SOIL SAMPLING

1.0 PURPOSE

This section sets forth the standard operating procedure (SOP) for soil sampling (surface samples, trench samples, and boring samples) to be used by AMEC personnel.

2.0 SCOPE

This procedure applies to all personnel involved with the managing or participating in drilling and soil sampling activities.

This procedure has been developed to serve as professional guidance for the AMEC personnel. However, it is not intended to obviate the need for professional judgment that may arise in unforeseen circumstances. Deviations from this procedure when planning or executing planned activities must be approved by the Project Manager.

3.0 DEFINITIONS

None.

4.0 RESPONSIBILITIES

The Project Manager is responsible for ensuring that these standard soil sampling procedures are utilized during projects conducted or supervised by a qualified individual. A qualified individual for subsurface sampling is defined as a person with a degree in geology, hydrogeology, or geotechnical/civil engineering with at least one year of experience in the supervision of soil boring construction. A qualified individual for trenching, excavation (e.g., pit), or surface sampling supervision is one who has sufficient training and experience to accomplish the objectives of the sampling program. The Project Manager shall also ensure that soil classification during all types of soil sampling is conducted by a qualified person, as defined in SOP, *Soil and Rock Classification*.

The Field Manager is responsible for ensuring that all project field staff follow these procedures.

5.0 PROCEDURES

5.1 SUBSURFACE SOIL SAMPLING

The purpose of subsurface soil sampling is to acquire accurate, representative information about subsurface materials penetrated during drilling or trenching. This is accomplished by logging lithologic information, classifying lithologic materials, and collecting lithologic samples for analysis by geotechnical or chemical methods.

5.1.1 Inspection of Equipment

The collection of reliable samples of subsurface materials depends partly on the type of samples that can be collected when using various subsurface exploration techniques. These procedures are described in Section 5.2. In all cases, the equipment shall be inspected prior to commencement of drilling for signs of fluid leakage, which could introduce contaminants into the soil. If, at any time during subsurface exploration, fluid is observed leaking from the rig, operations shall cease and the leak shall be immediately repaired or contained. All soil and other materials affected by the leak will be collected, containerized, and labeled for proper disposal (see SOP, *IDW Management*).

5.1.2 Preparation of Site

Proper preparation of the site prior to the commencement of subsurface exploration is essential for smooth drilling operations. It is required to protect the health and safety of site personnel. First, the site shall be inspected to ensure that there are no overhead hazards that could affect subsurface exploration. Then, all subsurface sampling locations shall be assessed using geophysical methods. If possible, the area shall be excavated by hand to a depth of 2 to 3 feet before beginning drilling. If surface or shallow samples are required, it is suggested that the hand excavation be done as close to the actual subsurface exploration as possible. The location of the kill switch for the equipment shall be known to all members of the field crew and shall be readily accessible.

The equipment shall be situated upwind or side-wind of the borehole. The area surrounding, and in the vicinity of, the borehole shall be covered with plastic, including the area where cuttings are placed into 55-gallon drums and the equipment

decontamination area. The required exclusion zones shall be established by using plastic tape or cones to designee the various areas.

5.1.3 Equipment Decontamination

To avoid cross-contamination, all sampling equipment utilized for borehole drilling and soil sampling that may potentially come into contact with environmental samples shall be thoroughly decontaminated as described in SOP, *Equipment Decontamination*. All sampling tools shall be decontaminated between each sampling event and between each borehole or trench. At a minimum, all equipment shall be steam-cleaned or undergo the wash and rinse process. All wash and rinse water shall be collected, containerized, and labeled for proper disposal. Clean equipment (e.g., augers and samplers) shall be protected from contact with contaminated soils or other contaminated materials prior to sample collection. Equipment shall be kept on plastic or protected in another suitable fashion. After a borehole is completed, all augers and contaminated downhole equipment shall be stored on plastic sheeting.

