# RCRA FACILITY INVESTIGATION
# FINAL WORK PLAN
# VOLUME II OF II

## U.S. ARMY ENGINEER DISTRICT, SAVANNAH
## CORPS OF ENGINEERS
## SAVANNAH, GEORGIA

GERAGHTY
& MILLER, INC.
*Environmental Services*
*Jacksonville, Florida*

JUNE 1, 1992

CORPS OF ENGINEERS

U. S. ARMY

| REVISIONS | | | | |
|---|---|---|---|---|
| SYMBOL | ZONE | DESCRIPTION | DATE | BY |
| | | | | |

FST-002
CAMP OLIVER LANDFILL

FST-003
TAC-X LANDFILL

FST-009
EOD AREA

FST-012
EOD AREA

FST-010
EOD AREA

FST-1001
POST SOUTH
CENTRAL LANDFILL

BORROW
AREA
NO. 10

FST-004 A
BURN PIT A

FST-004 B
BURN PIT B

FST-004 C
BURN PIT C

FST-004 D
BURN PIT D

FST-004 E
BURN PIT E

FST-004 F
BURN PIT F

FST-004 G
BURN PIT G

FST-011
EOD AREA

FST-014
OLD FIRE TRAINING
PIT

FST-020
NIGHT AIR FIELD
(SEWAGE DISPOSAL BEDS)

FST-029
EVANS ARMY HELIPOAT
POL FACILITY

FORT STEWART MILITARY RESERVATION

NOTE:

SWMUs WITHIN THE CANTONMENT AREA ARE LOCATED ON PLATE 2.

SCALE IN MILES
1 0 1 2 3

VICINITY MAP

SCALE IN MILES
20 0 20 40

GERAGHTY & MILLER, INC.
Environmental Services
Jacksonville, Florida

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

RCRA FACILITY INVESTIGATION

# LOCATION OF SWMU SITES OUTSIDE THE CANTOMENT AREA

FORT STEWART GEORGIA

| SIZE | INVITATION NO. | FILE NO. | PLATE |
|---|---|---|---|
| F | DACA-21-90-0079 | | 1 |
| SCALE: AS SHOWN | | | SHEET |

D. GOODSON 29

ATTACHMENT A

QUALITY ASSURANCE PROJECT PLAN

5

# QUALITY ASSURANCE PROJECT PLAN
# RCRA FACILITY INVESTIGATION
# FORT STEWART, GEORGIA

June 1, 1992

Prepared for

Department of Army
Savannah District Corps of Engineers
Savannah, Georgia

Geraghty & Miller Project No. JF24006

Prepared for

Geraghty & Miller, Inc.
8936 Western Way
Suite 7
Jacksonville, Florida 32256

GERAGHTY & MILLER, INC.

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# 1.0 PROJECT DESCRIPTION

Geraghty & Miller, Inc., was contracted in September 1990 by the United States Army Corps of Engineers (ACOE) to conduct a RCRA Facility Investigation (RFI) for selected sites at Ft. Stewart located near Hinesville, Georgia (Figure A1). The solid waste management units (SWMUs) are shown in Figures A2 and A3. This document addresses the quality control procedures that will be utilized for data collection efforts during the investigation of the SWMUs.

To ensure the quality of the field and laboratory data produced during the implementation of the RFI a Generic Quality Assurance Program Plan (QAPP) has been prepared. The QAPP has been prepared according to the guidelines set forth by the U.S. Environmental Protection Agency (EPA) in "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans", (QAMS-005/80), EPA. The QAPP has been structured as a generic document to provide general guidance to the field and laboratory personnel concerning methodologies for sampling and analysis of environmental media, proper record keeping protocols, data quality objectives, and procedures for data review.

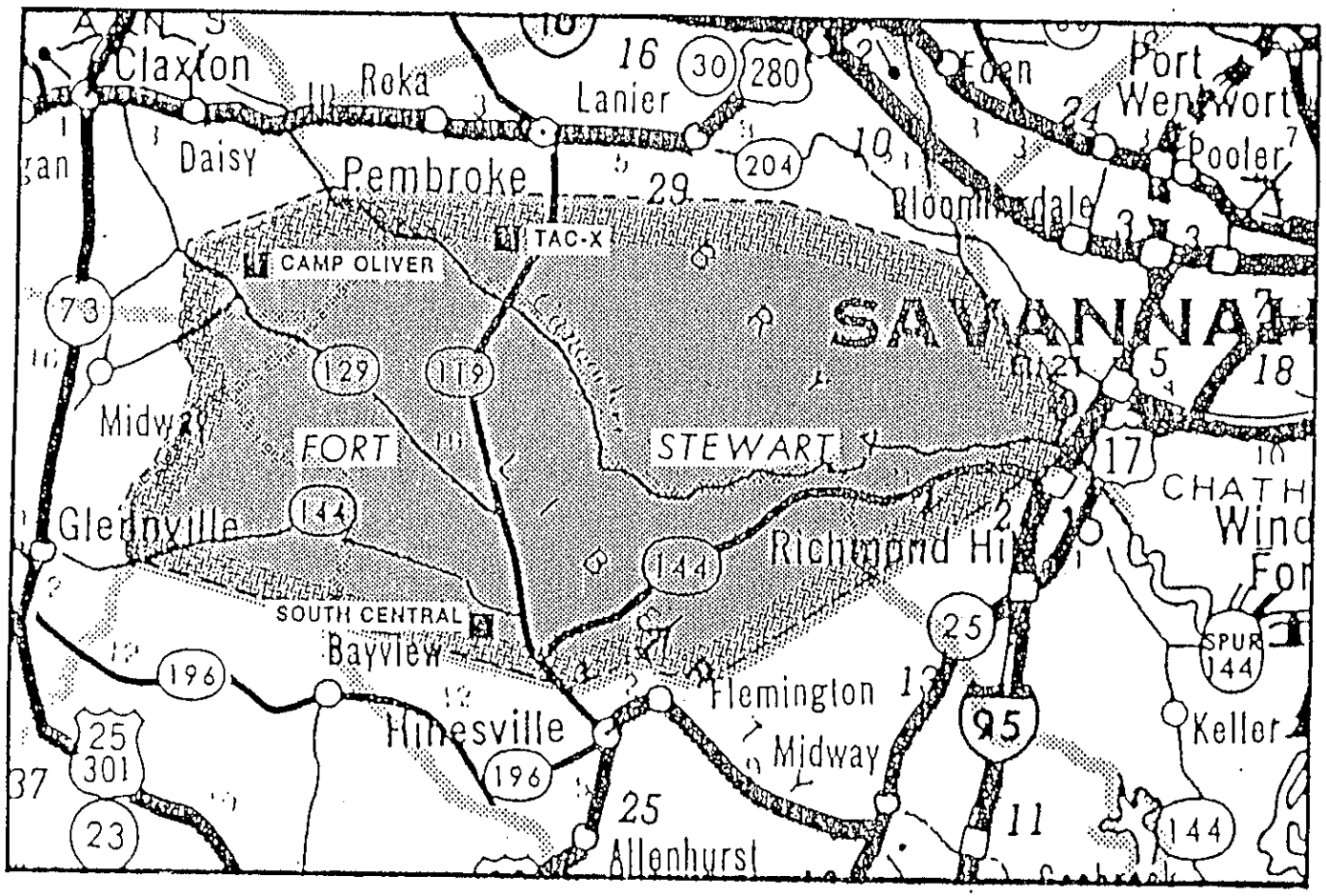
Savannah Laboratories and Environmental Services, Inc. of Savannah, Georgia has been selected to perform the bulk of the laboratory analyses for the proposed investigations. Operating information and a generic Laboratory Quality Assurance Plan (QAP) is included as Appendix A in this QAPP. Accuracy, precision, and completeness criteria for the potential chemical constituents to be evaluated is presented in Section 12. A Site Specific Field Sampling Plan (SSFSP), and a Site Specific Quality Assurance Project Plan (QAPP) is provided in the RFI work plan. The QAPP specifies the specific target compounds to be evaluated and analyses pertinent to the investigation.

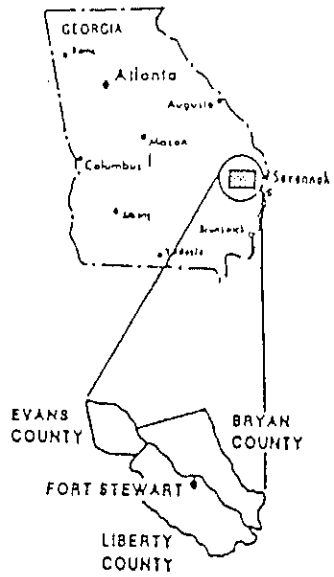
## 1.1 Project Background

A detailed description of historical activities, chemical production, usage, and disposal practices as well as previous investigations are provided in Section 4.0 of the Work Plan.

## 1.2 Scope of Work

The principal objectives of an RFI are: (1) confirm the presence or absence of contamination, (2) determine the extent (vertical and horizontal) and concentration of detected contaminants, (3) identify and characterize the sources of contamination, (4) assess the potential




0 5 10
SCALE IN MILES

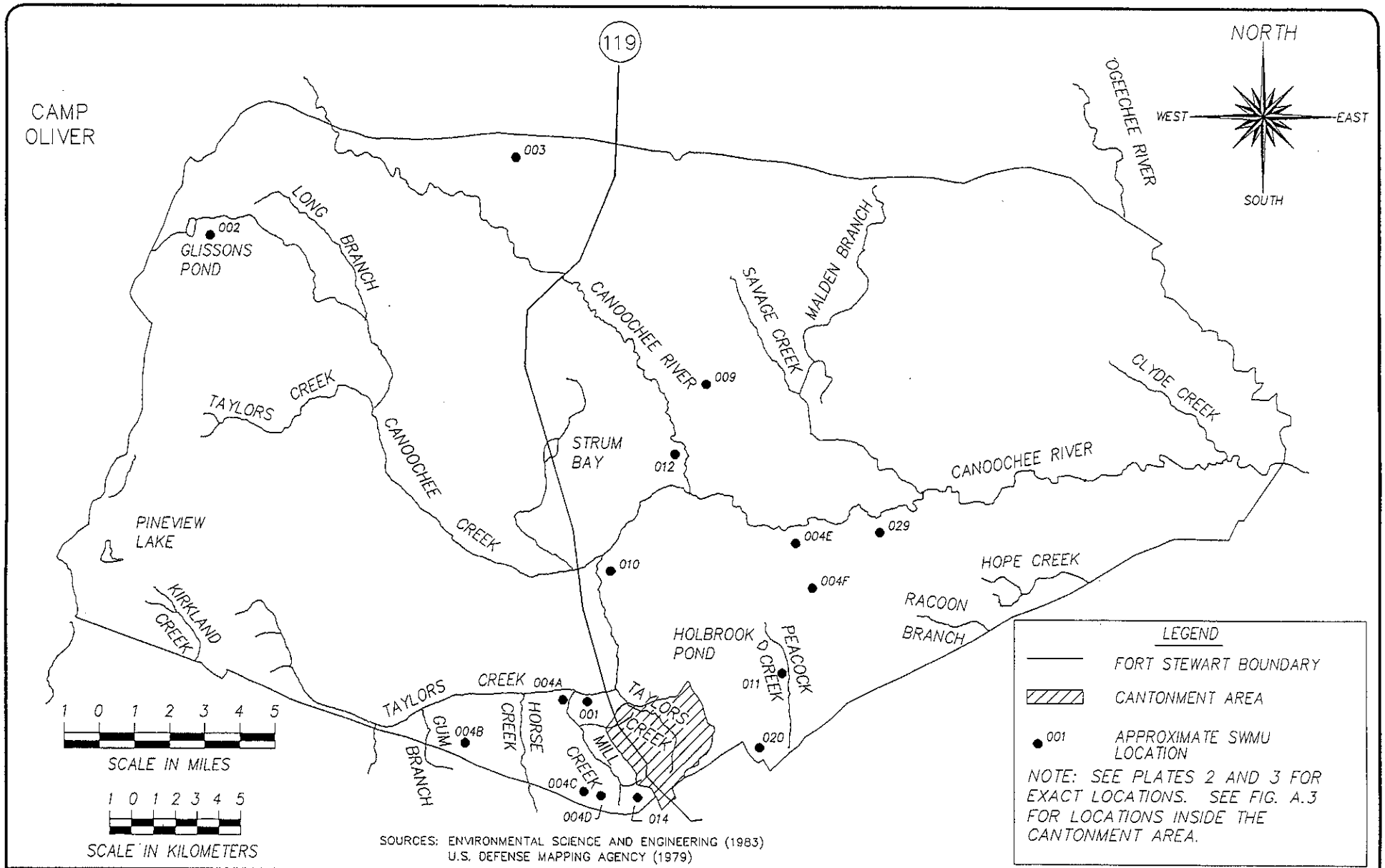
GERAGHTY & MILLER, INC.
*Environmental Services*

# FORT STEWART LOCATION

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
FORT STEWART, GEORGIA

DRAWING NO:
FT-022

FIGURE
**A. 1**



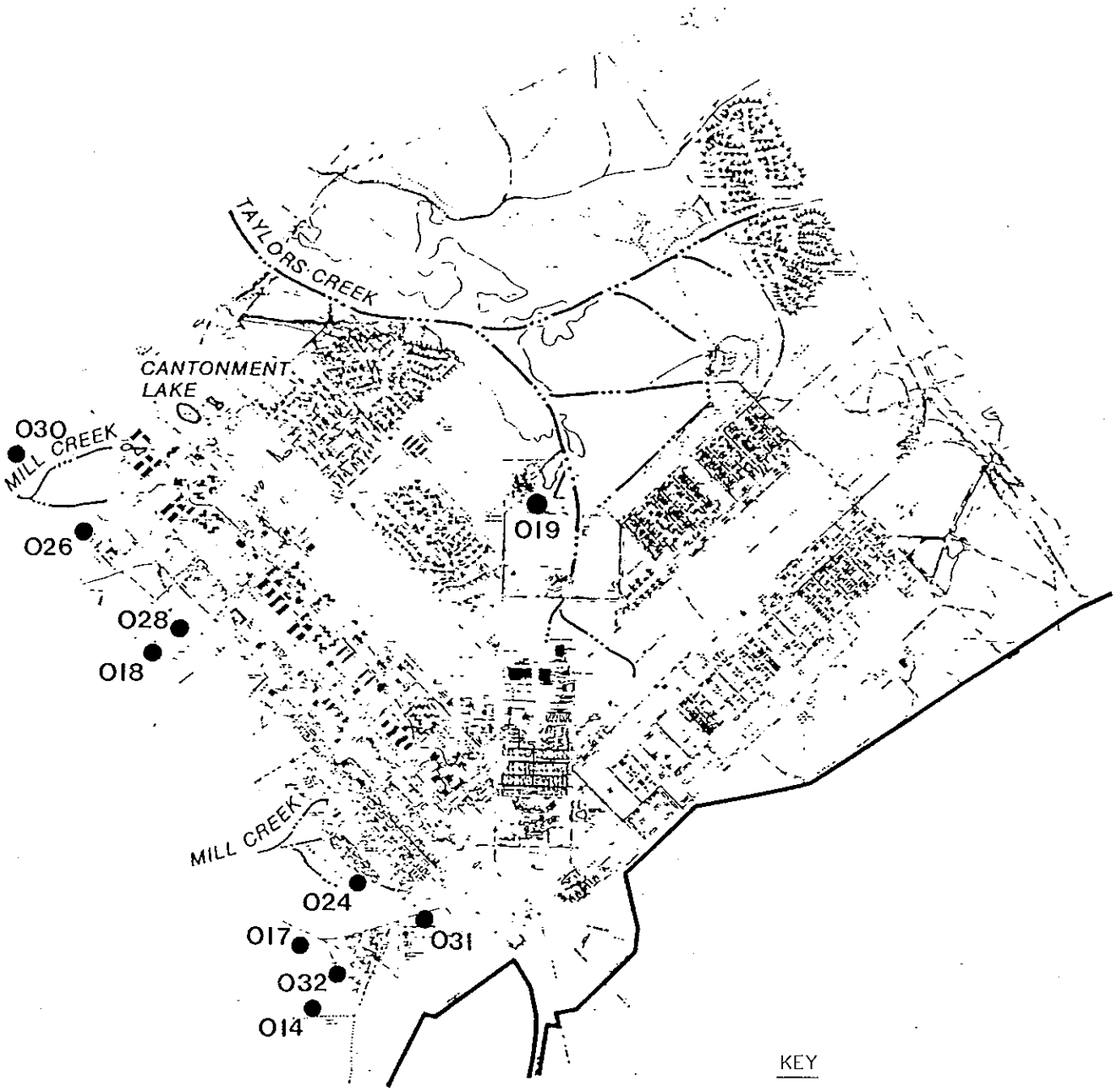

SOURCES: ENVIRONMENTAL SCIENCE AND ENGINEERING (1983)
U.S. DEFENSE MAPPING AGENCY (1979)

GERAGHTY & MILLER, INC.
*Environmental Services*
*Jacksonville, Florida*

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

*RCRA FACILITY INVESTIGATION*
*APPROXIMATE SWMU LOCATIONS OUTSIDE THE CANTONMENT AREA*
*FORT STEWART* *GEORGIA*

*FIGURE*
*A.2*




GERAGHTY & MILLER, INC.
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CORPS OF ENGINEERS
SAVANNAH, GEORGIA

*RCRA FACILITY INVESTIGATION*
*CANTONMENT AREA – APPROXIMATE SWMU LOCATIONS*
*FORT STEWART* *GEORGIA*

*FIGURE*
*A.3*

for contaminant migration to surrounding environments, (5) identify public health and environmental risks of the identified contaminants, and (6) define the scope of future investigations and/or required remedial actions, if warranted. To accomplish these objectives, numerous data gathering tasks will be performed.

The selection of data collection and sample collection locations, as well as constituents of interest, will be based on the review of existing laboratory and field data, the results of site observations, and guidelines provided in EPA RFI guidance documents. Sample collection techniques and the sample analysis methods, were chosen based on recommendations provided in guidance documents prepared and approved by EPA for use in conducting a RFI.

## 1.3 Designated Tasks

The following sections of the QAPP briefly describe tasks that may be performed during investigations of selected SWMUs. These tasks include (1) Geotechnical Tests; (2) Sampling and Analysis of Environmental Media; and (3) Data Analysis and Final Report Preparation.

### 1.3.1 Geotechnical Surveys

At each site the contractor will conduct sampling for the geotechnical evaluation of subsurface soils and, if encountered, solid or semi-solid wastes. The testing that will be completed at each site will be determined during the work plan development for each site. The sampling and geotechnical analysis of soil will be conducted according to the standard American Society for Testing and Materials (ASTM) methods presented in Section 4.0 of this QAPP.

The data collected from the geotechnical analyses will be used to determine the properties of the local soils, assist in determining the velocity of the ground-water migration, and provide engineering information for preliminary screening of remedial options.

Quality Assurance procedures for sample collection are described in Section 4.0 of this QAPP. Quality Assurance procedures utilized by the geotechnical laboratory are specified in each individual method.

1.3.2 Sampling and Analysis

Sampling and analysis may be conducted in selected matrices at each site as required. Potential matrices to be sampled and submitted for analysis will include soil (surface and subsurface from soil borings, trenches, and test pits), sediment (from surface impoundments, ponds, rivers, streams and lakes), sludge, waste waters, waste piles, landfills, surface water bodies, ground water from monitor wells, and ambient air. Samples will be taken from these matrices and analyzed to determine the nature and extent of chemical contaminants within the sample matrix. The specific samples to be collected, frequencies of sample collection, parameters, methods of analysis, detection limits, and appropriate field quality control samples will be described in each SSFSP and QAPP.

Samples collected for laboratory analysis will be properly preserved and packed according to the procedures specified in Section 4.0 and shipped under appropriate chain-of-custody procedures found in Section 5.0. As discussed earlier, Savannah Labs is the analytical laboratory designated for use during implementation of the RFI Work Plan. Samples of ground water, surface water, soil, sediments, and solid waste for analysis of volatile organic compounds (VOCs), pesticides, base-neutral and acid-extractable organic compounds (BNAs), metals and other standard chemical water quality parameters will be shipped to Savannah Labs. A Generic Quality Assurance Plan for Savannah Labs is presented in Appendix A.

The analytical and geotechnical methods to be used during the course of the site investigation are presented in Tables 1 and 2. References for the methods are contained in each table. All methods are approved and published in various EPA Documents and Manuals, The American Society for Testing Materials (ASTM) Manuals, Standard Methods (Seventeenth Edition) or The Federal Register.

1.4 Field Quality Control & Quality Assurance Sampling

During implementation of the field sampling program described in Section 3.4, Geraghty & Miller will collect field quality control and field quality assurance samples to assess the reproducibility of the field collection techniques, the quality of preservation reagents and sample bottles, and the adequacy of field decontamination procedures. Table 3 lists field quality assurance and quality control samples collected during field events.

Table 1. Analytical Methods, Data Precision Accuracy and Completeness of Objectives

| Parameter | Method | | | Precision | Accuracy | Completeness | Reporting Limit 1/ |
|---|---|---|---|---|---|---|---|
| | Matrix | Preparation | Analysis | Percent RPD of Duplicate | Spike Percent Recovery | % | Water = ug/L Soil = mg/kg |
| Metals | | | | | | | |
| Aluminum | Water | 3010/3005(d) | 6010(d)/200.7(a,b) | ±20(c) | 75 - 125 | 90 | 200 |
| | Soil | 3050(d) | 6010 | ±20(c) | 75 - 125 | 90 | 40 |
| Antimony | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 60 |
| | Water | 3020/3005 | 7041(d)/204.2(b,1) | ±20(c) | 75 - 125 | 90 | 50 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 20 |
| Arsenic | Water | --- | 7060(d)/206.2(a,b) | ±20(c) | 75 - 125 | 90 | 10 |
| | Soil | 3050 | 7060(d) | ±20(c) | 75 - 125 | 90 | 2 |
| Barium | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 100 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 20 |
| Beryllium | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 5 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 1 |
| Cadmium | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 5 |
| | Water | 3020/3005 | 7131(d)/213.2(a,b) | ±20(c) | 75 - 125 | 90 | 5 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 1 |
| Chromium | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 10 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 2 |
| Copper | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 50 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 10 |
| Iron | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 20 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 4 |
| Lead | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 100 |
| | Water | 3020/3005 | 7421(d)/239.2(a,b) | ±20(c) | 75 - 125 | 90 | 5 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 20 |
| | Soil | 3050 | 7421 | ±20(c) | 75 - 125 | 90 | 1 |
| Manganese | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 5 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 1 |
| Mercury | Water | --- | 7470(d)/245.1(a,b) | ±20(c) | 75 - 125 | 90 | 0.2 |
| | Soil | --- | 7471 | ±20(c) | 75 - 125 | 90 | 0.04 |
| Nickel | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 50 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 10 |
| Selenium | Water | --- | 7740(d)/270.2(a,b) | ±20(c) | 75 - 125 | 90 | 5 |
| | Soil | 3050 | 7740 | ±20(c) | 75 - 125 | 90 | 1 |
| Silver | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 10 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 2 |
| Sodium | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 500 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 100 |
| Thallium | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 100 |
| | Water | 3020/3005 | 7841(d)/274.2(a,b) | ±20(c) | 75 - 125 | 90 | 10 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 20 |
| | Soil | 3050 | 7841 | ±20(c) | 75 - 125 | 90 | 2 |
| Zinc | Water | 3010/3005 | 6010/200.7 | ±20(c) | 75 - 125 | 90 | 20 |
| | Soil | 3050 | 6010 | ±20(c) | 75 - 125 | 90 | 4 |

Table 1. continued

| Parameter | Matrix | Method: Preparation | Method: Analysis | Precision: Percent RPD of Duplicate | Accuracy: Spike Percent Recovery | Completeness: % | Reporting Limit 1/: Water = ug/L, Soil = mg/kg |
|---|---|---|---|---|---|---|---|
| General Chemistry | | | | | | | |
| EP Toxicity | Water | 1310(d) | --- | (j) | (j) | 90 | NA (m) |
| Extraction | Soil | 1310 | --- | (j) | (j) | 90 | NA |
| Nitrate | Water | --- | 9200(d) | (i) | (i) | 90 | 500 as N |
| Total Dissolved Solids | Water | 160.1(a,b) | 160.1 | (i) | (i) | 90 | NA |
| Gross Alpha/ | Water | --- | 900.0(e) | ±37(o) | 55-135 | 90 | 0.75 pCi/L |
| Gross Beta | | | 900.0(e) | ±43(o) | 55-150 | 90 | |
| Radium 228/226 (k) | Water | --- | 904.0(e)/903.1(n) | (j) | (j) | 90 | 0.5 pCi/L |
| Strontium 90 | Water | --- | 905.0(e) | (j) | (j) | 90 | 1 pCi/L |
| Uranium | Water | --- | 908.0(n) | (j) | (j) | 90 | 1 pCi/L |
| Total Recoverable Petroleum Hydrocarbons | Water | 418.1(a,b) | 418.1 | (i) | (i) | 90 | 1.0 mg/L |
| | Soil | 418.1 | 418.1 | (i) | | | 100 mg/kg |
| Ignitability | Water | --- | 1010(d) | (j) | (j) | 90 | NA |
| | Soil | --- | 1010 | (j) | (j) | | NA |
| Biochemical Oxygen Demand | Water | --- | 405.1(a,b) | (i) | (i) | 90 | NA |
| Cyanide, Total | Water | --- | 9010(d) | ±20(c) | 75 - 125 | 90 | 10 |
| | Soil | --- | --- | ±20(c) | 75 - 125 | 90 | 0.5 |
| Organics | | | | | | | |
| Volatiles | Water | 5030(d) | 8240(d)/624(f) | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| | Soil | 5030 | 8240 | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| Ethylene Dibromide | Water | --- | 8011 | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| | | | | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| Base/Neutral Acid Extractables | Water | 3520(d) | 8270(d)/625(f) | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| | Soil | 3550(d) | 8270 | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| Chlorinated Herbicides | Water | --- | 509.B(h)/8150(d) | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| | Soil | --- | 509.B(h)/8150 | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| Pesticides/ PCBs | Water | 3510(d,g) | 8080(d,g) | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| | Soil | 3550 | 8080 | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| Organo-Phosphorous Pesticides | Water | 3520 | 8140(d) | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| | Soil | 3550 | 8140 | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| Nitroaromatics and Cyclic Ketones | Water | 3520 | 8270(d) | See Table 1a | See Table 1a | See Table 1a | See Table 1a |
| | Soil | 3550 | 8270 | See Table 1a | See Table 1a | See Table 1a | See Table 1a |

Table 1. continued

(a) U.S. Environmental Protection Agency. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Revised March 1983.

(b) Federal Register, V. 79(209). Friday, October 26, 1984. 40 CFR 136, Appendix C - Inductively Coupled Plasma Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes Method. pp. 199-204.

(c)
- o RPD = [S-D)/(S+D)/2] x 100 for samples > 5X RDL
- o RPD not calculated (NC), result < DL
- o For results < 5X DL, values must agree within ± DL as specified by EPA-CLP Inorganics, SOW NO 788, July 1988.

(d) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods EPA SW-846. Third Edition, November 1986.

(e) Prescribed Procedures for Measurement of Radioactivity in Drinking Water EPA-600/4-80-032.

(f) According to procedures specified in the Federal Register, v. 49(209), Friday, October 26, 1984. 40 CFR 136, Appendix A - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, pp. 29-174.

(g) EPA Contract Lab Program. Organic Analysis: Multi-Media, Multi-Concentration SOW No. 2/88, February 1988.

(h) Standard Methods for the Examination of Water and Wastewater. 16th Edition 1985.

(i) Precision and accuracy where applicable will be evaluated according to procedures in U.S. EPA Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Revised March 1983.

(j) No criteria available in U.S. EPA reference method (d). Where precision and/or accuracy requirements are specified by the project for these parameters, Keystone will adhere whenever possible.

(k) Performed by Core Laboratory, Casper, Wyoming.

(l) Detection limit will vary depending on matrix differences that t\result in sample dilution and for soils, detection limit will also vary depending on moisture content of sample if results are reported as dry weight.

(m) NA = not applicable.

(n) Modified Methodology. Core Laboratory, Casper, Wyoming.

(o) % Relative Standard Deviation.

