

Atlantic Division Lab (SADL) at the address listed below. These samples will be selected based on physical appearance, odor or field screening results as contaminated samples.

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Source Blank. One water sample shall be collected for each source of water used for decontamination of drilling and sampling equipment at each sampling episode. A minimum of two samples (one tap and one deionized water sample) shall be submitted for complete analysis of project-specific analytes.

4.1.6.2 Field Screening With Gas Chromatograph

Ambient Condition Blanks are collected from field sites exhibiting a high ambient concentration of possible pollutants for daily analysis on the portable field GC. The analysis of these blanks yields results that serve as a baseline measurement of the ambient conditions for that location. Ambient condition blanks consist of a direct measurement of the ambient air by injecting a sample of ambient air into the portable GC.

Typically, two ambient condition blanks are taken per day of soil gas sampling. The technique employed for an ambient condition blank is usually the same as the technique being used to survey soil gas conditions.

Equipment Blanks are collected for each piece of sampling equipment used in the collection of samples. The analyses of these blanks serve to assess the cleanliness of the sampling equipment.

Equipment blanks are comprised of an ambient or "clean" air sample being drawn through decontaminated soil gas equipment and then analyzed on the portable GC. If the

decontamination of the equipment did, in fact, serve to clean the equipment, no response should be noted on the instrument. If, however, a response is noted from the instrument the sampling equipment should be decontaminated again and another equipment blank run on the sample apparatus. Any positive response on an equipment blank shall be noted in the field logbook. Typically, one equipment blank shall be collected per each day of sample collection during soil gas analysis.

Field Duplicates are defined as two samples collected independently of each other at the same sampling location during a single episode of sampling. Analysis of these duplicates provides statistical information relating to sample variability and serves as a check on the precision of any sample collection method as it pertains to the sampled area.

For soil gas analysis on field GC, 10 percent of all samples exhibiting a positive instrument response should be collected in duplicate and analyzed.

B.4.2 FIELD EQUIPMENT CALIBRATION PROCEDURES

This section outlines the procedures to ensure proper working condition of the field instrumentation. The Foxboro 128 organic vapor analyzer (OVA), the Hydac 910 pH/conductivity meter, and the portable GC are calibrated prior to use. To negate ambient temperature change effects, each instrument was calibrated in the field outside the work area. The OVA is calibrated on a daily basis; the pH/conductivity meter is calibrated prior to groundwater sampling, and the GC is calibrated each day prior to use.

B.4.2.1 OVA Calibration

During all sampling activities, a Foxboro 128 OVA is used to provide worker safety information and screen materials for contamination. The OVA readings are used to determine personal protection levels and sampling depths for soils. Daily calibration procedures for the OVA are performed in the field as follows:

1. The readout assay and electrical interface is connected to the instrument body. The pump and electronics are activated and allowed to warm for 5 minutes.
2. A battery check and leak test is performed to ensure proper instrument response.
3. The instrument alarm level is then set at 5 ppm. The hydrogen tank and hydrogen supply valves are opened and the flame ignited.
4. The instrument is then zeroed using zero grade air dispensed from a tedlar bag.
5. Instrument response is verified using 100.5 ppm methane (in air) dispensed from a tedlar bag.

B.4.2.2 pH and Conductivity Meter Calibration

During groundwater sampling, a conductivity/pH meter is used to measure these parameters of the groundwater during sampling. For calibration of a HYDAC model 910 meter, the following procedures are used:

1. After turning the instrument on and allowing a few minutes for warm-up, the conductivity portion of the meter is calibrated first. Conductivity fluid of a known standard is poured into the sample holder of the meter. The temperature is measured first and recorded. The temperature dial for the conductivity is then adjusted to the temperature measured.
2. The conductivity of the standard solution is read and calibrated using the screw dial inside the meter.
3. After the conductivity is calibrated, the standard solution is discarded. The sample holder is triple rinsed with pH 7 buffer solution. The temperature of the buffer solution is measured and the temperature dial for the pH is then adjusted to the temperature measured.
4. The pH probe is inserted into the buffer solution and the pH is measured. The reading is adjusted with the zero knob to read pH 7.00.
5. The sample holder is then triple rinsed with pH 4 buffer solution. The temperature is not adjusted since the buffer solutions are stored together at ambient temperatures. The pH of the buffer solution is read and calibrated to read pH 4.00 using the slope knob.

B.4.2.3 Gas Chromatograph

The qualitative calibration of a portable GC is a procedure whereby an aliquot of headspace gas is taken from above a standard liquid by means of an air tight syringe and is injected into a GC for chromatographic detection. The corresponding response peaks and retention times of the components in the standard gas are in direct relation to the individual compounds that make up the standard. Peak retention times from a sample can be matched to the standard peak retention times and a tentative compound identification can be made.

Instrument calibration is performed using the following steps and is documented on the instrument calibration worksheet (Figure B4.4).

1. Analyze a syringe blank to ensure a clean syringe. If the blank syringe yields a response, heat the syringe in a sample oven with a heat lamp and analyze again.
2. Analyze a known aliquot of the headspace above the standard liquid and note the corresponding retention times and peak heights demonstrated by the GC system.
3. Analyze an identical volume of the standard's headspace and note the corresponding retention times and peak heights.
4. Compare the peak areas and retention times of the two chromatograms. Peak areas must compare to within ± 20 percent and retention times must match to within ± 5 percent or else it is necessary to rerun the standard to obtain the required reproducibility.

Some portable GCs are equipped with isothermal columns which are affected by daily temperature fluctuations which may cause shifts in the individual compound retention times and thereby may cause misinterpretation of the data. To avoid misinterpretation of data due to retention time shift a standard must be run every hour to document any shifts in compound retention time.

FIGURE B4.4

SOIL GAS INSTRUMENTATION CALIBRATION

Date: _____

. Instrument ⁽¹⁾	OVA-FID	EXOTECTOR	CGI	HNu-PID
Model Number				
. Calibration Gas:				
Manufacturer				
Identification (Lot #)				
Concentration				
Reading/Adjustment				
. Zero Gas:				
Manufacturer				
Identification (Lot #)				
Reading/Adjustment				
. Time Calibrated:				
. Calibrated By:				
. Calibration Check:				
Time				
By				
Status				
Time				
By				
Status				

1. **OVA-FID:** Organic Vapor Analyzer, Flame Ionization Detector manufactured by Foxboro.
- EXOTECTOR:** Exotector Combustible Gas Monitor manufactured by GFG Electronics.
- CGI:** Combustible Gas Indicator manufactured by Industrial Scientific Devices.
- HNu-PID:** Photo-Ionization Detector manufactured by HNu.

GC: Initial Calibration

Gas chromatographs are calibrated prior to each day of use. Calibration standard mixtures are prepared from appropriate reference materials and contain analytes appropriate for the method of analysis.

Working calibration standards for initial calibration are prepared fresh daily. The working standards include a calibration blank and five calibration standards covering the anticipated range of measurement. At least one of the calibration standards shall be at or below the desired instrument detection limit. One way to determine linearity over a calibration range is to use a correlation coefficient. The correlation coefficient of this calibration must be equal to or greater than 0.995 to consider the response linear over a range. If a correlation coefficient of 0.995 cannot be achieved, additional standards must be analyzed to define the calibration curve.

The second way to determine linearity is to use relative retention factors (RRFs). The RRFs must be within a specified range or relative percentage difference when internal standards are used.

GC: Continuing Calibration

The response of the instrument is verified for each analysis sequence by evaluation of a mid-range calibration check standard. In order to demonstrate that the initial calibration curve is still valid, the calibration check standard must be within ± 20 percent recovery of the initial calibration for the compounds of interest or the instrument must be recalibrated. For multi-analyte methods, this check standard may contain a representative number of target analytes rather than the full list of target compounds. Optionally, initial calibration may be performed at the beginning of the analysis sequence.

Within the analysis sequence, instrument drift is monitored by analysis of a mid-range calibration standard every 10 samples. The percent difference (% D) in Calibration Factors

(CFs) for the continuing calibration standard compared to the average CF from the initial calibration is calculated and recorded. If significant ($> 20\%$) calibration factor drift is observed for the compounds of interest, appropriate corrective actions shall be taken to restore confidence in the instrumental measurements.

GC: Quality Control

At least one method blank and two method spikes shall be included in each laboratory lot of samples for all analyses. Regardless of the matrix being processed, the method spikes and blanks shall be in aqueous media. Method spikes shall be at a concentration of approximately five times the detection limit. The method blanks are examined to determine if any contamination is being introduced in the laboratory.

The method spikes are examined to determine both precision and accuracy. Accuracy is measured by the percent recovery of the spikes. These recoveries are plotted on control charts to monitor method accuracy. Precision is measured by the reproducibility of both method spikes and is calculated as Relative Percent Difference (% RPD). These % RPDs are plotted on control charts to monitor method precision.

GC: Detection Limits

Instrument detection limits are determined from triplicate analysis of target compounds measured at three to five times the reporting limit. The calculated instrument detection limit is three times the standard deviation of the measured values.

GC: Confirmation Column

GC methods usually require the use of a second analytical column in order to confirm the identification of analytes detected.

B.4.2.4 Preventive Maintenance

Preventive maintenance of field equipment is required in order to ensure the collection of valid field measurements. All field equipment undergoes regular maintenance service from the manufacturer prior to use in the field. Daily checks are performed in the field as necessary according to the manufacturer's manual. All necessary maintenance procedures are fully documented in the project-specific field logbook.

B.4.3 FIELD SAMPLING PROCEDURES

The procedures for collecting the samples from the different matrices are presented below. The sampling procedures and methods used are Metcalf & Eddy Standard Operating Procedures (SOP) based on recognized Region IV U.S. EPA and USACE SOPs when available.

Clean sample gloves are worn when collecting each sample. All sampling locations and procedures are documented in the field logbook. All sampling equipment is decontaminated prior to each use according to the procedures in Section B4.4.

B.4.3.1 Subsurface Soil Sampling

EQUIPMENT

Split-spoon sampler or hand auger, stainless steel spoons, spatula and knife, pyrex bowl, OVA, sample containers.

PROCEDURE

Subsurface soil sampling consists of collecting soils from the surface to 6 inches below land surface and lower depths at predetermined intervals. Two procedures are outlined that may be used to collect the subsurface soil samples. Either a hand auger or a drill rig will be used

to collect the samples. The following procedures are followed when collecting subsurface samples:

I. Hand Auger

1. If a grass cover exists at the sample location, it is removed prior to sampling.
2. A stainless-steel hand auger is used to advance the auger hole to the desired sampling depth.
3. Once the sampling depth is reached, a clean auger bucket is attached to collect the sample.
4. Once removed from the hole, the top 3 inches of soil are removed to minimize cross-contamination from fall-in.
5. Carefully transfer the soil sample to a stainless-steel bowl.
6. If a volatile sample is needed for analysis, this fraction is collected prior to mixing.
7. Once the volatile fraction is collected, the remaining soil is homogenized by thoroughly mixing with a stainless-steel spoon.
8. Once homogenized, the remainder of the sample jars are filled, beginning with the organic fractions followed by the inorganic fractions.

II. Drill Rig

1. A clean, stainless-steel split-spoon is attached to a 140-lb hammer once the sampling depth is reached.
2. The split-spoon is driven a distance of 24 inches and removed.
3. Withdraw the split spoon and its contents from the ground. Immediately after opening the split spoon, monitor each soil core with the photoionization detector or organic vapor analyzer. Put on clean, protective gloves prior to handling the sample. Sample aliquots are peeled and removed from the split spoon sampler using a stainless steel spoon or spatula.
4. If samples are being collected for volatile organics analysis, minimize any disturbance or mixing of the soil. Invert a 4 oz. sample jar and insert the sample soil into the jar. Quickly fill the container as completely as possible to eliminate air space.

5. Carefully transfer the soil sample to a stainless-steel bowl.
6. Once the volatile fraction is collected, the remaining soil is homogenized by thoroughly mixing with a stainless-steel spoon.
7. Once homogenized, the remainder of the sample jars are filled, beginning with the organic fractions followed by the inorganic fractions.
8. Procedures for labeling, preservation, packaging, chain-of-custody, and preparation for shipment are then followed (see Section B5.0).

4.3.2 Hydropunch Sample Field Gas Chromatographs

EQUIPMENT

Sample vials, Standards, Portable GC with FID

PROCEDURE

Preliminary groundwater sampling will consist of collecting groundwater using HP-II technology or a similar, direct-push method. The procedure is outlined below:

I) HP-II

- 1) Drive the HP-II tool directly through the unconsolidated soils.
- 2) The HP-II is advanced approximately 5 feet into the water table.
- 3) The HP-II is then pulled back approximately 1 foot to allow water to enter the inside cavity.
- 4) Once the cavity is full, the HP-II is retrieved from the hole.
- 5) The 40ml/VOA sample bottles are filled for field volatile analysis using a gas chromatograph. Approximately 20 ml of sample is decanted from the 40ml vial. The VOA cap is then secured with the teflon side of the septum toward the sample, and the vial is vigorously shaken for 30 seconds. The VOA sample is allowed to stand for at least 2 minutes. A 10ml, 1cc, or 2cc glass syringe needle is inserted through the 40ml vial septum into headspace, and

the needle is purged with sample headspace. A 1UL to 1,000UL of headspace is then extracted and immediately injected into the GC for analysis.

- 6) Install a temporary piezometer in the HP-II borehole.
- 7) Backfill any annular space in the borehole with clean silica sand to ground surface.

B.4.3.3 Surface Water

Equipment

Sample containers, preservatives, pH/conductivity meter, thermometer, disposable cups for collection of field monitoring samples.

Procedure

To prevent cross-contamination of samples, sample collection will start at the most downstream location and continue upstream, changing gloves between samples. Samples will be collected while standing downstream of each sample collection point according to the following procedures:

1. Estimate the water depth (if a pole is used, wait to perform this task until after actual sampling to avoid water turbulence).
2. Sketch the surface water boundaries and sampling locations and photograph the sampling locations and conditions.
3. Record the physical characteristics of the water body such as odor, color, temperature, pH, conductivity and dead vegetation.
4. Put on clean protective gloves immediately prior to sampling. Collect the sample by immersing the sample container into the water; rinse the container and lid in the water to be collected and pour it out. Do not sample at the surface; instead, the sample container should be inverted, lowered to the approximate sampling depth, and held at about a 45-degree angle. If the surface water is a flowing stream, river, or brook, hold the sample container at about a 45-degree angle with the mouth of the bottle facing upstream.

If samples require preservatives (such as HCl, HNO₃, etc.) do not collect samples in bottles that are pre-preserved; add preservative after sample collection except when collecting grab samples for VOCs, vials must be pre-preserved.

Samples collected for volatile organic analysis must contain no air bubbles in the VOA vial after it has been capped; ensure this by turning the vial upside down and tapping it lightly. Fill all other sample containers to the shoulder.

5. Collect a final sample aliquot in a disposable container and immediately measure and record the pH, temperature, and conductivity of that sample.
6. Immediately label; preserve if required; refrigerate/ ice; and log the samples into a bound field log book and complete the chain-of-custody form.

B.4.3.4 Sediment

Equipment

Stainless steel trowel, scoop, or stainless steel hand core sampler with stainless steel liner tubes, stainless steel spoons, sample containers, and pyrex bowls.

Procedure

1. Record the field information: weather conditions and physical characteristics of the stream and sediment such as color, odor, and particle texture.
2. Sketch the stream/ponded water boundaries and sampling locations.
3. Photograph the sampling locations. Put on protective gloves and change gloves between samples.
- 4a. Trowel or scoop: Collect equal portions of sediment at and immediately below the surface (0-6 inch depth) and transfer into a bowl. The sediment should be collected at a minimum of three points. The sample for VOC analysis will be collected as a grab sample from only one point.
- 4b. Hand core sampler: Place the sampler in a perpendicular position to the sediment surface and push the tube into the sediment with a continuous and rapid motion to a maximum depth of 8 inches (approximately 6-inch core sample). Before pulling out the tube, rotate the hand corer at least two revolutions to shear off the sample at the bottom. Remove the liner tube from the sampler and transfer the sediment into a bowl. The sediment should be collected at a minimum of three points. The sample for VOC analysis will be collected as a grab sample from only one point.

5. Collect enough sediment to fill all the sample containers. The sample is then thoroughly mixed to homogenize and the sample bottles are then filled beginning with the organic fractions.

B.4.3.5 Groundwater Sampling (including Quarterly Monitoring Sampling)

Equipment

- . Water level indicator with stainless steel probe used to measure the water level.
- . Low flow purging pump or Teflon or stainless steel bailer to purge the well (the entire pump and discharge lines in contact with groundwater are to be constructed of noncontaminating materials.)
- . Teflon or stainless steel wire cable to be used as leader line for bailers (it must be decontaminated between each use.)
- . Sample containers and preservatives.
- . Disposable cups for collection of field monitoring aliquots
- . pH/conductivity meter, thermometer

Procedure

Sampling must proceed beginning with the well located in the area suspected of least contamination (upgradient) and proceeding to areas of most contamination. Protective gloves shall be worn during sampling and changed between samples. The following procedure will be used:

1. Record the weather conditions and other on-site particulars.
2. Place plastic sheeting around the well to provide protection from contamination for any field sampling equipment used in this procedure.
3. Sample the air in the well head for organic vapors using the OVA.