5.1.4 Handling of Drill Cuttings

All soil cuttings from borehole drilling shall be placed into 55-gallon DOT-approved drums or other appropriate containers such as a roll-off bin. The containerized cuttings shall be stored in a centralized area pending sample analysis to determine their final disposition. Detailed drum handling and labeling procedures are described in the procedure on investigative-derived waste.

5.2 Soil Sample Collection Methods

Table 1 describes the characteristics of the sampling methods available for the drilling techniques frequently employed for conducting soil borings and monitoring well installation as described in SOP, *Monitoring Well Installation*. The split-spoon sampling method is the most commonly used soil sampling technique. However, in certain circumstances, other methods may have to be used to obtain optimal soil sampling results. The following text describes the primary soil sampling methods.

Table 1

CHARACTERISTICS OF COMMON SUBSURFACE FORMATION-SAMPLING METHODS

Type of Formation	Sample Collection Method	Sample Quality	Potential for Continuous Sample Collection	Samples Suitable for Analytical Testing	Discrete Zones Identifiable?
Unconsolidated	Bulk Sampling (Cuttings)	Poor	No	No	No
	Thin Wall	Good	Yes	Yes	Yes
	Split Spoon	Good	Yes	Yes	Yes
	Trench	Good	No	Yes	Yes
	Core Barrels	Good	Yes	Yes	Yes
Consolidated	Cuttings (direct rotary)	Poor	No	No	No
	Core Barrels	Good	Yes	Yes	Yes

5.2.1 Split-spoon Samples

Split-spoon sampling is usually used in conjunction with the hollow-stem or solid-stem auger drilling method and can be used for sampling most unconsolidated and semi-consolidated sediments. It is less frequently used for air and mud rotary, and casing drive methods. It cannot normally be used to sample bedrock such as basalt, limestone, or granite. The method can be used for highly unconsolidated sands and gravels if a stainless-steel sand catcher is placed in the lower end of the sampler.

The split-spoon sampler consists of a hardened metal barrel 2 to 3 inches in diameter (2 to 2.5 inches inner diameter) with a threaded, removable fitting on the top end for connection to the drill rods and a threaded, removable "shoe" on the lower end that is used to penetrate the formation. The barrel can be split along its length to allow removal of the sample.

The steps required to obtain a representative soil sample using a split-spoon sampler are presented below.

- The borehole is advanced by augering until the top of the desired sampling interval is reached. The drill bit is then withdrawn from the hollow-stem augers.

- If samples are to be retained for laboratory analytical analysis, the sampler shall be equipped with interior liners that are composed of materials compatible with the suspected contaminants. Generally, these liners consist of brass or stainless steel and are slightly smaller than the inner diameter of the sampler. If samples are to be analyzed for metals, it is recommended that stainless steel liners be used rather than brass. The composition of the liners shall always be evaluated with respect to the types of contaminants that are suspected.

- The properly decontaminated split-spoon sampler (equipped with liners) is attached either to the drill rods or to a cable system and lowered to the bottom of the borehole through the augers.

- The sampler is then driven into the formation by either a manual or automatic hammer (usually a 140-pound weight dropped through a 30-inch interval). The number of blows required to drive the sampler should be recorded at 6-inch intervals in the boring log because blow counts provide an indication of the density/compaction of the soils being sampled. The field geologist, hydrogeologist, or geotechnical engineer shall carefully observe the internal measuring technique of the driller and keep track of sampling materials to ensure that accurate location of samples is achieved. Continuous samples can be collected with the split-spoon method by augering or drilling to the bottom of the previously sampled interval and repeating the operation. Whether continuous or intermittent, the sample collected with this method is disturbed and cannot be used for certain geotechnical tests that require undisturbed samples.

- Following sample acquisition, the split-spoon sampler is brought to ground surface and removed from the drill rods or cable system. The upper and lower

fittings are loosened and the sampler is taken to the sample handling area. At the sample handling area, the fittings are removed, the barrel of the sampler is split, and one side of the sampler is removed. At this time, it is important to observe and record the percentage of sample recovery.

