DESCRIPTION AND IDENTIFICATION OF SOILS

CONTENTS

1.0 SCOPE AND APPLICATION

2.0 METHOD SUMMARY

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

5.0 EQUIPMENT/APPARATUS

6.0 REAGENTS

7.0 PROCEDURES

- 7.1 Soil Sample Origin
- 7.2 Soil Name or Type
- 7.3 Color
- 7.4 Soil Density Classification
- 7.5 Soil Structure Classification
- 7.6 Identification and Description of Soil Components
  - 7.6.1 Major and Minor Components
  - 7.6.2 Other Components
  - 7.6.3 Recording Modified Burmister Soil Descriptions
- 7.7 Soil Moisture
- 7.8 Soil Odor
- 7.9 Photoionization/Flame Ionization Detectors
- 7.10 Hydrochloric Acid Reaction
- 7.11 Cementation

8.0 CALCULATIONS

9.0 QUALITY ASSURANCE/QUALITY CONTROL

10.0 DATA VALIDATION

11.0 HEALTH AND SAFETY

12.0 REFERENCES

12.0 REFERENCES

13.0 APPENDICES

- A - Tables
- B - Figures

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) outlines the description and identification of soils in the field using a modified Burmister System. The intent of this SOP is to establish a consistent method for describing oils that are to be sampled and analyzed in the course of a site investigation. Soil descriptions and identifications provide key information when investigating hazardous waste sites. More precise engineering parameters may be determined in a laboratory using industry-recognized methods such as those published by the American Society for Testing and Materials (ASTM).

"Soil", as used in this SOP and in the environmental field in general, is considered to be any unconsolidated natural material composed of solid particles, with the pore spaces occupied by water, gas, or liquid. The term encompasses the engineering and geological properties of the material and is not limited by depth below ground surface (bgs) or the origin of the material. According to this usage, "soils" may therefore include formal or informal geologic units and material that may also be classified as "sediments", thus implying an origin. The more traditional use of the term "soil" was generally limited to the near-surface material that serves as a medium for plant growth.

2.0 METHOD SUMMARY

Major attributes of a representative soil sample to be identified in the field include soil type or lithology (sand, silt, clay), color, texture as determined by major and minor particle sizes, and sorting. Other characteristics that may be recorded include structure, cementation, moisture content, density, the presence of accessory minerals, foreign material, odor, and hydrochloric acid (HCl) reaction. Other critical parameters of the sample collected include method of collection, location, and depth.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Because field identification of soil is a learned skill, results may vary due to experience, weather conditions, and type of sampling. Determining if a sample is representative of native soil may also present difficulties. During borehole investigations, "fallback" of material in the hole is common, particularly in loose sediment, and thus it may be difficult to identify native soil. Sampling or drilling methods other than coring may segregate size fractions so that finer-grained portions of the samples may be lost or not recognized. Soils containing large gravel or cobbles may be difficult to core consistently.

5.0 EQUIPMENT/APPARATUS

Standard materials and equipment required for soil classification are:

- Pocket knife or small spatula,
- Hand magnification lens,
- Tape measure or ruled scale,
- Grain size chart,
- Munsell color charts
- Soil boring log or field logbook

6.0 REAGENTS

- Dilute 10 percent (%) hydrochloric acid
- Water; city, non-potable or any other natural source

7.0 PROCEDURES

The following items are typically determined and recorded for soil classification.

7.1 Soil Sample Origin

A soil sample should be representative of the stratum from which it was obtained using an industry-recognized procedure (e.g., ASTM D-1581). The sample is identified by soil boring number, location, and depth. This information is recorded in a field logbook or on soil boring logs (Figure 1, Appendix B) so that the origin of the sample can be readily ascertained away from the field. An example of a completed soil boring log is presented in Figure 2, Appendix B.

7.2 Soil Name or Type

The bulk soil type should be described by a generic name such as gravel, sand, silt, or clay. This is the primary descriptor with confirming or more detail added by the identification of major and minor particle sizes.

7.3 Color

The general color of the whole sample, preferably while it is moist, is described in the field. It is preferable that the Munsell Soil Color Charts be used for the soil color determination. The Munsell system provides a field standard for classifying soil color. It embodies three aspects of color - hue, value, and chroma. The hue documents the spectral color. The value is the lightness of the color. The chroma is the degree of departure from a specific color (e.g., weak or vivid). When using the Munsell description, the order for recording color is hue, value/chroma followed by the description. For example, 5YR 5/6 describes the hue as 5YR, yellowish-red with a value of 5 and a chroma of 6. Half values can also be used for colors falling halfway between chips (e.g. 5YR 5.5/6 yellowish-red). It should be noted if the Munsell Color Charts are not used for soil color descriptions.