4. Using a decontaminated water level indicator, measure and record the static groundwater level and depth to the bottom of the well. Decontaminate the water level indicator, after use.
5. From the well diameter, the measured depth of the standing water. Note and record this volume.
6. Using a low flow purging pump or bailer, begin purging the well. Three times the total of the volume in the well shall be purged. The volumes purged are estimated by discharging all the purge water into a precalibrated container. During purging, measure and record the temperature, conductivity, and pH of each volume of water as it is removed. Discontinue purging after three volumes have been removed provided the pH and conductivity readings have stabilized. If the measurements have not been stabilized (i.e., any given pH or conductivity reading demonstrates more than a 10 percent change from the previous reading) end the purging at five well volumes, and record the pH and conductivity of the last water sample purged.
7. Sample the well using a decontaminated bailer, withdraw one full bailer of groundwater from the well. Dispose of this first bailer of sample along with the discharged well purge water into a disposal drum along with the purged water. (Personnel handling the bailer must wear new protective gloves.)
8. Using the same bailer and connecting cord, collect groundwater samples for the well. Record the time at beginning and end of the bailing.
9. Immediately, wearing new protective gloves, transfer a groundwater sample directly from the bailer to the appropriate sample containers. Samples collected for volatile organic analysis must be collected first. Samples collected for volatile organic analysis must contain no air bubbles in the VOA vial after it has been capped; ensure this by turning the vial upside down and tapping it lightly. Fill all other sample containers to the shoulder.
10. Immediately label; preserve if necessary; refrigerate/ice; and log the sample into the field log book and complete the chain of custody procedures.
11. **Remeasure and record the standing water level in the well after the sampling. Replace the protective cap on the well.**

B.4.4 DECONTAMINATION PROCEDURES

All equipment involved in site investigation activities is decontaminated prior to being used at the site and before being transported from the site. The general outline for such decontamination procedures is included in the following sections.

B.4.4.1 Non-Sampling Field Equipment

Non-sampling field equipment is any equipment that may potentially contact a sample area. All equipment and power tools used as non-sampling equipment (i.e., drilling equipment, augers, etc.) are decontaminated before and following usage, as well as prior to removal from the site. Large and heavy drilling equipment is steam cleaned. Light or small equipment such as hand tools is rinsed with tap water, scrubbed with a water/mild phosphate-free detergent solution, and rinsed again with tap water, or steam cleaned. All equipment decontamination is performed at a decontamination station specified in the site-specific HASP.

Sawhorses and plastic ground cloths are used in handling drilling and other non-sampling equipment to prevent cross-contamination in the field. No equipment is laid directly on the ground.

B.4.4.2 Sampling Equipment

Prior to field use, the cleaning procedures outlined in this section will be used by M&E and subcontractor personnel for the cleaning of all sampling equipment that comes in direct contact with the sample being collected. A sufficient amount of clean equipment and sample containers should, whenever possible, be transported to the project site to minimize the need for excessive cleaning of equipment in the field.

B.4.4.3 Cleaning Procedures

Guidelines for routine decontamination of equipment used in the collection of samples at hazardous waste sites are outlined in the following sections. (Note: Rinse the sampling equipment thoroughly with tap water in the field as soon as possible after use to aid in future decontamination). Paint or coatings (e.g., rust) is removed from any part of the equipment that may contact the sample.

Teflon and/or Glass Equipment:

1. Wash the equipment thoroughly with phosphate-free laboratory detergent and tap water. Use a brush to remove any particulate matter or surface film.
2. Rinse the equipment thoroughly with tap water.
3. Rinse the equipment thoroughly with deionized water.
4. Rinse the equipment twice with pesticide-grade isopropanol and allow it to air dry.
5. Wrap the equipment completely with aluminum foil to prevent contamination during storage and/or transport to the field.

Stainless Steel Equipment:

1. Wash the equipment thoroughly with phosphate-free laboratory detergent and tap water. Use a brush to remove any particulate matter or surface film.¹
2. Rinse the equipment thoroughly with tap water.
3. Rinse the equipment thoroughly with deionized water.
4. Rinse the equipment with pesticide-grade isopropanol and allow it to air dry.
5. Wrap the equipment completely with aluminum foil to prevent contamination during storage and/or transport to the field.

Electronic Well Sounding Tapes and/or Measuring Tapes Used to Measure Groundwater Levels:

1. Wash the electronic well sounding tapes and/or measuring tapes with phosphate-free laboratory detergent and tap water.

¹ If the sampling equipment was used to collect samples that contained oil, grease, or other hard-to-remove materials, it may be necessary to rinse the equipment several times with pesticide-grade isopropanol to remove the materials and to steam clean the equipment prior to washing with the laboratory detergent solution. If the field equipment cannot be cleaned using these procedures, it should be properly discarded.

2. Rinse the equipment thoroughly with tap water.
3. Rinse the equipment thoroughly with deionized water. Follow with a rinse with organic-free water.
4. Rinse the equipment with pesticide-grade isopropanol and allow it to dry, (do not rinse plastic tapes with isopropanol).
5. Wrap the equipment in aluminum foil to prevent contamination during storage and/or transport to the field.

Gas Chromatograph

Prior to beginning the screening round, decontaminate the sample probes using a steam cleaner. Five to ten probes should be decontaminated in advance and wrapped in aluminum foil. To avoid cross contamination during soil gas analyses, a decontaminated sample probe will be used at each new location. Care should be taken to ensure that the probe is dry prior to use since moisture in the probe may cause sample interference. Alcohol or other solvent will not be used during the decontamination procedure so as to avoid false positives and other interferences.

After each decontamination process an equipment blank check must be performed on the probe assembly. The equipment blank check consists of zeroing the monitoring instrument, attaching the instrument to the probe, and drawing zero air through the probe. A positive response on the instrument indicates that further decontamination of the probe is necessary. The decontamination and equipment blank procedures should be repeated until no instrument response deviation is noted when the sample probe is on-line.

Ice Chests and Shipping Containers

All ice chests and reusable shipping containers are washed on-site (interior and exterior) with phosphate-free laboratory detergent, rinsed with tap water, and air dried before storage. In the event that an ice chest or shipping container becomes severely contaminated with waste or other toxic material, it is cleaned thoroughly and disposed of properly.

Vehicles

All vehicles used by M&E are steam cleaned or washed under a high pressure water spray at the site vehicle decontamination station at the conclusion of each field trip. If a steam cleaner is not available, then a high pressure sprayer may be used. This routine maintenance minimizes any chance of contamination of equipment, samples, or other sites due to the contamination of vehicles. A thorough interior and exterior cleaning is mandatory at the conclusion of all field investigations. At a minimum, this decontamination procedure consists of washing the exterior of the vehicle with a water/mild detergent solution, rinsing it with tap water, and vacuuming the interior. It is the responsibility of the field team leader to ensure this procedure is followed.

B.4.5 SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

Table B4-3 lists the appropriate sample containers, preservatives, and holding times for the samples collected at the Hunter Army Air Base.

B.4.6 FIELD DOCUMENTATION

A field logbook is maintained for this hazardous waste field investigation project. The logbook is comprised of a bound book with consecutively numbered pages; no pages are skipped when filling in the logbooks. The integrity of field documentation is further ensured by the use of field logbooks containing paper treated to repel the rain or any other aqueous splashings experienced during field documentation. If more than one field logbook is required, they are numbered sequentially.

The front of each field logbook contains the following information:

- . Project name and number
- . Name of the contract under which the investigation is being conducted
- . Date(s) of use

Table B4-3 SAMPLE CONTAINERS, AND PRESERVATION REQUIREMENTS						
Parameter	Matrix	Container	Minimum container size	Min. no. of containers per sample	Preservation	Maximum holding time limit
Metals	Water	Wide mouth polyethylene	1L	1	HNO ₃ to pH <2, Cool to 4°C	6 months mercury 28 days
Metals	Soil	Wide mouth polyethylene	10 oz	1	Cool to 4°C	6 months Mercury 28 days
PAH	Water	Amber glass with teflon lined cap	1L	2	Cool to 4°C	7 days to extraction 40 days to analysis
PAH	Soil	Wide mouth amber glass with teflon lined lid	8 oz	1	Cool to 4°C	14 days
BTEX	Soil	Wide mouth amber glass with teflon liner	4 oz	1	Cool to 4°C	14 days
BTEX	Water	Amber glass with teflon liner and vial with teflon lined septum cap	40 ml	4	HCL to pH <2, cool to 4°C	14 days

The field logbook contains the field technician's diary of all pertinent project activities. Standard information recorded in the field logbook includes: general observations made in the field, identification and calibration of instruments used, and field data. See **Figure B4.5** for an example of typical information that may be included at the beginning of each field logbook. **Figures B4.6 and B4.7** serve as guidelines for field logbook data entries for various sample collection procedures.

FIGURE B4.5. FIELD LOGBOOK INITIAL FIELD INFORMATION

Instrument Calibration

Include a brief description of the calibration procedures used for each instrument utilized in the field and the designated pages on which daily calibration entries are made. The field instruments may include:

- . OVA
- . HNu photoionization detector
- . pH meter
- . Conductivity meter
- . Explosimeter Combustible gas indicator
- . PCB Field Instrument

Decontamination Procedures

Include a brief description of the decontamination procedures used to clean all sampling equipment that may come in direct contact with the sample and designated pages on which daily decontamination procedure entries are made. The equipment may include:

- . Pump
- . Bailer
- . Filtration apparatus
- . Split spoon sampler
- . Hand trowel
- . Measurement tape (used to measure static water level)

Quality Control Sample Preparation

Include a brief description of all QC samples prepared in the field for both aqueous and soil/sediment sampling and the designated pages on which daily QC samples preparation entries are made. The QC samples may include:

- . Trip blank
- . Equipment blank
- . Field duplicates

Field Water

Include a brief description of the field water sources for tap, and distilled water. Outline the daily water usages, the applications of when each water type is used, and the designated pages on which daily use entries are made.

FIGURE B4.6 FIELD LOGBOOK GROUNDWATER MONITORING WELL WATER SAMPLING DATA

Date _____ Location _____

Samplers, Pumps, Bailers, Used _____

Description of sampling location _____

Weather _____

Water parameters/measurements:

pH _____

Conductivity _____

Temperature _____

Depth of well _____

Static groundwater level collection _____

Well water volume _____

Time of bailing: start _____ finish _____

Final groundwater water level _____

Air monitoring (list equipment used as well as the measured reading):

In well _____

In personnel breathing area _____

Sample description _____

Field preservation _____

Decontamination (page number reference):

Bailer _____

Measurement tape _____

Filtration apparatus _____

Pump _____

Sampler _____

Signature (of field team personnel making data entry) _____

FIGURE B4.7 FIELD LOGBOOK SOIL/SEDIMENT SAMPLING DATA

Date _____ Location _____

Samplers Used _____

Drawing of sampling location (including location description as well as the presence of debris, surface sheens, recent excavations, vegetation, etc.)

Weather _____

Soil/sediment sampling parameters:

Description of sample _____

Time of sample collection _____

Depth of water (for sediment sampling) _____

Decontamination (page number reference) _____

Spoons or spatulas _____

Trowel _____

Hand corer _____

Hand auger _____

Bowls _____

Split spoons _____

Photograph frame numbers _____

Signature (of field team personnel making data entry) _____

The field logbook will contain the following information:

- . Date and time of personnel entries on-site, weather conditions, temperature
- . List of start/stop times of all subcontractors hired for activities such as drilling, steam cleaning, well development
- . List of the personnel present on-site during each sampling day to include all M&E personnel, subcontractors, and visitors

- . List of the equipment decontaminated along with a reference to the procedures used
- . Description of the sampling locations in reference to permanent landmarks
- . List of any changes from standard operating procedures, decisions made in the field, and other pertinent information
- . QA/QC samples associated with the samples collected
- . Equipment and/or instrument identification numbers (if available) for those used
- . Sample preservation techniques performed
- . Air monitoring information gathered (e.g., HNu, OVA readings)
- . Level of personnel protection mandated (e.g., Level B, C, D) and record of pertinent time intervals spent by each field team member at each level (e.g., time spent in Level C developing a well, time spent in Level C sampling soil from a backhoe, etc.)
- . Other logs/paperwork used to document activities
- . Instrument calibration information including the instruments calibrated during the day and the individual who performed the calibration (Note: Instrument calibration information should be documented in the field logbook as well as on the instrument calibration log kept with each instrument and serving to document instrument response over time.)
- . List of the samples collected by media (i.e., soil, water, etc.)
- . Comments relative to any problem areas that occurred during the day's activities, their final resolution, and any anticipated impact on the outcome of the field investigation

The last item to be entered at the bottom of each page of the field logbook will be the signature of the person responsible for completing the data entry.

B.4.7 CORRECTIVE ACTION PROCEDURES

Corrective action procedures are initiated in the field when a failure to properly follow project plans or SOPs is recognized. Errors in following sampling protocols or improperly

or inadequately decontaminating sampling equipment may ultimately make it impossible to meet the project data quality objectives. Therefore, the deficiencies noted in the following standard protocol will be addressed immediately upon recognition.

Corrective action procedures for this project may be the result of a field surveillance activity, a direct result of performance or system audits or an observation made by a field team member or other trained personnel. The person recognizing the failure is responsible for bringing the error to the attention of the responsible party (i.e., the person improperly following procedures), making note of the problem in the field logbook, and, if appropriate, orally notifying the Project Manager of the error. If the problem recurs, the person recognizing the deficiency will submit a Corrective Action Report (CAR) (see **Figure B4.8**) to the Program QA Manager. The Program QA Manager, in turn, will file the original CAR, send a memo along with a copy of the CAR to the person in a position to effect the corrective action (be it Metcalf & Eddy or subcontractor personnel), and request a written response to the memo within a specified period of time. The issue addressed in the CAR is subject to follow up by the Program QA Manager during the next field surveillance or audit.

FIGURE B4.8
CORRECTIVE ACTION REPORT

Job No.: _____ Client: _____
Date of Report: _____ Prepared by: _____
NONCONFORMANCE REPORT NO. _____ Date of NCR: _____
Incident Reported by: _____ Date Reported: _____
Description of Cause:

Recommended Action to Prevent Recurrence:

Date Recommended Action to complete: _____
Action Recommended by: _____ Date: _____
Approved: _____ and _____
(Management/date) (Quality Assurance/date)

CORRECTIVE ACTION SENT TO CLIENT:

Orally: Date _____ to whom _____

Written: Date _____ to whom _____

By: _____

B.5 SAMPLE CHAIN-OF-CUSTODY, PACKAGING AND SHIPPING

B.5.1 CHAIN-OF-CUSTODY

The chain-of-custody procedures are initiated in the field following sample collection. The procedures consist of: 1) preparing and attaching a unique sample label to each sample collected, 2) completing the chain of custody form, and 3) preparing and packing the samples for shipment. These procedures are further described in the following sections.

B.5.1.1 Sample Labels and Tags

Field personnel are responsible for uniquely identifying and labeling all samples collected during a field investigation. All labeling will be in indelible/waterproof ink. Any errors are crossed out with a single line, dated, and initialed. Each sample label securely affixed to the appropriate sample container will contain the following information:

- . Client/site name
- . Unique project-specific sample identification number (i.e., station number)
- . Sample location/description number
- . Designation of the sample as a grab or composite
- . Type of analysis to be performed and the name of the laboratory to whom the samples are being sent
- . Sample volume, container type, and the type of chemical preservation used
- . Sampling date and time
- . Initials of the person obtaining the sample

B.5.1.2 Chain-of-Custody Record

A chain-of-custody form (see **Figure B5.1**) is completed for each sample set collected at a sampling location. The form is maintained as a record of sample collection, transfer, shipment, and receipt by the laboratory. The form contains pertinent information concerning sampling location, date, and times; signatures of the sampling team members; types of samples collected along with a unique sample identification number; the number of samples collected and shipped for analysis in each lot; the project name and number; and the name of the laboratory to which the samples are being sent.

B.5.1.3 Transfer of Custody

Samples are accompanied by an approved and completed chain-of-custody form during each step of custody, transfer, and shipment. When physical possession of samples is transferred, both the individual relinquishing the samples and the individual receiving them signs, dates, and records the time on the chain-of-custody form. In the case of sample shipment by an overnight courier, a properly prepared airbill serves as an extension of the chain-of-custody form while the samples are in transit.

B.5.1.4 Laboratory Sample Custody Procedures

Upon sample receipt, the laboratory representative responsible for accepting incoming sample shipment compares the samples received against the list on the chain-of-custody record and examine all the samples to determine if the proper temperature was maintained during shipment. The condition of the samples is documented in a signed, dated and bound log book. If the samples were damaged during transfer, the remaining samples are carefully examined to determine whether they were affected. Any samples so affected are considered

Distribution: Original to Lab Copy 1 to Field Files, Copy 2 to Project Manager
Form 274 (Rev 5/89)

FIGURE B5.1

damaged and the pertinent information noted on the chain-of-custody record (specifying which samples were damaged and that the samples were removed from the sampling program). Field personnel are notified of any sample damage as soon as possible so that resampling can take place or the testing program can be changed.

The laboratory representative will also: (1) verify that sample holding times have not been exceeded, (2) sign and date the chain-of-custody record, (3) list the received samples in the laboratory sample master log-in book which contains the following information:

- . Project identification number
- . Sample numbers
- . Type of samples
- . Date picked up by transfer personnel
- . Date received in laboratory

(4) notify the Laboratory Manager of sample arrival and alert him of any analyses requiring immediate attention due to short holding time, and (5) store the samples according to the requirements of the analytical protocols.

