and honest in your communication with others.
4. Complete your Agreements. Be responsible to yourself and your coworkers.
 - a. Only make agreements you are willing and able to keep.
 - b. Clear up any broken or potentially broken agreements at the earliest appropriate time with the appropriate person.
 - c. Don't commit others unless you have their agreement.
5. If a problem arises, look first at the system, then the people, then take corrective action.
6. If you can't help the customer, help someone who can.
7. Have the willingness to win, and allow others to win. Commit to win/win relationships.
8. Focus on what works. Discard that which does not work.
9. Bad news does not get better with time. Don't shoot the messenger.



10. "Raise the flag" to seek help when you are overloaded, and offer help to others when you are able to.
11. Maintain a sense of humor.
12. Innovation is good. Risk it.
13. Be "proactive", generally, its better to ask forgiveness, than to seek permission.

2.0 SCOPE AND PURPOSE OF THE QA PROGRAM

2.1 Content

Curtis and Tompkins, Ltd. (C&T) provides a broad range of analytical testing services to industry, public utilities, engineering firms and other private and public sector clients. This Quality Assurance Plan (QAP) describes in detail the measures taken by C&T to ensure the reliability of the analytical data produced in the laboratories. Approved technical and procedural standards are a corner stone of our approach. C&T fundamentally relies on, and requires, the participation of all employees in the quality program to meet our goal of providing clients with technically and legally defensible data.

This Quality Assurance Manual (QAM) describes our QA program (QAP) and is one of many documents used by C&T to ensure quality work. This manual describes the program which is implemented at both laboratories with allowances for variations in practice contained in various site and project specific documents and workplans. The other documents and tools of C&T's quality assurance program include Standard Operating Procedures, Statement of Qualification (SOQ, lists key certifications, lab equipment available at each facility, specific expertise and project experience), client specific Quality Assurance Project Plans (QAPjPs), and Sampling and Analysis Plans (SAPs).

Quality in its absolute sense is defined as adherence to specifications. In the world of analytical chemistry, the QAP is aimed specifically at procedures for control of common errors including false negatives, false positives and misquantitations. The QAP is also implemented to insure appropriate, accurate and complete documentation of all events related to the measurement process.

C&T has a policy of establishing quality specifications which encompass limits and acceptance criteria for calibration events, accuracy (spikes), precision (duplicates), control samples for false positives (blanks) for every measurement procedure employed in its laboratories. This manual does **not** contain quality control specifications for the various testing products offered at C&T. These specifications are contained in the standard operating procedures for each specific testing method. References to specific documents, including revision status, and date implemented containing these specifications (SOP's) appear in the Appendix of this manual.



2.2 Purpose

An established QA philosophy and program are essential for consistent production of valid data. The QA program ensures that all data generated and reviewed and all reports, are produced and interpreted by trained, capable people following appropriate procedures.

Quality Control is the specific checks and measurements within the QA framework which are used to assess both the measurement system and the quality of the data produced. The specific QC requirements for each analytical procedure can be found in the appropriate SOP, but the program guidelines are established in this manual. Project specific QC requirements are established using QAPjPs and SAPs and will not be addressed in this manual except to state that when these requirements are in conflict with C&T's quality assurance program the client's requirements take precedence (if known prior to analysis of the samples).

This QAM establishes the standards that C&T adheres to and provides mechanisms to:

- Document the precision, accuracy, representativeness, comparability, and completeness of the analytical measurement systems and the data produced.
- Recognize deficiencies quickly and provide an efficient mechanism for correction.
- Monitor and control the management of data and to document its validity.

2.3 Objectives and Scope

The objectives and scope of the quality assurance program include:

- Scheduling of independent review and audit of all technical procedures.
- Coordination of QA and QC procedures which provide a documented, consistent level of quality for environmental measurements.
- Responsibility for documentation of all data generated, stored, and reported as technically valid and legally defensible.

3.0 ORGANIZATION AND RESPONSIBILITIES

3.1 Organization

Curtis and Tompkins, Ltd. consists of two laboratories located in Berkeley and Irvine, California. The laboratories are organized to facilitate sample management, analytical performance and management, and data reporting and management. The laboratories operate as individual units within an overall corporate structure which provides direction and support functions. Each laboratory is fully staffed, including an on-site QA Director who reports directly to the President concerning quality issues. This ensures the autonomy of the quality function because responsibility for operational performance is entirely separate.

The corporate structure appears in the form of an organization chart in Figure 3.1. The laboratory organizations are quite similar in the two laboratories. Figures 3.2 and 3.3 are organization charts of the Berkeley and Irvine laboratories, respectively.

3.2 Responsibilities and Authority

Quality assurance is supported at the highest corporate level by C&T's President, Laboratory Directors, and Operation managers. Recognition and support of QA at this level is of paramount importance to ensuring its effectiveness.

Development and implementation of QA policy is delegated by the President to the QA Directors at each facility who are responsible for directing the overall QA effort at C&T. The following positions in C&T's organization have specific clear responsibilities for the implementation of the QAP at C&T. Quality Assurance Directors, Group Leaders, Project Managers, Chemists and Analysts.

3.2.1 QA Directors' responsibilities include, but are not limited to:

- policy development, implementation, and review
- identifying, reporting, and coordinating the resolution of QA issues
- performance reviews and audits
- documentation and review of personnel training
- providing training to all personnel regarding QA and QC policies
- implementing QC procedures and monitoring performance on all data deliverables
- stopping work until QC problems have been corrected

3.2.2 Group Leaders a C&T equip and maintain a well trained and informed staff to meet the expectations of our clients by efficiently and profitably generating defensible data on time. The tasks



specifically attributable to Group Leaders in the implementation of the QA Program are specified below under each of their five defined core management responsibilities:

- **Planning**
 - Setting management goals & objectives
- **Staffing**
 - Training staff in key technical skills, eg instrument & software operations
 - Providing documentation of training efforts and PE/LCS sample analysis performance to QA Director and Chemists individual files as needed.
 - Providing performance feedback to employees on their QA responsibilities
 - Orienting staff to QA responsibilities & procedures within their group
- **Organizing & Directing**
 - Assigning staff to complete tasks and projects related to QAP implementation
- **Controlling**
 - Reviewing data for compliance & completeness, implementation of the peer review process within their group.
 - Writing and updating SOP's assuring current SOP's are available to Chemists & Analysts in their group and at their workstations.
 - Assuring the correct and complete implementation of the benchbook, run log, and maintenance log procedures.
 - Assuring compliance with the Calibration standards tracking and control procedures within their group
 - Completion and as needed, initiation of corrective action procedures
- **Technical Functions**
 - Assuring the implementation of preventative maintenance procedures for instruments and equipment.

Generally Group Leaders are responsible for understanding, communicating specific requirements to chemists and analysts in their group, and ensuring compliance with QAPJP's and specific aspects of C&T's QA Plan. They ensure that all data produced in their group complies with all C&T specifications for technically and legally defensible data.

3.2.3 Project Managers are responsible for the interface between clients and the laboratory. Accordingly, clear communication to all constituents including: Clients, Group Leaders, QA & Lab Directors, Chemists, analysts and field technicians is their most important responsibility.

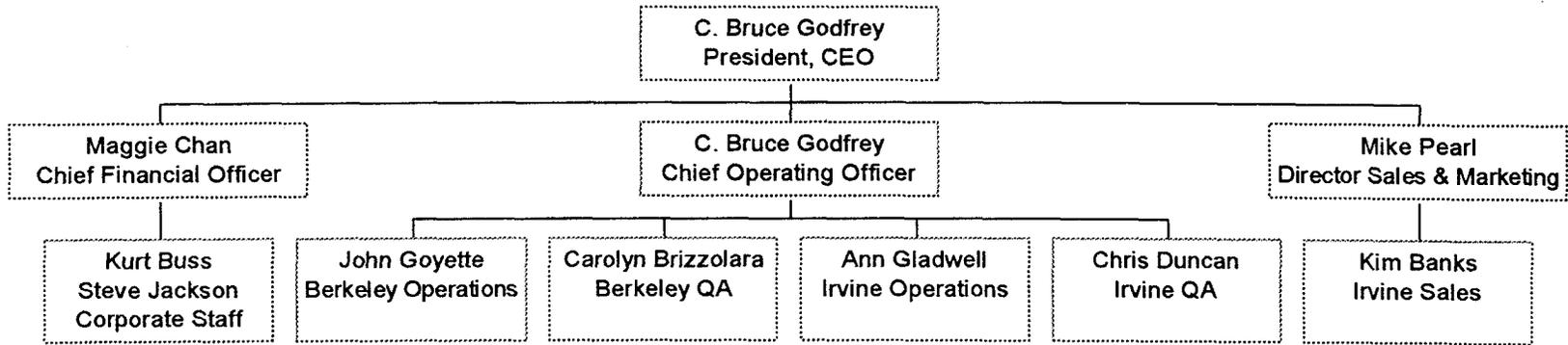


- Clear communication of client requirements to all affected individuals within the laboratory. Obtaining, by appropriate means, the required commitment of all relevant individuals to understand and agree to meet client requirements.
- Informing Lab and QA Directors of situations and issues, and recommending actions required to meet client needs and expectations.
- Reviewing data packages submitted by Group Leaders for compliance to Client requirements and QAPjP specifications. Compliance with Project Review SOP.
- Clear timely communication of the compliance status of work to clients either verbally, or through written reports such as case narrative or project management reports.

3.2.4 Chemists and Analysts are responsible for understanding and applying QA and QC procedures in the areas in which they are assigned and for seeking clarification as needed. C&T's QA Plan relies primarily on the ability of individuals performing analyses to do so in a manner that is technically and legally defensible. This demands attention to detail and a thorough understanding of the analytical process. Analysts receive formal training in the QAP during their orientation which is scheduled to be completed within their first 90 days of employment. As part of this process the following responsibilities are clearly communicated:

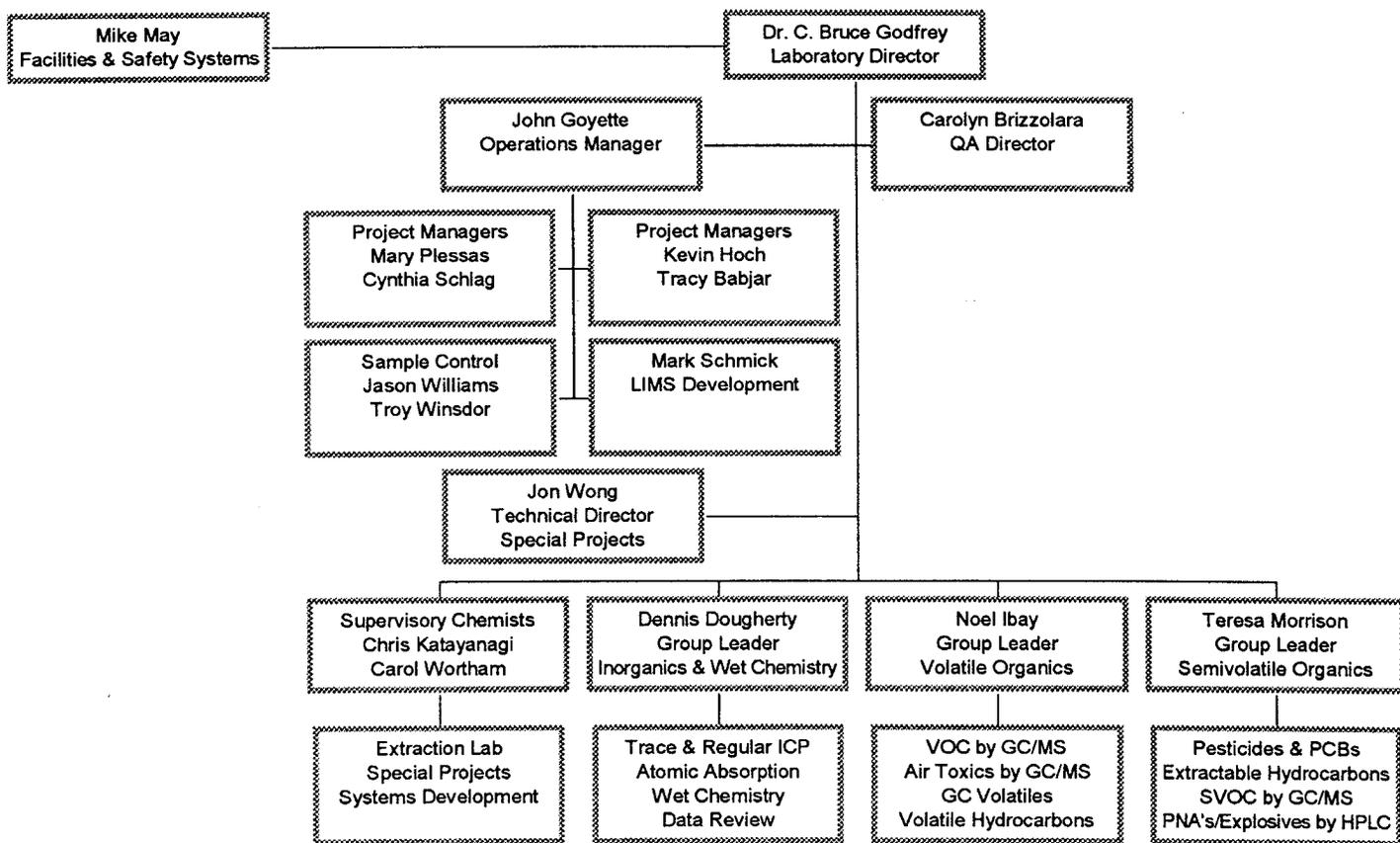
- Clear, legible and compliant entries into benchbooks, run logs and logbooks. Compliance with all procedures and specifications detailed in the SOP for Benchbooks entries.
- Clear and complete and compliant documentation of all significant events in the measurement process is a requirement. Significant is meant as any step required to reconstruct the process after the fact in order to detect an error or demonstrate compliance to procedure.
- To obtain from Group leaders or peers, a clear and complete understanding of QC compliance criteria for the tests and procedures they are performing.
- To inform Group Leaders or peers of their understanding of any situation which is out of compliance with the QAP such that corrective action is initiated, if required.

C&T Corporate Organization March 1995



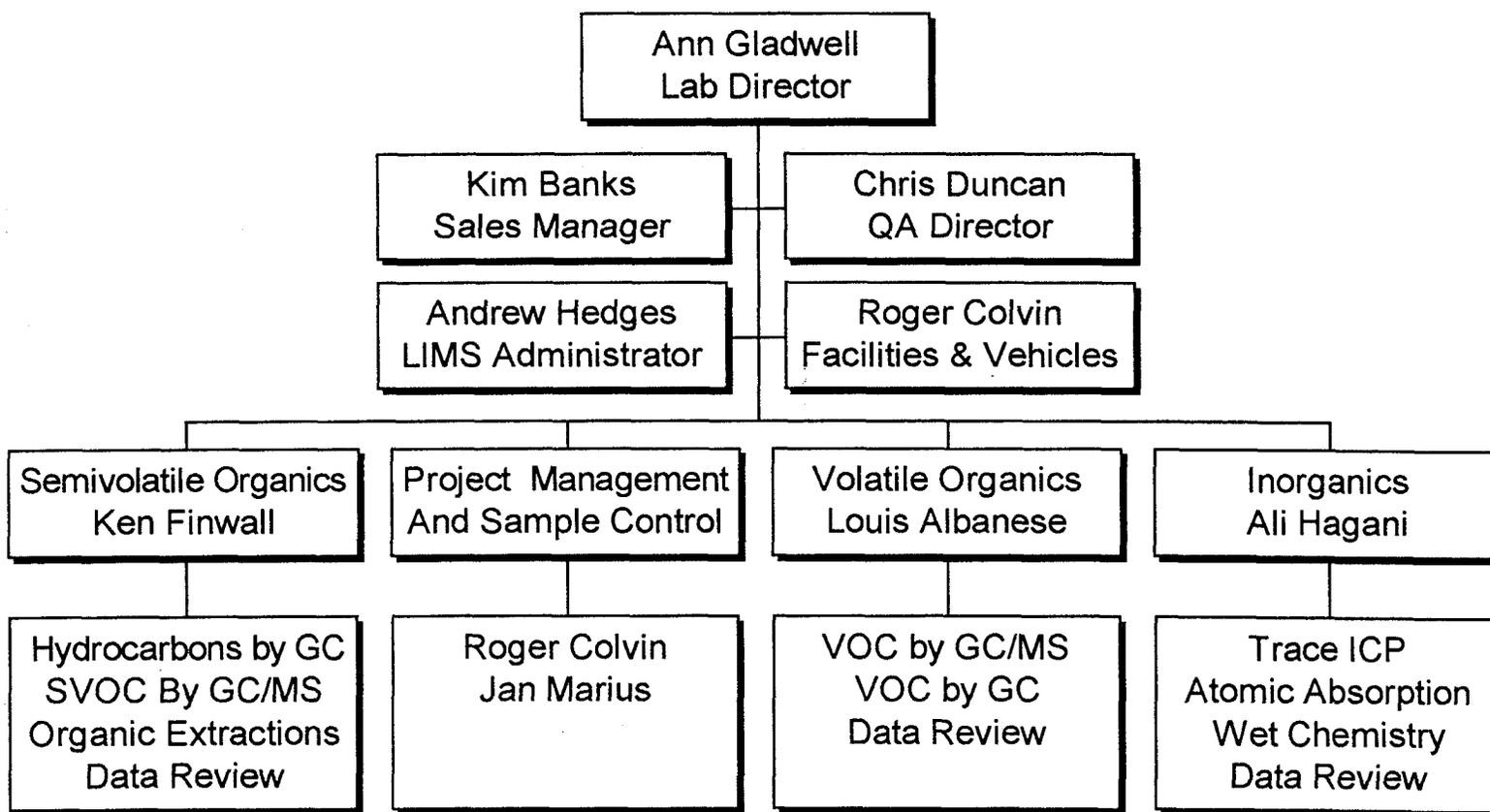
C&T Berkeley Organization

March 1995



C&T Irvine Organization

March 1995





4.0 PERSONNEL QUALIFICATIONS

The production of technically and legally defensible data can only be accomplished by well-trained personnel who are adequately educated in their technical and managerial areas and in QA/QC procedures. Specific requirements for key personnel are outlined below.

4.1 Qualifications for Lab & QA Directors, & Operations Managers

The minimum qualification for QA Directors, Laboratory Directors and Operations Managers are:

- A bachelor's degree and three years of experience in a related field or a master's degree and one year of related experience (three additional years of experience can substitute for the bachelor's degree).
- Proven communication skills.
- Proven management skills.
- Knowledge of the laboratory technical & business and relevant regulations.
- Laboratory Directors must have three years of experience directly related to laboratory management.

4.2 Group Leader Qualifications

Group leaders must have the following minimum qualifications:

- A bachelor's degree and three years of experience directly related to the activity they are supervising.
- One year of managerial/supervisory experience or two years of active participation within the existing group.
- Strong communication skills.
- Knowledge of applicable methodologies and systems under which the group routinely operates.
- Technical skills in computers and/or instrumentation relevant to the supervisorial area

4.3 Chemist and Analyst Qualifications

Analysts and chemists will range in experience from entry to senior level. We seek entry level employees for Chemist and analyst positions then we train them according to procedures and practices outlined in later sections of this chapter. We seek entry level chemists and analysts with the following skills and background.

- A bachelor's degree in chemistry or a related discipline.
- Ability to communicate (particularly about technical issues).
- A strong commitment to quality and teamwork.

4.4 Classroom Training

The quality of our results, responsiveness to customers, and efficiency throughout the organization depends on the competency of our staff. The way in which we address our mission statement "for the professional satisfaction of our staff" is largely manifest in our commitment and application of resources toward training and developing our people.

C&T has developed a Training Manual which outlines curricula and processes for formal training classes in the following areas:

- New employee orientation
- QA/QC Training
 - Fundamentals 1: Intro to QA Program
 - Fundamentals 2: Batch QC
 - Fundamentals 3: Calibration
 - Benchbooks, Logbooks and Documentation
 - Computer chromatographic integration procedures
- General methods and specific analytical procedures
- Management training
- Communication Skills
- LIMS System
- Laboratory Health & Safety

The training manual identifies specific resources, course content and outside workshops and meetings which have been approved for use in the development of our staff.

Periodic training is conducted to ensure that all staff maintain knowledge of current issues and practices in the laboratories. Selected personnel participate in managerial, QA/QC training or technical seminars, workshops and professional organizations.

4.5 Functional Skills Training and Proficiency Demonstrations.

In addition to the classroom type of training outlined above, C&T has developed and is implementing a workstation approach to laboratory skills training. Each group in the laboratory is broken down into workstations which typically comprise one test (for example Pesticides & PCB's by Method 8080), but may comprise many test (for example wet chemistry workstations). Workstation skills criteria have been developed with training and performance milestones. Group Leaders are responsible for providing or insuring training occurs. In many instances, senior chemists and peers provide training at each workstations. Performance criteria to demonstrate chemists competence to perform analyses at each workstation have been developed and are constantly refined. These criteria include successful analysis of PE samples and a series of Laboratory Control Samples at each workstation. The analyst proficiency demonstration criteria typically specify that an analyst must demonstrate adequate performance in the analysis of a minimum of four LCS and/or PE samples prior to performing measurements on samples with unknown analyte values.

4.6 Other Training

We at C&T are committed to providing the necessary training to ensure that our employees are abreast of changes in technology, QA procedures, and relevant environmental regulations. "Right to Know" and Hazardous Communication Programs are administered under the Safety Program and field personnel are required to complete all appropriate training (for example, OSHA 40-hour Hazardous Operations Certification).

5.0 FACILITIES, EQUIPMENT AND SUPPLIES

5.1 Laboratory Design

Curtis and Tompkins, Ltd. laboratories are designed for safety and to prevent contamination of samples, and are fully equipped to perform a wide variety of environmental analyses. The use of appropriate, well-maintained facilities, equipment and supplies is fundamental to the production of high quality data.

5.2 Facilities

Curtis and Tompkins, Ltd. maintains two laboratories which, taken together, consist of more than 40,000 square feet. The Berkeley and Irvine facilities are designed to facilitate sample handling, analysis, data management, and reporting. The Berkeley facility also contains the corporate support staff. Floor plans of the two facilities appear in C&T's Statement of Qualifications (SOQ)



5.3 Equipment

C&T uses state-of-the-art equipment for processing both samples and data. The proper working order and acceptable performance of our instruments and measurement equipment is of paramount importance to implementing a measurements Quality Assurance program. Procedures for calibration and maintenance of instrumentation ensure that our clients receive technically and legally defensible data. Method or instrument specific procedures are detailed in appropriate SOP's. C&T guidelines and method specific criteria established in SOPs require that each instrument be calibrated with traceable reference materials which are checked against a second source to prevent quantitation errors. Manufacturer recommended maintenance is performed and where applicable specific performance criteria are measured and documented at specified intervals.

SOPs which establish a system of Instrument and Maintenance logs has been designed and implemented to track calibration events, equipment utilization, and samples processed on each instrument. This system allows maintenance and calibration events to be documented for each instrument, provides instrument operators with historical information needed to quickly solve maintenance problems and conduct repairs.

C&T's LIMS system contains a comprehensive database of all equipment in use at each laboratory. The database treats each instrument as a system comprised of a collection of assets. Each asset is a discrete piece of equipment which typically can be interchanged with others of like kind to comprise another similar system. As example is a VOC GC/MS analysis system is comprised of assets including a Gas Chromatograph, a Mass Spectrometer, Purge & Trap Sampler, and possibly other component asset such as a stand alone PC data station, etc. The LIMS System Asset database contains detailed information on each component asset such as manufactured, model number, serial number, lab and room location, date entered into service and date retired if applicable.

Each instrument system at both laboratories has a unique identification and number which allows users of the LIMS system to identify the instrument used to analyze a sample or batch of samples. This electronic tracking system is a powerful adjunct to the system of bound instrument (run) logs and maintenance logs described above. The instrument ID system is a key to the sequence number ID system employed by C&T's LIMS which generates a unique ID number for every measurement processed by the LIMS. The 12 digit sequence number specifies the instrument system ID, date, time and temporal order relative to related measurements and calibration events.

Although currently inactive, systems have been designed to use this electronic equipment database application to schedule preventative maintenance events, automatically track calibrations, and list all samples, QC samples and calibration events processed by individual instruments.

The equipment available in each laboratory is constantly changing and is listed in C&T's statement of Qualifications (SOQ) for Berkeley & Irvine respectively. Contact the laboratory in your area if you require other information about our instrumentation and equipment.

5.4 Data Management Systems

Curtis and Tompkins, Ltd. has developed an advanced system of integrated local area networks (LANs) of computer hardware to automatically collect, reduce and distribute information and data throughout the laboratory. This integrated Laboratory Information Management System (LIMS) utilizes advanced distributed processing technology between UNIX, DOS and HP-RTE operating systems. The core of the LIMS system is a relational database UNIX/ORACLE network which provides sample tracking, results database, custom electronic and hardcopy reporting and data management services.

5.4.1 QA for Laboratory Information & Data Management Systems

C&T has designed and implemented a comprehensive complex computer network Laboratory Information Management System (LIMS) for the automated collection, processing, quality control, storage and archival of laboratory data. The primary functions of the LIMS are to provide rapid automated access to all data which are relevant to the measurement processes we conduct at C&T, and to automate as far as possible the data quality control and validation processes. This section describes specific quality assurance practices governing computerized data management which are crucially important to insuring the accuracy and integrity of our laboratory data.

The goals of C&T's LIMS QA program are:

- To insure computer processes and specific programming steps are appropriately and sufficiently documented.
- To insure that electronically reported and stored data reliably represent test results.
- To insure test results and other critical data are secure from unauthorized or inadvertent changes.
- To insure that automated data collection reduction and storage processes are in substantial compliance to government agency and industry recognized standards for ensuring data integrity in automated laboratory operations.

C&T's LIMS QA program is based on the following seven principles which define the necessary control issues underlying the automated collection and processing of laboratory data.

- **DATA:** Data corruption can occur at any stage from collection to recall. Acceptable programming control systems must provide evidence of reasonable protection from data corruption.
- **FORMULAS:** Formulas and programs must be verified by inspection. It is not safe to assume that test or decision criteria are correct.



- **AUDIT:** Critical transactions and processes should be designed with audit trails for logging transactions. The audit trail generally uses a password or equivalent to identify the responsible users or person(s). The LIMS components and system should be periodically inspected in-depth from raw data through final report.
- **CHANGE:** Program and process changes are a routine part of LIMS development and evolution, and must be documented. Change control procedures capable of tracking system operations, hardware and software changes should be established. Change procedures should include preinstall test protocols and appropriate document update routines.
- **STANDARD OPERATING PROCEDURES (SOPS):** Routine LIMS procedures are appropriately documented. These SOPs are for user training, and available, appropriate user documentation.
- **DISASTER:** Systems controls must incorporate planning for unusual events and system stresses. These include back-ups for prolonged total system failure, disk crashes, routine archiving, CPU and power supply failures.
- **SUPPLIERS & VENDORS:** laboratory instruments, data reduction systems, hardware, and/or software should meet agency guidelines (ie EPA's June 1990 draft US-EPA document: Automated Laboratory Standards, A Guide to EPA Requirements for Automated Laboratories or US-EPA-GALP's) for design, support, notification, and documentation criteria for the items they supply.

5.5 Supplies

Curtis and Tompkins, Ltd. is dependent on suppliers' capabilities to manufacture and deliver necessary items in a timely manner which conform to product specifications as agreed to by both parties. It is the group leader's responsibility to monitor supplier performance on these issues, ensure that incoming reagent checks and instrument verification are completed as needed and to initiate corrective action in the event of a performance failure.

Specific procedures have been written and implemented for screening solvents and reagents used in the measurement process. The screening of these supplies insures that they do not contribute artifacts which influence the measurement process. The screening of solvents and reagents, as well as the manufacturer and lot numbers of reagents and solvents are recorded as part of the measurement process.



5.6 Preventative Maintenance

Preventive maintenance is vital to the proper operation of analytical instruments and laboratory equipment. Routine, documented maintenance prevents unscheduled downtime and missed holding times or client due dates. It also increases the life span of most equipment. Some instruments and equipment at C&T is under service contract with outside suppliers or manufacturers. Routine maintenance tasks and intervals have been established for many of the instruments employed in C&T's two laboratories. Maintenance schedules and tasks for each instrument are maintained in bound instrument maintenance and run logs if applicable. Preventative maintenance if performed by C&T personnel is the responsibility of analysts, chemists and group Leaders. The documentation that maintenance has been performed and at what interval is to be available in the laboratory at or near the instrument, and available for review. by the QA Directors, auditors, or others.

Written SOPs and other procedures for preventative maintenance have been established for smaller equipment such as balances, pH meters, automatic pipettes, from larger more capital intensive equipment like ICP Spectrometers and Gas Chromatographs.

6.0 SAMPLE CUSTODY PROCEDURES

Data generation and processing begins in the field and proceeds in much the same manner as a physical sample through the laboratory. In a manner analogous to the travels of the sample, the data flows from one part of the laboratory to the next, with reviews at each stage. This chapter deals with the flow of data through the laboratory.

6.1 Sampling Procedures

In general, C&T receives samples collected by clients. C&T prepares sample containers for many of its clients in accordance with EPA requirements for container type, size and preservation. Technical assistance is available to our clients as needed. Project Managers and others at the labs provide up to date lists and information to clients regarding appropriate sample size, container type, preservation and holding time requirements for most parameters for both liquid and solid matrices.

At times, the C&T Sample Control Group is asked to perform a sampling event. In these instances a Sampling Plan is prepared and approved by the Project Manager and the client prior to sample collection. All Sample Control personnel are appropriately trained in these activities and receive the appropriate certifications (e.g., OSHA 40-Hour) prior to conducting a sampling event.

6.2 Sample Custody

All samples collected by and/or received at C&T are considered to be physical evidence and are handled accordingly. The possession of samples must be traceable from the time of sample collection until their final disposition. A sample is considered "in custody" when:



- It is in your actual possession.
- It is in your view after being in your possession.
- It is in a secure area.

The Sample Control Standard Operating Procedures define specific procedures for sample receipt, log-in, chain-of-custody, storage, and tracking throughout the analytical process. These procedures are briefly described below.

6.2.1 Sample Receipt

Sample shipments are received through a designated entrance at each laboratory. Sample Control Technicians verify the number of shipping containers being received against the number listed on the shipping manifest before signing the bill of lading. Any damage to the shipping container(s) or other discrepancy is noted on the bill of lading before signing it. A copy of this document is kept with the project file.

6.2.2 Sample Verification and Log-in

After a shipment arrives, a Sample Control Technician performs a sample inspection. Curtis and Tompkins, Ltd.'s Sample Control QA/QC Checklist (Figure 6.1) serves as a training tool and a checklist of procedures to follow. The checklist is kept as documentation when it is used or, alternatively, discrepancies are noted directly on the chain-of-custody. Specifics of the inspection include:

- Presence/absence of custody seals or tapes on the shipping containers and the condition of the seals (intact or broken)
- Presence/absence of a chain-of-custody
- Presence/absence of sample tags or labels
- Agreement between sample tags, the chain-of-custody and any other client documentation
- Condition of the samples when received (e.g., cold or ambient; intact, broken or leaking; headspace in VOA vials; etc.)
- Appropriate sample size (ie sufficient volume for analyses)
- Correct preservation (volatile samples are checked immediately prior to analysis, not on receipt).

If everything is acceptable the chain-of-custody is signed as verified. Any discrepancies are noted and the client is immediately notified. No work proceeds until the problem is resolved.

All samples are entered into the Laboratory Information Management System (LIMS) when they are received. A unique C&T laboratory number is assigned to each sample group and a sequential sample number is assigned to each sample within that group. The client's name, account number, location, telephone and facsimile numbers, analytical request, the date received, the date due, and storage location are entered into LIMS. A printout of this information is immediately generated which is attached to the client job jacket and stored in data management's active file until all analyses are completed.