Soil colors may be associated with certain soil attributes and environmental conditions. Yellow to reddish soil color may be indicative of the presence of oxidized iron (Fe^{+3}) and well-aerated soils.

The terms redoximorphic or mottling are used when several colors are present within a soil. These features are described using the following terms:

- size (small, medium, large),
- shape (round, semi-round, angular),
- edge contrast (smooth, sharp, distinct),
- density/abundance (frequent, infrequent).

7.4 Soil Density Classification

Density is determined through standard penetration resistance. Resistance in granular (cohesionless) soils is referred to as relative density while resistance in cohesive soils is referred to as soil consistency.

In the field, standard penetration resistance is the number of blows required to drive a standard two-inch outer diameter (OD) split-spoon sampler 12 inches into the soil column using a 140-pound hammer falling freely through 30 inches. The sampler is driven in three six-inch intervals for a total of 18 inches. The number of blows is recorded for each 6-inch interval. The N value is the number of blows required for the last 12 inches. This test demonstrates the compactness of granular soils, while it demonstrates the consistency of cohesive (silt and clay) soils on a shearing strength basis (Table 1, Appendix A).

7.5 Soil Structure Classification

Record soil structure attributes, as applicable, using the criteria described in Table 2, Appendix A.

7.6 Identification and Description of Soil Components.

7.6.1 Major and Minor Components

Examine the soil sample to determine the following components:

- Amount of sorting in the sediment (Figure 3, Appendix B),
- Size distribution (gravel, sand, silt, clay) (Tables 3 and 4, Appendix A),
- Major and minor components,
- Predominating grain shape (roundness) (Figure 4, Appendix B),
- Degree of compaction.

7.6.2 Other Components

Examine the soil sample to identify other components that may be present:

- Roots and root mass,
- Vegetation, peat, organic matter,
- Shells or fossils,
- Accessory minerals such as mica, gypsum, and magnetite,
- Slag, cinder or charcoal, trash, rubbish, fill, bricks, glass.

7.6.3 Recording Modified Burmister Soil Descriptions

Use the following guidelines when recording soil descriptions:

- If major component comprises more than 50% of the soil, than fully capitalize the major component descriptor (e.g., SAND);

- If the major component comprises less than 50% of the soil, capitalize the descriptor (e.g., Sand);

- Place a comma after the major and minor component descriptors;

- Place size qualifiers such as coarse, medium, or fine before the major component descriptors (Table 1, Appendix A);

- Describe the minor component with the first letter capitalized, preceded by the size descriptor (e.g., Fine Sand);

- Use these adjectives when describing the minor fraction(s):
  and = 35 to 50%
  some = 20 to 35%
  little = 10 to 20%
  trace = <10%

- Record formal or informal geological names for soil bodies when probable identification can be made from the literature or local experience.

Some examples of modified Burmister soil descriptions are:

- Gray medium to fine GRAVEL and coarse to fine Sand, trace silt;
- 2.5YR 5/4 reddish brown coarse to medium SAND, little Clayey Silt, some medium to fine Gravel; layered, occasional lens coarse Sand;
- Wet, Very loose grey 3/1 dark gray to black, fine to coarse SAND, little rounded fine to coarse Gravel, trace Silt, some debris (wood, organics, cinders)(fill).

7.7 Soil Moisture

Note the moisture content as dry, moist or wet. Dry refers to the absence of moisture, dusty, dry to the touch; moist is damp with no visible water; wet has visible free water and the soil sample is usually collected below the water table. The top of the capillary fringe should be recorded, if it can be identified, and the date noted on the soil boring log or in the field logbook.

7.8 Soil Odor

Soil odor may be classified as organic or chemical. Some decaying organic soils may exhibit a rotten egg or vegetable odor; whereas, contaminated soils may have a petroleum or chemical smell. Caution should be used and soil odors should not be inhaled directly if contaminants are suspected.

7.9 Photoionization/Flame Ionization Detectors

Photoionization detectors (PIDs) and/or flame ionization detectors (FIDs) may be used to identify areas of contamination. Detectors are sensitive to particular compounds, depending on the type of detector. Weather conditions, temperature, and moisture content of the sample may affect the readings. When measured, these readings are recorded on the soil boring logs or in the field logbook along with location and any other descriptors (i.e., discoloration between laminations or in fill).

7.10 Hydrochloric Acid Reaction

Reaction to a drop or two of dilute HCl is noted as strong, weak, or none. Strong refers to a violent reaction, with bubbles forming immediately; weak is some reaction, with the slow formation of bubbles; and none is any visible reaction. This test identifies the presence of carbonates, either in the cement (if present) or the soil matrix. Caution must be exercised when handling acids.