The chain-of-custody records are maintained and filed in the laboratory's sampling log-in area according to contract name and project number, becoming part of the permanent project documentation. All analysts are required to sign for receipt and return of samples obtained for analysis.

B.5.1.5 Laboratory Storage of Samples

Samples are maintained in storage in one of the secured storage refrigerators prior to sample preparation and analysis.

A summary of this procedure is included in the following paragraphs.

Storage refrigerators are maintained at $4^{\circ} \pm 2^{\circ}\text{C}$. The temperature is monitored and recorded

daily in a bound logbook by the sample custodian. During working hours, if equipment failure (compressor failure, door left open, etc.) results in the temperature of the storage refrigerator exceeding the upper or lower control limits, the samples are moved to a suitably controlled storage until the problem has been corrected.

Refrigerator storage is designed to segregate samples to prevent cross-contamination and to prevent sample mix-up. This includes storage of volatile samples separate from semivolatile and inorganic samples. Within the refrigerators, samples are stored according to CLP protocol by batch number for easy retrieval. Analysts request samples for analysis from the sample custodian. Both sign the chain-of-custody form acknowledging transfer of custody to the analyst.

B.5.2 SAMPLE PACKAGING AND SHIPPING

Following sample collection, all samples are brought to an on-site location for batching and paperwork checks. At this central location, like sample types are matched (i.e., solids, liquids, etc.) with similar sample types from all sample locations. Labels and log information are checked to ensure there is no error in sample identification. The samples are packaged to prevent breakage and/or leakage, and the shipping containers are labeled in accordance with the Department of Transportation (DOT) regulations for transport.

As soon as field personnel are ready to transport samples from the field to the laboratory, the laboratory is notified by telephone of the shipment along with the estimated time of arrival. All samples are shipped directly to the laboratory via an overnight carrier. The field team determines whether it is best to directly transport the packages to the shipping office or to arrange for on-site pick-up. For each sample shipment to a specific subcontracting laboratory, an overnight airbill is properly completed. An example of an airbill used when shipping non-hazardous samples to the laboratory is shown in **Figure B5.2**.

In order to ensure safe, secure delivery of all collected samples to the laboratory, the following packaging and shipping procedures have been prepared for this project. All

[illegible]

FIGURE B5.2

procedures presented below are written to comply with applicable DOT regulations for transportation by surface and/or air.

Prior to transport all samples are surveyed visually as well as with the on-site monitoring equipment in order to evaluate the hazardous nature of the samples. Air monitoring devices such as the HNu PI-101 Total Hydrocarbon Analyzer are used to screen every sample. Conductivity and pH meter readings are taken for each liquid sample as well. The collected data are recorded in the field logbook along with the documentation of the shipping procedures utilized. Any pertinent information in regards to particular sample hazards (i.e., any dangers anticipated upon opening of the sample bottle) is included on the chain-of-custody form.

Unless field collected information indicates otherwise, all environmental samples collected are treated as non-hazardous aqueous liquids and non-hazardous soil. Because of the expected non-hazardous nature of the collected samples, packaging and shipping criteria have been designed only to maintain chain-of-custody protocol as well as to prevent breakage of the sample containers. The packaging and shipping procedures are as follows:

- . Place a layer of cushioning material (e.g., bubble wrap) in the bottom of the watertight insulated metal or equivalent strength plastic shipping containers.
- . Wrap the properly labeled and secured glass sample bottles and purgeable vials with plastic bubble wrap. Place the wrapped containers into watertight zip lock bags and seal the bags closed.
- . Place sample bottles (top side up) into the shipping container arranging the bottles so that the glass bottles are surrounded by plastic bottles.
- . Using the necessary packing material, pack the sample bottles to ensure that they do not shift during transport.
- . Fill any void spaces of the shipping container, around and on top of the sample bottles, with ice cubes or chips sealed in plastic bags or with blue ice.
- . Seal the appropriate chain-of-custody form(s) in a zip-lock plastic bag, and tape them securely to the inside of the shipping container lid. A Cooler Receipt Form (see Figure B5.3) is included in each cooler for shipping.

- . Close and lock/latch the shipping container. If the shipping container used is a picnic cooler, tape the drain plug closed to prevent any leakage of water as the ice packs melt during transport.
- . Apply chain-of-custody tape to the shipping containers perpendicular to the seal. Also apply several wraps of strapping or other clear shipping tape to ensure that the lid remains closed if the latch is accidentally released or damaged during shipment. Do not obscure any stickers or labels on the shipping container with the chain-of-custody tape.
- . Place a completed overnight carrier airbill on the lid of the shipping container. Include the name, address, and telephone number of the receiving laboratory and the return address and telephone number of the shipper on the airbill.
- . Place a "This End Up" label on all four sides of the shipping container.
- . Each shipping container must not weigh more than 150 pounds if it is to be shipped overnight by Federal Express.

B.5.3 DOCUMENTATION

A simple program designed to ensure that field-performed analyses yield valid, useful data is summarized in **Table B5-1**. In all cases, the Field Team Leader maintains a concise, detailed site logbook containing accounts of all field activities and actions taken as well as documentation of observations made. The site logbook is the master field investigation document.

All sampling procedures, instrument calibration, and information pertinent to sampling conditions, progress, and field data collection are documented following a prescribed set of guidelines. The documentation serves as a permanent and traceable record of all activities related to a **specific** field investigation project. The record is legible and accessible to allow ease in verifying sampling activities and addressing future questions which may arise concerning such issues as sample integrity, sample traceability, etc.

FIGURE B5.3

COOLER RECEIPT FORM

Date Received _____ Project _____

Number of Coolers _____ Cooler Numbers _____

Date Checked In _____ By (sign) _____

1. Shipping Slip If yes, carrier and bill number _____	Yes	No
2. Custody seals on cooler	Yes	No
3. Custody Seals intact	Yes	No
4. Chain-of-Custody in plastic	Yes	No
5. Chain-of-Custody filled out properly	Yes	No
6. Lab signed Chain-of-Custody properly	Yes	No
7. Enough ice and packing Type of packing _____	Yes	No
8. All bottles sealed	Yes	No
9. Any bottles broken	Yes	No
10. Labels in good condition	Yes	No
11. Labels agree with COC	Yes	No
12. Correct containers used	Yes	No
13. Preserved properly	Yes	No
14. Sufficient sample	Yes	No
15. Bubbles absent from VOA	Yes	No
16. Client called Details:	Yes	No
17. Comments:		

**TABLE B5-1. FIELD SAMPLING TEAM DOCUMENTATION OBJECTIVES TO
ENSURE VALID DATA COLLECTION**

Objective	Action	Responsible Person
Verify sample and location information conforms to conditions and requirements specified	Review labeled samples and in-process samples using daily sample inventory	Field sampling team
Verify incoming field data and sample completeness	Maintain daily count of incomplete items	Field sampling team
Verify completeness of field log books	Review daily	Field team leader
Review field calibration criteria and record test calibration acceptance	Perform as necessary	Field team leader
Ensure all data forms are properly completed	Review and check off during each sample collection	Field team leader
Verify all field generated QC samples were collected as required	Review requirements and confirm sample collection	Field team leader

All samples are identified by a unique sample identification number which includes the project number hyphenated with a consecutive numbering system specific to the samples collected for that project. This identification number is used to ensure sample traceability and identifies this particular sample.

Also, within a specific project, all samples are identified using a numbering system to cross-reference descriptive sample information. The cross-index is designed and maintained by the field team leader. The sample location number identifies the sample.

Both the unique sample identification number (sample number) and project sample identification number (sample location) are recorded on the chain-of-custody forms accompanying each sample to the laboratory for sample analysis.

B.6 ANALYTICAL METHODS AND PROCEDURES

The analytical laboratory for this project is Savannah Laboratories in Tallahassee, Florida. The contract laboratory has also been validated by USACE Hazardous, Toxic, and Radioactive Waste Mandatory Center of Expertise (HTRW MCX). The QA laboratory for this project is South Atlantic Division Lab in Marietta, Georgia (see Section B4.1.6). The address for the contract laboratory is:

Savannah Laboratories
ATTN: Sample Custodian
2846 Industrial Plaza Drive
Tallahassee, Florida 32301
(904) 878-3994

B.6.1 STANDARD ANALYTICAL METHODS

The standard analytical methods to be utilized for the investigation of samples collected are summarized in **Table B6-1**. Further information on the procedural techniques is included in the method references listed.

B.6.2 PROJECT SPECIFIC DETECTION LIMITS

Detection limits are determined using procedures outlined in Test Methods for Evaluating Solid Waste. **Attachment 1** list the Practical Quantitation Limits (PQLs) expected to be achieved by the laboratory during analysis of environmental soil samples and groundwater at the Hunter Army Airfield. These are the lowest levels that a laboratory can be expected to report reproducible quantitative results. The method detection limit (MDL) is the lowest level that a laboratory can achieve. Analysis of PAH in water using Method 8310 will be reported, if detected, below the PQL and flagged with a "J" to indicate that the compounds were detected below the PQL and at or above the MDL.

TABLE B6-1 STANDARD ANALYTICAL METHODS		
Parameter	Method No.	Reference
LABORATORY ANALYSES:		
RCRA metals	EPA 3050/6010, 7060, 7421, 7740	<u>Test Methods for Evaluating Solid Waste</u> , SW-846, 3rd ed., USEPA, Nov. 1986.
Benzene, toluene, ethylbenzene, xylene (BTEX)	EPA 5030/8020	<u>Test Methods for Evaluating Solid Waste</u> , SW-846, 3rd ed., USEPA, Nov. 1986.
Polynuclear Aromatic Hydrocarbons (PAH)	soil - EPA 3550/8100 water - EPA 8310	<u>Test Methods for Evaluating Solid Waste</u> , SW-846, 3rd ed., USEPA, Nov. 1986.
FIELD ANALYSES:		
Temperature Specific Conductivity pH	EPA 170.1 EPA 120.1 EPA 150.1	<u>Methods for Chemical Analysis of Water and Wastes</u> , EPA-600/4-79-020, March 1983.

B.6.3 LABORATORY STANDARDS AND REAGENTS

Laboratory standards and reagents are obtained from the following suppliers:

- For organic analysis, analytical standards are obtained from EPA repositories, USATHAMA, NBS, Supelco, Inc. (Bellefonte, PA), and Ultra Scientific (Hope, RI). Spectral grade and reagent grade solvents and reagents are obtained from Fisher Scientific, Burdick and Jackson, and American Scientific. Also, chemicals are purchased from various suppliers for use as analytical standards.
- For inorganic analysis, standard reference materials are obtained from the National Bureau of Standards and Spex. Spectral grade and reagent grade standards are obtained from Spex, Fisher, and Ricca.

All standards and laboratory reagents, with the exception of common laboratory solvents, are dated upon receipt. The preparation and use of all standards are recorded in bound laboratory notebooks which document standard traceability to EPA or NBS standards. Additional information recorded includes the date of preparation, concentration of the prepared standard, and the name of the preparer.

B.7 DATA REDUCTION, VALIDATION AND REPORTING

B.7.1 LABORATORY PROCEDURES

This section describes data reduction, and reporting procedures which are used by the subcontract laboratory participating in this project. A flow chart outlining the steps which occur during the data review process is shown in **Figure B7.1**. Primary responsibility for implementation of these procedures within the laboratory resides with the Laboratory Manager. The Laboratory Manager conducts the final review and approves of all data reports before transferring the information to the Point of Contact (POC) or designated Project Manager. The POC in turn, communicates with the M&E Project Manager and QA Project Officer in an effort to review the laboratory data for compliance with CDAP specifications. Final responsibility for data evaluation and reporting of data resides with the M&E Project QA Officer.

Data processing begins with the collection of data and continues through the reduction and validation processes to the final data reporting procedure. Discussion of this process is outlined in the following sections.

B.7.1.1 Data Collection

At the analytical laboratory, analytical data are usually recorded in bound laboratory notebooks. Data recorded shall at a minimum contain: a unique sample identification number, a project sample identity, the analytical method used, the analyst's signature and date of analysis, reagent concentrations, instrument settings (where applicable), raw data, and any comments or descriptions pertinent to the analysis.

The laboratory analysts must sign and date all notebook entries on a daily basis. The notebooks shall be available for periodic review by the appropriate laboratory section manager or during an audit of the laboratory section by client representatives.

DATA REVIEW FLOWCHART

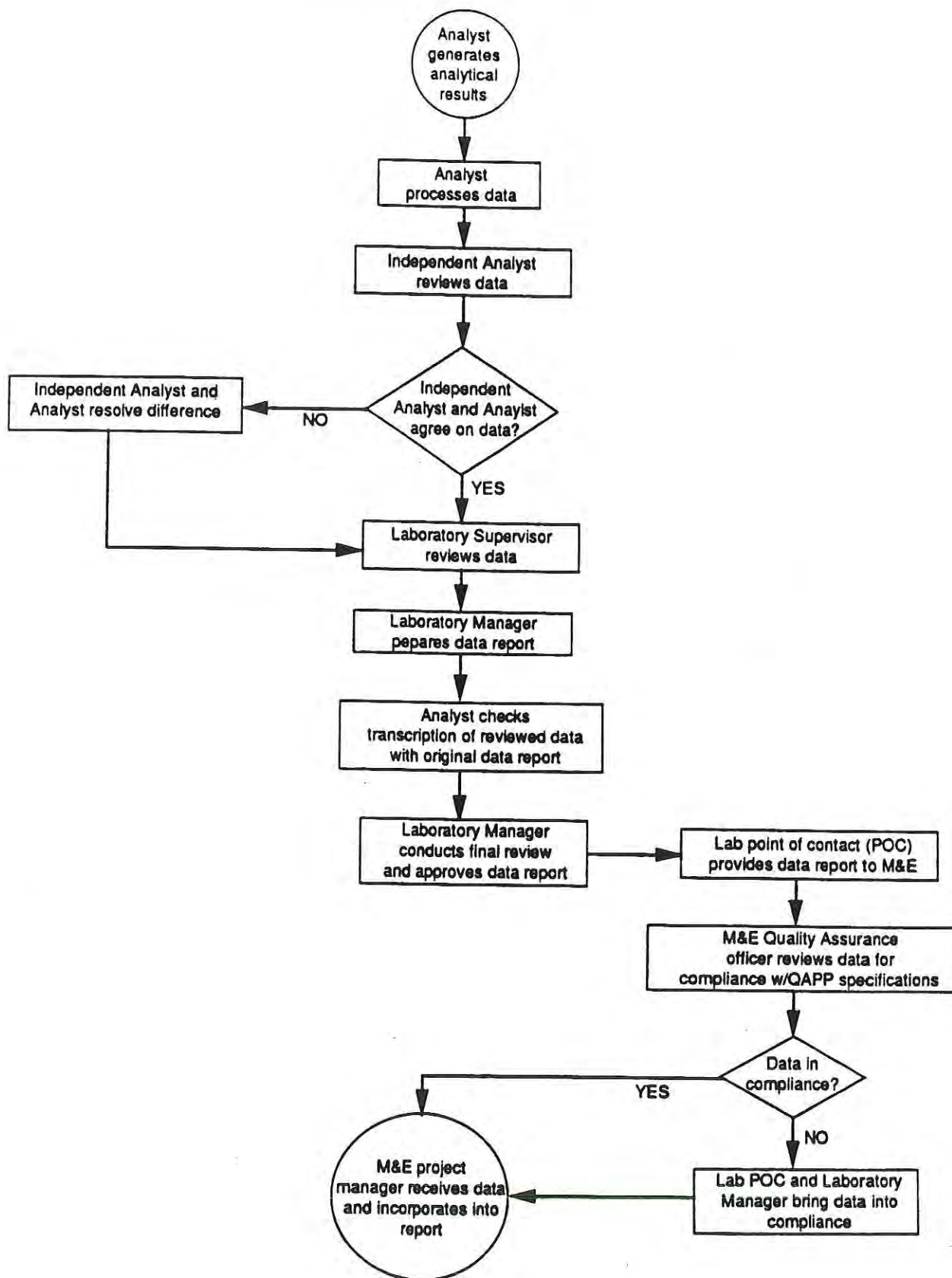


FIGURE B7.1

Copies of all instrument outputs (chromatograms, strip charts, etc.) and computer-generated data are maintained in a project-specific file and can be easily available for review if needed at a later date to aid in data evaluation. Raw data will be held and available, if requested, for a period of 2 years after sample analysis.

The laboratory information management system has precomputerized internal checks used to avoid errors in the laboratory data collection process and to ensure analytical accuracy.

These checks may include instrumental calibration and performance evaluation; initial and continuing calibration verification; analysis of matrix spikes and matrix spike duplicates, surrogate spike recoveries, duplicate samples, and field, method, and equipment blanks; and verification of analysis performance within the allotted sample holding time.

All of the analytical data will be produced at DQO Level III. The data will go through a data evaluation process checking all the QC summary data.

B.7.1.2 Laboratory Data Reduction

Data reduction includes the process of validation, reduction, and verification. Data reduction may also include statistical and mathematical analysis of the raw data in order to reduce the size or dimensionality of the data set.

Initial Data Reduction. Initial data reduction is performed by the individual analysts and consists of calculating concentrations in samples from the raw data obtained from the analytical instruments. The complexity of the data reduction depends on the specific analytical method and the number of discrete operations (extractions, dilutions, and concentrations) involved in obtaining a sample that can be measured.

