Chapter 4
Borehole Logging

4-1. General

Each boring log should fully describe the subsurface environment and the procedures used to gain that description. Guidance on field logging of subsurface explorations of soil and rock may be found in ASTM Standard Guide D 5434.

4-2. Format

All borings should be recorded in the field on Engineer (ENG) Form 1836 and 1836-A, per EM 1110-1-1804 (Figure 4-1) or on ENG Form 5056-R and 5056A-R, developed for HTRW work (see Figure 4-2). This guidance applies to in-house and contracted activities. Suggested data for recording are discussed throughout this manual. Because of the large quantity of information routinely required on logs at HTRW sites, a scale of 25 mm (1 in.) on the log equaling 300 mm (1 ft) of boring is usually adequate.

4-3. Submittal

Each original boring log should be submitted directly from the field to the FA after each boring is completed. In those cases where a monitoring well or other instrument is to be inserted into the boring, both the log for that boring and the installation diagram may be submitted together.

4-4. Original Logs and Diagrams

Only the "original" boring log (and diagram) should be submitted from the field to the FA. Carbon, typed, or reproduced copies are not considered "original." The original should be of sufficient legibility and contrast to provide comparable quality in reproduction.

4-5. Time of Recording

Logs should be recorded directly in the field without transcribing from a field book or other document. This technique lessens the chance for errors of manual copying and allows the completed document to be field-reviewed closer to the time of drilling.

4-6. Routine Entries

In addition to the data desired by the FDO and uniquely required by the drilling plan, the information should include those items listed in ASTM Standard Guide D 5434, except items under section 6.1.4 in D 5434. The other exceptions would be weather conditions, and certain items concerning sample handling procedures in sections 6.1.6 and 6.1.7 in D 5434. Sample handling procedures are required to be entered in the field logbook that is described in EM 200-1-3. The following information should also be routinely entered on the boring log.

a. Each boring and well (active and abandoned) should be uniquely numbered and located on a sketch map as part of the log.

b. Depths/heights should be recorded in meters (feet) and decimal fractions thereof (millimeters or tenths of feet). English units are acceptable if typically used by the site geologist.

c. Field estimates of soil classifications shall be in accordance with ASTM Standard Practice D 2488 and shall be prepared in the field at the time of sampling by the geologist. Guidance on soil and rock classification may also be found in EM 1110-1-1906, Spigolon 1993, Murphy 1985 and U.S. Army FM 5-410.

d. Each soil sample taken should be fully described on the log. The descriptions of intact samples should include the parameters shown in Table 4-1.

e. In the field, visual numeric estimates should be made of secondary soil constituents; e.g., "silty sand with 20 percent fines" or "sandy gravel with 40 percent sand." If such terms as "trace," "some," "several," etc., are used, their quantitative meaning should be defined on each log.

f. When used to supplement other sampling techniques, disturbed samples (e.g., wash samples, cuttings, and auger flight samples) should be described in terms of the appropriate soil/rock parameters to the extent practical. "Classification" should be minimally described for these samples along with a description of drill action and water losses/gains for the corresponding depth. Notations should be made on the log that these descriptions are based on observations of disturbed material rather than intact samples.

g. Rock core should be fully described on the boring log. Typical rock core parameters are shown in Table 4-2.