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Table 1a. Accuracy, Precision and Completeness Data Objectives For Organics [1/]

| Parameter | Precision [2/] Percent RPD of Duplicates Water | Precision [2/] Percent RPD of Duplicates Soils | Accuracy [2/] Spike Percent Recovery Water | Accuracy [2/] Spike Percent Recovery Soils | Completeness (%) | Reporting Limit [4/] Water ug/l | Reporting Limit [4/] Soils ug/kg |
|---|---|---|---|---|---|---|---|
| Volatile Organics | | | | | | | |
| Acetone | ±25 | ±30 | 70-135 | 55-145 | 90 | 50 | 500 |
| Benzene | ±25 | ±30 | 70-135 | 55-145 | 90 | 5 | 50 |
| Bromodichloromethane | ±35 | ±30 | 70-135 | 55-145 | 90 | 5 | 25 |
| Bromoform | ±35 | ±40 | 60-145 | 45-155 | 90 | 5 | 25 |
| Bromomethane | ±35 | ±40 | 60-145 | 45-155 | 90 | 10 | 50 |
| Carbon tetrachloride | ±25 | ±30 | 70-135 | 55-145 | 90 | 5 | 25 |
| Chlorobenzene | ±25 | ±30 | 70-135 | 55-145 | 90 | 5 | 25 |
| Chloroethane | ±35 | ±40 | 60-145 | 45-155 | 90 | 10 | 50 |
| 2-Chloroethylvinyl ether | ±35 | ±40 | 50-160 | 45-155 | 90 | 10 | 50 |
| Chloroform | ±25 | ±35 | 70-135 | 55-145 | 90 | 5 | 25 |
| Chloromethane | ±35 | ±40 | 60-145 | 45-155 | 90 | 10 | 50 |
| Dibromochloromethane | ±25 | ±35 | 70-135 | 55-145 | 90 | 5 | 25 |
| 1,1-Dichloroethane | ±25 | ±30 | 70-135 | 55-145 | 90 | 5 | 25 |
| 1,2-Dichloroethane | ±25 | ±30 | 70-135 | 55-145 | 90 | 5 | 25 |
| 1,1-Dichloroethene | ±25 | ±30 | 70-135 | 55-145 | 90 | 5 | 25 |
| trans-1,2-Dichloroethene | ±25 | ±30 | 70-135 | 55-145 | 90 | 5 | 25 |
| 1,2-Dichloropropane | ±25 | ±30 | 70-135 | 55-145 | 90 | 5 | 25 |
| cis-1,3-Dichloropropene | ±35 | ±40 | 60-145 | 45-155 | 90 | 5 | 25 |
| trans-1,3-Dichloropropene | ±35 | ±40 | 60-145 | 45-155 | 90 | 5 | 25 |
| Ethyl benzene | ±25 | ±40 | 70-145 | 45-155 | 90 | 5 | 25 |
| Methylene chloride | ±25 | ±40 | 70-145 | 45-155 | 90 | 5 | 25 |
| 1,1,2,2-Tetrachloroethane | ±25 | ±40 | 70-145 | 45-155 | 90 | 5 | 25 |
| Tetrachloroethene | ±25 | ±40 | 70-145 | 45-155 | 90 | 5 | 25 |
| Toluene | ±25 | ±40 | 70-145 | 45-155 | 90 | 5 | 25 |
| 1,1,1-Trichloroethane | ±25 | ±40 | 70-145 | 45-155 | 90 | 5 | 25 |
| 1,1,2-Trichloroethane | ±25 | ±40 | 70-145 | 45-155 | 90 | 5 | 25 |
| Trichloroethene | ±25 | ±40 | 70-145 | 45-155 | 90 | 5 | 25 |
| Vinyl Chloride | ±35 | ±40 | 60-145 | 45-155 | 90 | 10 | 50 |
| Total Xylenes | ±35 | ±45 | 60-155 | 55-145 | 90 | 5 | 50 |
| Ethylene dibromide | ±25 | ±35 | 70-135 | 45-155 | 90 | 0.02 | 1 |
| Vinyl acetate | ±35 | ±45 | 50-160 | 45-155 | 90 | 10 | 100 |
| Styrene | ±25 | ±35 | 70-145 | 55-145 | 90 | 5 | 50 |
| Carbon Disulfide | ±25 | ±45 | 60-155 | 55-145 | 90 | 5 | 50 |
| 2-Butanone | ±35 | ±45 | 50-160 | 45-155 | 90 | 50 | 500 |
| 4-Methyl-2-pentanone | ±35 | ±45 | 50-160 | 45-155 | 90 | 10 | 50 |
| 2 hexanone | ±35 | ±45 | 50-160 | 45-155 | 90 | 10 | 50 |

Table 1a. continued

| Parameter | Precision 2/ Percent RPD of Duplicates Water | Soils | Accuracy 2/ Spike Percent Recovery Water | Soils | Completeness (%) | Reporting Limit 4/ Water ug/l | Soils ug/kg |
|---|---|---|---|---|---|---|---|
| Nitrobenzene | ±40 | ±45 | 35-114 | 25-120 | 90 | 10 | 500 |
| N-Nitrosodimethyl Amine | ±50 | ±50 | 25-120 | 25-120 | 90 | 10 | 500 |
| N-Nitrosodi-n-propylamine | ±40 | ±40 | 40-120 | 40-130 | 90 | 10 | 500 |
| N-Nitrosodiphenylamine | ±40 | ±45 | 35-125 | 35-125 | 90 | 40 | 1000 |
| Phenanthrene | ±30 | ±35 | 50-120 | 45-125 | 90 | 10 | 500 |
| Pyrene | ±30 | ±35 | 25-130 | 35-140 | 90 | 10 | 500 |
| 1,2,4-Trichlorobenzene | ±30 | ±30 | 40-100 | 35-110 | 90 | 10 | 500 |
| Acid Extractables | | | | | | | |
| 4-Chloro-3-methylphenol | ±40 | ±35 | 25-100 | 25-105 | 90 | 35 | 500 |
| 2-Chlorophenol | ±40 | ±50 | 25-125 | 25-105 | 90 | 10 | 500 |
| 2,4-Dichlorophenol | ±35 | ±40 | 35-130 | 30-130 | 90 | 10 | 500 |
| 2,4-Dimethylphenol | ±35 | ±40 | 30-120 | 30-120 | 90 | 10 | 500 |
| 2,4-Dinitrophenol | ±50 | ±55 | 1-190 | 1-190 | 80 | 80 | 3000 |
| 2-Methyl-4,6-dinitrophenol | ±95 | ±95 | 1-185 | 1-190 | 90 | 50 | 1500 |
| 4-Nitrophenol | ±50 | ±50 | 10-110 | 10-115 | 80 | 50 | 1500 |
| 2-Nitrophenol | ±40 | ±45 | 25-185 | 20-185 | 80 | 10 | 500 |
| Pentachlorophenol | ±50 | ±50 | 10-105 | 15-110 | 80 | 50 | 1500 |
| Phenol | ±45 | ±35 | 10-100 | 25-100 | 90 | 10 | 500 |
| 2,4,6-Trichlorophenol | ±35 | ±40 | 30-145 | 25-145 | 90 | 10 | 500 |
| Pesticides/PCBs | | | | | | | |
| Aldrin | ±25 | ±35 | 40-125 | 35-130 | 80 | 0.05 | 8.0 |
| alpha-BHC | ±25 | ±35 | 35-135 | 30-135 | 80 | 0.05 | 8.0 |
| beta-BHC | ±35 | ±40 | 15-150 | 10-150 | 80 | 0.05 | 8.0 |
| delta-BHC | ±40 | ±45 | 20-140 | 15-145 | 80 | 0.05 | 8.0 |
| gamma-BHC (Lindane) | ±25 | ±35 | 30-130 | 25-135 | 80 | 4.0 | 8.0 |
| Chlordane (technical) | ±25 | ±35 | 40-120 | 35-125 | 80 | 0.5 | 80.0 |
| 4,4'-DDD | ±35 | ±40 | 30-145 | 25-145 | 80 | 0.1 | 16.0 |
| 4,4'-DDE | ±35 | ±40 | 30-145 | 25-145 | 80 | 0.1 | 16.0 |
| 4,4'-DDT | ±40 | ±50 | 25-160 | 20-160 | 80 | 0.1 | 16.0 |
| Dieldrin | ±40 | ±50 | 30-145 | 25-150 | 80 | 0.1 | 16.0 |
| Endosulfan I | ±30 | ±35 | 40-155 | 35-160 | 80 | 0.05 | 8.0 |
| Endosulfan II | ±65 | ±70 | 1-210 | 1-210 | 80 | 0.1 | 16.0 |
| Endosulfan sulfate | ±35 | ±40 | 25-145 | 20-150 | 80 | 0.1 | 16.0 |
| Endrin | ±40 | ±50 | 30-150 | 25-150 | 80 | 0.1 | 16.0 |
| Endrin aldehyde | ±65 | ±70 | 10-170 | 5-190 | 80 | 0.1 | 16.0 |

Table 1a. continued

| Parameter | Precision 2/ Percent RPD of Duplicates Water | Soils | Accuracy 2/ Spike Percent Recovery Water | Soils | Completeness (%) | Reporting Limit 4/ Water ug/l | Soils ug/kg |
|---|---|---|---|---|---|---|---|
| Base/Neutral Extractables | | | | | | | |
| Acenaphthene | ±30 | ±30 | 35-125 | 20-125 | 90 | 10 | 500 |
| Acenaphthylene | ±30 | ±30 | 35-125 | 20-125 | 90 | 10 | 500 |
| Anthracene | ±30 | ±30 | 35-125 | 20-125 | 90 | 10 | 500 |
| Benzo(a)anthracene | ±30 | ±30 | 35-125 | 20-125 | 90 | 10 | 500 |
| Benzo(b)fluoranthene | ±30 | ±30 | 35-125 | 20-125 | 90 | 10 | 500 |
| Benzo(k)fluoranthene | ±30 | ±30 | 35-125 | 20-125 | 90 | 15 | 500 |
| Benzo(ghi)perylene | ±60 | ±60 | 35-125 | 20-125 | 90 | 15 | 500 |
| Benzo(a)pyrene | ±30 | ±30 | 35-125 | 20-125 | 90 | 10 | 500 |
| Benzidine | ±65 | ±65 | ND 3/ | ND | 75 | 10 | 500 |
| Butyl benzyl phthalate | ±40 | ±50 | 1-125 | 1-125 | 90 | 10 | 500 |
| Bis(2-chloroethoxy)methane | ±40 | ±50 | 25-140 | 20-130 | 90 | 10 | 500 |
| Bis(2-chloroethyl)ether | ±55 | ±60 | 10-150 | 5-150 | 90 | 10 | 500 |
| Bis(2-chloroisopropyl)ether | ±50 | ±55 | 25-140 | 20-130 | 90 | 10 | 500 |
| Bis(2-ethylhexyl)phthlate | ±40 | ±50 | 5-130 | 5-135 | 90 | 10 | 500 |
| 4-Bromophenyl phenyl ether | ±30 | ±35 | 50-130 | 40-135 | 90 | 10 | 500 |
| 2-Chloronaphthalene | ±30 | ±35 | 50-120 | 45-125 | 90 | 10 | 500 |
| 4-Chlorophenyl phenyl ether | ±40 | ±45 | 25-150 | 20-150 | 90 | 10 | 500 |
| Chrysene | ±50 | ±55 | 25-150 | 20-150 | 90 | 10 | 500 |
| Dibenzo(a,h)anthracene | ±60 | ±75 | 1-170 | 1-170 | 90 | 20 | 500 |
| Di-n-butyl phthalate | ±30 | ±35 | 1-120 | 1-125 | 90 | 10 | 500 |
| 1,2-Dichlorobenzene | ±35 | ±40 | 30-140 | 25-140 | 90 | 10 | 500 |
| 1,3-Dichlorobenzene | ±40 | ±45 | 30-150 | 25-150 | 90 | 10 | 500 |
| 1,4-Dichlorobenzene | ±30 | ±30 | 35-100 | 25-105 | 90 | 10 | 500 |
| 3,3-Dichlorobenzidine | ±75 | ±80 | 1-200 | 1-230 | 90 | 10 | 500 |
| Diethylphthalate | ±30 | ±35 | 1-115 | 1-125 | 90 | 10 | 500 |
| Dimethyl phthalate | ±30 | ±35 | 1-115 | 1-125 | 90 | 10 | 500 |
| 2,4-Dinitrotoluene | ±40 | ±50 | 25-100 | 25-100 | 90 | 30 | 500 |
| 2,6-Dinitrotoluene | ±30 | ±40 | 40-120 | 35-125 | 90 | 20 | 500 |
| Di-n-octylphthalate | ±30 | ±35 | 5-135 | 5-135 | 90 | 10 | 500 |
| Fluoranthene | ±35 | ±40 | 25-135 | 20-140 | 90 | 10 | 500 |
| Fluorene | ±30 | ±30 | 55-120 | 50-125 | 90 | 10 | 500 |
| Hexachlorobenzene | ±30 | ±30 | 1-150 | 1-150 | 90 | 10 | 500 |
| Hexachlorobutadiene | ±30 | ±25 | 25-120 | 20-125 | 90 | 10 | 500 |
| Hexachlorocyclopentadiene | ±40 | ±45 | 1-150 | 1-150 | 90 | 35 | 1000 |
| Hexachloroethane | ±30 | ±35 | 40-115 | 35-115 | 90 | 10 | 500 |
| Indeno (1,2,3-cd) pyrene | ±45 | ±50 | 1-160 | 1-160 | 90 | 15 | 500 |
| Isophorone | ±65 | ±65 | 20-190 | 15-200 | 90 | 10 | 500 |
| Naphthalene | ±30 | ±35 | 20-130 | 15-135 | 90 | 10 | 500 |

Table 1a. continued

| Parameter | Precision 2/ Percent RPD of Duplicates Water | Soils | Accuracy 2/ Spike Percent Recovery Water | Soils | Completeness (%) | Reporting Limit 4/ Water ug/l | Soils ug/kg |
|---|---|---|---|---|---|---|---|
| Heptachlor | ±30 | ±35 | 30-115 | 25-115 | 80 | 0.05 | 8.0 |
| Heptachlor epoxide | ±30 | ±35 | 35-145 | 30-145 | 80 | 0.05 | 8.0 |
| Methoxychlor | ±65 | ±70 | 10-170 | 5-190 | 80 | 0.5 | 80 |
| Toxaphene | ±30 | ±40 | 35-130 | 30-135 | 80 | 1.0 | 160 |
| PCB-1016 | ±30 | ±35 | 40-120 | 35-125 | 80 | 0.5 | 80 |
| PCB-1221 | ±50 | ±55 | 15-180 | 10-185 | 80 | 0.5 | 80 |
| PCB-1232 | ±40 | ±50 | 10-200 | 5-205 | 80 | 0.5 | 80 |
| PCB-1242 | ±30 | ±35 | 40-150 | 35-155 | 80 | 0.5 | 80 |
| PCB-1248 | ±30 | ±35 | 40-155 | 35-160 | 80 | 0.5 | 80 |
| PCB-1254 | ±30 | ±35 | 30-130 | 25-135 | 80 | 1.0 | 160 |
| PCB-1260 | ±30 | ±35 | 20-130 | 15-135 | 80 | 1.0 | 160 |
| Herbicides | | | | | | | |
| 2,4-D | ±40 | ±50 | 45-125 | 35-135 | 80 | 100 | 10,000 |
| Dalapon | ±40 | ±50 | 45-125 | 35-135 | 80 | 100 | 10,000 |
| 2,4-DB | ±40 | ±50 | 45-125 | 35-135 | 80 | 20 | 2,000 |
| Dicamba | ±40 | ±50 | 45-125 | 35-135 | 80 | 10 | 1,000 |
| Dichlorprop | ±40 | ±50 | 45-125 | 35-135 | 80 | 20 | 2,000 |
| Dinoseb | ±40 | ±50 | 45-125 | 35-135 | 80 | 10 | 1,000 |
| MCPA | ±40 | ±50 | 45-125 | 35-135 | 80 | 5,000 | 500 mg/kg |
| MCPP | ±40 | ±50 | 45-125 | 35-135 | 80 | 5,000 | 500 mg/kg |
| 2,4,5-T | ±40 | ±50 | 45-125 | 35-135 | 80 | 20 | 2,000 |
| 2,4,5-TP | ±40 | ±50 | 45-125 | 35-135 | 80 | 10 | 1,000 |
| Nitroaromatics and Cyclic Ketones | | | | | | | |
| Isophorone | ±65 | ±65 | 20-190 | 15-200 | 90 | 5 | 500 |
| Nitrobenzene | ±40 | ±45 | 35-114 | 25-120 | 90 | 5 | 500 |
| 2,4-Dinitrotoluene | ±40 | ±50 | 25-100 | 25-100 | 90 | 15 | 500 |
| 2,6-Dinitrotoluene | ±30 | ±40 | 40-120 | 35-125 | 90 | 10 | 500 |
| 1,2-Dinitrobenzene | ±35 | ±45 | 35-110 | 30-110 | 90 | 10 | 500 |
| 1,3-Dinitrobenzene | ±35 | ±45 | 35-110 | 30-110 | 90 | 10 | 500 |
| 1,4-Dinitrobenzene | ±35 | ±45 | 35-110 | 30-110 | 90 | 10 | 500 |
| 1,2-Napthoquinone | ±35 | ±40 | 35-120 | 30-125 | 90 | 10 | 500 |
| 1,4-Napthoquinone | ±35 | ±40 | 35-120 | 30-125 | 90 | 10 | 500 |

1/ As applied to project methods specified in Table 1.
2/ As determined from spiking actual sample matrix, these objectives are very near to those specified by EPA in SW-846
3/ ND = not determined according to EPA.
4/ Reporting limit will vary depending on matrix differences that result in sample dilution and for soils, reporting limit will also vary depending on moisture content of sample if results are reported as dry weight. Instrument detection limits are approximately 10 times less than the reporting limit. Any compound detected between the detection limit and reporting limit will be reported and qualified as estimated.

820TBL1A.DOC

Table 2. Geotechnical Test Methods for Soil Evaluations

| NAME OF TEST | METHOD |
|---|---|
| Soil Description | ASTM D-2488 |
| Soil Classification | ASTM D-2487 |
| Natural Moisture (Water) Content | ASTM D-2216 |
| Atterberg Limits (Liquid and Plastic Limits) | ASTM D-4318-84 |
| Particle-Size (Grain-Size) Analysis | ASTM D-422-63 |
| Moisture-Density Relationship | ASTM D-698 |
| Falling-Head Permeability with Pressure Chamber (Saturated Sample) | EM 1110-2-1906 USCE App. VII (6) |
| One-Dimensional Consolidation | ASTM D-2435 |
| Consolidation<br>Consolidation test of undisturbed sample, including loading to overburden pressure, unloading and reloading | ASTM D-4186-82 |
| Sampling by Auger Methods | ASTM D-1452 |
| Thin-Walled Tube Sampling | ASTM D-1587 |
| Maximum and Minimum Density | ASTM D-4254-83 |
| Specific Gravity | ASTM D-854 |
| Organic Content | ASTM D-2974-87 |
| Soil Resistivity/Laboratory | |
| Soil Corrosivity Index | AWWA/FDOT |
| Soil pH | ASTM G-51-77 |
| Swell Test of Undisturbed Sample | ASTM D-4546-85 |
| Shear Strength - Unconfined compression Test on Shelby Tube Sample | ASTM D-2166-85 |
| Shear Strength - Triaxial Compression Test - CU/point | ASTM D-4767-88 |
| Compaction and Stabilization: | |
| Standard or Modified Proctor on Soil | AASHTO T-99 or T-180, 4" mold) |
| Modified Proctor on Limerock | ASTM D-1557-78 |
| Laboratory LBR or CBR Including Modified Proctor | |
| Florida Bearing Value | |

Table 3. Field QA/QC Samples per Sampling Event

| Type of Sample | Inorganic | Organic |
|---|---|---|
| QC Samples | | |
| Trip Blank (for VOAs only) | NA[1/] | 1/cooler |
| Equipment Rinsate[2/] | 1/day | 1/day |
| Field Blank[3/] | 1/20 | 1/20 |
| Field Replicates[4/] | 10% | 10% |
| QA Samples[5/] | | |
| Trip Blank (for VOAs only) | NA[1/] | 1/cooler |
| Equipment Rinsate[2/] | 1/day | 1/day |
| Field Blank[3/] | 1/20 | 1/20 |
| Field Replicates[4/] | 10% | 10% |

1/ NA = Not applicable

2/ Samples are collected daily; however, only samples from every day are analyzed. Other samples are held and analyzed only if evidence of contamination exists.

3/ Field Blank samples will be collected in lieu of equipment blanks if sampling collection is accomplished without the use of sampling equipment.

4/ The duplicates must be taken from the same sample which will become the laboratory matrix/matrix spike duplicate for organics or for the sample used as a laboratory duplicate in inorganic analysis.

5/ Field Splits of all QC samples.

### 1.4.1 Field Quality Control Samples

Field replicate samples, equipment blank samples (water only), and trip blank samples will be collected (at each unit) at a minimum frequency of one per 20 samples per matrix. These samples are collected, preserved, and handled in the same manner as the field samples. Each field QC sample is packed and shipped along with the field samples to the appropriate laboratory for analysis of the same constituents by the same analytical procedures as the field samples. Specific procedures for preparing field QC samples are presented in Section 8.0 of this QAPP.

### 1.4.2 Field Quality Assurance Samples

Field splits of equipment blank samples, trip blank samples and field replicate samples will be collected for all constituents at the same frequency as quality control samples. USACE guidance for collection, handling, and shipping of Quality Assurance (QA) samples is presented in ACOE Sample Handling Protocol, Draft Revision, September 1988. These field QA samples will be collected at the same time as the field samples and in the same type of containers. The QA samples will be handled in an identical manner as the field samples (see Section 6.0) and shipped to the ACOE contract laboratory for analysis. ACOE guidance for sample labeling, chain-of-custody, and packaging will be explicitly followed.

The Geraghty & Miller Project Manager will contact the USACE laboratory project manager at the initiation of field activities, one week prior to the first shipment of QA samples and upon shipment of the last group of QA samples. Geraghty & Miller also will frequently update the ACOE laboratory within 24 hours of any shipment of QA samples. The ACOE laboratory will be notified by Geraghty & Miller at least 24 hours prior to shipment of any samples for Saturday delivery. Communication with the ACOE laboratory and sample shipments will be addressed through:

U.S. Army Engineer Division
South Atlantic, COE Division Laboratory
611 Cobb Drive (Georgia Hwy 280)
Marietta, GA 30060
ATTN: Mr. James F. Nowland
(404) 421-5271

## 1.5 Data Analysis and Report Preparation

After the completion of each sampling and analysis program, the field and analytical data will be reviewed, validated, and analyzed using appropriate checklists. All data will be classified for usability as described in Section 9.0 and summarized into appropriate tables, charts, and figures.

## 2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

This section provides a description of the organizational structure of personnel to be used on this project. This description illustrates the lines of authority and identifies the key personnel assigned to various activities for the project. A proposed organizational structure chart for the investigation is shown in Figure A4.

### 2.1 Authority and Responsibilities

The responsibilities of the individual positions for this project are described in the following sections.

#### 2.1.1 U.S. ACOE Project Manager

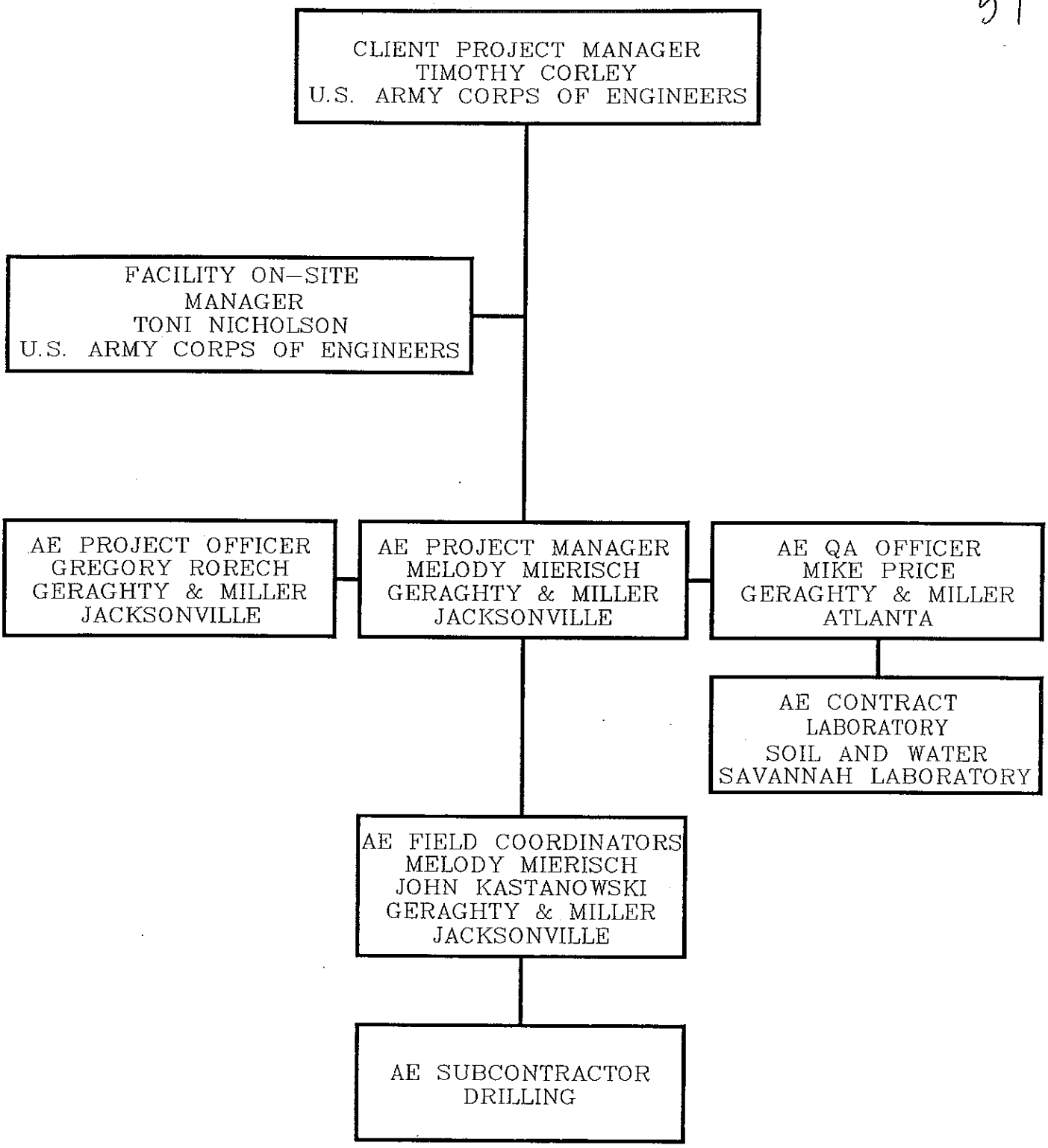
Ms. Toni Nicholson
U.S. Army Engineer Division, Savannah District
P.O. Box 889
Savannah, Georgia 31402

The ACOE Project Manager will review and approve the work plans and work activities for the duration of the project and direct the coordination of ACOE policy and environmental objectives.

#### 2.1.2 Facility On-Site Manager

Ms. Toni Nicholson
U.S. Army Engineer Division, Savannah District
P.O. Box 889
Savannah, Georgia 31402

The Facility On-Site Manager will be the primary contact at the Facility. She will be responsible for coordination of on-site activities described in the Work Plan. She will assure that all site activities conducted by Geraghty & Miller and its subcontractors are in agreement with the policies of the ACOE and the Facility. She will also be responsible for review of all Geraghty & Miller submittals. The office of the Facility On-Site Manager is located off base in Savannah.




GERAGHTY & MILLER, INC.
*Environmental Services*
*Jacksonville, Florida*

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

*RCRA FACILITY INVESTIGATION*
*ORGANIZATIONAL CHART*

*FORT STEWART* *GEORGIA*

*FIGURE*
*A.4*

2.1.3 A-E Project Officer

Mr. Gregory J. Rorech, P.E.
Geraghty & Miller, Inc.
8936 Western Way, Suite 7
Jacksonville, Florida 32256

The Project Officer is responsible for the overall implementation of the project. As an officer of the firm, he has the authority to commit the necessary resources to ensure timely completion of project tasks. Other duties, as required, may include:

- Coordination with the Project Manager concerning scheduling equipment and manpower.
- Review of project progress.
- Final review of all documents, plans, and drawings.

2.1.4 A-E Project Manager

Ms. Melody Mierisch
Geraghty & Miller, Inc.
8936 Western Way, Suite 7
Jacksonville, Florida 32256

The Project Manager will serve as the primary Geraghty & Miller contact for ACOE personnel and subcontractors. Other duties, as required, may include:

- Approval of project-specific procedures and internally prepared plans, drawings, and reports;
- Ensuring that the technical, schedule, and control requirements established by the QA Officer are enforced on the project;
- Serving as the "collection point" for the project staff reporting any changes or deviations from the project work plan;
- Determining the significance of these changes or deviations to the work plan, and the appropriateness for reporting such items to the appropriate regulatory and ACOE representative;
- Arranging subcontractor services;
- Assigning duties to the project staff and orientation of the staff to the requirements of the project; and
- Preparation of status update reports and revisions to the project work plan.

2.1.5 A-E Field Coordinator

Ms. Melody Mierisch
Geraghty & Miller, Inc.
8936 Western Way, Suite 7
Jacksonville, Florida 32256

The A-E Field Coordinator principally is responsible for interacting with the Facility On-Site Manager to schedule the day-to-day field activities. Other duties required may include:

- o Review of on-site activities for compliance with the RFI Work Plan;
- o Preparation of daily/weekly status report;
- o Resolution of on-site scheduling conflicts; and
- o Monitoring of staff and subcontractor progress.

2.1.6 A-E Quality Assurance Officer

The Quality Assurance Officer (QA Officer) will be responsible for liaison between the laboratories, Geraghty & Miller, and the ACOE. The QA Officer will ensure the accuracy of the collected data through the performance of the following tasks:

- o Field and laboratory systems and performance audits;
- o Field sample collection and analytical QA program design;
- o Field and analytical data validation;
- o Selection of the analytical laboratory; and
- o Preparation of laboratory contracts.

Mr. Mike Price
Geraghty & Miller, Inc.
3200 Highlands Parkway, Suite 205
Atlanta, Georgia 30082

2.1.7 Support Staff

In addition to the individuals previously mentioned, senior staff from Geraghty & Miller offices located in Tampa, Jacksonville, Aiken, and Oak Ridge will be responsible for coordinating their respective specialized functions, if required, during the implementation of the RFI Work Plan.

## 2.2 Primary Analytical Laboratory

Savannah Laboratories and Environmental Services, Inc. of Savannah, Georgia has been selected to act as the primary analytical laboratory for this project.

Savannah Laboratories and Environmental Services, Inc.
5102 LaRoche Avenue
Savannah, Georgia 31404
(912) 354-7858
Attn: Ms. Janette Long

The Laboratory Director is Ms. Janette Long. The Laboratory Project Manager assigned to this project by Savannah Labs is Ms. Janette Long. Savannah Labs Quality Assurance Officer for this project will be Ms. Kimberly D. Cribb. The personnel qualifications of Savannah Lab's staff and their organization are provided in Appendix A of this QAPP.

Ms. Long will act as the primary liaison for Geraghty & Miller during implementation of this work plan and he will be responsible for review of analytical data as well as review of the final analytical report submitted for this project. Ms. Long also will be involved with scheduling of sample receipt, sample handling practices, and assuring that analyses are complete and reported in a timely manner.

Ms. Cribb will be responsible for implementation of Savannah Lab's quality assurance program as well as assuring adherence to the QAPP. She will be responsible for review of quality control data generated during the analysis of samples from this project to assure that analyses meet the data quality objectives established in this QAPP.

# 3.0 DATA QUALITY OBJECTIVES

The overall quality assurance objective is to ensure that data of known and acceptable quality are produced. Proper execution of each task will yield consistent results that are representative of the media and conditions measured and are useful for meeting the intended project objectives. Data will be calculated and reported in units consistent with those of other agencies and organizations to allow comparability of data bases.

Data quality objectives (DQOs) are statements of the level of uncertainty that a decision maker is willing to accept in results derived from environmental data. Throughout the project planning process, DQOs are developed for each phase of the project and will be documented in the site specific work plans.

## 3.1 Objectives for Air, Water, Soil, Sludge, Sediment, and Waste Analyses

Quality assurance objectives for samples and sample analysis are presented in Table1 and Table 1a. These tables have been prepared to provide flexibility in the selection of appropriate methods for each SWMU to be evaluated at the Facility. The appropriate analytical, geotechnical, and other associated quality assurance objectives required for a specific site are to be selected from Tables 1 and 2.

The DQO statements of the precision, accuracy, and completeness have been established by each of the contracted laboratories for each analyte of interest in the soil, water waste, or air matrices as are appropriate for the analyses they are required to perform. The DQOs for the major analytes to be measured have been summarized in Table1 and Table 1a.