Initial Data Validation. Validation is achieved by ensuring that the internal checks in the data collection system are addressed properly. Chromatographic determinations are screened

manually according to CLP guidelines. The reviewer makes professional judgments and expresses concerns and comments on the validity of this data package.

Data Verification. The verification process addresses the chain-of-custody protocol of each sample (as described in NEIC Policies and Procedures EPA-330/9-78-001-R, revised February 1983) which sets guidelines for sample traceability from field sampling through data collection and validation. This protocol verifies that the data reported for each sample corresponds to the appropriate site sampled. A software package may be used to retrieve appropriate information from the computer mainframe and produce a concise and accurate flowchart of sample tracking information. The use of such a computer package eases the task of manual review and time constraints of informational access.

B.7.1.3 Laboratory Data Review

System reviews are performed at all levels. The individual analyst constantly reviews the quality of data through calibration checks, quality control sample results, and performance evaluation samples. These reviews are further verified by an independent analyst or unit leader prior to data submission to the Section Managers or the Analytical Project Manager.

The final routine review is performed by the section managers or the analytical project manager prior to reporting the results to the client. Non-routine audits are performed by regulatory agencies and client representatives.

B.7.1.4 Laboratory Data Reporting

Initial Laboratory Data Report. Reports will contain final results (uncorrected for blanks and recoveries), methods of analysis, levels of detection, surrogate recovery data, and method blank data. In addition, special analytical problems, and/or any modifications of referenced methods are noted. The number of significant figures reported must be consistent with the limits of uncertainty inherent in the analytical method; most analytical results are reported to no more than two (2) significant figures. Data are normally reported in units

commonly used for the analyses performed. Concentrations in liquids are expressed in terms of weight per unit volume (e.g., micrograms per liter). Concentrations in solid or semi-solid matrices are expressed in terms of weight per unit weight of sample (e.g., micrograms per gram).

Report Review. Review of data reports is required to verify that information reported by the laboratory corresponds with processed analytical results. Review is only required of the data as it is presented for issuance. Preparation of the report is the responsibility of the Department Supervisor or a designated representative.

After the draft data report is prepared, the reported results are checked against the reviewed processed data so that transcription errors do not occur. The checker is not required to be independent of the work because only the transcription from the reviewed data to the data report is being checked.

The draft data report is reviewed to ensure that the items cited for data presentation in Section 3.0 are complete and correct.

If data printouts, such as chromatograms or Gas Chromatograph/Mass Spectrometer (GC/MS) data processing, are included in the data report, review is not required for the data printout. If computer output is used directly as the data report without further transcription, only the input requires review.

After the reviewer has checked the data report, the report is given to the Program Administrator or designated representative for final review. This step is not intended to verify any reported data since it serves as a final check to determine that the report is complete and meets project requirements. The data report is approved for issue by the Laboratory Manager.

Final Laboratory Data Report. The final presentation is checked in accordance with data verification requirements specific for this project and approved by the Laboratory Manager.

Data is presented in a tabular format whenever possible and is formatted in the standard lab report required by DQO Level III.

As a minimum, data presentation will include:

- . A case narrative describing any problems encountered during analysis
- . Sample identification number used by the laboratory and/or the sample identification provided to the laboratory, if different than identification used in the laboratory
- . Chemical parameters analyzed, reported values, and units of measurement
- . Detection limit of the analytical procedure if the reported value is less than the detection limit
- . Data for a chemical parameter reported with consistent significant figures for all samples
- . Results of QC sample analysis such as method blank, trip blank, equipment blanks, surrogate data, matrix spike duplicate and field or lab duplicates
- . Achieved accuracy and precision of data compared to required ranges
- . Footnotes referenced to specific data if required to explain reported values

Along with the case narrative and the analytical results, a letter of transmittal is issued and includes:

- . Name(s) of person(s) receiving the data
- . Name of person transmitting the data
- . Documentation of whether the chain-of-custody was incorrect or not provided; whether any samples were damaged in shipment; whether sample containers were inappropriate for analysis; if samples were not preserved; and whether the quantity of sample provided was adequate for proper analysis
- . Brief discussion of samples analyzed and the analytical program
- . Discussion of any apparent data anomalies

- . Discussion of any analytical difficulties and follow-up actions taken to remedy such difficulties

DQO Level III QC also requires the reporting of the data associated with the laboratory analysis of method blanks, blank/spikes, surrogates, matrix spike/matrix spike duplicates, and initial and continuing calibration standards.

B.7.2 METCALF & EDDY DATA EVALUATION PROCEDURES

The data evaluation criteria used by M&E in reviewing the analytical data from the Hunter Army Airfield will include: data editing, screening, checking, auditing, verification, certification, and review. M&E will indicate in writing that the data have been evaluated using Level III Data Validation Guidelines as presented in USEPA Functional Guidelines for Organic Data Review and Evaluation of Inorganics Analysis.

B.8 LABORATORY QUALITY CONTROL

All analyses performed in support of this investigation will use the standard laboratory methods and procedures detailed in Section B6 and Section B7. The QC program developed by M&E uses both known and unknown (or "blind") QC samples, field blanks, trip blanks, and replicate aliquot samples (duplicates). The various types of field QC samples are described in Section B4.1.2. Laboratory QC samples, the type and frequency of analysis for each QC sample is shown in **Table B8-1**. The laboratory control limits for matrix spikes are listed in **Attachment 1**.

B.8.1 LABORATORY GENERATED QC SAMPLES

The laboratory will comply with the QC sample requirements of each analytical method specified. The QC sample types generally required by the analytical methods are described below.

Laboratory Control Standard

One (1) laboratory control standard (LCS) is analyzed for all parameters for each batch of samples tested for organics. The LCS is routinely used to establish that an instrument or procedure is precise and accurate. The analytical results of the LCS is recorded in the instrument logbook and on the control chart; results must be within the acceptable control limits. A LCS solution is prepared by adding known quantities of an EMSL-Cincinnati Standard, a NBS Standard Reference Material, or a reference-traceable stock material to deionized water or the solvent of interest. A LCS solution is typically carried through the entire sample preparation and analysis procedure. A laboratory control standard is run on soil samples when a suitable standard is available in a similar matrix.

TABLE B8-1
SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES FOR
LABORATORY GENERATED QC SAMPLES

Type	Purpose	Frequency	Criteria	Corrective Action
Method Blank	Verifies clean reagents, instrument systems and lab environment	1 per 12-hour analysis day per sample matrix	No compound of interest > 5 times MDL	Reanalyze; if second blank exceeds system's criteria, clean and recalibrate system; document corrective action
System Performance Check (for GC/MS compounds)	Checks performance of analytical system	When sample matrix interference is suspected	≥ 0.05 response factor % recovery specific to method	Check system; recalibrate; reanalyze
Laboratory Replicates (including matrix spike duplicates)	Precision check on analytical method	1 per batch of 20 samples as supplied from the field	RPD ¹ as outlined in Tables 3.1 and 3.2	Compare with field duplicates; check for matrix interferences
Calibration Check Sample	Verifies calibration curve	≥ 1 per analysis day per sample matrix	$\geq 20\%$ initial calibration	Recalibrate; check system
Matrix Spikes and Duplicates (MS/MSD)	Checks recovery from real matrix	Performed at 5 % frequency of samples or 1 in 20 samples	Specified in analytical methods	Qualify data or recalibrate, reanalyze, and document corrective action
Surrogate Standards	Determine recoveries, control limits, matrix effects	All GC/MS samples and all GC samples	As specified in analytical methods	Reanalyze samples; qualify or reject data
Laboratory Control Samples (for AA, ICP)	Verifies analyst proficiency with method and instrumentation	1 per sample batch	$< 20\%$ RSD ³ $\pm 15\%$ recovery	Check system; require additional operator training

¹ RPD - Relative Percent Difference of Duplicate Measurements

² MDL - Method Detection Limit

³ RSD - Relative Standard Deviation of at least 5 replicates

Calibration Check Sample

One (1) calibration check sample (CCS) is analyzed for every 10 samples analyzed sequentially for all project-specific parameters. A CCS is chosen as one of the mid-range working calibration standards that is reanalyzed periodically throughout the sample analysis to verify that the original calibration is still valid. CCS's are not used in organic analysis by CLP protocols. Instead, a full continuing calibration curve is run for every 12 hours of analysis.

Method/Reagent Blank

One (1) method/reagent blank is analyzed with each sample batch tested. A method blank is comprised of laboratory-pure, analyte-free water carried through the entire sample preparation and analysis procedure. Analysis of the method blank provides a check of the background contamination due to sample preparation procedures.

Laboratory Replicates

One sample per batch of twenty (20) samples analyzed for project required metals analysis shall be analyzed in replicate. A replicate sample is produced by dividing a single collected sample into two equal parts for the purpose of determining analytical precision.

Matrix Spike/Matrix Spike Duplicates

Matrix spikes and matrix spike duplicates are performed for every 20 samples, or once for every group of less than 20 samples. Matrix spikes and matrix spike duplicates are performed for each group of samples having a similar concentration range and matrix composition. The analyte spike is added prior to digestion/distillation of the sample. If the spike recovery is not within the acceptable criteria limits specific to this project, the data of those samples associated with that spiked sample is handled appropriately.

Surrogate Spikes

All samples collected that require organic analysis by GC are spiked with an appropriate surrogate standard(s) prior to sample preparation. The surrogate standard(s) will encompass the full range of types of organics to be analyzed in the sample and shall also serve as checks on any matrix interference exhibited by the samples. If the percent recoveries of the surrogates are outside the acceptable project-specific criteria limits, the associated samples may be reanalyzed if the problem appears to be due to lab error. An independent analyst or unit leader will determine whether to reanalyze the sample or qualify the data.

Documentation and Review of Quality Control Activities

The analyses of quality control samples are entered chronologically onto quality control charts specifically maintained for each analytical procedure. These control charts are labeled with upper and lower warning and control limits, the analysis which is being charted and the value (e.g., % recovery, % RPD, etc.) which is being monitored. Control charts are updated monthly and are used to demonstrate method performance and help identify system errors.

The laboratory documents its QC activities by means of discrete sections of their report that include:*

- . A case narrative describing any problems encountered with method blanks, matrix spike, and matrix spike duplicates, surrogate recoveries, initial calibration, and continuing calibration
- . Compilation of method blanks data
- . Compilation of matrix spike and matrix spike duplicate
- . Surrogate recoveries data
- . Initial calibration and continuing calibration information

* All QA activities are documented in the laboratory but are only delivered upon request of the contracting agency. Delivery of the entire QA/QC package must be contracted prior to sample analysis.

B.8.2 PREVENTIVE MAINTENANCE

The ability to generate valid analytical data requires that all analytical instrumentation be properly and regularly maintained. The laboratory maintains all major instruments. These instruments receive not only routine preventative maintenance but also emergency repair service. The elements of the maintenance program are discussed in the following sections.

B.8.2.1 Instrument Maintenance Logbooks

Each analytical instrument is assigned an instrument logbook in which is recorded all maintenance activities, problems, and repairs. The information entered in the instrument logbook includes:

- . Date of service
- . Person performing service
- . Type of service performed and reason for service
- . Replacement parts installed (if appropriate)
- . Miscellaneous information

If service is performed by the manufacturer, a copy of the service record is taped into the page facing the notebook page where the above information is entered.

B.8.2.2 Instrument Calibration and Maintenance

Preventive maintenance and calibration by manufacturer service representatives are provided on a routine basis. The maintenance procedures and frequencies for major analytical instrumentation are given in Table B8-2.

**TABLE B8-2
PREVENTIVE MAINTENANCE REQUIREMENTS FOR LABORATORY EQUIPMENT**

Instrument	Items Checked/Serviced	Frequency	Documentation	Reference
Atomic Absorption Spectrophotometer	3-point calibration performed	When serviced by repairman	Logbook	Manufacturers' Manual
	Clean burner head	Each shift used		
	Clean nebulizer	Each shift used		
	Tune optics	Each shift used		
	Check lamps	Each shift used		
Inductively Coupled Plasma Spectrometer	Check electronics	As required	Logbook	Manufacturers' Manual
	Check pump	As required		
	Replace tubing	As required		
	Sample introduction system	Each analysis day		
	Clean Optics	As required		
GC/MS	Check pumps	As required	Logbook	Manufacturers' Manual
	Check electronics	As required		
	Replace column	As required		
	Clean source	As required		
	Change glass wool plug	As required		
GC	Clean insert	As required	Logbook	Manufacturers' Manual
	Replace septa	Each analysis day		
	Gases (purity checks)	New cylinders		
	Flow controller check	Semi-annually		
	Replace column	As required		
Analytical Balance	Gases (purity checks)	New cylinders	Logbook	Manufacturers' Manual
	Flow controller check	Semi-annually		
	Replace septa	Each analysis day		
	Internal weight training gears, electronics	Annual or semi-annually		

B.8.2.3 Spare Parts

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment downtime. This inventory should emphasize those parts (and supplies) which:

- . Are subject to frequent failure
- . Have limited useful lifetimes
- . Cannot be obtained in a timely fashion should failure occur

B.8.3 CORRECTIVE ACTION PROCEDURES

Corrective action procedures in the laboratory are normally initiated by the analytical laboratory personnel (and their supervisors) directly involved with the analysis of the samples and the implementing of the procedures presented in the Laboratory Quality Assurance Plan (QAP). Quality control records for daily instrument calibration, replicate analyses, and surrogate analysis are utilized to indicate the necessity for corrective action. Control records are established for each procedure indicating upper and lower limit ranges. At the point when the control records indicate a determination is outside the warning ranges, investigation as to the cause is initiated.

The laboratory analyst verifies that all quality control procedures are followed and that the results of the analysis of quality control samples are within the allowable acceptance criteria. This requires that the analyst assess the correctness of all of the following items as appropriate:

- . sample preparation procedure
- . initial calibration
- . calibration verification
- . method blank result
- . duplicate analysis
- . laboratory control standard
- . fortified sample result

If the assessment reveals that any of the QC acceptance criteria are not met, the analyst immediately assesses the analytical system to correct the problem. The analyst notifies the appropriate supervisor and QA Manager of the problem and, if possible, identifies potential causes and corrective action. A summary of corrective action procedures is outlined in Table B8-1. In turn, the Lab QA Manager notifies the prime contractor if the quality of data deliverables has been compromised or if the laboratory has determined that the problem is field related.

When the appropriate corrective action measures have been defined and the analytical system is determined to be "in control", the analyst documents the problem and the corrective action. Copies of the form summarizing these actions are provided to the Laboratory Section Manager and QA Coordinator.

Data generated concurrently with an out-of-control system is evaluated for usability in light of the nature of the deficiency. If the deficiency does not impair the usability of the results, data is reported and the deficiency is noted in the case narrative. Where sample results are impaired, the Laboratory Project Manager is notified and appropriate corrective action (e.g., reanalysis) is taken.

The routine analytical corrective action procedures within the laboratory are documented and may result in the reanalysis of samples or recalibration of analytical instrumentation. Routine corrective action takes place as necessary and does not require the approval of the M&E Quality Assurance Manager. However, should significant events occur such as sample breakage or loss, exceeding sample holding times, extensive instrumentation downtime, or changes or additions to sample clean-up for removal of interferences, the laboratory reports these events to M&E immediately.

B.9 CHEMICAL QUALITY CONTROL DELIVERABLES

The following Chemical Quality Control Reports (CQCR) will be submitted during the project:

- . Daily Quality Control Report (DQCR) during field activities which will include:
 - Reference the sections in the CDAP for sampling and analysis
 - Weather conditions
 - Information concerning all field sampling, field samples, sample shipping, etc.
 - Deviations from the CDAP
 - Problems identified, corrective actions and verbal/written instructions from Government personnel
 - Documentation that the sampling, packaging and shipping elements for samples were checked using the Government "Cooler Receipt Form."
 - Indicate the person responsible for the DQCR and the method for forwarding the DQCR to the Government Project Manager or Government Inspector.
 - Inspections made and the results
 - Calibrations performed and the calibration procedures for the instruments used.
- . DQCR from the contract laboratory, if applicable.
- . Non-routine occurrences: including problems identified, corrective actions taken, and any instructions from the USACE Commanding Officer.
- . **Data Report to the QA Laboratory** including sample blank and internal QC results **such as MS/MSD**. Data reporting will include the following:
 - **Sample IDs.** M&E shall prepare a tabular presentation which matches contract laboratory sample IDs to QA laboratory sample IDs. This table identifies all Field Duplicates and match their corresponding field samples where applicable.