6.2.3 Sample Storage and Tracking

After sample log-in, all samples are labeled with the laboratory number and stored under refrigeration at 4 C. Aqueous samples for volatile organic analysis are stored in a separate refrigerator. All locations are recorded.

All analysts and chemists follow internal chain-of-custody procedures to further ensure the validity of all data. All samples are signed out either by hardcopy or through LIMS in the Sample Custody Log when they are removed for analysis. The sample number, date, and analyst initials are recorded in this log. When samples are returned, the date, time, and analyst's initials are again required.

6.2.4 Sample Disposal

Samples are disposed of in accordance with the sample disposal SOP approximately thirty days after the final report date unless otherwise requested. The disposal date is recorded for closure of chain-of-custody. Samples are always disposed of in proper manner. The Laboratory Director is responsible overall for the safe and legal handling of all lab waste streams, including waste or residual samples. The Sample Control Group Leader is responsible for assisting the Facilities Manager implement these procedures.

Whenever possible, clients are requested to take back their samples. Transportation of the samples shall be arranged to insure proper safety precautions have been taken. If this is not possible the samples shall be classified according to the procedures listed below. The residual portion of all soil, water, wastewater and industrial waste samples is considered hazardous and or toxic for the particular testing characteristics for which they were submitted.

The hazardous and/or non hazardous status of all classified waste samples is determined according to Federal, State and Local regulations and exemptions. Residual portions of waste samples are stored in appropriate designated sample storage areas until samples are designated to be disposed eg walk-in refer or Delfield sample storage refers. Once designated for disposal, residual samples are



stored at the laboratory waste storage facility where they are drummed appropriately and transported off site and disposed of properly. Waste samples are stored in proper containers eliminating or minimizing the possibility of incompatible wastes contacting each other. Waste sample containers are clearly labeled on the top of the container as to their content and status. If either is unknown a reasonable explanation of the nature of the wastes shall be clearly visible on the container.

All sample waste transported off site is properly manifested and appropriate records are maintained to document the disposition of the waste when it leaves our facility. The Sample Control Group Leader and or Facilities Manager is responsible for these activities. The Facilities Manager or Sample Control Group Leader is responsible for selecting a TSD facility or similar service for all sample wastes handled at the laboratory. Names of qualified suppliers are filed and accessible. Waste treatment, storage and transportation to a TSD facility is fully documented and files will be stored for five (5) years. Reports of measurement of waste types, change in waste streams and other activities related to waste handling will be prepared by the Facilities Manager or Sample Control Group Leader quarterly.

Waste risk management and prevention shall be the practice of the company. Staff shall be regularly trained in waste handling practices. Standard operating procedures (SOPS) will be prepared for handling individual waste streams and unique situations. emergency response plans shall be developed by the laboratory Safety Officer to deal with contingencies of accident and uncontrolled hazard due to laboratory waste.

7.0 ANALYTICAL PROCEDURES AND METHODS

Analytical methods employed at C&T are generally EPA methodologies specified in the Code of Federal Regulations (CFR) including those found in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA Number SW-846 or other EPA manuals. At times, industrial methods are utilized to analyze for specific compounds or parameters for which no EPA methods exist. In these instances ASTM or other methods are used. Appropriate methods are used for air samples including NIOSH or other applicable sources.

7.1 Adherence to Accepted Methods

C&T's policy is to adhere strictly to the letter and spirit of compendial methods published by regulatory agencies (US-EPA SW-846) industry organizations (WPCF-SMWW), and standards organizations (ASTM or AOAC). Strict adherence to method performance parameters insures our clients receive a defined and recognized product, which will be legally defensible. Adherence to published recognized and accepted standard methods insures that C&T meet its goal to produce technically and legally defensible data.



Periodically it is necessary to modify compendial methods to fit our equipment, the sample type received or to accommodate client requests and meet requirements. It is C&T's policy that whenever methods are modified either in the performance, acceptance criteria, or in any significant manner, the method reference on the client report will reflect the modification and the modification will be described. Major method variances require approval of regional EPA offices, or adherence to recently developed performance based methods criteria developed by US-EPA.

7.2 Method Selection

As a client driven organization whenever specified, C&T performs measurement services according to the methods our clients request. If the client requested method(s) is inappropriate, technically unsound, or if a substitute method will provide superior results, useability or service, C&T will recommend substitution. Project managers are most frequently involved in method selection processes. The Lab and QA Directors are also involved in and responsible for this process.

Criteria for selecting methods are multivariant. Method selection at C&T is guided by principles of data usability, and the data quality objective process. C&T endeavors to recommend methods which provide the accuracy, precision and regulatory defensibility required for the intended use of the data. It is our policy to insure clients are fully apprised of the utility of the data they purchase from C&T.

7.3 Calibration of Lab Equipment

The appropriate calibration of all instrumentation and equipment is crucial to the validity of measurement processes. All C&T analytical SOPs specify calibration procedures by instrument type, calibration frequency, reference standards used, calibration acceptance criteria, and calibration documentation procedures. Specification requirements for calibration procedures and practices apply to all measurement process including instrumental (GC, GC/MS, ICP etc) and general chemistry methods (i.e., volumetric, gravimetric, titrimetric, etc.)

Procedures for assuring that balances, refrigerators, ovens, automatic pipettors, and other minor laboratory equipment are operating within measurable tolerances are established at each laboratory. Logs of all measurements are maintained by the designated group.

7.4 Source & Working Standards: LIMS Standards Utility

The acquisition, inventory, general preparation, shelf life, and use of calibration, surrogate, matrix spikings, and internal standards is documented and tracked. C&T has developed an electronic database utility within the LIMS for performing this task. Analysts are required to use this utility for logging, tracking, and reporting on the source, concentration and component identity of all calibration solutions used for measurement processes. The system consists of a source standards and working

standards database. References to registered lab benchbooks and page numbers are included for details of solution preparation.

7.5 Recording & Documenting Events & Activities in Lab Benchbooks

At C&T benchbooks are defined as either binders or bound laboratory notebooks which contain raw laboratory data, notes, and records of activities performed by individual chemists, or group activities. Typically and most frequently, benchbooks are bound paginated laboratory notebooks suitable for legally recording laboratory activities. Benchbooks are a vital and important part of proper laboratory documentation. The process of generating legally defensible data requires written documentation, many times this documentation must be in bound benchbooks. Computer print-outs must be generated and cataloged to document the contemporaneous properties of the information contained on our systems. In the modern computerized laboratory benchbooks serve three primary functions:

- Benchbooks provide a means to independently document the validity of data entered or contained in the LIMS using hardcopy data linkages.
- Benchbooks provide a mechanism for documenting events, procedures and observations which are not easily, or not yet established in the LIMS.
- The integrity of control systems associated with automatic data acquisition and digital storage is continually open to question by many of C&T's data users. Benchbooks provide a means of data traceability which lawyers and other officers of the court can understand.

Benchbooks can be important tools for the training and development of chemists. By recording observations and events, benchbooks provide a ready reference to professional experience. In spite of the advantage of the LIMS ability to link all data acquisition aspects of laboratory processes, providing swift and comprehensive means of relating data to events, many activities cannot be readily documented in the LIMS. Many clients require use of laboratory benchbooks to document activities and processes even if the practice is redundant in digital systems.

7.5.1 LIMS Logging of Benchbooks

Each benchbook must have a unique number traceable at both labs in the company. The Laboratory, location, department, status (active or inactive), function or purpose, and assigned individual must be logged onto the LIMS. If the benchbook is inactive, its archived location must be logged.

LIMS Benchbook Database Field Definitions

NUMBER: Unique number generated by the system for each book



DEPARTMENT:	Group or Department to which the book is assigned
LAB:	Lab Location, BK, IR
INDIVIDUAL:	Responsible Individual
LOCATION:	Room number or shelf
DESCRIPTION:	Function, description of the book's purpose or content
STATUS:	Active or Inactive

7.5.2 Auditing Benchbooks

The benchbooks are audited as part of the periodic internal audit procedure, and more often as part of training activities. Compliance to LIMS logging, content, use, clarity and reconstruction testing, and archiving are monitored.

7.5.3 Types of, and uses for Benchbooks

Benchbooks have several uses and users, the primary uses of benchbooks follows:

- Individual Analysts & all data generators are assigned a personal benchbook to record events and activities on an ongoing basis.
- Instrument Benchbooks: stored at or near the workstation or instrument to which they are assigned. These typically function to record balance calibration, pH meter operation, DI water system performance checks etc.
- Bound Instrument Logs: Are for recording any changes or adjustments to an instruments which are likely to affect performance, resolution, and/or detection of analytes. Examples include, calibration events, repairs, preventative maintenance, changes in configuration, detectors, columns, injection port liners, new lamps, source cleaning, instrument detection limit studies, and all other events of significance. The purpose of logging this information is to allow reconstruction of events for troubleshooting and error detection.
- Run Log, Binders and all notebooks. Computer printed data is essential to the benchbook documentation process. Critical hardcopy reports are dated and signed by analysts & chemists, in addition their content is referenced in a bound notebook to a sufficient level to document the validity of data in the computer output. Typical uses are instrument run logs and sample run tables from lab automation systems.
- Bound Calibration Standard Benchbooks: Are for recording the preparation of source, intermediate and working standard calibration solutions. These benchbooks are used for inserting (gluing) source standard certificates of traceability, content, lot # etc.

- **Bound Balance Calibration Logs:** These can be custom, paginated, preprinted spiral bound books as well as bound benchbooks. The data recorded in these books documents the calibration of balances for gravimetric and mass determinations. These data are used to track the accuracy and precision characteristics of the analytical and top loading balances we use.

7.5.4 Archiving Benchbooks

Once a benchbook is filled up, the analyst making the last entry in the book, or the individual to whom the numbered book is assigned, is responsible for returning the book to the QA Director who is responsible for implementing the benchbook archival procedure. Benchbooks which are removed from active service are deactivated in LIMS, where their archived location will be designated. The responsibility for maintaining the integrity and storage of the book(s) is transferred to the QA Directors and their designees in the Client Services group.

8.0 DATA QUALITY CONTROL & ASSESSMENT

Quality assurance as practiced at C&T consists of general quality control and assessment procedures that are adapted to the specific procedures throughout the laboratory. The use of a general framework which is then adapted to specific activities facilitates training and consistent data generation throughout the laboratory. Routine internal audits are employed to monitor the application of this framework within the entire quality program.

8.1 Quality Control Limits & Acceptance Criteria

Curtis & Tompkins, Ltd. employs EPA references such as SW-846, CLP SOWs and other references to determine the appropriate QC parameters for each measurement system. The C&T philosophy holds that laboratory quality control consists of a tri-level assessment system, each level with its own set of quality control measurements. The three levels are the instrument, the analytical batch, and sample specific quality assessment. Figure 8.1 details how this procedure works in the laboratory. In some cases, only one or two of the levels apply, but this concept is widely applicable in the laboratory. The following sections explain each level.

8.2 Instrument Calibration Criteria

A fundamental concept of the C&T philosophy is that in order to ensure accurate and precise data the instrument system must be demonstrated to be in working order. To this end calibration criteria, various instrument performance criteria, and similar measurements are made to assess the ability of the instrument system to produce data of acceptable quality.



8.2.1 Initial Instrument Calibration Criteria

First, the instrument is calibrated using traceable standard reference materials. Specific performance criteria on linearity, or curve fit, response factors and similar measurements are established and adhered to for each analysis (these criteria are detailed in the specific SOP). After the initial calibration meets criteria a standard from a second source is analyzed at a mid-level concentration. This is an initial calibration verification and is done to ensure that the standards used to calibrate the instrument were reasonably accurate. Agreement criteria must be met or the source of the problem determined.

8.2.2 Continuing Instrument Calibration

When the initial calibration is complete and verified, the analyst begins routine analysis. For most methods this includes the analysis of a specific number of samples followed by a continuing calibration verification standard to demonstrate that the instrument is still performing in a manner similar to when it was calibrated and an instrument blank to demonstrate that the instrument is free of "carry-over" or contamination. This provides the analyst with regular feedback regarding the performance of the system and the need for maintenance or re-calibration. In addition to calibration verification many instrument systems have other performance criteria which are also performed on a regular basis to demonstrate the ability of the instrument to measure the analytes of interest. Examples of these performance checks would be the tune criteria for mass spectrometers or the endrin/dieldrin breakdown criteria for organochlorine pesticide analysis.

Following the above outline the analyst can be assured that the measurement system is performing correctly. This is fundamental to the generation of data of known quality.

8.3 Batch QC

Samples are batched together by matrix and analyses requested for efficient data production in the laboratory. Each batch of samples (20 or fewer samples of the same matrix type prepared using the same reagents, standards and procedures in the same time frame) are processed with a set of specific QC "samples" which are used to assess the performance of the entire measurement process (sample preparation, analysis and data reduction).

Each batch contains a method blank to assess contamination and prevent false positive results. In the event that a method blank results in a value above the detection limit, the analyst uses the Method Blank Flowchart to determine the impact on the sample data in the batch.

To assess performance with respect to precision and accuracy the batch contains a Laboratory Control Standard (LCS) and matrix QC. An LCS is a reagent blank spiked with a representative selection of the target analytes and prepared and analyzed in exactly the same manner as the samples in the batch. This standard is free of any interferences from sample matrix or similar problems and



demonstrates the ability of the entire measurement system to recover the target analytes. Matrix QC consists of selecting one sample in the batch and analyzing a duplicate and spike of that sample. For organic analyses a spike and spike duplicate are generally used. The purpose of matrix QC is to obtain both precision and accuracy information. In the absence of sufficient sample to perform matrix QC two LCSs are prepared so that both precision and accuracy data are available.

Accuracy is expressed as percent recovery of the spike and is determined using the following equation:

$$\%R = \frac{\text{Spike Result} - \text{Sample Result}}{\text{Concentration added}} \times 100$$

Precision between two measurements is expressed as relative percent difference and is calculated as follows:

$$\text{Percent Difference (\%D)} = \frac{|\text{Result A} - \text{Result B}|}{(\text{Result A} + \text{Result B})/2} \times 100$$

Where A and B can be two sample results, two matrix spike results, or two LCS results. Acceptance criteria are established so that the analyst can rapidly assess the quality of the data. (Results near the detection limit, within five times, often demonstrate high RPD which does not invalidate the data because error near the detection limit of most analyses is greater than is expected for other measurements.)

With as many measurements as the laboratory performs and because acceptance criteria are based on a 99 percent confidence interval and the wide variety of matrix types that the laboratory receives, QC parameters do at times fail to meet acceptance criteria. In the event that a particular limit is exceeded the analyst must determine if the failure invalidates the entire batch. To facilitate this assessment the Batch QC Assessment Matrix is used to determine the disposition of the batch.

8.3.1 Batch QC Acceptance Matrix appears on page 31

8.3.2 Method Blank Analyses

Method blanks are used to control the presence of false positives which can arise from contamination at any point in the measurement system. Method blanks are required to be analyzed at a frequency of one per batch. The blanks are required to be comprised of all reagents and steps utilized in the method with the exception of sample. Typically, reagent water and kiln fired sand are used to substitute for liquid and solid matrices respectively. Acceptance criteria and problem solving for blank contamination is illustrated graphically in the method blank flowchart which appears on page 32.



8.3.1 BATCH QC ACCEPTANCE MATRIX									
+ = PASS									- = FAIL
CASE	1	2	3	4	5	6	7	8	
LCS - % REC	+	+	+	+	-	-	-	-	
MS,MSD -% REC	+	-	+	-	+	-	+	-	
MS,MSD - RPD	+	+	-	-	+	+	-	-	

LCS % REC: The analyte concentrations in a laboratory control standard (LCS) are determined within limits established for the method and defined in the SOP's as a percentage of the known concentration of the analyte(s) in the LCS. For example, measurements which determine analytes within 75% and 125% of the known concentration value(s) would be passable.

MS/MSD % REC: The Matrix Spike (MS) and Matrix Spike Duplicate (MSD) % recovery determinations demonstrate the accuracy of the measurement system on the sample matrices. The analyte concentrations in an MS and MSD are determined and compared to limits set in the SOP's for each method as a % of the known concentration of the analyte(s) added to the samples. Measurements which determine analytes within limit of the known concentration value(s) in both MS and MSD samples would be passable.

MS/MSD -RPD: The relative percent difference (RPD) of duplicate recovery measurements from the MS and MSD are determined and compared to limits set for each method as a measurement of the precision of the measurement system. Typically, RPD limits are set at 25%, thus duplicate recoveries from MS/MSD samples would need to agree to within 25% of each other for the precision of the measurement to be acceptable.

Possibilities, Evaluations and Acceptance Criteria for Batch QC Sample Measurements

Case 1: Batch QC data are acceptable.

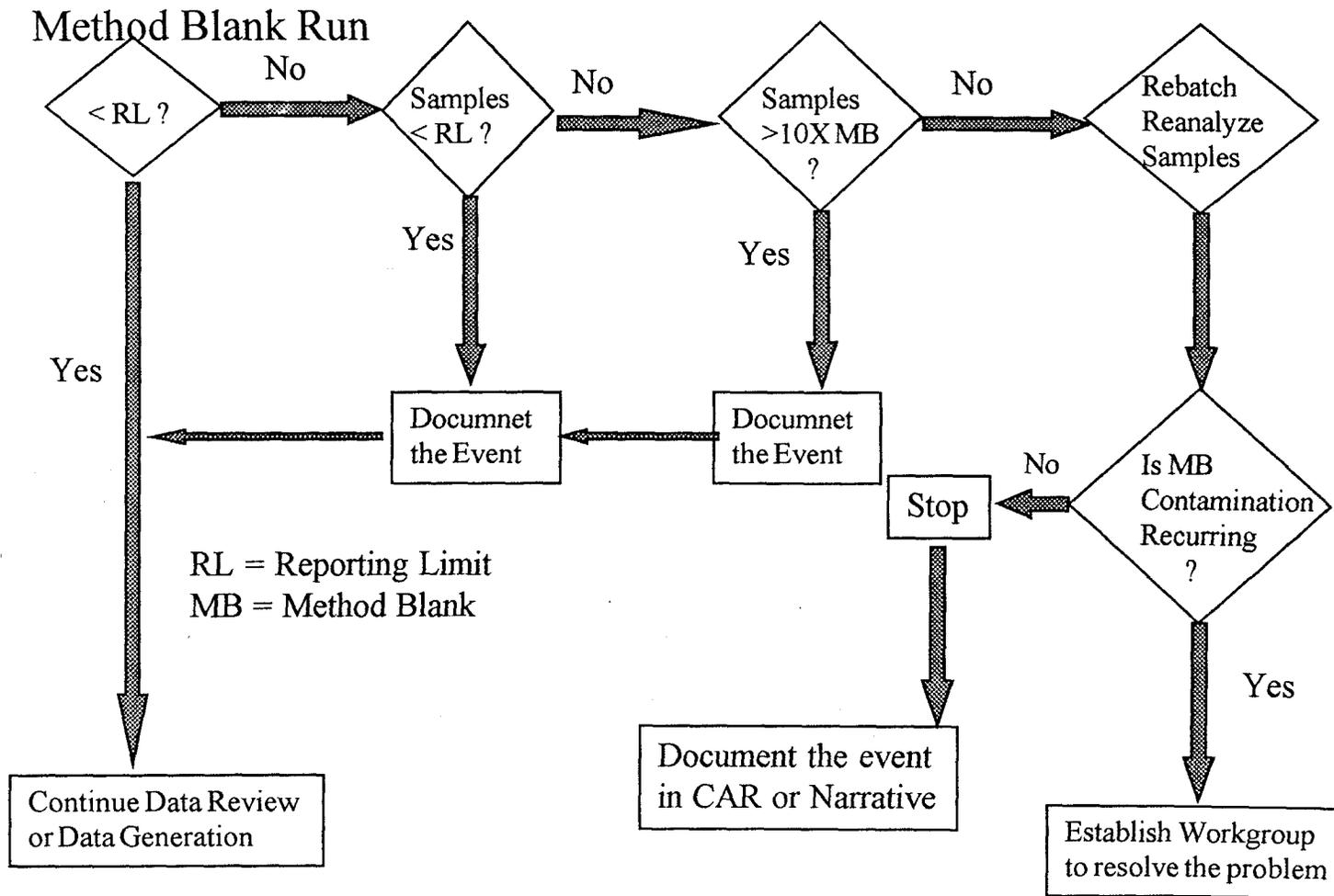
Case 2: Batch QC Data are acceptable; matrix effect confirmed.

Cases 3 & 4: Batch QC data are unacceptable. Data are rejected, all samples in the batch must be reextracted and reanalyzed unless sample matrix problem is determined and documented.

Case 5: Batch QC data are unacceptable. Data are rejected, all samples in the batch must be reextracted and reanalyzed unless isolated LCS problem is determined and documented.

Cases 6, 7 & 8: Batch rejected. Data are rejected, all samples in the batch must be reextracted and reanalyzed.

Method Blank Acceptance Flowchart



8.4 Sample Quality Control

In many analyses there are methods of determining the performance on particular samples. Surrogate spikes, a non-target analyte added to each sample and QC "sample" prior to extraction or sample preparation, assist with determining the accuracy of the analysis on a particular sample. Failure to meet acceptance limits results in the rebatching and reanalysis of a single sample. Repeated failure indicates that the sample result may be biased or the sample is not amenable to analysis by the method being used. Other sample specific controls might include precision between repeat injections, internal standard recovery (where this calibration technique is used) or sample background interference for atomic absorption measurements.

8.5 Audits and Scheduled Quality Assessments

In addition to assessing environmental data for precision and accuracy, C&T participates in several types of assessment programs.

8.5.1 Performance Evaluation Samples

Performance evaluation samples are obtained from certified sources (EPA and third party) and analyzed by C&T. The results are reported back to the agency or supplier who then evaluates the results against the known or true values and provides C&T with a performance report. These reports are used to determine corrective action and method development priorities and to demonstrate comparability of the data produced by C&T with that generated by other laboratories analyzing the samples.

Curtis and Tompkins, Ltd. participates in at least one performance evaluation study per quarter. This includes EPA WS and WP studies which are augmented by purchasing samples from third party suppliers. Many clients also send performance evaluation samples to the laboratory as part of project quality requirements.

8.5.2 Internal Audits

The C&T QA directors conduct internal audits semi-annually, at a minimum. In addition to scheduled audits, random audits of specific procedures or areas are an effective means of ensuring that QA practices such as method and SOP compliance and documentation is maintained at a high level at all times.

8.5.3 External Audits

External audits are performed by outside agencies, most particularly accrediting agencies such as the California Department of Health Services, Environmental Laboratory Accreditation Program (ELAP)

or the American Association for Laboratory Accreditation (A2LA). In addition, the laboratories are frequently audited by clients or their representatives as part of quality assurance project plans. The laboratories are dedicated to providing information to clients regarding procedures and QA practices.

8.6 Comparability, Representativeness and Completeness

Three less quantifiable quality criteria are comparability, representativeness and completeness of the data generated for a particular project. With respect to comparability of data, C&T's participation in performance evaluation studies which compare results among a number of laboratories demonstrates that the laboratory, given the same sample as another laboratory, can generate comparable data. Representativeness and completeness have to be assessed on a project level and relate to the Sampling and Analysis Plan. Completeness is usually defined by data users in specific project plans as the quotient of the total valid data acquired and delivered by the laboratory and the total amount of valid data expected. Laboratory duplicates provide an indication of the ability of the laboratory to select representative aliquots of the samples provided, but does not provide information regarding the representativeness of the samples taken for a project with respect to the scope of the project. This must be assessed by the project manager in cooperation with the client. The percent of data generated by the laboratory for a project which meets all analytical data quality objectives is just one measure of the overall data completeness for a project.

8.7 Method Validation

The implementation of a new measurement method requires the a Method Detection Limit study, valid initial and continuing calibration, and the compliant analysis of two laboratory control standards (LCS) and at least one PE sample from an outside source. The performance of this validation study must be on file at the laboratory, associated and supporting raw data shall be filed with the validation report or obtainable in the archive lab records. X

8.7.1 Method Detection Limit Studies

Method detection limit studies are required to be performed at periodic (annual) intervals to demonstrate the performance of the method to reporting and detection limits. C&T has established procedures for performing & documenting MDL studies.

8.7.2 Instrument Detection Limit Studies

For some equipment, ICP spectrometer Instrument detection limit studies are required to be performed at periodic (quarterly) intervals to demonstrate the performance of the method to reporting and detection limits. C&T has established procedures for performing & documenting IDL studies.

8.7.3 Reporting Limits

Reporting limits are defined as the detection concentration limits, above the method detection limit which we estimate the method will perform reliably in a given matrix, or the limits specified by clients below which the clients are not interested in receiving a measurement or determination. In the instance where reporting limits are client specified the reports must specify that ND means that the analytes were "Not Detected at or above the Specified Reporting Limits."

8.7.4 Quantitation Limits

Quantitation limits are defined as the detection concentration limits which are above the method detection limits but which have been determined in a specific matrix using the same procedures as the method detection limit but instead of employing water or kiln fired sand, the actual sample matrix is employed.

9.0 DATA REVIEW

9.1 Peer Review Process

Second party review is a fundamental principle of quality control for analytical data. At C&T we follow this principle through the application of a peer review program. This program is supplemented by Group Leader review as a training and management tool. All analytical results, whether generated by computer systems or through manual calculations, must be reviewed by a second party to prevent simple errors from being reported.

For all activities where analysts are entering data into the LIMS a second party review is required. Daily procedures such as sample digestion or extraction must be verified through the peer review of data. Infrequent or irregular procedures will also be subjected to second party review and files documenting this process must be maintained. All reviews must be documented by signing on the pre-printed "Reviewed by" line or through the use of the "Reviewed by" ink stamp which is available throughout the laboratory. (See Attachment 1 for an example of the stamp.)

General data package preparation and review is completed as follows: When an analyst completes a batch of data or a client job, he/she prepares the data package referring to the appropriate SOP. The analyst initiates a review checklist and verifies the contents and accuracy of the data package using the checklist as a guide. The analyst then signs off on the data package and passes it to a peer for review. This review includes a 100% verification of the original analysis, again using the checklist as a guide. Both the analyst and peer reviewer must be familiar with the data package requirements for the analysis (specifics are located in the appropriate analytical SOP) and have been designated as a peer reviewer by the group leader.

It is the responsibility of the individual performing a specific activity to secure a peer review of the task in a timely fashion. Group leaders are responsible for verifying that infrequent tasks are receiving review in a timely manner. Individuals using the data in the next step (analysis of extracts or digestates, or preparing reports) must verify that the data have been reviewed. If the review has not been done they must alert the responsible individual who must obtain review. Unreviewed data cannot be passed on to the next step in the process. An individual can request that the next person to utilize the information perform the peer review, but it is the party actually doing the work who is responsible for securing a second party review prior to the data proceeding in the system.

All data are subject to second party review within the group to prevent simple transcription or calculation errors. Both the analyst and reviewer must initial the data prior to sending it to the Group Leaders and ultimately the Project Managers for reporting. QA Directors are required to review at least 10% of the data packages generated at their laboratory.

9.2 Analytical Data Review

C&T's quality program requires 100 % peer review of all analytical data, and 10% of all data must be reviewed by the QA Director or his/her designee. The analyst completing the work is responsible for securing peer review prior to passing the data to the next step in the system (usual final report and client data package preparation). The Peer review process must include the following procedures:

- Each data package must include a review checklist which is initiated by the analyst performing the analysis. The first thing the peer reviewer must check is whether or not the review checklist has been completed by the analyst. If this has not been done the data package is returned immediately to the analyst for completion. It is not the responsibility of the peer reviewer to finish the work of the analyst.
- The peer reviewer then completes each step in the checklist. If a calculation is verified this is written directly on the raw data accompanied by a date and initial to demonstrate that the calculation was verified. Notes concerning the QC are recorded directly on the checklist. Any questions concerning the data is taken first to the analyst and then to the group leader if the analyst and peer reviewer cannot reach a consensus. All decisions regarding the data should be clearly documented. All QC outliers must be clearly documented, the reason for reporting the data logically stated, and the participating parties must initial and date the records.
- Every item on the checklist must be completed prior to the peer reviewer signing off on the data package. Unanswered questions must be taken to the group leader or other senior chemist for resolution prior to signing off on the data package. It is the responsibility of the peer reviewer, working with the analyst and group leader as necessary, to assure that the data is complete and reconstructible.



- When the peer reviewer is confident that the package is complete and correct, the checklist is finished by signing and dating in the appropriate space. The data package is then passed on to the group leader for review.

9.2.1 Semi-Volatiles and Volatiles

The sample preparation (extraction) associated with organic analyses utilizes method-specific bound notebooks to record all data associated with sample extraction and preparation. Alternatively, the process can be documented in LIMS and a batch report used as documentation of the extraction process. In either case a copy of the record is transferred to the appropriate analyst with the sample extracts and becomes part of the permanent record.

The Gas Chromatography (GC) and Gas Chromatography/Mass Spectrometry (GC/MS) analyses utilize either computer generated sequence files or instrument specific bound log-books for injection data. Computer generated quantitation reports, chromatograms, and/or mass spectra are filed by analytical batch number. The analytical and QC results are transferred to worksheets and reviewed by the analyst before submittal to the Group Leader or their designee who approves the data and transfers it to the appropriate project file where it is maintained. Data generated using an Infrared Spectrometer (IR) are maintained in a similar manner.

9.2.2 Metals and General Chemistry

The sample preparation (digestion) associated with metals analyses utilizes a bound notebook to record all data associated with sample digestion and preparation. A method number, designation of whether Inductively Coupled Plasma Spectroscopy (ICP), Flame Atomic Absorption (FAA) and /or Graphite Furnace Atomic Absorption (GFAA) digestion was performed is recorded by batch in the notebook. A separate logbook is maintained for all cold vapor atomic absorption spectroscopy sample preparation. A copy of the appropriate digestion logbook is transferred with the digested samples to the analyst and after that, with the analytical data to the Group Leader.

Records for metals and other inorganic parameters analyzed using automated instrumentation (ICP, GFAA, Lachat Autoanalyzer, Ion Chromatography, etc.) are maintained in analysis specific Run Logs. Computer printouts from these instruments and a copy of the run log are reviewed and initialed by the analyst prior to final review by the Group Leader or their designee. After this the data are transferred with each project to the project file where it is maintained.

All records for tests using non-automated general chemistry techniques are maintained in method specific notebooks. A copy of these notebook pages is submitted to the Group Leader for review along with the reduced, final result which is recorded on an analytical worksheet.

9.3 Peer Qualifications

It is clear that in order for the peer review program to function the reviewers must meet certain minimum requirements. Analysts new to a particular procedure are not qualified to complete the review of another analysts' work. Group leaders are responsible for determining if an individual has sufficient knowledge in a particular analysis to complete the review. Peer reviewers must be sufficiently proficient in the relevant procedure(s) to adequately complete the peer review process.

- Group leaders are responsible for determining the skills necessary for peer review of each analysis in their group. As it is the goal of the documentation to make the analytical process clear to an individual who has not actually performed the analysis it will not be necessary for all reviewers to be proficient analysts in each procedure. Familiarity with the appropriate SOP, EPA method, and QC criteria is a requirement.
- Group leaders are responsible for maintaining lists of peers for each analysis. Peers need not currently be assigned to the work group (many project managers can serve as peer reviewers if necessary for analyses in which they are trained) but must be familiar with the procedures and the SOP. It is the group leader's responsibility to provide sufficient training (and documentation of training) to have two peers available for every analysis within their group.

9.4 Group Leader Data Review, Reporting and Verification

Group leader review is necessary to assure that the decisions made by analysts of different experience levels are acceptable. This review has two distinct parts:

Group leaders are responsible for determining that the review process has been completed appropriately and by qualified individuals. Any QC outliers which are to be reported must be reviewed by the group leader to assure that the logic is sound and expressed in an understandable manner. The group leader's initials and the date must appear by each explanation to confirm that the decision is acceptable. This level of review must be completed by the group leader for all data generated by the group.