It is intended that laboratories will use the practical quantitation limits (PQLs) listed in Table1 and Table 1a. These PQLs are consistent with limits presented in the USEPA document entitled "Test Methods for Evaluating Solid Waste-Physical/Chemical Methods," SW-846, Third Edition. Specific PQLs, based on the site specific requirements will be provided to the selected laboratory prior to the submittal of samples.

## 3.2 Objectives for Field Measurements

### 3.2.1 Geotechnical Interpretations

Geologic interpretations made during field operations for the collection of geotechnical data will be recorded on Sample/Core Log forms such as shown in Figure A5. Additional data, such as well construction will be indicated in column "e." Instrument readings will be recorded in the "remarks" column. The purpose of developing geotechnical data is to provide information for the remedial design activities with regard to the soil classification and physical properties of materials present at the SWMU as well as to identify profiles of the underlying stratigraphy. To obtain this information, selected samples will be collected of soils for geotechnical testing. The methods of testing are presented in Table 2.

Soil classification tests will define the types of soils and sediments encountered at the site. Moisture content tests will be used in combination with Atterberg Limits determinations to define the effects of compaction of the materials. Particle-size analyses will be used to evaluate soil porosity and the relative flow characteristics of liquids through the soils. Total organic carbon content will be used to assess the potential of soils to retard the migration of organic contaminants present in the ground water.

### 3.2.2 Field Analyses

Field analyses that are commonly performed are presented in Table 4. The precision, accuracy, and completeness criteria presented in the table are consistent with the criteria established by EPA for the methods referenced.

Analyses of volatile organic compounds in soil and water with a mobile laboratory, or using a Photovac Gas Chromatograph (GC), can provide data with detection limits, precision, and accuracy comparable to laboratory data. However, due to the limited quality control employed in field analyses, the data generated by the field techniques will be considered semi-quantitative. Data generated by these techniques is substantiated by submitting split samples to the contract laboratories for analysis.

Hole No.

| DRILLING LOG | DIVISION | INSTALLATION | SHEET OF SHEETS |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1. PROJECT | | 10. SIZE AND TYPE OF BIT | |
| | | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL) | |
| 2. LOCATION (Coordinates or Station) | | 12. MANUFACTURER'S DESIGNATION OF DRILL | |
| 3. DRILLING AGENCY | | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED / UNDISTURBED |
| 4. HOLE NO. (As shown on drawing title and file number) | | 14. TOTAL NUMBER CORE BOXES | |
| 5. NAME OF DRILLER | | 15. ELEVATION GROUND WATER | |
| 6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT. | | 16. DATE HOLE | STARTED / COMPLETED |
| 7. THICKNESS OF OVERBURDEN | | 17. ELEVATION TOP OF HOLE | |
| 8. DEPTH DRILLED INTO ROCK | | 18. TOTAL CORE RECOVERY FOR BORING | % |
| 9. TOTAL DEPTH OF HOLE | | 19. SIGNATURE OF INSPECTOR | |

| ELEVATION a | DEPTH b | LEGEND c | CLASSIFICATION OF MATERIALS (Description) d | % CORE RECOVERY e | BOX OR SAMPLE NO. f | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g |
|---|---|---|---|---|---|---|
| | | | | | | |

GERAGHTY & MILLER, INC.
*Environmental Services*

# SAMPLE CORE LOG

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
FORT STEWART, GEORGIA

DRAWING NO: FT-030

FIGURE A.5

Table 4. QA Frequency and Objectives for Field Measurements

**QA Sample Objectives**

| Parameter | Analyses Method | Precision | Accuracy (Recovery) | Completeness % |
|---|---|---|---|---|
| pH | 150.1 | 0.05 units | ±0.2 units | 95 |
| Conductivity | 120.1 | 7.6 umhos/cm | ±2% | 95 |
| Temperature | -- | 0.1°C | ±0.2°C | 95 |
| Volatile Organic Halocarbons (VOHs) | 8021M | 30% RPD | 40% | 90 |

**QA Sample Frequency**

| Analysis | Initial Calibration | Calibration Check | Matrix Reagent Blank | Matrix Spike | Spike Duplicate |
|---|---|---|---|---|---|
| pH | Daily | Every 4 Hours | -- | -- | -- |
| Cond. | Daily | Every 4 Hours | -- | -- | -- |
| (VOHs) [1/] | Weekly [2/] | Daily | Daily | 5% | 5% |

| Analysis | Reagent Water Spike | Reagent Water Spike Duplicate | Sample Duplicate |
|---|---|---|---|
| pH | -- | -- | Daily |
| Cond. | -- | -- | Daily |
| VOHs | As Needed [3/] | As Needed [3/] | 5% |

1/ Method 8021M is a modified EPA Method 8021. The modification includes the substitution of a Flame Ionization Detector for the specified Electrolytic Conductivity Detector.

2/ An initial calibration will be run at the beginning of each week. If the continuing calibration check sample exceeds ±15% of the expected value a new initial calibration is performed.

3/ A reagent water spike and spike duplicate is analyzed only if the matrix spike or matrix spike duplicate are not in control.

Analytical methodologies, that are modifications of standard EPA methods, will be developed for each field analysis program. The quality control procedures that will be used are described in the standard operating procedures presented in Appendix B.

Appropriate uses of field measured VOCs using field portable GC techniques include:

- Analysis of effluent streams with unknown or highly variable concentrations;
- Head space analysis of drummed waste;
- Analyses of soil or ground water to determine the areal extent of constituents of interest prior to installation of permanent monitor wells and/or submission of samples to contract laboratories;
- Analysis of air samples to provide real time monitoring data during excavations; and
- Analysis of soil or ground water during deep well installation to determine well screen intervals.

### 3.2.3 Water-Level Measurements

The measurement of water levels is a critical aspect of any ground-water investigation. Water-level measurements are required during the course of the investigation to confirm the ground-water flow direction.

Water levels will be measured by sampling team personnel during all sampling events. Water levels will be measured with an electronic measuring device, in accordance with standard operating procedures published by EPA Region IV (Appendix C) and described in Section 4.3.1.1. Water-level measurements will be recorded to the nearest one-hundredth of a foot. Water-level data will be referenced to the National Geodetic Vertical Datum or other common datum.

# 4.0 SAMPLING PROCEDURES

The quality of the data collected in an environmental study depends on the quality of the sampling activities. Therefore, field operations will be carefully planned and implemented. Detailed procedures and protocols for site selection, sample collection, handling, preservation, shipping and storage are described in detail in the following sections.

## 4.1 General Sampling Procedures

Sampling for ground water, surface water, soil/sediment, and solid wastes will be accomplished in accordance with protocols described in Section 4 of the EPA Region IV SOP/QAM (Appendix C). Ambient air sampling will be conducted in accordance with established NIOSH protocols as outlined in "NIOSH Manual of Analytical Methods, Third Edition, 1984", and EPA procedures specified in both the "Third Edition of Test Methods for Evaluating Solid Waste, 1986", and the "Compendium of Methods for the Determination of Toxic Organics in Ambient Air, 1984".

### 4.1.1 Types of Samples

Samples collected for laboratory analysis may consist of sediments from streams, swamps, and lakes; surface soils and soil from soil borings; ground water from permanent and temporary monitoring wells; surface water; solid-waste from test pit excavations; and air samples from disposal areas, and background locations as well as during test pit excavations. The number of samples of each matrix to be collected for each parameter, and the number of pertinent field QC samples required to be submitted for each parameter will be determined prior to each field investigation.

### 4.1.2 Sample Containers

Sample containers supplied by the laboratories for the collection of solid-waste, sediment, soil, ground-water, and surface-water will be new, pre-cleaned, and pre-baked according to the procedures specified in the analytical methods.

ACOE guidelines have been adopted concerning the sample volumes, sample containers, and handling procedures for environmental samples containing varying degrees of contaminants. The three levels of contamination have been defined as follows:

- Low level samples are considered to be those collected off-site, around the perimeter of a waste site, or in areas where hazards are thought to be significantly reduced by normal environmental dilution, attenuation, and degradation processes.

- Medium level samples are commonly those collected in areas of moderate dilution by normal environmental processes.

- High level samples include those in drums, surface impoundments, direct discharges, and chemical spills where there is little or no evidence of environmental dilution. High level samples are suspected to contain greater than 15% concentration of any individual chemical constituent.

It is anticipated that the majority of samples collected for this investigation will be classified as low level samples.

Tables 5, 6, and 7 summarize the sample containers and preservation procedures required for each type of sample. Sample containers will be kept closed and in the cooler until use. Sample packing and shipping procedures are outlined in Appendix E of "Chemical Data Quality Management for Hazardous Waste Remedial Activities," ACOE, October 1990 and is included as Appendix D to this QAPP.

Containers for geotechnical samples may be undisturbed sample tubes or soil sampling jars provided by the contracted soils laboratory. The type of soil sample containers employed will be in accordance with the requirements established for the geotechnical analysis methods presented in Table 2.

Table 5. Sample Container, Preservative, and Holding Time Specifications for Low Concentration Samples

| Parameter | Container[1/] | Sample Preservation | Holding Time |
|---|---|---|---|
| Ground Water/Surface Water | | | |
| Volatile Organics | Two 40-mL glass VOC vials, no headspace | 1:1 $HNO_3$ to pH <2 | 14 Days <24 Hours On Site |
| Base/Neutral/ Acid Extractables | One 1-gallon amber glass bottle | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| Nitro-aromatics | One 1-gallon amber glass bottle | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| TRPH | 1-Liter amber glass | Ice to 4°C | 28 days |
| Pesticides and PCBs | 2-Liter amber glass | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| Common Anions | 1-Liter high-density poly-ethylene | Ice to 4°C | 28 days[2/] |
| Total or Dissolved Metals | 1-Liter high-density poly-ethylene | 1:1 $HNO_3$ to pH <2 | 6 Months, Except for Mercury, analyze in 28 days, CR(VI) 24 hrs |
| Cyanide | 1-Liter high-density poly-ethylene | NaOH to pH<12 Ice to 4°C | 14 days |
| Radio-nuclides | 1-Liter high-density poly-ethylene | 1:1 $HNO_3$ to pH <2 | 6 Months, |

Table 5 (continued)

| Parameter | Container[1/] | Sample Preservation | Holding Time |
|---|---|---|---|
| Soil and Sediment[2/] | | | |
| Volatile Organics | Two 40-mL glass VOC vials, full | Ice to 4°C | Analyze in 14 days, <24 hours on site |
| TRPH | One 8-oz glass jar, 3/4 full | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| Pesticides/ PCBs | 1 8-oz glass jar, full | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| Acid/Base/ Neutral Extractables | One 8-oz glass jar, full | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| Nitro-aromatics | 1 8-oz glass jar, full | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| | | Ice to 4°C | 6 months |
| Metals/cyanide | 1 8-oz glass jar, full | Ice to 4°C | 6 months, except for mercury, analyze in 28 days |

1/ All containers must have Teflon-lined lids

2/ Chloride, Bromide, Fluoride, Nitrate, Nitrite, Ortho-phosphate, Sulfate; Ortho-phosphate requires filtration; holding times for nitrate, nitrite, and ortho-phosphate is 48 hours.

3/ Holding times for soil and sediment samples are advisory only.

Table 6. Sample Container, Preservative, and Holding Time Specifications for Medium Concentration Samples

| Parameter | Container[1/] | Sample Preservation | Holding Time |
|---|---|---|---|
| Ground Water and Surface Water | | | |
| Volatile Organics | Two 40-mL glass VOC vials, no headspace | Ice to 4°C | 14 Days <24 Hours On Site |
| Base/Neutral/ Acid Extractable Organics | Four 32-oz wide-mouth amber glass jars | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| Pesticides/ PCBs | Four 32-oz wide-mouth amber glass jars | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| Cyanide | One 16-oz wide-mouth jar | Ice to 4°C | 14 days |
| Nitro-aromatics | Two 40-mL glass VOC vials, no headspace | Ice to 4°C | Extract in 7 days, analyze within 40 days of extraction |
| Metals | One 16-oz wide-mouth jar | 1:1 $HNO_3$ to pH <2 | 28 days for Hg, 6 mos. for all others |
| Soil and Sediment | | | |
| Organics and Inorganics | Two 8-oz wide-mouth glass jars | Ice to 4°C | None specified |

1/ All containers must have Teflon-lined lids

Table 7. Sample Container, Preservative, and Holding Time Specifications for High Concentration Samples

| Parameter | Container[1/] | Sample Preservation | Holding Time |
|---|---|---|---|
| Ground Water/Surface Water/Liquid | | | |
| Organics and Inorganics | One 8-oz wide-mouth glass jars | Ice to 4°C | None specified |
| Soil/Sediment/Solid | | | |
| Organics and Inorganics | One 8-oz wide-mouth glass jars | Ice to 4°C | None specified |

1/ All containers must have Teflon-lined lids

4.1.3 Sample Labels and Sampling Logs

Samples collected for chemical analysis will be fully labeled at the time of collection. At a minimum, the sample label information will include the sample identification, the date and time of collection, sample matrix, the analyses requested, the preservatives used, and the initials of the personnel collecting the sample. An example of a sample label is shown in Figure A6. Sample collection data, including information contained on the labels, will be recorded in the bound field log book as the samples are collected. All recorded entries will be made in indelible ink. No erasures will be made. If an error is made, a correction may be made by drawing a line through the error, initialing the error, and starting a new entry on the next line. Sample containers will be placed on ice in coolers immediately after sampling.

A soil/sediment sampling log similar to the one presented in Figure A7 will be completed for the collection of every soil, sediment, and solid waste sample. A water-sampling log similar to the one presented as Figure A8 will be completed during the collection of ground-water and surface-water samples. These logs will be completed as samples are collected. Field QC samples will be clearly identified on the appropriate field sampling log and in the field log book.

4.1.4 Equipment Cleaning

Sampling equipment cleaning procedures (pre- and post-sampling) will be conducted in accordance with procedures specified in the EPA Region IV SOP/QAM presented in Appendix F of this QAPP. The cleaning procedures specified in this section are to be used by sampling personnel to decontaminate sampling and other field equipment prior to field use. The specific cleaning materials and procedures for equipment decontamination are presented in the following paragraphs.

(a) Laboratory Detergent and Cleaning Solvent. The laboratory detergent used for equipment decontamination will be a standard brand of phosphate-free laboratory detergent such as Alquinox™, Liquinox™, or Micro™. The standard cleaning solvent shall be pesticide grade isopropanol. The use of other detergent or solvent must be approved by the A-E QA Officer, and its use must be documented in the field log books.

| GERAGHTY & MILLER, INC. Environmental Services | | SAMPLE I.D. |
|---|---|---|
| PROJECT # | | DATE |
| SAMPLE TYPE<br>☐ Soil/Sediment<br>☐ Water | COLLECTION MODE<br>☐ Composite<br>☐ Grab | TIME |
| ANALYSIS | | |
| SAMPLER(S) | | PRESERVATIVE |

GERAGHTY & MILLER, INC.
*Environmental Services*

# SAMPLE LABEL

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
FORT STEWART, GEORGIA

DRAWING NO:
FT-005

FIGURE
A.6

GERAGHTY & MILLER, INC.
*Environmental Services*

# SOIL/SEDIMENT SAMPLING LOG

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Project No. _____ Page ____ of ____

Project Location _____

Sample I.D. No. _____ Coded/Replicate No. _____

Date _____ Time of Sampling: Begin _____ End _____

Weather _____

Site Description _____

_____

_____

## SAMPLING DATA

Collection Method _____

Depth _____ Moisture Content _____ pH _____

Color _____ Odor _____

Description _____

_____

_____

| Analyses Required | Container |
|---|---|
| | |
| | |
| | |
| | |

Sample Monitoring (TIP, OVA, HNU, etc.) _____

_____

_____

Remarks _____

_____

Sampler(s) _____

GERAGHTY & MILLER, INC.
*Environmental Services*

SOIL/SEDIMENT SAMPLING LOG

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
FORT STEWART, GEORGIA

DRAWING NO: FT-007

FIGURE A.7

GERAGHTY & MILLER, INC.
*Environmental Services*

# WATER SAMPLING LOG

Project/No. _____ Page _____ of _____

Site Location _____

Site/Well No. _____ Coded/ Replicate No. _____ Date _____

Weather _____ Time Sampling Began _____ Time Sampling Completed _____

## EVACUATION DATA

Description of Measuring Point (MP) _____

Height of MP Above/Below Land Surface _____ MP Elevation _____

Total Sounded Depth of Well Below MP _____ Water-Level Elevation _____

Held _____ Depth to Water Below MP _____ Diameter of Casing _____

Wet _____ Water Column in Well _____ Gallons Pumped/Bailed Prior to Sampling _____

Gallons per Foot _____

Gallons in Well _____ Sampling Pump Intake Setting (feet below land surface) _____

Evacuation Method _____

## SAMPLING DATA/FIELD PARAMETERS

Color _____ Odor _____ Appearance _____ Temperature _____ °F/°C

Other (specific ion; OVA; HNU; etc.) _____

_____

Specific Conductance, umhos/cm _____ pH _____

Sampling Method and Material _____

| Constituents Sampled | Container Description From Lab ____ or G&M ____ | Preservative |
|---|---|---|
| | | |
| | | |
| | | |

Remarks _____

Sampling Personnel _____

WELL CASING VOLUMES

| GAL./FT. | | | | |
|---|---|---|---|---|
| | 1-¼" = 0.06 | 2" = 0.16 | 3" = 0.37 | 4" = 0.65 |
| | 1-½" = 0.09 | 2-½" = 0.26 | 3-½" = 0.50 | 6" = 1.47 |

GERAGHTY & MILLER, INC.
*Environmental Services*

WATER SAMPLING LOG

U.S ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
FORT STEWART, GEORGIA

DRAWING NO: FT-008

FIGURE A.8

(b) Cleaning Water. Tap water from any municipal water supply may be used for initial equipment rinses and steam cleaning prior to decontamination. The use of an untreated potable water supply is not an acceptable substitute for tap water (EPA, Region IV, 1986).

Distilled or deionized water will be used during cleaning procedures for field equipment after tap water rinses. Deionized water is defined as tap water that has been treated with activated carbon and deionizing units. Deionized water should contain no metals, inorganics, pesticides, herbicides, extractable organic compounds, and purgeable organic compounds as measured by appropriate analysis of the field and/or equipment blanks that are submitted with the samples.

Distilled or deionized/organic free water will be used to prepare soap solutions and for final rinses during field equipment cleaning. The solvents, laboratory detergent, and rinse waters used to clean equipment shall not be reused.

(c) Location of Decontamination Process. When possible, equipment will be decontaminated in batches at a central staging area. Solutions, rinse solvents, and deionized water will be disposed in the Facility sanitary sewer system. When necessary, decontamination of soil and sediment sampling equipment as well as water sampling equipment may be conducted at a designated location within each SWMU. Small volumes of waste solutions, solvents, and rinses generated at the sampling sites during equipment decontamination will be disposed on the ground at a location that will not impact soil, surface water, or monitor well sampling location at the SWMU.

4.1.4.1 General Decontamination Procedures. Non-dedicated sampling equipment (bailers, Kemmerer-type samplers, glass bowls, split spoon, stainless-steel scoops, spoons, augers, etc.) will be decontaminated using the following procedure.

1. Rinse equipment thoroughly with potable tap water or deionized/distilled water in the field as soon as possible after use.

2. Rinse equipment with isopropanol alcohol.

3. Rinse equipment thoroughly with distilled or deionized/organic-free water.

4. Wash equipment thoroughly with laboratory detergent and deionized/organic-free or distilled water using a brush to remove particulate matter or surface film.

5. Rinse equipment thoroughly with distilled or deionized/organic-free water.

6. Wrap equipment completely to prevent contamination during storage and/or transport to the field.

Note: Sample equipment for metals will be rinsed with an acid solution as prescribed in the Engineering Support Branch SOP and Quality Assurance Manual, Appendix B, Section B.8.3, Field Equipment Cleaning Procedures.

4.1.4.2 Equipment Storage. Decontaminated field and sampling equipment will be stored in covered containers or wrapped in aluminum foil to minimize contamination. Decontaminated equipment shall be clearly identified by labeling the wrapping material. Field equipment and reusable sample containers needing cleaning or repairs shall not be stored with clean equipment. Field sampling equipment that needs to be repaired shall be clearly identified and the repairs shall be documented.

4.1.4.3 Quality Control Procedures for Cleaning Operations. The effectiveness of field cleaning procedures shall be monitored by collection of equipment blanks. Equipment blanks will be prepared according to the procedures specified in Section 8.0 of this QAPP. The equipment blank is collected in the same type of sample bottle as the field samples, preserved in the same manner, and analyzed for parameters of interest. Equipment blanks will be collected during each sampling event and analyzed for parameters at a minimum frequency of one per 20 samples. It should be noted that contamination detected in equipment blanks may be due to factors other than poor decontamination techniques. Other sources of potential contamination include the chemical preservatives and the sample bottles used during the investigations as well as laboratory sample handling procedures. Additional quality control samples (field blanks) may be collected to help evaluate these sources of potential contamination.

4.2 Sampling Preparation Procedures

Prior to initiating each sampling event, the senior member of the field team will assure that the team members have available the appropriate equipment and documents to complete the task. In addition, the senior member will notify the Facility On-Site Manager of the sampling schedule at least five days prior to sampling. The Facility On-site Manager will be notified at least one week prior to arrival at the Facility. Upon arrival at the Facility, the A/E Field Coordinator shall check-in with personnel at the Fort Stewart DEH Environmental Office and obtain keys needed for access to the SWMU and the monitoring wells. Names of points of contact will be provided by the COE Facility on-site manager/project manager. Access restrictions will be confirmed at this time. Prior to initiating drilling, the A/E Field Coordinator will obtain all the necessary drilling permits from DEH personnel.

The A-E QA Officer will contact the appropriate contract laboratories one to two weeks prior to sample collection to obtain bottles and schedule the analyses. During sampling, the senior member of the sampling team will contact the A-E QA Officer or the laboratory manager to confirm sample collection and shipments. In the event samples are to be shipped on a Friday, the A-E QA Officer will notify the laboratory that a shipment will be delivered Saturday.

4.2.1 Sampling Procedure Documentation

Prior to departure for the sampling site each member of the field team will have become familiar with, and have access to, the following documents:

- The Quality Assurance Program Plan (QAPP);
- The Site Specific Quality Assurance Project Plan (QAPP);
- The Site Specific Field Sampling Plan (SSFSP); and
- The USEPA Region IV SOP/QAM.

4.2.2 Sampling Equipment and Materials

Prior to the sampling event, the field personnel will prepare for field sampling/air monitoring by stocking the sampling vans with the items listed below.

- Site map, names of contacts, and access keys;
- Water sampling logs, sample core logs, soil/sediment sampling logs, air sampling logs, chain-of-custody forms, sample labels, waterproof ink pen, and tape;
- Sample containers (check for proper number, type, and preservatives), coolers, and ice;
- Cooler Custody seals;
- Water-level measurement equipment (150 ft steel tape with weight electronic tape);
- Well purging equipment (peristaltic pumps, 2-inch diameter submersible pumps);
- Water sampling equipment (Teflon™ bailers, Kemmerer-type samplers, peristaltic pumps);
- Filtering equipment (in-line filter stand, glass fiber pre-filter, 0.45 micron membrane filter);
- Soil/sediment sampling equipment (stainless-steel hand auger, stainless-steel spoons, bowls, etc.);
- Air sampling equipment (pumps, filters, solid sorbent, carbon tubes);
- Power source;
- Field analysis (pH, temperature, conductivity) instruments and calibration standards;

- o Teflon™-coated stainless-steel cable or disposable nylon rope, knife, and miscellaneous tools;
- o Disposable vinyl gloves;
- o Appropriate Health and Safety equipment and dress;
- o Decontamination equipment and supplies (laboratory grade detergent, deionized/ distilled water, pesticide grade isopropanol, buckets, scrub brushes, plastic sheeting);
- o Five-gallon graduated bucket;
- o Laboratory wipes and Ziploc bags; and
- o Plastic sheeting and folding table.

All equipment must be checked for proper operation. Equipment that will come in contact with the samples must be properly decontaminated before use. Upon arrival at each sampling location, sampling personnel will clear the area around the sample site of obstructions and possible sources of contamination. Plastic sheeting and a folding table will be placed next to the sampling location to provide a work area that minimizes sample contamination.

## 4.3 Ground-water Sampling

Ground-water sampling can be conducted using temporary monitor wells and permanent monitor wells. When sampling permanent monitor wells it is imperative that water level measurements and sample collection be conducted at least 24 hours after well installation. Ground-water samples can be collected from temporary wells immediately after purging is complete.

Upon arriving at the well, check the well for above-ground damage and the grout for structural integrity. Unlock and remove the well cap (a wrench may be required). New plastic sheeting should be placed around the well. Clean the top of the well casing prior to purging and sampling. Preliminary information can be recorded on the well sampling log.

4.3.1 Ground-Water Level, Total Sounded Depth, and Free-Product Level Measurements.

Procedures for measuring water-level and free product elevations are described in the following two sections.

4.3.1.1 Ground-water Level and Total Sounded Depth Measurements. The static water level and the total sounded depth of the well should be measured prior to purging and sampling well water. An electronic water-level indicator (M-scope) may be used for the water-level measurement if liquid hydrocarbon is not detected. Measurements should be referenced to the survey point (top of well casing).

The total depth of the well will be measured to the nearest 0.1 inches from top of casing and the datum recorded. If the construction specifications are available, this datum can be used to determine if the proper well has been identified, whether the well has filled with silt, and the volume of standing well water in the well. Record the measurements on the water sampling log. Prior to measuring another well, decontaminate the tape with a detergent solution and then rinse with deionized water.

4.3.1.2 Free Product (Liquid Hydrocarbon) Level Measurements. Determining the thickness of liquid hydrocarbon is accomplished by two separate measurements: depth-to-water and depth-to-hydrocarbon, the difference between the two being the hydrocarbon thickness. The measurements are to be made with an electronic hydrocarbon interface probe. The water level will be determined, when liquid hydrocarbon is present, by submerging the probe below the water/hydrocarbon interface and then determining the location of the interface by raising the probe from water to hydrocarbon. Record the measurements on the well sampling log. Typically, ground water samples are not collected if free-phase hydrocarbons are detected.

A calculation must be used to establish the potentiometric water surface when liquid hydrocarbon is present. The true water-table elevation must be calculated to account for the depression of the water surface caused by the mass of hydrocarbon product floating on the surface.

The formula for this determination is:

WATER-TABLE ELEVATION = TOC - (DTW- [0.85 x PT])

where, TOC = elevation of top of casing (ft mean-sea-level)
DTW = depth to water (ft)
PT = product thickness (ft)

4.3.2 Purging the Well (General Procedure)

After a water-level measurement has been taken, the well should be purged to remove the standing water. Purging can be accomplished by pumping or bailing, but pumping is preferred. If a pump is used, be sure the pump intake is at the top of the water column. As the water level drops, the pump or suction tube intake should be lowered so that the water column in the well casing is completely and efficiently removed. The intake tube should be removed before suction has been discontinued. Bailing the well is acceptable; however, if a bailer is employed, use extreme care in lowering the bailer into the well to avoid "surging" the water in the casing, which could disturb deposits at the bottom of the well. More information on purging techniques and equipment is presented in subsequent sections.

Routinely five times the calculated standing well water volume will be purged from each well prior to sampling. The volume of water in the well (in gallons) is calculated using the following equation:

$$v = 7.48\ Q\ r^2\ h$$

where, v = volume of standing water (gallons)
r = radius of well casing (ft)
h = height of standing water (ft)

Wells that recharge slowly (those not filled back to the static level within eight hours), should be purged completely at least once and then sampled after the water level has recovered sufficiently to fill the necessary sample containers.

Deciding when the required volume of water has been purged can be determined by directly measuring the amount of water pumped or bailed from the well with a container of known volume, or by purging with a calibrated pump and calculating the operating time required to remove five well volumes. Direct volume measurements are preferred for submerged pumps inasmuch as pumping rates are a function of head. A purge pump (peristaltic or submersible) may be calibrated by measuring the time required to fill a container of known volume. Once the required volume to be purged and the pumping rate are known, the time necessary to pump the required amount may be calculated by the formula:

$$T = \frac{V}{R}$$

where, T = time (minutes)
V = volume of standing water (gallons)
R = rate of flow (gallons/minute)

Water sample logs (see Figure A8) used by Geraghty & Miller have a table of well bore volumes per linear ft for various well sizes to allow calculation of well volumes in the field.

Using purging times to determine the volume of purged water shall be used only with pumps with a constant pump rate.

4.3.2.1 Purging Equipment and Techniques. Monitoring well purging is accomplished by using in-place plumbing/pumps or when in-place pumps are not available, by using either a peristaltic, turbine, bladder, centrifugal, or other appropriate pumps, depending on well depth. When pumping is not practical a Teflon™ or PE disposable bailer also may be used for purging.

Other equipment used during purging includes water level indicators, pH meters, thermometers, and conductivity meters.

4.3.2.2 Purging Techniques (Wells Without Plumbing or In- Place Pumps). For permanently installed wells, the depth of water and the volume of water in the well shall be determined as indicated in Sections 4.3.1 and 4.3.2 prior to purging. Field personnel should exercise extreme caution during this procedure to prevent contamination of the well.

**Using pumps to purge** - When suction lift or centrifugal pumps are used, only the intake tubing is placed into the water column. To minimize contamination, the tubing placed into the water is either standard decontaminated Teflon™, in the case of the suction lift pumps, or standard decontaminated stainless-steel pipe attached to a hose, when centrifugal pumps are used. When submersible pumps (bladder, turbine, displacement, etc.) are used, the pump itself is lowered into the water column.

**Using bailers to purge** - Standard decontaminated Teflon™ bailers with new nylon rope, monofilament line, or decontaminated Teflon™ coated stainless-steel wire are lowered into top of the water column, allowed to fill, removed and the water is discarded.

**Field care of purging equipment** - Regardless of which method is used for purging, plastic sheeting shall be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, lines, etc., in the event they need to be placed on the ground during the purging or accidentally come into contact with the ground surface.

It is preferable that hoses used in purging be kept on a spool, both during transporting and during field use, to further minimize contamination.

**Purging entire water column** - The pump/hose assembly or bailer used in purging should be lowered into the top few feet of the standing water column and not deep into the column. Purging in this manner will "pull" water from the formation into the screened area of the well and up through the casing so that the entire static water column can be removed. If the pump intake is placed deep into the water column, the water above the intake may not be removed, and the subsequent samples collected may not be representative of the ground water.

To minimize cross contamination between wells, no more than 3 to 5 ft of hose should be lowered into the water column. If the recovery of the well is at least as fast as the pump rate, the pump intake may be suspended at the initial level until an adequate volume has been purged. If the

pump rate exceeds the recovery rate of the well, the pump intake will have to be lowered, as needed, to accommodate the drawdown. After the pump intake is removed from the well, all wetted portions of the hose and the pump shall be decontaminated as outlined in Section 4.1.4.1.