- Sample receipt. M&E will complete and submit a "Cooler Receipt Form" to the QA Lab (SADL) with all shipments to note problems in sample packaging, chain-of-custody, and sample preservation.
- General Organic and Inorganic Reporting: For each analytical method run, the subcontractor laboratory will report all analytes for each sample as a detected concentration or as less than the specific limits of concentration. Generally all samples with out-of-control spike recoveries attributed to matrix interferences will be designated as such. All soil samples will be reported on a dry-weight basis with percentage moisture also reported unless otherwise approved. The subcontractor laboratory will also report dilution factors for each sample as well as extraction and analysis date.
- Internal QC Reporting: Minimally, internal QC samples will be analyzed at rates specified in the specific methods or higher rates if required to meet project specific DQOs.
- Laboratory Blanks (Method Blanks and Instrument Blanks). All analytes will be reported for each laboratory blank. All non-blank sample results will be designated as corresponding to a particular laboratory blank in terms of analytical batch processing.
- Surrogate Spike Samples: Surrogate Spike Recoveries are reported with all organic method reports where appropriate (i.e. when method requires surrogate spikes). The report also specifies the control limits for surrogate spike results as well as the spiking concentration. Any out-of-control recoveries (as defined in the specified method) will result in the sample being re-run (both sets of data are to be reported) at no additional cost to the government.
- Matrix Spike Samples: Matrix Spike Recoveries are reported for all organic and inorganic analyses. All general sample results are designated as corresponding to a particular matrix spike sample. The report indicates what field sample was spiked even if it was not a USACE project sample. The report also specifies the control limits for matrix spike results for each method and each matrix.
- Laboratory Duplicates and/or Matrix Spike Duplicate Pairs: RPD is reported for all duplicate pairs as well as analyte/matrix specific control limits.

Quality Control Summary Report summarizing the DQCR which will include the following:

- A Project Description, elements of the report organization and site description.

- A summary of laboratory quality control activities, a summary of any deviations from planned activities, and a summary of the evaluation of the data quality of each analysis and matrix.
- A summary of planned field quality control activities, and a summary of the evaluation of the quality of the sampling.
- An assessment of sampling and analysis techniques, an evaluation of the data quality of each matrix and parameter, and an evaluation of the usability of the data.
- A summary of field or analytical procedures that were changed or modified to better characterize chemical contamination and future work efforts.
- DQCRs will be consolidated and summarized.

APPENDIX B

LIST OF REFERENCES

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USEPA, RCRA Facility Investigation Guidance, Waste Management Division, Office of Solid Waste, OSWER Directive 9502.00-6D, EPA 530/SW-89-031, May 1989.

Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Branch; USEPA Region IV, Environmental Services Division, February 1991.

Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, Hazardous Site Evaluation Division, USEPA, July 1, 1988.

National Functional Guidelines for Organic Data Review, USEPA Contract Lab Program, Draft December 1990, Revised June 1991.

ATTACHMENT 1

Laboratory Analytical Methods, QA Objectives, and
Practical Quantitation Limits for Water and Soil

TABLE 5.1. LABORATORY ANALYTICAL METHODS, QA OBJECTIVES AND METHOD DETECTION LIMIT (MDL) FOR WATER AND OTHER LIQUIDS

PARAMETER	METHOD (Prep)	REFERENCE	ACCURACY* (% Rec)	PRECISION* (% RPD)	MDL** (ug/L)	Reporting Limit (ug/L)
Aluminum	6010(3010)	3/2	75-125	0-20	27	200
	200.7	3/2	85-115	0-20	20	200
	Saltwater	5	50-140	0-40	2.5	10
	CLP	45	80-120	0-20	200	200
Antimony	6010(3010***)	3/2	75-125	0-20	15	50
	200.7	3/2	85-115	0-20	15	50
	7041(3005)	3/2	75-125	0-20	0.65	10
	CLP	45	80-120	0-20	60	60
	204.2	3/2	80-120	0-20	5.0	5.0
Arsenic	200.7 (4X)	3/2	85-115	0-20	10	25
	6010(3010)	3/2	75-125	0-20	26	100
	200.7	3/2	85-115	0-20	23	100
	7060(3020***)	3/2	75-125	0-20	1.7	10
	206.2	3/2	80-120	0-20	3.6	10
	206.3/7061	3/2	60-140	0-40	1.4	2.0
	CLP	45	80-120	0-20	10	10
Barium	6010(3010)	3/2	75-125	0-20	1.2	10
	200.7	3/2	85-115	0-20	0.68	10
	CLP	45	80-120	0-20	200	200
Beryllium	6010(3010)	3/2	75-125	0-20	2.3	5.0
	200.7	3/2	85-115	0-20	0.95	5.0
	7091(3020)	3/2	75-125	0-20	1.2	5.0
	CLP	45	80-120	0-20	5.0	5.0
	210.2	3/2	80-120	0-20	1.3	5.0
Boron	6010(3010***)	3/2	75-125	0-20	13	50
	200.7	3/2	85-115	0-20	13	50
Cadmium	6010(3010)	3/2	75-125	0-20	3.3	5.0
	200.7	3/2	85-115	0-20	2.8	5.0
	7131(3020)	3/2	75-125	0-20	0.065	1.0
	Saltwater	5	60-140	0-40	0.050	0.050
	CLP	45	80-120	0-20	5.0	5.0
	213.2	3/2	80-102	0-20	0.25	1.0
Calcium	6010(3010)	3/2	75-125	0-20	26	500
	200.7	3/2	85-115	0-20	48	500
	CLP	45	80-120	0-20	5000	5000
Chromium	6010(3010)	3/2	75-125	0-20	7.6	10
	200.7	3/2	85-115	0-20	4.6	10
	7191(3020)	3/2	75-125	0-20	0.34	10
	CLP	45	80-120	0-20	10	10
	218.2	3/2	80-120	0-20	2.5	10
Chromium, hexavalent	7196	2	75-125	0-20	2.2	10
Cobalt	6010(3010)	3/2	75-125	0-20	3.6	10
	200.7	3/2	85-115	0-20	2.2	10
	CLP	45	80-120	0-20	50	50
Copper	200.7 (4X)	3/2	85-115	0-20	2.5	6.0
	6010(3010)	3/2	75-125	0-20	18	25
	200.7	3/2	85-115	0-20	19	25
	220.1/220.2(3020)	3	80-120	0-20	0.57	10
	Saltwater	5	60-140	0-40	0.50	0.50
	CLP	45	80-120	0-20	25	25
Iron	6010(3010)	3/2	75-125	0-20	15	50
	200.7	3/2	85-115	0-20	7.8	50
	236.2(3020)	3	75-125	0-20	2.5	10
	Saltwater	5	60-140	0-40	2.0	2.0
	CLP	45	80-120	0-20	100	100

TABLE 5.1. LABORATORY ANALYTICAL METHODS, QA OBJECTIVES AND METHOD DETECTION LIMIT (MDL) FOR WATER AND OTHER LIQUIDS

PARAMETER	METHOD (Prep)	REFERENCE	ACCURACY (% Rec)	PRECISION (% RPD)	MDL** (ug/L)	Reporting Limit (ug/L)
Lead	6010(3010)	3/2	75-125	0-20	11	50
	200.7	3/2	85-115	0-20	11	50
	239.2	3/2	80-120	0-20	2.0	5.0
	Saltwater	5	60-140	0-40	0.30	0.30
	CLP	45	80-120	0-20	3.0	3.0
	7421(3020)	3/2	75-125	0-20	0.33	5.0
Lithium	3500-Li B	4	80-120	0-20	28	100
Magnesium	6010(3010)	3/2	75-125	0-20	36	500
	200.7	3/2	85-115	0-20	25	500
	CLP	45	80-120	0-20	5000	5000
Manganese	6010(3010)	3/2	75-125	0-20	2.1	10
	200.7	3/2	85-115	0-20	0.73	10
	CLP	45	80-120	0-20	15	15
Mercury	7470	3/2	75-125	0-20	0.087	0.20
	Saltwater	5	60-140	0-40	0.025	0.10
	CLP	45	80-120	0-20	0.20	0.20
	245.1	3/2	80-120	0-20	0.20	0.20
Molybdenum	6010(3010)	4/2	75-125	0-20	6.4	10
	200.7	4/2	85-115	0-20	4.5	10
Nickel	200.7 (4X)	3/2	85-115	0-20	3.6	10
	6010(3010)	3/2	75-125	0-20	6.5	40
	200.7	3/2	85-115	0-20	5.0	40
	249.2	3	75-125	0-20	0.25	10
	Saltwater	5	60-140	0-40	1.4	2.0
	CLP	45	80-120	0-20	40	40
Phosphorus	200.7***	3/2	85-115	0-20	50	50
	6010*** (3010***)	3/2	75-125	0-20	50	50
Potassium	6010(3010)	3/2	75-125	0-20	670	1000
	200.7	3/2	85-115	0-20	85	1000
	7610(3010)	3/2	75-125	0-20	25	100
	CLP	45	80-120	0-20	5000	5000
	258.1	3/2	80-120	0-20	25	100
Selenium	6010(3010)	3/2	75-125	0-20	91	500
	200.7	3/2	85-115	0-20	20	500
	270.2	3/2	80-120	0-20	3.9	5.0
	270.3/7741	3/2	60-140	0-40	0.25	2.0
	CLP	45	80-120	0-20	5.0	5.0
	7740(3020***)	3/2	75-125	0-20	1.7	10
Silica	6010(3010***)	3/2	75-125	0-30	120	500
	200.7	3/2	85-115	0-20	120	500
Silver	6010(3010***)	3/2	75-125	0-20	6.0	10
	200.7	3/2	85-115	0-20	2.9	10
	272.1	3	80-120	0-20	2.5	10
	7761	3/2	75-125	0-20	0.25	1.0
	Saltwater	5	60-140	0-40	0.050	0.050
	CLP	45	80-120	0-20	10	10
	272.2	3/2	80-120	0-20	0.25	1.0
Sodium	6010(3010)	3/2	75-125	0-20	14	500
	200.7	3/2	85-115	0-20	19	500
	273.1	3	75-125	0-20	125	500
	CLP	45	80-120	0-20	5000	5000
Strontium	200.7***	3/2	85-115	0-20	0.54	10
	6010*** (3010***)	3/2	75-125	0-20	1.1	10

TABLE 5.1. LABORATORY ANALYTICAL METHODS, QA OBJECTIVES AND METHOD DETECTION LIMIT (MDL) FOR WATER AND OTHER LIQUIDS

PARAMETER	METHOD (Prep)	REFERENCE	ACCURACY ^a (% Rec)	PRECISION ^a (% RPD)	MDL ^a (ug/L)	Reporting Limit (ug/L)
Thallium	6010(3010)	3/2	75-125	0-20	66	500
	200.7	3/2	85-115	0-20	92	500
	279.2	3/2	80-120	0-20	3.5	10
	CLP	45	80-120	0-20	10	10
	7841(3020)	3/2	75-125	0-20	0.53	10
Tin	200.7 ^{***}	3/2	85-115	0-20	15	50
	282.2	3	75-125	0-20	10	50
	6010 ^{***} V	3/2	75-125	0-20	10	50
Titanium	200.7 ^{***}	3/2	85-115	0-20	2.2	10
	6010 ^{***} (3010 ^{***})	3/2	75-125	0-20	2.2	10
Tributyl tin	Atomic absorption	40	60-140	0-40	0.0010	0.0010
Vanadium	6010(3010)	3/2	75-125	0-20	2.5	10
	200.7	3/2	85-115	0-20	2.2	10
	CLP	45	80-120	0-20	50	50
Zinc	6010(3010)	3/2	75-125	0-20	7.5	20
	200.7	3/2	85-115	0-20	5.9	20
	Saltwater	5	60-140	0-40	0.25	1.0
	CLP	45	80-120	0-20	20	20
Zinc Phosphide	PDER Special Method	31	10-210	0-80	0.50	0.50
Zirconium	6010 ^{***} (3010 ^{***})	2	75-125	0-20	1100	9000

TABLE 5.1. LABORATORY ANALYTICAL METHODS, QA OBJECTIVES AND METHOD DETECTION LIMITS (MDL) FOR WATER AND OTHER LIQUIDS

PARAMETER	METHOD (Prep)	REFERENCE	ACCURACY* (% Rec)	PRECISION* (% RPD)	MDL** (ug/L)	Reporting Limit (ug/L)
Benzene (MS)	602/8020(5030)	1/2	68-134	0-19	0.11	1.0
Chlorobenzene (MS)	602/8020(5030)	1/2	70-133	0-17	0.090	1.0
1,2-Dichlorobenzene	602/8020(5030)	1/2	69-125	0-13	0.16	1.0
1,3-Dichlorobenzene	602/8020(5030)	1/2	67-131	0-12	0.10	1.0
1,4-Dichlorobenzene	602/8020(5030)	1/2	75-127	0-14	0.080	1.0
Ethylbenzene	602/8020(5030)	1/2	78-124	0-13	0.070	1.0
Methyl t-butyl ether	602/8020*** (5030)	1/2	50-150	0-30	3.6	10
Toluene (MS)	602/8020(5030)	1/2	69-131	0-19	0.080	1.0
Xylenes	602***/8020(5030)	2	50-150	0-30	0.28	1.0
Surrogate - a,a,a-Trifluorotoluene	602/8020(5030)	1/2	77-140	NA	NA	NA

TABLE 5.2. LABORATORY ANALYTICAL METHODS, QA OBJECTIVES AND
METHOD DETECTION LIMITS (MDL) FOR SOLIDS AND SEMISOLIDS

PARAMETER	METHOD (Prep)	REFERENCE	ACCURACY* (% Rec)	PRECISION* (% RPD)	MDL** (ug/kg)	Reporting Limit (ug/kg)
Acenaphthene (MS)	8310	2	11-144	0-35	5.4	20
Acenaphthylene	8310	2	10-139	0-40	3.9	20
Anthracene	8310	2	10-126	0-40	0.15	4.0
Benzo(a)anthracene	8310	2	12-135	0-40	0.27	4.0
Benzo(b)fluoranthene	8310	2	10-150	0-40	0.12	4.0
Benzo(k)fluoranthene	8310	2	10-159	0-40	0.10	10
Benzo(g,h,i)perylene	8310	2	10-120	0-40	0.42	10
Benzo(a)pyrene	8310	2	10-128	0-40	0.37	4.0
Carbazole	8310***	2	10-150	0-40	5.0	20
Chrysene (MS)	8310	2	10-199	0-40	0.19	4.0
Dibenz(a,h)acridine	8310***	2	NA	NA	NA	NA
Dibenzo(a,h)anthracene	8310	2	10-110	0-40	0.79	20
Fluoranthene	8310	2	56-136	0-28	0.27	10
Fluorene (MS)	8310	2	10-142	0-40	1.0	10
Indene	8310***	2	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	8310	2	10-116	0-40	0.20	10
6-Methylchrysene	8310***	2	NA	NA	NA	NA
1-Methylnaphthalene	8310***	2	10-125	0-40	5.0	20
2-Methylnaphthalene	8310***	2	10-125	0-40	5.0	20
Naphthalene (MS)	8310	2	31-159	0-34	5.0	20
Phenanthrene	8310	2	10-155	0-40	0.58	4.0
Pyrene (MS)	8310	2	49-156	0-28	0.41	10
Thiophenol	8310***	2	NA	NA	NA	NA
Surrogate - 4-Terphenyl-d4	8310	2	28-106	NA	NA	NA

TABLE 5.2. LABORATORY ANALYTICAL METHODS, QA OBJECTIVES AND METHOD DETECTION LIMITS (MDL) FOR SOLIDS AND SEMISOLIDS

PARAMETER	METHOD (Prep)	REFERENCE	ACCURACY* (% Rec)	PRECISION* (% RPD)	MDL** (mg/kg)	Reporting Limit (mg/kg)**
Aluminum	6010(3050) CLP	2 45	70-130 70-130	0-30 0-20	2.0 40	20 40
Antimony	6010(3050) CLP 7041(3050)***v	2 45 2	70-130 70-130 70-130	0-30 0-20 0-30	1.5 12 0.082	5.0 12 1.0
Arsenic	6010(3050) 7060(3050) 7061(3050) CLP	2 2 2 45	70-130 70-130 70-130 70-130	0-30 0-30 0-30 0-20	1.4 0.23 0.25 2.0	10 1.0 1.0 2.0
Barium	6010(3050) CLP	2 45	70-130 70-130	0-30 0-20	0.059 40	1.0 40
Beryllium	6010(3050) CLP 7091(3050)	2 45 2	70-130 70-130 70-130	0-30 0-20 0-30	0.095 1.0 0.25	0.50 1.0 0.10
Boron	6010(3050)***	2	70-130	0-30	1.2	5.0
Cadmium	6010(3050) CLP 7131(3050)	2 45 2	70-130 70-130 70-130	0-30 0-20 0-30	0.15 1.0 0.25	0.50 1.0 0.10
Calcium	6010(3050) CLP	2 45	70-130 70-130	0-30 0-20	4.8 1000	50 1000
Chromium	6010(3050) CLP 7191(3050)	2 45 2	70-130 70-130 70-130	0-30 0-20 0-30	0.80 2.0 0.25	1.0 2.0 1.0
Cobalt	6010(3050) CLP	2 45	70-130 70-130	0-30 0-20	0.22 10	1.0 10
Copper	6010(3050) CLP	2 45	70-130 70-130	0-30 0-20	0.54 5.0	2.5 5.0
Iron	6010(3050) CLP	2 45	70-130 70-130	0-30 0-20	0.78 20	5.0 20
Lead	6010(3050) 7421(3050) CLP	2 2 45	70-130 70-130 70-130	0-30 0-30 0-20	0.62 0.26 0.60	5.0 0.50 0.60
Lithium	3500-Li B(3050)***	4/2	70-130	0-20	2.5	10
Magnesium	6010(3050) CLP	2 45	70-130 70-130	0-30 0-20	2.5 1000	50 1000
Manganese	6010(3050) CLP	2 45	70-130 70-130	0-30 0-20	0.073 3.0	1.0 3.0
Mercury	7471 CLP	2 45	70-130 70-130	0-30 0-20	0.0032 0.10	0.030 0.10
Molybdenum	6010(3050)	2	70-130	0-30	0.054	1.0
Nickel	6010(3050) CLP	2 45	70-130 70-130	0-30 0-20	0.50 8.0	4.0 8.0