In addition, group leaders must complete a complete review of 10 percent of the data generated in their group. This task can be done by the group leader serving as the peer reviewer on at least 10 percent of the data generated in their group. It is the group leader's responsibility to maintain a balance in this level of review, making sure that they review 10 percent of the data generated by each analyst to assure that on going training is provided to all analyst. This review is documented in the same manner as regular peer review.

9.5 Data Entry

Final results and associated quality control are reported daily by analysts through the Group Leader and/or are keyed into the computer by Data Management personnel. Any QC results falling outside acceptable limits are appropriately flagged and an explanation included on the report.

After the results are verified by the data entry personnel, the sample is listed as data complete for that analysis. When all of the required analyses on all of the samples in a project file are complete, entered, and verified, a report is generated. At this point, the report is transferred to the appropriate project manager for final review.

9.6 Project Management Review

Each project is assigned to a Project Manager when the samples are received at C&T. This individual is selected based on the scope of work, familiarity with a particular client's requirements, laboratory workload, or, in some cases, upon the client's specific needs or requests.

The project manager is responsible for tracking the progress of the samples from the time they are logged into the laboratory, through analysis, and until the analytical data are reported to the client.

Once an analytical report is complete, the project manager reviews the final report against the following criteria:

- Reasonableness of data. The data are reviewed as to whether the results reported on various analyses are internally consistent. They compare analyses such as BOD and COD, and the amount of organic contamination reported; general mineral balances; volatile organics measured by different methods; TDS and specific conductivity; and other chemical relationships. They also compare data on samples within the same project file, and if descriptive information about the samples is available, may conclude that the results are reasonable in comparison with each other or known site history. In some instances the project manager will ask the laboratory staff to try to discover the source of a discrepancy. If the discrepancy cannot be resolved the client is informed.
- Accuracy in transcription of names, dates, sample number, results, and consistency in labeling throughout the report.
- Acceptability of QA/QC data. The project manager ensures that the QC data are within acceptance limits and that appropriate QC data are included in the final report. If a QC parameter is outside acceptance limits, the project manager ensures that an appropriate explanation is included in the report. This includes "flagging" data points and qualifying batches of data in case narratives. Project Managers, Group Leaders, Lab and QA Directors and Operations managers are authorized to flag or otherwise qualify data which do not meet QC acceptance criteria.



The final report is then received by the Laboratory Director. The report is generally signed by both the Project Manager and the Laboratory Director (or a designee). Questions about final reports should be directed to the project manager, or, when appropriate, to the laboratory manager.

10.0 DATA STORAGE & DOCUMENT CONTROL

All data and reports are archived on computer tape and in hard copy for storage within a secured building. These documents will be stored for a period of no less than five years. All hard copy data over a year old is stored off site for security and is accessible by box number on a database in LIMS.

10.1 Data Storage

Data at both laboratories are stored in a secure place on site for approximately one year after the date they were generated. After the one year period data boxes are cataloged by a third party data storage and retrieval firm, and transported to off site storage.

10.2 Data Security & fraud

C&T maintains controls to insure that the highest ethical practices are implemented at our laboratories. Effective procedures to control for the most common types of laboratory fraud rely primarily upon the individual integrity of the data generator. For this reason, we focus our training and efforts at defeating lab fraud on the individual. The following systemic control procedures have been developed to protect C&T and its clients from incidents of fraudulent data generation practices.

10.2.1 Integration Procedures: Controls for "Peak Shaving"

Spacewalking/Peakshaving is defined as the practice of inappropriately manipulating chromatographic peak integrations in Chromatography lab automation systems software (CLASS) for the purpose of making what would *obviously* be noncompliant data, adhere to specifications. *Spacewalking/Peakshaving* is usually confined to chromatographic peak integrations involving calibration data, surrogate and MS/MSD spike recovery data.

C&T conducts formal training classes to define the practice and clarify C&T policies, work rules and ethical issues involving CLASS data manipulation practices. The guidelines covered for this practice are outlined below.

Hardcopy raw data, printed for review and filing should contain, to the greatest extent practical, the integration limits and baseline information. C&T's policy is that manual reintegration of CLASS datafiles is a matter of professional judgement. We allow analysts to manually manipulate and reintegrate CLASS files within defined guidelines using professional judgement. Manual integration,

if performed, must follow a pattern of consistency. This guidance refers to the consistent treatment of similar files. For example, continuing calibration files should be integrated in the same fashion as initial calibrations. Surrogates and matrix spiking compounds in samples with similar matrix effects should be consistently integrated.

Files which are manually integrated must be flagged. If a CLASS data file is manually integrated it should, to the extent allowed by software, carry a flag to identify it as manually reintegrated. It is not permissible to alter, by deletion, the chromatogram. It is not permissible to change the CLASS data file to the extent that it does not conform to the definition of raw data. It is not permissible to delete peaks or "alter the picture" by deletion.

Unacceptable CLASS file manipulation is defined as an *obvious* manipulation of the chromatographic data for the purposes of obtaining a compliant result, when that result could *clearly and only* be obtained by an inappropriate manipulation of the data.

Standard Operating Procedures (SOP) for the method shall specify parameters for integration and conditions for manual modification of automatic integrator presets. Allowable manual reintroduction for the *sole purpose of improving the QC compliance data*, and only *for this reason*, is not permissible.

10.2.1 "Time Travel" Controls

"Time travel" is the practice of turning off a LAS or instrument control computer, resetting the date/time clock and performing an analysis at an erroneous date & time, for the purpose of meeting data quality objectives, usually holding time for samples.

The primary systemic control mechanism for time travel rests with two, and if needed three, separate timekeeping systems in the data collection process. The LIMS data collection systems are designed in a manner such that time travel cannot occur as a result of one person acting alone. The primary clock for datalogging at each C&T facility shall be the LIMS server (Sun SPARCstation) clock. LAS clocks ie HP-UX, HP-RTE, TJA-Thermospec, are secondary clocks, tertiary clocks are instrument control and acquisition computers or devices, ie PC's, connected to an LAS. Only those individuals authorized as Database administrators, logging on LIMS as superusers will have the required security clearance sufficient to set (or reset) the LIMS Server system clock. For valid data to be entered on the system at an incorrect time, both the LIMS clock and the data acquisition or LAS clock must be reset to within plus or minus 30 minutes of the same time. For this to occur, the User/Data generator and the DBA must operate together, simultaneously & in a conspiratorial manner.

10.3 Document Control Procedures

C&T has developed and is implementing a system of controls for documents to insure that current documents are in use, and that superceded documents are filed in appropriate records.

Title and Approval Page - Contains the title of the document, the appropriate revision number, the date the document was generated and two approval signatures.

If the document is an SOP is for analytical use within Sample Control, Volatile Organic, Semivolatile Organic or Inorganic areas, the SOP must be signed and dated by the Group Leader and the QA Director (or designees in their absence).

If the document is an SOP is for general office use, LIMS use or QA/QC purposes, the SOP must be signed by the Laboratory Director and the QA Director. The LIMS SOPs may be signed by the primary Data Systems Manager in place of the Laboratory Director.

Header Information - The header must appear on each page of the document following the Title Page and must contain the following information in this order:

Volume: Label or Number if applicable Refers to the book in which the document is found

Section Number: assigned using the Volume Table of Contents

Page Number: (e.g., 1 of 4, 2 of 4, etc.)

Revision Number: The first copy is revision 0, thereafter whole numbers are used

Date: the document was generated (or revised)

Filename: describing where that particular document can be found in electronic format

For standard Operating Procedures the following information is required to be included:

Title - Repeat the title at the top of the first page of the SOP. The title must be the same as it appears on the Title and Approval Page.

Scope - The scope should briefly (one or two sentences) describe the purpose of the SOP. For analytical SOPs it is appropriate to include applicable matrices and reporting limits.

References - Cite the references used in generating the SOP.

Variations - For analytical SOPs list deviations from the reference method.

Safety - List any special safety requirements or concerns that may be encountered in the performance of the procedure.



QC Requirements - List the QC requirements of the method (e.g., method blank, LCS, matrix spike, calibration, etc).

11.0 THE CORRECTIVE ACTION PROCESS

An effective Quality Assurance program requires rapid, effective and thorough identification and correction of issues and errors which affect data quality. Timely & effective action minimizes the possibility of producing data of unknown or insufficient quality. The Laboratory Director and the QA Director, with the concurrence of the Group Leaders, direct the corrective action when problems that affect product or service quality are identified.

Once a situation has been identified as producing marginal or non-compliant data, the cause of the problem must be identified. Corrective action requires defined responsibilities for scheduling, performing, documenting, and demonstrating the effectiveness of the action. It is the responsibility of the appropriate Group Leader to work with the QA Director to develop a plausible corrective action plan. The plan is tested, if possible, to determine whether the action results in the production of compliant data by eliminating the problem.

The overall goal of the corrective action process is to identify and permanently correct situations which lead to generation of errors in the measurement process. The documentation component of this process is implemented to record the samples affected by the situation, and as a managerial tool to facilitate correcting the errors in a timely manner.

A Corrective Action Report is used to document corrective actions plans and activities. The form may be initiated by any member of the C&T staff, but the plan itself must involve the QA Director and should involve any affected Group Leaders.

Data are not generated in a situation where questions concerning the data quality may exist unless the client has been informed of the situation and has dictated that course of action. The QA Directors have the authority and responsibility to require any activities which could compromise or have compromised data quality objectives to be discontinued or limited until corrective action is complete and quality is no longer compromised.

11.1 Corrective Actions for Sample Analyses and Related Activities

11.1.1 Sample Analysis QC Outside of Criteria/Not within Specified Range: When spike recoveries, duplicate %RPD, calibration response factors, sample loss, or other method specific QA procedures or criteria cannot be met by the analyst, corrective action must be initiated.



11.1.2 RTQC and Automated Exception Reporting: The LIMS system as it is progressively implemented will identify products which PASS or FAIL specifications. LIMS system FAIL notifications and case narratives will serve as corrective action notices.

11.2 Corrective Action Notices

For product evaluations which have not yet been automated, a corrective action must be initiated within 4 hours of detecting the out of control event. Corrective actions which can be completed within 48 hours need not be documented by a notice. Corrective action notices must be signed by the analyst the group leader, and, brought to the attention of the QA Officer. The corrective action notices are to be serially numbered, copies filed in the job jacket of the order(s) affected, and originals maintained by the QA Officer in three-ring binders in chronological order for a year.

11.3 When Sample Analyses Cannot Meet Acceptance Criteria

If corrective action cannot remediate an out of control sample analysis, and results of sample analysis are continually affected, the Operations Manager or Lab Director must notify the President. If in the Lab Director's judgement, results of sample analysis are affected, a summary of out of control QA procedures must be communicated to the client with the results of the affected analyses. The process outlined below for correcting systems must be initiated.

Many instances, methods and procedures designed for a wide variety of sample matrices do not (cannot) be completed to meet acceptance criteria. Typical examples of these conditions are matrix effects which prevent the achievement of surrogate recoveries, and matrix spiking accuracy and/or precision criteria. Data reported from testing activities which do not meet acceptance criteria must be flagged, annotated or otherwise qualified to the client receiving the data. Every effort must be made to clearly identify the reason the acceptance criteria could not be met and to report efforts made by C&T to achieve compliant results. Case narratives and notes columns on certificates of analyses are acceptable means of informing clients of analyses which could not be performed to meet established performance criteria.

11.4 Corrective Action for Systemic Errors

C&T has developed and implemented a process to identify and correct recurring errors, and those which arise from system design or implementation processes. It is the QA Directors's responsibility to manage and document the process.

1. Identify the problem: as briefly and clearly as possible, identify the problem or conditions which lead to the problem in writing.



2. Identify a responsible person or team of people who can be held accountable for the outcome of the corrective action. Select an individual(s) who is responsible and able by authority or ability to achieve the results desired.
3. With the input, feedback and general agreement of the responsible individual or task force, the QA Director will develop a written outline of what lab processes are affected and what actions needs to be taken.
4. Identify all steps which must be taken immediately: The Urgent and Important Actions and correct them with alacrity.
5. Set corrective action goals in writing with the following criteria addressed:

Responsible Party: One person who will be responsible for completing the task or realizing the goal

Timetable: a date when the action will be completed

Completed Specifications: What a corrected situation looks like

Priority: Where does this goal/task fit in with other tasks and responsibilities addressed by the responsible parties named to correct the error or system.

11.5 Filing & Tracking Corrective Actions

Each laboratory has established a system for recordkeeping and documenting the efforts and results of the system of corrective action outlined above. Generally, but not in every instance, copies of the completed corrective action forms will be filed at the workstation where the event occurred, and in the project file for associated affected samples. Corrective action notices and documentation of efforts will always be filed in completed corrective action notebook (or files) maintained at each laboratory by the QA Director.

11.6 Auditing Corrective Actions

The corrective action files and efforts will be periodically audited by the President and Lab Director at each facility. All corrective actions are subject to progress/completion checks during internal audits.

12.0 QUALITY ASSURANCE REPORTING & RECORDS

Each QA Director maintains sufficient records to furnish evidence of the day-to-day activities affecting quality in accordance with the requirements of the C&T QA Plan. Based on the results of internal and external audits, the C&T QA Directors prepare, reports as needed for Laboratory Directors, Group Leaders, and the President. Typical QA reports contain:

- Identified deficiencies and problems identified throughout the period or audit, and the action items, and results of monitoring efforts.
- Procedural problems that have affected quality results.
- Past due corrective actions, if relevant or applicable
- Objectives from any previous reports that were not achieved
- QA/QC objectives for the period

12.1 Reports to Lab Directors & the President

Any major problem that is not easily resolved at the Group Leader level, is brought to the attention of the appropriate laboratory management staff for resolution. Any time problems occur on a frequent basis, reports to laboratory management are made weekly or daily, as needed, until the situation is resolved.

12.2 QA Directors' Planning and Review Reports

Goal setting and reviews of priorities for personnel responsible to develop and implement the QAP are important Quality management tools. The QA Director is responsible to prepare periodic reports detailing shorter and longer term goals for the QAP at C&T. These reports are expected to summarize the periodic reports outlined above, report on monitoring results of corrective action plans, and identify and propose solutions to recurring problems if they exist.

12.3 President's and Lab Directors Performance Reviews of QA Directors

The President and the Lab Directors are expected to produce periodic reports on the design, development and implementation of the QAP at C&T. The performance reviews of QA Directors and the QAP, particularly the items which relate to the effectiveness of efforts taken by the QA Director to meet his or her responsibilities is an important component of the QAP at C&T.

These reports can be useful to identify the financial or managerial freedom or limitations and constraints placed on QA Directors in their efforts to implement the QAP. The "top down" report is



also a review of effectiveness from the individuals with ultimate authority and is a testimonial if nothing else, to their involvement with and commitment to the Quality improvement process.

12.4 QA Recordkeeping

Documenting the efforts undertaken by C&T staff toward implementing the QAP is a significant undertaking requiring skills in filing and document retrieval. The QA Director is responsible for filing documentation supporting the activities related to the QAP. Filing systems for the following reports, documents events and activities are the responsibility of the QA Director.

Corrective Actions

Method validation files

MDL Studies

Control Charts and Control Limit determinations

Standard Operating procedures

Benchbooks, Run Logs, Instrument Logs and other bound notebooks

Training files and participation records

Audits results and follow-up

Certification applications and approvals



Table of Content

QA STANDARD OPERATING PROCEDURES 4

- SECTION 1: Calibrations and Equipment 4
- SECTION 2: Auditing and Compliance Measurement 4
- SECTION 3: Performance Evaluations 4
- SECTION 4: Specifications and Corrective Actions 4
- SECTION 5: Documentation Procedures 4
- SECTION 6: Staff Training and Development 5
- SECTION 7: Miscellaneous Procedures 5
- SECTION 8: Definitions, Glossary and References 5
- SECTION 9: Procedures for Control Charting 5
- SECTION 10: EPA-RCRA Outline of Mandatory & Recommended QA Practices 5

VOC GROUP STANDARD OPERATING PROCEDURES 5

- SECTION 1: General Information 5
- SECTION 2: GC/MS Methods for VOC's 5
- SECTION 3: Extraction & Dilutions 6
- SECTION 4: AIR ANALYSIS: SORBENTS 6
- SECTION 5: AIR TOXICS 6
- SECTION 6: Low Level VOC's By GC/MS 6
- SECTION 7: Volatile Hydrocarbon Methods 6
- SECTION 8: VOC Methods By GC 6
- SECTION 9: Reserved for Expansion 6
- SECTION 10: Misc. Procedures 7

SEMIVOLATILE ORGANICS SOPS 7

- SECTION 1: General Procedures & Information 7
- SECTION 2: PHENOLS, PHTHALATES, PAH's 7
- SECTION 3: ECD Analyses: Pesticides, Herbicides and PCB's 7
- SECTION 4: GC-FID and GC-NPD Analyses 7
- SECTION 5: Extractable Hydrocarbon Methods 7
- SECTION 6: CLP Methods 8
- SECTION 7: HPLC Methods 8
- SECTION 8: Semivolatile Organics by GC/MS 8
- SECTION 9: LIMS & SVOC Data Systems Procedures 8



Table of Content

SVOC EXTRACTION LAB STANDARD OPERATING PROCEDURES 8

- SECTION 1: General Extraction Lab Procedures 8
- SECTION 2: Liquid Sample Extractions 8
- SECTION 3: Solid Sample Extractions 8
- SECTION 4: Waste Dilutions and Screening Methods 9
- SECTION 5: Sample Cleanup Methods 9
- SECTION 6: CLP Extraction Methods 9
- SECTION 7: PCB Extraction Methods 9
- SECTION 8: Sample Containers, Wipes & Polyurethane Foam Filters (PUFFs) 9
- SECTION 9: LIMS Procedures in the Extraction Lab 10
- SECTION 10: TEH Extraction Procedures 10

WET CHEMISTRY STANDARD OPERATING PROCEDURES 10

- SECTION 1: Wastewater Methods I 10
- SECTION 2: Wastewater Methods II 10
- SECTION 3: Wastewater Methods III 11
- SECTION 4: Drinking Water Methods 11
- SECTION 5: Physical Properties of Hazardous Waste 11
- SECTION 6: AIR 11
- SECTION 7: Food Methods 11
- SECTION 8: Instrument & Equipment Operation & Maintenance 12
- SECTION 9: Miscellaneous Methods & Specifications and Fuels 12

METALS PREPARATION & ANALYSIS STANDARD OPERATING PROCEDURES 12

- SEC 1: TCLP, WET, AND WASTE EXTRACTIONS 12
- SEC 2: RCRA DIGESTIONS AND DISSOLUTIONS 12
- SECTION 3: CERCLA/CLP DIGESTIONS 12
- SECTION 4: ICP ANALYSIS METHODS 12
- SECTION 5: COLD VAPOR AND HYDRIDE METHODS 13
- SECTION 6: GRAPHITE FURNACE AA METHODS 13
- SECTION 7: FLAME AA METHODS 13
- SECTION 8: DISSOLUTION AND ANALYSIS OF ORGANOMETALLIC COMPOUNDS 13
- SECTION 9: ANALYSIS OF TRACE METALS IN FOOD SAMPLES 13
- SECTION 10: Hex Chrome, Impinger Solutions & Air Filters 13
- SECTION 11: MISCELLANEOUS 13

Table of Content

LIMS & Datasystems SOP's & Documentation	14
Section 1: GALP Compliance SOP's	14
Section 2: LIMS Procedures	14
Section 3: LIMS System Software Architecture & Data Structures	14
Section 4: LIMS Systems & Software Diagrams	14
Section 4: LIMS Systems & Software Diagrams	15
Section 5: IDXL Programs	15
Section 6. Revision Control System	15

QA STANDARD OPERATING PROCEDURES

SECTION 1: Calibrations and Equipment		Filename	Rev	Date
1.1	Controlling Sample Refer VOC Contamination	RFR_BLNK	2	11-Sep-94
1.2	Calibration Standard Log/Prep	CAL_STD	2	03-MAR-94
1.3	Equipment Database	EQUIP_DB	0	21-Aug-90
1.4	Balance Calibration Procedures	BAL_CAL	2	18-SEP-94
1.5	Minor Equipment: pH, Cond, Refer	MINR_EQP	0	04-Sep-90
1.6	Pipet Calibration Check Procedures	PIPET	0	01-May-91
1.7	Solvent & Reagent Screening Procedure	SLVT_SCR	0	23-May-91
1.8	DI Water Specifications & Testing Procedures	DI_WATER	0	12-Jan-91
SECTION 2: Auditing and Compliance Measurement		Filename	Rev	Date
2.1	Total Quality Measurements	QA_MSMT	0	21-Aug-90
2.2	Auditing QA Program	AUD_QAP	1	06-Aug-91
2.3	Auditing Facilities	AUD_FACL	1	06-Aug-91
2.4	Auditing Wet Chem Group	AUD_WC	1	06-Aug-91
2.5	Auditing Metals Group	AUD_MET	1	06-Aug-91
2.6	Auditing SVOC Group	AUD_SVOC	2	18-SEP-94
2.7	Auditing GC/MS Group	AUD_GCMS	1	06-Aug-91
2.8	Auditing S&D Group	AUD_S&D	1	06-Aug-91
2.9	Auditing Subcontract Labs	AUD_SCL	0	13-Feb-91
2.10	Auditing the LIMS	AUD_LIMS	0	18-SEP-94
2.11	Audit Follow-up Procedure	AUD_FU	0	18-SEP-94
SECTION 3: Performance Evaluations		Filename	Rev	Date
3.1	Quarterly PE Samples	PE_SOP	0	17-Aug-90
3.2	Monthly QA Activity Reports: Under Revision	QA_RPT	0	17-Aug-90
SECTION 4: Specifications and Corrective Actions		Filename	Rev	Date
4.1	Determining Product QC Limits	QC_SPECS	0	21-Aug-90
4.2	Corrective Action Procedure	COR_ACTN	1	12-Sep-90
4.3	Specifying Sample Holding Times	HLD_TME	1	12-Sep-90
4.4	Determining Method Detection Limits	MDL_PROC	0	01-Jul-87
4.5	Corrective Action Notice Form	COR_NTCE	2	06-Aug-91
SECTION 5: Documentation Procedures		Filename	Rev	Date
5.1	Methods File Contents	METH_FLE	1	8-Aug-90
5.2	Reserved for Expansion			
5.3	Generating and Updating SOP's	SOP_SOP	2	8-SEP-94
5.4	Lab Benchbooks, Content & Filing	BNCHBOOK	0	04-Oct-90



5.5 Data Package Review Checklist	CHEK_LST	0	21-Aug-90
5.6 Data Review & Documentation Requirements	DOCM_REQ	0	06-Sep-87
5.7 Data Quality Levels: Reporting	QA_LEVL	0	24-May-90
5.8 Data Quality Levels: Selection Guidelines	QA_LEVL1	1	02-Aug-89

SECTION 6: Staff Training and Development

6.1 Reserved for Expansion

6.2 Analytical Methods & Skills Training

TRAINING 0 20-Apr-91

SECTION 7: Miscellaneous Procedures

7.1 Dishwashing Procedures

DISHWASH 0 13-Nov-89

7.2 Glassware Kiln Operation

KILN 0 01-May-91

7.3 Purge & Trap Glassware Cleaning & Maintenance

P&TCLEAN 0 12-Feb-91

SECTION 8: Definitions, Glossary and References

8.1 Definitions and Glossary of QA Terms

DEFINTNS 1 12-Jan-89

8.2 List of Reference Publications

8.3 List of Check Sample Programs

8.4 List of PE Sample Sources

SECTION 9: Procedures for Control Charting

9.1 SOP for Control Charting QC Data

CNTL_CHT 0 05-May-91

**SECTION 10: EPA-RCRA Outline of Mandatory & Recommended QA Practices
Manual for the Certification of Laboratories Analyzing Drinking Water,
Criteria and Procedures Quality Assurance, Third Edition**

VOC GROUP STANDARD OPERATING PROCEDURES**SECTION 1: General Information**

	Filename	Revision	Date
1.1 Calculating Various QA Parameters	MATH.DOC	1	21-Oct-92
1.2 Cleaning Purge & Trap Spargers	P&TCLEAN	1	28-Oct-92

SECTION 2: GC/MS Methods for VOC's

	Filename	Revision	Date
2.1 VOC'S by Mass Spec	8240_SOP	7	26-Jan-94
2.2 SW-846 Method 8240	SW-846 ED.3	1	DEC-87
2.3 SW-846 Method 8260	SW-846 ED.3	0	DEC-87
2.4 8240 QC Specifications	8240_SPC	5	26-Jan-94
2.5 VOC's by GC/MS-8260	8260_SOP	9	10-Oct-94
2.6 8260 QC Specifications	8260_SPC	4	26-Jan-94



SECTION 3: Extraction & Dilutions		Filename	Revision	Date
3.1	Methanol Extraction for Volatiles	MEOH_VOC	2	27-APR-93
3.2	TCLP Zero Headspace Extn	ZHE.SOP	1	21-Dec-93
3.3	Copy of Method 1311	SW-846		
SECTION 4: AIR ANALYSIS: SORBENTS		Filename	Revision	Date
4.1	Semi-Volatiles on Air Tubes	AIRBNA	0	14-MAY-90
4.2	Method T02-Volatiles on Tubes	AIRVOA	0	30-MAY-90
4.3	Sorbent Tube Preparation	TUBEPREP	0	14-MAY-90
SECTION 5: AIR TOXICS		Filename	Revision	Date
5.1	TO14: VOC's in Bags or Cannisters	T014_SOP	2	10-Oct-94
5.2	VOC's GC/MS by Direct Injection	GC_DIR	Under Development	
5.5	EPA TO14: Compendial Method			
5.6	Atmospheric (Gross) Gasses by GC	GROS_GAS	0	30-MAY-90
5.7	Method TO14 Specs	T014_SPC	0	16-AUG-91
5.8	Making Gas Phase Standards	GAS_PREP	0	16_AUG-91
SECTION 6: Low Level VOC's By GC/MS		Filename	Revision	Date
6.1	VOC's in Drinking Water	524.SOP	1	10-Dec-90
6.2	25 ml Purge Method	25ML.SOP	Under Revision	
6.3	Low Levels VOC's in Soils	LOW_SOIL	Under Revision	
6.4	524.2 QC Specifications	5242_SPC	1	4-OCT-92
SECTION 7: Volatile Hydrocarbon Methods		Filename	Revision	Date
7.1	TVH/BTXE	TVH_BTXE	2	15-Sep-94
7.2	Initial Calibrations TVH/BTXE	5PT.SOP	1	21-Dec-94
7.3	Preparing BTXE Calibration STDs	BTXEPREP	1	21-Dec-94
7.4	Cleaning PID Lamp	LAMPCLEN	1	21-Dec-94
7.5	TVH/BTXE QC Specifications	TVH_BTXE.SPC	1	10-Oct-94
7.6	TVH PE Nelson Program	TVH_PRN.DOC	1	10-Oct-94
7.7	BTXE PE Nelson Program	BTXE_PRN.DOC	1	10-Oct-94
SECTION 8: VOC Methods By GC		Filename	Revision	Date
8.1	Halogenated & Aromatics: 8010/8020	80108020.SOP	2	21-Dec-93
8.2	8010/8020 QC Specifications	80108020.SPC	1	4-Oct-92
8.3	8021 QC Specifications	8021_SPC.SPC	1	4-Oct-92
8.4	Screening Samples for VOC's by GC	SCREEN.SOP	0	8-Oct-94
SECTION 9: Reserved for Expansion				



SECTION 10: Misc. Procedures

- | | | |
|------|--------------------------------|------------------|
| 10.1 | Lab Waste Disposal & Handling | Facility SOP 2.2 |
| 10.2 | Glassware & Implement Cleaning | QA SOP 7.1 |

SEMIVOLATILE ORGANICS SOPS

SECTION 1: General Procedures & Information

1.1	Calculations using volumes and concentrations	MATH.DOC	1	29-OCT-92
1.2	Data Archive Room Directory	DATAARCH	0	16-MAY-94
1.3	GC Data Package SOP	GCPACK	1	24-SEP-92
1.4	Ordering Supplies	SUPLIES	1	03-NOV-93

SECTION 2: PHENOLS, PHTHALATES, PAH's

2.1	Method 8040 - Phenols by 8270	8040GCMS	0	08-APR-94
2.3	Method 8060 - Phthalates	8060GCMS	0	08-APR-94
2.5	Method 8100 Polynuclear Aromatic Hydrocarbons	8100GCMS	0	08-APR-94
2.6	Method 8040-Phenols by GC-FID	8040.SOP	1	20-Sep-93
2.7	Method 8040-Phenols-QC Specifications	8040.SPC	1	20-Sep-94

SECTION 3: ECD Analyses: Pesticides, Herbicides and PCB's

3.1	PCB Analysis by GC-ECD	PCB.SOP	1	08-APR-94
3.2	8080 - Organochlorine Pesticides and PCB's	8080_SOP	3	20-SEP-94
3.3	Method 8150 - Chlorinated Herbicides	EPA8150	2	07-MAR-94
3.4	8080- Pesticide & PCB QC Specs	8080_SPC	0	28-Sep-90
3.6	PCB-QC Specifications	PCBS_SPC	0	20-Apr-91
3.7	8150-Herbicides QC Specifications	8150.SPC	1	20-Sep-94

SECTION 4: GC-FID and GC-NPD Analyses

4.1	Organophosphate Pesticides	EPA8140	1	01-MAR-93
4.2	GC FID Analysis SOP	GC-FID.SOP	2	28-APR-94
4.3	Alcohols & Ketones By Direct Injection GC	Under Revision		

SECTION 5: Extractable Hydrocarbon Methods

5.1	Total Extractable Hydrocarbons (Low Level)	TEH.SOP	3	22-JUN-94
5.2	Total Extractable Hydrocarbons (Medium Level)	PRCTEH	1	28-OCT-92
5.3	TEH-Alaska DRO Method	DRO.SOP	0	22-SEP-94
5.4	TEH GC Maintenance	TEHMAINT.DOC	0	28-JAN-94
5.5	TEH GC Table	TEH_GC.TBL	0	09-SEP-94
5.6	TEH-QC Specifications	TEH.SPC	1	10-Oct-94

**SECTION 6: CLP Methods**

6.1	CLP Pests SOW 3/90	CLPPEST	1	23-FEB-93
6.2	CLP SVOC SOW 3/90	CLPSVOC	1	25-FEB-93
6.3	CLP Pest Data Package Checklist	CLPPESTD	0	23-NOV-92

SECTION 7: HPLC Methods

7.1	PAH by HLPC UV-FLUOR	EPA8310	1	20-SEP-94
7.2	Formaldehyde by HPLC: CARB	UNDER REVISION		
7.4	8310-PAH by HPLC QC Specifications	8310.SPC	1	20-SEP-94

SECTION 8: SemiVolatile Organics by GC/MS

8.1	SVOC by Method 8270	8270_SOP	3	17-OCT-94
8.2	Library Search Methods	LIB_SRCH	0	24-OCT-93
8.3	SVOC-8270 QC Specifications	8270_SPC	2	20-Sep-94

SECTION 9: LIMS & SVOC Data Systems Procedures

9.1	LIMSNAME	LIMSNAME	0	28-JAN-94
9.2	TEH Basic Program Documentation	TEHBASIC	0	26-OCT-94

SVOC EXTRACTION LAB STANDARD OPERATING PROCEDURES**SECTION 1: General Extraction Lab Procedures**

1.1	Sampling/Preservation Considerations	SW-846 Chapter 4		
1.2	Organic Extraction and Sample Preparation	SW-840 Method 3500		
1.3	Choosing the Correct Procedure	SW-846 Chapter 2		
1.4	Calculations & Dilutions	MATH.DOC	1	29-OCT-92
1.5	Extraction Lab Technical Skills	EXTTECH.EXT	1	20-JAN-94
1.6	GPC Quiz	GPCQUIZ.DOC	1	14-FEB-94
1.7	Surrogate List	SURROGAT.EXT	1	02-JUN-94
1.8	Ordering Supplies	SUPLIES.EXT	1	3-Nov-93
1.9	Extn Training Checklist	EXT_TRN.TRN	1	3-Nov-93