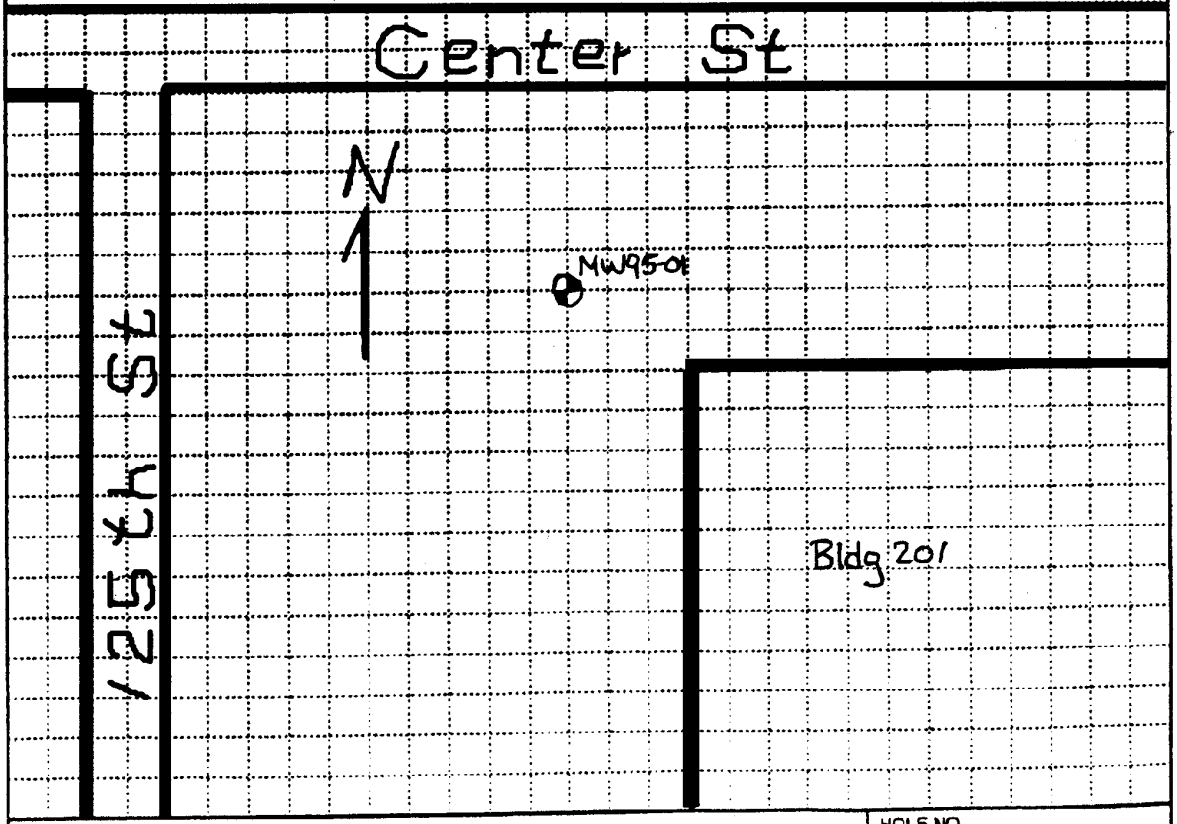
h. For rock core, a scaled graphic sketch of the core should be provided on or with the log, denoting by depth, location, orientation, and nature (natural or coring-induced) of all core breaks. Also mark the breaks purposely made to fit the core into the core boxes. If fractures are too numerous to be individually shown, their location may be drawn as a zone and described on the log. Also note, by

HTRW DRILLING LOG

DISTRICT: OMAHA
HOLE NUMBER: MW95-01
SHEET 1 OF 3 SHEETS

1. COMPANY NAME: CONTRACTING FIRM, INC.
2. DRILL SUBCONTRACTOR: SUBCONTRACT DRILLERS, INC
3. PROJECT: BIG SUPERFUND SITE
4. LOCATION: Site A
5. NAME OF DRILLER: JOE SUPER DRILLER
6. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 Milwaukee Heavy Duty Drill Rig
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: CME-75, using 4 1/4" hollow stem augers, 3" O.D. Stainless Steel split-spoons (chemical and geotech), bullet bit (outer) drag bit (inner)
8. HOLE LOCATION: See Map Below
9. SURFACE ELEVATION: Not Yet Available
10. DATE STARTED: 8-6-95
11. DATE COMPLETED: 8-7-95
12. OVERBURDEN THICKNESS: 12.0'
13. DEPTH DRILLED INTO ROCK: 0
14. TOTAL DEPTH OF HOLE: 12.0'
15. DEPTH GROUNDWATER ENCOUNTERED: 5.0'
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: 4.5' TOC ~72 hours (in well)
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)
18. GEOTECHNICAL SAMPLES: DISTURBED 0; UNDISTURBED 0
19. TOTAL NUMBER OF CORE BOXES: 0
20. SAMPLES FOR CHEMICAL ANALYSIS: VOC; METALS; OTHER (SPECIFY): BTEX 4x40z; OTHER (SPECIFY): TRPH 2x8 oz; OTHER (SPECIFY): Lead 2x8 oz.
21. TOTAL CORE RECOVERY: 0 %
22. DISPOSITION OF HOLE: BACKFILLED; MONITORING WELL: 8-6-92; OTHER (SPECIFY)
23. SIGNATURE OF INSPECTOR: Field Geologist

LOCATION SKETCH/COMMENTS — SCALE: 1" = 20'



PROJECT: BIG SUPERFUND SITE
HOLE NO.: MW95-01

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

Figure 4-1. Boring log format (Sheet 1 of 3)