TABLE 5.2. LABORATORY ANALYTICAL METHODS, QA OBJECTIVES AND METHOD DETECTION LIMITS (MDL) FOR SOLIDS AND SEMISOLIDS

PARAMETER	METHOD (Prep)	REFERENCE	ACCURACY* (% Rec)	PRECISION* (% RPD)	MDL** (mg/kg)	Reporting Limit (mg/kg)
Potassium	6010(3050)	2	70-130	0-30	37	100
	CLP	45	70-130	0-20	1000	1000
	7610(3050)	2	70-130	0-30	2.5	10
Selenium	6010(3050)	2	70-130	0-30	1.9	5.0
	7740(3050)	2	70-130	0-30	0.27	1.0
	7741(3050)	2	70-130	0-30	0.25	1.0
	CLP	45	70-130	0-20	1.0	1.0
Silica (acid extractable)	6010(3050***)	2	70-130	0-30	12	50
Silver	6010(3050)	2	70-130	0-30	0.18	1.0
	CLP	45	70-130	0-20	2.0	2.0
	7761(3050)	2	70-130	0-30	0.025	0.10
Sodium	6010(3050)	2	70-130	0-30	12	50
	CLP	45	70-130	0-20	1000	1000
Strontium	6010*** (3050***)	2	70-130	0-30	0.054	1.0
Thallium	6010(3050)	2	70-130	0-30	7.2	50
	7841(3050)	2	70-130	0-30	0.065	1.0
	CLP	45	70-130	0-20	2.0	2.0
Tin	6010***v (3050***v)	2	70-130	0-30	1.5	5.0
Titanium	6010*** (3050***)	2	70-130	0-30	0.25	1.0
Tributyl tin	Atomic absorption	40	70-130	0-40	0.025	0.025
Vanadium	6010(3050)		70-130	0-30	1.4	1.0
	CLP	45	70-130	0-20	10	10
Zinc	6010(3050)	2	70-130	0-30	0.58	2.0
	CLP	45	70-130	0-20	4.0	4.0
Zinc Phosphide	FDER Special Method	31	NA	NA	NA	NA
Zirconium	6010*** (3050***)	2	70-130	0-30	125	500

TABLE 5.2. LABORATORY ANALYTICAL METHODS, QA OBJECTIVES AND METHOD DETECTION LIMITS (MDL) FOR SOLIDS AND SEMISOLIDS

PARAMETER	METHOD (Prep)	REFERENCE	ACCURACY* (% Rec)	PRECISION* (% RPD)	MDL** (ug/kg)	Reporting Limit (ug/kg)
Benzene (MS)	8020(5030)	2	63-133	0-27	0.24	5.0
Chlorobenzene (MS)	8020(5030)	2	69-129	0-25	0.63	5.0
1,2-Dichlorobenzene	8020(5030)	2	37-154	0-30	0.79	5.0
1,3-Dichlorobenzene	8020(5030)	2	50-141	0-30	0.57	5.0
1,4-Dichlorobenzene	8020(5030)	2	42-143	0-30	0.54	5.0
Ethylbenzene	8020(5030)	2	32-160	0-30	0.53	5.0
Methyl tert-butyl ether (MTBE)	8020*** (5030)	2	50-150	0-30	23	50
Toluene (MS)	8020(5030)	2	70-138	0-26	0.35	5.0
Xylenes (total)	8020(5030)	2	50-150	0-30	1.1	5.0
m-Xylene	8020(5030)	2	50-150	0-30	0.87	5.0
o+p Xylene	8020(5030)	2	50-150	0-30	0.71	5.0
Surrogate - a,a,a-Trifluorotoluene	8020(5030)	2	67-137	NA	NA	NA

TABLE 5.2. LABORATORY ANALYTICAL METHODS, QA OBJECTIVES AND
METHOD DETECTION LIMITS (MDL) FOR SOLIDS AND SEMISOLIDS

PARAMETER	METHOD (Prep)	REFERENCE	ACCURACY* (% Rec)	PRECISION* (% RPD)	MDL** (ug/kg)	Reporting Limit (ug/kg)
Acenaphthene (MS)	8100(3550)	2	37-115	0-32	10	330
Acenaphthylene	8100(3550)	2	36-114	0-32	16	330
Benzo(a)pyrene (MS)	8100(3550)	2	21-125	0-45	51	330
Benzo(b+k)fluoranthene	8100(3550)	2	26-128	0-41	82	330
Benzo(g,h,i)perylene	8100(3550)	2	25-126	0-42	70	330
Chrysene+Benzo(a)anthracene	8100(3550)	2	30-127	0-42	82	330
Fluoranthene	8100(3550)	2	28-132	0-33	32	330
Fluorene (MS)	8100(3550)	2	36-117	0-33	89	330
Indeno(1,2,3-cd)Pyrene + Dibenzo(a,h)anthracene	8100(3550)	2	20-131	0-47	13	330
1-Methylnaphthalene	8100(3550)	2	20-140	0-50	12	330
2-Methylnaphthalene	8100(3550)	2	20-140	0-50	12	330
Napthalene (MS)	8100(3550)	2	29-111	0-45	15	330
Phenanthrene + Anthracene	8100(3550)	2	38-118	0-32	82	330
Pyrene (MS)	8100(3550)	2	35-123	0-32	21	330
Surrogate - 2-Fluorobiphenyl	8100(3550)	2	17-164	NA	NA	NA
Surrogate - o-Terphenyl	DRO 8100 (modified) (3550)	69 12	50-150 33-127	NA NA	NA NA	NA NA

REFERENCES AND NOTES FOR TABLES 5.1, 5.2, AND 5.3

- * Accuracy data are presented as recoveries for spikes or surrogates. For routine analysis of organics, percent recoveries are evaluated only on the CLP or lab selected spiking compounds. The routine organic matrix spiking compounds are designated by an (MS) following the parameter name. Not all of the matrix spike or surrogate compounds listed in these tables are used with a given set of samples. Precision data are presented as relative percent difference (%RPD). Since reportable levels (above detection limit) for most of the organic parameters may not be detected in all environmental samples, precision is usually evaluated on duplicate spike data.

Accuracy and precision control limits are primarily derived from in-house laboratory data. Some accuracy and precision control limits have been rounded to the nearest "5". In some cases, published limits may be used in lieu of in-house limits because insufficient in-house data are available to calculate limits. In cases where insufficient data are available to generate in-house limits, and no EPA-approved method limits exist, limits are estimated based on available data.

** Method Detection Limit

*** This compound is not included in EPA's list of compounds for this method. However, Savannah Laboratories has verified (validated) that this compound can be analyzed by this method and will report data for this compound if specifically requested by the client.

***V Method validation data for this compound are included in Appendix A.

1. *Code of Federal Regulations, Title 40, Part 136*; U.S. Government Printing Office: Washington, DC, July 1, 1988.
2. *Test Methods for Evaluating Solid Waste, Third Edition, SW-846*; U.S. EPA Office of Solid Waste and Emergency Response: Washington, DC.
3. *Methods for Chemical Analysis of Water and Wastes*; U.S. EPA Office of Research and Development: Cincinnati, OH, March 1983; EPA 600/4-79-020.
4. *Standard Methods for the Examination of Water and Wastewater, Seventeenth Edition*; American Public Health Association: Washington, DC, 1989.
5. *Deepwater Ports Maintenance, Dredging, and Disposal Manual*; Florida DER.
6. CLP - US EPA Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Medium, Multi-Concentration, Revision 10/92.
7. *Determination of Triazine Pesticides in Industrial and Municipal Wastewater*: EPA Method 619; January, 1982.
8. *Determination of Thiophosphate Pesticides in Industrial and Municipal Wastewater*: EPA Method 622.1; January, 1982.

APPENDIX C

GEOTECHNICAL DATA ACQUISITION PLAN

**APPENDIX C
HUNTER ARMY AIRFIELD
SAVANNAH, CHATHAM COUNTY, GEORGIA
SITE INVESTIGATION AND CONFIRMATORY SAMPLING
GEOTECHNICAL DATA ACQUISITION PLAN**

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GEOTECHNICAL DATA ACQUISITION PLAN

1.0 INTRODUCTION

The objective of the geotechnical data acquisition plan (GDAP) is to assure that soil and groundwater samples accurately characterize both the nature and extent of contamination at the Hunter Army Airfield (HAAF). The GDAP documents the procedures that will be followed for the Site Investigation (SI) and Confirmatory Sampling (CS). These procedures will be used to drill and collect hand auger boring samples, perform geotechnical laboratory testing, install and develop monitoring wells, collect groundwater samples from wells and direct push Hydropunch II (HP-II) boreholes, perform geophysical and site surveys, and decontaminate equipment.

This project will involve the investigation of three areas located at HAAF. The Building 728 site is comprised of airport hydrant system underground storage tanks (USTs) and approximately 10,800 linear feet of associated pipeline. The pipelines distributed fuel to fueling pits near the runways and to another UST farm located near the hangars. The two remaining sites are UST investigations associated with a motor pool and base gas station.

The objectives of this project are as follows:

- a. Airport Hydrant System (vicinity of Building 728) - Determine the extent of the soil and groundwater contamination resulting from release(s) from the USTs and the associated fuel distribution pipelines leading to the fueling pits and to the UST farm near the hangars.
- b. Locate and map approximately 10,800 linear feet of airport hydrant system pipelines. Determine locations and types of access points for future pipeline content sampling.
- c. Building 710 and Building 133 Sites - complete CS in accordance with the CAPs (AT&E, 1992, 1993).
- d. Complete Quarterly Monitoring (QM) for a period of 1 year at the Building 710 and Building 133 sites.

- e. Complete a Phase I SI Report for the Building 728 Airport Hydrant System.
- f. Prepare Completion Reports (for Building 710 and Building 133) in accordance with CAP requirements.
- g. Prepare Quarterly Progress Reports (QPRs) for the Building 710 and Building 133 sites.

To this end, the pipeline will be located using appropriate geophysical or line locating methods. Then, a total of 98 hand auger borings will be conducted at the three sites. The locations are discussed in Section 6.2 of this Work Plan. Based on data collected during the hand auger phase of the investigation, an estimated 75 hydropunch locations will be selected for groundwater sampling at the three sites. Finally, based on data collected from the soil boring and hydropunch locations, an estimated 42 monitoring wells will be installed and sampled. The number of hydropunch and well locations may be adjusted to adequately address any contamination found at the three sites. In addition, two surface water and sediment samples shall be collected from the storm drain system at the Building 133 site.

Soil boring and groundwater monitoring well installation will be conducted using a hollow stem auger (HSA) drilling method. HSAs will be used to drill through unconsolidated sediments to termination depth. Depth to groundwater in the areas of interest typically ranges from 3-6 feet below ground surface (BGS). Borings will average approximately 15 feet deep, and soil samples will be collected continuously via split spoon sampler during augering. These borings will be completed with monitoring wells for groundwater sampling and groundwater flow determination.

This plan details the procedures that will be used for geotechnical data collection. In preparing this plan, consideration has been given to the USACE Scope of Work (SOW) for the investigation and EM1110-7-XX(FR); Draft Monitor Well Installation at Hazardous and Toxic Waste Sites. Each site geologist will have a copy of this Work Plan and the EM manual in their possession.

2.0 GEOTECHNICAL DATA QUALITY OBJECTIVES

Comprehensive data quality objectives (DQOs) for investigating the potential contamination at HAAF have been developed to provide guidelines for all field activities during the SI and CS. The DQOs are used to ensure that the data collected are of sufficient quantity and quality to be legally defensible under regulatory requirements. The intention of the sampling and analysis effort is to produce data of acceptable quality and allow an accurate evaluation. A detailed presentation of the DQOs is included in Section 3 of the Work Plan.

The primary Quality Assurance (QA) objective is that all measurements be representative of the actual site conditions and that all observations resulting from field inspection activities be comparable. The use of accepted, published standards and classification methods, as well as the use of standard measurement units, will aid in ensuring the comparability of the data.

DQO Level I will be used for screening soil samples for laboratory analysis and health and safety air monitoring. Level II will be used for field gas chromatograph analysis of groundwater samples from HP-II borings. Laboratory analyses of soil and groundwater samples will be at Level III. All geotechnical data will be recorded with indelible ink in bound field books or on appropriate USACE forms to assure complete recording of observations.

A trained geologist familiar with soil identification procedures will be present at each operating drill rig and will perform all soil descriptions in the field. Each geologist will have the necessary equipment and supplies listed in the EM1110-7-XX(FR)(Draft). A registered professional geologist will supervise all field activities to ensure proper procedures are followed. Forms specifically developed for the purpose of recording field data include well construction logs, lithologic description logs, well development forms, well water level gauging forms, and related sampling logs. Where possible, forms will be used to maximize the comparability and completeness of the data record. Forms used to document field sampling and instrument operation are discussed in the Chemical Data Acquisition Plan (CDAP). Standard methodology and procedures outlined in ASTM, USACE, and USEPA

guidance documents will be used to achieve adequate levels of representativeness and comparability.

3.0 EQUIPMENT DECONTAMINATION PROCEDURES

All drilling and sampling equipment will be decontaminated prior to arrival on site, before the start of each hole, and before leaving the site. Decontamination of the drill rig, tools, and downhole equipment will consist of steam cleaning. Decontamination of split spoons and HP-II tools will consist of analconox wash, a potable water rinse, a pesticide-grade isopropanol rinse, and deionized, organic free (DIOF) water rinse.

All water used for decontamination and well construction will be from a potable source to be designated. The bulk of decontamination operations will take place on a plastic lined "decon pad." The decon pad will be equipped with a sump area to collect decon fluids, which will be pumped into drums or a tank pending analysis. The pad will be located in a paved area to preclude any lost fluids from infiltrating into the ground. The area adjacent to the decon pad will serve as a storage area for well construction materials, water trucks, etc. and will be protected from over-spray and splash from decon activities. The only decontamination not conducted at the decon pad will be decontamination of sampling tools during active sampling; split spoons will be decontaminated between each sample in clean 5-gallon buckets at the drilling location. This water will be containerized in drums at each drilling location. All decontamination fluids will be stored in a secured area until proper disposal is arranged.

4.0 PRODUCT PIPING LOCATION

Geophysical methods will be used to locate the approximately 10,800 feet of product piping of the Building 728 airport hydrant system. A simple line locating system will be used first to locate and trace the lines. If this method is unsuccessful, ground penetrating radar (GPR) will be used to locate the lines. Applied Engineering Science, Inc. (AES) will perform the line location. The primary line locating instrument will be a Geonics EM31 ground conductivity meter, or some similar instrument. The EM31 induces a magnetic field in the

ground, part of which is intercepted by the instrument resulting in an output voltage that is linearly related to ground conductivity. The EM31 records two sets of data, a conductivity component and an inphase component. Non-metallic substances tend to show up as anomalies in the conductivity data while the inphase component is generally more useful for detecting buried metallic objects.

A grid will be used by AES personnel to perform the initial surveys with 25 ft. grid spacing to locate the pipeline initially. Once the line is located, a zig zag pattern will be used back and forth along the path of the pipeline to pinpoint its exact location, which will be marked with flagging.

The EM31 will be checked and zeroed at a background location following specifications in the manual prior to beginning the surveys. Data is recorded (in millimhos) by a Polycorder 720 data logger at operator determined intervals (typically every one or two seconds) while the operator walks with the instrument along established grid lines. Specific distance information is recorded in the data file by depressing a button on the instrument at predetermined intervals (i.e., at grid marker points).

Ground penetrating radar (GPR) will be used if the above method proves unsuccessful. GPR is a more sophisticated electromagnetic method that detects interfaces between subsurface materials with differing dielectric constants. The GPR system consists of: an antenna, which houses the transmitter and receiver; a profiling recorder, which processes the received signal and produces a graphic display of the data; and a video display unit, which processes and transmits the output signal to a color video display and tape recorder.

The transmitter radiates repetitive short-duration electromagnetic (EM) signals into the earth from an antenna moving across the ground surface. Electromagnetic waves are reflected back to the receiver by interfaces between materials with differing dielectric constants. The intensity of the reflected signal is a function of the contrast in the dielectric constant at the interface, the conductivity of the material which the wave is traveling through, and the frequency of the signal. Subsurface features which may cause such reflections are:

1) natural geologic conditions such as changes in sediment composition, bedding and cementation horizons, voids, and water content; or 2) man-introduced materials or changes to the subsurface such as soil backfill, buried debris, tanks, drums, pipelines, and utilities. The profiling recorder receives the signal from the antenna and produces a continuous cross section of the subsurface interface reflections, referred to as reflectors.

Depth of investigation of the GPR signal is highly site specific and is limited by signal attenuation (absorption) of the subsurface materials. Signal attenuation is dependent upon the electrical conductivity of the subsurface materials. Signal attenuation is greatest in materials with relatively high electrical conductivities such as clays and brackish groundwater and lowest in relatively low conductivity materials such as unsaturated sand or rock. Depth of investigation is also dependent on antenna frequency and generally increases with decreasing frequency; however, the ability to identify smaller subsurface features is diminished.

The various GPR antennas used are internally shielded from above-ground cultural interference sources. Accordingly, the GPR signal is not usually affected by nearby above-ground conductive objects such as metal fences, overhead power lines, vehicles or other metallic structures.