SECTION 2: Liquid Sample Extractions

	Filename	Rev.	Date
2.1	Separatory Funnel - Method 3510	EPA3510.EXT	1 24-JAN-94
2.2	Continuous Liquid-Liquid - Method 3520	EPA3520.EXT	5 05-MAY-94
2.2.1	Diesel Range Organics	UNDER REVISION	
2.2.2	Total Extractable Hydrocarbons	TEH50LL.EXT	5 23-JUN-94
2.2.3	TCLP/SVOC	TCLPSVOC.EXT	3 17-MAY-94
2.2.4	Polynuclear Aromatic Hydrocarbons	8310_W.EXT	0 25-JAN-94
2.3	EPA Manchester - Low Level PCBs	PCBLLH20.EXT	0 25-JAN-94
2.4	Micro-Extraction of EDB/DBCP - Method 504	EPA504.EXT	0 26-JAN-94

SECTION 3: Solid Sample Extractions



3.1	Soxhlet Extraction - Method 3540	EPA3540.EXT	1	25-JAN-94
3.2	Sonication Extraction - Method 3550	EPA3550.EXT	1	03-FEB-94
3.3	Diesel Range Organics-Alaska	DRO_AK.EXT	1	25-AUG-94
3.4	TEH-10 Sonication	TEH10_SC.EXT.	1	20-OCT-92
3.5	Polynuclear Aromatic Hydrocarbons	8310_S.EXT	1	23-AUG-94
3.6	8270+	ESI_8270.EXT	0	28-OCT-93
3.7	TEH- 10 ppm Shaker Table	TEH_10.EXT	2	02-JUN-94
3.9	Total Ext. Hydrocarb: 1 ppm Shaker Table	TEH_1.EXT	1	02-JUN-94

SECTION 4: Waste Dilutions and Screening Methods

4.1	Organochlorine Pesticide Waste	WASTE.EXT	1	24-JAN-94
4.2	CLP Screening Method	UNDER REVISION		
4.3	Waste Dilution - Method 3580	EPA3580.EXT	1	27-OCT-92

SECTION 5: Sample Cleanup Methods

		Filename	Revision	Date
5.1	General Cleanup Notes - Method 3600		SW-846	
5.2	Alumina Column Cleanup - Method 3610		SW-846	
5.3	Alumina Cleanup of Petroleum Waste - Method 3611		SW-846	
5.4	Florisol Column Cleanup - Method 3620		SW-846	
5.5	Silica Gel Column Cleanup - Method 3630		SW-846	
5.6	Automated GPC Cleanup - Method 3640		SW-846	
5.7	GPC Using ABC Model 1002A	EPA3640.EXT	3	16-FEB-94
5.8	GPC Using ABC Model AS2000	AS2000.EXT	1	23-AUG-94
5.9	Acid/Base Cleanup - Method 3650	UNDER REVISION		
5.10	Sulfur Cleanup - Method 3660	EPA3660.EXT	1	26-OCT-92
5.11	Silica Gel Clean-up of TEH Extracts	TEHSG.EXT	1	27-OCT-92

SECTION 6: CLP Extraction Methods

6.1	CLP PESTS in Water - SOW 3/90	CLPESTLL.EXT	1	25-JAN-94
6.2	CLP PESTS in Soil - SOW 3/90	CLP3550.EXT	1	25-JAN-94
6.3	CLP SVOC in Water - SOW 3/90	CLPSV_W.EXT	1	23-FEB-94
6.4	CLP SVOC in Soil - SOW 3/90	CLP_SV.EXT	1	23-FEB-94
6.5	CLP SVOC in Water by EPA 3520	CLPSVLL.EXT	1	25-JAN-94

SECTION 7: PCB Extraction Methods

7.1	Bechtel Low Level Water Method	BECHTEL.EXT	0	25-JAN-94
7.2	PCB Microextraction Technique	PCBMICRO.EXT	0	01-MAR-93
7.3	PCB Soil Extraction	PCB_SOIL	2	19-MAY-94
7.4	PCB-Soxhlet Extraction: Wood Chips	PCB_SOX.EXT	0	05-MAR-93
7.5	PCB Water Extraction	PCB_WATER.EXT	2	19-MAY-94
7.6	PCB's in Oil	PCB_OIL.EXT	1	19-MAY-94

SECTION 8: Sample Containers, Wipes & Polyurethane Foam Filters (PUFFs)

8.1	PAH's on PUFF's by Methods TO13	TO13.EXT	1	24-FEB-94
-----	---------------------------------	----------	---	-----------

8.2	Pesticides on PUFF's by Method TO10	TO10.EXT	1	24-FEB-94
8.3	Phenols & Cresols by Method TO8	TO8.EXT	1	23-FEB-94
8.4	PCBs in Wipe Samples	PCBWIPE	1	25-JAN-94
8.5	Semivolatiles in Wipe Samples	8270WIPE	1	19-MAY-94
8.6	Sample Jar and Bottle Extraction	ESSJAR.EXT	0	21-APR-94

SECTION 9: LIMS Procedures in the Extraction Lab

9.1	Extraction Lab Data Entry Screens	UNDER REVISION		
9.2	LIMS Login Procedure	LOGIN	1	19-MAY-94

SECTION 10: TEH Extraction Procedures

10.1	TEH Extraction Guidelines	TEHEXT.DOC	1	28-JAN-94
10.2	TEH Extraction Table	TEH_EXT.TBL	1	10-SEP-94
10.3	TEH FIQ Liquid/Liquid Extraction	FIQWATER	0	28-JUL-94
10.4	Burns & Mac TEH-10 Extraction	B&MTEH10	0	08-NOV-93

WET CHEMISTRY STANDARD OPERATING PROCEDURES**SECTION 1: Wastewater Methods I**

	Filename	Rev.	Date
1.1	Acidity, EPA 305.1	ACIDSOP	0 6-May-91
1.2	Alkalinity, 310.1	ALKALINI	0 21-SEP-90
1.3	Ammonia, EPA 350.2	NH3NSOP	0 16-Apr-91
1.4	BOD, SMWW 507		
1.5	CBOD, SMWW 507		
1.6	COD, EPA 410.1	COD_SOP	1 4-Mar-91
1.7	Chloride Residual, Total SMWW 408A	RESCLSOP	0 18-Jun-91
1.8	Cyanide Amenable To Chlorination SMWW 412F	AMENSOP	0 2-May-91
1.9	Fluoride, SMWW 413B	FLUORIDE	0 18-Jun-91

SECTION 2: Wastewater Methods II

2.1	Hardness, EPA 130.2	HARDNESS	1 7-MAR-91
2.1.1	Hardness by Calculation	HARDCALC	0 22-APR-91
2.2	Kjeldahl Nitrogen, SMWW 417D	TKNSOP	0 16-Apr-91
2.3	Oil & Grease, EPA 413.1		
2.3.1	QC Specs: Oil & Grease, EPA 413.1	O&G_SPEC	0 20-APR-91
2.4	Oxygen, Dissolved, SMWW 421F		
2.5	pH, EPA 150.1	PH_SOP	1 7-MAR-91
2.5.1	QC Specs: pH	PH_SPECS	0 20-APR-91
2.6	Phenols, EPA 420.1	PHENOLSO	0 1-May-91
2.7	Phosphorous, all forms	PO4_PSOP	0 01-NOV-90
2.8	Phosphorus, Total, EPA 365.2	PHOS_SOP	0 7-MAR-91
2.9.1	Total, EPA 160.3 (Solids)	TTL_RES D	0 6-AUG-90



2.9.2	Filterable, EPA EPA 160.1 (TDS)	FILT_RES	0	6-AUG-90
2.9.3	QC Specs: TDS	TDS_SPEC	0	20-APR-91
2.9.3	NonFilterable, EPA 160.2 (TSS)	RESIDUE	0	6-AUG-90
2.9.4	Settleable, EPA 160.5, (SS)	SET_RESD	0	6-AUG-90
2.9.5	Volatile, EPA 160.4	VOL_RESD	0	6-AUG-90

SECTION 3: Wastewater Methods III

		Filename	Revision	Date
3.1	Specific Conductance, EPA 120.1	ECSOP	0	11-APR-91
3.2	Sulfate, EPA 375.3			
3.3	Sulfide, Total & Soluble, EPA 376.1	SULFSOP	0	1-MAY-91
3.4	Sulfite, EPA 377.1			
3.5	Surfactants, MBAS, SMWW 512B	MBASSOP	0	1-MAY-91
3.6	Tannin & Lignin, SMWW 513	TANLISOP	0	2-MAY-91
3.7	Turbidity, EPA 180.1	TURBSOP	0	17-APR-91
3.8	Anions by Ion Chromatography	EPA300_0	0	30-JAN-91
3.8.1	QC Specs: Anions by IC	ANIONSPC	0	20-APR-91
3.9	Total Organic Carbon TOC, EPA 415.1	TOC	1	5-SEP-89

SECTION 4: Drinking Water Methods

4.1	Alkalinity, EPA 310.1	ALKALINI	0	21-SEP-90
4.2	Corrosivity, SMWW 203			
4.3	Hardness, SMWW 314B	HARDNESS	1	7-MAR-91
4.4	MBAS, SMWW 512B	MBASSOP	0	1-MAY-91
4.5	Total Filterable Residue, EPA 160.1	FILT_RES	0	6-AUG-90
4.6	Color	COLOR	0	6-AUG-90

SECTION 5: Physical Properties of Hazardous Waste

5.1	Ignitability, Flash Point, EPA 1010	FLASHSOP	0	1-MAY-91
5.1.1	QC Specs: Flash Point	FLASHSPC	0	20-APR-91
5.2	Corrosivity: pH; EPA 9040-9045	PH_SOP	1	7-MAR-91
5.3	Corrosivity toward Steel, EPA 1110	CORRSOP	1	11-APR-91
5.4	Reactivity, Sulfide & Cyanide	REACSOP	0	2-MAY-91
5.5	Flash Point of Solid Waste: BFI Method	FLSH_BFI	0	5-FEB-91
5.6	Heat of Combustion (BTU/lb)	BTU	0	6-JUN-91

SECTION 6: AIR

6.1	Silica on Filters	SILCA_IH	0	14-MAY-90
-----	-------------------	----------	---	-----------

SECTION 7: Food Methods

7.1	Moisture in Food, AOAC	MOIST_FD	1	7-MAR-91
7.2	Protein in Foods & Feeds	PROTEIN	0	7-MAR-91
7.3	Salt in Meats	SALT	0	7-MAR-91
7.4	Ash in Foods	ASH	1	7-MAR-91
7.5	Fat in Foods & Feeds	FAT	1	7-MAR-91

SECTION 8: Instrument & Equipment Operation & Maintenance

8.1 Operation of Gilford/Beckman UV-VIS	GILFORD	1	7-MAR-91
8.2 Operation of HP UV-VIS			

SECTION 9: Miscellaneous Methods & Specifications and Fuels

9.1 QC Specs: CLP Cyanide	CLPCNSPC	0	20-APR-91
9.2 TPH/Oil & Grease by Infra-Red	418_SOP	0	25-JAN-90
9.3 QC Specs: TRPH	TRPH_SPC	0	20-APR-91
9.4 QC Specs: Nitrate	NO3_SPEC	0	20-APR-91
9.5 QC Specs: Ortho-Phosphate	OPHOSSPC	0	20-APR-91
9.6 Temperature, EPA 170.1	TEMP	0	6-AUG-90
9.7 QC Specs: % Moisture, CLP SOW 9/91 ILMO2.1	MOISTSPC	0	20-APR-94

METALS PREPARATION & ANALYSIS STANDARD OPERATING PROCEDURES**SEC 1: TCLP, WET, AND WASTE EXTRACTIONS**

	Filename	Rev	Date
1.1 TCLP Extraction of Mixed Phase Samples	TCLP_BP	1	27-Jun-90
1.2 TCLP Extraction of Liquid Samples	TCLP_LIQ	1	27-Jun-90
1.3 Cal Title 26 WET: Solid Samples	WET_SLD	1	14-Jun-90
1.4 Cal Title 26 WET: 100% Liquid samples	WET_LIQ	1	14-Jun-90
1.5 Cal Title 26 WET: Mixed Phase Samples	WET_MXD	1	14-Jun-90
1.6 TCLP QA/QC Specifications	TCLP_SPC	1	01-May-91
1.7 TCLP Leaching Procedure	TCLP_LCH	0	22-Jun-90

SEC 2: RCRA DIGESTIONS AND DISSOLUTIONS

	Filename	Rev	Date
2.1 Method 3005: Liquid Digestion for ICP & FAA	3005_ICP	0	03-Jul-90
2.2 Method 3010: Liquid Digestion for ICP & FAA	3010_ICP	2	08-AUG-94
2.3 Method 3020: Liquid Digestion for GF-AAS	3020_ICP	2	08-AUG-94
2.4 Method 3050: Solids Digestion for ICP & FAA	3050_ICP	4	08-AUG-94
2.5 Method 3050: Solids Digestion for GF-AAS	3050_GF	3	08-AUG-94

SECTION 3: CERCLA/CLP DIGESTIONS

	Filename	Rev	Date
3.1 CLP ILMO2.1 9/91 Liquids Digestion ICP	CLP_DG_1	2	Revising
3.2 CLP ILMO2.1 9/91 Liquid Digestion for GF-AAS	CLP_DG_2	1	Revising
3.3 CLP ILMO2.1 9/91 Solids Digestion for ICP	CLP_DG_3	1	Revising
3.4 CLP ILMO2.1 9/91 Solids Digestion for GF-AAS	CLP_DG_4	1	Revising
3.5 CLP QC Specifications for Metals Analyses	CLP_SPEC	1	Revising

SECTION 4: ICP ANALYSIS METHODS

	Filename	Rev	Date
4.1 Method 6010: Metals Analysis by ICP	6010_SOP	1	11-Feb-91
4.2 CLP 9/91 ILMO2.1: Metals Analysis by ICP	CLP_ICP	1	Revising
4.3 ICP Metals: General Scanning Method	ICP_METL	0	05-Jul-90
4.4 Trace ICP Metals Analysis by 6010	6010_TRC	0	18-SEP-94

SECTION 5: COLD VAPOR AND HYDRIDE METHODS

5.1 Method 7471: Hg analysis in Liquid Samples	HG_SOP_W	0	23-Jul-90
5.2 Method 7471: Hg Analysis in Soil Samples	HG_SOP_S	1	20-Feb-91
5.3 CLP 9/91 ILMO2.1 Hg in Liquid Samples	CLP_HG_W	1	Revising
5.4 CLP 9/91 ILMO2.1 Hg Analysis in Soil/Solids	CLP_HG_S	0	Revising
5.5 Spreadsheet for Determining IDL's for Hg	HG_IDL	0	06-Feb-91

SECTION 6: GRAPHITE FURNACE AA METHODS

6.1 CLP 9/91 ILMO2.1 GF-AA Analysis of Digests	CLP_GFAA	1	Revising
6.2 SW-846 GF-AA Analysis of Sample Digests	7000GFAA	2	02-MAR-94
6.3 GF-AAS Analysis of digests & waters	GFAASCAN	0	25-Jul-90
6.4 GF-AA Run Tables: QC Specifications	GFAA_SPC	0	01-Sep-89

SECTION 7: FLAME AA METHODS

7.1 Analysis of Digests & Waters for Lead by FAA	PB_FAA	0	25-Jul-90
7.2 Determination of Lead in Hi Volume air Filters	PBFLTSOP	0	30-SEP-92

SECTION 8: DISOLUTION AND ANALYSIS OF ORGANOMETALLIC COMPOUNDS

8.1 Analysis of Organometallics in Oil Samples	DILT&SHT	0	25-Jul-90
8.2 Analysis of Organic Lead in Soil & Water	ORG_PB	1	26-SEP-92
8.3 Organic Lead QC Specifications	ORGPBSPC	0	20-Apr-91
8.4 ASTM D3683	D3683SOP	0	16-Nov-93

SECTION 9: ANALYSIS OF TRACE METALS IN FOOD SAMPLES

9.1 ICP Analysis of Nutritional Metals in Foods	NUT_MTLS	0	20-Apr-91
---	----------	---	-----------

SECTION 10: Hex Chrome, Impinger Solutions & Air Filters

10.1 Multiple Metals Stationary Sources (CARB 436)	DRFT_MTL	0	11-Nov-92
10.2 Analysis of Silica on Air Filters	AIR_SI	1	20-Sep-90
10.3 Analysis of Metals in Impinger Solutions	IMP_MTLS	1	20-Sep-90
10.4 Analysis of Metals on Air Filters by ICP	AIR_ICP	1	30-May-90
10.5 Method 7196: Hexavalent Chrome	CR6_7196	1	Revising
10.6 Method 7196: Hexavalent Chrome QC Spec	CR6_SPEC	0	20-Apr-91

SECTION 11: MISCELLANEOUS

11.1 Sample Digest Waste Disposal	WASTDISP	1	01-May-91
11.2			
11.3 Action Level Concentrations for Trace Metals	MET_MDLS	0	27-Jun-90



LIMS & Datasystems SOP's & Documentation

Section 1: GALP Compliance SOP's		Filename	Revision	Date
1.1	LIMS System Security	security.wpd	0	02-MAR-94
1.2	Defining Raw Data	raw_def.wpd	0	02-MAR-94
1.3	LIMS data entry specifications & controls	dtaentry.wpd	0	02-MAR-94
1.4	Data validation & verification	dataverf.wpd	0	02-MAR-94
1.5	Error codes & response action	err_code.wpd	0	02-MAR-94
1.6	Controlling data changes	dta_chng.wpd	0	02-MAR-94
1.7	Program verification & testing	softtest.wpd	0	03-MAR-94
1.8	Backup & recovery of LIMS data	backup.wpd	0	03-MAR-94
1.9	Preventative maintenance	prevent.wpd	0	03-MAR-94
1.10	Electronic Data Reporting	electrpt.wpd	0	03-MAR-94
1.11	Documenting LIMS Procedures	documnts.wpd	0	03-MAR-94
1.12	Archiving Outdated LIMS Procedures	sop_arch.wpd	0	03-MAR-94
1.13	Insuring Data Integrity: Time Travel	integ_tt.wpd	0	03-MAR-94
1.14	Insuring Data Integrity: Space Walking	integ_sw.wpd	0	03-MAR-94

Section 2: LIMS Procedures		Filename	Revision	Date
2.1	Batching Samples	batching.wpd	0	03-MAR-94
2.2	Generating Electronic Deliverables	edd_gen.wpd	0	15-AUG-94
2.3	Calibration Standards Utility	cal_stds.wpd	0	03-MAR-94
2.4	Asset/Instrument Tracking Utility	aset_mnu.wpd	0	03-MAR-94
2.5	Benchbook Database	bench_bk.wpd	0	09-MAR-94
2.6	Updating Detection Limits	idl_updt.wpd	0	09-MAR-94
2.7	Sequence Numbers	sequence	1	08-DEC-94

Section 3: LIMS System Software Architecture & Data Structures

3.1 Results Database "root & view" structure under development

Section 4: LIMS Systems & Software Diagrams		Filename	Revision	Date
4.1	LIMS Software Organization	LIMS_ORG.PPT	1	5-MAR-94
4.2	Seedpak 1 Applications	LIMS_ORG.PPT	1	5-MAR-94
4.3	CLP Metals Application	LIMS_ORG.PPT	1	5-MAR-94
4.4	LIMS System Components	LIMS_ORG.PPT	1	5-MAR-94
4.5	LIMS Software Tools	LIMS_ORG.PPT	1	5-MAR-94
4.6	Laboratory Data Management Scheme	LIMS_ORG.PPT	1	5-MAR-94



Section 4: LIMS Systems & Software Diagrams		Filename	Revision	Date
4.7	The Results Database	LIMS_ORG.PPT	1	5-MAR-94
4.8	Real Time Quality Control	LIMS_ORG.PPT	1	5-MAR-94
4.9	Automated Project Quality Assurance			

Section 5: IDXL Programs		Filename	Revision	Date
5.1	For Expansion			
5.2	IDXL Programs Inventory	idxl_inv.wpd	0	7-AUG-94
	Screen & Pump Programs Diagram	lims_org.ppt		
	IDXL Report Programs Diagram	lims_org.ppt		
5.3	Data pumps	lims_org.ppt		
5.4	Pump Program development	lims_org.ppt		
5.5	Report Program development	lims_org.ppt		

Section 6. Revision Control System RCS Software

- 6.1 Introduction to RCS commands
- 6.2 Programs to prepare files for RCS
- 6.3 Changing RCS file attributes
- 6.4 Merging RCS revisions
- 6.5 Freezing a configuration of sources checked in under RCS
- 6.6 Clean-up for working files
- 6.7 Comparing RCS revisions
- 6.8 Checking out RCS revisions
- 6.9 Check-in RCS revisions

APPENDIX B

FP-1

GENERAL FIELD PROCEDURES

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	OBJECTIVES	1
1.2	SCOPE	1
2.0	PLANNING	2
3.0	DOCUMENTATION OF FIELD ACTIVITIES	4
3.1	FIELD LOGBOOKS	4
3.1.1	Field Logbook Cover	5
3.1.2	Daily Entries	5
3.2	FIELD DATA SHEETS	7
3.3	PHOTOGRAPHS	7
3.4	CORRECTIONS TO DOCUMENTATION	8
4.0	FIELD CHANGES/CORRECTIVE ACTION	9
4.1	FIELD CHANGES	9
4.1	CORRECTIVE ACTION	11 12
5.0	CALIBRATION	14
6.0	DECONTAMINATION	15 16
6.1	NON-SAMPLING EQUIPMENT	16 17
6.1.1	Equipment Required for Decontamination	16 17
6.1.2	Heavy Equipment Decontamination	16 17
6.1.3	Downhole Equipment Decontamination	17 18
6.2	SAMPLING EQUIPMENT	18 19
6.2.1	Equipment for Decontamination	18 19
6.2.2	Sampling Equipment Decontamination	19 20
6.3	PUMPS AND PUMP ASSEMBLIES	20 21
6.3.1	Equipment Required for Decontamination	20 21
6.3.2	Pump Decontamination Procedure	20 21
7.0	DISPOSAL OF CONTAMINATED MATERIAL	22 23
8.0	HEALTH AND SAFETY	25 26
9.0	FORMS	26 27

1.0 INTRODUCTION

This document presents general procedures to be followed for various types of field activities.

1.1 OBJECTIVES

The objective of the General Field Procedures is to provide a standard method for planning, performing, and documenting field activities. This procedure addresses general requirements which are applicable to most field investigations. Requirements for each activity (drilling, trenching, sampling, etc.) are addressed in separate field procedures. Project-specific requirements will be addressed in the project Work Plan, Sampling and Analysis Plan, Health and Safety Plan, and other project documents.

1.2 SCOPE

This procedure covers the following activities:

- o Planning
- o Field documentation
- o Field changes and corrective action
- o Calibration and maintenance
- o Decontamination
- o Disposal of contaminated material
- o Health and safety.

2.0 PLANNING

Three types of planning documents are generally prepared for field investigations:

- o **Work Plan** - Describes the site history and summarizes existing information regarding the environmental setting and known or suspected contamination. Also describes investigation or remedial activities to be conducted at the site and the project management structure to be used to complete the project.
- o **Sampling and Analysis Plan (SAP)** - Summarizes data quality objectives and field procedures for installation of wells, boreholes, remediation systems, etc. Procedures to be used for sample collection, identification, and handling are identified. Quality assurance/quality control provisions for field and laboratory activities are identified.
- o **Health and Safety Plan** - Identifies known or suspected physical and chemical hazards at the site, action levels, required personal protective equipment, location of emergency medical facilities, and emergency response procedures. This document is prepared in accordance with "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities; NIOSH; OSHA; USCG; EPA; 1985)." All Health and Safety Plans will be reviewed by the Corporate Health and Safety Officer.

The Work Plan and SAP are prepared in accordance with EPA guidelines (guidelines for Conducting Remedial Investigations and Feasibility Studies Under CERCLA) or client documents. Another useful reference is "A Compendium of Superfund Field Operations Methods (EPA, 1987)."

The planning documents should incorporate standard Moju Environmental procedures and forms for recording data. The documents are prepared by the core project team and are peer reviewed within Moju Environmental for completeness and accuracy.

3.0 DOCUMENTATION OF FIELD ACTIVITIES

The purpose of documenting field activities is to: (1) provide a complete record of procedures as performed in the field, (2) permit accurate identification of samples and tracking of their status in the field during shipment and at the laboratory, (3) facilitate chain of custody and accountability procedures by providing legible, concise information, and (4) facilitate retention and completeness of project records. Inadequate information regarding field activities, including circumstances of the collection and handling of samples may diminish the usefulness of resulting data. Accurate sample and project records and proper chain-of-custody procedures are imperative, especially during investigations involving sites which may be subject to legal action.

3.1 FIELD LOGBOOKS

Field logbooks provide a daily handwritten record of all field activities at a site. The logbooks are permanently bound with sequentially numbered pages. They are a detailed daily record kept in real time for each activity at a site. Field logbooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during projects and to refresh the memory of the field personnel if called upon to give testimony during legal proceedings. In a legal proceeding, notes, if referred to, are subject to cross-examination and are admissible as evidence. The field logbook entries should be factual, detailed, and objective. Language should be clear, concise and free of personal interpretation or terminology which might be misconstrued.

A field logbook should be maintained for each field crew working on a site. Some projects (e.g., HAZWRAP) require that each field logbook be assigned in sequential number.

3.1.1 Field Logbook Cover

Label the front cover of each logbook with the following:

Project Name

Project Number

Location

Activity covered by logbook

Start date, and when complete, the finish date.

3.1.2 Daily Entries

The following steps must be followed when making entries in the field logbook:

1. Enter the day and date; time the task started; weather conditions; and the names, titles, and organizations of personnel performing the task.
2. Record the name, title, and organization of all visitors to the task area.
3. Describe all site activities in specific detail or indicate which forms were used to record such information (e.g., soil boring log or well completion log). It is good practice to duplicate the most important information in the field logbook, as well as on data forms. A sample data list is given below:
 - Wells and piezometers: elevations, reference elevation, total depth, size and length of casing and screen, casing and screen material, screen slot size, formation in which screen is installed, drilling conditions and rate, rig type, bit size(s), and detailed lithologic data.
 - Trenches, pits, and soil borings: excavation dimensions or borehole size and depth, sampling equipment or method(s), detailed lithologic data, and samples collected.

General Field Procedures
Procedure FP-1

- Soil gas and geophysical surveys: grid or line dimensions, probe or sensor spacing, depths, survey and recording equipment type and serial or identification number, and location of resulting data (e.g., strip chart, analog data record, computer file, and file name). Sketches are valuable additions to field notes and should be used where possible.
- 4. Describe in specific detail any field tests that were conducted. Reference any forms that were used, other data records, and the procedures followed (e.g., Field Procedure FP-8, Surface Water Discharge Measurement) in conducting the test. It is good practice to duplicate important data in the field logbook, where possible. If the final results of any field activity are obtained in the field, these data should be annotated in the field logbook.
- 5. Describe in specific detail any samples collected and whether splits, duplicates, matrix spikes, or blanks were prepared. Reference the procedure(s) (e.g., FP-10-1 Soil and Rock Sampling, and Field Sampling and Analysis Plan) followed in sample collection or duplicate, and blank preparation. List all sample numbers, type of sample matrix (e.g., soil, groundwater, etc.) date and time of collection, personnel collecting samples, sample type (composite, split, etc.), and shipment number and date.
- 6. List the time, equipment, and crew involved in decontamination efforts and identify the decontamination process used. Decontamination Record, F-1022, is available to record this type of data.
- 7. List all instrument calibrations, person(s) performing calibration, and the page number of the calibration log that provides specific information on calibration procedures and results when the calibrations occur in the field. If not referenced, detailed calibration information shall be recorded in the field logbook. Projects may require maintenance of a separate equipment calibration logbook.
- 8. List any equipment failures or breakdowns that occurred, together with a brief description of repairs or replacements.
- 9. State any field changes that occurred in which the field effort deviated from the Work Plan or Field Sampling and Analysis Plan, and why. Reference the Field Change Request (FCR) (Form 3E-1) for more detailed information.

10. Record all telephone calls relating to field activities in the field logbook and reference the field telephone log (if any) for specific details.
11. The person preparing the log must sign the field logbook at the bottom of each page.

No pages may be removed from the field logbooks for any reason. Blank pages must be marked "page intentionally left blank." Mistakes must be crossed out with a single line, initialed, and dated, per Section 3.4. Only persons authorized by the Project Manager may make entries in logbooks.

3.2 FIELD DATA SHEETS

In addition to the information entered into the logbook, the appropriate data sheets as given in the field procedures must be completed as specified in the appropriate procedure.

3.3 PHOTOGRAPHS

Photographs, if taken, will be recorded in the appropriate field logbook. Information to be recorded includes:

- Roll and frame number
- Subject, e.g., "installation of Borehole XX"
- Location, e.g., "east side of Building 3"
- Significant features
- Names of any personnel included in the photograph
- Time
- Photographer.

The photographer should review the photographs or slides when they return from developing and compare them to the log to assure that the log and photographs match. It can be particularly useful to photograph the labeled sample jars before packing them into shipping containers. A clear photograph of the sample jar, showing the label, any evidence tape sealing the jar, and the color and amount of sample, can be most useful in reconciling any later discrepancies.

3.4 CORRECTIONS TO DOCUMENTATION

All original data recorded in field logbooks, on sample tags, or in custody records, as well as other data sheet entries, will be written with black or blue waterproof ink. If an error (e.g., incorrect data or sample depth) is made on the document, corrections will be made simply by crossing a single line through the error (in such a manner that the original entry can still be read) and entering the correct information. All corrections will be initialed and dated.

All original data recorded in field logbooks on sample identification tags, chain-of-custody records, airbills, and receipt-for-samples forms and other data sheets are not to be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. In this case, prepare a new document and put a single line through the information on the superseded document. Note in the new document the reason for the new document being generated.

4.0 FIELD CHANGES/CORRECTIVE ACTION

4.1 FIELD CHANGES

During the course of an investigation, analysis or construction activities, approved work plans, technical procedures and design documents shall be followed unless some unforeseen contingency occurs. In this instance, the performed of the task is required to use his or her judgment as to the best approach toward satisfactory completion of the task through one of the following actions:

- o Stop affected activities until a supervisor evaluates the situation.
- o Instigate field changes.

Field changes shall be documented by completing the Field Change Request (FCR) Form (Form 3E-1) describing the reasons for the change, the recommended action and type of change (Minor, Major, Major Project Impact). The signed and dated form shall be sent to the project manager and project QA/QC coordinator for review, and a copy forwarded to the client for his review, if required by the program.

Minor changes may be implemented prior to approval by the project manager and project QA/QC coordinator.

Field changes are defined as:

- o A minor change is defined as a field change which would not adversely affect the quality of the data in the field or the rationale for the field procedures and sampling locations. Examples of minor changes are as follows:

General Field Procedures
Procedure FP-1

- Changing the sequence of the field investigations
 - Changing the device by which surface soil samples are taken
 - Changing any of the administrative requirements relative to a hazardous waste field investigation with the exception of those requirements mandated by federal or state regulations, i.e., chain-of-custody procedures.
- o A major change is defined as a field change which may adversely affect the quality of the data, will cause a significant change in the cost of the field effort, can be defined as a major change in the scope of the field effort, or will cause significant delays in the schedule. Examples of major changes are as follows:
- Significantly changing the number of wells
 - Significantly changing the number of sampling points
 - Significantly changing the location of wells and/or sampling points
 - Changing drilling method or well construction design
 - Creating changes which would change the rationale of the field program.
- o A change with Major Project Impact is defined as a change which has a major impact on project cost, schedule and/or technical performance. Some changes defined as major changes may have major project impact.

For major field changes, the field change request shall be submitted to the program manager and program QA/QC officer for review and approval. Major field changes shall not be implemented until the proposed change has been approved by the program manager and program QA/QC officer.

Field changes with major project impacts shall not be implemented until the client project manager has approved the proposed change.