Careful consideration shall be given to using pumps to purge wells which are excessively contaminated with oily compounds, because it may be difficult to adequately decontaminate severely contaminated pumps under field conditions. When excessively contaminated wells are encountered, bailing should be considered.

4.3.2.3 Purging Techniques (Wells With In-Place Plumbing). In-place plumbing is found at water treatment plants, industrial water supply wells, private residences, etc. The objective of purging is the same as with monitoring wells without in-place pumps; to ultimately collect a sample representative of the ground water.

The volume to be purged depends on several factors: whether the pumps are running continuously or intermittently, how close to the source the sample can be collected, and the presence of any storage/pressure tanks between the sampling point and the pump.

(1) Continuously running pumps. If the pump runs continuously, and the sample can be collected prior to a storage/pressure tank, no purge, other than opening a valve and allowing it to flush for a few minutes, is necessary.

If the pump runs continuously, and a storage/pressure tank is located ahead of the sample location, the purge must include the entire storage volume to be sure that a sample representative of the ground water will be collected.

(2) Intermittently running pumps. If the pump runs intermittently, it is necessary to determine the volume to be purged, including the volume of the water column in the well and the volume of the storage/pressure tanks that are located ahead of the sampling location. The pump should then be run continuously until the calculated volume has been purged.

4.3.3 Sampling the Well

4.3.3.1 Equipment. Sampling equipment to be used by Geraghty & Miller will include Teflon™ or PE disposable bailers, peristaltic pumps, and submersible pumps as appropriate.

4.3.3.2 Field Measurements. After purging is complete, a water sample will be collected to obtain measurements of pH, temperature, and specific conductivity. Prior to obtaining these measurements, the field instrumentation must be properly calibrated with reference standards in accordance with the manufacturer's recommendations and procedures specified in Appendix E.

4.3.3.3 Sampling Techniques - Wells with In-Place Plumbing. Samples should be collected following purging from a valve or cold water tap as near to the well as possible. Samples should be collected directly into the appropriate containers referenced in Tables 5, 6, and 7 of the QAPP.

4.3.3.4 Sample Collection - Wells Without Plumbing. Ground water sampling and performance of field measurements should be completed within 2 hours of purging the well. Care should be exercised when selecting sampling equipment to ensure that the materials that make up the equipment are compatible with the sample parameters and also comply with state and federal regulatory requirements for sampling. Generally speaking, Teflon™ is preferred but stainless steel, polyethylene, or PVC may be acceptable. Teflon™ is universally accepted by the U.S. Environmental Protection Agency (EPA).

Various types of equipment are available for sample collection, the most commonly used being bailers (Teflon™, steel, or disposable polyethylene), submersible pumps, peristaltic pumps, and selected bladder pumps. Bottom-entry Teflon™ bailers will be employed to collect organic parameters. Bailers will be fitted with Teflon™-coated stainless steel cable, or disposable cables of nylon or large-diameter monofilament fishing line. If a Teflon™-coated stainless-steel cable is used instead of a disposable cable, the cable should be decontaminated between each use.

Stainless-steel submersible pumps are readily available. Slow discharge rates should be set on the pump to avoid surging the well. However, because these pumps may aerate the sample, they are not acceptable for collecting volatile and semi-volatile organic constituents.

A peristaltic pump fitted with a Teflon™ intake hose is ideal for collecting inorganic ground-water samples but is not acceptable for volatile and semi-volatile organic constituents. Some manufacturers offer variable-speed peristaltic pumps which facilitate slowing the discharge rate when conducting in-line filtering.

Bladder pumps work by forcing an inert gas into a submerged bag or "bladder." As the bladder expands, ground water between the bladder and pump chamber is driven to the surface. Only bladder pumps made of Teflon™ may be used for collecting both inorganic and organic constituents. Regardless of the parameter of interest, the gas used to drive the bladder pump cannot come in contact with the sample. If bladder pumps are to be used for sample collection, intake and output hoses must be constructed of Teflon™ or stainless steel and either decontaminated or replaced between each use.

Once ground water to be sampled is brought to land surface, the water must be placed immediately in the appropriate container as listed in Tables 5, 6, and 7 of this QAPP. Bottle caps should not be removed until the bottle is to be filled.

When sampling for volatile organic compounds (VOCs), extreme care must be taken in order to keep aeration of the sample to a minimum. This can be achieved by pouring the sample down the inner-side of the container until the vial is full and the water is mounding. Never remove the Teflon™ lining from the cap used to seal the bottle because any natural oil from the skin that adheres to the liner might be detected in the laboratory analysis. After filling, invert the vial and tap the container to be sure there are no bubbles. If there are bubbles, remove the cap, fill it, and repeat the procedure. If bubbles persist, the vial may be defective. Containers for semi-volatile organics and inorganic analyses should be filled to about 90 percent capacity and sealed.

When samples require preservation, and the laboratory has provided pre-preserved containers take care not to overfill the container. If pre-preserved containers are not available, add the appropriate preservative as listed in Tables 5, 6, and 7 of the QAPP and adjust the sample to the correct pH.

If an inorganic sample is to be filtered, the filtration should be done immediately. Where possible, the procedure should use an in-line flow-through filter. Water samples for dissolved metals analyses must be filtered through a 0.45-micrometer filter; fiber filters are not acceptable.

When bottle filling is complete, identify each sample container with a properly completed label. Labels should be filled out completely with date, time, sample ID, matrix, parameters to be analyzed, method number, preservative added, and the sampler's initials. The labels should be affixed to the containers prior to sampling. Place the paired VOC vials for each sample in two Ziplock bags (one bag inside the other) to avoid cross-contamination and place the sample container in a cooler previously packed with ice.

## 4.4 Sampling of Potable Water Supplies

When sampling potable water supplies, utmost care must be taken to ensure that samples are representative of the water supply being sampled. This is important not only from a technical and public health perspective, but also from a public relations standpoint. Poor sampling techniques may result in incorrect results (either not detecting a compound which is present or by contaminating the sample and falsely indicating a compound which is not present). If incorrect results are disclosed to the public, it may be impossible to change public opinion when correct results are reported.

### 4.4.1 Sampling Site Selection

Even though the same care and techniques used in wastewater, ground-water, etc., sampling (including thorough documentation of location, date, time, etc.) are used in potable water supply sampling, there are certain additional special procedures which shall be used.

When water samples are collected from wells, either by mechanical or hand pumping, the wells must be purged before the sample is collected. This procedure ensures that water in the well field is sampled, not the standing water in the pump or holding tank. As a rule of thumb, at least one volume of water in the well casing and storage tank should be evacuated (a 15-minute period is usually sufficient for residential wells). This also ensures that contaminants that might have entered the area of the tap from external sources are flushed away.

Potable water samples shall be representative of the water quality within a given segment of the distribution network. Taps selected for sample collection should be supplied with water from a service pipe connected directly to a water main in the segment of interest and should not be separated from the segment of interest by a storage tank.

The sampling tap must be protected from exterior contamination associated with being too close to the sink bottom or to the ground. Contaminated water or soil from the faucet exterior may enter the bottle during the collecting procedure since it is difficult to place a bottle under a low tap without grazing the neck interior against the outside faucet surface. Leaking taps that allow water to flow out from around the stem of the valve handle and down the outside of the faucet, or taps in which water tends to run up on the outside of the lip, are to be avoided as sampling locations.

Aerator, strainer, and hose attachments on the tap must be removed before sampling. These devices can harbor a bacterial population if they are not cleaned routinely or replaced when worn or cracked. Whenever a steady stream of water cannot be obtained from taps, after such devices are removed, a more suitable tap shall be sought.

Taps where the water flow is not steady should be avoided because temporary fluctuation in line pressure may cause sheets of microbial growth that are lodged in some pipe section or faucet connection to break loose and contaminate the sample.

4.4.2 Sampling Techniques

Generally, the cold water tap should be used to collect samples. Open the tap for a minimum of 10 to 15 minutes or for sufficient time to permit clearing the service line. A smooth-flowing water stream at moderate pressure without splashing should be obtained. Then, without changing the water flow, the samples can be collected.

Regardless of the type of sample bottle being used, the bottle cap should not be placed on the ground or in a pocket. Instead, hold the bottle in one hand and the cap in the other, keeping the bottle cap right side up (threads down) and using care not to touch the inside of the cap. Exercise care not to lose the Teflon™ liner in certain bottle caps. Avoid contaminating the sample bottle with fingers or permitting the faucet to touch the inside of the bottle. When using pre-preserved sample containers the containers should not be rinsed before use to prevent removal of preservative

and the thiosulfate dechlorinating agent (if used). When filling any container, care should be taken so splashing drops of water from the ground or sink do not enter into either the bottle or cap. When sampling at a water treatment plant, samples should be collected both from the raw water supply and after chlorination.

Duplicate samples will always be collected for volatile organics and bacterial analyses. Single samples may be collected for extractable organic compounds, metals, phenol, cyanide, and conventional parameter analyses.

Geraghty & Miller will obtain the name(s) of the resident or water supply owner/operator and the resident's exact mailing address, as well as the resident's home and work telephone numbers. The information is required so that the residents or water supply owner/operators can be informed of the results of the sampling program.

## 4.5 Surface-Water Sampling

### 4.5.1 Sampling Equipment and Techniques

The physical location of the investigator when collecting a sample may dictate the equipment to be used. When collection of surface-water samples are required, direct dipping of the sample container into the stream is a desirable technique. This is possible, however, only from a small boat, a pier, etc., or by wading in the stream. Wading, however, may cause bottom deposits to rise and bias the sample. Wading is acceptable if the stream has a noticeable current (is not impounded), and the samples are collected directly into the bottle while pointed upstream. If the stream is too deep to wade or if the sample must be collected from more than one water depth or from a bridge, supplemental sampling equipment must be used.

For most samples, including those for trace organic compounds or metals analyses, a Teflon™ coated Nansen bottle (or equal) or Teflon™ coated DO dunker™ can be used. Teflon™ allows the container to be properly decontaminated. The Nansen bottle allows specific depth samples to be collected.

The DO dunker™ allows water to slowly enter the chamber as it moves downward through the water column. This configuration allows a composite of the water column to be collected rather than a grab at a single depth.

In addition to using the DO dunker for collecting samples, the DO dunker has the capability for placing two DO bottles inside for collecting water directly into the bottles with the proper overflow collection procedures. Additionally, a bacteriological or oil and grease bottle can be attached to the top of the dunker for direct sample collection.

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon™ coated sampler, a standard Kemmerer or Van Dorn sampler may be used. The Kemmerer sampler is a brass or plastic cylinder fitted with silicone rubber stoppers that leave the ends of the cylinder open while being lowered in a vertical position to a specific depth. This allows free passage of water through the cylinder. The Van Dorn sampler is usually constructed of plastic and is lowered in a horizontal position. In each case, a messenger is sent down the rope when the sampler is at the designated depth, releasing the stoppers and sealing the cylinder. The sampler is slowly raised and the water sample poured from a valve into the respective sample bottles. By attaching a piece of tubing to the valve, DO sample bottles can be properly filled by allowing an overflow. When sampling near the bottom of a water body, care should be taken not to stir up the bottom sediment and thus bias the sample.

Teflon™ or stainless-steel bailers or beakers may also be used to collect samples from surface waters. However, the bailers or beakers, must be properly decontaminated and then rinsed twice with the sample water prior to collection of the sample. Also, an acid rinsed Teflon™ bailer or beaker can be used to collect samples for trace metals analyses and a solvent rinsed stainless-steel bailer or beaker can be used to collect samples for trace organic compounds analyses.

## 4.6 Soil Sampling

### 4.6.1 Equipment

The following equipment may be used for soil sampling: stainless-steel spoons; stainless-steel hand augers; Shelby tubes; portable power augers; stainless-steel scoops; glass pans; and drill rigs and associated equipment (i.e., split spoon samplers).

4.6.2 Sample Handling

Soil samples collected for analysis of VOCs will be transferred from the sampling device to the appropriate bottles or vials as soon as possible after the sample is obtained. Soil samples collected for chemical analysis of other constituents should be thoroughly mixed before being placed in the appropriate sample containers. The proper mixing procedure is described below.

The soil should be removed from the sampling device and placed in a glass or Teflon™-coated stainless-steel pan. Thoroughly mix the soil using a stainless-steel or Teflon™-coated stainless-steel spoon. The soil in the pan should then be scraped from the sides, corners, and bottom of the pan, rolled to the middle of the pan, and mixed again. The sample should then be quartered and moved to the four corners of the container. Each quarter of the sample should be mixed individually. Each quarter is then recombined in the center of the container and the entire sample is mixed again.

This procedure should be continued to ensure that all parts of the sample are mixed and that the sample is as homogeneous as possible before being placed in the sample containers. Sample containers will then be placed into coolers containing ice pending repackaging and shipment.

4.6.3 Soil Sampling Techniques

Various sampling techniques are available which are dependent on the depth from which soil samples are to be collected, whether samples are disturbed or undisturbed, and the equipment which is readily available. Boring techniques include the use of shovels or spoons, hand augers, power augers, and drill rigs. Sampling techniques include the use of stainless-steel spoons and hand augers, shelby tubes, and split-spoon samplers.

4.6.3.1 Surface and Shallow Subsurface Sampling. Shovels and spoons are commonly used when surface or shallow subsurface (0 to 3 ft in depth) soil samples are to be collected. Samples are obtained by digging a hole or trench to the desired depth with a shovel or spoon, removing the loose soil and then collecting the sample with a stainless-steel scoop by scraping soil from the sides of the hole at the desired depth. The sample is then placed into a glass mixing bowl and handled as described in Section 4.6.2.

Hand augers can be used from depths of 1 ft to 20 ft depending on the nature of the formation from which soil samples are to be taken. The hand auger consists of three parts: (1) the bucket, (2) extension, and (3) handle. At the bottom end of the bucket are two cutting edges. The extensions can be joined end-to-end to increase the depth of boring. Prior to collecting the sample from the desired depth, the bucket should be decontaminated. The sample is transferred with a stainless-steel spoon to a glass mixing bowl prior to handling as described in Section 4.6.2.

Often the depth which can be reached using a hand auger is limited due to low soil cohesion which leads to the hole collapsing or very cohesive soils which make turning and removing the hand auger difficult. In cases such as these, a power auger can be used to depths up to 10 ft or a drill rig equipped with a hollow stem auger can be used if sampling from greater depths is required. Use of a drill rig for performing soil borings and collecting samples is discussed in Section 4.6.3.2.

The power auger requires two sampling personnel to operate and consists of a powered drive unit which is coupled to crew-like auger flights. The hole is drilled to the desired depth and samples are collected using either a hand auger as previously described or with a Shelby tube.

The Shelby tube is a stainless-steel tube approximately 12 inches long and 2 inches in diameter. One end of the tube has the edges beveled into a cutting edge. The other end can be mounted on an adapter which allows attachment to the end of the hand auger. The Shelby tube is pushed into the soil to be sampled and then removed. The tube is then removed from the adapter and the soil pushed out using a decontaminated piece of equipment such as the handle of a stainless-steel spoon. If an undisturbed sample is required, the Shelby tube with its sample intact may be sealed and shipped directly to the laboratory for analyses.

4.6.3.2 Deep Subsurface Sampling. For depths from 5 ft bls to the water table a split-spoon sampler or Shelby tubes may be used for sample collection.

The split-spoon sampler is used in conjunction with a drill rig and hollow stem auger. The hollow stem auger is used to advance the borehole to the desired depth. The split spoon is attached to the end of the drilling rod and driven or forced into the soil the length of the sampler. The split spoon is removed from the borehole, detached from the drilling rod and opened. The soil is scraped from the split spoon and the portion of the split-spoon sample that represents slough

discarded. The soil obtained from the split spoon will be composited according to the procedures described is Section 4.6.2.

Shelby tubes can also be attached to the end of the drilling rod and forced into the formation with the drill rig. Shelby tubes were previously described in Section 4.6.3.1.

4.6.4 Sampling Equipment Quality Assurance

The field log book shall identify the equipment used and document all cleaning, maintenance and repair procedures.

All equipment used to collect soil samples shall be decontaminated as outlined in Section 4.1.4.1 and repaired, if necessary, before being stored at the conclusion of field studies. Any cleaning conducted in the field or field repairs should be thoroughly documented in field records.

A system of logging all pertinent data collected during drilling and sampling operations should be maintained. The test hole locations should be recorded and referenced to the site map and/or datum base so that each location can be permanently established. Samples should be accurately labeled with all pertinent site information at the time of sampling.

4.7 Sediment Sampling

Sediment samples can be collected using a variety of methods and equipment, including dredges, core samplers, and scoops. The methods, their application as well as the advantages and disadvantages of each technique are discussed in detail in the following paragraphs.

4.7.1 Dredges

Sediment samples will be collected using a dredge in areas of deep or remote shallow waters. The selection of dredging equipment is dependent upon the expected composition of sediments as well as the presence or absence of benthic organisms.

The Ekman dredge performs well in waterways with light currents and when the bottom materials are unusually soft such as organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in waters with high velocities.

The Peterson dredge is useful when the bottom is rocky, the water is deep, benthic organisms are present, or the water velocity is high. The dredge is heavy and should be lowered very slowly as it approaches bottom, because it can displace lighter materials if allowed to drop freely.

The Ponar dredge is similar to the Peterson dredge but has been modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave."

The dredges are generally operated by lowering the dredge into the water column. Upon contact will the bottom sediments, either a locking mechanism releases or in the case of the Ekman dredge a weighted messenger is sent down the sampler line to close the dredge. When the dredge has been returned to the surface, water captured in the top is gently drained to minimize the loss of organic flocks and fines that are often found at the sediment surface. The dredge is then opened and its contents removed.

### 4.7.2 Core Samplers

Core samplers are used to sample vertical columns of sediment. They are particularly useful when a historical approach to sediment deposition is desired for they preserve the sequential layering of the deposit. Many types of coring devices have been developed depending on the depth of water from which the sample is to be obtained, the nature of the bottom material, and the length of core to be collected. They vary from hand push tubes to weight or gravity driven devices.

Coring devices are particularly useful in pollutant monitoring because the "shock wave" created by descent is minimal, thus the fines of the sediment-water interface are only minimally disturbed. The sample obtained is withdrawn intact permitting the removal of only those layers of interest. Core liners manufactured of glass or Teflon™ can be purchased, thus reducing possible sample contamination, and the samples are easily delivered to the lab for analysis in the tube in which they were collected. The disadvantage of coring devices is that a relatively small sample size is obtained often necessitating repetitive sampling in order to obtain the required amount for

analysis. Because it is felt that this disadvantage is offset by the advantages, coring devices are recommended in sampling sediments for trace organic compounds or metals analyses.

In shallow waters, the direct use of a core liner or tube manufactured of Teflon™ or glass is recommended for the collection of sediment samples. Their use can also be extended to deeper waters when SCUBA equipment is available. Teflon™ is preferred over glass to avoid breakage and subsequent sample loss. Stainless-steel push tubes are also acceptable and provide a better cutting edge and higher strength than Teflon™. However, the use of the glass or Teflon™ tube by itself eliminates potential metal contamination from core barrels, and cutting heads.

The coring tube should be approximately 12 inches long if only recently deposited sediments (8 inches or less) are to be sampled. Longer tubes should be used when the depth of the substrate exceeds eight inches. Soft or semi-consolidated sediments such as mud and clays have a greater adherence to the inside of the tube and thus can be sampled with larger diameter tubes. Because coarse or unconsolidated sediments such as sands and gravel tend to fall out of the tube, a small diameter tube is required when sampling these materials. A tube about two inches in diameter is usually the best size. The wall thickness of the tube should be about 1/3 inch for either Teflon™ or glass. The inside wall may be filed down at the bottom of the tube to facilitate entry of the liner into the substrate.

When wading in shallow water caution should be exercised not to disturb the area to be sampled. The core tube is pushed into the substrate until only four inches or less of the tube is above the sediment-water interface. When sampling hard or coarse substrates, a gentle rotation of the tube while it is pushed will facilitate greater penetration and cut down on core compaction. The tube is then capped with a Teflon™ plug or a sheet of Teflon™ held in place by a rubber stopper or cork. After capping, the tube is slowly extracted. The negative pressure and adherence of the sediment to the core tube will keep the sample in the tube. Before pulling the bottom part of the core above the water surface, it too is capped.

To help prevent contamination from direct contact between the sampler's hand and the upper part of the tube, a collar-type device should be constructed of wood and should have a circular recess to accept the top of the tube. The recess should have a hole in it to allow water to pass through when pushing the tube in. Handles should be attached to the sides of the collar. After the tube is driven in, impart a wide circular motion to help loosen the core for easy removal;

take off the collar device; cap the top of the tube (as described above); pull it up out of the sediment layer; and cap the bottom of the tube before removing it from the water.

### 4.7.3 Scoops

If the water is shallow, the easiest and most acceptable way to collect a sediment sample is to scoop the sediment using a stainless-steel spoon or grain scoop. This reduces the potential for cross-contamination. This method is accomplished by wading into the stream, and while facing upstream (into the current), scooping the sample along the stream bottom in the upstream direction. If the stream is too deep to wade but less than 8 ft deep, a stainless-steel grain scoop attached to a piece of conduit can be used either from the banks if the stream is narrow or from a boat.

### 4.7.4 Sample Handling

After sediment samples are obtained they will be handled following the general protocol presented for soil samples. Samples for VOC analyses are collected by combining a number of subsamples from the sampling device into the VOC vials without mixing. Due to the saturated nature of sediment samples, the vials can be filled completely without bubbles. Sediment samples for the remaining analyses are mixed according to the procedures described for soil samples in Section 4.6.2.

## 4.8 Landfills and Hazardous Waste Site Sampling

Sampling procedures for collecting soil, sediment, surface water, and ground-water samples in areas containing "concentrated" wastes are similar to those given in the previous sections. A major difference is the degree of caution and safety precautions and procedures utilized for sampling of severely contaminated or "hazardous" materials. Where possible, disposable sampling equipment shall be used to collect on-site samples of concentrated wastes.

All "concentrated" samples shall be clearly labeled as such when they are submitted for laboratory analyses. Any observations (odor, appearance, container labeling, etc.) made by the field team which might alert the laboratory to potential dangers or provide laboratory personnel with information on possible constituents in the samples (high concentration, etc.) shall be explained on the chain-of-custody form and if possible communicated verbally to the sample custodian or other laboratory personnel.

### 4.8.1 Specific Quality Control Procedures for Sampling Equipment

All major sampling and safety equipment used during investigations at hazardous waste sites including barrel openers, safety equipment (other than disposable gear), Geiger counters, explosion meters, cameras, etc. shall be numbered so that this equipment can be traced through field records. The field log book shall be used to identify the equipment, so that all cleaning, maintenance, and repair procedures can be traced to the person performing such procedures and to specific repairs made. Quality control procedures for certain pieces of equipment, such as pumps, soil sampling equipment, etc., are contained elsewhere in this manual.

All equipment utilized to collect samples at hazardous waste sites shall be decontaminated as outlined in Section 4.1.4.1 and repaired, if necessary, before being stored at the conclusion of a field study. In some instances, special decontamination procedures in excess of standard procedures will be necessary. These procedures will be developed on a case-by-case basis according to the specific material encountered. Provisions should also be made for disposal of contaminated disposable equipment.

All equipment shall be tested before being used for field studies. Any cleaning procedures conducted in the field or field repairs, shall be thoroughly documented in field records.

### 4.8.2 Collection of Auxiliary Information

The collection of auxiliary information and data is particularly important when collecting waste samples. Any field analyses, including those conducted with safety equipment such as photoionizers, explosion meters or approximate analyses such as those obtained with pH indicator paper shall be recorded in field logbooks. Sketches of sampling locations, arrangements of tank trucks and storage tanks, markings on barrels, drum tanks, etc., should be thoroughly documented in the logbooks. Photographs are particularly useful for recording this information and they should be used extensively during waste sampling operations.

## 4.9 Waste Sampling

### 4.9.1 Pits, Ponds, and Lagoons

For the purposes of this subsection, pits, ponds, and lagoons refer to any basin, pit, or open tank, lined or unlined, which contains or is suspected of containing unknown concentrated liquid chemical waste. This discussion does not include municipal and industrial wastewater treatment ponds or other man made or natural surface water impoundments.

4.9.1.1 Sampling Locations. Sampling locations within pits, ponds, and lagoons should yield samples which are representative of that section, or of the entire pit, pond, or lagoon being sampled. All phases in the pit, pond, or lagoon (floating solids, all liquid phases, and sludge) should be sampled. The only exception to this policy will be situations where representative samples cannot be safely collected or where the investigative team is attempting to determine worst case conditions.

Because of the inherent dangers with sampling known or unknown concentrated waste, sampling personnel should never attempt to sample pits, ponds, and lagoons by using a boat. All sampling should be accomplished from the banks of pits, ponds, and lagoons, or from piers. Any deviation from this policy must be cleared with the Project Manager.

4.9.1.2 Liquid-Waste Sampling Equipment. The following equipment may be used in collecting liquid waste samples from pits, ponds, and lagoons: sampling containers; sampling containers affixed to a piece of conduit pipe; stainless-steel scoops affixed to a piece of conduit pipe with tape or scoop bracket; stainless-steel spoon attached to a conduit pipe; peristaltic pump and vacuum jug arrangement; Bacon-Bomb samplers; and profile tubes for phase determination and possible sampling.

4.9.1.3 Liquid-Waste Sampling Techniques. If the sampling technique utilized requires multiple aliquots, or if the final sample will consist of aliquots from several different locations in the pit, pond, or lagoon, all aliquots should be placed into a pyrex beaker or large glass sample container, or other suitable compositing container, and mixed thoroughly before containerization. However, samples for VOCs shall be collected in separate vials and composited by the laboratory

during sample preparation and analysis. Floating solids can be sampled directly or with a stainless-steel scoop or spoon attached to a piece of conduit pipe.

The presence of individual liquid phases can be determined by using a profile tube. The top liquid phase can be sampled by direct dipping with the sample container; dipping with the sample container attached to a conduit pipe, either directly or by way of a fishing pole type arrangement, or dipping the sample with a stainless-steel scoop attached directly to conduit pipe. Other liquid phases can be sampled with a peristaltic pump/vacuum jug arrangement, with the end of the Teflon™ tube intake attached to a conduit pipe and held at the desired depth, or with a Bacon-Bomb sampler opened at the desired depth. The Bacon-Bomb sampler can be operated directly from the banks of pits, ponds, and lagoons or from piers or operated by way of a fishing pole type arrangement using a piece of conduit pipe.

4.9.1.4 Sludge Sampling Equipment Available. The following equipment may be used in collecting sludge samples from pits, ponds, and lagoons: Stainless-steel ponar dredges; stainless-steel scoops attached to conduit pipe; and stainless-steel push tubes.

4.9.1.5 Sludge Sampling Techniques. If the sampling technique involves multiple aliquots, or if the final sample will consist of aliquots from several different locations in the pit, pond, or lagoon, all aliquots should be placed into a Pyrex™ beaker or other suitable container and mixed thoroughly before containerization. As indicated in Section 4.9.1.3, discrete samples for VOCs shall be collected and composited by the laboratory.

Sludge samples can be collected by pushing a stainless-steel push tube into the sludge and emptying the tube contents into a Pyrex™ or other suitable container. "Emptying" can include shaking to remove sludge or extrusion of thick or gummy sludges with a new wooden dowel. A disadvantage of this technique is the need for multiple insertions of the tube into the sludge to collect sufficient sample volume.

Sludge samples can also be collected with a stainless-steel ponar dredge. An advantage of this technique is that one operation of the dredge usually yields sufficient sample volume for most sampling efforts.

One of the easiest methods of collecting a sludge sample consists of attaching a stainless-steel scoop to a piece of conduit pipe with either strapping tape or a scoop bracket, and dipping the scoop into the sludge. An advantage of strapping tape is that it generates less equipment to decontaminate. However, glue on the tape may dissolve rapidly in oily or solvent type wastes. The scoop bracket has a decided advantage in that it allows sampling personnel to adjust the angle between the scoop an the conduit pipe.

4.9.2 Open and Closed Container Sampling

Sampling of closed containers (drums, barrels, tanks) should only be conducted when absolutely necessary. Whenever container sampling is necessary, the first priority should be the collection of samples from open containers since open containers generally present less hazard to the sampling personnel than closed containers. Closed containers must be considered as extremely dangerous due to the potential toxicity, explosion, or fire hazards. Chronic toxicity may be a danger in both open or closed containers.

4.9.2.1 Stratification/Phase Separation. A problem which often arises in container sampling is stratification and/or phase separation of the container contents. When this condition occurs or is suspected, care must be taken to ensure that the sample collected is representative of the container contents. If only one layer or phase is sampled, this should be noted and taken into account when interpreting analytical results. For example, if a large tank is being sampled for PCBs and the only valve or access port available for sampling is at the bottom of the tank, it should be noted that the concentration of PCBs might be biased toward high concentrations, since PCBs are heavy and tend to collect near the bottom of a container.

Where possible, samples should be composited with depth (i.e., collected throughout the entire depth of the container or at several different depths) to provide a representative sample. When a drum or cylindrical container is standing vertically, depth compositing provides a good quantitative estimate of the container content. In other cases where such containers are tipped, horizontal, deformed, etc., depth compositing will provide a representative sample at least on a qualitative basis. (Note: A quantitatively representative sample could be collected, but would require sophisticated sampling methodology involving multi-layer sampling and volume measurements; this is not recommended unless initial screening indicates it is absolutely necessary.)

4.9.2.2 Equipment. The following equipment may be used in collecting waste samples from open and closed containers: a complete set of spark-proof tools including barrel bung wrenches, adjustable wrenches, etc.; a remote barrel opening device; glass tubes for barrel sampling; glass profile tubes for container sampling; Bacon-Bomb samplers for container sampling; and peristaltic pumps and vacuum bottle arrangements for liquid-waste sampling from containers.

4.9.2.3 Sampling Techniques. Closed drums, barrels, or other containers (including storage tanks) containing unknown materials or known hazardous materials should be opened only using spark proof opening devices. A remotely controlled device may be used when deemed necessary. Such a device involves the use of a remotely operated pneumatic wrench along with a brass pressure fitted bung socket.

Samples from drums or barrels can be collected using a 4-ft length of glass tube. In most instances, glass tubes with a one-half inch or less inside diameter work best. The tube is inserted into the opening of the drum or barrel as far as possible. The open end is then sealed either with the thumb or a rubber stopper to hold the sample in the tube while removing the tube from the container. The sample is then placed in the appropriate container and the procedure is repeated until an adequate amount of sample is collected. Sample volume shall be held to the absolute minimum required for analysis. An optional method involves the use of a piercer valve which is inserted into the drum or barrel using a remotely operated hydraulic jack; however, this method should be used only as a last resort. Several valves may be required at different depths on the drum or barrel if stratification has occurred. The sample is collected directly from the valve.