The liners containing the soil samples are immediately removed from the sampler. Generally, the lowermost liner is considered the least disturbed and shall be retained as the analytical laboratory sample. However, in certain circumstances (such as with the use of a sand catcher), other liners may be more appropriate for retention as the laboratory sample. The ends of the sample liner to be retained as the analytical laboratory sample shall be covered with Teflon® film and sealed with plastic caps. The site geologist, hydrogeologist, or geotechnical engineer shall observe the ends of the liner destined for analytical sampling and describe the physical nature of the sample (e.g., soil or rock type, grain size, color, moisture, etc., as indicated in SOP, *Soil and Rock Classification*.) The sample shall then be labeled according to SOP, *Record Keeping, Sample Labeling, and Chain-of-Custody*, and immediately placed on ice in a cooler as described in SOP, *Sample Handling, Storage, and Shipping Procedures*.

- The remaining liners collected from the sample, if any, can then be used for other purposes. These include providing a duplicate sample for field QC or material for lithologic logging. These samples can also be used for headspace analysis as described in Section 5.4.

- Lithologic logging of each sample shall be conducted in accordance with the methods outlined in SOP, *Soil and Rock Classification*, and entered into the boring log presented in Figure 1. In most instances, an additional liner full of material is available for this purpose. A check shall be made to ensure that the liners all contain similar material. If an extra liner full of material is not available, then logging will be accomplished by collecting the extra material present in the end of the sampler shoe. A comparison to the material visible at the end of the sample liner destined for laboratory analysis shall be made to ensure that the entire sample consists of similar material. If not, then

Field Log of Boring

BORING NUMBER										SHEET ___ OF ___
PROJECT NAME		PROJECT NUMBER		ELEVATION AND DATUM				LOCATION		
DRILLING COMPANY		DRILLER		DATE AND TIME STARTED				DATE AND TIME COMPLETED		
DRILLING EQUIPMENT		DRILLING METHOD		COMPLETION DEPTH				TOTAL NO. OF SAMPLES		
SIZE AND TYPE OF BIT		HOLE DIAMETER		NO. OF SAMPLES	BULK	SS		DRIVE	PITCHER	
DRILLING FLUID		DRILLING ANGLE		WATER LEVEL	FIRST			AFTER _____ HOURS		
SAMPLE HAMMER TYPE DRIVING WT. DROP				HYDROGEOLOGIST/DATE				CHECKED BY/DATE		

LITHOLOGY	DEPTH (FEET)	SAMPLES	RECOVERY	BLOWN COUNT	DESCRIPTION	USCS SYMBOL	ESTIMATED PERCENT OF GR	SA	FI	COMMENTS

Figure 1
FIELD LOG OF BORING

- the different material is described to the extent possible by relating it to similar material previously encountered.

- If volatile organic compounds are suspected to be present, screening of the sample with an OVM or equivalent, and collection of headspace samples shall also be conducted according to the methods outlined in Section 5.4.

- All sampling equipment must be decontaminated prior to each use according to the methods presented in SOP, *Equipment Decontamination*.

The steps required to obtain a representative soil sample using a thin-wall sampler are presented below.

- Lithologic logging of each sample shall be conducted in accordance with the methods outlined in SOP, *Soil and Rock Classification*. If the sample is contained in a sleeve, the ends of the sample in the sleeve shall be observed to assess lithologic and stratigraphic characteristics.

- If volatile organic constituents are suspected to be present, screening of the sample with an OVM or equivalent, and collection of headspace samples shall also be conducted according to the methods outlined in Section 5.4.

- All sampling equipment must be decontaminated prior to each use according to the methods presented in SOP, *Equipment Decontamination.*

Soil or rock core samples shall be obtained with a core barrel or a 5-foot split-spoon core barrel using the following procedure:

- The core barrel shall be drilled to the appropriate sampling depth. Note: the only drilling fluid to be used while coring to obtain samples for laboratory analysis is clean, filtered air (i.e., particulate- and petroleum-free.) Distilled water may be added through the delivery system of the coring device by the driller, if necessary, provided that the drilling returns cannot be brought to the surface by air alone.