After completion of the review process, the field Change Request Form shall be forwarded to personnel responsible for the work, and the project QA/QC coordinator with the following action requested:

General Field Procedures
Procedure FP-1

- o If approved, the personnel responsible for the work shall implement the change

- o The project QA/QC coordinator shall note final disposition of the field change request (e.g., change incorporated and work completed, change rejected, and work performed per original requirements, etc.) on the Field Change Request Form and assign an FCR number, log the FCR on the Field Change Request Log (Form 3E-2).

4.1 CORRECTIVE ACTION

During the course of a project it is the responsibility of the Project Manager and sampling team members to see that all procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event a problem arises, it is imperative that prompt action be taken to correct the problem. Engineering and scientific calculations will be checked and corrected as required by technical personnel, and normally require no QA reporting.

A nonconformance exists if there is a deviation from or noncompliance with contract specifications, the QA program, approved procedures, or work plans. Nonconformances also include major errors in documented analysis, data or results, and deficiencies in documentation or any other aspect of the project that affects quality. Personnel who identify a nonconformance should report the condition by completing Part A of the Nonconformance Report (NCR), Form 15A-1, and distributing the NCR to the supervisor, Project Manager, and QA manager. The sample numbers of the samples affected by the nonconformance should be noted on the NCR.

The supervisor, Project Manager, and QA manager will review the NCR to determine if:

- o Ongoing work should be stopped
- o The nonconformance involves a major deviation from the contract or client-approved work plans, or may significantly impact the cost or schedule of the work, in which case the nonconformance will be reported to the client
- o The nonconformance has any impact on previously obtained data or reports submitted to the client or other organization. If impacted, the Project Manager will note the impact in the Remarks section of the

General Field Procedures
Procedure FP-1

NCR and notify in writing all individuals and organizations that may be affected by the nonconformance and resulting data.

The evaluation will be documented by completing Part B of the NCR.

The supervisor will recommend corrective action to resolve the nonconformance by completing Part C of the NCR, and the recommended corrective action will be reviewed and approved by the Project Manager and QA manager.

The approved corrective action will be implemented by appropriate personnel, and reviewed and approved by the Project Manager and QA manager.

5.0 CALIBRATION

Field equipment will be calibrated prior to use in the field as appropriate. The calibration procedures will follow standard manufacturers' instructions and/or Moju Environmental calibration/service specifications (C/SS) to ensure that the equipment is functioning within tolerances established by the manufacturers or C/SS and required by the project. Calibration procedures and the frequency of calibration are described in the C/SSs. Copies of the instrument manuals will be maintained in the field office. A record of field analytical instrument (e.g., pH meter and conductivity meter) calibration will be maintained in the instrument calibration/maintenance logbook or on the Equipment Calibration Daily Log (Form F-1027) by field personnel. Other equipment calibration records (e.g., thermometers, sounders) will be maintained at Moju Environmental offices and copies will be maintained in the field offices. These records will be subject to QA audit. In addition, any notes on unusual results, changing of standards, battery charging, and operation and maintenance will be included in the logbook.

All instruments are to be stored, transported, and handled with care to preserve equipment accuracy. Damaged instruments will be taken out of service immediately and not used again until a qualified technician repairs and recalibrates the instruments.

All instruments, gages and tools used it to take field measurements (pH meters, OVA, thermometers, conductivity meters, etc.) shall be calibrated at periodic intervals using standards traceable to nationally recognized standards. Rulers, tape measurers, levels and other such devices need not be calibrated if normal commercial equipment provides adequate accuracy, but shall be maintained in good working condition.

May 1992

General Field Procedures
Procedure FP-1

C/SS Forms 12A-1 and 12A-2 or equivalent (Form 12A-2 required only for equipment being calibrated in house) should be completed for all equipment requiring calibration. New C/SSs should be submitted for inclusion in the C/SS Manual upon acquiring equipment not covered by an existing C/SS. Manufacturer's instructions will be used as the basis for the C/SS and will be used until the new C/SS is approved.

In-house calibrations will be performed by qualified personnel, and documented on Form 12A-3 or Form 12A-4 (Form 12A-4 is for recalibration requiring only a visual check) or similar forms including the same information.

If, during calibration, equipment is found to not meet calibration specifications, an analysis of the data obtained during the "out of calibration" status of the equipment will be made and documented on Form 12A-5 or equivalent and approved by the appropriate technical/laboratory manager and QA manager to determine the validity or, and ability to use the data.

All equipment (e.g., measuring devices, gages, test instrumentation, graphical recorders) shall bear a calibration label in plain view that shall indicate date last calibrated, calibration due date, equipment ID and initials of personnel who performed the calibration.

Any instrument or measuring device noted with expired calibration shall be marked with red tape and placed out of service until recalibrated.

6.0 DECONTAMINATION

Personnel conducting activities that involve hazardous substances may have their personal protective gear contaminated by those substances through the course of the work effort. In addition, equipment may become contaminated. Since such contamination is not always easily discernible, it is necessary to assume that all personnel and equipment working in the area (where the presence of such substances is known or suspected) have been contaminated. Effective decontamination procedures are implemented to minimize the potential for cross contamination (the transfer of contaminants, usually from one sample to another, by improperly decontaminated sampling equipment, containers, or devices such as drill rigs); offsite contaminant migration (the transfer of contaminants to areas outside the exclusion zone, usually by improperly decontaminated equipment); or personnel exposure from improperly decontaminated protective gear.

Decontamination is the process of neutralizing, washing, rinsing, and removing exposed outer surfaces of equipment and personal protective clothing to minimize the potential for contamination migration. **Cross Contamination** is the transfer of contaminants from their known or suspected location into a noncontaminated area; a term usually applied to sampling activities.

Procedures for protecting personnel from exposure and decontamination of personal protection gear is addressed in the Moju Environmental Health and Safety Manual. These procedures address decontamination on nonsampling equipment, small equipment, pumps and pump assemblies, and sample containers.

Decontamination of equipment shall be recorded on the Decontamination Record (Form F-1022) or in a field logbook.

6.1 NONSAMPLING EQUIPMENT

Nonsampling equipment includes rigs, backhoes, augers, drill pipe, bits, casing, and screen. The procedure for decontaminating nonsampling equipment is as follows unless otherwise specified in the Sampling and Analysis Plan.

6.1.1 Equipment Required for Decontamination

- o High-pressure pump with metered soap dispenser or steam-spray unit.
- o Stiff-bristle brushes
- o Gloves, goggles, boots, and other protective clothing, as specified in the site-specific Health and Safety Plan.

6.1.2 Heavy Equipment Decontamination

Heavy equipment includes earth moving equipment, drilling rigs, etc. The following steps must be followed when decontaminating this equipment:

1. Set up a decontamination pad that is large enough to fully contain the equipment to be cleaned. If a poured concrete pad with a containment sump is not available, construct a pad from plastic sheeting. Use two or more layers of heavy plastic sheeting to cover the ground surface and create a lip by rolling the edges of the plastic over railroad ties or sand bags.
2. With the equipment on the pad, spray areas exposed to contaminated soils with a steam or high-pressure sprayer. Be sure to spray down all surfaces, including the undercarriage. It is also a good practice to clean motor, hydraulic lift, oil fill, and fuel tank areas to avoid introducing contaminants to the work site.

3. If soapy water was used for the washdown step, rinse the equipment with potable (tap) water.
4. Remove equipment from the decontamination pad and allow to air dry before returning it to the work site.
5. Record equipment type, date, time, and method of decontamination in the appropriate logbook.

6.1.3 Downhole Equipment Decontamination

Downhole equipment includes hollow-stem augers, drill pipe, casing, and screen. The following steps must be followed when decontaminating this equipment:

1. Set up a centralized decontamination area as described in Section 6.1.2.
2. Set up a "clean" area upwind of the decontamination area to receive cleaned equipment for air drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed.
3. Put on gloves, boots, goggles, and any other personal protective clothing and equipment as specified in the site-specific Health and Safety Plan.
4. Place object to be cleaned on metal- or plastic-covered wooden sawhorses or other supports.
5. Using soapy water in the high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.
6. If using soapy water, rinse the equipment using clean, clear tap water. If using steam, the rinse step is not necessary if the steam does not contain detergent. If the steam contains a detergent, a final clean water rinse is required.

7. Using the manual-pump sprayer, rinse the equipment thoroughly with distilled water.
8. Remove the equipment from the decontamination area and place in the clean area to air-dry.
9. Record the decontamination protocol, equipment type, and the date and time of decontamination in the appropriate field logbook, or on the Decontamination Record (Form F-1022).
10. After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

6.2 SAMPLING EQUIPMENT

Small equipment includes split spoons, spatulas, bailers, compositing bowls, and filtration equipment, etc.

6.2.1 Equipment for Decontamination

- o 5-gallon plastic buckets and/or troughs
- o Laboratory-grade detergent (phosphate free)
- o Stiff-bristle brushes
- o Nalgene or Teflon™ sprayers or wash bottles or 2- to 5-gallon manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- o Plastic sheeting
- o Disposable wipes or rags
- o Distilled water [American Society for Testing and Materials (ASTM) Type II or better]
- o Appropriate decontamination solutions (pesticide grade or better)
- o Gloves, goggles, and other protective clothing, as specified in the site-specific Health and Safety Plan.

6.2.2 Sampling Equipment Decontamination

1. Set up a decontamination line on plastic sheeting. The decontamination line should progress from "dirty" to "clean" and end with an area for drying decontaminated equipment. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed.
2. Wash the item thoroughly in a 5-gallon bucket of soapy water. Use a stiff-bristle brush to dislodge any clinging dirt. Disassemble any items that might trap contaminants internally before washing. Do not reassemble until decontamination is complete.
3. Rinse the item in clean tap water. Rinse water should be replaced as needed, generally when cloudy.
4. Repeat Step 3 in a separate bucket (optional).
5. Using a hand sprayer, wash bottles, or manual-pump sprayer, rinse the item with ASTM Type II or higher quality water.
6. If the sampling equipment is to be used to collect a sample for trace metals analysis, and the equipment is acid compatible, rinse the item with nitric acid. Ten percent nitric acid should be used for stainless steel, glass, plastic, and Teflon™; items made of low-carbon steel should be rinsed with a 1 percent acid solution. **Note: Care should be taken not to get nitric acid on skin or clothing. This step should not be used unless required by sampling needs. Caution: Do not allow nitric acid to contact methanol or hexane. Contain nitric acid waste separately from organic solvents.**
7. Rinse item with methanol and collect the spent methanol in a safety can for disposal.
8. If the sample is to be analyzed for polar organic compounds such as pesticides, polychlorinated biphenyls (PCBs), rinse the item with hexane. This step should not be used unless required by sampling needs. A second hexane rinse may be used to aid in drying on wet days. Collect the spent hexane in a safety can for disposal.

9. After drying, wrap the cleaned item in aluminum foil, shiny side out, for storage.
10. Record the decontamination protocol, equipment number or description, together with the date and time of decontamination in the appropriate logbook.
11. After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable gloves, boots, and clothing. Place contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately.

6.3 PUMPS AND PUMP ASSEMBLIES

6.3.1 Equipment Required for Decontamination

- o Three or more empty 55-gallon drums
- o Plastic sheeting
- o 5-gallon (or larger) containers of distilled water (ASTM Type II or better) and other required decontamination solutions
- o Disposable wipes or rags
- o Gloves, goggles, and other protective clothing as specified in the site-specific Health and Safety Plan.

6.3.2 Pump Decontamination Procedure

The following steps must be followed when decontaminating pumps:

1. Set up decontamination area and separate "clean" storage area using plastic sheeting to cover the ground, tables, and other porous surfaces. Set up three 55-gallon drums in a triangle. The two drums at the base of the triangle will be used to contain diluted (nonfoaming) soapy water and potable water. The drum at the apex will receive wastewater. Place 5-gallon cans of distilled water adjacent to the waste drum on the same side as the potable water drum.

General Field Procedures
Procedure FP-1

2. The pump should be set up in the same configuration as for sampling. Submerge the pump intake (or the pump if submersible) and all downhole wetted parts (tubing, piping, foot valve) in the soapy water of the first drum. Place the discharge outlet in the waste drum above the level of wastewater. Pump soapy water through the pump assembly until it discharges to the waste drum.
3. Move the pump assembly to the potable water drum while leaving discharge outlet in the waste drum. All downhole wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.
4. Move the pump intake to the distilled water can. Pump water through the pump assembly. Usually, three pump-and-line assembly volumes will be required.
5. Decontaminate the discharge outlet by hand following the steps outlined in Section 6.3.
6. Remove the decontaminated pump assembly to the "clean" area and allow to air dry. Intake and outlet orifices should be covered with aluminum foil to prevent the entry of airborne contaminants and particles.
7. Record the equipment type and identification, and the date, time, and method of decontamination in the appropriate logbook.

7.0 DISPOSAL OF CONTAMINATED MATERIAL

Three types of contaminated materials are associated with hazardous waste sites:

- o Contaminated soil (e.g., cuttings)
- o Contaminated groundwater (e.g., well development water)
- o Decontamination fluids and used PPE.

Procedures to be followed in the containerization, transportation, storage, and disposal of wastes are discussed below.

Contaminated Soils

Contaminated soils will initially be placed in labeled 55-gallon drums or will be stored in earthen berms covered with two or more layers of 8-mil (or thicker) plastic. Soils will be covered with plastic sheeting weighted with sandbags. Lined and covered rolloff bins may also be used to store soils.

Soils suspected of being contaminated will be kept segregated from uncontaminated cuttings to the greatest extent practical. The field decision to segregate cuttings will be based on elevated HNu or OVA readings or obvious staining or discoloration of cuttings.

Composite samples of soils may be collected and analyzed according by the Toxicity Characteristic Leaching Procedure (TCLP: 40 CFR 268, Appendix I) to determine disposal requirements. Due to contingencies and the normal turnaround for laboratory analysis, soils may be stored 8 weeks to 12 weeks before disposal.

Analytical results will be evaluated against EPA critical limits and standards to determine if soils must be classified as hazardous wastes. If the soils are hazardous, they will be disposed of according to all applicable regulations. Moju Environmental personnel will not sign hazardous waste manifests; this is the responsibility of the client. If the soils are nonhazardous, the material will be transported to an appropriate disposal location.

Purge Water from Groundwater Monitoring Well Sampling

Purge water evacuated from groundwater monitoring wells prior to sample collection will be discharged (subject to regulatory agency approval) or containerized at the well head. Only groundwater from the same site groupings and the same aquifer will be placed in the same containers. Containers will be labeled to show the site and date of sample collection, and will be left at the well head until analytical results are received. Drums will be labeled with the accumulation start date and the well number.

The hazardous characteristics of the containerized purge water will be assumed to be the same as the water sample from that well. If the water sample is hazardous, the purge water will be disposed of according to applicable regulations. Moju Environmental personnel will not sign hazardous waste manifests; this is the responsibility of the client. If the water sample is nonhazardous, the purge water will be discharged to an industrial wastewater treatment plant after approval by plant personnel and regulatory agencies, if necessary.

Decontamination Fluids and Disposable Protective Clothing and Supplies

All sampling of equipment decontamination fluids will be presumed hazardous and placed in 55-gallon drums. All disposable protective clothing and supplies will also be presumed hazardous and will be double bagged and placed in additional 55-gallon drums. Drums will be sealed and labelled. If analytical results for the site show no hazardous wastes are present, the drum contents may be disposed of as nonhazardous waste. Otherwise, the

General Field Procedures
Procedure FP-1

contents will be transported and disposed of as hazardous waste. Moju Environmental personnel will not sign hazardous waste manifests; this is the responsibility of the client.

8.0 HEALTH AND SAFETY

A project-specific Health and Safety Plan shall be prepared and followed. The Health and Safety Plan identifies known or suspected physical and chemical hazards at the site, action levels, required personal protective equipment, location of emergency medical facilities, and emergency response procedures. This document is prepared in accordance with "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities; NIOSH; OSHA; USCG; EPA; 1985)." All Health and Safety Plans will be reviewed by the Corporate Health and Safety Officer.

9.0 FORMS

F-3E-1	Field Change Request
F-3E-2	Field Change Request Log
F-12A-1	Calibration/Service Specification
F-12A-2	Calibration/Service Specification, Page 2
F-12A-3	Calibration Data Record
F-12A-4	Recalibration Visual Check Record
F-12A-5	Analysis of Data Obtained from Equipment Out of Calibration
F-15A-1	Nonconformance Report
F-1022	Decontamination Record
F-1027	Equipment Calibration Daily Log

No. _____
Dated _____

Calibration/Service Specification

Item name _____ Model number _____

Manufacturer _____ Classification _____

Calibration source _____ Maximum interval _____

Maintenance _____ Maximum interval _____

Prepared by _____ Approved by _____ Date _____

Approved by _____ Date _____

Description		
Operational requirements		
Calibration specification		
Characteristic/range	Tolerance	Condition/limitation
Maintenance specification		

Procedure :

C/SS No.

Dated

Analysis of Data Obtained from Equipment Out of Calibration

Calibration information

Description of equipment _____

C/SS No. _____ Equipment serial or I.D. No. _____

Description of characteristics found out of calibration spec. _____

Reported by _____ Date _____

Analysis

Data Obtained with equipment since last calibration _____

Effect on data _____

Corrective action required _____

By _____ Date _____

Approved by _____ Date _____

Approved by _____ Date _____

Program QA/QC officer

NCR No. _____

Nonconformance Report (NCR)

Project _____ Project No. _____

Activity _____ Location _____

Part A

Description of non-conformance

Personnel reporting non-conformance _____ Date _____

Part B

Evaluation of non-conformance

Work stoppage required Yes _____ No _____ Significant condition adverse to quality Yes _____ No _____
Impacts previous data/reports Yes _____ No _____

Remarks _____

Evaluated by _____ Date _____ Title _____

Approved by _____ Date _____ Date _____

Project Mgr.

Program QA/QC officer

Part C

Recommended corrective action/disposition _____

Recommended by _____ Date _____ Title _____

Approved _____ Date _____ Date _____

Project Mgr.

Program QA/QC officer

Part D

Corrective action/disposition completed by _____ Date _____

Remarks _____

Corrective action approved and NCR closed by:

_____ Date _____ Date _____

Project Mgr.

Program QA/QC officer

APPENDIX C

FP-10

GENERAL SAMPLING PROCEDURES

1.0 PURPOSE AND SCOPE

This procedure prescribes general requirements for all field sampling operations to ensure that sample integrity is maintained. Specifically this procedure establishes the protocol for sample:

- Custody
- Labeling
- Documentation
- Preservation
- Packaging
- Shipment

The Quality Assurance Plan (QAP) contains requirements that pertain to all sampling operations conducted by Moju Environmental Technologies, Inc. (Moju). For specific projects, additional quality assurance requirements may be included in other quality assurance documents.

This procedure applies to all sampling activities that are the direct responsibility of Moju. Subcontractors may operate under other documented procedures if the project manager has determined that those procedures are adequate for the intended purpose.

2.0 RESPONSIBILITIES

Moju will appoint a Field Team Leader (FTL) for every field activity. The FTL is responsible for ensuring that personnel who are under the control of the FTL comply with the requirements of this procedure.

3.0 SAMPLING REQUIREMENTS

Documentation during sampling activities is essential to ensure proper sample identification. Standard sample custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. The field team leader (FTL) is responsible for proper sample handling and documentation that will allow for tracing the possession and handling of individual samples from the time of collection to laboratory receipt.

The laboratory QA coordinator is responsible for establishing a sample control system that will allow for tracing sample possession from laboratory receipt to final sample disposition.

3.1 SAMPLE CUSTODY

The sample custody procedures employed in the field are discussed below. All sample custody and documentation material will be completed in ink by field personnel. Corrections will be made by drawing one line through the incorrect entry, entering the correct information, and initialing and dating the change.

Sample custody materials discussed below include sample labels, custody seals, and chain-of-custody records.

3.1.1 Sample Labeling

A sample label will be affixed to all sample containers sent to the laboratory. This identification label will be completed with the following information:

- Project name and location
- Sample location
- Laboratory identification number
- Date and time of sample collection
- Preservative used, if any
- Sampler's initials
- Type of sample (for example, grab or composite)
- Analyses requested

If a sample is split with another party, sample labels with identical information will be attached to each sample container. After labeling, each sample will be refrigerated or placed in a cooler containing ice or "blue ice" to maintain the sample temperatures at 4 degrees Celsius (°C).

3.1.2 Custody Seals

Custody seals will be used on each ice chest containing samples (sample cooler) to ensure that no tampering occurs. Custody seals used during the course of the project will consist of

security tape with the date and initials of the sampler. Two seals will be placed on each sample cooler so that they must be broken to gain access to the contents. If the seals are serially numbered, these numbers will be cross-referenced on both the field logbook and the chain-of-custody (COC) Record.

3.1.3 Sample Custody

Chain-of-custody procedures provide an accurate written record tracing the possession of individual samples from the time of field collection through laboratory receipt. A sample is considered in custody if it is in one of the conditions:

- In a person's immediate possession
- In view of a person at all times after being in possession
- In an area which can be accessed by only authorized persons
- In a locked container that can be opened by only authorized persons

3.1.4 Chain-of-Custody Record

The COC Record will be used to document the samples taken and the analyses requested. Information that field personnel will record on the COC Record includes the following:

- Project name and number
- Printed name and signature of samplers
- Destination Of samples
- Laboratory sample identification number
- Date and time of collection
- Sample designation
- Sampling location
- Number and type of containers filled
- Analyses requested
- Preservative used, if any
- Sample matrix
- Signatures of individuals involved in custody transfer (including date and time of transfer)

- Airbill number noted at bottom, if appropriate

Unused lines on the COC record will be crossed out. COC records initiated in the field will be signed, placed in a plastic bag, and taped to the inside of the shipping container used for sample transport. Signed airbills will serve as evidence of custody transfer between the field sampler and courier and between the courier and laboratory. Copies of the COC record and the airbill will be retained and filed by the sampler.

Occasionally, multiple coolers will be sent in one shipment to the laboratory. Each cooler will have a separate COC record with the samples contained in that cooler listed. In addition, the outside of the coolers will be marked to indicate how many cooler are in the shipment.

3.2 SAMPLE DOCUMENTATION

Sampling activities during the field effort require several forms of documentation. While some custody documentation is discussed above, additional documentation is mandatory. The documents discussed above are prepared to maintain sample identification and chain of custody, as well as provide records of significant events or observations. Other documents that will be prepared during the conduct of this investigation include the following:

- Project log books
- Boring logs
- Well construction diagrams
- Sample register
- Daily field reports
- Field change notification

3.3 SHIPPING REQUIREMENTS

Procedures for transporting samples to the laboratory will be based on the estimated contaminant concentrations in the samples to be shipped. All samples will be identified as environmental samples. All Department of Transportation (DOT) regulations will be followed for packaging and shipment. The procedures outlined below meet these requirements, which are taken from EPA guidance on field operation methods (1987).

General Sampling Procedure
Procedure FP-10

- A cooler will be lined with a large plastic bag. The cooler will then be filled with "bubble wrapped" sample bottles and packing material such as "plastic peanuts". Sufficient packing material will be used to prevent sample containers from making contact during shipment. Enough ice or "blue ice" will be added to maintain sample temperatures at 4°C. The large inner bag will be taped closed with a "J-seal".
- The COC records that will accompany the shipment will be placed inside a separate plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The airbill will be completed before the samples are transferred to the carrier. The laboratory will be notified if the shipper suspects that the sample contains any substance requiring special precautions by the laboratory personnel.
- The cooler will be closed and taped securely with strapping tape (filament type) around both ends. If the cooler has a drain, it will be taped closed both inside and outside.
- Two signed custody seals will be placed on the cooler, one on the front and one on the back. Additional seals may be used if the sampler or shipper determines more seals are necessary.
- The cooler will be handed over to the overnight carrier. A standard airbill is necessary for shipping environmental samples.

No samples will be held on site for more than 24 hours except during weekend or holiday field activities. Samples collected on the weekends or holidays will be stored under refrigeration and shipped the first workday. Samples for analytes with extremely short holding times (24 hours or less) will not be scheduled as a weekend or holiday activity.

- Upon receipt of a sample cooler, laboratory personnel will review the contents and sign and retain the COC record and the airbill. Information that will be recorded on the COC record, or another appropriate document, at the time of sample receipt will include the following:
 - Status of the custody seals
 - Temperature of the ice chest upon receipt
 - Identification number of any broken sample containers
 - Description of discrepancies between the COC records, sample labels, and requested analyses
 - Observations of visible headspace in VOC sample containers indicating inadequate sample collection

General Sampling Procedure
Procedure FP-10

- pH of water sample upon receipt (Note: pH of VOC samples will be documented at the time of analysis)

Laboratory personnel will contact the analytic coordinators regarding discrepancies in documentation and sample preservation and will document nonconformances according to the laboratory's standard operating procedures (SOPs).

Once samples have been accepted by the laboratory, checked, and logged in, they must be maintained in a manner consistent with custody and security requirements specified in the laboratory's QA plan. Specific laboratory chain-of-custody procedures are described the the laboratory's SOPs

APPENDIX D

FP-10-1

SOIL AND ROCK SAMPLING

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1
1.1 OBJECTIVES	1
1.2 SCOPE	1
2.0 PLANNING	3
2.1 METHOD OF SELECTION	3
2.2 SAMPLING PLAN	4
3.0 METHODOLOGY	7
3.1 BOREHOLE SAMPLING	7
3.1.1 Disturbed Samples	8
3.1.1.1 Split-Barrel Sampler	8
3.1.1.2 Grab/Bulk Sample	13
3.1.2 Undisturbed Samples	14
3.1.2.1 Thin-Walled or Shelby Tube	15
3.1.2.2 Pitcher Tube	18
3.1.2.3 Rotary Core Barrel	20
3.2 TRENCH SAMPLING	24
3.2.1 Backhoe Sampling	24
3.2.2 Front-End Loader Sampling	26
3.3 SURFACE AND SHALLOW SUBSURFACE SAMPLING	26
3.3.1 Hand Operated Auger	26
3.3.1.1 Hand Bucket Augers	29
3.3.1.2 Screw Auger and Thin-Walled Tube Sampler	30
3.3.1.3 Acker Soil Sampling Kit	32
3.3.2 Soil Sampling with a Spade and Scoop	33
4.0 RECORDS	35
5.0 REFERENCES	36
6.0 FORMS	37

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>	<u>Page</u>
3-1	Split Barrel Sampler, ASTM D-1586	9
3-2	Split Barrel Sampler, Schematic Diagram	10
3-3	Thin Wall Tube Sampler	16
3-4	Pitcher Tube Sampler	19
3-5	Swivel Type Double Tube Core Barrel	21
3-6	Coring Bits	23
3-7	Hand Augers	27
3-8	Bucket Auger and Thin Wall-Walled Tube Sampler	28

1.0 INTRODUCTION

This document presents standard procedures and types of equipment to be used to obtain soil and rock samples. Three sample collection methods are described here: borehole sampling, trench sampling, and shallow subsurface sampling. Methods for collecting both disturbed and undisturbed samples are described. Criteria for use in selecting the most appropriate sampling method are discussed in Section 2.0, Planning.

1.1 OBJECTIVES

The objective of the Soil and Rock Sampling Field Procedure is to standardize the methods used by Moju Environmental. This procedure should serve as a guide to: (1) ensure collection of samples that are representative and appropriate for the required testing; (2) optimize the selection of the appropriate sampling technique to meet the desired objectives; and (3) standardize the recording of data and information to assure proper documentation of sample collection.

1.2 SCOPE

This procedure covers the following methods of soil and rock sampling:

- o Borehole sampling
- o Trench sampling
- o Surface/shallow subsurface sampling.

General sampling procedures, including general requirements, chain of custody, documentation, QC samples, decontamination of equipment, and packaging and shipping, are

Soil and Rock Sampling
Procedure FP-10-1

presented in Procedures FP-1, General Field Procedure; and FP-10, General Sampling Procedure. Procedures for borehole drilling and logging of boreholes are presented in FP-3, Borehole Drilling and Logging. Trenching and tank removal procedures are described in FP-4, Trenching and Test Pit, and FP-4-1, Tank Pulls.

2.0 PLANNING

2.1 METHOD OF SELECTION

The purpose of a typical soil/rock sampling program is to locate the extent, depth, and concentrations of contaminants, and/or to characterize the physical and mechanical properties of the soils/rock.

Choosing a soil sampling method should be based on the following considerations: physical properties of the soil such as grain size, cohesiveness and moisture; site characteristics such as depth to bedrock and water table; and sampling depth required to reach the horizon of interest. In addition, the intended tests to be performed on the sample dictate whether a disturbed or an undisturbed sample is required.

Disturbed samples are generally used for chemical analysis, visual classification, water content, grain size analysis, Atterberg limit tests, specific gravity, and compaction tests. Undisturbed samples are required for shear, consolidation, and permeability testing.

The required sampling depth dictates the type of method used in many cases. Shallow subsurface sampling is most efficient at depths of less than 10 feet, while trenching can be used to depths of 20 feet. In general, borehole sampling is required for depths over 20 feet.

The American Society for Testing and Materials (ASTM) has developed a number of methods that are directly applicable to soil/rock sampling for site investigations. These methods are designed primarily for engineering applications but can be modified slightly to obtain samples for chemical analysis.

2.2 SAMPLING PLAN

Project-specific requirements for soil sampling shall be stated in the Sampling Plan or Work Plan and made available to all field personnel before going into the field. These requirements include:

- o List of sites or locations at a particular site to be sampled
- o Number of samples to be collected
- o Depth(s) of samples to be collected or criteria for selecting samples
- o Sampling method to be used
- o Sample numbering system
- o Recording forms to be used
- o Personnel assigned to conduct field activities
- o Schedule of sampling activities
- o Sampling criteria to select samples for analysis (i.e., sample at pre-selected depths, or choose samples that show field indications of contamination)
- o Analysis or test to be performed on samples
- o Sample containers, preservation and holding times required for the tests to be performed
- o Name and address of laboratory performing test or analysis
- o Arrangements for transportation of samples to the laboratory.

The criteria for choosing the specific soil samples to be tested are dependent on the objectives of the investigation. In some cases, the required sampling depths are dictated by

regulatory requirements. More frequently, the objectives of chemical testing are to assess the horizontal and vertical extent of soil contamination. In this situation, it is most effective to select a series of samples within the zone of contamination, and a sample outside the limits of contamination. The data collected can then be used to demonstrate zonation of the contaminant away from the source. Field indicators such as discoloration, headspace OVA or HNu measurements, or odor, often provide a guide to sample selection. In other cases, the objective may be to collect "worst case" samples for remedial planning or hazardous waste characterization testing. When physical tests are to be performed, sample locations and depths will most likely be determined by observed changes in soil properties such as texture, grain size, or moisture content. Samples are often collected at each observed change in strata.

Because the choice of samples to be tested is usually dependent on decisions made in the field, it is particularly important to record all field observations on the borehole log or other form for future reference.

The testing or analytical method and sample containers should always be selected in conjunction with the laboratory, to assure that the samples obtained are appropriate to provide the desired results.

Where representative sampling points is required for statistical analysis, a random sampling grid may be established. For a detailed discussion of statistical sampling plans, see Mason (1983), or Barth and Mason (1984).

The sampling plan may call for compositing of soils collected at several sampling points. Compositing is commonly used to combine all samples from one borehole, or from one trench, to provide an average value for that area. In general, compositing is chosen to reduce laboratory costs. In most waste management site investigations, compositing should

Soil and Rock Sampling
Procedure FP-10-1

not be used, because it does not provide information on the vertical or horizontal extent of contamination, or on the variability between samples. Where field indicators do not suggest the presence of contaminants, and where the contaminant of interest is detectable by odor, color, OVA, etc., it may be acceptable to composite from the same borehole. However, where large variations in contaminant level are observed or where field indicators are not reliable, compositing is not suggested. Mixing soils is also not recommended when analysis of volatile compounds is required.

3.0 METHODOLOGY

3.1 BOREHOLE SAMPLING

Sampling depths of greater than about 20 feet usually require the use of a drilling rig to advance a borehole. Borehole drilling is discussed in Procedure FP-3, Borehole Drilling and Logging. The maximum depth is dependent on the soils and the type and size of drilling equipment used.