Other sampling procedures that include the use of automatic samplers, pumps, siphons, multiple valves and ports, etc., may be used depending on the specific container involved. These procedures should not be used unless it can be established that their use will not constitute a fire or explosion hazard. This determination shall be made only after field reconnaissance, collection of appropriate field data (explosion meter, photoionizer, etc.), and consideration of available file information on the site.

Tank trucks and storage tanks containing liquid wastes are a special case. Samples may be collected from access ports on top of these tanks or trucks using the techniques outlined above. Tank trucks are often compartmentalized and the investigator should insure that all compartments

of the tank truck are sampled. Sampling from discharge valves usually found on tank trucks is not recommended due to potential stratification of tank contents.

If the investigator has to sample from a tank truck discharge valve, the valving arrangement of the particular tank truck being sampled must be clearly understood to insure that the contents of all compartments are sampled. The same precautions apply to sampling from storage tank valves. In either case, the investigator must realize that samples obtained from valves (particularly those at or near the bottom of tank truck and storage tanks) may not yield representative samples.

4.9.3 Waste Piles

Waste piles may consist of sludges and solid waste, liquid waste mixed with soil, or any type of waste mixed with construction debris, household garbage, etc. Each situation presents a unique challenge to the sampler in the selection of an appropriate sampling location and technique.

4.9.3.1 Sampling Locations. Sampling locations should be selected which will yield a sample which is representative of the waste pile being investigated. The only exception of this policy will be situations in which representative samples cannot be collected safely or where the investigative team is attempting to determine worst case conditions. A representative sample from a small waste pile can often be obtained by collecting a single sample. The collection of a representative sample(s) from large waste piles, however, presents problems with both the number and locations of samples. For a sample(s) to be truly representative, a statistical approach should be used in selecting both the number of samples and the location where they are to be collected. A discussion of statistical methods which can be utilized is given in Chapter Nine, Volume II of the manual entitled Test Methods for Evaluating Soil Waste (SW-846), Third Edition, issued by the EPA Office of Solid Waste and Emergency Response.

4.9.3.2 Equipment Available. The following equipment may be used in collecting samples from waste piles: stainless-steel hand augers; stainless-steel push tubes; stainless-steel shovels; stainless-steel scoops; and stainless-steel spoons.

4.9.3.3 Sampling Techniques. Stainless-steel shovels, spoons, or scoops should be used to clear away surface material before samples are collected. Near surface samples can then be collected with a clean stainless-steel spoon. Samples at greater depths can be collected from the cleared location by forcing a stainless-steel push tube into the pile or by augering to the desired

depth with a stainless-steel hand auger. When the desired depth is reached with a hand auger, a clean auger head should be used for collecting the sample. An alternate method is to dig to the desired depth with a stainless-steel shovel or scoop and collecting the sample with a stainless-steel spoon.

The samples of solid waste or sludge shall be handled according to the procedures presented for soil samples in Section 4.6.2.

## 4.10 Air Monitoring Program

To assess the potential for off-site hazardous emissions, ambient air samples may be collected during site investigation as appropriate.

### 4.10.1 Preparation and Sampling Site Selection

Prior to performing sample collection, one upwind and two downwind sampling sites will be selected with the aid of a wind indicating system. To document the field conditions and equipment operation at the time of air sample collection, the data will be recorded. Selection of the upwind site will be made in an attempt to characterize background levels at the upwind site perimeter before impacting the test site. Downwind locations will be chosen to represent air quality at the downwind perimeter and will reflect the quality of air impacting any potential off-site receptors. The actual selection of sampling sites will be deferred until the day of testing at which time current meteorological data may be reviewed.

By deducting upwind levels (background) from downwind concentrations, the true impact of the site along with the ambient air quality may be determined. Meteorological data including ambient temperature, soil surface temperature, barometric pressure, wind speed, and direction, will be recorded at reoccurring intervals during each test. Once testing commences, if recorded wind direction data indicate a shift in wind direction the test will be temporarily stopped to permit an assessment of the true wind direction. In the event that a sustained shift in average wind direction of greater than a 45 degree angle occurs, the sampling stations will be repositioned to maintain their upwind/downwind orientation with respect to the site.

During the test period, collocated samplers will be operated, at each of the upwind and two downwind sampling positions for each of the subject compounds at a frequency established in the

QAPP to permit assessment of the overall precision for the test procedure. A minimum sampling duration of 4 hours for each train has previously proven satisfactory in providing a sufficient quantity of sample to achieve reasonable detection limits while allowing maintenance of upwind/downwind orientation with respect to the site. Experience has shown that the likelihood of a wind shift during an 8-hour sampling period is extremely high. Because these wind shifts are potential cause for sample network re-orientation or invalidation of the test, a 4-hour, rather than an 8-hour, sampling period was selected. The duration of the test may be adjusted, however, if visual inspection of filter medium during the test indicates over- or under-sampling. If warranted, replication of air monitoring on three or more individual days may be conducted to provide for a statistical database from which to evaluate the effects of temperature, humidity, wind speed and direction at the site.

4.10.2 Particulate and Metal Sampling

Air samples for particulate matter and metals will be collected with General Metals Works Model GMWS-2310 ACCU-VOL high volume samplers or equivalent. Eight-by-ten inch glass fiber filters will be used as the collection medium. A calibrated flow rate of approximately 42 cubic ft per minute (CFM) will be maintained by the electronic flow controller in each unit.

4.10.3 Semi-volatile Organics Sample Collection

Air samples for semi-volatile organics will be collected using General Metal Works PS-1 PUF sample pumps or equivalent. Four-inch-diameter glass fiber filters coupled to glass cartridge XAD-2 absorbent will be used for collection of both particulate and vapor phase semi-volatile organics. A calibrated flow rate of approximately 3 CFM will be maintained for each test through the use of an in-line calibrated flow orifice.

4.10.4 Volatile Organic Sample Collection

If required air samples for volatile organics for field analyses will be collected with Sensidyne Model BDX34 Super Sampler pumps or equivalent. Tenax and/or activated charcoal tubes will be the collection medium. A calibrated flow rate of approximately 0.05 liters per minute will be maintained for each test. If GC analysis shows greater than 10% breakthrough at this sampling rate, the site will be re-monitored at a lower target collection volume.

Air samples for laboratory analysis of VOCs will be obtained on a Tenax adsorbent medium in accordance with applicable specifications of EPA Method TO-1. Sample gas will be drawn at a calibrated flow rate through precleaned Tenax resin contained in a 1.6 centimeter (cm) I.D. by 10 cm long adsorbent tube. Sample flow rate will be maintained with a calibrated in-line critical flow orifice. Samples collected on Tenax will be analyzed for VOCs by a thermal desorption purge and trap technique in accordance with EPA Method 5040/8240.

## 4.11 Geotechnical Sampling

All geotechnical sampling will be performed in accordance with ASTM methods identified in Table 2. Geotechnical samples shall be handled and shipped, in accordance with the following procedures.

### 4.11.1 Disturbed Soil Samples

Disturbed soil samples shall be placed in moisture tight containers provided by the laboratory and then sealed. The sealed containers will be packed in either coolers or cardboard boxes for shipment. The containers shall be taped shut in the field and labeled to show the project name and number, identification of sample location contained in the box, total depth interval of the samples, and other information as required by the on-site geologist or engineer.

If the samples are to be temporarily stored at the Facility, they shall be protected from the weather, including excessive heat. Indoor storage shall be employed, where possible. For commercial shipment, the containers should be marked "keep from heat and freezing". Samples shipped or hand carried to the geotechnical laboratory shall be accompanied by a chain-of-custody form providing a record of the samples.

### 4.11.2 Undisturbed Soil Samples

Upon recovery of an undisturbed sample using a Shelby tube or equivalent, at least one-half inch of soil shall be cleaned from each end of the tube and the ends of the soil sample squared off. Usually, the tip of the sample will contain drill cuttings and these must be removed prior to sealing. The in-situ soil which has been cleaned from the tube can be used to give a visual classification for the sample. Under certain circumstances, such as excessively moist samples, a tube may be allowed to drain prior to the sealing process.

To seal the tube, the resulting space at each end shall be filled with hot paraffin wax or an equivalent melted sealing material or with expandable packers as approved by the on-site geologist or engineer. As an alternate for tubes containing partial samples, after sealing the ends of the sample (using approximately one inch of melted sealing material), a dry, clean filler, sand, etc., can be placed in the void areas. The filler prevents the sample from breaking the end seals during handling and shipment. The ends of the tube then shall be closed with tight-fitting metal or plastic caps and the seam, between the cap and tube, wrapped with tape. Finally, the ends of the tube shall be dipped in hot wax, beyond the tape, as a final sealing measure.

Preferably the tubes shall be hand carried to the geotechnical laboratory in a vertical position to maintain an in-situ orientation and shall be marked with a "this way-up" arrow, using an indelible marker. If the tubes are being transported via airplane, they shall be carried on to the plane and not checked as baggage. If the tubes are to be transported by truck or automobile, they shall be padded carefully and wedged in place to prevent movement (e.g., through use of a tube rack). If tubes must be shipped as freight, they shall be packed in secure wooden boxes which have dividers built in to prevent movement of the tubes, or the boxes shall be tightly filled with packing material such as wood chips, paper, etc., to prevent movement. The boxes should be marked "fragile" and "keep from heat and freezing". All packaging of tubes for shipment will be directed by the on-site geologist or engineer.

4.12 Changes in Procedures

Any changes in the sampling procedures as outlined in this QAPP will be discussed with the on-site coordinator to obtain technical concurrence and all changes will be documented in the field log book and described on the Sample Alteration Checklist (Figure A9). Approval from the Field Coordinator and QA Officer will be necessary to implement on-site changes and/or major modifications of the sampling design or procedures.

# SAMPLING ALTERATION CHECKLIST

Sample Program Identification: _____

Material to be Sampled: _____

Measurement Parameter: _____

Standard Procedure for Analysis: _____

_____

Reference: _____

_____

_____

_____

Variation from Standard Procedure: _____

_____

_____

_____

_____

_____

Reason for Variation: _____

_____

_____

Result Change in Field Sampling Procedure: _____

_____

_____

_____

Special Equipment, Material, or Personnel Required: _____

_____

_____

Author's Name: _____ Date: _____

Approval: _____ Title: _____

Date: _____

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SAMPLE ALTERATION CHECKLIST

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DRAWING NO: FT-012

FIGURE A.9

## 5.0 SAMPLE CUSTODY

Sample custody is a vital aspect of site investigations as well as ground-water monitoring studies because these type of programs generate data that may be used as evidence in a court of law. The samples must be traceable from the time of sample collection until the time the data are introduced as evidence in enforcement proceedings.

### 5.1 Field Record Log Book

The key aspect of documenting sample custody is thorough record-keeping. A bound field log book with sequentially numbered pages will be maintained during field work to document the collection of every sample. In addition, logs for geologic interpretation, well completion, soil/sediment sampling, water sampling, and air sampling, previously described in Section 4.0, will be filled out for each well drilled and/or each sample collected. All loose-leaf log sheets will be arranged in sequential order and bound together upon completion of each sampling event. All documents will be completed in ink, dated, and signed by the field person conducting the work.

### 5.2 Sample Labeling

Sample containers will be labeled at the time of sampling with the information specified in Section 4.1.3. At the time of sampling the identification assigned to each sample will be recorded on the appropriate sample log form (see Figures A7 and A8). After each bottle is filled and before it is placed in storage, the sampler will initial the label to document proper sample handling.

### 5.3 Sample Container Custody

All sample containers to be provided by the subcontract laboratories for this project must be prepared as described in Section 4.0. All containers will be shipped from the laboratory to the designated location by common carrier in sealed coolers. The laboratory will include a shipping form listing all containers shipped and the purpose of each container. This list will become part of the chain-of-custody record.

## 5.4 Sample Custody, Shipment, and Laboratory Receipt

For the purpose of this discussion, samples are considered in custody if the following conditions are not violated:

- The responsible person maintains possession;
- After the samples are received, they remain in the view of, or in the physical possession of, responsible persons;
- Samples are locked so that no one can tamper with them; or
- Samples are maintained in a secured area, restricted to authorized personnel.

All samples will be maintained in the custody of the sampling personnel. At the end of each sampling day and prior to the transfer of the samples off-site, chain-of-custody entries will be made for all samples using the standard chain-of-custody form illustrated in Figure A10. All information on the chain-of-custody form and the sample container labels will be checked against the sample field log entries and samples will be recounted before leaving the sampling site. Upon transfer of custody, the chain-of-custody form will be signed and dated by the sample team leader. Because common carriers (Federal Express, Purolator Courier, etc.) will not sign chain-of-custody forms, the forms will be sealed in the cooler prior to shipping.

A signed, dated, custody seal (Figure A11) will be placed over the lid opening of the sample cooler to indicate if the cooler has been opened during shipment prior to receipt by the laboratory. All chain-of-custody forms sent to the laboratory must be signed and dated by the senior staff member assigned to the field team.

Upon receipt of the samples at the laboratory, the laboratory sample custodian will note the condition of each sample received as well as any questions or observations concerning sample integrity. The laboratory sample custodian also will maintain a sample-tracking record that will follow each sample through all stages of laboratory processing. The sample tracking records will document sample removal from storage as well as the date of sample extraction or preparation, and sample analysis. These records will be used to determine compliance with handling and holding time requirements. Samples will be stored by the laboratory in their original containers in walk-in refrigerators designated by the contracted laboratories. Specific chain-of-custody procedures used by the commercial laboratories contracted for this project are included in their respective quality assurance plans presented in Appendices A through D.

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## CHAIN-OF-CUSTODY RECORD

Page_____ of_____

Project Number _____

Project Location _____

Laboratory _____

Sampler(s) _____

| SAMPLE IDENTITY | Date Sampled | SAMPLE BOTTLE / CONTAINER DESCRIPTION | | | | | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |
| | | | | | | | | | | | | Total No. of Bottles/ Containers | |

| | | | | |
|---|---|---|---|---|
| Relinquished by: _____ | Organization: _____ | Date__/__/__ Time_____ | Seal Intact? |
| Received by: _____ | Organization: _____ | Date__/__/__ Time_____ | Yes No N/A |
| Relinquished by: _____ | Organization: _____ | Date__/__/__ Time_____ | Seal Intact? |
| Received by: _____ | Organization: _____ | Date__/__/__ Time_____ | Yes No N/A |

Special Instructions/Remarks: _____

Delivery Method: ☐ In Person ☐ Common Carrier _____ (SPECIFY) ☐ Lab Courier ☐ Other _____ (SPECIFY)

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# CHAIN-OF-CUSTODY FORM

U.S. ARMY CORPS OF ENGINEERS
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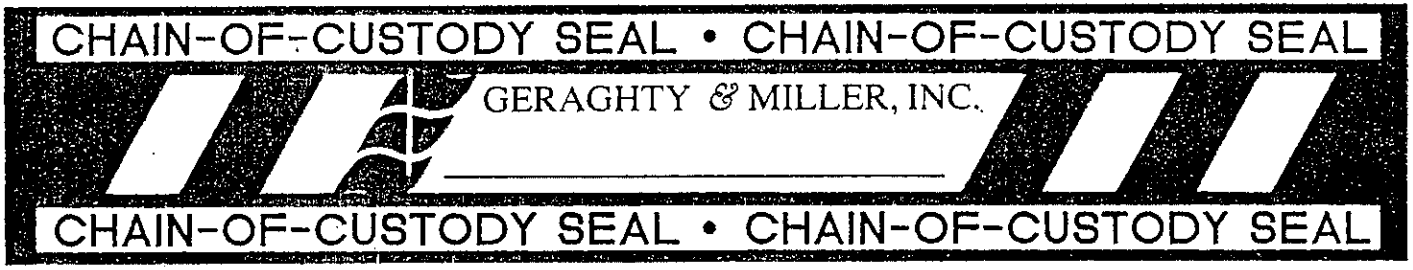
FORT STEWART, GEORGIA

DRAWING NO: FT-009

FIGURE A.10

59

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# CHAIN-OF-CUSTODY SEAL

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
FORT STEWART, GEORGIA

DRAWING NO:
FT-014

FIGURE
A.11

## 6.0 CALIBRATION PROCEDURES AND FREQUENCY

The calibration procedures and calibration frequency employed by the contracted laboratories will be in accordance with the analytical procedures listed in Table1 and Table 1a of this QAPP.

Calibration of field equipment, such as pH meters and specific conductance meters, will be performed according to the procedures described in Appendix D of the EPA SOP/QAM referenced in Appendix C of this document. Specific calibration protocols for field instruments used by the Contractor are summarized in the Equipment Maintenance and Calibration Procedures presented in Appendices B and E of this QAPP. Calibration of air sampling equipment will be performed before each sampling episode according to procedures specified for the methods listed in Table1 and Table 1a.

Other field equipment used for analyzing samples in the field or conducting geophysical surveys, that are not described in the EPA SOP/QAM, Appendices B or E will be calibrated and operated in accordance with the manufacturer's recommendations.

# 7.0 ANALYTICAL PROCEDURES

## 7.1 Laboratory Analytical Procedures

The analytical procedures used during the implementation of the work plan are listed in Table1 and Table 1a. Analyses of samples collected by the Contractor will be performed by selected contracted laboratories in accordance with protocols and QA procedures established by EPA.

## 7.2 Field Analytical Procedures

Conductivity, pH, and temperature will be measured in the field according to EPA methods referenced in the EPA SOP/QAM in Appendix F of the QAPP and instrument manufacturers instructions. As indicated in Section 3.2, procedures used to perform chemical analyses in the field will be developed and presented as an attachment to the QAPP for the site.

## 8.0 INTERNAL QUALITY CONTROL CHECKS

Internal laboratory control checks used by the contracted laboratories are described in detail in each method performed. The laboratories will demonstrate the ability to produce acceptable results using the methods recommended. The data will be evaluated by the laboratories based on the following criteria (as appropriate for organic and inorganic chemical analyses):

- Method performance is evaluated using the following QA checks:
  - Calibration curve linearity
  - Blanks
  - Continuing calibration standards
  - Spike recoveries (matrix and surrogate)
  - RPDs between matrix spikes and matrix spike duplicates, samples and laboratory duplicates
  - Recoveries of laboratory control samples and independent QC check samples
- Percent recovery of internal standards
- Percent recovery of surrogate compounds
- Adequacy of detection limits obtained
- Precision of replicate analyses

Internal quality control checks of sampling procedures and laboratory analyses will be conducted periodically. These checks will consist of the preparation and submittal of equipment blanks, trip (travel) blanks, and field replicates for analysis of all parameters at frequencies described in Section 1 and provided in Table 3.

The above field QC blanks and replicates included as internal QC checks are described below:

- Equipment Blank: An equipment blank is made by taking organic-free deionized or distilled water and pouring it into or through the field sampling apparatus (bailer, pump

tubing, etc.) that conceivably could be a source of contamination. The water is then sealed in the same type of sample bottle as the other samples, preserved in the same manner (using the exact preservative source) transported to the laboratory with the samples, and analyzed for the parameters of interest.

- Trip Blanks: A trip (travel) blank is a sample container filled with organic-free water in the laboratory that travels unopened with the sample bottles. It is returned to the laboratory with the field samples, opened in the laboratory and analyzed along with the field samples for VOCs. In some instances, trip blanks may be submitted for parameters other than VOCs.

- Field Replicate: A field replicate is a duplicate sample prepared at the sampling location from equal portions of all sample aliquots combined to make the sample. Both the field replicate and the sample are collected at the same time, in the same container type, preserved in the same way, and analyzed by the same laboratory as a measure of sampling and analytical precision.

As indicated in Section 1, Quality Assurance samples will be collected and shipped to the ACOE laboratory for analysis. These samples consist of field splits of equipment blanks, trip blanks, and field replicates. Field Splits are defined as follows:

- Field Split: A field split is a duplicate sample prepared at the sampling location from equal portions of all sample aliquots combined to make the sample. Both the field split and the sample are collected at the same time, in the same container type, and preserved in the same fashion.

Field splits will be analyzed for the same parameters as the original blanks and samples. The laboratory data provided by the ACOE will assess precision between laboratories as well as assist in evaluating the validity of analytical results.

## 9.0 DATA REDUCTION, VALIDATION, AND REPORTING

The contract laboratories will utilize EPA precision and accuracy criteria as guidance for data validation. Reporting formats will correspond to EPA Contract Laboratory Program guidelines specified in their most recent contract statement of work. Geraghty & Miller will complete its own data validation to verify that the laboratory has performed in accordance with requirements specified by the QAPP. Therefore, all laboratories employed during this investigation will be required to submit data that are supported by sufficient QA backup information and data to enable data reviewers to conclusively evaluate the quality of the data.

The use of laboratories will be accomplished by a laboratory services agreement (contract) between Geraghty & Miller and the laboratory. The contract will specify the scope of services to be performed by the laboratory, the specific analytical quality assurance requirements to be met, and the information to be developed and reported, if beyond that stated herein.

The Geraghty & Miller Analytical Quality Assurance and Laboratory Contract Program (AQA/LCP) will be used in part to accomplish the quality assurance and data validation objectives of the projects. The Geraghty & Miller AQA/LCP defines four levels of analytical reporting for laboratories with uniform analytical quality assurance performance requirements. For the RFI, Level II reportables are required except that matrix spikes and laboratory duplicates will be "sample" specific instead of "batch" specific. These spikes and duplicates will be performed by the laboratory at a frequency of one per 20 samples per matrix. The reporting requirements for Level II are specified in Appendix F. Since the analytical quality assurance requirements for all reporting levels in the AQA/LCP are essentially identical, all of the data generated at any level may potentially be classified as quantitative. If increased defensibility of laboratory report data is required, additional documentation of analytical QA data will be available upon request to the laboratory to support validation conclusions and data usability determinations.

The data validation procedures employed will include an evaluation of the field data package and an evaluation of the laboratory analytical data package. The data validation checklists presented in this section will be used as guides in evaluating sample collection, field records, and analytical performance; these checklists will aid in identifying valid data and classifying the data into one of three use categories: unusable data, qualitative data (class A), and quantitative data (class B).

## 9.1 Validation of Field Data Package

The field data package may be reviewed by the A-E QA Officer for completeness and accuracy using a Field Data Validation Checklist. The field data package includes all of the field records and measurements developed by the sampling team personnel. Failure in any of these areas may result in the data being in-validated. The field data package validation procedure will consist of:

- o A review of field data contained in water, air, and soil/sediment sampling logs for accuracy and completeness.
- o A verification that samples, field replicates, field splits, equipment blanks, and trip blanks were properly prepared, preserved, identified and analyzed (field analyses).
- o A check on field analyses for equipment calibration and instrument condition.
- o A review of chain-of-custody forms for proper completion, signatures of field personnel and the laboratory sample custodian and dates.

## 9.2 Validation of the Analytical Data Package

After validation of the field data package, validation of the analytical data package will be performed by the project QA officer. The validation steps will be performed by applying where appropriate the most current (7/88 inorganic and 2/88 organic) EPA Laboratory Data Validation Functional Guidelines For Evaluating Organics and Inorganics Analyses, and the precision and accuracy statements specified in Section 5.0.

The analytical data package validation procedure may include but not be limited to a review of the following:

- o A comparison of the data package to the reporting level requirements specified in Appendix F to ensure completeness in the analytical data package and compliance with the contract.
- o A comparison of sampling dates, sample extraction dates, and analysis dates to check that samples were extracted and/or analyzed within proper holding times.
- o Analytical methods and required detection limits to verify that they agree with the QAPP (Section 7.0) and the laboratory contract.
- o Field and laboratory blanks to evaluate possible contamination sources. The preparation techniques and frequencies, and the analytical results (if appropriate) will be considered.

All blanks will be evaluated in accordance with the EPA Functional Guidelines for Validation of Laboratory Data.

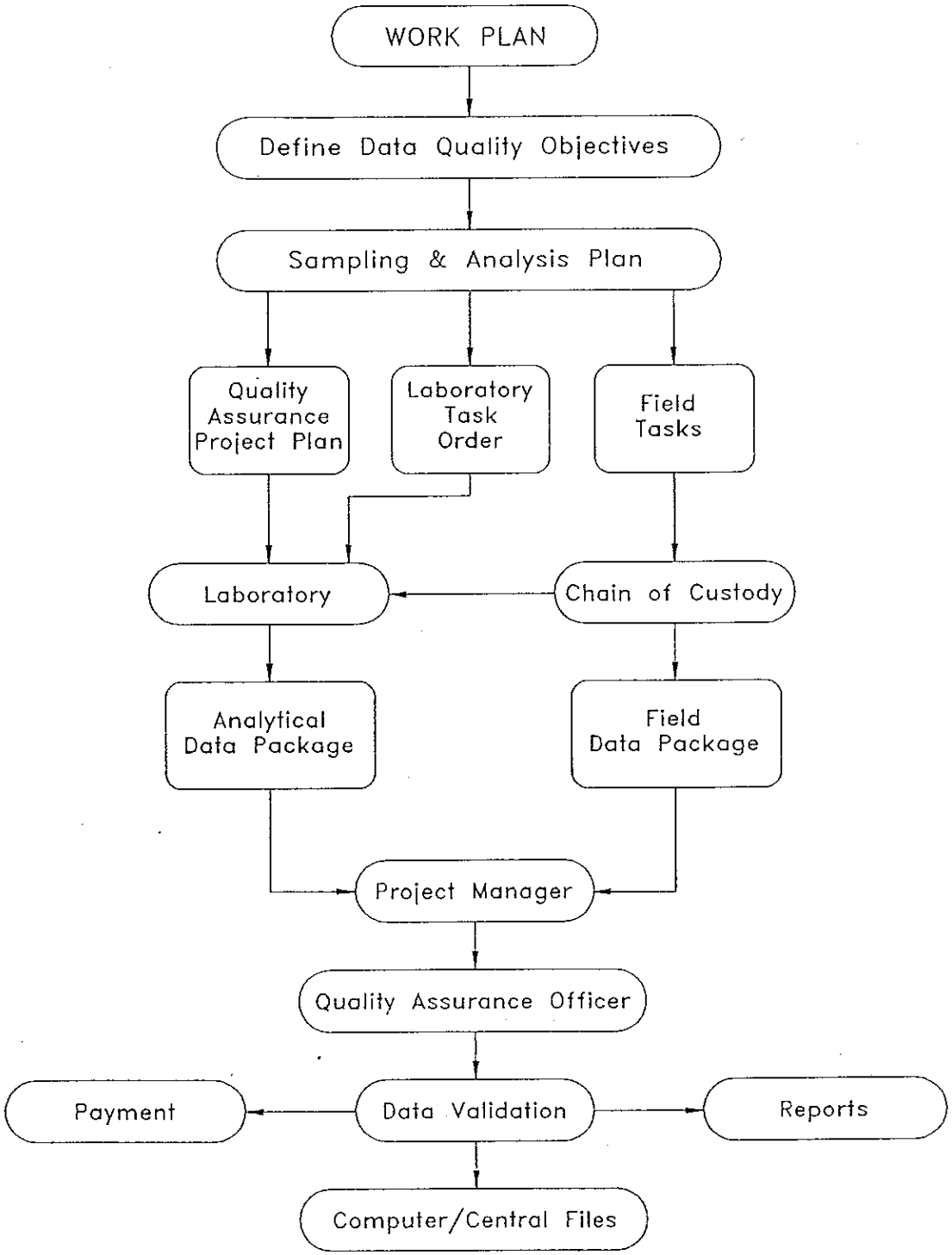
- Field replicates will be reviewed to check the precision of chemical analyses and field sample collection techniques. Field replicates and laboratory duplicates for water matrices, if available will be reviewed. The results must be within the EPA specified requirements for each method's precision (specified in Section 7.0); in the absence of this information, inorganic parameter duplicates must have a relative percent difference (RPD) of 20 percent if the analyte value is greater than five times the detection limit; if the value is less than five times the detection limit, the duplicates must have an RPD no greater than 5 percent.

- Surrogate spikes to ensure that recoveries are within the allowable control limits specified for the method.

- Matrix spike recoveries to evaluate the presence of matrix interferences that may be affecting recovery of a particular analyte. Control limits must be reported when matrix spike data is reported. When matrix spike duplicates are performed and/or reported, the relative percent difference (RPD) must be calculated and RPD control limits reported.

- Field Splits to evaluate accuracy, precision, and comparability of analyses methods.

A data management flow chart is presented in Figure A12 to illustrate the flow of data through the project management system.

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# DATA MANAGEMENT FLOW CHART

U.S. ARMY CORPS OF ENGINEERS
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FORT STEWART, GEORGIA

DRAWING NO: FT-006

FIGURE A.12

## 10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits for sampling and analysis operations consist of on-site review of field and laboratory quality assurance systems and on-site review of equipment for sampling, calibration, and measurement. Information may be recorded on the Daily Quality Control Report (Figure A13).

### 10.1 Field System Audit

The A-E Field Coordinator, the A-E Project Manager, and/or the A-E QA Officer will evaluate the performance of field personnel and general field operations in progress. The auditor will observe the performance of the field operations team during activities, such as water-level readings and sampling rounds.

### 10.2 Laboratory System Audit

A laboratory systems audit is conducted, at least annually, of all laboratories subcontracted by Geraghty & Miller. These audits assure that systems and operational capability is maintained and test methodology and quality control measures for the project are being followed as specified in the laboratory written standard operating procedures and generic Quality Assurance Plans. The Systems Audit Checklist used by the EPA Contract Laboratory Program (CLP) forms the procedural basis for conducting these audits.

The contracted laboratories for this investigation participate in the EPA Contract Laboratory Program or other federal and state agency programs that require recurring on-site audits. In addition, laboratory initiated audits may also be conducted by each laboratory's QA Officer on a routine basis.

### 10.3 Performance Evaluation Audits

A performance evaluation (PE) audit evaluates a laboratory's ability to obtain an accurate and precise answer in the analysis of a known check sample by a specific analytical method. Following the analytical data validation described in Section 9.0, a performance evaluation audit of the laboratory may be requested and conducted by the Contractor. This audit may be conducted if it is determined that the quality assurance data provided in the analytical data package or other

A-E DAILY QUALITY CONTROL REPORT
(A-E DQCR)
FORT STEWART, GEORGIA

Date _____

A. Weather (temperature, wind speed and direction, precipitation, etc.):

B. Work Performed:

C. Sampling Performed (location/number, sample type, etc.):

D. Field Analyses Performed (including instrument checks, calibration, etc.):

E. Problems Encountered and Corrective Actions Taken (sampling problems, alternate methods/locations, etc.):

F. Quality-Control Activities Initiated:

Signature of Reporter: _____
Geraghty & Miller, Inc.