7.11 Cementation

Cementation is an indicator of cohesiveness and should be recorded as strong, moderate, or weak. Intact soils that will not crumble or break with finger pressure are classified as strong. Moderate refers to intact soils that crumble or break with considerable finger pressure and weak refers to those that crumble or break with handling or little finger pressure. Cement type can often be recognized. Common cement types are iron and carbonate (effervesces with dilute hydrochloric acid).

8.0 CALCULATIONS

This section not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

All data must be documented on soil boring logs or in field logbooks.

10.0 DATA VALIDATION

If additional analyses (e.g., sieve analyses or other engineering tests) are required by a laboratory, the results will be reviewed prior to release. All soil boring logs will become part of a deliverable package and will be reviewed in accordance with SERAS Administrative Procedure (AP) #22, *Peer Review of SERAS Deliverables*.

11.0 HEALTH AND SAFETY

General field safety practices must be followed. Waste samples should be handled with care and disposed of in accordance with SERAS SOP #2049, *Investigation-Derived Waste Management*. Refer to the specific material safety data sheet (MSDS) for any chemical or reagent utilized in this procedure. All excess samples, used samples, and waste material generated during any additional analysis not covered in this SOP must be disposed in accordance with SERAS SOP #1501, *Hazardous Waste Management.*

When working with potentially hazardous materials, follow United States Environmental Protection Agency (U.S. EPA), Occupational Safety and Health Administration (OSHA), and corporate health and safety procedures.

12.0 REFERENCES

American Society of Testing and Materials (ASTM). 2000. *Annual Book of ASTM Standards*, Designation D2488 - 00: Description and Identification of Soils (Visual-Manual Procedure).

13.0 APPENDICES

A - Tables
B - Figures

APPENDIX A
Tables
SOP #2074
February 2004

TABLE 1. Relative Density and Consistency of Soils

Compactness of Cohesionless Soils

Relative Density	*Standard Penetration Resistance,* (bpf) blows per foot
very loose	0-4
loose	5-10
medium dense	11-30
dense	31-50
very dense	>50

> = greater than

Consistency of Cohesive Soils

Consistency	*Unconfined Compressive Strength,* (tons per ft^2)	*BPF*	*Field Identification*
very soft	<0.25	0-2	Easily penetrated several inches with fist.
soft	0.25-0.50	3-4	Easily penetrated several inches with thumb.
medium stiff	0.50-1.0	5-8	Penetrated several inches with thumb under moderate pressure.
stiff	1.0-2.0	9-15	Readily indented with thumb, but penetrated with great effort.
very stiff	2.0-4.0	16-30	Readily indented with thumbnail.
hard	>4.0	>30	Indented with difficulty with thumbnail.

ft^2 = foot squared, < = less than

TABLE 2. Soil Structures

Examples of Soil Structures

Description	*Criteria*
Stratified	alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	alternating layers of varying material less than 6 mm thick, note thickness
Massive	no visible layers
Stringers	layers or different material or color
Lenses	small pockets of different material or color; note thickness and extent.
Homogeneous	same color and appearance throughout.
Heterogeneous	non-uniform color and appearance throughout.

mm = millimeters

Bedding Thickness

Thickness (English)	*Thickness (Metric)*	*Bedding Classification*
>3.3'	>1m	v. thickly bedded
1'-3.3'	30cm-1m	thickly bedded
4"-1'	10cm-30cm	medium bedded
1"-4"	3cm-10cm	thinly bedded
2/5"-1"	1cm-3cm	v. thinly bedded
1/8"-2/5"	3mm-1cm	laminated
1/32"-1/8"	1mm-3mm	thinly laminated
< 1/32"	<1mm	microlaminated

m = meters, cm = centimeters, mm= millimeters, > = greater than, < = less than, v. = very, ‘ = inches

TABLE 3. Grain Size and Type Definitions

Component	*Definition*	*Fractions*	*Upper Sieve Limit*	*Lower Sieve Limit*
boulders	lithified material > 9 inches			9 inch
cobbles	lithified material < 9 inched but > 3 inches		9 inch	3 inch
gravel	material passing through the 3 inch sieve and retained on the no. 10 (2000-micron) sieve	Coarse Medium Fine	3 inch 1 inch 1/8 inch	1 inch 1/8 inch No. 10
sand	material passing the No. 10 sieve and retained on the No. 200 (74 micron) sieve	Coarse Medium Fine	No. 10 (2000 micron) No. 30 (590 Micron) N0. 60 (250 micron)	No. 30 N0. 60 No. 200
silt	Material passing the 200 sieve that is non-plastic in character and exhibits little or no strength when air dried	Coarse Fine	No. 200 (74 micron) 0.02 mm	0.02 mm
clay	Material passing the No. 200 sieve which can be made to exhibit plasticity and clay qualities within a certain range of moisture content, and which exhibits considerable strength when air dried.			