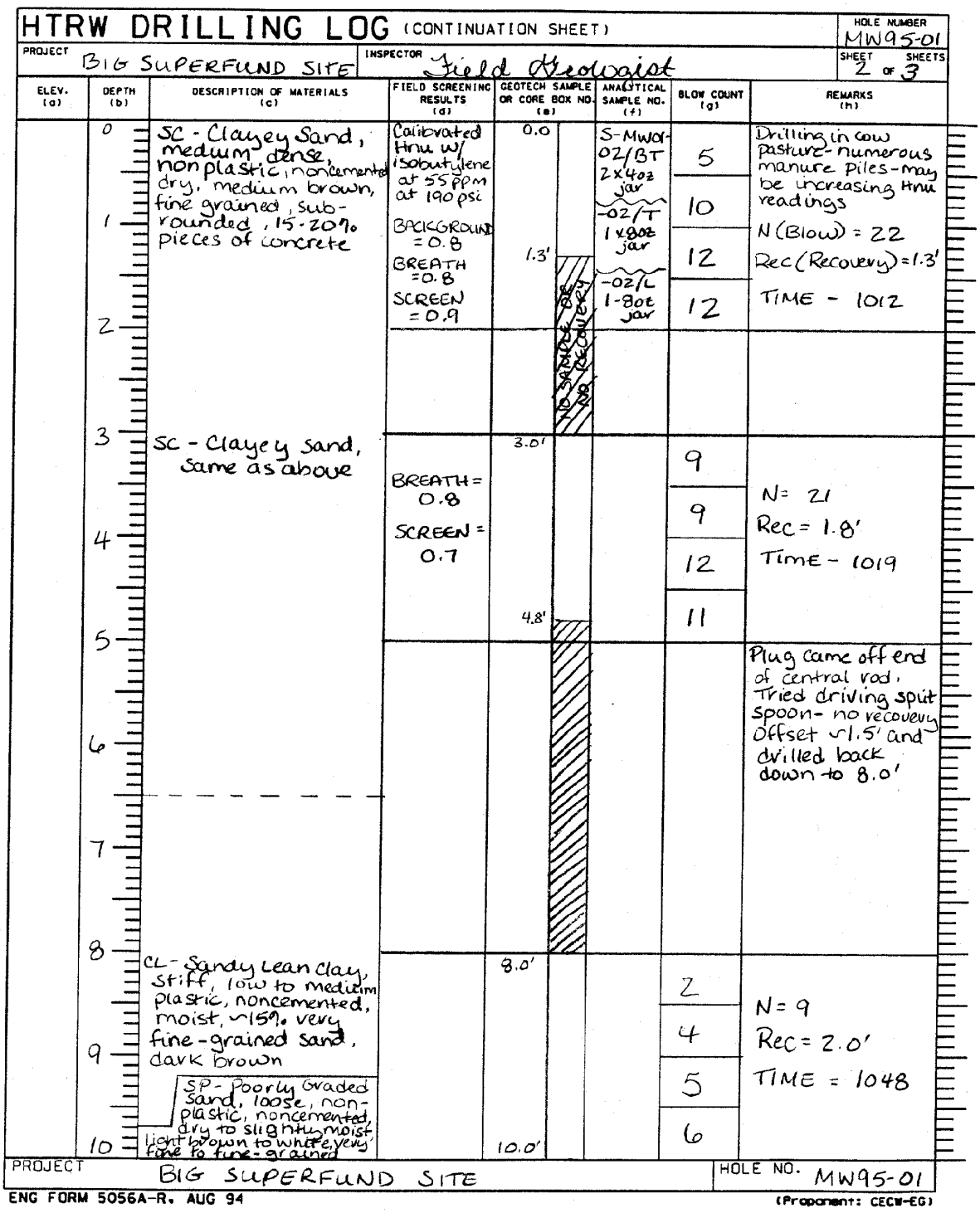


Figure 4-1. (Continued) **(Sheet 2 of 3)**

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER MW95-01

PROJECT BIG SUPERFUND SITE

INSPECTOR Field Geologist

SHEET 3 OF 3 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	10	SP- Poorly Graded Sand, dense, non-plastic, patchy light cementation, moist, light brown to grayish white, very fine to fine-grained, subrounded	Breath = 0.8 Screen = 0.7	10.0		6 24 56 60	N=80 Rec = 2.0' Time - 1144
	11						
	12			12.0'			
		BOTTOM OF HOLE = 12.0'					Bailed sand from inside bottom of augers. Installed well to top of seal. 8-7-95 - Grouted to surface. Did surface completion. See attached well construction diagram.
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						