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DAILY QUALITY CONTROL REPORT

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
FORT STEWART, GEORGIA

DRAWING NO: FT-010

FIGURE A.13

parameters as described in Sections 8.0 and 9.0 are outside acceptance criteria control limits. These PE audits may include a review of all raw data developed by the laboratory and not reported (laboratory non-reportables) and the submission of blind spiked check samples for the analysis of the parameters in question. These check samples may be submitted disguised as field samples, in which case, the laboratory will not know the purpose of the samples or the samples may be obvious (known) check samples (EPA or NIST traceable).

PE Audits also may be conducted by reviewing the laboratory's results from "round-robin" certification testing and/or EPA CLP evaluation samples. An additional component of PE Audits includes the review and evaluation of raw data generated from the analysis of PE samples and actual field samples that may be in question.

10.4 Regulatory Audits

It is understood that field personnel and subcontractor laboratories also are subject to quality assurance audits by the Georgia Environmental Protection Division (GA EPD) and EPA.

# 11.0 PREVENTIVE MAINTENANCE

## 11.1 Field Equipment

A listing of the field testing equipment that may require preventive maintenance and routine service are presented in Table 8, Preventive Maintenance Procedures are described in Appendix E. Mobile laboratory equipment must be routinely serviced after each field program, and checked for proper operation prior to analyzing samples at each SWMU. Records of calibration and maintenance activities for each piece of equipment are maintained in log books assigned to that instrument.

## 11.2 Laboratory Equipment

To obtain good analytical data, all instruments must be operating properly at all times. To ensure that instruments are operating properly, rigorous maintenance and trouble-shooting procedures must be followed.

All laboratory instruments, including the inductively coupled plasma spectrometers, graphite furnace atomic absorption spectrophotometers, gas chromatographs, and mass spectrometers, undergo regular maintenance as prescribed in the manufacturer's operation manual for each of the instruments. Trouble-shooting procedures also are carried out for each instrument according to instructions in the operation manual.

Table 8. List of Field Testing Equipment

Tampa Office

| Item | Manufacturer and I.D. Number | Model Type | Location | Preventive Maintenance |
|---|---|---|---|---|
| Conductivity Meter | Beckman/36079 | RB-5-338 | Equip Rm/Van | See Appdx H |
| | 21950 | RF3-339 | Equip Rm/Van | |
| | 90415 | RB-5-338 | Equip Rm/Van | |
| | 36035 | RB-5-338 | Equip Rm/Van | |
| | 36101 | RB-5-338 | Equip Rm/Van | |
| pH Meter | Corning/5055 | Field Type | Equip Rm/Van | |
| | 2951 | Field Type | Equip Rm/Van | |
| | UOU | Field Type | Equip Rm/Van | |
| Thermometers | --- | C° Mercury Field Thermometer | | |
| Organic Vapor Analyzer | Foxboro | OVA128GC | Equip Rm/Van | |
| Portable Gas Chromatograph | Photovac/0471525 | 10S50 | Equip Rm | |
| Gas Chromatograph | HNu/729024 | 301 | Van | |
| Filter Photometer | Hach | DR-1A | Van/Engineering Lab | |

## 12.0 ASSESSMENT OF DATA PRECISION, ACCURACY, AND COMPLETENESS

### 12.1 Precision

Precision is an estimate of the reproducibility of a method, and it may be estimated by several statistical tests including the coefficient of variation and the relative percent difference between replicate (duplicate) samples. Geraghty & Miller will determine the precision of the analyses conducted during this investigation by reviewing the results of field replicate samples and laboratory duplicate samples (where applicable), then, if sufficient data are obtained, the arithmetic mean and standard deviation of a group of results may be calculated.

Precision can then be assessed by using the coefficient of variation (CV), which expresses the standard deviation as a percentage of the mean. Specific statistical comparison of duplicate samples (field and laboratory), as a measure of precision evaluating both sample collection procedures and laboratory instrument performance, may be accomplished by first comparing the obtained duplicate results with the published EPA criteria for method precision. If EPA criteria is not available, the relative percent difference (RPD) may be calculated and compared to the precision criteria established by the laboratory for the analysis of laboratory duplicates.

### 12.2 Accuracy

The accuracy of a method is an estimate of the difference between the true value and the determined mean value. Certain QA parameters such as laboratory control samples, reagent water spike samples, QC check samples, matrix spike samples, and surrogate spike samples all have known concentrations prior to analysis. By comparing the percent recovery of the analysis of these samples to the known true value it is possible to measure the accuracy of the analysis.

In routine practice the laboratory collects recovery data for each of these parameters from approximately 30 analytical batches. The percent recovery data are averaged and the standard deviation of the percent recoveries is calculated. Then, based on the desired level of confidence, ranges are established as practical control limits. To be valid, these control limits must be at least as stringent as the accuracy limits specified by EPA for each analyte measured by the method. If the determined control limits are within the range established for that analyte and method by EPA then the determined range becomes the practical control limits used by the laboratory until another set of data is developed and new control limits are calculated.

Specific statistical comparison of percent recovery values and control limits (DQOs) reported by the laboratory as a measure of method accuracy will be compared with the published EPA criteria for the accuracy of an individual method. Data not meeting the EPA criteria for accuracy may be considered qualitative or unusable.

12.3 Completeness

Data completeness will be expressed both as the percentage of total tests conducted that are deemed valid and as the percentage of the total tests required in the scope of work that are deemed valid.

# 13.0 CORRECTIVE ACTION

## 13.1 Field Conditions

During the course of implementation of the RFI Work Plan, the field personnel are responsible for seeing that field instruments are functioning properly, that work progresses satisfactorily, and that work performed is in compliance with the QAPP.

If a problem is detected by the field personnel, the ACOE Project Manager and the Contractor Project Manager shall be notified immediately by the Field Coordinator, at which time the problem will be further investigated and corrective action will begin. Similarly, if a problem is identified during a routine audit by the A-E QA Officer or the EPA Project Manager or QA Officer, an immediate investigation will be undertaken and the corrective measures deemed necessary will be implemented as quickly as possible.

## 13.2 Laboratory Corrective Action

Within time constraints imposed by individual analysis procedures, data evaluations necessary to verify proper analytical function must be performed as early as possible in the analysis program.

When practical, a preliminary check of standard curve linearity, precision, and sensitivity should be performed either before the analysis of the samples is begun (manual procedures), or while the first samples are being analyzed (automated procedures). Results are compared to quality assurance control limits established by the laboratory and EPA.

Any analysis not conforming to control limits for precision, accuracy, detection limit, or linearity will be halted until the problem is identified and corrected. Laboratory batch sheets and control charts will document data evaluations and will contain all information necessary for assessment of the data quality, including: (1) information regarding indices of sensitivity, (2) precision, (3) detection limit, and (4) accuracy achieved during that run or batch.

For out-of-control incidents, it is essential to document the nature of the incident and the corrective actions taken to set the system back in control. A corrective action report, to be signed by the laboratory director and the laboratory quality assurance officer, should be prepared and

reported in the narrative summary of the laboratory report. The following topics should be discussed:

- Where did the out-of-control incident occur (laboratory name, address, telephone number, section name)?
- When did the incident occur and when was it corrected?
- Who discovered the out-of-control incident, verified the incident, and corrected the problem?
- What was the method number and name of the test?
- What was the disposition of the test or control and/or instrument?
- What was the nature of the corrective action?
- What will be done to prevent the reoccurrence of the problem?
- Why did the incident happen (if scientific explanation is available)?

A copy of the subject control charts and other data describing the out-of-control conditions should be included in the corrective action report. All out-of-control incident documentation and copies of the corrective action reports should be (1) placed in the laboratory archive record for the sample(s) in question; and, (2) placed in the laboratory QA officers file of incidents documentation.

13.3 Reporting of Corrective Actions

In all cases in which corrective actions of field procedures are required a written report describing the nature of the problem, an evaluation of the cause, if known, and the action taken will be prepared by the Contractor Field Coordinator or the A-E QA Officer. The report will be distributed to the Geraghty & Miller Project Manager, the A-E QA Officer (if not preparing the report), and the Project Officer.

Any corrective actions taken by the contracted laboratories will be reported to the A-E QA Officer. The laboratory will include in each data package a discussion of the problems encountered and corrective actions taken. In addition, the laboratories will maintain a file for Geraghty & Miller's review that documents all corrective actions taken regardless of whether the actions performed were pertinent to the analysis of samples from Geraghty & Miller's projects. Reports of corrective actions taken during the implementation of the RFI Work Plan will be provided to the ACOE.

APPENDIX A

SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.
GENERIC QAP AND QUALITY OBJECTIVES TABLES

AVAILABLE UPON REQUEST

# APPENDIX B

## GERAGHTY & MILLER FIELD INSTRUMENT STANDARD OPERATING PROCEDURES MANUALS

GERAGHTY & MILLER, INC.
PORTABLE GAS CHROMATOGRAPHY

# Standard Operating Procedure for the Analysis of Volatile Organic Compounds with a Photovac 10S50 Portable Gas Chromatograph

TABLE OF CONTENTS

TABLES



FIGURES

This manual is intended as a supplement to the operator's manual for the Photovac 10S50 that was supplied by the manufacturer. The operator's manual will be referenced where appropriate, and should be reviewed to gain a broad overview of the instrument, its capabilities, and its operation prior to reading this supplement. The operator's manual is meant to be used in conjunction with this supplement.

The Photovac 10S50 Portable Gas Chromatograph (GC) is used for the analysis of air, soil, and water samples in a field setting. The instrument is a fully portable analytical GC equipped with capillary chromatograph columns. Compounds in the sample are separated based on their solubility in the solid phase of the capillary column and the carrier gas which is air. Compounds are detected with a Photoionization Detector (PID). Any compound with an ionization potential (IP) of less than 11 electron volts (eV) may be analyzed with this instrument. The Photovac GC also has an alternate detector lamp for compounds whose IP is greater than 11 eV but less than 16 eV. Table 1 presents a list of the IPs of selected compounds that are frequently evaluated in environmental or industrial hygiene investigations.

Though the Photovac GC has the potential to detect a variety of compounds, it can not effectively separate some compounds that occur within the same sample. Since the Photovac GC can only be operated isothermally, it may not be possible to effectively separate or confidently identify compounds with similar physical and chemical characteristics. Therefore, the Photovac GC has the greatest utility in the analysis of a selected group of compounds that has been previously identified and is known to be representative of a particular site.

The Photovac GC has a varying degree of sensitivity to various organic compounds. Compound sensitivity is controlled by the degree of unsaturated bonds present in the compound. Compounds that are polar in character also exhibit good sensitivity.

When analyzing water or soil, two or more factors need to be considered. Vapor pressure and boiling point, although not directly related to sensitivity, control the ability of the compound to volatilize into a headspace. Since a sample of headspace gases from the water or soil sample container is injected into the instrument, the smaller the fraction of the compound in the headspace gases, the less sensitive the analysis becomes. Table 2 lists the volatile organic compounds that are routinely analyzed on the Photovac GC and the approximate detection limit for each compound in water/air and soil.

# INSTRUMENT OPERATING CONDITIONS

## Initial Set-Up

The internal tank of the Photovac GC must be filled with high-purity air before turning on the instrument to prevent detector failure. The UV light produced by the detector lamp causes oxygen in the detector housing to be ionized to ozone. Without a steady flow of air through the detector housing, ozone can build up and degrade the ion collectors in the detector. Also, if the isothermal unit is being used, a steady flow of air is needed to prevent over-heating of the capillary column and subsequent degradation of the liquid phase in the column.

Pushing the "On" key sends a high voltage current to the detector lamp to activate the lamp. Prior to activation, the LCD display will read "Not Ready". When the detector lamp is activated, the Ready, Enter Command will appear on the LCD display. The instrument automatically reduces the high voltage current once the detector lamp activates. After the instrument is turned on, Not Ready status should not persist for more than 2 minutes. The high voltage current used to activate the detector lamp may damage circuitry associated with the detector if allowed to be on for extended periods of time. Therefore, if the detector does not activate within 2 minutes, turn the instrument off and consult the operating manual for further instructions.

Prior to sample analysis, the instrument should be allowed to warm up for a period of 20 to 30 minutes to achieve stable operation. If the isothermal oven is being operated at 40°C or 50°C, the instrument will require additional time to stabilize.

20 is appropriate for normal operation under most conditions. Although the gain settings are supposed to be linear throughout the range of possible settings, it is not good procedure to change gain settings once the method has been developed. The gain should not be changed in the middle of a run. There is no autozero on the Photovac GC so changing the gain setting results in the following: 1) a shift in baseline shown by a pen deflection on the integrator, and 2) the amount of baseline noise "seen" by the detector.

Other settings such as the chart, area, sens, and windo, are held in internal memory and will not change when the Photovac GC is turned off. These settings should be checked and modified if project conditions require different settings.

The "Chart" key should be set to "On With Baseline" simply to save integrator paper. A discussion of the different chart settings and the output obtained with each setting is found in Chapter 4, pages 6 and 7 of the operator's manual.

The "Area" key is used to set the peak area threshold value. Peaks below this value will not be reported on the printout. This setting does not prevent peaks from being "seen" by the detector and integrated by the instrument; therefore, depending on the "Area" setting, peaks may appear on the chromatogram that are not listed in the printout following the run.

The "Sens" key determines the sensitivity settings for peak integration. Settings are determined by peak shape. The sharper the peak the higher the "sens" setting. Peak width is usually set at 4 unless the peaks become very broad early in the analytical run.

The "Windo" key is used in conjunction with an internal library. A description of the "Windo" is given in Chapter 4, page 15, Exercise (8) of the operator's manual.

Program Keys

Programming the event settings is discussed in Chapters 5 and 6 of the operator's manual.

Chapter 5 discusses each of the events, corresponding valve settings and flow paths, and sample introduction by pumping. A sample is drawn into the instrument with an internal pump and held in a sample loop. An explanation of the eight available events is presented on page 6 of Chapter 5. The rules for programming the events are listed on page 8. Page 7 of Chapter 5 shows how to activate the various gas flow events.

Chapter 6 discusses manual operation of the Photovac GC. This is the normal mode of operation. Sample is introduced into the instrument through direct injection. Although the manual indicates activation of Events 1, 3, and 5 (Chapter 6,page 1) only Events 1 and 3 have to be programmed for manual operation.

In manual operation, Event 1 is turned on at 8 seconds, and off at 10 seconds. The sample should be injected when the pump turns off.

Event 3 determines how long the precolumn will be in series with the analytical column. The duration of Event 3 is determined during method development and is specific for a given set of operating conditions and analytes of interest. For example, if the analyst is determining benzene, toluene, ethylbenzene and xylenes with a carrier gas flow of 5 millimeters/minute (ml/min)and the isothermal oven set at 30$^{o}$C, xylenes will be the last compounds to appear in the analysis at approximately 1000 seconds. Series flow (Event 3) is set at 1/10 of the time of the latest eluting compound (xylene); therefore, for this example, the duration of Event 3 would be 100 seconds. Since late eluting peaks can have

considerable asymmetry in their peak shape an additional 20% should be added to allow for all of the compound to move from the precolumn to the analytical column. This would mean that the series flow for the example given should be 120 seconds.

Series flow will be determined for each set of compounds analyzed during method development according to the following procedure: (1) estimate the retention time of the compound of interest that will elute last; (2) program series flow (Event 3) to be two times longer than the estimated retention time; and, (3) shorten the series flow once the actual retention times of compounds have been established.

If an event is reprogramed during a run, the new programming will be in effect for subsequent runs; however, the current analytical run also may be affected by the reprogramming.

The cycle key has 3 components: plotter delay, analysis time, and cycle time min. The plotter delay determines when a plot starts and should always be set at 10 seconds to correspond with the time of sample injection. If the sample is being pumped in, the plotter delay is equal to the time Event 1 is turned off. The length of the analytical run should be the retention time of the last compound plus 100 to 200 seconds to allow the compound to be integrated. Analysis time is determined during method development. The analysis time can be reprogrammed at any time during the analysis to extend or shorten the run.

Analysis Keys

There are 3 keys in this section: Info, Stop/Start, and Cal. The Info key allows the analyst to key in 3 lines of information concerning the sample, identification, the sampling location, the site, or other pertinent information. This information will be printed on the sample chromatograms. The information is keyed in

using the keypad with each entry being the letter of the alphabet that is printed on each key. To type in numbers, hit the "Cal" key followed by the desired number(s). To return to alphanumeric, hit the "Cal" key again.

The Stop/Start key starts or stops analytical runs.

The Cal key is for updating the calibration of all compounds in an internal library. The retention times and the internal calibration factors can be adjusted. Chapter 4, pages 15-17 of the operator's manual explain how to use this key. Retention times or the calibration concentration of individual analytes cannot be changed with this key. Updating calibration data for a single compound can only be accomplished by deleting data for the compound from the internal library followed by entry of the new calibration data into the library.

Flow Controls

The carrier gas is split into two flow paths during backflush, and series flow. It is important that all four flows be equal during sample analysis. This balancing procedure is detailed in Chapter 4, pages 7-9 of the operator's manual. The dual flow rotatometer works well for balancing high flows (greater than 10 ml/min). The capillary bubble flowmeter should be used for methods requiring a low flow condition (less than 10 ml/min). The capillary bubble flowmeter is mandatory for methods where the flow is less than 5 ml/min. Flow adjustments should be small and should allow time for the flow to stabilize before checking the new flow. Once flows are balanced, they remain stable unless one of the flow controls is bumped or jarred.

## Procedures for Making Up Standards

### Water/Soil Standards

Standards for water and soil samples are made using the same method. Forty ml of Trihalomethane (THM) grade methanol is pipetted into a 40-ml VOC vial using a Class A pipet. An aliquot of pure compound for each of the compounds of interest is transferred to the methanol using a microliter (ul) syringe to create a stock standard. Table 3 lists selected compounds, the aliquot needed, and the final stock concentration. The compounds listed are compounds that have been successfully analyzed with the Photovac GC in the field on one or more projects. The concentration of the stock standard is determined using the following equation:

[(ul used of pure compound) * (density of pure compound (grams(g)/ml)) * (1 ml/1000 ul) * ($1x10^6$ micrograms(ug)/1g)]/ 40 ml

The stock standard can be transferred into smaller septum vials and sealed. Each individual septum vial is used for daily analysis during an extended project. If refrigeration is unavailable, individual vials of stock should be discarded after each use. The stock should be kept on ice and, when possible, stored in the freezer. Stock standards stored on ice may be stable for a week or more.

Working standards are prepared by adding an aliquot of the stock standard, using a ul syringe, to 20 ml of water in a 40-ml VOC vial. The working standard should be in the expected range of the sample concentrations. More than one standard should be run to cover a range of concentrations. If a standard curve is needed, the aliquot of solvent injected into water must be constant for all

three standards. For example, if the highest standard is prepared using 4 ul of stock and the lowest standard is prepared using 1 ul of stock, the aliquot injected into the 20 ml of water for the lowest standard should be 1 ul of stock and 3 ul of methanol. The methanol should be drawn into the syringe prior to the stock.

Working standards should be made twice a day if a full day of operation is anticipated. Fresh working standards must be made for each day's operation.

Air Standards

Several methods are available for preparation of air standards for use with the Photovac GC. Chapter 8 of the operator's manual discusses two common methods for standards preparation. A third method for preparing air standards has been developed by Geraghty & Miller when air analysis of multiple compounds is required.

A stock standard is prepared in methanol according to the procedure for preparing a water standard, except that the stock standard should be 10 to 100 times more concentrated than a water standard. The stock standard should be sufficiently concentrated so that only 1 to 2 ul of the stock needs to be injected into a 1-liter air sampling bag to obtain an air standard in the working range of the instrument. The low injection volume is critical to minimize the size of the methanol peak.

This method is useful because air standards rapidly deteriorate and often must be prepared several times a day, and multiple compound working standards can be made rapidly using this method. The methods described in the operator's manual require the analyst to transport pure compounds into the field. Using a solvent-based standard also facilitates the evaporation and volatilization of the compounds in the air sampling bag and

eliminates the need for multiple injections into the bag to create a nulti-compound air standard.

The major disadvantage with this technique is the possibility that the solvent peak may interfere with compounds of interest. The possibility of solvent interference must be evaluated for each project. Isopropanol, ether, or tetrahydrofuran may be used instead of methanol. The solubility of the compounds of interest in various solvents and the presence of contaminants or interference are key factors in determining which solvent to use.

## Analysis of Standards

### Water/Soil Standards

Twenty milliliters of each working standard is shaken vigorously in a VOC vial for a period of one minute. The sample is allowed to stand for 3 to 10 minutes to allow water vapor to settle from the headspace, and to allow compounds in the standard to equilibrate with the headspace gas. The top of the VOC vial is tapped gently to remove water droplets clinging to the septum. A 500 ul gas tight syringe is flushed with several aliquots of the headspace gas above the water sample. The headspace gas is collected through the septum and injected into ambient air. A 500 ul sample of the headspace gas is then collected for immediate analysis with the Photovac GC. Water-based standards are used for both water and soil samples.

### Air Samples

The working standard is prepared in the air sampling bag just prior to analysis. The air sampling bag is filled with high-purity air. An aliquot of the stock standard is drawn into a ul syringe and injected into the bag through the septum port. The air sampling bag is then gently squeezed to ensure adequate mixing of

the standard. As with the water standard, several aliquots from the air sampling bag are withdrawn for the purpose of flushing the syringe. Finally, a 500 ul aliquot of gas is withdrawn from the bag and analyzed immediately with the Photovac GC.

Set-Up of the Internal Library

The library programming keys are explained in detail in Chapter 4 of the opertor's manual. It is the operator's decision whether or not to program the calibration curve for the compounds of interest into an internal library. If less than five compounds are to be analyzed and internal temperatures will remain uniform, then an internal library is programmed with a one-point calibration. Under this programming condition, if a compound is detected, only the concentration will be given, not the area of the peak. Since matrix effects and ambient temperature changes often shift retention times and alter peak shape, close-eluting peaks can frequently be incorrectly identified and integrated using the internal library calibration.

## SAMPLE HANDLING AND ANALYSIS

Prior to the analysis of any samples, a blank and one or two standards must be analyzed to confirm instrument operation and sensitivity.

### Water Samples

Water samples are collected in 40-ml VOC vials. A 20-ml aliquot of the sample is pipetted into a second VOC vial. The sample is handled in the same manner as a water standard (as described in Analysis of Standards - Water/Soil Standards). If a sample needs to be diluted, either a smaller aliquot can be drawn from the headspace and brought to 500 ul by pulling ambient air into the syringe or a smaller aliquot of the water is diluted to 20 ml in the VOC vial.

### Soil Samples

Soil samples also are collected in 40-ml VOC vials. Approximately 10 g of the soil is weighed out in a tared 40-ml VOC vial. Water is added to the vial until the soil/water mixture occupies a volume of 20 ml. The vial is gently inverted several times to mix the soil and water to form a slurry mixture. The vial is inverted so that the slurry mixture is on the septum and allowed to equilibrate with the headspace gas for 15-30 minutes. After the mixture has equilibrated, the sample is shaken like a water sample. Next, the top of the vial is tapped gently to dislodge any slurry mixture on the septum. If a sample requires dilution, a smaller aliquot can be drawn from the vial headspace and brought to 500 ul by pulling ambient air into the syringe, or a smaller soil sample can be weighed into a VOC vial.

Air Samples

Air samples are collected in either an air sampling bag or an air sampling glass vessel. Samples should be collected just prior to analysis, transported in the dark, and kept at ambient temperature until analyzed. Analysis should be conducted as soon as possible after collection. If a sample needs to be diluted, a smaller aliquot can be drawn from the sampling container and brought to 500 ul by pulling ambient air into the syringe, or an aliquot of the sample can be injected into a second air sampling bag or glass vessel containing a known volume of high purity air. The diluted sample is then withdrawn from the second sample container for analysis with the Photovac GC.

## DATA INTERPRETATION AND REPORTING

The operating conditions of the instrument are logged on a daily basis on the form included as Figure 1. All standards and samples analyzed are logged on a daily basis on sample log forms (Figure 2). The description of the standard should include the compounds in the standard and the concentrations of each compound. Compounds detected during analysis of the standard should be noted in the comments section of the sample log.

An analysis results log is completed for each sample in which compounds are detected. The water and air analysis results logs are identical (Figures 3 and 4). The soil analysis results log (Figure 5) takes into account the weight of the soil. Results for each compound may be calculated from the response of a single standard or a 3-point calibration curve. If an internal library is used, the instrument performs the calculation and the results presented on the chromatogram printout are transferred to the air or water sample analysis log. If an internal library is used in conjunction with the analysis of soil samples, the concentration in ug/kg must be calculated using results on the chromatogram printout and the factor determined in column 8 of Figure 5.

If the Photovac does not integrate a peak correctly, the operator may have to manually integrate the peaks for the sample and the appropriate standard. This should be noted in the log by putting an (M) behind all appropriate numbers. This procedure also is used for late eluting peaks that are not integrated by the instrument. In addition, it may be necessary to manually calculate the retention time of late eluting peaks that are not integrated by the instrument.

# QUALITY ASSURANCE

Quality Assurance (QA) samples are analyzed to ensure field and instrument performance.

## System QA Samples

Method blanks are analyzed to ensure the following: (1) the system is free from contamination, and (2) the deionized or distilled water source is free from contaminants. Blanks and standards should be analyzed at a minimum of twice per day to ensure system performance. If the results of a continuing calibration standard are not comparable to the initial standard run on that day a new standard is prepared and analyzed. If the second continuing calibration standard does not compare to the initial standard run, sample analysis is stopped and corrective action is taken. One sample in 20, or at least one sample per day, is analyzed in duplicate to ensure reproducibility of the instrument. When soil samples are being analyzed, the duplicate results may be significantly different due to sample non-heterogeneity.

Matrix spike samples are analyzed at the same frequency as sample duplicates; however, recoveries may be low due to matrix effects. Therefore, results of matrix spikes should not be the sole criteria for evaluating analytical performance. In the event that the results of matrix spike samples are not within recovery limits, a continuing calibration shall be analyzed to verify instrument performance.

## Field QA Samples

Collection of field blanks and equipment blanks is routinely performed at frequencies of one set of blanks per 20 samples collected. Analysis of equipment blanks evaluates the efficiency of field decontamination procedures for sampling equipment.

Analysis of field blanks evaluates the cleanliness of sample bottles and provides an additional check on the purity of the deionized or distilled water source.

Field duplicate samples also may be collected at the analysts discretion.

Data Review

Prior to preparation of the final analysis report, all raw data, field forms, and the draft analysis report are submitted to the project Quality Assurance Officer for review. Upon approval of the draft report, a final report is prepared and submitted to the project manager. All raw data field forms and the final report are stored as a part of the permanent project file.

## ROUTINE MAINTENANCE

Routine maintenance items and their frequency of performance are listed below.

1. Injection Port Septum - change at the end of every project, or weekly on long-term projects.

2. Blank Analysis - run a blank at the end of every day to flush the system.

3. Detector lamp - the lamp should be cleaned at the end of every project.

4. Detector housing - the detector housing should be disassembled and cleaned on a bi-monthly basis.

Additionally, if the Photovac is not used for a long period of time, the internal cylinder should be filled with high purity air and allowed to flow through the system.