A GPR survey is performed by towing an antenna across land surface along predetermined transect lines. The antenna is either pulled by a person or towed behind a vehicle. Preliminary test GPR transects are performed over random areas of the site to calibrate the GPR equipment and characterize overall site conditions. Based on these preliminary transect results, the optimum antenna frequency and time range settings are selected to provide the best combination of depth of investigation and data resolution for the subsurface conditions at this site. For this site a zig zag pattern will be used along the path of the piping. The location of the antenna along a transect line is electronically marked on the data cross section at each grid intersection point to allow correlation of the data to actual ground locations. The location of the targets can be marked on the ground surface using spray paint or survey flags. The GPR output data is also tape recorded for further analysis and review using computer software post-processing techniques.

All activities associated with the geophysical surveys will be governed by the Site Health and Safety Plan. However, certain exceptions and amendments apply. None of the investigation activities will be physically intrusive into the subsurface; therefore it is not expected that chemical exposure hazards will be encountered. Because the equipment responds strongly to conductors, the operator and others associated with the survey will take necessary precautions to minimize interference with the instrument reading. As a consequence, the use of steel-toe and steel-shank boots during the geophysical survey will be avoided.

5.0 HAND-AUGERED SOIL BORINGS

This section describes equipment and procedures used to drill and collect samples from hand-augered soil borings. Hand-augered soil borings will be drilled to determine the extent of soil contamination within the Building 728 site, and to determine the success of the overexcavation at the Building 710 and 133 sites.

Equipment

- . Stainless steel spoon
- . Stainless steel hand auger
- . Sample containers
- . Stainless steel or glass bowl

Boring Procedure

1. Record the physical characteristics of the surface soil such as grain size, color, texture, etc., in accordance with USACE EM 1110-7-XX(FR) (Draft).
2. Make a sketch of the sampling location.
3. Auger a borehole at the test site in 6-inch increments using a decontaminated stainless steel hand auger. Screen each auger sample with an OVA. The sample with the highest OVA reading from each location will be collected and sent for chemical analysis as specified in the CDAP. If inability to turn the auger occurs before the desired total depth is reached, one offset location will be attempted. The offset boring will be within 3 feet of the original location.

The boring location will be abandoned if hand auger refusal is reached a second time.

4. Collect samples for chemical analysis and log soil as described above.
5. Borings should be drilled to approximately 1/2 foot below the saturated zone. At completion of the hand auger drilling, the boring will be backfilled with grout cement and finished to match the existing surface (grass, asphalt, etc.).
6. The hand auger soil borings will be surveyed to determine their location and elevation as described in Section 9.0.

5.1 Field Logs

A field boring log and a monitoring well record will be completed for each soil boring and monitoring well installed. USACE engineering form 1836 will be utilized for logging the holes. Information provided in the logs will include:

- a. Reference elevation for all depth measurements
- b. Depth of each change of stratum
- c. Thickness of each stratum
- d. Identification of the material which each stratum is composed of according to the Unified Soil Classification System
- e. Depth interval from which each formation sample was taken
- f. Depth at which hole diameter changes
- g. Depth at which groundwater is first encountered
- h. Depth to the static water level
- i. Total depth to which boring was advanced
- j. Depth or location of any loss of tools or equipment
- k. Location of any fractures, joints, faults, or cavities
- l. Depth to grouting or sealing

- m. Nominal hole diameters
- n. Amount of cement used for grouting or sealing
- o. Static water level upon completion of the soil boring
- p. Soil boring date or dates
- q. Readings obtained on field monitoring equipment used for health and safety purposes, and for the continuous headspace readings
- r. Depth to top of bedrock (if encountered)

6.0 HYDROPUNCH II (HP-II) SAMPLING

Based on the data collected from the hand auger borings, an estimated 75 hydropunch locations will be selected to collect groundwater samples for analysis, and obtain water table elevation data. Temporary piezometers will be utilized to obtain water level data.

The HP-II is a stainless steel and teflon sampling tool designed to collect chemically representative groundwater samples without the installation of a permanent well. The HP-II is designed to be pushed or driven to the desired sample depth, either from the ground surface (in soft soils) or from the bottom of a drilled borehole (similar to a split barrel sampler). Typically this is accomplished by using a drill rig or a cone penetrometer rig. The tool utilizes an air-tight and water-tight sealed intake screen and sample chamber which is isolated from the surrounding environment as the tool is advanced.

The outer surface of the HP-II is designed to prevent the downward transport of contamination as the tool is advanced; it cleans itself as the soil particles are displaced to the side. A very tight annular seal is produced around the tool as the soil is displaced and compacts into the walls of the hole. The tight seal enables the HP-II to collect a very discrete sample from a specific depth by sealing off ground water from above and below the zone to be sampled.

When the desired depth for collection of a sample is reached, the HP-II is opened by pulling back on the body of the tool. Soil friction holds the drive cone in place as the body is pulled back. Once the HP-II is open and the O-ring seal between the drive cone and the body of the tool is broken, the tool fills from the bottom with no aeration and minimal agitation of the sample. Once the sample chamber is filled, the tool is pulled towards the surface. This increases the hydrostatic pressure in the unit, which closes the two Teflon check valves and retains the sample within the sample chamber. Upon retrieval, the cone is removed and a simple stainless steel and Teflon sample discharge device is inserted for transferring the groundwater sample to a sample container.

As a general rule, the HP-II can be driven into position in formations where a standard 2-inch split barrel (spoon) soil sampler can be driven. Suitable geologic materials would include unconsolidated clays, silts, sands, fine gravels, and in some cases weathered saprolite.

Blow counts of over thirty (30) blows per 6 inches with the 2-inch split barrel sampler may indicate that damage might occur while driving the HydroPunch, which could occur if very hard materials (i.e., cobbles, rock layers, etc.) are mixed in with a matrix of softer material than if the HP-II is being advanced through a uniformly dense material. In dense formations it is better to drive the HydroPunch using frequent blows with a standard 140 pound hammer than to increase the hammer weight (this is because the length of the tool (5.38 ft.) will be left unsupported and the heavier hammer may induce more lateral stress on the unit, resulting in bending of the body). The deeper the body of the HP-II is in the soil, the less likely bending is to occur. This same principle is true for pushing the HP-II. As a general rule it is not a good idea to push the HP-II from the surface into the soil with the entire barrel unsupported. If thrust moves out of the vertical plane or an obstruction is encountered, the unit may be damaged by bending.

An important feature of the HP-II is that it is designed to fill using the aquifer's hydrostatic pressure. Consequently, the sample reservoir will only fill as fast as the formation will yield water. The discrete sampling intake of the HP-II (the area between the drive cone and the

body when the tool is in the open position) must be in hydraulic contact with a water bearing zone for a sample to be collected.

The location of the sample chamber above the intake requires that the HP-II be pushed a minimum of 5 feet below the static water level for a sample to be collected. Attempts to collect samples with less than 5 feet of penetration into the aquifer will likely result in very slow fill times, inadequate sample volume or improper function of check valves, due to extremely low hydrostatic pressure. Shallow permanent wells may need to be installed in areas where the static water table is encountered at or near the surface of impenetrable bedrock.

7.0 MONITOR WELL INSTALLATION PLAN

7.1 Purpose

The following section outlines the procedures for performing soil boring operations and installation of monitoring wells. Borings will be drilled with hollow stem auger equipment. Soil samples will be collected for laboratory analysis as outlined in the CDAP. Preparations for drilling borings and installing monitoring wells shall be initiated in advance to allow time for ordering equipment and supplies. The M&E geologist shall prepare a contract with a qualified drilling company well ahead of the startup date to ensure sufficient labor and equipment are available. All applicable drilling permits will be obtained prior to commencement of drilling operations. The following subsections describing drilling methods were adapted from EPA publication G2S/R-93/003A, Subsurface Characterization and Monitoring Techniques, May 1993, Section 2.

This Monitoring Well Installation Plan (MWIP) is provided within the GDAP, but can serve as a separate document in the field. The MWIP will provide consistent technical guidelines for well installation. A qualified geologist shall be onsite to log and describe all drilling, installation, development, and testing operations. Each borehole will be logged on an appropriate engineering form, in accordance with Section 5-1 of this document, utilizing the

Unified Soil Classification System (USCS), and soil descriptions presented in USACE Engineering Manual EM1110-7-XX(DR)(Draft). Boring logs will be included in the reports prepared for each facility.

7.2 Well Locations and Depths

Actual monitoring well locations and depths are dependent on site conditions. The locations will be determined after analyzing all hand auger and HP-II data. Well depths are variable, depending on the first occurrence of water. The depth to groundwater is anticipated to be between 3 and 6 feet BGS.

7.3 Drilling Equipment

The drilling equipment will consist of one drill rig equipped with HSA, and split spoon sample (SSS) equipment. Support vehicles will include pickup trucks and potable water trucks. The HSA sections will be 5-foot lengths, and of sufficient inside and outside diameter to accommodate placement of all surface casing and well construction materials. The split spoons will be 2 inch O.D., and 24 inches long.

The drilling rig will be a power rotary, truck-mounted Mobil B-57, CME-75, or similar make and model. The rig type will be capable of augering and Standard Penetration Test (SPT) sampling.

7.4 Drilling Methods

Drilling method selection was based on: 1) obtaining representative data; 2) minimization of cross contamination potential, and 3) economy. The following section outlines the specific methods and techniques which will be utilized to meet these goals.

7.4.1 Hollow Stem Auger

A HSA column simultaneously rotates and axially advances using a mechanically or hydraulically powered drill rig. The hollow stem of the auger allows the use of various methods for continuous or intermittent sampling of soil material. Augers with an outside diameter of no less than 6.25" will be used to allow sufficient borehole annulus for well material placement. Casing and screens for monitoring wells can be set through the augers when the desired depth has been reached, and gravel pack and grouting placed as the auger is gradually withdrawn from the hole.

All borings will be started by post-holing or hand-augering to 3 feet to clear any unknown underground utilities at each location. Samples will be collected for lithological definition and/or chemical analysis every 1/2 foot during hand augering. The holes will be opened at least as wide as the outside diameter of the augers (or other downhole tools). Drilling will begin at 3 feet and continue with the addition of 5-foot auger sections. Split spoon samples, will be collected from 3-5 feet BGS and continuously thereafter, to the bottom of the hole. Soil samples will be taken through the HSA in advance of the auger bit. HSA drilling will be used to drill to the desired depth. Generally, the boring will be drilled to a depth such that 5-7 feet of water will collect in a well installed in the boring.

7.4.2 Split Spoon Sampling and Logging Procedures

This section discusses the methods used to collect samples during drilling operations and the logging of soil samples. Specific procedures for the bottling and packaging of soil samples for chemical analysis are found in the CDAP.

Split spoon sampling will be conducted in accordance with ASTM D1586, "Method for Penetration Test, and Split Barrel Sampling of Soils." Soil samples will be collected for lithologic description and/or chemical analysis for the first 3 feet from the surface using post-hole diggers or hand augers. From 3-5 feet, and continuously thereafter during HSA drilling, a split spoon sampler will be utilized to collect samples. The sampler is a hollow

steel barrel approximately 2 inches in diameter, 24 inches long, split lengthwise and threaded at the ends. The two pieces are held together at the bottom by the drive shoe which screws onto the threads, and at the top by screwing onto the sampling rods. The split spoon sampler is attached to the bottom of a rod and driven into the ground by a 140-pound hammer, free falling 30 inches. The number of hammer blows required to drive the sampler 24 inches in 6-inch increments (blow counts) is recorded along with the length of soil actually recovered.

After driving the split spoon sampler 24 inches, it is removed from the borehole, opened, and screened for volatile organics using the OVA. Samples shall be scraped on the sides and ends (peeled) to expose a fresh soil surface prior to vapor screening. The volatile sample will be collected from the portion of the spoon having the highest OVA reading and placed in a laboratory-approved container as soon as possible. Each volatile sample will be refrigerated while the boring is advanced to the desired depth. The remaining soil will be placed into a stainless steel bowl and covered with aluminum foil. A portion of soil (approximately 2 ounces) taken from the same area of the spoon as the volatile sample, will be placed into a foil topped glass jar for headspace screening. A minimum of seven soil samples will be collected from each boring (assuming a boring depth of 15 feet).

OVA headspace readings from each soil sample will be reviewed upon completing the boring. Additional laboratory glassware will be filled from the stainless steel bowl containing soil from the sampling horizon which had the most elevated OVA reading or a predetermined horizon in the absence of volatile confirmation with the OVA. If no readings are detected, the sample from the soil/water table interface will be selected for chemical analysis.

Soil in each split spoon will be examined and described by the geologist. Descriptions will include comments on grain size percentages, color, plasticity, consistency, density, moisture content, texture structure, and angularity, etc., as described in USACE EM 1110-7-XX(FR) (Draft). This information will be logged on USACE Engineering Form 1836, which will be submitted in the report for each facility.

Samples for the physical analysis of grain size, Atterburg limits, and moisture content (ASTM C117 and 136, ASTM D4318, and ASTM D2216, respectively), will be retained from each monitoring well boring. At the end of the drilling operations, a representative sample from each well location will be selected for geotechnical analysis. The selected samples will cover the range of lithologies encountered during drilling.

The storage, packaging, and shipment procedures for samples suspected of being hazardous will be in accordance with the site health and safety plan, and applicable DOT regulations for transporting hazardous materials.

7.5 Well Materials

The materials that are used in the construction of a monitoring well and that come in contact with the water sample should not alter the chemical quality of the sample for the constituents being examined using appropriate sampling protocols. The casing, well screen, and tremie pipe equipment must be steam cleaned prior to usage or certified clean by the manufacturer with protective wrapping intact. Samples of the filter pack, annular seal, and grout materials will be retained to serve as quality control until the completion of at least one round of groundwater quality sampling and analysis.

7.5.1 Well Casing and Screen Materials

The riser pipe will consist of new 2 inch I.D., flush-threaded schedule 40 PVC that conforms to National Sanitation Foundation (NSF)/ASTM F480 potable-water grade requirements. Riser lengths to be used will be either 5 or 10 feet. Well screens will also be made of the above material and be factory slotted. Slot size shall be determined so as to be compatible with the aquifer. Screen lengths will be 10 feet long unless a shorter section of screen (5 ft) is required because of an extremely shallow water table. The screen bottom will be sealed with a 2-inch threaded PVC cap or plug. Labeling on the screen and casing will be sanded off if it will be located below the bentonite seal.

7.5.2 Centralizers

A centralizer will be installed if needed on the monitoring wells just above the bentonite seal. One centralizer per well should be sufficient to center the pipe over the expected depths. The centralizers will be 2-inch adjustable stainless steel and bolted onto the riser casing.

7.5.3 Artificial Sand Pack

Clean, inert, natural fine silica sand will be used to construct a uniform and continuous filter pack extending from the well bottom to 2 feet above the screen. If the water table is very shallow, the amount of filter pack above the screen may have to be reduced to accommodate bentonite and well completion. The filter sand will be placed via tremie pipe, if practical. The filter sand grain size will be such that it is compatible with the screen and aquifer. Filter pack depth will be checked with a weighted measuring tape during placement. The sand will be obtained by the drilling subcontractor from a source of suitable, clean granular material.

7.5.4 Bentonite Seal

At least a 2-foot-thick bentonite seal will be installed above the filter pack. A commercial-grade bentonite in 3/8-inch to 1/4-inch pellet form will be used and depth checked with a weighted measuring tape. If necessary, the bentonite pellets will be hydrated with 5 to 10 gallons of potable water and hydrating time will be at least 1 hour before grouting. The bentonite will be obtained by the drilling subcontractor from a source of suitable, clean drilling supplies. For very shallow water table wells, the thickness of bentonite seal may be reduced to accommodate well completion.

7.5.5 Grout Mixture

A cement-bentonite grout will be placed in the borehole annulus from the top of the bentonite seal to the ground surface. Cement grout will consist of a mixture of not more than 7

gallons of water and 3 pounds bentonite powder per 94-pound sack of Portland Type II cement. Due to the expected shallow well depths, grout will be mechanically mixed and poured in the borehole from the surface.

7.6 Monitoring Well Installation

The following section outlines the methodology for installing monitoring wells. Deviations from these methods due to field conditions will be noted on appropriate forms and approved by the USACE Project Manager.

All well materials must be handled in a fashion to ensure that potential contaminants do not contact any portion of the well material. If couplings can't be threaded by hand, steam cleaned wrenches may be used.

7.6.1 Temporary Piezometer Installation

A temporary piezometer will be installed in each HP-II borehole. A 1- or 2-inch diameter factory slotted PVC screen will be lowered into the borehole upon retrieving the water sample. Filter sand will be added around the screen section of the piezometer if insufficient space exists between the casing and the borehole annulus. The placement of a filter pack will most likely not be necessary because of the sandy nature of the material at HAAF. The piezometer will be completed to surface with filter sand. The piezometer casing will be cut flush to ground and equipped with a water-tight plug. A 4-inch diameter PVC cap will be placed over the piezometer and seated into in-situ soils to protect the casing. Water levels in the piezometers will be measured after allowing at least 48 hours for stabilization. The top of casing elevations will be determined by a registered surveyor. Each piezometer will be abandoned following data collection by pumping cement bentonite grout into the casing from the surface. If possible, the piezometer casing will be removed from the ground and the borehole will be filled with grout.