- The core barrel is then retrieved from the hole. Care must be taken to ensure that the contents of the core barrel do not fall out of the bottom of the core barrel during withdrawal and handling.

- Open the core barrel by removing both the top and bottom fittings. The sample within the inner liner can then be removed from the core barrel and taken to the sample handling area.

- All sampling equipment must be decontaminated prior to each use according to the methods presented in SOP, *Equipment Decontamination*.

5.2.2 Borehole Abandonment

Following completion of soil sampling, the borehole shall be properly abandoned unless a monitoring well is to be installed. Abandonment shall occur immediately following acquisition of the final sample in the boring and shall consist of the placement of a bentonite-cement grout from the bottom of the boring to within 2 feet of ground surface. The grout mixture shall consist of a mix of 7 to 9 gallons of water per 94 pound bag of Portland Type I or II cement with 3% to 5% by weight of powdered bentonite. Other commercial products such as Volclay® are also acceptable with approval of the Project Manager. The bentonite-cement grout shall be placed in one continuous pour from the bottom of the boring to within at least 0.5 to 2 feet of ground surface through a tremie pipe or hollow-stem augers. Additional grout may need to be placed if significant settlement occurs. The remaining portion of the boring can be filled with topsoil.

5.2.3 Pit Sampling

Soil sampling locations within each trench or pit shall be chosen on the basis of visual inspection and any VOC screening results. Samples shall be collected from either the sidewalls or the bottom of the trenches/excavations. Soil sampling should be conducted outside the trench/excavation and personnel generally should not enter a trench or pit if there is any other means (e.g., backhoe buckets, hand augers, shovels, or equivalent) to perform the work. If entry is unavoidable, then a competent person shall first determine acceptable entry conditions including sloping, shoring, and air monitoring requirements, personal protective equipment, and inspections. In addition, the site-specific Health and

Safety Plan must be amended to include applicable requirements of 29 CFR 1910.146 and 29 CFR 1926 Subpart B.

5.3 SURFACE SAMPLING

All surface soil samples shall be accurately located on field maps in accordance with AMEC SOP, *Land Surveying*, and detailed soil classification descriptions completed in accordance with AMEC SOP, *Soil and Rock Classification* shall be recorded on the surface soil sampling log (Figure 2). Methods commonly utilized for collection of surface soil samples are described below.

5.3.1 Hand Trowel

A stainless steel or disposable hand trowel may be utilized for sampling surface soil in instances where samples are not to be analyzed for volatile organics. The hand trowel is initially used to remove the uppermost 2 inches of soil and is then used to acquire a representative sample of deeper materials to a depth of 6 inches. Generally, only samples within the upper 6 inches of soil should be sampled using these methods. The depth of the sample shall be recorded in the surface soil sampling log (Figure 2). The soil classification shall include all the information outlined in AMEC SOP, *Soil and Rock Classification*.

Soil samples collected using a hand trowel are usually placed into pre-cleaned, wide-mouth glass jars. The jar is then sealed with a tight-fitting cap, labeled according to AMEC SOP, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures*, and placed on ice in a cooler in accordance with AMEC SOP, *Sample Handling, Storage, and Shipping Procedures*. All sampling equipment must be decontaminated prior to each use according to the methods presented in AMEC SOP, *Equipment Decontamination*.

5.3.2 Hand Auger

A soil recovery hand auger (SRA) consisting of a metal rod, handle, detachable stainless steel core barrel, and inner sleeves can be used to obtain both surface soil and trench samples. Multiple extensions can be connected to the sampler to facilitate the acquisition of samples at depths up to 15 feet below the existing ground surface.