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| Compound | 1 ppm = x mg/m$^3$ @NTP | Density (g/mL) | VP@30°c | B.P(°C) | M.W. |
|---|---|---|---|---|---|
| Acetone | 2.37 | 0.7899 | 270 | 56.2 | 58.08 |
| Benzene | 3.19 | 0.8786 | 118 | 80.1 | 78.12 |
| Carbon disulfide | 3.11 | 1.2632 | 430 | 46.25 | 76.14 |
| Carbon Tetrachloride | 6.29 | 1.5940 | 137 | 76.54 | 153.82 |
| Chloroform | 4.88 | 1.4832 | 245 | 61.7 | 119.38 |
| Dibutyl Ether | 5.33 | 0.764 | 4.8(20°C) | 142-143 | 130.23 |
| 1,1-Dichloroethane | 4.05 | 1.1757 | 270 | 57.28 | 98.96 |
| 1,2-Dichloroethane | 4.05 | 1.2351 | 105 | 83.47 | 98.96 |
| 1,1-Dichloroethene | 3.96 | 1.218 | 720 | 37 | 96.94 |
| trans-1,2-dichloroethene | 3.96 | 1.2565 | 200(14°C) | 47.5 | 96.94 |
| cis-1,2-dichloroethene | 3.96 | 1.2837 | 200(25°C) | 60.3 | 96.94 |
| Diethyl Ether | 3.03 | 0.7079 | 681 | 35 | 74.12 |
| Dimethyl disulfide | | 0.846 | | 38 | 62.13 |
| Dimethyl sulfide | 2.58 | 1.046 | 635 | 109 | 94.20 |
| Ethylbenzene | 4.34 | 0.8670 | 12 | 136.2 | 106.17 |
| Heptane | 4.10 | 0.6838 | 58 | 98.42 | 100.21 |
| Hexane | 3.52 | 0.6603 | 190 | 68.95 | 86.18 |
| Hydrogen Sulfide | 1.42 | | 15200 | -60 | 34.08 |
| Methanol | 1.33 | 0.7914 | 192 | 65 | 32.04 |
| Methylene Chloride | 3.47 | 1.3266 | 500 | 40 | 84.93 |
| Methyl Mercaptan | 2.05 | | 859 | 6 | 48.11 |
| Methyl Tert-butyl Ether | | 0.758 | | 54 | 88.15 |
| Propyl Mercaptan | 3.165 | 0.8411 | 230 | 67.5 | 76 |
| Tetrachloroethene | 6.78 | 1.6227 | 24 | 121 | 165.83 |
| Toluene | 3.77 | 0.867 | 40 | 111 | 92.14 |
| 1,1,1-Trichloroethane | 5.45 | 1.3390 | 155 | 74.1 | 133.41 |
| 1,1,2-Trichloroethane | 5.45 | 1.4397 | 32 | 113.77 | 133.41 |
| Trichloroethene | 5.37 | 1.4642 | 95 | 87 | 131.39 |
| Vinyl Chloride | 2.56 | | 2660(25°C) | -13.9 | 62.5 |
| Xylene-m | 4.34 | 0.868 | 11 | 138-139 | 106.17 |
| Xylene-o | 4.34 | 0.870 | 9 | 143-145 | 106.17 |
| Xylene-p | 4.34 | 0.866 | 12 | 138 | 106.17 |

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Table 2. Sensitivity of Selected Volatile Organic Compounds on the Photovac 10S50 Portable GC

| COMPOUND | APPROXIMATE DETECTION LIMIT water/air (ug/L) | soil (mg/kg) |
|---|---|---|
| Acetone | 5 | 25 |
| Benzene | 1 | 5 |
| Carbon Disulfide | 3 | 15 |
| Carbon Tetrachloride | 50 | 150 |
| Chloroform | 50 | 150 |
| 1,1-dichloroethane | 50 | 150 |
| 1,1-dichloroethene | 10 | 50 |
| 1,2-dichloroethane | 10 | 50 |
| cis/trans-1,2-dichloroethene | 5 | 25 |
| Dimethyl disulfide | 10 | 50 |
| Dimethyl sulfide | 5 | 25 |
| Ethylbenzene | 5 | 25 |
| Ethyl ether | 5 | 25 |
| Hydrogen sulfide | 0.5 | 5 |
| Methylene Chloride | 5 | 25 |
| Methyl mercaptan | 5 | 25 |
| Methyl tert-butyl ether | 10 | 50 |
| n-Propyl mercaptan | 5 | 25 |
| Tetrachloroethene | 2 | 10 |
| Toluene | 2 | 10 |
| 1,1,1-trichloroethane | 50 | 150 |
| 1,1,2-trichloroethane | 25 | 125 |
| Trichloroethene | 2 | 10 |
| Vinyl chloride | 2 | 10 |
| m-Xylene | 5 | 25 |
| o-Xylene | 5 | 25 |
| P-Xylene | 5 | 25 |

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Table 3. Suggested Settings For Set Up Keys on Photovac GC



| Set Up Key | Setting |
|---|---|
| Gain | 20 |
| Chart | On, With Baseline |
| Sens | Up - 12<br>Down - 10<br>Pk Wd - 4 |
| Windo | +/- 10% |
| Area | 50 |

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Table 4. Suggested Concentration For Each Compound For A Stock Standard

| COMPOUND | uL OF PURE COMPOUND IN 40 ML SOLVENT | CONCENTRATION OF STOCK (mg/L) |
|---|---|---|
| Acetone | 10 | 200 |
| Benzene | 5 | 110 |
| Carbon Disulfide | 5 | 160 |
| Carbon Tetrachloride | 25 | 1000 |
| Chloroform | 25 | 1000 |
| 1,1-dichloroethane | 40 | 1200 |
| 1,1-dichloroethene | 10 | 300 |
| 1,2-dichloroethane | 10 | 310 |
| cis/trans-1,2-dichloroethene | 10 | 320/310 |
| Dimethyl disulfide | 10 | 210 |
| Dimethyl sulfide | 5 | 130 |
| Ethylbenzene | 10 | 220 |
| Ethyl ether | 10 | 180 |
| Hydrogen sulfide 1/ | | |
| Methylene Chloride | 7.5 | 250 |
| Methyl mercaptan 1/ | | |
| Methyl tert-butyl ether | 10 | 190 |
| n-Propyl mercaptan | 10 | 210 |
| Tetrachloroethene | 4 | 160 |
| Toluene | 5 | 110 |
| 1,1,1-trichloroethane | 30 | 1000 |
| 1,1,2-trichloroethane | 25 | 900 |
| Trichloroethene | 4 | 150 |
| Vinyl chloride 1/ | | |
| m-Xylene | 5 | 110 |
| o-Xylene | 5 | 110 |
| p-Xylene | 5 | 110 |

1/ - Standard is normally a bought air standard due to volatility and toxicity of these compounds

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# PHOTOVAC 10S50 GC DAILY OPERATING CONDITIONS

| | |
|---|---|
| PROJECT NO: | PROJECT NAME: |
| ANALYSIS DATE: | INITIALS: |
| COLUMN: | GAS FLOW RATE: |
| PEAK SLOPE SENSITIVITY: | 1) UP: _____ |
| | 2) DOWN: _____ |
| | 3) PEAK WIDTH @ 4 MIN: _____ |

| | | |
|---|---|---|
| GAIN: | MINIMUM AREA (MVS): | PLOTTER DELAY: |
| WINDOW (± % TIME): | LIBRARY USED: | SAMPLE INJECTION METHOD: |
| ANALYSIS TIME: | CHART SPEED: | |
| ISOTHERMAL OVEN USED: | TEMPERATURE: | |

| VALVE EVENT SETUP: | | ON | OFF |
|---|---|---|---|
| | EVENT 1 | ____ | ____ |
| | EVENT 2 | ____ | ____ |
| | EVENT 3 | ____ | ____ |
| | EVENT 4 | ____ | ____ |
| | EVENT 5 | ____ | ____ |

COMMENTS:

_____

_____

_____

_____

_____

(10S50OPCO)

PHOTOVAC 10S50 SAMPLE LOG

PROJECT NO.: _____ PROJECT NAME: _____ ANALYSIS DATE: _____ INITIALS: _____

| ANALYSIS # | SAMPLE I.D. | MATRIX | DESCRIPTION | INJECTION SIZE (uL) | SAMPLE SIZE (ml or g) | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
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(ANALRES)

PHOTOVAC 10S50 SOIL ANALYSIS RESULTS LOG

PAGE: _____

PROJECT NO.: _____ PROJECT NAME: _____ STD INJECTION VOLUME (STDV)(uL): _____ ANALYSIS DATE: _____

SAMPLE I.D.: _____ ANALYSIS #: _____ SAMPLE INJECTION VOLUME (SV)(uL): _____ DILUTION (DIL) FACTOR: _____ INITIALS: _____

| COMPOUND | SAMPLE RT (sec) | SAMPLE AREA (vs) | STD ANALYSIS # | STD RT (sec) | STD AREA (vs) | STD CONC | STD RESPONSE FACTOR (RF) in ug = (STD CONC * STD SIZE)/STD AREA | RESULTS in ug/g = [SAMPLE AREA * STD RF * (STDV/SV) * DIL]/SOIL WT (g) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| Acetone | | | | | | | | | |
| Benzene | | | | | | | | | |
| Carbon disulfide | | | | | | | | | |
| Carbon tetrachloride | | | | | | | | | |
| Chloroform | | | | | | | | | |
| 1,1-dichloroethane | | | | | | | | | |
| 1,1-dichloroethene | | | | | | | | | |
| 1,2-dichloroethane | | | | | | | | | |
| trans-1,2-dichloroethene | | | | | | | | | |
| cis-1,2-dichloroethene | | | | | | | | | |
| Dimethyl disulfide | | | | | | | | | |
| Dimethyl sulfide | | | | | | | | | |
| Ethyl benzene | | | | | | | | | |
| Ethyl ether | | | | | | | | | |
| Hydrogen sulfide | | | | | | | | | |
| Methylene chloride | | | | | | | | | |
| Methyl mercaptan | | | | | | | | | |
| Methyl tert-butyl ether | | | | | | | | | |
| n-Propyl mercaptan | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | |
| Toluene | | | | | | | | | |
| 1,1,1-trichloroethane | | | | | | | | | |
| 1,1,2-trichloroethane | | | | | | | | | |
| Trichloroethene | | | | | | | | | |
| Vinyl chloride | | | | | | | | | |
| m-Xylene | | | | | | | | | |
| o-Xylene | | | | | | | | | |
| p-Xylene | | | | | | | | | |

(M) = manual integration and/or retention time calculation

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PHOTOVAC 10S50 AIR ANALYSIS RESULTS LOG

PAGE: _____

PROJECT NO.: _____ PROJECT NAME: _____ STD INJECTION VOLUME (STDV)(uL): _____ ANALYSIS DATE: _____

SAMPLE I.D.: _____ ANALYSIS #: _____ SAMPLE INJECTION VOLUME (SV)(uL): _____ DILUTION (DIL) FACTOR: _____ INITIALS: _____

| COMPOUND | SAMPLE RT (sec) | SAMPLE AREA (vs) | STD ANALYSIS # | STD RT (sec) | STD AREA (vs) | STD CONC | STD RESPONSE FACTOR (RF) = (STD CONC)/(STD AREA) | RESULTS = (SAMPLE AREA) * (STD RF) * (STDV/SV) * DIL FACTOR | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| Acetone | | | | | | | | | |
| Benzene | | | | | | | | | |
| Carbon disulfide | | | | | | | | | |
| Carbon tetrachloride | | | | | | | | | |
| Chloroform | | | | | | | | | |
| 1,1-dichloroethane | | | | | | | | | |
| 1,1-dichloroethene | | | | | | | | | |
| 1,2-dichloroethane | | | | | | | | | |
| trans-1,2-dichloroethene | | | | | | | | | |
| cis-1,2-dichloroethene | | | | | | | | | |
| Dimethyl disulfide | | | | | | | | | |
| Dimethyl sulfide | | | | | | | | | |
| Ethyl benzene | | | | | | | | | |
| Ethyl ether | | | | | | | | | |
| Hydrogen sulfide | | | | | | | | | |
| Methylene chloride | | | | | | | | | |
| Methyl mercaptan | | | | | | | | | |
| Methyl tert-butyl ether | | | | | | | | | |
| n-Propyl mercaptan | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | |
| Toluene | | | | | | | | | |
| 1,1,1-trichloroethane | | | | | | | | | |
| 1,1,2-trichloroethane | | | | | | | | | |
| Trichloroethene | | | | | | | | | |
| Vinyl chloride | | | | | | | | | |
| m-Xylene | | | | | | | | | |
| o-Xylene | | | | | | | | | |
| p-Xylene | | | | | | | | | |

(M) = manual integration and/or retention time calculation

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PHOTOVAC 10S50 WATER ANALYSIS RESULTS LOG

PAGE: _____

PROJECT NO.: _____ PROJECT NAME: _____ STD INJECTION VOLUME (STDV)(uL): _____ DILUTION (DIL) FACTOR: _____ ANALYSIS DATE: _____

SAMPLE I.D.: _____ ANALYSIS #: _____ SAMPLE INJECTION VOLUME (SV)(uL): _____ INITIALS: _____

| COMPOUND | SAMPLE RT (sec) | SAMPLE AREA (vs) | STD ANALYSIS # | STD RT (sec) | STD AREA (vs) | STD CONC | STD RESPONSE FACTOR (RF) = (STD CONC)/(STD AREA) | RESULTS = (SAMPLE AREA) * (STD RF) * (STDV/SV) * DIL FACTOR | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| Acetone | | | | | | | | | |
| Benzene | | | | | | | | | |
| Carbon disulfide | | | | | | | | | |
| Carbon tetrachloride | | | | | | | | | |
| Chloroform | | | | | | | | | |
| 1,1-dichloroethane | | | | | | | | | |
| 1,1-dichloroethene | | | | | | | | | |
| 1,2-dichloroethane | | | | | | | | | |
| trans-1,2-dichloroethene | | | | | | | | | |
| cis-1,2-dichloroethene | | | | | | | | | |
| Dimethyl disulfide | | | | | | | | | |
| Dimethyl sulfide | | | | | | | | | |
| Ethyl benzene | | | | | | | | | |
| Ethyl ether | | | | | | | | | |
| Hydrogen sulfide | | | | | | | | | |
| Methylene chloride | | | | | | | | | |
| Methyl mercaptan | | | | | | | | | |
| Methyl tert-butyl ether | | | | | | | | | |
| n-Propyl mercaptan | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | |
| Toluene | | | | | | | | | |
| 1,1,1-trichloroethane | | | | | | | | | |
| 1,1,2-trichloroethane | | | | | | | | | |
| Trichloroethene | | | | | | | | | |
| Vinyl chloride | | | | | | | | | |
| m-Xylene | | | | | | | | | |
| o-Xylene | | | | | | | | | |
| p-Xylene | | | | | | | | | |

(M) = manual integration and/or retention time calculation

GERAGHTY & MILLER, INC.
GAS CHROMATOGRAPHY VAN

# Standard Operating Procedure for the Analysis of Volatile Organic Compounds with an HNU Model 301 Gas Chromatograph

CONTENTS

## 1.0 INTRODUCTION

This Standard Operating Procedure (SOP) outlines the analysis of water and soils/sediments for halogenated, nonhalogenated and aromatic volatile organic compounds with an HNU Model 301 gas chromatograph (GC) mounted in a van. The analytical procedures are adapted from Methods 5030, 8010, 8015, 8020, 8021 of SW-846, USEPA Test Methods for Evaluating Solid Waste, 3rd Edition 1986. The compounds which may be analyzed using this method and practical detection limits are listed below.

| Compound | Detection Level ug/l water | Detection Level ug/kg soil/sediments |
|---|---|---|
| Bromodichloromethane | 5 | 15 |
| Bromoform | 2 | 5 |
| Carbon tetrachloride | 5 | 15 |
| Chloroform | 5 | 15 |
| 2-Chloroethyl vinyl ether | 2 | 5 |
| Dibromochloromethane | 5 | 15 |
| 1,1-Dichloroethane | 3 | 10 |
| 1,2-Dichloroethane | 3 | 10 |
| 1,1-Dichloroethylene | 2 | 5 |
| Trans-1,2-Dichloroethylene | 2 | 5 |
| Dichloromethane | 5 | 15 |
| 1,2-Dichloropropane | 5 | 15 |
| Trans-1,3-Dichloropropylene | 3 | 10 |
| 1,1,2,2-Tetrachloroethane | 5 | 15 |
| 1,1,1,2-Tetrachloroethane | 5 | 15 |
| Tetrachloroethylene | 1 | 5 |
| 1,1,1-Trichloroethane | 5 | 15 |
| 1,1,2-Trichloroethane | 5 | 15 |
| Trichloroethylene | 1 | 5 |
| Vinyl chloride | 2 | 5 |
| Benzene | 1 | 5 |
| Chlorobenzene | 1 | 5 |
| 1,4-Dichlorobenzene | 1 | 5 |
| 1,3-Dichlorobenzene | 1 | 5 |
| 1,2-Dichlorobenzene | 1 | 5 |
| Ethyl benzene | 1 | 5 |
| Toluene | 1 | 5 |
| Xylenes | 1 | 5 |

## 1.1 Summary

An aliquot of water or soil/sediment in water is purged with nitrogen to transfer the volatile components to the vapor phase. The vapors are collected on an adsorbent trap and the trap is rapidly heated and backflushed with nitrogen to desorb the components to the GC. A temperature-varying program is used in the GC to separate the components of interest. Detection is achieved by photoionization (PID) and flame-ionization (FID) detectors in series which allows confirmation of analytes of interest through a single injection. Data is collected with a dual channel Spectra Physics SP4290 integrator.

## 1.2 Sample Handling

| Sample type | Sample Container | Preservative | Holding Time |
|---|---|---|---|
| Water | 40 ml screw cap vial with teflon septa | none | 7 days |
| Soil/sediment | 500 ml amber with teflon lined lid | none | 7 days |

# 2.0 OPERATING PARAMETERS

## 2.1 Compressed Gases

The GC system uses three gases 1) Ultra High Purity (UHP) nitrogen as a carrier and desorption gas, 2) compressed air for the FID, and 3) hydrogen for the FID. The PID does not require any special gases. The gases in use, and extra cylinders, are located in the rear of the GC van. The cylinders should always be properly secured with straps to prevent movement or damage during transport between sites.

Delivery pressures and flow rates should be set as follows:

| | | |
|---|---|---|
| Nitrogen | 40 PSI | 40 mls/min |
| Air | 50 PSI | 300 mls/min |
| Hydrogen | 20 PSI | 30 mls/min |

## 2.2 uP Controller

The operation of the GC oven conditions is controlled by the uP controller supplied with the instrument. Refer to the instrument manual for operation of the uP controller. The following settings are used for the standard analysis of volatile organic compounds.

| command | entry |
|---|---|
| Ambient Mode | Yes |
| Oven temp ramp | No |
| Initial temp | 50 |
| Hold time | 300 |
| Ramping rate | 8 |
| 2nd temp | 215 |
| 2nd hold time | 2000 |
| 2nd ramp rate | no entry |
| Final oven temp | 215 |
| Final hold time | no entry |
| 1st auto zero | no entry |
| 2nd auto zero | no entry |

The detector/injector temperature should be set at 225 degrees C.

## 2.3 Purge and Trap Desorber (PTD)

The PTD unit connected to the instrument is used for purging organic constitutents from waters and soil/sediment samples. The unit consists of a sorbent trap wrapped in heater wire, two-position valve for directing gas flow, sparger, and a timer-rheostat for controlling the temperature of the trap. A thermometer is wrapped within the heater wire adjacent to the trap used to monitor the trap temperature.

When not in use, the timer and rheostat should be in the OFF position and the two-position valve should be in the PURGE position.

## 2.4 GC Settings

GC front panel settings should be set as follows:

| | | |
|---|---|---|
| Channel A (PID) | INPUT - | MED |
| | OUTPUT - | Disabled with integrator |
| Channel B (FID) | INPUT - | MED |
| | OUTPUT - | Disabled with integrator |
| Lamp (PID) - | on | |

## 3.0 STANDARDS PREPARATION

### 3.1 STOCK STANDARDS

Stock solutions should be prepared in methanol from pure standard materials (>98% purity) or from certified solutions. For standards prepared from pure compounds, the stock solution is prepared by a single dilution of specified volumes of the pure compound. Assuming the stock solution was prepared in a 10 ml volumetric flask, the concentration of any given component would be,

$$\text{concentration, mg/ml} = \frac{(\text{Vstd})\ (\text{Dstd})}{(10\ \text{ml})\ (1000)}$$

where Vstd = volume of pure standard used, ml

Dstd = density of pure standard, g/ml

10 ml = dilution volume

1000 = conversion, mg/g

After preparation, the stock solution should be stored in a teflon-sealed screw-cap vial with minimal headspace, away from light, and at -10 C. The solution should be labeled with the concentration of each constituent, the solvent, the date of preparation, and the analysts initials.

Stock solutions should be prepared every six months or sooner if comparison with check standards indicate a problem.

### 3.2 Secondary Dilution Standards

Prepare secondary dilutions in methanol from the stock solution (section 3.1) that contain the analyte(s) of interest, either singly or as a mixture. The secondary dilution standard

should be prepared at a concentration so that calibration standards prepared from it are within the working range of the instrument.

Secondary dilution standards should be prepared immediately prior to each project's initiation. They should be stored and labeled in the same manner as stock solutions.

### 3.3 CALIBRATION STANDARDS

Calibration standards should be prepared at three to five concentration levels with one standard near the detection limit of the method. The remaining standards should correspond to the expected range of sample concentrations. The standards should contain all the analytes of interest.

For aqueous standards:

$$\text{concentration, ug/L of standard} = \frac{(Cstd)\ (Vstd)}{10\ ml}$$

where Cstd = concentration of secondary dilution standard, ug/ml

Vstd = volume of secondary standard, ul

10 ml = purge volume, ml

For soil/sediments:

$$\text{concentration, ug/Kg of standard} = \frac{(Cstd)\ (Vstd)}{10\ g}$$

## 4.0 SAMPLE ANALYSIS

### 4.1 Water

Ten ml aliquots of water are analyzed, and the following PTD conditions are used:

| | time(min) | temp(C) | valve position |
|---|---|---|---|
| Purge | 12 | ambient | PURGE |
| Desorb | 4 | 180 | DESORB |
| Bake | 8 | 180 | PURGE |

A setting of 8 on the rheostat corresponds to 180 C. The fans adjacent to the trap can be used to help control the trap temperature.

After baking is complete, the sparger is drained and a dry purge is performed for 3 minutes in the PURGE mode before the next sample is introduced.

### 4.2 Soil/Sediment

A 10 gram aliquot is weighed into the sparger and 10 ml of DI blank water is introduced. The procedure and conditions are identical to 4.1 above.

Final results for soil samples are reported on a wet weight basis. To calculate results on a dry weight basis, laboratory analysis for % solids must be performed and the result obtained used to correct the wet weight result.

## 5.0 CALIBRATION

### 5.1 Initial

For each analyte of interest three to five calibration standards over the the range of interest should be analyzed. The lowest concentration standard should be near but above the method detection limit. Each standard should be analyzed as in 4.0 above. The results can be used to prepare a calibration curve for each analyte or a calibration factor (CF) can be calculated for each analyte. If the %RSD of the CF is less than +/-20% over the working range the average calibration factor can be used in place of the calibration curve.

$$CF = \frac{\text{total area of peak}}{\text{concentration of std}}$$

### 5.2 Calibration Verification

The working calibration curve or CF must be verified each working day by the injection of a mid-range standard. If the response for any analyte varies from the inital calibration by more than +/- 20% the system must be recalibrated.

$$\% \text{ Difference} = \frac{R1 - R2}{R1} \times 100$$

R1 - first calibration factor
R2 - second calibration factor

### 5.3 Continuing Calibration

A mid-range continuing calibration standard must be run once per every ten samples and at the end of the day. If the response for any analyte varies from the initial calibration by more than +/-20%, the system must be recalibrated.

## 6.0 CALCULATIONS

The concentration of each analyte in the sample is determined by calculating the amount of standard purged, from the peak response using the calibration curve or calibration factor from 5.0 above.

For water samples:

$$\text{concentration (ug/L)} = \frac{(\text{Asmp})\ (\text{Cstd})\ (\text{D})}{(\text{Astd})}$$

where Asmp = sample analyte response, area counts or peak height.

Cstd = concentration of standard, ug/L

Astd = standard analyte response in same units as Asmp above.

D = dilution factor

For soil/sediment samples:

$$\text{concentration (ug/Kg) dry weight} = \frac{(\text{Asmp})\ (\text{Cstd})\ (\text{D})}{(\text{Astd})\ (1 - \text{M})}$$

where Asmp = as above

Cstd = concentration of standard, ug/Kg

Astd = as above

D = as above

M = fractional % moisture

# 7.0 QUALITY CONTROL

## 7.1 System Check

Before sample analysis, the system must be checked for interferences. This is done by performing a purge in the absence of a sample and allowing the GC to run through the temperature program while monitoring the baseline.

This check is generally performed after periods of long down time or on a daily basis if the samples from the previous day are suspected of contaminating the system.

## 7.2 Method Blank

Method blank analysis is performed on a daily basis (after the system check). The method blank consists of DI blank water which is used for standards preparation and sample dilution.

Method blanks should also be analyzed after samples which are suspected of contaminating the system to verify the absence/presence of interferences.

## 7.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

A matrix spike and matrix spike duplicate will be analyzed 1 per 20 samples. The spiking level must be within the working range of the calibration standards and greater than 25% of sample concentration if present. The spiking solutions must be added after any sample dilution. Precision and accuracy must fall within the range of +/- 20% RPD and 75-125% recovery. Samples failing this criteria will be reanalyzed to verify possible matrix interferences.

### 7.4 Duplicate

Duplicate samples must be analyzed once per day. In the event that measureable concentrations of the analytes of interest are not present in any of the samples, a MS/MSD will need to be analyzed.

### 7.5 QA Review

All data must be reviewed by the analyst performing the analysis before submission to the QAO. Adherence to guidelines previously outlined must be demonstrated.

## 8.0 REPORTING/RECORDKEEPING

All results will be reported on G&M GC Analyses Report forms as illustrated in Figure 1.

Each sample or standard analyzed will be recorded in the GC van log book. Date of analysis, analyst, instrument conditions, and purge volume will also be recorded. In addition, the standards preparation are to be documented in the log book.

After each sampling/analysis episode, a project summary report will be submitted to the project QAO. The summary report will include a project narrative, the analytical results, raw data, quality control summary, and a description of any problems encountered during the project episode.

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APPENDIX C

ENGINEERING SUPPORT BRANCH, STANDARD OPERATING PROCEDURES, AND QUALITY ASSURANCE MANUAL, U.S. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL SERVICES DIVISION ATHENS, GEORGIA, APRIL 1986

(One Copy Enclosed)

APPENDIX D

SAMPLE HANDLING PROTOCOL FOR LOW, MEDIUM, AND HIGH CONCENTRATION SAMPLES OF HAZARDOUS WASTE;
APPENDIX E: CHEMICAL DATA QUALITY MANAGEMENT FOR HAZARDOUS WASTE ACTIVITIES, ACOE,
ER1110-1-263, 15 DECEMBER 1989

# APPENDIX E

## SAMPLE HANDLING PROTOCOL FOR LOW, MEDIUM AND HIGH CONCENTRATION SAMPLES OF HAZARDOUS WASTE

E.1. Purpose. This protocol provides guidance on sample volumes, containers, packing, and shipping for low, medium, and high concentration environmental samples taken for chemical analysis.

E.2. Applicability. The guidance in this appendix applies to all samples taken by USACE for HTW chemical analysis. The requirements are consistent with those of the Environmental Protection Agency and all standard chemical methods generally used are included.

E.3. Low Concentration Samples. Low level samples are considered to be those collected off-site, around the perimeter of a waste site, or in areas where hazards are thought to be significantly reduced by normal environmental processes.

a. Waters.

(1) Organics.

(a) Bottle and Preservative Requirements.

- Four 1-liter amber glass bottles (Teflon-lined caps), iced to 4° C (may not be held at site over 24 hours). Remember: Leave some headspace!
- Two 40 mL glass VOA vials (with Teflon septa), iced to 4° C (may not be held at site over 24 hours). Fill completely! All air bubbles should be excluded. Add $NaHSO_4$ or HCl to pH<2 (4 drops of concentrated HCl).
- The samples above are needed when Method 8240 is used to analyze for volatile (or purgeable) organics, when Methods 8250 or 8270 are used to analyze for Acid/Base Neutral (A/B/N) extractable organics, and when Method 8080 is used to analyze for pesticides and PCB's. Two of the 1-L bottles are needed for 8250/8270 and two for 8080.

- Oil and Grease, Total Organic Carbon (TOC) or TRPH. For each analyte, two 1-liter glass bottle (Teflon-lined cap), 5 mL 1:1 HCl (to pH < 2), and 4° C. Leave headspace.

(b) Paperwork/Labels.

- Chain of Custody Record. See attached example. It is important to note that only one site may be listed per form even if the sites have the same project number. Top original goes with the samples; a copy should be saved for the sampler's files.

- Receipt for Samples. See attached example. This form complies with the requirements that the owner, operator, or agent-in-charge is legally entitled to: (1) a receipt describing the samples obtained from the site and; (2) a portion of each sample equal in weight or volume to the portion retained, if requested. The original form is retained for the Project Coordinator and a copy is given to the owner, operator, or agent-in-charge.

- Sample Labels. See attached example. You must label the sample with a date, time of collection, site name, and brief description on a label that will not float/soak off - no masking tape, please. Use only indelible ink on all labels. Numbered sample labels should be used on all samples.

(c) Packaging and Shipping.

- Waterproof metal (or equivalent strength plastic) ice chests or coolers only.

- After filling out the pertinent information on the sample label and tag, put the sample in the bottle or vial and screw on the lid. For bottles other than VOA vials, secure the lid with strapping tape. (Tape on VOA vials may cause contamination.) Then, secure the string from the numbered approved tag around the lid.

- Mark volume level on bottle with grease pencil.

- Place about 3 inches of inert cushioning material such as vermiculite in the bottom of the cooler.

- Enclose the bottles in clear plastic bags through which sample tags and labels are visible, and seal the bag. Place bottles upright in the cooler in such a way that they do not touch and will not touch during shipment.

- Put in additional inert packing material to partially cover sample bottles (more than halfway). Place bags of ice around, among, and on top of the sample bottles. If chemical ice is used, it should be placed in a plastic bag.

- Fill cooler with cushioning material.

- Put paperwork (chain of custody record) in a waterproof plastic bag and tape it with masking tape to the inside lid of the cooler.

- Tape the drain shut.

- Secure lid by taping. Wrap the cooler completely with strapping tape at a minimum of two locations. Do not cover any labels.

- Attach completed shipping label to top of the cooler.

- Put "This Side Up" labels on all four sides and "Fragile" labels on at least two sides.

- Affix numbered and signed custody seals on front right and back left of cooler. Cover seals with wide, clear tape.

Remember that each cooler cannot exceed the weight limit set by the shipper.

(2) Inorganics.

(a) Bottle and Preservative Requirements.

- Metals. One 1-liter high density polyethylene bottle (Teflon-lined cap), adjust to pH $\leq$ 2 with 1:1 $HNO_3$ (usually 3 mL).

- o Cyanides. One 1-liter high density polyethylene bottle (Telfon-lined cap), adjust to pH > 12 with NaOH (usually 2 mL of 10N NaOH or 4 pellets), and 4° C.

- o Sulfide. One 1-liter high density polyethylene bottle (Teflon-lined cap), 4 mL 2.0 N zinc acetate and adjust pH > 9 with NaOH, and 4° C.

- o Fluoride. One 1-liter high density polyethylene bottle (Teflon-lined cap), no preservative, and 4° C.

- o pH. No preservative. Must be measured twice immediately in field. Do not ship.

- o Ammonia, Total Nitrogen, Organic Nitrogen, Nitrate/Nitrite. For each analyte, one 1-liter high density polyethylene bottle (Telfon-lined cap), adjust to pH < 2 with $H_2SO_4$ (usually 4 mL 1:1 $H_2SO_4$), and 4° C.

(b) Paperwork/Labels.

- o Inorganic Paperwork is the same as described for organics (see I.A.1.b. above) and includes the Chain of Custody Record, Receipt for Samples, and Labels/Sample Tags. See previous examples and explanations.

(c) Packaging and Shipment

- o Follow packaging and shipping requirements listed for organics (see Section I.A.1.c. above). "Fragile" labels are optional for coolers not containing glass bottles. In cases where ice is not required (metals), fill cooler with only packing material. Once again, remember that the cooler must not exceed the shipper's weight limit.

b. Soils/Sediments (Organics and Inorganics)

(1) Bottle Requirements

- o Two 8-ounce glass wide mouth jars at least 3/4 full (Teflon-lined caps), iced to 4° C - one jar for organics (non-VOA) and one jar for

inorganics. For analysis of volatiles in soil, 2-40 mL VOA vials (with Teflon septa or Teflon lined caps), 2-120 mL wide mouth glass vials or 2-4 oz. wide mouth jars (with Teflon lined caps) are used. These should be completely filled and iced to 4° C.

(2) Paperwork/Labels

- Follow paperwork requirements listed for water samples in Section I.A.1.b. above. See attached examples of forms.

(3) Packaging and Shipping

- Follow packaging and shipping requirements in Section I.A.1.c. above. Be sure that the shipping cooler does not exceed the shipper's weight limits.

E.4. Medium Concentration Samples. Medium level samples are most often those collected on-site, in areas of moderate dilution by normal environmental processes.

a. Water/Liquids (Organics and Inorganics)

Note: Samples are not known to contain highly toxic compounds.

(1) Bottle and Preservative Requirements.

- Four 32-ounce wide mouth glass jars (Teflon-lined caps), no preservatives, and iced to 4° C for A/B/N extractable organics and PCB/Pest (two jars for each method). Remember: Leave some headspace.

- Two 40 mL glass VOA vials (Teflon septa), Iced to 4° C. Fill completely. No headspace.

- Two 16-ounce wide mouth glass jars nearly full (Teflon-lined caps) one for metals and one for cyanides. (Preserve as for low level I.2.a.)

(2) Paperwork/Labels

- See previous examples. Follow paperwork requirements in I.A.1.b. for low concentration samples.