PROJECT BIG SUPERFUND SITE HOLE NO. MW95-01

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

Figure 4-1. (Concluded) **(Sheet 3 of 3)**

HTRW DRILLING LOG	DISTRICT		HOLE NUMBER
1. COMPANY NAME	2. DRILLING SUBCONTRACTOR		SHEET OF SHEETS
3. PROJECT		4. LOCATION	
5. NAME OF DRILLER		6. MANUFACTURER'S DESIGNATION OF DRILL	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT		8. HOLE LOCATION	
		9. SURFACE ELEVATION	
		10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS		15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK		16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE		17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

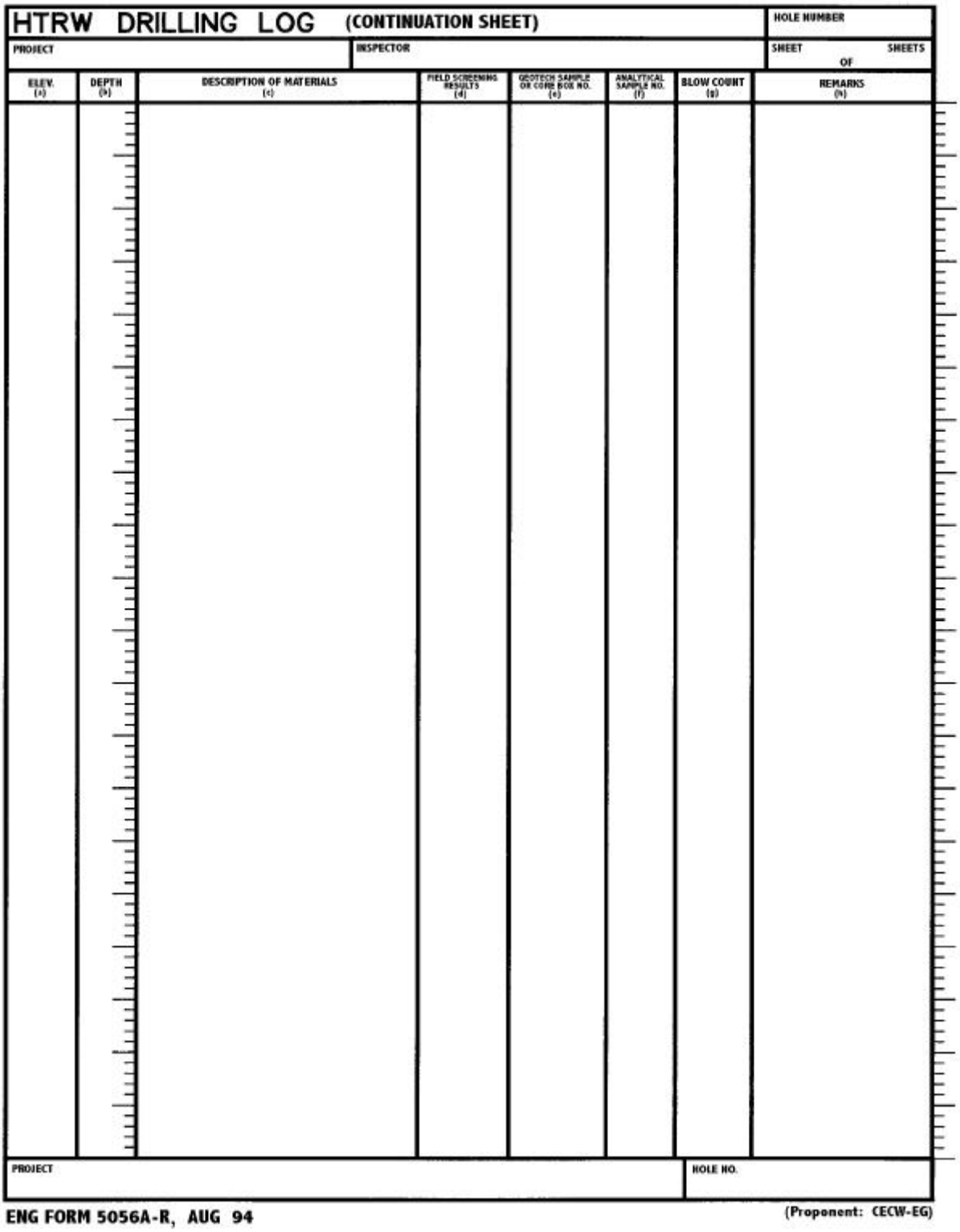
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

LOCATION SKETCH/COMMENTS SCALE:

PROJECT	HOLE NO.