7.6.2 Permanent Well Installation

A stable borehole must be constructed prior to attempting to install the monitoring well assembly. Installation will begin within 12 hours of borehole completion. Once begun, installation will not be stopped until the grout is in place and the augers have been removed. Termination depth for the borings will be dependent on depth to the water table, and will be determined in the field by the geologist. Well depths are not anticipated to exceed 15 feet BGS. When assembling the threaded well materials, O-rings may also be used to assure a tight seal of couplings. The riser will be completed below grade and be capped temporarily to prevent entrance of materials during completion operations.

The volume of filter pack required to fill the annular space will be computed and recorded in the well completion log. The filter pack should extend 2 feet above the top of the screen. The filter pack will be placed with a decontaminated, flush threaded tremie pipe. Alternatively, the filter pack may be added directly between the riser pipe and auger if bridging occurs inside the tremie pipe. If necessary, water from an approved source may be added to help move the filter material inside the tremie pipe. A gauged, weighted line will be used to monitor filter pack placement.

A 2-foot thick bentonite pellet seal will be placed above the top of the filter pack. The pellets may be allowed to fall into the annulus between the auger and the well casing. A tamper may be necessary to tamp the pellets in place. If the seal is installed above the water level, approximately 5 to 10 gallons of water from an approved source will be used to hydrate the pellets. A minimum of 1 hour will be allowed for the pellets to hydrate.

Grout will be placed by pouring from the surface. Grout will be placed from the top of the bentonite seal to the surface. Following curing and settling, additional grout may be added as needed.

Deviations from the thicknesses of filter pack and bentonite may be necessary for very shallow wells. For example, if the water table is 3 feet BGS, then the top of the well screen

should be placed at about 2 feet BGS. This would leave room for about 6 inches of sand and 6 inches of bentonite, and 1 foot for grout and well completion. Deviations from the standard well construction will be noted both on the logs and in the reports.

All wells will be completed flush to ground with an 8-inch diameter traffic-bearing manhole with a bolt-down cover to prevent tampering. A 4-inch thick, 3-foot square concrete pad, sloped away from the well, will be constructed around the steel casing. All wells will be protected with a vented, locking well cap. All locks will be keyed alike.

A metal plate bearing the contractor's name and registration number, date the well was completed, well number, total depth, depth of screen section, and surveyed elevation (TOC) will be affixed to the concrete well collar. The tag will also bear a warning that the well is not for water supply and that groundwater may contain hazardous materials. The manhole cover will be permanently labeled as MONITOR WELL - DO NOT FILL.

7.6.3 Borehole Abandonment

All power auger soil borings will be completed with groundwater monitoring wells. Any boring deemed unacceptable for monitoring well installation will be abandoned by pumping a bentonite/grout slurry to the bottom of the hole via tremie pipe. Grout will be pumped until it flows at the ground surface. After 24 hours, the hole will be revisited to top off any settling that may have occurred. This process will be repeated as necessary. Samples of bentonite and cement used in borehole abandonment will be collected for quality control.

7.7 Well development

Well development will begin at least 48 hours after grouting. Development will consist of either mechanical or manual pumping or bailing. Water levels, specific conductance, temperature, and pH will be measured and recorded before, during, and after development. Development shall continue until the water is clear and relatively free from sediment. At least five well volumes of water, including the saturated borehole volume (assuming 30

percent porosity) will be removed during development. Also, five times the volume of any water added to the well during filter pack placement will be removed. A clear glass jar will be filled with groundwater from the well, labeled, and photographed with 35 mm color print film to be part of the well log. All developed water will be drummed pending analysis. The COE will be contacted if development is hindered by slow recharging wells, or other requirements cannot be met.

8.0 GROUNDWATER SAMPLING

Each well will be allowed to chemically equilibrate for at least 48 hours after development before sampling. Well sampling will begin with the well located in the area suspected of least contamination. Protective gloves shall be worn during sampling and changed between samples. The following procedure will be used:

1. Record the weather conditions and other on-site data.
2. Unlock the protective casing on the well. Place plastic sheeting around the well to provide protection from contamination for any field sampling equipment used in this procedure.
3. Sample the air in the well head for organic vapors using a photoionization detector or organic vapor analyzer and record the measurements.
4. Using a decontaminated water level indicator, measure and record the static groundwater level and depth to the bottom of the well. Decontaminate the water level indicator, after use.
5. From the well diameter and the measured depth of the standing water, calculate (or use a well volume table to determine) the volume of standing water in the well. Note and record this volume.
6. (Optional) If a floating layer is suspected, gently lower a decontaminated clear teflon bailer to below the water surface and withdraw. Using the photoionization detector or organic vapor analyzer, sample the headspace of the sample in the bailer and record the reading. Visually examine the surface of the water in the bailer for floating chemicals. If possible, measure and record the thickness of this layer. Wells containing a floating layer will not be sampled for chemical analysis.

7. Using a pump or disposable teflon bailer, purge the well until up to five times the total of the volume in the well and filter pack (assuming 30 percent porosity) has been removed. The volumes purged are estimated by discharging all the purge water into a precalibrated container. During purging, measure and record the temperature, conductivity, and pH of each volume of water as it is removed. Purge water will be drummed with the development water from the same well. Discontinue purging after at least three volumes have been removed provided the pH and conductivity readings have stabilized to within 10 percent from the previous reading. If the readings have not stabilized, purge another well volume.

If all water is evacuated during the purging process, several options are available. The options are based on the time required for the water-level recovery, the type of analysis to be performed, and the type of purging and sampling equipment being used. The option to be used for each investigation should be approved on a site-specific basis prior to sampling. The options may include the following:

- . For water-level recoveries of 0.5 to 1 hour, purge three well volumes. Sampling should be performed as soon as sufficient volume has recharged.
 - . For water-level recoveries of up to 8 hours, the well may be purged early in the day. Sampling can be performed after the well level has recovered to within 80 percent of the original static water level measured.
 - . If water-level recoveries exceed 24 hours, the well may be purged once on one day and samples may be collected within 24 hours on the following day.
 - . If water-level recoveries exceed 48 hours, the water remains discolored, or excess sediment remains after five volumes removal, the COE will be contacted for guidance.
8. Using a disposable teflon bailer and connecting cord, collect groundwater samples for the well. Record the time at beginning and end of the bailing. (During sample collection and purging the downhole equipment should not touch the ground or any objects except the well casing.)
 9. Transfer a groundwater sample directly from the bailer to the appropriate sample containers. Samples collected for volatile organic analysis must be collected first. Samples collected for volatile organic analysis must contain no air bubbles in the VOA vial after it has been capped; ensure this by turning the vial upside down and tapping it lightly. Fill all other sample containers to the shoulder.

10. Immediately label; preserve if necessary; refrigerate/ice; and log the sample into the field log book and complete the chain-of-custody forms.
11. Remeasure and record the standing water level in the well after the sampling.
12. Replace the protective cap on the well and lock.

9.0 SURVEY DATA ACQUISITION AND METHODOLOGIES

The locations of the pipelines, all borings, HP-II locations, and monitoring wells shall be surveyed by a licensed professional surveyor. This survey will provide coordinates of all sampling locations referenced to the National Plane Coordinate System. Elevations shall be referenced to the National Geodetic Vertical Datum (NGVD) of 1929.

Elevation of natural ground surface shall be surveyed at every sampling location to the closest 0.1 foot. In addition, the top of casing elevation shall be determined to the closest 0.01 foot for each well. Horizontal accuracy shall be to the nearest foot. Coordinates and elevations shall be surveyed using nearby U.S. Geological Survey benchmarks.

The location, identification, coordinates, and elevations of the wells and monuments shall be plotted on maps with a scale large enough to show their location with reference to other structures at the individual sites.

The surveyors shall furnish copies of the field notes from all surveys, 30 days after completion of surveying. Two copies of the survey data shall be furnished on 3.5 inch floppy diskettes in a format which meets the Corps CADD Deliverables standards. Original survey notes shall be furnished at the completion of the contract.

10.0 WELL ACCEPTANCE

Detailed boring logs and well construction drawings shall be included in all the reports. Boring logs shall be prepared by a qualified geologist or hydrogeologist who shall be present

during all drilling and well construction operations. The original and one copy of each boring log and well construction drawing shall be submitted to the COE Technical Manager not later than 30 calendar days after the field work is completed. Each well construction drawing shall be on a different sheet. The well will not be accepted by the COE until the logs are received. Information provided in the logs shall include, but will not be limited to, the following:

- . Depth of each change of stratum
- . Thickness of each stratum
- . Identification and description of the materials of which each stratum is composed
- . Types and sizes of samplers being used
- . Depth interval from which each formation sample was taken. (Include sample number, sample recovery, and blow count readings on the boring logs).
- . Depth at which hole diameter (bit size) change
- . Depth at which ground water is first encountered
- . Depth to the static water level and changes in static water level with well depth
- . Total depth of completed well
- . Location of any fractures, joints, faults, cavities, or weathered zones
- . Depth of any loss of tools or equipment, or drill fluids
- . Depth of any grouting or sealing
- . Nominal hole diameters
- . Amount of cement used for grouting or sealing
- . Depth and type of well casing
- . Description (to include length, location, diameter, slot sizes, material, and manufacturer) of well screen(s)
- . Any sealing-off of water-bearing strata

- . Static water level upon completion of the well and after development
- . Drilling date or dates
- . Construction details of monitoring well
- . Name of driller
- . Name of A-E's inspector
- . Type of drill rig
- . Time allowed for hydration of the bentonite seal
- . Hole number and location
- . Type of pump and pumping rate/bailing rate
- . Volume of water purged

Well development records shall be provided for each well, along with photos of recovered water.

11.0 SITE RESTORATION AND DISPOSITION OF INVESTIGATION-DERIVED WASTES (IDW)

All drilling locations will be returned to as near their original state as is practical. Grassed areas will be cleaned and reseeded if necessary. Paved and concreted areas will be patched and pressure washed to remove any detritus caused by drilling operations.

All drill cuttings, well water, and decontamination water will be collected in drums. Plastic sheeting will also be collected and removed from each site as IDW. The drums will be labeled as to their contents, source, generation date, and point of contact. The drums will be moved to a central fenced location near Building 728 during the drilling, development, and sampling activities. The drums will remain in the fenced area until analytical results are reviewed and the best method of disposal has been determined.

Disposal of expendable supplies, gloves, tyvek, etc., will be collected in plastic garbage bags and screened with the OVA prior to placing in the trash. Bags with elevated readings will be drummed, labelled, dated and placed at the central storage location. Analytical results from the soil samples will be used to determine if the wastes are hazardous or not. If the results indicate sufficient contamination, these drums will be disposed of at a licensed hazardous waste facility. A suitable, EPD-approved disposal facility will be used to recycle or dispose of IDW containing non-hazardous petroleum hydrocarbons. All non-contaminated materials may be disposed at the HAAF provided approval of such disposal can be obtained from both the EPD and the USACE project manager.

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APPENDIX D
DATA MANAGEMENT PLAN

APPENDIX D

HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA
PHASE I SITE INVESTIGATION, BUILDING 728
CONFIRMATORY SAMPLING AND QUARTERLY MONITORING
BUILDINGS 710 AND 133
DATA MANAGEMENT PLAN

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APPENDIX D

DATA MANAGEMENT PLAN

1.0 INTRODUCTION

The purpose of this Data Management Plan is to ensure effective data management by documenting and tracking physical and analytical investigation data and results. This plan will address data and report processing procedures, project file requirements, and all project related progress reporting procedures and documents. This plan will also provide the format to be used to present the data, including data reduction.

2.0 DATA PRESENTATION

Tables and maps will be used to present results and facilitate data evaluation. For example, a display of analytical results for each sampling location will be superimposed on a map of the site to help in identifying data gaps and in selecting potential future sampling locations.

Certain types of data, such as stratigraphy and sampling location coordinates, will be displayed in graphic form using Intergraph and Word Perfect. Such data may be presented in tabular form but will also be transformed into graphic presentations. Sampling locations will be illustrated on a topographic map and will follow the regulatory requirements for its preparation.

2.1 Tables

Tables of both raw and sorted data will be used as a means of data presentation. These tables are discussed in the following subsections.

2.1.1 Listed (Raw) Data

Each data record will provide the following information:

- . Unique sample code
- . Sampling location and sample type
- . Sampling date
- . Laboratory analysis identification number
- . Property or component measured
- . Result of analysis (e.g., concentration)
- . Detection limits
- . Reporting units

All data will be reported to the USACE, including suspected outliers or samples contaminated due to improper collection, preservation, or storage procedures. The rejected data will be marked as such in the data tables, and explanation of rejected data will be presented in footnotes.

Sampling logs will be provided for all samples obtained during the investigation.

Information in the logs may include but are not limited to the following:

- . Name and address of sampler
- . Purpose of sampling
- . Date and time of sampling
- . Sample type (e.g., soil) and suspected contaminants
- . Sampling location, description, and grid coordinates (including photos)
- . Sampling method, sample containers, and preservation (if any)
- . **Sample weight or volume**
- . **Number of samples taken**
- . **Sample I.D. number(s)**
- . **Field observations**
- . Field measurements made (e.g., pH, temperature)
- . Weather conditions
- . Name and signature of person responsible for observations

Unusual conditions encountered during sampling (e.g., difficulties with the sampling equipment, post-sampling contamination, or loss of samples) will also be described.

2.2 Graphic Presentation of Data

Graphic methods of data presentation will be used to better illustrate trends and patterns. Some graphic formats which may be used include bar graphs, line graphs, areal maps, and isopleth-plots. These graphic methods of data presentation are discussed below.

2.2.1 Bar Graphs and Line Graphs

Bar graphs and line graphs may be used to display changes in contaminant concentration with time, distance from a source, or other variables. The following principles of graphing will be followed to provide clear and effective line and bar graphs:

- . Data will not be crowded. Different symbols or textures will be used to distinguish each line or bar.
- . Choose the scale of the X and Y axes so that data are spread out over the full range of the graph. If one or two data points are far outside the range of the rest of the data, a broken line or bar may be used to indicate a discontinuous scale. If the data range exceeds two orders of magnitude, the logarithms of the data may be plotted.
- . The X and Y axes of the plot will be clearly labeled with the parameter measured and the units of measurement.
- . The X axis generally represents the independent variable and the Y axis the dependent variable.

2.2.2 Area or Plan Views (Maps)

The distribution of contaminants at a site may be represented by superimposing sample analytical results over a map of the site. Distributions may be shown by listing individual measurements, or by contour plots of the contaminant concentrations. The individual techniques which may be used are discussed below:

- Contamination shown at discrete points--in this format, no assumptions are made concerning contamination outside the immediate sampling area.
- Display of average concentrations--Shadings or textures will be used to represent average contamination concentrations within smaller areas at a site. Shading represents estimated areas of similar concentration only and should not be interpreted as implying concentration gradients between adjacent points.
- Contaminant Isopleth Maps--Construction of a contaminant isopleth map generally requires a relatively large number of sampling locations spaced regularly across the study area. The isopleth maps will be prepared by marking the site map with the concentrations detected at each sampling location. Lines will be drawn to connect data points of the same concentration, similar to contours of elevation.

2.2.3 Vertical Profiles or Cross-Sections

Vertical profiles will be useful for displaying the distribution of a contaminant release. For soil and groundwater, the approach will be to select several soil cores (or monitoring wells) that approximately lie in a straight line through the center of the contaminant release. This cross-section **represents** a transect of the site. A diagram of the soil (or groundwater) profile will be **prepared along** the length of the transect, displaying subsurface stratigraphy, location of the waste source, and the location and depth of boreholes. Concentrations may also be indicated on the plot as discrete measurements or isopleths. If the sampling points do not fall in a straight line, an alternate display called a fence diagram can be used.

3.0 DATA REDUCTION

Data will be reported according to accepted practices of QA and data validation. All data will be reported. Considerations, however, include treatment of replicate measurements, identification of outlier values, and reporting of results determined to be below detection limits.

3.1 Treatment of Replicates

Replicate measurements of a single sample will be averaged prior to further data reduction.

3.2 Reporting of Outliers

Any program of environmental measurements can produce numbers that lie outside the "expected" range of values. Because field variability of environmental measurements can be great, deciding whether an extreme (outlier) value is representative of actual contaminant levels may be difficult. Outlier values may be the result of:

- . A catastrophic unnatural (but real) occurrence such as a spill
- . Inconsistent sampling or analytical chemistry methodology
- . Errors in the transcription of data values or decimal points
- . True but extreme concentration measurements

If the cause of the problem can be documented, the correction of outlying values will be attempted. **The data** will be corrected, for example, if outliers are caused by incorrect transcription **and** the correct values can be obtained and documented from valid records. Also, if a catastrophic event or a problem in methodology occurred that can be documented, data values will be reported with clear reference. Documentation and validation of the cause of outliers must accompany any attempt to correct or delete data values, because true but extreme values must not be altered. Statistical methods for identifying outliers require that

- . Actions being taken to rectify problems
- . Changes in personnel during the reporting period
- . Projected work for the next reporting period
- . Copies of daily reports, inspection reports, laboratory/monitoring data, etc.

In addition, a final Phase I SI report and Completion Reports will be written that incorporate all the previous events in this project. These reports will be comprehensive and will be sufficiently detailed to allow decisions to be made by the USACE regarding the need for interim corrective measure and/or a Remedial Investigation (RI). These decisions may also be made by the USACE on the basis of results of progress reports and/or other reports.

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