(3) Packaging and Shipping

- Secure sample jar lids with strapping tape or evidence tape. At the same time secure string from USEPA numbered tag around lid.
- Mark volume level of bottle with grease pencil.
- Position jar in Ziploc bag so that tags may be read.
- Place about 1/2 inch of cushioning material in the bottom of metal can.
- Place jar in can and fill remaining volume of can with cushioning material.
- Close the can using three clips to secure lid.
- Write sample number on can lid. Indicate "This Side Up" by drawing an arrow and place "Flammable Liquid N.O.S." label on can. Personnel who ship samples must be sure to comply with DOT shipping regulations and not knowingly over-classify a sample prior to shipment. If the person shipping a sample knows that the sample is not a "Flammable Liquid" (i.e., a water phase sample or a soil sample), he should not classify it as "Flammable Liquid."
- Place about 1 inch of packing material in bottom of cooler.
- Place cans in cooler and fill remaining volume of of cooler with packing material. Add ice bags if required.
- Put paperwork in plastic bags and tape with masking tape to inside lid of cooler.
- Tape drain shut.
- After acceptance by shipper, tape cooler completely around with strapping tape at two locations. Secure lid by taping. Do not cover any labels.
- Place lab address on top of cooler.

Note: Write "Flammable Liquid N.O.S." on side of cooler if this is not marked on the margin of your DOT label.

- o For all medium and high concentration shipments, complete shipper's hazardous material certification form.

- o Put "This Side Up" labels on all four sides, "Flammable Liquid N.O.S." and "Danger-Peligro" on all sides.

Note: "Danger-Peligro" labels should be used only when net quantity of samples in cooler exceeds 1 quart (32 ounces) for liquids or 25 pounds for solids. In other words, for our purposes "Danger-Peligro" labels will never be used for Flammable Solids N.O.S.

- o Affix numbered custody seals on front right and back left of cooler. Cover seals with wide, clear tape.

b. Soils/Sediments/Solids (Organics and Inorganics)

(1) Bottles and Preservatives

- o For analysis of volatiles, 2-40 mL VOA vials (with Teflon septa or Teflon lined caps), 2-120 mL VOA vials, or 2-8 oz wide mouth jars (with Teflon lined caps) are used. These should be completely filled and iced to 4° C.

- o Two 8-ounce wide mouth glass jars, 3/4 full (Teflon-lined caps), no preservatives, one jar for organics (non-VOA) and one jar for inorganics (metals and cyanide) or

- o Four 4-ounce wide mouth glass jars each 3/4 full (Teflon-lined caps), no preservative; two jars for organics (non VOA) and two jars for inorganics.

(2) Paperwork/Labels

- o See previous examples. Follow paperwork requirements listed in section I.A.1.b. for low concentration samples.

(3) Packaging and Shipping

- Follow packaging and shipping requirements listed in Section II.A.3. for medium concentration water/liquids above substituting "Flammable Liquid N.O.S." with "Flammable Solid N.O.S."

E.5. High Concentration Samples (Hazardous: Determined Not to be D.O.T.- Defined Poison A). High concentration samples include those from drums, surface impoundments, direct discharges, and chemical spills, where there is little or no evidence of environmental dilution. High concentration (or high hazard) samples are suspected to contain greater than 15% concentration of any individual chemical substituent.

a. Liquids (Organics and Inorganics)

(1) Bottle and Preservative Requirements

- One 8-ounce wide mouth glass jar filled 1/2 to 3/4 full (Teflon-lined cap). No preservative.

(2) Paperwork/Labels

(a) See previous examples. Follow paperwork requirements listed in Section I.A.1.b. above.

(b) Shipper may require special forms to be completed before shipment of high hazard concentration samples.

(3) Packaging and Shipping

- Follow packaging and shipping requirements listed in Section II.A.3. above for medium concentration water/liquids.

b. Soils/Sediments/Solids (Organics and Inorganics)

(1) Bottle and Preservative Requirements

- One 8-ounce wide mouth glass jar filled 1/2 to 3/4 full (Teflon-lined cap). No preservative.

(2) Paperwork/Labels

- See attached examples. Follow paperwork requirements in Section I.A.1.b. above.

(3) Packaging and Shipping

- Follow packaging and shipping requirements listed in Section II.A.3. for medium concentration water/liquids, substituting "Flammable Liquid N.O.S." with "Flammable Solid N.O.S."

# APPENDIX E

## GERAGHTY & MILLER PREVENTATIVE MAINTENANCE AND CALIBRATION FREQUENCY FOR FIELD EQUIPMENT

## Preventive Maintenance and Calibration Frequency for Field Equipment

1.0 Conductivity Meters

a. Each Use: Meter probes are cleaned before and after each use with distilled/deionized water.

Before each use (once daily) the instruments are checked with a commercial conductivity standard for proper calibration.

The battery is checked for proper charge.

b. Quarterly: The instrument is inspected on a quarterly basis, whether used during the quarter or not.

The inspection consists of a general examination of the electrical system (including batteries) nd a calibration check.

Instruments not functioning properly are shipped to the manufacturer for repair and calibration.

2.0 pH Meters

a. Each use: Before each use (daily), the probe should be checked for cracks in the electrode bulb and complete filling with electrolyte solution.

At the beginning of any sampling day, the pH meter must be calibrated using standard pH buffers as referenced in Section 6.0.

The battery is checked for proper charge.

Following each use, the probe is rinsed with deionized water. The probe cap is filled with electrolyte solution and placed on the probe tip. Excess electrolyte is rinsed off and the probe dried with a paper towel. The instrument is then placed in its carrying case.

b. Quarterly: The instrument is inspected on a quarterly basis whether or not it has been used.

The inspection consists of a general examination of the probe, wire, electrical system (battery check) nd a calibration check.

Any malfunctioning equipment is returned to the manufacturer for repair and recalibration.

3.0 Thermometers

a. Each use: Before each use, thermometers are visually checked for cracks and mercury separation.

After use, thermometers are rinsed with deionized or distilled water and replaced in their protective case to prevent breakage.

b. Monthly: Thermometers are visually inspected as described above, whether used or not. They are checked against an NBS certified thermometer for accuracy.

4.0 Foxboro Organic Vapor Analyzer

a. Each use: The instrument calibration will be checked in the field with a secondary standard (isobutylene) prior to any analysis and at the end of the day. Gas flows are checked periodically.

If the instrument response deviates by more than 10 percent from the known value, the instrument is removed from the field and recalibrated against the primary standard (methane). If calibration procedures indicate poor performance, the instrument is returned to the rental agency.

b. Monthly: The instrument calibration is checked against a primary standard (methene). Recalibration is performed if required. Electrical and gas connections will be checked and cleaned.

5.0 Photovac 10S50 Portable Gas Chromatograph

a. Preventative/Routine Maintenance

Preventative maintenance of the Photovac Gas Chromatograph (GC) consists of the following items: (1) routine septum replacement; (2) daily check of gas flow; (3) use of high purity air for a carrier gas; (4) new sample syringes for each new project; and (5) use of new VOC vials for samples and standards.

b. Corrective Action

Corrective action in the field may consist of any of the following: (1) septum replacement; (2) syringe cleaning or replacement with new syringe; (3) clean detector; (4) clean injection part; (5) check of gas flow; (6) column replacement; and (7) checking electronics.

Photovac also provides telephone support for any replacement that may occur.

c. Calibration and Operation Procedures

For each project, compound-specific method development is conducted. This method development is completed prior to use in the field. Blanks are run to determine baseline conditions. A standard for each compound is run to determine retention time and response.

Blanks and calibration checks are run daily in the field. Prior to the analysis of samples, a blank and standard are run. The standard is compared to the standard run during method development for determining reproducibility. If significant change is noted, corrective action is taken prior to sample analysis. A blank and standard also run at the end of sample analysis or after every 20 samples, which is most frequent. Duplicates are run 1 per twenty samples. Blanks are also run if samples with high concentrations are analyzed or whenever system contamination is suspected.

6.0 HNU 301 Gas Chromatograph

a. Preventative/Routine Maintenance

Preventative maintenance for the HNU 301 GC consists of the following items: (1) daily check of gas flow; (2) use of high purity gases; and (3) standard cleaning procedures for associated glassware.

b. Corrective Action

Corrective action in the field may consist of any of the following: (1) replace column; (2) replace trap; (3) replace purge apparatus; (4) check for leaks; (5) clean detector(s); (6) check electronics; and (7) clean or replace sample and/or standard syringes.

HNU also provides technical telephone support on a limited basis.

c. Calibration and Operational Procedures

For each project, compound-specific method development is conducted. This method development is completed prior to use in the field. Specific procedures for calibration criteria are described in Geraghty & Miller's Standard Operating Procedures for GC Calibration.

7.0 Hach™ DR-1A Filter Photometer

a. Preventative/Routine Maintenance

Preventative maintenance of the DR-1A consists of the following items: (1) daily sensitivity check of absorbance; (2) cleaning of sample cell windows, filters, and lamp; and (3) instrument zero and full scale check.

b. Corrective action in the field may consist of any of the following: (1) battery replacement; (2) lamp replacement; and (3) filter replacement.

c. Calibration and Operation

For each project, compound specific procedures and calibrations following the appropriate published EPA methods and Hach™ modifications are used. Specific procedures for calibration are found in standard operating procedures for field colorimetric analyses.

# APPENDIX F

# LEVEL II REPORTING REQUIREMENTS

# LEVEL II

## Field QC and

## Laboratory Reporting Requirements

# ANALYTICAL QA PROGRAM

## Field QC Samples

LEVEL II

- o Sampling Procedures
  - Follow standardized sampling procedures
- o Field QC Samples REquired to be Collected:
  - Volatile Organic Compounds: Trip Blanks: 1 per 20 (Florida DER requires trip blanks for all parameters at a frequency of 1 per 20 samples per matrix);
  - Field Blanks: 1 per 20 Samples per Matrix for all parameters;
  - Field Replicates: 1 per 20 Samples per Matrix for all parameters;
  - Sampler Rinsate Blanks: 1 per 20 Samples per Matrix for all parameters.

# LEVEL II LABORATORY QUALITY ASSURANCE REQUIREMENTS

I. LABORATORY REPORTABLES:

The following information will be included in the data package for each sample where applicable:

A. General Information:

1. The results of sample analysis;
2. The parameters of interest;
3. The method of analysis;
4. The detection limits of analysis;
5. For large numbers of samples per report, a master list of laboratory tracking ID numbers correlated with field sample ID numbers and sample analysis batch identification to correlate QA samples to sample analysis batch;
6. Sample collection date;
7. Sample received date;
8. Sample preparation/extraction date;
9. Sample analysis date;
10. Copy of the chain-of-custody form signed by the laboratory sample custodian;
11. A narrative summary identifying any QA or sample problems encountered, required sample manipulations (dilutions), and the corrective action taken.

Level II Reportables

B. Inorganics Analyses:

For inorganics analyses involving the use of atomic absorption (flame or furnace), inductively coupled plasma (ICP), ion chromatograph (IC), light (visible or ultraviolet) spectrophotometric methods, other turbidimetric, gravimetric, auto analyzer procedures and inorganic procedures generally referred to as "wet bench" chemistry, the following QA data should be provided where applicable:

1. Results of method blanks;

2. Results of batch specific laboratory duplicates, relative percent difference (RPD) from sample, and control limits;

3. Results of batch specific matrix spikes, expected value, percent recovery, control limits, and source;

4. Results of a Laboratory Control Sample (LCS) spiked into reagent water and carried through the preparation method prior to analysis (may also be called a digested spike or QC Check Sample), expected value, percent recovery, and control limits;

5. Results of a QC Check Sample (Initial Calibration Verification Standard and Continuing Calibration Verification Standard) spiked into reagent water (non-digested), expected value, percent recovery, and control limits. This sample is an analytical spike, not carried through the method. Lot No. and source should be provided.

C. Organics Analyses:

1. Gas Chromatography (GC) Analysis:

The results of the following analyses should be reported where applicable:

a. Blanks:

(1) Water blanks (non-extraction);
(2) Extraction blanks (Laboratory blank);
(3) Trip blanks

Note: Field blanks are treated as samples.

b. Results of most recent independent QC check sample, expected value, percent recovery, and control limits (include Lot No. and source);

c. Results of batch specific matrix spikes, expected value, percent recovery, and control limits;

d. Results of batch specific laboratory duplicates or matrix spike duplicates;

e. Results of surrogate spikes, expected value, percent recovery, and control limits;

f. Results of reagent water spikes and reagent water spike duplicate of compounds of interest, expected value and percent recovery, and control limits should be reported if matrix spikes are outside control limits.

2. GC/Mass Spectrometer Analysis:

The results of the following analyses should be reported where applicable:

a. Blanks:

(1) Water blanks;
(2) Extraction blanks;
(3) Trip blanks.

b. Results of most recent independent QC check sample results expected value, percent recovery, and control limits (include Lot No. and source);

c. Results of batch specific matrix spikes;

d. Results of batch specific matrix spike duplicates;

e. Laboratory duplicates - optional;

f. Surrogate spikes expected value, percent recovery, and control limits;

g. For matrix spike/matrix spike duplicate, the expected value, percent recovery, matrix spike control limits, relative percent difference (RPD), and RPD control limits.

h. Results of reagent water spikes and reagent water spike duplicate of compounds of interest, expected value, and percent recovery and control limits should be reported if matrix spikes are outside control limits.

II. LABORATORY NON-REPORTABLES: (LEVEL II)

All raw data and data not included under the reportables described in paragraph I developed by the contracted laboratory during sample analysis must be maintained by that laboratory as a record for a period of three years unless specified otherwise by the contract. Such data may include, but not be limited to, the following:

A. Inorganics Analyses:

1. Concentration of calibration curve standards;

2. Results of linear range check samples for ICP;

3. Results of linear range (1 to 4) dilution sample for ICP;

4. Results of interference check sample (ICS) analysis and expected value (ICP only);

5. Results of analytical (post-digested) spike analysis;

6. Sequential measurement readout records;

7. Digestion logs;

8. Percent solids raw data;

9. Raw data calculation worksheets.

B. Organics Analyses:

Records of the analysis results of the following types of QA samples:

1. Initial calibration data;

2. GC/Mass Spectrometer tuning with BFB or DFTPP and mass calibration summary;

3. Continuing calibration standards including results of system performance check compounds (CCC) and expected results;

4. Response factors and relative retention time for each parameter;

5. Internal standard parameter (compound) and concentration;

6. Sample chromatograms;

7. Mass spectral data tape for each sample.

NOTE: The laboratory non-reportable inorganic and organic information is not required to be submitted with the laboratory report, but should be available for audit review upon 30-days notice. A copy of all reported data must also be retained by the laboratory for a period of three years along with the non-reportable data.

Attachment J

Data Validation Checklist

# DATA VALIDATION CHECKLIST
## SECTION ONE

PROJECT NAME: _____
PROJECT NUMBER: _____
SAMPLING DATE: _____ VALIDATION DATE: _____
SAMPLE IDENTIFICATION: _____
_____
SAMPLING TEAM: _____
ANALYZING LABORATORY: _____
ANALYSES PERFORMED: _____
_____
SAMPLE MATRIX: _____
QA REPORTING LEVEL: _____

## FIELD DATA PACKAGE DOCUMENTATION

| FIELD SAMPLING LOGS:1/ | REPORTED NO | REPORTED YES | PERFORMANCE ACCEPTABLE NO | PERFORMANCE ACCEPTABLE YES | NOT REQUIRED |
|---|---|---|---|---|---|
| 1. SAMPLING DATES NOTED | | | | | |
| 2. SAMPLING TEAM INDICATED | | | | | |
| 3. SAMPLE IDENTIFICATION TRACEABLE TO LOCATION COLLECTED | | | | | |
| 4. SAMPLE LOCATION | | | | | |
| 5. SAMPLE DEPTH FOR SOILS | | | | | |
| 6. COLLECTION TECHNIQUE (BAILER, PUMP ETC | | | | | |
| 7. FIELD SAMPLE PREPARATION TECHNIQUES | | | | | |
| 8. SAMPLE TYPE (GRAB, COMPOSITE) | | | | | |
| 9. SAMPLE CONTAINER TYPE | | | | | |
| 10. PRESERVATION METHODS | | | | | |
| 11. CHAIN OF CUSTODY FORM COMPLETED | | | | | |
| 12. REQUIRED ANALYTICAL METHODS REQUESTED | | | | | |
| 13. FIELD (WATER AND SOIL) SAMPLE LOGS COMPLETED PROPERLY AND SIGNED | | | | | |
| 14. NUMBER AND TYPE OF FIELD QC SAMPLES COLLECTED (BLANKS, REPLICATES, SPLITS, ETC.) | | | | | |
| 15. FIELD EQUIPMENT CALIBRATION | | | | | |
| 16. FIELD EQUIPMENT DECONTAMINATION | | | | | |
| 17. SAMPLE SHIPPING | | | | | |
| 18. LABORATORY TASK ORDER | | | | | |

1/ FIELD SAMPLING LOGS = WATER AND/OR SOIL/SEDIMENT SAMPLING LOGS

COMMENTS: _____

DATA VALIDATION CHECKLIST
SECTION ONE CONTINUED

ANALYTICAL DATA PACKAGE DOCUMENTATION

GENERAL INFORMATION

| ALL QA REPORTING LEVELS | REPORTED NO | REPORTED YES | PERFORMANCE ACCEPTABLE NO | PERFORMANCE ACCEPTABLE YES | NOT REQUIRED |
|---|---|---|---|---|---|
| 1. SAMPLE RESULTS | | | | | |
| 2. PARAMETERS ANALYZED | | | | | |
| 3. METHOD OF ANALYSIS | | | | | |
| 4. DETECTION LIMITS OF ANALYSIS | | | | | |
| 5. MASTER TRACKING LIST | | | | | |
| 6. SAMPLE COLLECTION DATE | | | | | |
| 7. LAB SAMPLE RECEIVED DATE | | | | | |
| 8. SAMPLE PREPARATION/EXTRACTION DATE | | | | | |
| 9. SAMPLE ANALYSIS DATE | | | | | |
| 10. COPY OF CHAIN-OF-CUSTODY FORM SIGNED BY THE LAB SAMPLE CUSTODIAN | | | | | |
| 11. A NARRATIVE SUMMARY OF QA OR SAMPLE PROBLEMS IS PROVIDED. | | | | | |

COMMENTS: _____

AFTER COMPLETING SECTION ONE PROCEED TO THE APPROPRIATE QA REPORTING LEVEL OF SECTION TWO (INORGANIC ANALYSES) AND/OR SECTION THREE (ORGANIC ANALYSES). FOLLOWING COMPLETION OF THESE SECTIONS PROCEED TO SECTION FOUR (DATA EVALUATION SUMMARY).

ANALYTICAL DATA VALIDATION CHECKLIST
SECTION TWO

INORGANIC ANALYSES

METALS AND CLASSICAL WET CHEMISTRY METHODS

| QA REPORTING LEVEL: I<br>REQUIREMENTS (BATCH SPECIFIC QA)[1] | REPORTED NO | REPORTED YES | IN LIMITS NO | IN LIMITS YES | NOT REQUIRED |
|---|---|---|---|---|---|
| 1. METHOD BLANKS | | | | | |
| 2. MS[2] OR RWS[3] % RECOVERY (%R) | | | | | |
| 3. MSD[4] OR RWSD[5] OR LD[6] %R | | | | | |
| 4. RPD[7] | | | | | |

COMMENTS: _____

1/ BATCH SPECIFIC QA: APPLIES TO ANY SAMPLES IN ANALYTICAL BATCH REGARDLESS OF THE SOURCE.
2/ MS = MATRIX SPIKE; 3/ RWS = REAGENT WATER SPIKE;
4/ MSD = MATRIX SPIKE DUP.; 5/ RWSD = REAGENT WATER SPIKE DUP.;
6/ LD = LABORATORY DUPLICATE; 7/ RPD = RELATIVE PERCENT DIFFERENCE

ANALYTICAL DATA VALIDATION CHECKLIST
SECTION THREE

ORGANIC ANALYSES

QA REPORTING LEVEL: I
REQUIREMENTS

| | Reported | | In Limits | | Not |
|---|---|---|---|---|---|
| | No | Yes | No | Yes | Required |
| 1. Water blanks | | | | | |
| 2. Extraction blanks | | | | | |
| 3. RWS[1/] | | | | | |
| 4. RWSD[2/] | | | | | |
| 5. RPD[3/] | | | | | |

Comments:

QA REPORTING LEVEL: II
REQUIREMENTS

A. GAS CHROMATOGRAPHY (NO MASS SPEC) OR WET CHEMISTRY PROCEDURE

| | | | | | |
|---|---|---|---|---|---|
| 1. Water blanks | | | | | |
| 2. Extraction blanks | | | | | |
| 3. MS[4/] (batch specific) | | | | | |
| 4. MSD[5/] (batch specific) | | | | | |
| 5. LD[6/] (optional) | | | | | |
| 6. MS/MSD RPD or sample/LD RPD | | | | | |
| 7. RWS | | | | | |
| 8. RWSD | | | | | |
| 9. RWS RPD | | | | | |
| 10. Surrogate spikes | | | | | |

B. GAS CHROMATOGRAPH/MASS SPECTROMETER

| | | | | | |
|---|---|---|---|---|---|
| 1. Water blanks | | | | | |
| 2. Extraction blanks | | | | | |
| 3. MS (Batch specific) | | | | | |
| 4. MSD (Batch specific) | | | | | |
| 5. LD (Optional) | | | | | |
| 6. MS/MSD RPD or sample/LD RPD | | | | | |
| 7. RWS | | | | | |
| 8. RWSD | | | | | |
| 9. RWS RPD | | | | | |
| 10. Surrogate spikes | | | | | |

COMMENTS:

1/ RWS = REAGENT WATER SPIKE; 2/ RWSD = REAGENT WATER SPIKE DUPLICATE;
3/ RPD = RELATIVE PERCENT DIFFERENCE; 4/ MS = MATRIX SPIKE;
5/ MSD = MATRIX SPIKE DUPLICATE; 6/ LD = LAB DUP

ANALYTICAL DATA VALIDATION CHECKLIST
SECTION TWO

INORGANIC ANALYSES
METALS AND CLASSICAL WET CHEMISTRY METHODS

QA REPORTING LEVEL: II
REQUIREMENTS (BATCH SPECIFIC QA)[1/]

| | Reported No | Reported Yes | In Limits No | In Limits Yes | Not Required |
|---|---|---|---|---|---|
| 1. METHOD BLANKS | | | | | |
| 2. MS % RECOVERY (%R) | | | | | |
| 3. MSD OR LAB DUPLICATE % R | | | | | |
| 4. RWS % R | | | | | |
| 5. RWSD % R | | | | | |
| 6. RPDs FOR MS/MSD, SAMPLE/LD, RWS/RWSD | | | | | |
| 7. LCS[8/] %R | | | | | |
| 8. ICVS [9/] %R | | | | | |

COMMENTS: _____

QA REPORTING LEVEL: III
REQUIREMENTS (SAMPLE SPECIFIC QA)[10/]

| | | | | | |
|---|---|---|---|---|---|
| 1. CALIBRATION CURVE STANDARDS | | | | | |
| 2. ICVS %R | | | | | |
| 3. CCVS[11/] %R | | | | | |
| 4. LCS %R | | | | | |
| 5. METHOD BLANKS | | | | | |
| 6. ICS[12/] %R (ICP ONLY) | | | | | |
| 7. DCS[13/] %R (ICP ONLY) | | | | | |
| 8. MS %R | | | | | |
| 9. LD OR MSD %R AND RPD | | | | | |
| 10. POST DIGESTION ANALYTICAL SPIKE[14/] | | | | | |

COMMENTS: _____

1/ BATCH SPECIFIC QA: APPLIES TO ANY SAMPLES IN ANALYTICAL BATCH.
2/ MS = MATRIX SPIKE; 3/ RWS = REAGENT WATER SPIKE;
4/ MSD = MATRIX SPIKE DUP.; 5/ RWSD = REAGENT WATER SPIKE DUP.;
6/ LD = LABORATORY DUPLICATE; 7/ RPD = RELATIVE PERCENT DIFFERENCE
8/ LCS = LABORATORY CONTROL SAMPLE;
9/ ICVS = INITIAL CALIBRATION VERIFICATION STANDARD;
10/ SAMPLE SPECIFIC QA: APPLIES TO PROJECT SPECIFIC SAMPLES..
11/ CCVS = CONTINUING CALIBRATION VERIFICATION STANDARD;
12/ ICS = INTERFERENCE CHECK SAMPLE; 13/ DCS = DILUTION CHECK SAMPLE;
14/ POST DIGESTION ANALYTICAL SPIKE APPLIES TO FURNACE AA ONLY;

ANALYTICAL DATA VALIDATION CHECKLIST
SECTION THREE CONTINUED

ORGANIC ANALYSES

QA REPORTING LEVEL: III
REQUIREMENTS

A. GAS CHROMATOGRAPH OR WET CHEMISTRY

| | Reported No | Reported Yes | In Limits No | In Limits Yes | Not Required |
|---|---|---|---|---|---|
| 1. Water blanks (VOC) | | | | | |
| 2. Extraction blanks | | | | | |
| 3. MS[1] %R sample specific | | | | | |
| 4. MSD[2] %R sample specific | | | | | |
| 5. LD[3] sample specific (optional) | | | | | |
| 6. MS/MSD RPD[4] or sample/LD RPD | | | | | |
| 7. RWS[5] | | | | | |
| 8. RWSD[6] | | | | | |
| 9. RWS/RWSD RPD | | | | | |
| 10. Surrogate spikes | | | | | |

B. GAS CHROMATOGRAPH/MASS SPECTROMETER

| | | | | | |
|---|---|---|---|---|---|
| 1. BFB or DFTPP Tuning[7] | | | | | |
| 2. Initial Calibration (IC) | | | | | |
| a. SPCC Compounds (RRF[8] >0.3/0.05) | | | | | |
| b. CCC Compounds (RSD[9] < 30% ) | | | | | |
| c. Other Compounds (RRF > 0.05) | | | | | |
| 3. Continuing Calibration (CC) | | | | | |
| a. SPCC Compounds (RRF >0.3/0.05) | | | | | |
| b. CCC Compounds (Max %D[10] < 25%) | | | | | |
| c. Other Compounds (RRF >0.05) | | | | | |
| 4. Water blanks | | | | | |
| 5. Extraction blanks | | | | | |
| 6. RWS | | | | | |
| 7. RWSD | | | | | |
| 8. RWS/RWSD RPD | | | | | |
| 9. MS (sample specific) | | | | | |
| 10. MSD (sample specific) | | | | | |
| 11. Surrogate spike | | | | | |

COMMENTS: _____

1/ MS = matrix spike; 2/ MSD = matrix spike duplicate; 3/ LD = lab dup
4/ RPD = relative percent difference; 5/ RWS = reagent water spike;
6/ RWSD = reagent water spike duplicate; 7/ BFB tuning is for volatiles and DFTPP tuning is for semi-volatiles (BNA extractables). 8/ RRF = relative response factor;
9/ RSD = relative standard deviation; 10/ %D = percent difference;

ANALYTICAL DATA VALIDATION CHECKLIST
SECTION FOUR

DATA EVALUATION SUMMARY

PROJECT NAME: _____ PROJECT NUMBER: _____
QA REPORTING LEVEL: _____ VALIDATION DATE: _____

ALL QA REPORTING LEVELS (I,II,III)

SUMMARY OF CHECKLIST FINDINGS

| | Reported No | Reported Yes | Performance Acceptable No | Performance Acceptable Yes | Not Required |
|---|---|---|---|---|---|
| 1. FIELD MEASUREMENTS OF PH AND SPECIFIC CONDUCTANCE ARE CONSISTENT WITH HISTORICAL DATA | | | | | |
| 2. FIELD RECORDS | | | | | |
| 3. METHODS (GEN.INFO. SECTION ONE) | | | | | |
| 4. HOLDING TIMES (MASTER SAMPLE LIST) | | | | | |
| A. EXTRACTION HOLDING TIMES | | | | | |
| B. ANALYSIS HOLDING TIMES | | | | | |
| 5. DETECTION LIMITS (SECTION ONE) | | | | | |
| 6. BLANKS (SECTIONS TWO OR THREE) | | | | | |
| A. EQUIPMENT RINSATE BLANKS | | | | | |
| B. FIELD BLANKS | | | | | |
| C. TRIP BLANKS | | | | | |
| D. LABORATORY BLANKS | | | | | |
| 7. FIELD REPLICATES | | | | | |
| 8. FIELD SPLITS | | | | | |
| 9. GEOPHYSICAL COMPARISONS | | | | | |
| A. CATION VS ANION | | | | | |
| B. TDS VS SPEC. CONDUCTANCE | | | | | |
| C. PH VS ALK/ACIDITY | | | | | |
| D. OTHER | | | | | |
| 10. METALS QA DATA (SECTION TWO) | | | | | |
| 11. INORGANIC WET CHEMISTRY (SEC. TWO) | | | | | |
| 12. ORGANIC QA DATA-GC (SECTION THREE-A) | | | | | |
| 13. ORGANIC WET CHEMISTRY (SEC. THREE-A) | | | | | |
| 14. ORGANIC QA DATA-GC/MS (SEC. THREE-B) | | | | | |

AFTER COMPLETING THIS SECTION GO TO SECTION FIVE.
COMMENTS: _____

ANALYTICAL DATA VALIDATION CHECKLIST
SECTION FIVE

## DATA VALIDATION CODING

PROJECT NAME:_____ PROJECT NUMBER:_____
QA REPORTING LEVEL:_____ VALIDATION DATE:_____

1. QUALIFIER CODES ASSIGNED TO DATA: R, U, J, U/J, B, NO FLAG

2. IDENTIFICATION OF SAMPLES AND PARAMETERS WITH CODES:

| | SAMPLE ID | PARAMETERS |
|---|---|---|
| R CODE | | |
| B CODE | | |
| U CODE | | |
| J CODE | | |
| U/J CODE | | |

EXPLANATION:_____

VALIDATION PERFORMED BY:_____

SIGNED:_____

DATE:_____

# DATA USABILITY CLASSIFICATION
## SECTION SIX

NOTE: USE OF THIS FORM IS OPTIONAL.

PROJECT NAME: _____ PROJECT NUMBER: _____
QA REPORTING LEVEL: _____ VALIDATION DATE: _____

| DATA CLASS: SAMPLE MATRIX: | LEVEL A | LEVEL B | UNUSABLE |
|---|---|---|---|
| SOIL | | | |
| SEDIMENT | | | |
| GROUND WATER | | | |
| SURFACE WATER | | | |
| | | | |

IDENTITY OF SAMPLES AND PARAMETERS THAT ARE IN DIFFERENT USE LEVELS:

| SAMPLE ID | PARAMETER | QUALIFIER CODE | LEVELS A | B | UN.1/ |
|---|---|---|---|---|---|
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1/ UN. = UNUSABLE DATA

VALIDATION PERFORMED BY: _____

SIGNED: _____
QUALITY ASSURANCE OFFICER

DATE : _____