The choice of sampling technique for collecting soil samples from boreholes depends primarily of (1) soil type, and (2) whether an undisturbed, partially disturbed or disturbed sample is required. Undisturbed samples include push-tube or thin-wall-type samplers (Shelby tube), and rotary core barrel type samplers. Totally disturbed samples are obtained from the borehole cuttings. Representative but partially disturbed samplers include thick-wall open-drive samplers or split-barrel samplers.

Borehole samples are typically collected in increments of 5 feet for relatively homogeneous soil profiles. This is convenient because a sample can be collected after each 5-foot length of auger or drill rod is advanced. Where soil type is variable, or where impermeable strata are thought to control contaminant migration, it is important to sample at every observed change in lithology. Borehole sample information is recorded on the Borehole Log, Form F-1009.

3.1.1 Disturbed Samples

3.1.1.1 Split-Barrel Sampler

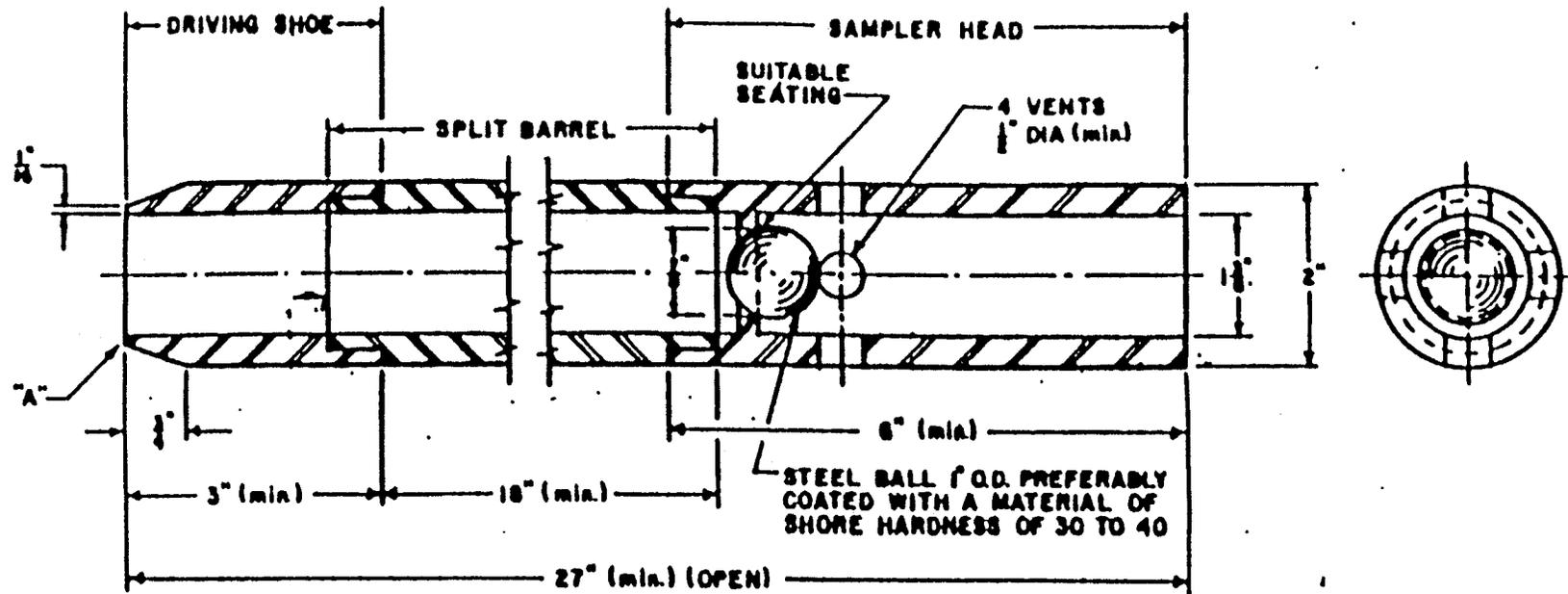
Applicability

The split-barrel sampler is the most commonly used soil sampling device, and can be used with hollow-stem auger, rotary, and percussion hammer drilling equipment. The method also provides a measure of the resistance to sampler penetration (blow count), to be used in characterizing soil density. Split-barrel sampling can be used in most soils to obtain representative driven samples for chemical analysis, visual identification, and density. The standard method for a penetration test and split-barrel sampling of soils is described in ASTM D-1586.

Equipment

The sampler consists of (1) a hollow, 18 inches or longer split steel sample barrel, threaded at both ends, (2) drive shoe made of hardened steel, and (3) a sampler head which includes a check valve (Figures 3-1 and 3-2). The sampler is opened by removing the drive shoe and adapter. Stainless steel or brass liners are used inside of the sampler barrel to hold the sample.

Samples collected from soil below the water table or in very loose soils may require the use of split barrels equipped with retainers or "sample catchers." The sample catcher is made with flexible prongs that close over the end of the tube as the sampler is retracted from the soil. The sample catcher is placed between the sampler shoe and barrel, with the prongs facing in toward the barrel.

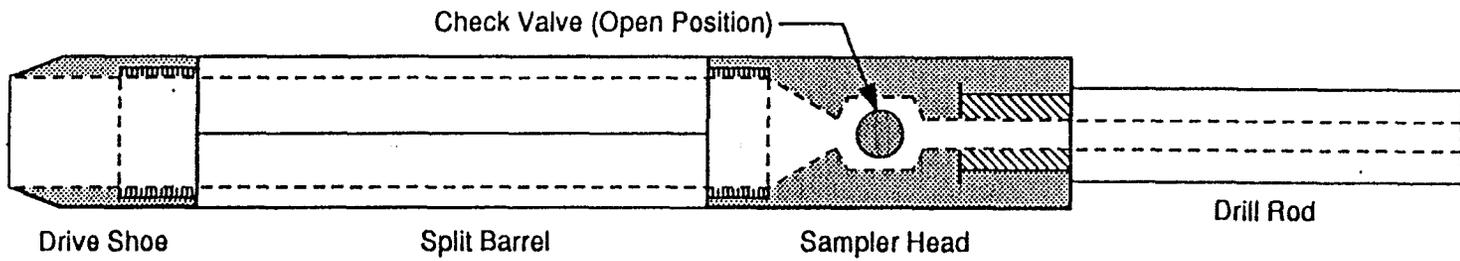


- NOTE 1—Split barrel may be 1 1/2 in. inside diameter provided it contains a liner of 16-gage wall thickness.
 NOTE 2—Core retainers in the driving shoe to prevent loss of sample are permitted.
 NOTE 3—The corners at A may be slightly rounded.

Project No.	265-000
Procedure FP-10-1	

**Split Barrel Sampler,
ASTM D-1586**

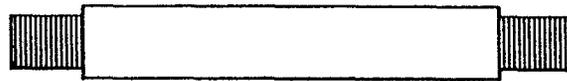
Figure 3-1



Split Spoon Sampler



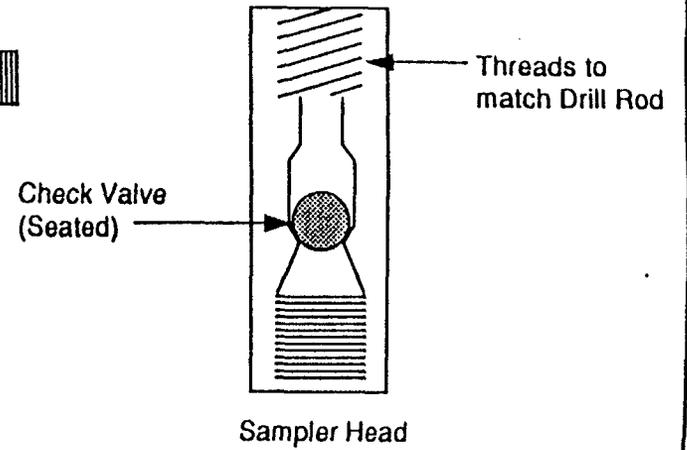
Drive Shoe



Half of Split Barrel
Side View



End view



Split Spoon Sampler Disassembled

Project No.	265-000
Procedure FP-10-1	

**Split Barrel Sampler,
Schematic Diagram**

10

Soil and Rock Sampling
Procedure FP-10-1

The split barrel is available with inside diameters ranging from 1.5 inches to 4.5 inches in 0.5-inch increments. Barrels are available in standard lengths of 18 inches and 24 inches, with a wall thickness of 0.25 inch.

The following is a list of equipment and sampling procedures. Equipment to be used for split-barrel sampling includes:

Split-barrel sampler

Sampler shoe

Sampler head

Sample catchers, to fit sampler

Brass or stainless steel liners, 4-inch or 6-inch length O.D. to fit sampler

Teflon™ paper

Polycarbonate end caps to fit liners

Headspace jars (8-oz. glass jars with hole punched Teflon™-lined lid)

Aluminum foil

Knife (to separate liners)

Labels

Pipe wrenches

Screwdriver

Wire brush.

Procedures

Procedures for split-barrel sampling are as follows:

1. a. Fill out sample labels as completely as possible (refer to FP-10, General Sampling Procedure.)

Soil and Rock Sampling
Procedure FP-10-1

- b. Set up a sampler decontamination area (see FP-1, General Field Procedures).
2. Assemble the split-barrel sampler (Figure 3-2); place clean liners in barrel and close the barrel. If needed, the sample catcher is placed between the barrel and the sampler shoe, with the prongs facing in toward the barrel. Screw on shoe and sampler head.
3. Attach the sampler to the sampling rods and lower into borehole. Mark the drill rods in three successive 6-inch increments so that the advance of the sampler under the impact of the sampler can be easily observed.
4. Collect sample in sampler; drive sampler into ground with a 140-lb weight dropped 30 inches until either 18 inches have been penetrated or 100 blows have been applied. Count the number of blows required to effect each 6 inches of penetration and record on borehole log as the "blow count." The sum of the number of blows required for the second and third 6 inches of penetration is termed the "standard penetration resistance."
5. Open the sampler immediately after removal from the borehole and log the sample characteristics in the borehole log, per Procedure FP-3, Borehole Drilling and Logging.
6. Seal the two sample liners closest to the drive shoe with Teflon™ paper and polycarbonate end caps. Label the sample, seal it in a plastic bag (to prevent water infiltration) and place in a cooler containing ice. In order to prevent freezing, samples should not be placed directly on the ice. Samples for physical testing, such as grain size analysis, do not need to be chilled.
7. Extrude the soil from the third sample liner into a clean, laboratory-supplied glass jar. This headspace sample should fill the jar approximately half way. The jar is covered with aluminum foil and capped with a Teflon™-lined lid which has a hole in it. The jar shall be sealed tightly (make sure it is labeled appropriately) and placed in a warm sunny location for volatilization.
8. Clean the sampler with an Alconox™ wash, followed by two clean water rinses, and followed by a distilled water rinse. Dry the sampler with lint-free paper towels or allow to air dry.

9. After the headspace sample has set for a minimum of 25 minutes, test the headspace for volatiles using an Organic Vapor Analyzer (OVA). The probe of the OVA is pushed through the hole in the lid and the aluminum foil. Record the data on the boring log. Empty the headspace sample into the drum containing drilling cuttings. Headspace sample jars should either be disposed with the drill cuttings or washed/decontaminated for reuse.
10. Upon completion of sampling:
 - a. All equipment which has come in contact with samples should be thoroughly decontaminated and steam-cleaned when necessary, per Procedure FP-1, General Field Procedures.
 - b. Sample should be properly packaged and a chain-of-custody form filled out (see FP-10, General Sampling Procedure).

3.1.1.2 Grab/Bulk Sample

Applicability

A simple method of obtaining bulk samples of large volume is to sample the soil cuttings directly as they are removed from the borehole. Because this method results in a completely disturbed sample, it is not recommended for most applications. However, it can be used to obtain samples for visual classification, or where large volumes are needed for testing. An important disadvantage of this technique is that a measure of the source depth can only be estimated on the basis of soil type, depth, and drilling method. For example, with the hollow-stem auger drilling method, sandy cuttings are quickly brought to the surface on the auger flights, while clay cuttings may remain in the augers for a longer duration. With percussion drilling, the cuttings are blown to the surface almost instantaneously.

Equipment

The basic equipment for this sampling method consists of a stainless steel shovel, spade, or scoop, and sample containers. Sample containers shall be laboratory-supplied, precleaned glass jars.

Procedure

1. Using a precleaned stainless steel scoop or equivalent, transfer soil from a representative portion of the soil cuttings into an appropriate sample container (usually an 8-oz. jar).
2. Label sample container. Place in an ice-filled cooler. Complete chain-of-custody documentation, per Procedure FP-10, General Sampling Procedure
3. Decontaminate all sampling equipment between samples, per Procedure FP-1, General Field Procedures.

3.1.2 Undisturbed Samples

There are many types of samplers for collecting undisturbed samples, including thin-walled tube samplers (Shelby tube), piston samplers (thin-walled, stationary, Lowe-Acker, Osterberg and McClelland, Swedish foil), and double-tube core barrel samplers (Denison, TAMS; Pitcher). Only the Shelby tube and Pitcher samplers are described here. Most of the other samplers are of complex design and require extensive decontamination when used for waste investigations. Further information on these sampling methods is available in the references listed at the back of this procedure.

In most cases, undisturbed soil samples are sealed and transported to the testing laboratory inside the tube in which they are collected. To obtain an undisturbed soil sample, a clean, open borehole of sufficient diameter must be drilled to the desired sampling depth. The borehole diameter should be as small as possible, usually 3/8 inch greater than the O.D. of

the sampler, or 3/8 inch to 5/8 inch greater than the O.D. of the sampler if casing is used (U.S. Army Corps of Engineers, 1972).

3.1.2.1 Thin-Walled or Shelby Tube

Applicability

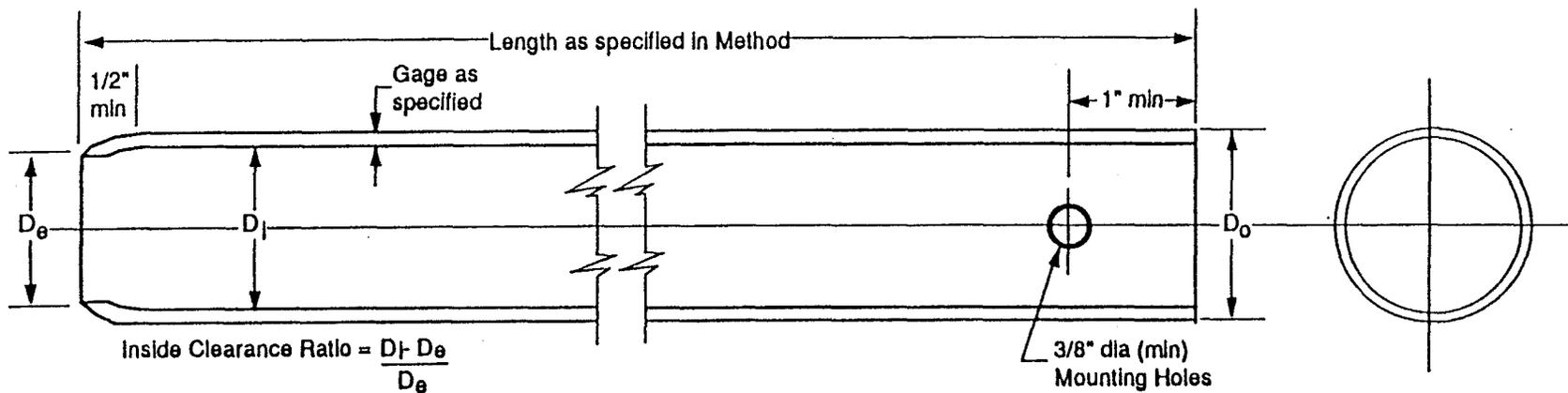
Thin-walled tube samplers (ASTM D 1587) are recommended for penetration tests or to recover undisturbed soil samples for laboratory testing of structural properties. This method is recommended for use in very soft to stiff clays, silts, or sands with no appreciable amounts of gravel (U.S. Army Corps of Engineers, 1972).

Equipment

Thin-walled or Shelby tubes consists of thin-walled metal tubes connected to a sampler head containing a ball check valve and ports (Figure 3-3). The tubes are generally 2 inches, 3 inches or 5 inches O.D., and 36 inches to 54 inches in length. The U.S. Army Corps of Engineers recommends the use of 5-inch tubes in cohesive soils (clays and silts); 3-inch-I.D. tubes in cohesionless deposit soils (clays and silts), and 3-inch-I.D. tubes in cohesionless deposits (sand), particularly at greater depths. Because soil samples may be stored within the steel sampling tube for extended periods, the tubes are coated with lacquer or treated with a rust inhibitor to prevent corrosion.

Equipment includes:

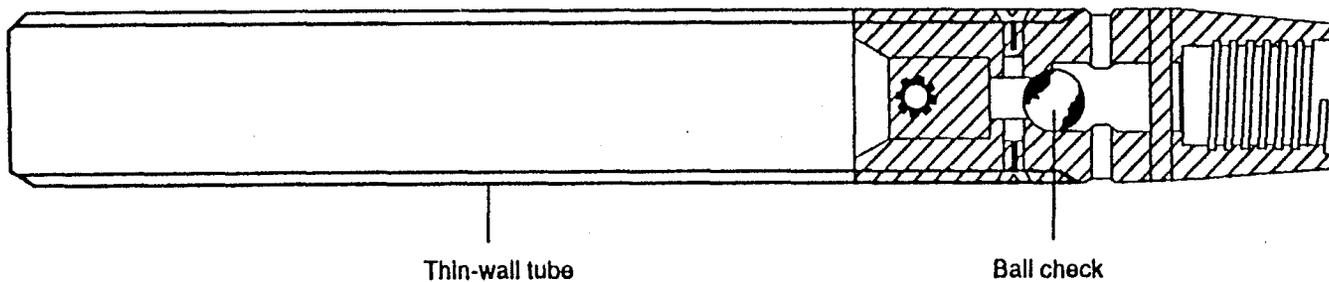
- o Thin-walled tubes
- o Sampler head
- o Sealant wax



Note 1 - Minimum of two mounting holes on opposite sides for 2 to 3 1/2 in. sampler.

Note 2 - Minimum of four mounting holes spaced at 90 deg for samplers 4 in. and larger

Note 3 - Tube held with hardened screws.



Project No.	265-000
Procedure FP-10-3	
Thin Wall Tube Sampler	
Figure 3-3	

Soil and Rock Sampling
Procedure FP-10-1

- o End caps
- o Electrical tape
- o Labels.

Procedure

1. Clean out the borehole to sampling elevation. Remove loose material as carefully as possible to avoid disturbance of the material to be sampled.
2. Place the assembled sample tube so that its bottom rests on the bottom of the hole. Place a mark on the piston rod extension as a reference.
3. Advance the sample without rotation by a continuous rapid motion of constant rate using the hydraulic drive mechanism on the drill rig.
4. Determine the length of advancement by measuring the difference from the reference mark.
5. Withdraw the sampler slowly and uniformly, without rotation, to its original position.
6. Separate the tube from the sampler head. The sample is usually prepared for shipment to the laboratory while still intact in the sample tube. Alternatively, for cohesive soils, the sample may be extruded from the tube.
 - a. Prepare the sample for shipment in the tube. Remove approximately 1 inch of soil from each end for identification tests. Fill the ends of the tube with wax added in increments to prevent the formation of voids, or with a perforated expanding packer. The wax is used to prevent loss of water content. Both ends of the tube are capped with close fitting plastic caps and secured with electrical tape. If the sample is to be tested by chemical analysis, electrical tape should not be used. The samples are carefully packed for shipment.

- b. Cohesive soils can be removed from the tube by extruding the sample using a hydraulically operated sampler jack. The sample should be extruded as soon as possible to minimize the buildup of adhesion and friction. The sample can be extruded onto a half-section receiving tube or onto foil or plastic. Plastic should not be used for samples intended for chemical analysis.

If a soil sample extruded from the tube is to be tested by chemical analysis, it is necessary to scrape off the outer edge of the core, to remove any contamination of the soil with the protective coating on the tube. The soil can then be placed inside glass jars and capped.

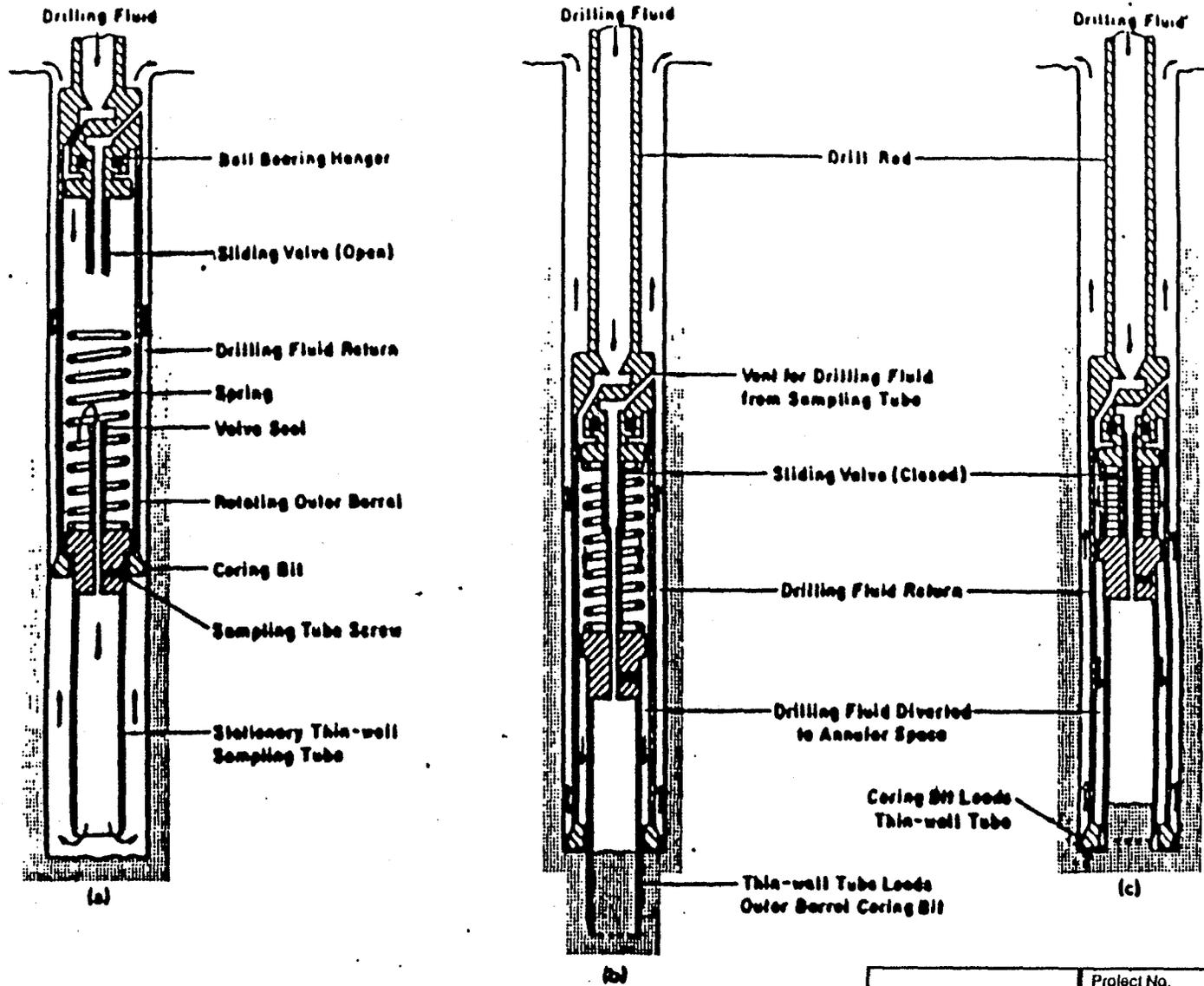
3.1.2.2 Pitcher Tube

Applicability

The Pitcher tube is a type of double-tube core barrel sampler. It is used primarily in stiff to hard cohesive soils and coarse sands and gravels, where undisturbed samples are required, but thin-walled samplers cannot be used. It is particularly well adapted for deposits consisting of alternative hard and soft layers. The Pitcher tube is used primarily with the rotary method of drilling (see Procedure FP-3, Borehole Drilling and Logging).

Equipment

The Pitcher sampler (Figure 3-4) is a type of double-tube core barrel soil sampler (Denison sampler) consisting of an outer rotating core barrel with a bit, and an inner stationary, spring-loaded, thin-walled sampling tube (Winterkorn and Fang, 1975). The sampling tube leads or trails the outer barrel drilling bit, depending on the hardness of the material penetrated. In soft material, the inner barrel leads the cutting bit to prevent erosion of the soil by the drilling fluid. In hard material, the spring compresses and the outer barrel with the bit leads the inner tube. Drilling fluid flows downward between the inner tube and outer barrel, and carries cuttings between the outer barrel and the wall of the borehole.



Schematic Drawing Showing: (a) Sampler being lowered into drill hole;
 (b) Sampler during sampling of soft soils
 (c) Sampler during sampling of stiff or dense soils
 (Courtesy of Mobile Drilling, Inc.)

	Project No. 265-000
	Procedure FP-10-1
Pitcher Tube Sampler	
Figure 3-4	

Procedure

1. Clear the borehole of all loose material, and lower the sampler to the bottom of the hole. During this operation, the sampling tube is suspended from the outer barrel, and the sliding valve at the top of the barrel is open to allow drilling fluid to be introduced to flush cuttings from the hole.
2. When the inner tube reaches the bottom of the hole, it telescopes into the outer barrel and closes the sliding valve. This directs the drilling fluid downward into the annular space and then upward between the sampler and borehole wall.
3. Sampling is performed by rotating the outer barrel at 100 rpm to 200 rpm while exerting downward pressure. In soft soils, the tube leads the outer barrel, while the outer barrel leads in hard soils.
4. Remove the sampler from the hole, and detach the inner tube with the enclosed sample. The samples are sealed and preserved in the manner described in Section 3.1.2.1 for thin-walled tube samplers.

3.1.2.3 Rotary Core Barrel

Applicability

This method (ASTM D 2113) is applicable for rock or soils that are too dense to be sampled by the other methods described above. A 1-inch or less penetration for 50 blows indicates that drive sampling is not an applicable method for that soil (ASTM D 1586). Coring is usually performed by the rotary drilling method, which employs a drilling fluid (mud, air or water) to lubricate and cool the bit, and to bring cuttings to the surface (see Procedure FP-3, Borehole Drilling and Logging).

Equipment

The sampler consists of a core barrel with a cutting bit at its lower end. The core barrel assembly (Figure 3-5) consists of a head section, core barrel, inner barrel, liners, reaming shell, and coring bit. The coring bit, which grinds and cuts the rock core, can be diamond,

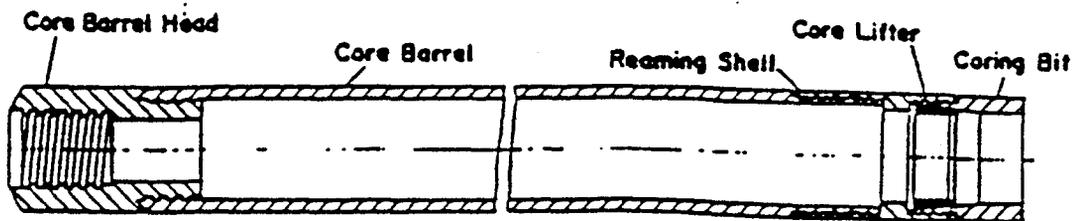


Fig. 1.37 Single tube core barrel. (Courtesy of Sprague & Herwood, Inc.)

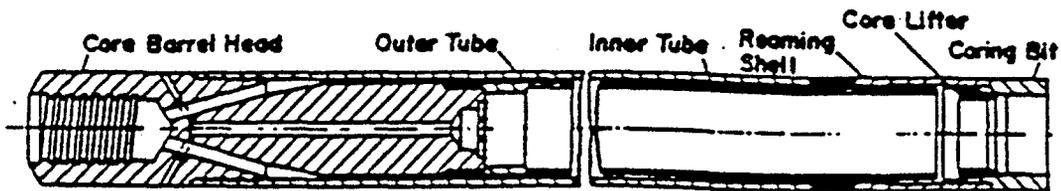
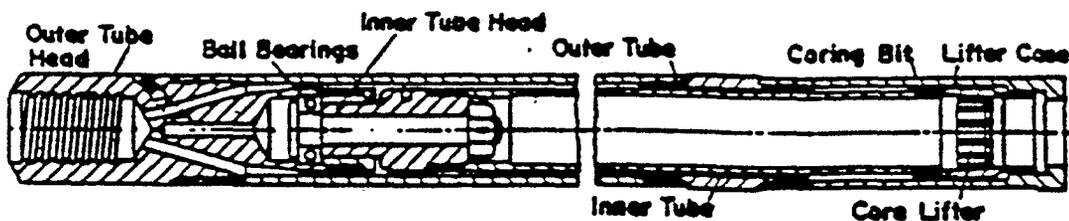


Fig. 1.38 Rigid type double tube core barrel. (Courtesy of Sprague & Herwood, Inc.)



Project No.	265-000
Procedure FP-10-1	

**Swivel Type Double
Tube Core Barrel**

Figure 3-5

carbide insert, or sawtooth (Figure 3-6). The reaming shell attaches the bit to the core barrel. The type and size of core barrels used depends on the depth, type of rock, and size of sample required. The three basic types of core barrels are (1) single tube, (2) double tube (rigid type and swivel type), and (3) triple tube.

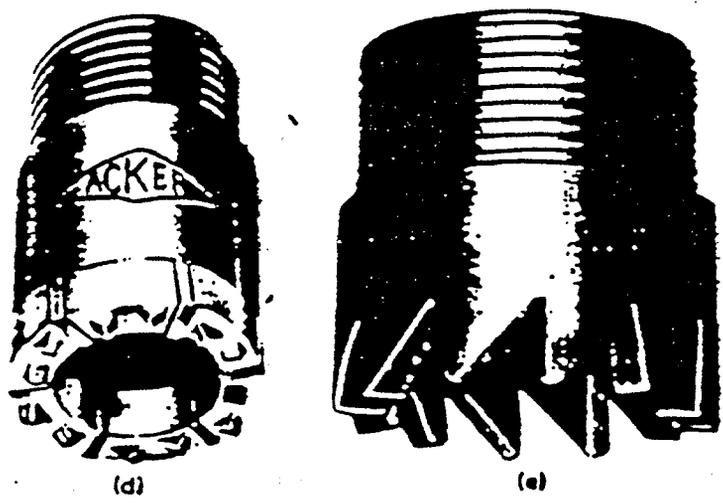
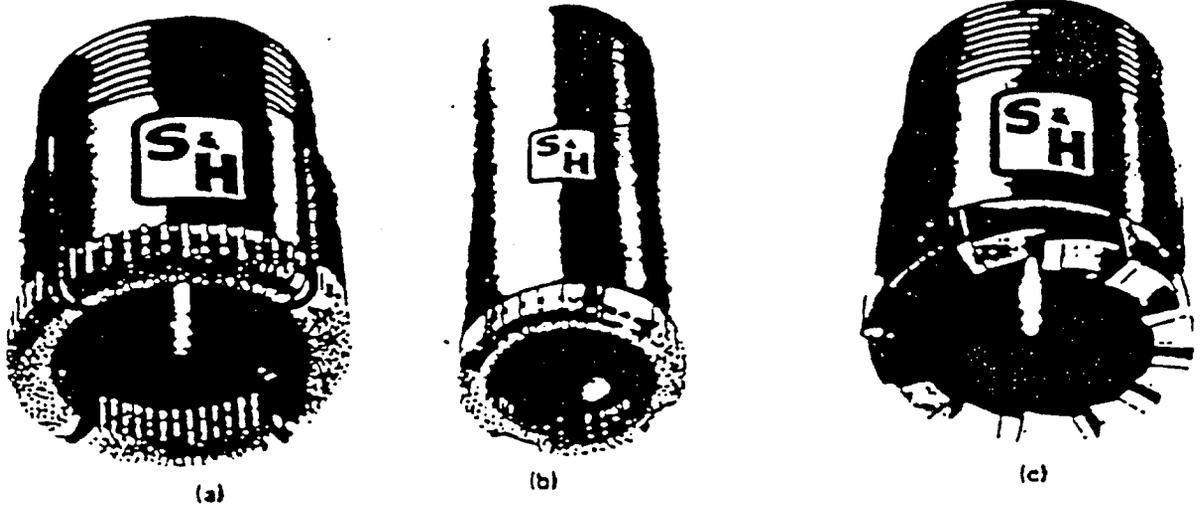
In operation, the core barrel is advanced by rotating and applying downward pressure while pressurized drilling fluid is introduced into the hole. With a single-core barrel, the fluid passes between the core and the core barrel wall, then carries the cuttings to the surface between the barrel and borehole wall. The double-tube core barrel allows drilling fluid to pass downward between the inner and outer core barrel, thereby lessening the erosive action of the fluid on the core. The double-tube core barrel is therefore best suited for sampling friable rock. Triple-tube core barrels have an inner retrievable liner within the liner barrel and are used to sample weak or broken rocks.