< = less than, > = greater than, mm = miliimeters

TABLE 4. Field Identification of Silt and Clay Component Ratio

Component	*Smallest Diameter of Rolled Thread*	*Plasticity Index*	*Plasticity*
silt	none	0	Non-plastic
clayey silt	thread crumbles at1/4"	1 to 5	slight
silt and clay	thread crumbles at 1/8"	5 to 10	Low
clay and silt	thread crumbles at 1/16"	10 to 20	medium
silty clay	thread crumbles at 1/32"	20 to 40	High
clay	thread crumbles at 1/64"	>40	very high

" = inches, > = greater than

APPENDIX B
Figures
SOP #2074
February 2004

FIGURE 1. Example Soil Boring Log

BORING LOG

		HOLE ID
1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	SHEET 1 OF 1 SHEETS
3. PROJECT	4. LOCATION	
5. NAME OF DRILLER	6. HOLE LOCATION (SEE REPORT & SITE PLAN)	
7. SIZES AND TYPE OF DRILLING AND SAMPLING EQUIPMENT	8. DATE STARTED	9. DATE COMPLETED
	10. TOTAL DEPTH OF HOLE	
11. OVERBURDEN THICKNESS	12. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	14. SIGNATURE OF INSPECTOR	
15. DISPOSITION OF HOLE	BACKFILLED / MONITORING WELL / OTHER (SPECIFY)	

ELEV	DEPTH FT.	DESCRIPTION OF MATERIALS	PID READING(S)	REMARKS
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			
	14			
	15			
	16			
	17			

FIGURE 2. Completed Soil Boring Log

FIGURE 3. Soil Boring Log

BORING LOG

HOLE ID: MCB-3

1. COMPANY NAME: Locked Martin (REAC)
2. DRILLING SUBCOTRACTOR: GROTZK DRILLING. CO
SHEET 1 OF 1 SHEETS
3. PROJECT: Benda Site
4. LOCATION: Interior Building
5. NAME OF DRILLER: Mark
6. HOLE LOCATION: (SEE REPORT & SITE PLAN)
7. SIZES AND TYPE OF DRILLING AND SAMPLING EQUIPMENT: acetate sleeves
GEOPROBE
8. DATE STARTED: 5/9/2003
9. DATE COMPLETED: 9-May-03
10. TOTAL DEPTH OF HOLE: 16 FT.
11. OVERBURDEN THICKNESS:
12. DEPTH GROUNDWATER ENCOUNTERED: DRY
13. DEPTH DRILLED INTO ROCK:
14. SIGNATURE OF INSPECTOR: Gary Newhart
15. DISPOSITION OF HOLE: BACKFILLED: x | MONITORING WELL: | OTHER (SPECIFY):

ENVIRONMENTAL SAMPLES	DEPTH FT.	DESCRIPTION OF MATERIALS BURMISTER SYSTEM	PID READINGS	REMARKS UNIFIED SYSTEM
0-4 FT	1	Med. To fine SAND,some fine gravel (fill)		rec. only 6inches
	2			SW
	3			
	4			
	5	Brown, f.SILT & Clay organic peat stringers		Marsh deposit very wet
	6			rec. 42 in. OL
	7			
	8			
	9	f.to coarse SAND,some f.to med.gravel,some silt		Fluvial deposit saturated SW
	10			
	11			
	12			SW
	13	v.dk. Brown med(+) to coarse SAND &med.GRAVEL,little silt		Fluvial deposit heavily stained
	14	Green Saprolite/Residual Clay DRY		severly weathered
	15			
	16	E.O.B. @ 16FT.		
	17			

Figure 3 Soil Sorting

poorly sorted moderately sorted well-sorted

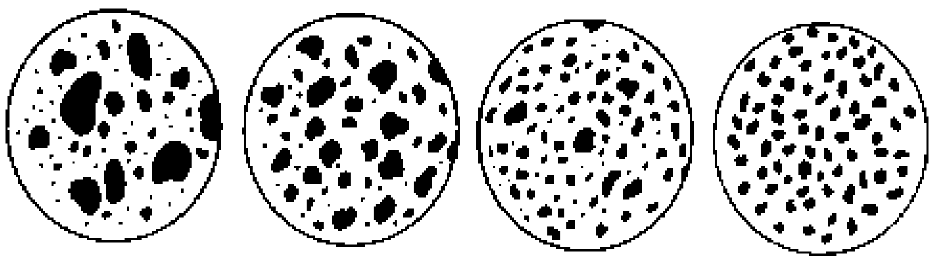

FIGURE 4. Grain Shape Diagram

well-rounded rounded sub-rounded sub-angular angular