SURFACE AND SHALLOW SOIL SAMPLE LOG

Project Number	Project Name	Date	Time

Sample Identification Number and Time	Checked by

Sampled by	Recorded by

Method of Collection

Surface Description

Notes

Soil Sample Data

Location

Coordinates	Elevation

LITHOLOGY	DEPTH (FEET)	DESCRIPTION	USCS SYMBOL	Est. % of G	S	F	COMMENTS

Figure 2
SURFACE AND SHALLOW SOIL SAMPLE LOG

Pre-cleaned sample liners are loaded into the core barrel prior to sampling. In general, these liners are used not only to acquire samples, but also serve as the sample container. Alternatively, in instances where VOCs are not to be analyzed or where not enough samples can be collected to completely fill a liner, samples can be transferred to wide-mouth glass jars. In either case, the sample shall be labeled according to SOP, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures* and immediately placed on ice in a cooler as indicated in SOP, *Sample Handling, Storage, and Shipping Procedures*. To minimize possible cross-contamination, the SRA and sample liners shall be decontaminated prior to each use according to the procedures described in SOP, *Equipment Decontamination*.

5.3.3 Slide Hammer Sampling

In instances where the soil type precludes the acquisition of soil samples using the SRA, a manually operated slide hammer can be used to collect relatively undisturbed soil samples from excavations and surface soils. The slide hammer consists of a 6- to 12-inch core barrel that is connected to the slide hammer portion of the device using detachable extensions.

The core sampler is typically loaded with two to four sample liners, depending on the liner length, which are not only used to acquire the samples, but also serve as the sample container. Immediately following acquisition, samples shall be labeled according to SOP, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures* and immediately placed on ice in a cooler as indicated in SOP, *Sample Handling, Storage, and Shipping Procedures*.

All of the sampling equipment that comes into contact with the sample medium shall be decontaminated in accordance with the SOP, *Equipment Decontamination*. Split-barrel slide hammer core samplers, which have recently become available, are much easier to decontaminate than the older, single-piece core barrel, and should be utilized in place of the older core barrels, where possible.

5.3.4 Hand Sampling Using Sample Liners

Surface soil samples can sometimes be collected by hand using just the sample liners. This method can be used in cases where the surface soils are soft or where it is

advantageous to minimize the disturbance of the sample (such as when sampling for volatiles). Obtaining surface soil samples with this method consists merely of pushing or driving the sample tube into the ground by hand.

The sample liner (with the collected sample inside) is then removed from the ground and capped with Teflon® film and plastic end caps. The sample is labeled according to SOP and immediately placed on ice in a cooler. All liners shall be decontaminated prior to use, in accordance with SOP, *Equipment Decontamination*. Since the only equipment used are the sample liners themselves, this method helps to minimize the required amount of equipment decontamination.

5.4 VOLATILE ORGANICS SCREENING AND HEADSPACE ANALYSIS

Volatile organics screening and headspace analysis is performed to preliminarily assess if the sample contains volatile organic constituents. Volatile organics screening and headspace analysis of samples shall be performed using a Foxboro Model 128-GC portable OVA, an HNU model PI 101 portable PID, a Microtip MP 100 PID, or other similar instrument.

Volatile organics screening and headspace analysis is intended as a field screen for the presence of VOCs. The method measures the presence or absence of VOCs in the headspace (air) above a soil sample. Various factors affect the level of VOCs volatilizing from soils, such as concentration in the soil, temperature of the soil and air, organic carbon content of the soil, equilibration time, moisture content of the soil, and the chemical and physical characteristics of the VOCs. Therefore, headspace readings can only be regarded as qualitative assessments of volatiles, and caution should be exercised if using this technique to select samples for analytical testing. OVA and PID readings can vary because the two instruments have different sensitivities to the various VOCs and are usually calibrated relative to different gas standards (i.e., methane for the OVA and isobutylene for the PID).

In order to screen samples for VOCs, the instrument probe shall be inserted into the top of the sample liner immediately after the sampler is opened. The instrument response (normally in ppm) is then recorded in the field notebook and/or the field log.

For headspace analysis, a portion of the sample is transferred into a Ziplock® bag or pre-cleaned glass jar, which is then sealed and agitated. The VOCs are allowed to volatilize into the headspace and equilibrate for 15 to 30 minutes. Next, the instrument probe is then inserted into the container to sample the headspace, and the instrument response is recorded in the field notebook and/or the field log.