In general, a core barrel should be chosen to obtain close to 100 percent recovery of core from the weakest rock encountered.

Procedure

The procedure for rotary core barrel sampling is outlined in ASTM D 2113 and summarized below:

1. Begin core drilling until core blockage occurs or until the net length of the core barrel has been drilled in.
2. Remove core barrel from hole. Disassemble. Remove core. Resume coring.
3. Place recovered core in core box with upper end of core in upper left corner of core box, using spacer blocks to indicate any gaps in recovered core. Wrap soft or friable cores or those subject to material changes upon drying in plastic film or seal in wax.



(a) diamond with conventional waterways; (b) diamond with bottom discharge waterways; (c) carbide insert, blade type; (d) carbide insert, pyramid type; (e) sawtooth. (Courtesy of Sprague & Herwood, Inc. and Acker Drill Co., Inc.)

	Project No. 265-000 Procedure FP-10-1
Coring Bits	

Figure 3-6

4. Stop core drilling when soft materials or those with less than 50 percent recovery are encountered. Sample these horizons by another technique.
5. Record detailed observations concerning the occurrence of seams, fissures, cavities, and broken areas.

3.2 TRENCH SAMPLING

Backhoe or front-end loader trenching is a common, cost-effective method to characterize the shallow soils (less than 20 feet deep) on a site where a detailed investigation of soil structure is required. In addition to exposing soils for sample collection, trenching allows detailed visual observation of subsurface conditions, including soil stratigraphy and structural features. Bedding attitudes and depth to contacts between soil horizons can be measured directly. Trenching techniques are described in detail in Procedure FP-4, Trenching and Test Pits.

3.2.1 Backhoe Sampling

Equipment

Collection of samples from a trench is usually done from the backhoe bucket and can be accomplished with a stainless steel spade, shovel, and scoop which shall be carefully decontaminated between collection of each sample, per Procedure FP-1, General Field Procedures.

Soil samples can be collected in laboratory-supplied precleaned glass jars.

Procedure

In general, a backhoe is used to excavate a narrow trench as close as possible in width to the width of the backhoe bucket. The trenching supervisor should observe the excavation closely, and should indicate to the operator by use of hand signals when collection of a sample is desired. In many cases, the trenching supervisor will select the horizons to be sampled as trenching proceeds, based on visual observations of the soils such as staining, changes in texture, or color. Viewing of the trench should be done from a position at least 1 foot from the edge of the trench and from the end nearest to the backhoe. Each time a sample is collected, the depth should be measured with a tape and recorded on the excavation log (Form F-1029, Excavation Log; FP-4, Trenching and Test Pit).

Sampling with a backhoe requires the collection of samples from the backhoe bucket. Not all of the soil in the bucket is representative of the bottom of the trench. Soil from the trench walls may fall into the trench before the cut is made, and the bucket can scrape soil from the walls as it is being brought out of the trench. It is therefore necessary that the following procedure be followed when collecting samples from the backhoe bucket.

After making the cut, have the operator set the bucket down (with the soil still in it) at least 2 feet from the edge of the trench. Using a stainless steel scoop, scrape the first 3 inches of soil out of the bucket. The sample may now be collected from the center of the bucket. Avoid the soil 3 inches from either side and do not dig deep enough to reach the bottom 3 inches of soil. The sample container (glass jar) should be pushed into the soil in order to collect the sample. Sample information is recorded on Form F-1029, Excavation Log. The sample should then be handled according to the sampling procedures described in Procedure FP-10, General Sampling Procedure

If soil conditions do not permit the sample container to be driven into the soil, the sample may be collected by scooping soil into the container. These conditions may be encountered

in stiff clays or extremely rocky soils. In this case, the container should be tightly packed with soil to minimize the amount of headspace in the container. This is particularly important when the soil is to be tested for volatile organic compounds.

3.2.2 Front-End Loader Sampling

Sampling with a front-end loader involves the collection of a sample either from the loader bucket or by physically entering the trench. No one should enter a trench except under the conditions set out in Procedure FP-4 Trenching and Test Pit, Section 5.0, Safety Considerations. Collecting a sample from the loader bucket is similar to backhoe sampling (Section 3.2.1). The sample should be collected from the soil while it is still in the bucket. The first 3 inches to 5 inches should be removed with a stainless steel scoop and the sample container pushed into the soil to collect the sample. Sample information is recorded on Form F-1029, Excavation Log. The sample should then be handled according to the sampling procedures in Procedure FP-10, General Sampling Procedure

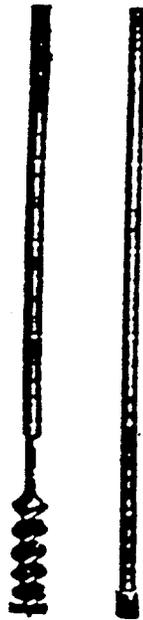
Samples can be collected from the floor of the trench using any of the methods described for shallow subsurface sampling in Section 3.3.

3.3 SURFACE AND SHALLOW SUBSURFACE SAMPLING

3.3.1 Hand Operated Auger

Applicability

Hand auger borings are a simple, inexpensive method of obtaining soil samples from relatively shallow depths above the water table (up to 20 feet). Several types of augers are available (Figures 3-7 and 3-8), including: (1) hand bucket augers, (2) "post-hole diggers" or Iwan-type augers, (3) small-diameter helical or screw type augers, and (4) spiral augers.



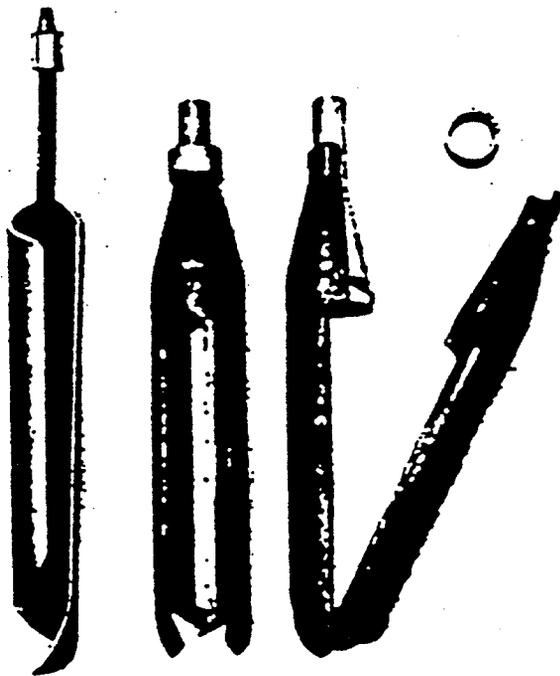
SMALL HELICAL AUGER



POSTHOLE OR IWAM AUGER

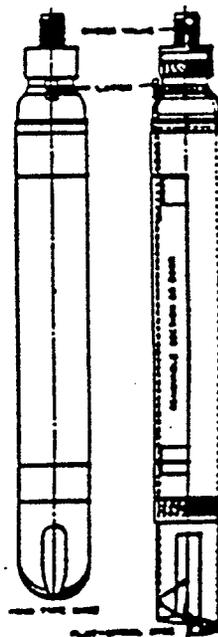


LARGE HELICAL OR WORM TYPE AUGERS



SPOON AUGER

VICKERS WINGED AUGER



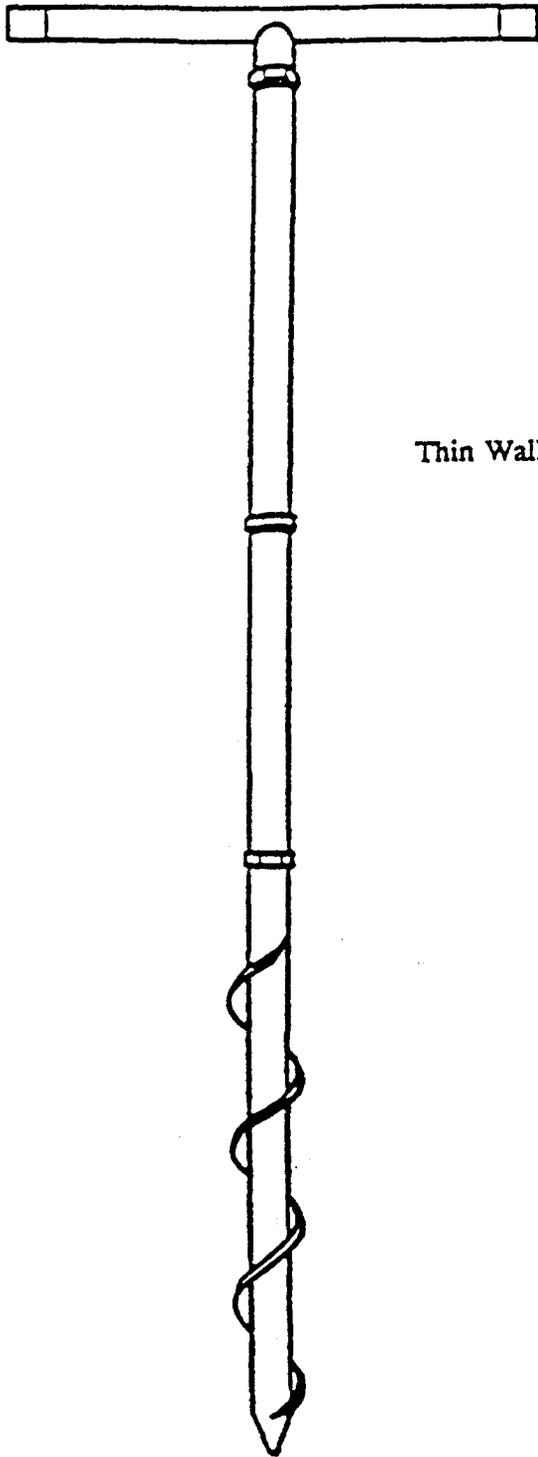
SPRAGUE & MENWOOD
BARREL AUGERS



BUCA CONTINUOUS
HELICAL AUGERS

	Project No. 265-000 Procedure FP-10-1
Hand Augers	

Figure 3-7



Thin Wall-Walled Tube Sampler



Bucket Auger



Project No.	265-000
Procedure FP-10-1	

Bucket Auger and Thin Wall-Walled Tube Sampler

Figure 3-8

Hand bucket augers are suitable for sampling all types of soil except loose saturated materials and hard or cemented soils. Helical or screw type augers with continuous flights are most useful for cohesive soils. Spiral augers are used for loose or gravelly soils.

3.3.1.1 Hand Bucket Augers

This system consists of a bucket auger, a series of rods, and a "T" handle. The bucket auger consists of a sample barrel that is composed of stainless steel and generally is 3 inches in diameter and 6 inches to 8 inches in length with an auger bit at the lower end (Figure 3-8). This sampling method can be used in many soil types, excluding coarse gravels, cobbles, and boulders, and is limited to sampling depths of approximately 5 feet to 10 feet below ground surface.

Equipment

- o Hand bucket auger, "T" handle, and extensions
- o Precleaned glass jars with Teflon™-lined lids
- o Cooler and ice
- o Labels (glass jars may be prelabeled).

Procedure

1. Attach the auger to a drill rod extension and further attach the "T" handle to the drill rod.
2. Clear the area to be sampled of any surface debris (twigs, rocks, litter). It may be advisable to remove the first 8 cm to 15 cm of surface soil for a radius of approximately 15 cm around the drilling location.

Soil and Rock Sampling
Procedure FP-10-1

3. Advance the precleaned hand auger into the soil by twisting the "T" handle. Dependent upon the length of the sample barrel, the auger is generally advanced in 6-inch intervals.
4. When the sample barrel is full, withdraw the auger and remove the soil from the barrel using a precleaned stainless steel extruder. After the soil has been removed, carefully place the auger back in the borehole and continue advancing the sample barrel.
5. When the desired sampling depth is achieved, remove the auger from the borehole, extrude the soil from the core barrel, and decontaminate the equipment. Decontaminate the auger prior to taking the sample then carefully place the auger back in the borehole and collect the sample by advancing the sample barrel.
6. After collecting the sample, withdraw the auger and extrude the soil into an appropriate sample container using the decontaminated, stainless steel extruder.
7. Check that a Teflon™ liner is present in the lid of the sample container, if required. Secure the lid tightly. Label the sample container with the appropriate sample tag, per Procedure FP-10, General Sampling Procedure. Record sample information on Form F-1026, Soil/Sediment Sampling Record.
8. Store the sample in an ice-filled cooler, and complete all chain-of-custody documents and record information in the field logbook, per Procedures FP-1, General Field Procedures, and FP-10, General Sampling Procedure.
9. Decontaminate equipment between sample locations and sampling intervals to minimize the potential for cross contamination, per Procedures FP-1, General Field Procedures and record the decontamination on Form F-1026, Soil/Sediment Sampling Record.

3.3.1.2 Screw Auger and Thin-Walled Tube Sampler

Equipment

- o Auger bit

- o Series of drill rods
- o "T" handle
- o Thin-walled tube corer
- o Precleaned glass jars with Teflon™-lined lids
- o Cooler and ice
- o Labels (glass jars may be prelabeled).

Procedure

The drill hole is advanced by manually rotating the auger while applying downward pressure. The procedure for sampling with a screw auger and thin-walled tube sampler is as follows (deVera et al., 1980):

1. Attach the auger to a drill rod extension and further attach the "T" handle to the drill rod.
2. Clear the area to be sampled of any surface debris (twigs, rocks, litter). It may be advisable to remove the first 8 cm to 15 cm of surface soil for a radius of approximately 15 cm around the drilling location.
3. Advance the precleaned hand auger into the soil by twisting the "T" handle, periodically removing accumulated soils. This prevents accidentally brushing loose material back down the borehole when removing the auger or adding drill rods.
4. After reaching the desired depth, slowly and carefully remove the auger from the boring. (Note: When sampling directly from the auger, collect the sample after the auger is removed from the boring and proceed to Step 10).
5. Remove the auger tip from the drill rods and replace with a precleaned thin-walled tube sampler. Install the proper cutting tip.
6. Carefully lower the corer down the borehole. Gradually force the corer into the soil. Care should be taken to avoid scraping the borehole sides. Hammering of the drill rods to facilitate coring should be avoided as the vibrations may cause the boring walls to collapse.

7. Remove the corer and unscrew the drill rods.
8. Remove the cutting tip and remove the core from the device.
9. Discard the top of the core (approximately 2.5 cm), which represents any material collected by the corer before penetration of the layer in question. Place the remaining core into the sample container.
10. Check that a Teflon™ liner is present in the cap, if required. Secure the cap tightly. Label the sample bottle with the appropriate sample tag, per Procedure FP-10, General Sampling Procedure.
11. Store the sample in an ice-filled cooler, and complete all chain-of-custody documents and record information on Form F-1026, Soil Sediment Sampling Record and in the field logbook, per Procedures FP-1, General Field Procedures, and FP-10, Sampling Procedure, General Requirements.
12. Decontaminate sampling equipment after use and between sampling locations, per Procedure FP-1, and record the decontamination on Form F-1026.

3.3.1.3 Acker Soil Sampling Kit. The "Acker Kit" consists of several types of augers and a variety of sampling tools in a compact carrying case. These tools can be used to recover representative samples from practically any material, except rock, within the limits of hand operation.

The Acker Soil Sampling Kit includes an open spiral auger, a closed spiral auger, and an Iwan post hole auger, all designed for two-person manual operation. The open spiral auger is best suited for dry clay and gravel, while the closed spiral auger is best suited for soft moist clays and loose soils. The Iwan post hole auger has a 3-foot shaft and carbon steel blades, and is useful in loose and loamy soils. The kit contains sufficient drill rod extensions to sample to a depth of 25 feet. The Acker kit also contains a steel probe, a chisel bit for rudimentary wash borings, and split-tube and thin-walled tube samplers. The latter two samplers are used to obtain undisturbed samples for laboratory analysis.

The kit contains several types of sample retainers for use with the split-tube sampler, including a basket retainer for loose dry material, a trap valve for watery muds, and a L.A.D. Sample Retainer for flowing sands. A pocket shoe, designed for collecting samples of loose sand and gravel, and a sawtooth shoe for compact or cemented soils, are included for use in place of the drive shoe with the split-tube sampler. These shoes screw directly onto the sampler.

In operation, the auger is advanced by connecting it to the drill rod and rotating with the drive head and handle following the procedure for screw augers and thin-walled tube samplers. To collect a drive sample, the sampler is connected to the drill rod and driven by attaching the drive head and striking it with a sledge. The sampler is driven 12 inches or to refusal, turned clockwise 1-1/2 turns to shear off the core, and is then carefully withdrawn to the surface.

Sample processing is as described above in Sections 3.3.1.1 or 3.3.1.2.

3.3.2 Soil Sampling with a Spade and Scoop

Applicability

The simplest, most direct way to collect surface or very shallow subsurface (several feet depth) samples is with a spade and scoop. This method cannot be used when undisturbed samples are required, but is adequate for collecting samples for chemical analysis. This method can be used for most soil types.

Equipment

Stainless steel scoop

Shovel or spade

Sample containers

Labels.

Procedures (from Ford et al., 1984)

1. Carefully remove the top layer of soil to the desired sample depth with a precleaned spade.
2. Using a precleaned stainless steel scoop or trowel, remove and discard a thin layer of soil from the area which comes in contact with the shovel.
3. Transfer the sample into an appropriate sample bottle with a stainless steel spoon or equivalent.
4. Check that a Teflon™ liner is present in the cap, if required. Secure the cap tightly. Label the sample bottle with the appropriate sample tag, per Procedure FP-10, General Sampling Procedure
5. Store the sample in an ice-filled cooler, and complete all chain-of-custody documents and record information on Form F-1026, Soil/Sediment Sampling Record and in the field logbook, per Procedures FP-1, General Field Procedures, and FP-10, General Sampling Procedure.
6. Decontaminate equipment after use and between sample locations, per Procedure FP-1, General Field Procedures, and record the decontamination on Form F-1026, Soil/Sediment Sampling Record.

4.0 RECORDS

Record requirements for soil and rock sampling are addressed in Procedures:

- o FP-1, General Field Procedures
- o - FP-2, Preliminary Investigation Procedures
- o FP-4, Trenching and Test Pit
- o FP-4-1, Tank Pulls
- o FP-10, General Sampling Procedure

Sample information for borehole samples is recorded on Form F-1009 - Borehole Log (FP-3, Borehole Drilling and Logging), sample information for trench and test pit samples is recorded on Form F-1029 - Excavation Log (FP-4, Trenching and Test Pit), or Form F-1028, Underground Tank Removal, Soil Sampling Report, (FP-4-1, Tank Pulls). Sample information for surface soil sampling and hand auger sampling is recorded on Form F-1026, Soil/Sediment Sampling Record, in this procedure. Chain of custody and field logbook procedures are discussed in FP-10, General Sampling Procedure and FP-1, General Field Procedures, respectively.

5.0 REFERENCES

- Acker, W.L. III, 1974. Basic Procedures for Soil Sampling and Core Drilling.
- American Society for Testing and Materials, 1987. Annual Book of ASTM Standards, Section 4 - Construction, Volume 4.08, Soil and Rock; Building Stones; Geotextiles: D 3550-84, "Standard Practice for Ring-lined Barrel Sampling of Soils"; D 4220-83, "Standard Practices for Preserving and Transporting Soil Samples"; D 1586-84, "Standard Method for Penetration Test and Split-Barrel Sampling of Soils"; D 1587-83, "Standard Practice for Thin-Walled Tube Sampling of Soils"; D 2113-83, "Standard Practice for Diamond Core Drilling for Site Investigation"; D 1452-80, "Standard Practice for Soil Investigation and Sampling by Auger Borings."
- Barth, D.S., and B.J. Mason, 1984. Soil Sampling Quality Assurance User's Guide, prepared for Environmental Monitoring systems Laboratory, Las Vegas, Nevada, under cooperative agreement CR 810550-01, EPA-600/4-84-043, March, 1984.
- deVera, E.R., B.P. Simmons, R.D. Stephens, and D.L. Storm, 1980. "Samplers and Sampling Procedures for Hazardous Waste Streams," EPA 600-2-80-018, January 1980.
- Ford, P.J., Turina, P.J., and Seely, D.E., 1984. Characterization of Hazardous Waste Sites - A Methods Volume II Available Sampling Methods, prepared for Lockheed Engineering and Management Services Company, Inc., under EPA Contract Number 68-03-3050, Las Vegas, Nevada.
- Hvorslev, M.H., 1949. Subsurface Exploration and Sampling of Soils for Engineering Purposes, American Society of Civil Engineers, Waterways Experiment Station, Vicksburg, Mississippi, November, 1949.
- Mason, B.J., 1983. Preparation of Soil Sampling Protocol: Techniques and Strategies, prepared under contract to the U.S. EPA, Environmental Monitoring Systems Laboratory - Las Vegas, under contract No. CR 808529-01-2, August 1983.
- Tomlinson, M.J., 1980. Foundation Design and Construction, Pitman Publishing Limited, Fourth edition.
- U.S. Army Corps of Engineers, 1972. Engineering and Design, Soil Sampling, March 31, 1972, EM 1110-23-1907.
- Winterkorn, H.F., and Hsai-Yang Fang, eds, 1975. Foundation Engineering Handbook, Van Nostrand Reinhold Company, Inc.

6.0 FORMS

<u>Form No.</u>	<u>Title</u>
F-1009	Borehole Log
F-1026	Soil/Sediment Sampling Record
F-1028	Underground Tank Removal, Soil Sampling Report
F-1029	Excavation Log

Borehole Log

Project Name:						Project Number:								
Borehole Location:						Borehole No.			Sheet 1 of					
Drilling Agency:						Driller:								
Drilling Equipment:						Date Started:			Total Depth (feet):					
Drilling Method:						Date Finished:			Depth to Bedrock (feet):					
Drilling Fluid						Number of Samples:			Depth to Water (feet):					
Completion Information:						Borehole Diameter (in):			Elevation and Datum:					
						Logged by:								
Depth (feet)	Sample				Field Analysis		LOG		Checked by:			Date:		
	Number	Interval	Blow Count	Recovery	Time	FID (ppm) S/B*	PID (ppm) S/B*	Graphic	USCS or Rock Type	Lithologic Description			Remarks	
5														
10														
15														
20														
25														
30														

Key

* S/B = Sample reading / background reading;

NA = not analyzed

Soil / Sediment Sampling Record

Project Name _____	Project Number _____
Location _____	Sample Number _____
Recorded By _____	Duplicate Number _____
Date _____	Checked by _____
Site _____	Date _____

Sampling Equipment _____

Sample Type: Soil Sediment Rock

Sample Type Description

USCS Soil Type _____

Color _____

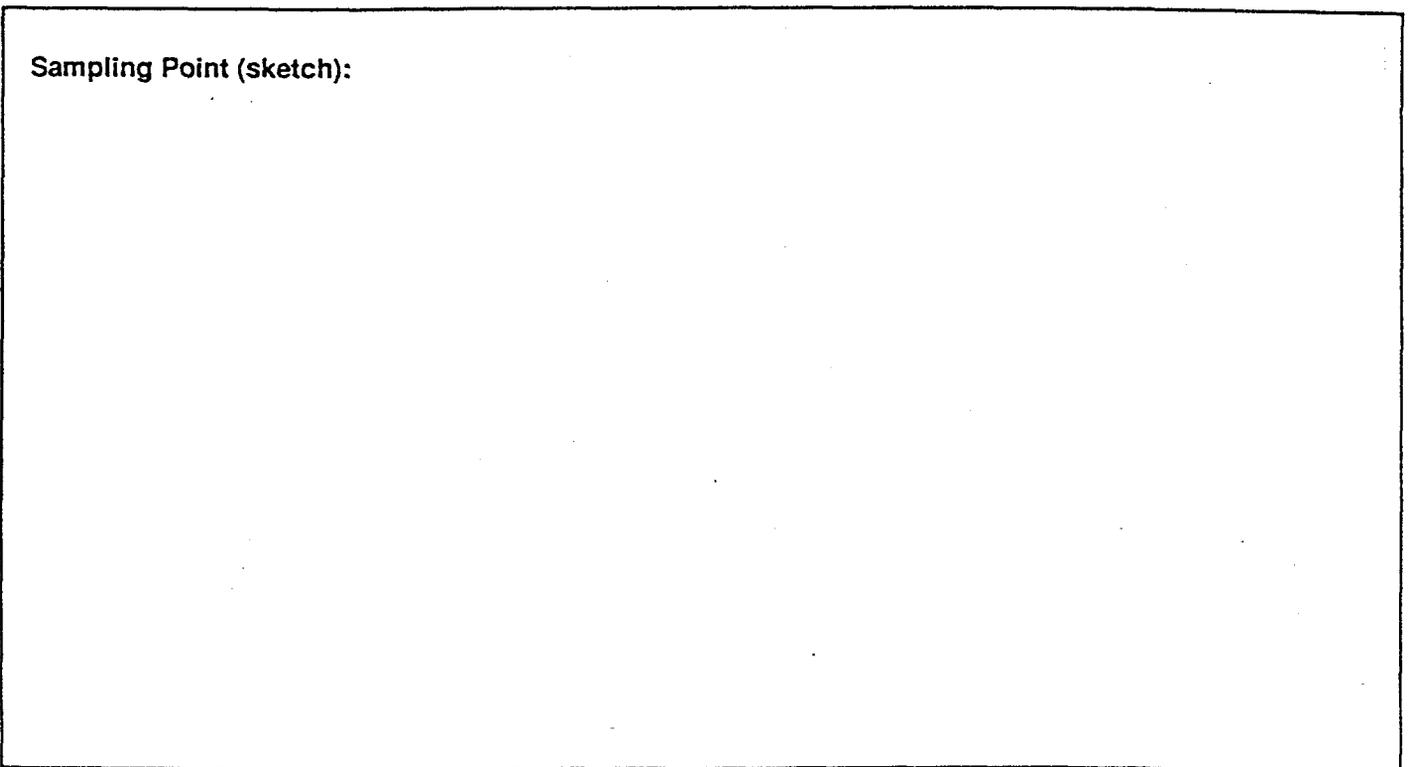
Odor _____

Depth _____

Number of Samples _____

Comments _____

Sampling Point (sketch):



APPENDIX E

FP - 4

TRENCHING AND TEST PIT PROCEDURES

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1.0 INTRODUCTION	1
1.1 PURPOSE AND OBJECTIVE	1
1.2 SCOPE	1
2.0 PLANNING PROCEDURES	3
2.1 GENERAL	3
2.2 PRELIMINARY TRENCHING AND TEST PIT PROCEDURES	4
3.0 EXCAVATION PROCEDURES	5
3.1 EQUIPMENT	5
3.1.1 Excavation Equipment	5
3.1.2 General Field Equipment	6
3.2 TRENCH AND TEST PIT EXCAVATION	6
3.2.1 Backhoe Trenches and Test Pits	7
3.2.2 Front-End Loader Trenches and Test Pits	8
3.3 SAMPLING	9
3.3.1 Disturbed Samples	9
3.3.2 Undisturbed Samples	10
3.4 DECONTAMINATION	11
3.5 TRENCH AND TEST PIT CLOSURE	11
4.0 RECORDS	12
5.0 SAFETY CONSIDERATIONS	13
6.0 BIBLIOGRAPHY	17
7.0 FORMS	18

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>	<u>Page</u>
5-1.	Approximate Angle of Repose for Sloping of Trench Excavation Walls	15
5-2.	Subsidence, Bulging, Tension Cracks, and Overhangs in Excavation Walls	16

1.0 INTRODUCTION

Backhoe or front-end loader excavating is a common, cost-effective method of investigating the shallow soil (less than 20 feet below grade) on a site. Trench excavations and test pits are useful investigative tools for many situations including: (1) exploratory characterization of a site for the existence of contaminated soils, (2) assessment of the approximate extent, depth, and concentration of soil contaminants, and (3) investigations in tight places such as underground storage tanks.

1.1 PURPOSE AND OBJECTIVE

This document provides procedures to be followed during excavation and soil sampling of trenches and test pits. The objective of the Trenching and Test Pits Procedure is to standardize the method for backhoe and front-end loader (or bulldozer) excavating. This will ensure that the data collected from the trench or test pit accurately represents the subsurface conditions of the area being monitored while ensuring the safety of the field crew.

1.2 SCOPE

This procedure covers the following topics:

- o Planning
- o Excavation Equipment
- o Sampling Equipment
- o Excavation
- o Sampling
- o Decontamination
- o Trench and Test Pit Closure

Trenching and Test Pit
Procedure FP-4

- o Records
- o Safety Considerations
- o Forms.

2.0 PLANNING PROCEDURES

2.1 GENERAL

Trenching and test pit excavations will be described in the Work Plan that is developed for each project site. In addition to the standard information required by Procedure FP-1, the scope of work will include the following information:

1. A description of the trenching and test pit program to be performed by TETC and the subcontractor, including:
 - o Number of excavations
 - o Excavation location
 - o Excavation orientation
 - o Excavation depth
 - o Number and depth of samples
 - o Laboratory analyses required for samples.
2. Excavation closure procedures including backfill specification, i.e., material, compaction requirements, etc.
3. Decontamination requirements for excavation buckets, sampling tools, testing equipment, site vehicles, etc. The type of decontamination equipment required should be stated.
4. Excavation schedule.

5. Safety requirements, as presented in the site Health and Safety Plan.
6. Permit requirements.

These requirements can be dependent on site conditions and may be modified by the TETC field representative, per QA Procedure 3E, Field Changes.

The TETC field representative will be responsible for the following:

1. Becoming familiar with the Work Plan.
2. Initiating purchase requisition form(s) and writing the subcontractor's scope of work, per QA Procedure 4A, Procurement.
3. Acquiring clearances and permits required for the excavation. Copies of permits should be kept on site at all times.
4. Arranging for subsurface clearance for the excavation locations.

2.2 PRELIMINARY TRENCHING AND TEST PIT PROCEDURES

Prior to excavating the trench or test pit at the site, the TETC field representative shall:

1. Locate and flag the trench or test pit locations designated by the Work Plan.
2. Ensure that the excavating equipment is of the type specified in the purchase requisition and is in satisfactory operating condition.
3. Ensure that the equipment operator is equipped with appropriate safety equipment as specified in the site Health and Safety Plan.

3.0 EXCAVATION PROCEDURES

3.1 EQUIPMENT

3.1.1 Excavation Equipment

Excavation equipment can be broadly divided into two categories: (1) backhoes, and (2) front-end loaders (including bulldozers).

Backhoes. Backhoes are generally the best choice for trenching and test pits. A backhoe excavates from a stationary position, and therefore, does not drive over the freshly exposed material. Backhoes can excavate trenches as narrow as 10 inches, thus reducing the amount of material excavated and disturbing very little area. This can be especially beneficial where contaminated soil is involved and it is desirable to characterize the existence and/or extent of the contaminated soil with a series of small trenches. Backhoes can operate and excavate in tight areas (such as for underground storage tanks).

Front-end Loaders. The front-end loader is an excavator and not a trenching or test pit piece of equipment. It excavates coarsely and has the potential of mixing noncontaminated with contaminated soil. This is extremely undesirable; therefore, the front-end loader should be used for trenching and test pits only in very specialized circumstances, or when large volumes of soil need to be removed.

Front-end loaders or bulldozers are used when it is not possible to use a backhoe, for example when materials are too cohesionless or too stiff for a backhoe, or in terrain that is too steep. The width of the excavation is the width of the bucket or blade, which is no smaller than the

width of the piece of equipment. Front-end loader trenches and test pits are useful when geologic logging of the excavation wall is required or when it is required that the sample collector physically enter the trench or test pit (see Safety Considerations, Section 5.0).

3.1.2 General Field Equipment

The TETC field representative is responsible for assuring that all field supplies required for the job are on site. Site specific requirements will dictate specific equipment needs.

3.2 TRENCH AND TEST PIT EXCAVATION

Trenches and test pits will be excavated in accordance with the scope of work. This includes, but is not limited to: (1) excavating in the flagged location, (2) excavating to the depth required, and (3) following the applicable safety requirements. The TETC field representative will supervise the excavation to ensure that the operation is conducted in accordance with specified requirements. These requirements can be dependent on site conditions and may be modified, if necessary, by the TETC field representative, per QA Procedure 3E, Field Changes.

Assuming that the trench or test pit location has been cleared of any subsurface interferences and all personnel are wearing the appropriate safety equipment, the excavation can begin. All required information and a sketch of the excavation shall be recorded on the excavation log, Form F-1029.

Trenching and Test Pit
Procedure FP-4

A minimum two-person crew, in addition to the excavating equipment operator, shall be used for trenching and test pit work at a hazardous waste site. Larger crews may be required if unusually hazardous conditions may be encountered or the scope of work requires additional staffing. One person on site must function as the Health and Safety Officer to monitor compliance with health and safety requirements. Other duties that may be required include sampling operations, both chemical and/or geotechnical, and soil or rock descriptions. The personnel on site may divide the required duties according to their capabilities.

3.2.1 Backhoe Trenches and Test Pits

Unless caving occurs during excavation, the backhoe trench width is to be no more than the bucket width, while test pits may be as wide as is necessary. The walls of the excavation shall be cut as near vertical as safety permits. The operator should be informed on which side of the trench or test pit the excavated material is to be deposited. The excavated material should be placed at least 2 feet from the edge of the trench or test pit to minimize stress loads at the edge of the excavation. If there is a definite visual distinction between contaminated and noncontaminated soil, create a separate pile for each material. The operator should be made to understand the significance between the two, and the TETC field representative should observe the excavation closely and indicate to the operator into which pile each bucket of material is to be deposited. If there is a possibility that any contaminated soil is in the bucket, then it shall be deposited in the contaminated pile. The "clean" pile should be sampled or screened to verify that it is free from contamination according to the Work Plan. It may also be desirable to have the excavated material spread out. In this way, the change in material with depth can be viewed. This may not be possible due to the terrain and the excavation depth; it is also time-consuming and, therefore, possibly not cost effective.

Rev. 1
3/1/91

During excavation, the safest position to stand is at the end of the trench or test pit nearest to the backhoe and on the opposite side of the deposited material. While it is tempting to stand near the excavated, deposited soil, it is not advisable as the backhoe bucket is moving in and out of this area and the operator should have full view of all personnel at all times. To view the material being excavated, the site supervisor can direct the operator to set the bucket down (with the soil still in it), take a handful of soil, and direct the operator to continue, if necessary. Personnel should stay at least 1 foot from the edge of the excavation. The only reason for standing near the edge is to measure the excavation depth. Any viewing of the excavation should be done from the end near the backhoe.

Hand signs should be developed so that quick communication between the operator and the TETC field representative is possible (the backhoe can be very noisy when operating). The most important hand sign is "stop," which is universally indicated by an upright closed fist. Continuous monitoring of the equipment operator is essential to ensure that the excavation operation is in accordance with the requirements stated in the scope of work.

Note: Do not excavate trenches or test pits immediately adjacent to a building or structure without procedures for underpinning or stabilizing the foundation.

3.2.2 Front-End Loader Trenches and Test Pits

A front-end loader's trenches and test pits are very large -- usually no less than 6 feet wide. The machine will drive through the trench or test pit itself while excavating, so the TETC field representative should use the side walls for in situ soils logging and sampling. If it is desirable to collect a sample from the excavation floor, the equipment operator can be instructed to back out of the excavation after making a cut. While having the front-end loader on site, it may be

Rev. 1
3/1/91

Trenching and Test Pit Procedure FP-4

desirable to increase the trench or test pit size to completely excavate the contaminated soil. In some cases, the front-end loader excavation will remove the majority of the material. As with the backhoe, it is important to determine where the excavated soil is to be deposited (separate contaminated and noncontaminated soils). All personnel should stay in full view of the operator (never walk behind an operating front-end loader), and hand signs should be developed for quick communication. Continuous monitoring of the front-end loader is essential to ensure that the excavation operation is in accordance with the requirements stated in the scope of work.

3.3 SAMPLING

The objective of any sampling program is to produce a set of samples representative of the area under investigation. If contaminated soil is known to exist, a trench or test pit excavation program may be conducted to locate the extent, depth, and concentration of the contaminant. Field analytical techniques may be employed to screen soil samples to define the approximate boundary of contamination. Trench or test pit samples shall be collected, preserved, labeled, handled, stored and shipped, per Procedure FP-10, General Sampling Procedures; FP-10-1, Soil Sampling; and the Work Plan. Sample information shall be recorded on Form F-1029.

3.3.1 Disturbed Samples

Disturbed samples are those that have been collected in a manner in which the in situ physical structure and fabric of the soil have been disrupted. Disturbed sampling techniques typically include sampling from the walls or floors of the trench or test pit by means of scraping or digging with a trowel, rockpick, or shovel. Disturbed samples may also be collected directly from a backhoe or front-end loader bucket during excavation; however, care must be taken to assure that the sample is actually from the unit desired and does not include slough or scraped

Rev. 1
3/1/91

Trenching and Test Pit Procedure FP-4

material from the sides of the trench or test pit. Therefore, it is necessary that the following procedure be followed when collecting samples from the backhoe bucket.

After making a cut, have the operator set the bucket down (with the soil still in it) at least 2 feet from the edge of the excavation. Using a clean stainless steel spatula, scrape the first 3 inches of soil out of the bucket. The sample may now be collected from the center of the bucket. Avoid the soil 3 inches from either side of the bucket, and do not scrape so deep as to encounter the bottom 3 inches of soil. The sample container (glass jar or metal sleeve) should be pushed into the soil in order to collect the sample. The soil in the bucket should be logged according to Procedure FP-3, Borehole Drilling and Logging, and the sample handled according to Procedure FP-10, General Sampling Procedures.

3.3.2 Undisturbed Samples

"Relatively undisturbed" samples can be obtained from trenches and test pits. Typically, an undisturbed sample is collected by isolating by hand a large cube of soil at the base or side of the excavation. This sample can be cut using knives, shovels, and the like. Care is taken to keep disturbances to a minimum. After the block of soil is removed, it is placed in an airtight, padded container for shipment to the lab. The overexcavated sample is "trimmed" at the laboratory to the size required for the designated test. In some instances (e.g., in soft cohesive soil), it may be possible to get an undisturbed sample by pushing a Shelby tube sampling device into an undisturbed portion of the test pit, or in the bucket of a backhoe. The soil in the side wall should be logged according to Procedure FP-3, Borehole Drilling and Logging, and the sample should be handled according to Procedure FP-10, General Sampling Procedures, if required by the Work Plan.

3.4 DECONTAMINATION

If decontamination is required (see Work Plan), the decontamination procedures in Procedure FP-1, General Field Procedures, and the Work Plan shall be followed.

The backhoe or front-end loader are usually decontaminated by steam cleaning between trenches or test pits upon completion of field activities. Sampling equipment and tools are decontaminated prior to and after taking a sample.

3.5 TRENCH AND TEST PIT CLOSURE

Trench or test pit excavations will be backfilled upon completion unless it is otherwise explicitly stated in the Work Plan. If an excavation is to be left open, it will be cordoned off with yellow rope or caution tape. Excavations should not be left open on a site without a perimeter fence. For long-term situations, provisions should be made for a more permanent enclosure of the open trench or test pit (these provisions are to be specified in the scope of work and/or site Health and Safety Plan).

If an excavation is designated for closing, it is to be backfilled and compacted according to the requirements of the Work Plan, permits, special stipulations, local regulations, and/or contract specifications, as applicable. The TETC field representative shall check the excavation for conformance to the appropriate requirements.

4.0 RECORDS

A Project Field Notebook must be kept, and all observations, measurements, and other pertinent information shall be recorded in this log or on the appropriate data sheets. A field logbook shall be maintained per Procedure FP-1, General Field Procedures. Trenching-related information that shall be entered in the field logbook includes:

- o Site/location
- o Date of excavation
- o Name of subcontractor and equipment operator
- o Type of excavating equipment used
- o Trench or test pit identification number
- o Elevation of the trench or test pit
- o Depth and length of trench or test pit
- o Depth to groundwater, if encountered
- o Visual description of the soil using the Unified Soil Classification System
- o Depth of each sample and sample number
- o Remarks on miscellaneous conditions (i.e., caving, odors, soil discoloration, etc.).

In addition to the field logbook, an Excavation Log (Form F-1029) shall be completed for each trench or pit.

5.0 SAFETY CONSIDERATIONS

Field operations call for several safety considerations. The combination of open excavations and heavy equipment is a dangerous one; therefore, it is necessary that all the safety procedures described in this section are followed completely.

Generally, it is not advisable for persons to enter a trench or test pit. Optimally, a backhoe will be used with samples collected from the bucket and the excavation closed immediately afterward. Since conditions may arise in which an individual must enter a trench or test pit, the following safety considerations have been devised.

Several of the hazards to consider when entering a trench or test pit are:

1. Death by suffocation or crushing when falling soil buries a worker.
2. Equipment, rocks, dirt, or tools falling on a person in the excavation.
3. Falls by persons when climbing into or out of the excavation.
4. Encountering toxic or irritating soils, vapors, liquids or flammable vapors.

According to the Code of Federal Regulations, Subpart P, Part 1926:

- o Banks more than 5 feet high shall be shored or laid back to a stable slope
- o Excavations less than 5 feet deep shall also be effectively protected when examination of the ground indicates hazardous ground movement may be expected

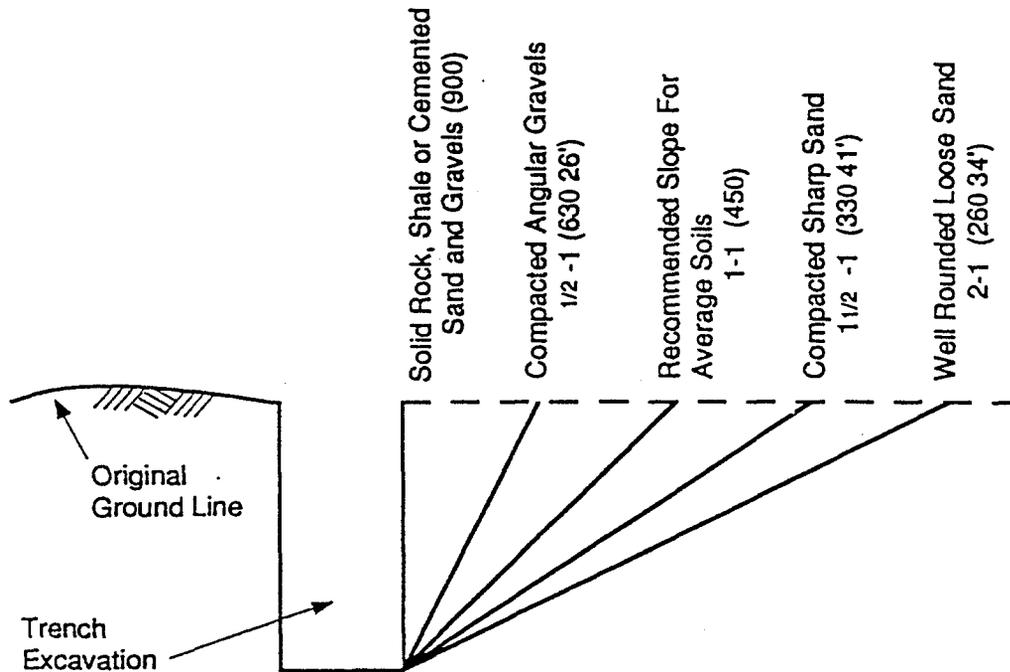
Trenching and Test Pit
Procedure FP-4

- o When employees are required to be in trenches 4 feet deep or more, an adequate means of exit, such as a ladder or steps shall be provided and located so as to require no more than 25 feet of lateral travel.

The Earth Technology Corporation procedure for entering an excavation follows the OSHA requirements:

- o No person will enter an excavation more than 5 feet in depth without proper shoring (per OSHA) or without the side walls having a stable angle of repose for the soil type encountered (Figure 5-1). An angle of repose of 1:1 (or 45°) is considered acceptable for most soils and shallow trenches and test pits (this will be addressed in the scope of work and/or site Health and Safety Plan).
- o Any time an excavation is entered, no matter what depth, the excavation should be examined for tension cracks, bulging, or other indications of cave-ins or slides (Figure 5-2).
- o There must be at least two persons present at the immediate site before entry into the trench or test pit by one of the investigators.
- o No person will enter a trench or test pit without monitoring the excavation air space and/or without wearing the proper personal protective equipment as per the site Health and Safety Plan.

A qualified subcontractor should be brought in for any sheeting or bracing (shoring) needed.



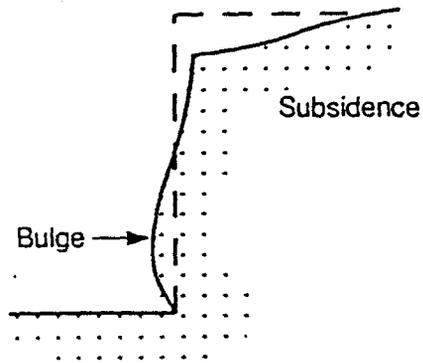
Note:
Clays, silts, loams or non-homogenous soils require shoring and bracing.

The presence of groundwater requires special treatment.

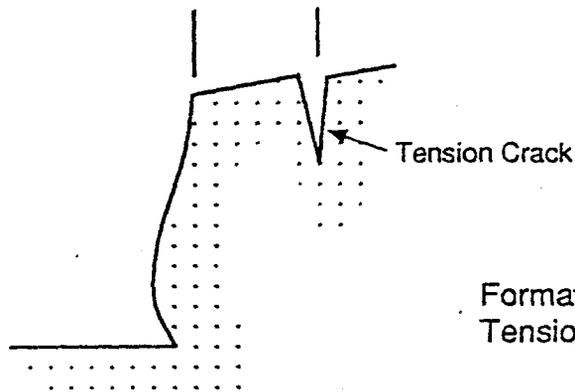
Source: U.S. Department of Labor, 1986

	Trenching and Test Pit Procedure FP-4
--	---------------------------------------

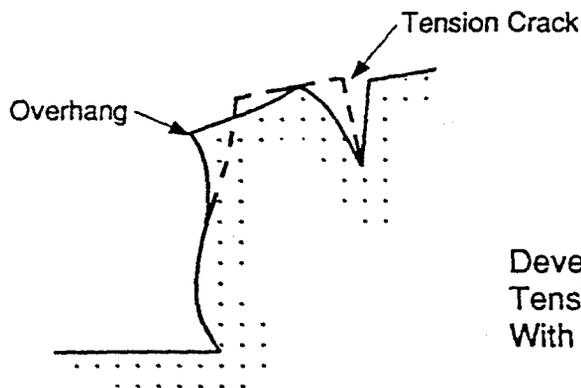
Approximate Angle of Repose for Sloping of Trench Excavation Walls



Profile of Excavation Showing Subsidence and Bulging



Formation of Tension Cracks



Development of Tension Crack With Overhang

Source: U.S. Department of Labor, 1982

Trenching and Test Pit
Procedure FP-4

**Subsidence, Bulging,
Tension Cracks, and Overhangs
in Excavation Walls**

Rev 1 3/1/91

Figure 5.2

6.0 BIBLIOGRAPHY

- Coia, M. F., and M. H. Corbin, 1984. Applying an Innovative Approach to Field Investigations at a Remedial Action Site, Proceedings of the Environmental Systems Symposium, Bethesda, Maryland.
- Compton, R., 1962. Manual of Field Geology, John Wiley & Sons, Inc., New York, NY.
- Fugro Inc., 1975. Trenching (Backhoe/Bulldozer), Fugro, Inc., Long Beach, California.
- U.S. Department of Labor, Occupational Safety and Health Administration, 1986. Occupational Safety and Health Standards for the Construction Industry, Code of Federal Regulations, Title 29, Part 1926, Subpart P.
- U.S. Environmental Protection Agency, 1984. Sampling for Hazardous Materials, Office of Emergency and Remedial Response, Hazardous Response Support Division, Cincinnati, Ohio.
- U.S. Environmental Protection Agency, 1987. A Compendium of Superfund Field Operations Methods, Office of Emergency and Remedial Response, Washington D.C.

7.0 FORMS

<u>Form No.</u>	<u>Title</u>	<u>Dated</u>
F1029	Excavation Log	2/15/91

APPENDIX F

FP - 10 - 5

SOIL GAS SURVEY PROCEDURES

TABLE OF CONTENTS

1.0	INTRODUCTION	1
2.0	PLANNING	2
2.1	GENERAL APPLICABILITY	2
2.2	SAMPLING DESIGN	2
2.3	STAKING AND SITE CLEARANCE	3
3.0	FIELD SAMPLING PROCEDURES	4
3.1	PROBE INSTALLATION	4
3.2	SAMPLING COLLECTION	4
3.3	LOGGING PROCEDURE	5
3.4	DECONTAMINATION PROCEDURE	5
4.0	ANALYTICAL PROCEDURES	9
4.1	ANALYTICAL METHODS - MODIFIED EPA METHODS 601 AND 602	9
4.2	ANALYTES AND REPORTED QUANTIFICATION LIMITS	9
4.3	CALIBRATION PROCEDURES	11
4.4	QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES	12
4.4.1	Sample Control	12
4.4.2	Control Samples	12
4.4.3	LABORATORY CONTROL SAMPLES	12
5.0	REPORTING	15
6.0	HEALTH AND SAFETY	16
7.0	REFERENCES	17

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>	<u>Page</u>
3-1	Report Summary	6
3-2	Sample Log	8
4-1	Chain-of-Custody	13

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
4-1	Reported Quantification Limits	10

1.0 INTRODUCTION

Soil gas surveys are used as an assessment tool in the investigation of waste sites. The soil gas survey was developed to investigate subsurface contamination from volatile organic compounds by measuring the concentration of their vapors in shallow soils.

All soils contain inter-granular voids that are either filled with fluid or occupied by air or gas. The air or gases that fill these spaces are referred to as soil gas. Volatile organic compounds establish a vapor phase plume in the inter-granular space in the vadose zone above contaminated areas, and soil gas surveys exploit this process to obtain information that can be used both for contaminant source detection and plume delineation. The rapid acquisition of environmental samples, short turnaround time of data, and capability to thoroughly screen large areas, makes the soil gas data available to focus or redirect project resources.

2.0 PLANNING

2.1 GENERAL APPLICABILITY

The applicability of soil gas techniques to identifying or delineating contamination is dependent upon site- and chemical-specific factors. The key site-specific consideration is the presence of a continuous subsurface source-to-atmosphere contaminant vapor concentration gradient. Soil gas technology can be effectively employed in these situations, which typically are present in unconsolidated soils above water table aquifers. Environmental settings that contain conditions to impede or retard the formation of this vapor-phase gradient (barriers such as confined aquifers or soils impermeable to gas-phase diffusion) are not amenable to soil gas investigation techniques. Best results are obtained at sites where groundwater is at depths greater than 10 feet, due to more consistent vapor-phase contaminant profiles.

Chemical-specific considerations are closely tied to the study objectives. For studies designed to identify source areas, indicator chemicals that preferentially partition to soil are used. Where migration and plume delineation efforts are paramount, indicator compounds that preferentially partition to groundwater should be chosen. Quantitative studies that incorporate both types of indicator chemicals allow for this type of analysis to be completed for source detection and plume delineation.

2.2 SAMPLING DESIGN

Samples are collected at regular intervals by employing a sampling grid. Grid spacing is typically two to four times the depth to groundwater for shallow aquifers. Fifty- to 100-foot grid spacings are frequently employed for screening large areas.

Soil gas sampling points are plotted on a map of each site in the area of estimated contamination, using a rectilinear grid pattern where possible. These maps are typically

included in the Field Sampling Plan (FSP). A portion of the potential sampling points may be held in reserve to track contamination plumes, if present.

2.3 STAKING AND SITE CLEARANCE

Sampling locations will be checked in the field against the site plan and the proposed locations. Sampling locations are typically located by using a tape and compass, with appropriate measurements double-checked to known landmarks to ensure accuracy. Each sample location is marked with paint, a wooden stake, or a wire flag.

Soil gas sampling points in areas where subsurface obstructions may exist will be cleared by either site personnel or geophysical techniques as specified in the FSP.

3.0 FIELD SAMPLING PROCEDURES

3.1 PROBE INSTALLATION

At each location, a 0.5-inch-diameter hole will be made to the sampling depth (3 feet to 5 feet) by using a slide hammer, which consists of a 0.5-inch-diameter steel rod with a sliding weight attached to one end. The rod is driven into the ground by a reciprocating motion manually applied to the weight). The rod is then removed and a stainless steel probe inserted to the full depth of the hole and sealed off from the atmosphere using a biodegradable sealant. An electric hammer drill is used to penetrate pavement, where necessary, prior to using the slide hammer. Holes in the pavement will be repaired with appropriate surface material upon completion of sampling.

3.2 SAMPLING COLLECTION

Prior to sample collection, the sampling probe and apparatus (including valves and injection needle) are purged with a volume of filtered ambient air (approximately 70 times the void space volume of the sampling system) prior to each sample extraction using a manual syringe pump. The sampling apparatus is then purged with in situ soil gas approximately 25 void space volumes of the sampling system. This in situ soil gas, which is withdrawn through the probe and used to purge the filtered air from the sampling equipment, is then vented to the atmosphere. A second sample of in situ soil gas is withdrawn and encapsulated in a preevacuated, precleaned EPA protocol Level B glass vial at 15 psig (pounds per square inch, gage) pressure.

Field control (ambient) samples and field duplicates will be taken as specified in Section 4.4.2.

3.3 LOGGING PROCEDURE

The following information will be logged for each sampling point (Figures 3-1 and 3-2):

- o Sample number
- o Probe depth
- o Apparent moisture content (dry, moist, saturated) of the sampled zone
- o Type and thickness of cover materials (concrete, asphalt, soil)
- o Soil gas purge rate and pump vacuum (mm Hg)
- o Weather conditions
- o Notes or comments on any factors that may affect analytical results.

3.4 DECONTAMINATION PROCEDURE

The following decontamination procedure will be performed prior to sample collection at each site:

- o The slide hammer bar will be washed with a Contrad cleaner/distilled water solution, and wiped dry with clean paper towels
- o The slide hammer bar will be rinsed with distilled water and then dried with clean paper towels
- o The exterior of the sampling probe will be washed with Contrad/distilled water, and scrubbed with clean paper towels
- o The interior of the sampling probe will be flushed with Contrad/distilled water and purged for approximately 30 seconds with 20 psi of ultra-zero grade air, prepurified nitrogen, or filtered ambient air.

REPORT SUMMARY

JOB CODE:

Survey date(s): _____

Site description: _____

Remarkable sample locations and situations: _____

Weather changes: _____

Survey on: Site property? _____ Adjacent property? _____

Details: _____

Number of samples:	Manual	Hydraulic	Other
Soil Gas			
H ₂ O			
Soils			
Ambient Air			
Product			
Other			

Number of Duplicates: _____ Itemize: _____

Unsampled stations: _____

Reason for unsampled stations: _____

Number of QA/QC Blanks: _____ Itemize: _____

Gas used: _____ Purity grade: _____

Average sampling depth: _____

Variations: _____

Reasons: _____

Initials _____

Project No.	265-000
Procedure FP-10-5	

Report Summary

8

SAMPLE NUMBER	AREA		SURFACE	SUBSURFACE	PROBE INFO.		DEPTH	ROTARY HAMMER SLIDE HAMMER/DRIVE ROD HYDRAULIC PROBE	SOIL GAS SAMPLE	WATER SAMPLE	SOIL SAMPLE	OTHER	ADDITIONAL OBSERVATIONS (WRITTEN DESCRIPTION OF SAMPLE LOCATIONS)
	GENERAL	SPECIAL	MATERIAL / DEPTH	COMPOSITION	INT.	EXT.							
	WOODS												
	FIELD												
	LANDSCAPED/PLANTER												
	PAVED OR GRAVEL LOT												
	ROAD												
	INSIDE BLDG.												
	EXCAVATION												
	OTHER												
	U.S.T.												
	SURFACE TANKS												
	PUMPS/LINES												
	GROUND STAIRS												
	DUMPS												
	JUNK/REFUSE												
	CONTERS												
	VEGETATION												
	SOIL												
	GRAVEL												
	ASPHALT												
	CONCRETE												
	ORGANICS												
	CLAY												
	SILT												
	SAND												
	GRAVEL												
	FILL												
	DRY												
	DAMP												
	WET												
	LIQUID												
	RESIDUE												
	DECON PROBE												
	SOIL												
	RESIDUE												
	PURGE RATE (1/m) ³ PULL												
	SUCTION (mm Hg)												
	4" S.S. PROBE												
	UNPACKER PROBE												

JOB CODE

DATE: _____

ADDITIONAL NOTES: _____

Project No. 265-000
 Procedure FP-10-5

Sample Log

4.0 ANALYTICAL PROCEDURES

4.1 ANALYTICAL METHODS - MODIFIED EPA METHODS 601 AND 602

Samples will be analyzed in either a mobile field laboratory or sent to an offsite laboratory. A gas chromatograph equipped with an electron capture detector (GC/ECD), following modified EPA 601 methodology will be used to identify and quantify chlorinated compounds typically found in industrial solvents. A flame ionization detector (GC/FID), following a modified EPA 602 methodology, will be used for petroleum and other nonhalogenated compounds.

4.2 ANALYTES AND REPORTED QUANTIFICATION LIMITS

The "Reported Quantification Limit" is a concentration level at which the degree of confidence in the actual presence of a compound becomes meaningful. A reported quantification limit should not be confused with the concentration represented by the smallest detectable chromatogram peak area. The importance of reported quantification limits should also be weighed in the context of acceptable exposure levels and the general levels of contamination on a site. The reported quantification levels for compounds to be identified on the GC/FID (petroleum hydrocarbons) will be 1.0 $\mu\text{g}/\text{l}$. The reported quantification levels for compounds identified on the GC/ECD vary from 0.05 $\mu\text{g}/\text{l}$ to 1.0 $\mu\text{g}/\text{l}$.

Table 4-1 lists the minimum concentrations (the reported quantification limits) of the proposed compounds.

Total FID volatiles will also be calculated. Since carbon tetrachloride and 1,2-DCA co-elute on the ECD, they will be reported together in the tables and the maps. Analysis is available using GC/MS for unique identification of 1,2-DCA.

TABLE 4-1. REPORTED QUANTIFICATION LIMITS

<u>VOLATILE ORGANIC COMPOUNDS</u>	<u>REPORTED QUANTIFICATION LIMITS ($\mu\text{g/L}$)</u>
Benzene	1.0
Ethylbenzene	1.0
Toluene	1.0
Total xylenes (ortho-, meta-, para-isomers)	1.0
1,1-Dichloroethene (1,1-DCE)	1.0
C-1,2-DCE	1.0
T-1,2-DCE	1.0
Dichloroethane (1,1,-DCA)	1.0
Methylene chloride	1.0
Trichloroethene (TCE)	0.10
1,1,1-Trichloroethane (1,1,1,-TCA)	0.10
Carbon tetrachloride/1,2-dichloroethane (1,2-DCA)	0.05
Tetrachloroethene (PCE)	0.05

4.3 CALIBRATION PROCEDURES

Three-point least squares linear regression calibration curves are generated for each detector as needed and the correlation coefficients are examined for each standardized analyte. Correlation coefficients must be greater than 0.99. The curve is then used to quantify the concentration of analytes in samples. Alternatively, a one-point calibration at a higher range may be conducted when responses have exceeded the linear range of the detector's electrometer (using the highest standard concentration for the type of analysis standard to be analyzed). This one-point calibration is used to quantify the total volatiles of any sample if the original analysis was not quantifiable. Furthermore, check standards are analyzed at the beginning and end of each day to ensure retention time and response stability. Windows for retention times will be set in the time band method, i.e., \pm a value. The value used will be the narrowest possible (usually 0.05-0.1) without including nonstandardized peaks. Retention times of the standards are used to identify the peaks in the chromatograms of the field samples, and their response factors are used to calculate the analyte concentrations.

The FID and ECD stock standards are replaced as needed from preprepared (Scott Specialty Gases) cylinders that contain mixtures of standard analytes. The volume of gas is extracted from the main pressurized cylinder. The line is purged to eliminate contamination or dilution and then a 1-liter TedlarTM bag with a TeflonTM-lined septa is filled. Each TedlarTM bag is used only once.

Aliquots from the TedlarTM bags are withdrawn using HamiltonTM gas-tight glass syringes. The volumes of each standard (as indicated with concentrations on the included calibration standard concentration sheets) are then injected into 30-ml precapped, precleaned (EPA protocol B Level II) evacuated glass vials. Each standard has its own designated syringe which is cleaned with ultrapure nitrogen (99.9 percent) before the standards are prepared.

4.4 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

4.4.1 Sample Control

Each sample is numbered according to a designated numbering system. Chain-of-custody forms (Figure 4-1) including date of collection, type of analysis and name of samples are provided both for samples analyzed off site, and for samples that are analyzed in the field.

4.4.2 Control Samples

Field control samples will be collected per Section 3.2 by drawing prepurified nitrogen or ambient air (filtered through an MSA organic cartridge filter) through the sampling apparatus and probe:

- o Prior to and at the conclusion of each day's sampling activities
- o After every twentieth sample.

These field control samples are visually indistinguishable from the actual field samples.

Field duplicates will be collected at a frequency of 10 percent. For every tenth sample, two sample vials will be collected and analyzed individually.

4.4.3 LABORATORY CONTROL SAMPLES

Laboratory blanks are analyzed prior to each sample batch and after every tenth sample.

Duplicate analyses are run of every tenth sample analyzed. Check standards are run at intervals specified in Section 4.3. Accuracy and precision with regards to data quality is documented in reports with the results of QC/QC procedures.

Precision is calculated as relative percent difference (RPD).

$$RPD = \frac{|X_1 - X_2|}{(X_1 + X_2)/2} \times 100$$

where X_1 and X_2 are duplicate sample measurement results.

Accuracy is evaluated based on the percent recovery of the check standard.

$$\% \text{ Recovery} = \frac{\text{Concentration found}}{\text{Concentration spiked}} \times 100$$

5.0 REPORTING

After completion of the field survey, a report will be prepared that will include:

- o Data tables identifying sample number and compound concentration
- o Tables identifying analytical results of QA/QC samples
- o Descriptions of QC/QC, field, and analytical procedures
- o Notes or comments about any factors which may have affected the results
- o Maps showing sample locations at each site
- o Maps showing isoconcentration lines for primary analytes at each site.

6.0 HEALTH AND SAFETY

The project-specific Health and Safety Plan (HSP) should be followed by all field personnel including subcontractor soil gas survey personnel.

7.0 REFERENCES

Godoy, Franco E., and David S. Naleid, Optimizing the Use of Soil Gas Surveys, HMC
September/October 1990.

Target Environmental Services, Inc., 9180 Rumsey Road, Columbia, MD, 21045.