6.0 RECORDS

Soil classification information collected during soil sampling should be documented in borehole, trench, and surface soil log forms. All log entries shall be made in indelible ink. Information concerning sampling activities shall be recorded on sample log forms or in the field logbook. All field logs shall be reviewed by the Project Manager or designee on at least a monthly basis. Procedures for these activities are contained in this manual. Copies of this information should be sent to the Project Manager and to the project files.

7.0 HEALTH AND SAFETY

Standard Health and Safety (H&S) practices shall be observed according to the site-specific Health and Safety Plan (HSP). Ambient air and soil vapor monitoring during excavation activities shall provide data related to relative volatile contaminant concentrations and any required personal protective equipment (PPE) that may be necessary. In addition, an air monitoring program and suggested PPE is listed in the site-specific HSP.

Suggested minimum PPE during soil sampling activities in conjunction with field excavations shall include inner disposable vinyl gloves, outer chemical protective nitrile gloves, Tyvek® coveralls, steel-toed boots and overboots, safety glasses, hearing protection (around heavy equipment in operation), and an ANSI-Standard hard hat. Half-face respirators and cartridges may be necessary depending on the contaminant concentrations and shall always be available onsite. At no time during soil sampling activities are personnel to reach for debris near machinery that is in operation.

In addition to the aforementioned precautions and depending upon the type of contaminant expected, the following safe work practices will be employed:

Particulate or Metal Compounds:

1. Avoid skin contact and/or incidental ingestion of soil.

2. Utilize protective clothing, steel-toed boots, gloves, safety glasses, and hearing protection as warranted.

Volatile Organic Compounds:

1. Avoid breathing constituents venting from soil borings, trenches, pits, or holes by approaching upwind, and/or by use of respiratory protection.

2. For trenches, pits, or holes, presurvey the area with a FID/PID prior to sampling.

3. If monitoring results indicate organic vapors that exceed action levels as specified in the site-specific HSP, sampling activities may need to be conducted in Level C protection. At a minimum, skin protection will be required by use of gloves and Tyvek® or other media that is protective against the media being encountered.

Flammable or Explosive Conditions:

1. Explosive gases should be monitored as continuously as possible using an explosimeter and oxygen meter.

2. All ignition sources should be placed upwind or crosswind of the borehole.

3. If explosive gases exceed the designated action levels as specified in the site-specific HSP, cease operations and evaluate conditions.

Physical Hazards Associated With Soil Sampling:

1. To avoid possible back strain associated with sample collection, use the large muscles of the legs, not the back when retrieving soil samplers.

2. Stay clear of all moving equipment and avoid wearing loose fitting clothing.

3. To avoid slip/trip/fall hazards, be wary of open trenches, pits, or holes.

4. To avoid heat/cold stress as a result of exposure to extreme temperature and PPE, drink electrolyte replacement fluids (1-2 cups/hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.

5. Be aware of restricted mobility due to the wearing of PPE.

6. To avoid hand, wrist, arm, shoulder, and back trauma due to the use of slide hammers or hand augers, rotate sampling among field personnel.

8.0 REFERENCES

EPA SW-846-Appendix 2, Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports.

USEPA. 1987. A Compendium of Superfund Field Operations Methods. U.S. Environmental Protection Agency/540/P-87/001.

USEPA Environmental Response Team. 1988. Response Engineering and Analytical Contract Standard Operating Procedures. U.S. EPA, Research Triangle Park, NC.

SOP, *IDW Management*

SOP, *Monitoring Well Installation*

SOP, *Soil and Rock Classification.*

SOP, *Equipment Decontamination*

SOP, *Land Surveying*

SOP, *Record Keeping, Sample Labeling, and Chain of Custody Procedures*, and

SOP, *Sample Handling, Storage, and Shipping Procedures*

9.0 ATTACHMENTS

None.