Figure 4-2. HTRW Drilling Log



HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER

PROJECT

INSPECTOR

SHEET SHEETS OF

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)

PROJECT

HOLE NO.

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

Figure 4-2 (Concluded)

Table 4-1
SOIL PARAMETERS FOR LOGGING

PARAMETER	EXAMPLE
Classification	Sandy clay
Depositional environment and formation, if known	Glacial till, Twin Cities Formation
ASTM D 2488 Group Symbol	CL (field estimate)
Secondary components and estimated percentages	Sand: 25 percent Fine sand 5 percent Coarse sand 20 percent
Color (Soil color charts such as Munsell Soil or the Geological Society of America (GSA) Rock Color Chart are helpful for describing the color of soil samples. If a color chart is used, give both narrative and numerical description and note which chart was used. Suggested standard colors can be found in Spigolon 1993)	Gray: (Gr) (7.5 YR 5.0 (Munsell))
Plasticity	Low plasticity
Consistency (cohesive soil)	Very soft, soft, medium stiff, very stiff, hard
Density (noncohesive soil)	Loose, medium loose, dense, very dense
Moisture content Use a relative term. Avoid a percentage unless a value has been measured.	Dry, moist, wet, saturated
Structure and orientation	No apparent bedding: numerous vertical, iron-stained, tight fractures
Grain angularity	Rounded

depth, the intervals of all lost core and hydrologically significant details. This sketch should be prepared at the time of core logging, concurrent with drilling.

i. A record of the brand name and amount of any bentonite used for each boring should be made on the log, along with the reason for and start (by depth) of this use. If measured, record mud viscosities and weight.

j. The drilling equipment used should be generally described on each log. Include such information as rod size, bit type, pump type, rig manufacturer, and model.

k. Each log should record the drilling sequence; e.g.:

(1) Opened hole with 8-in. auger to 9 ft;

(2) Set 8-in. casing to 10 ft;

(3) Cleaned out and advanced hole with 8-in. roller bit to 15 ft (clean water, no water loss);

(4) Drove 1-3/8-in. ID X 2-in. outside diameter (OD) sampler to 16.5 ft;

(5) Advanced with 8-in. roller bit to 30 ft, 15-gal water loss;

(6) Drove 1-3/8-in. ID X 2-in. OD sampler to 31.5 ft;

(7) Hole heaved to 20 ft; and

(8) Mixed 25 lb of ABC bentonite in 100 gal of water for hole stabilization and advanced with 8-in. roller bit to 45 ft, etc.

l. All special problems and their resolution should be recorded on the log; e.g., hole squeezing, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, unrecovered tools in hole, lost casings, etc.

m. The dates and times for the start and completion of borings should be recorded on the log along with notation by depth for drill crew shifts and individual days.

n. Each sequential boundary between the various soils and individual lithologies should be noted on the log by depth. When depths are estimated, the estimated range

Table 4-2
ROCK CORE PARAMETERS FOR LOGGING

PARAMETER	EXAMPLE
Rock type	Limestone, sandstone, granite
Formation	Anytown Formation
Modifier denoting variety	Shaly, calcareous, siliceous, micaceous
Bedding/banding characteristics	Laminated, thin bedded, massive, cross bedded, foliated
Color (Color charts such as Munsell or the GSA Rock Color Chart are helpful for describing the color of rock samples. If a color chart is used give both narrative and numerical description and note which chart was used. Suggested standard colors can be found in Spigolon 1993).	Light brown: (lBr)
Hardness	Soft, very hard
Degree of cementation	Poorly cemented, well cemented
Texture	Dense, fine-, medium-, coarse-grained, glassy, porphyritic, crystalline
Structure and orientation	Horizontal bedding, dipping beds at 30 degrees, highly fractured, open vertical joints, healed fractures, slickensides at 45 degrees, fissile
Degree of weathering	Unweathered, slightly weathered, highly weathered
Solution or void conditions	Solid, cavernous, vuggy with partial infilling by clay
Primary and secondary permeability, include estimates and rationale	Low primary; well cemented High secondary: several open joints
Lost core interval and reason for loss	50-51 ft, noncemented sandstone likely

should be noted along the boundary.

o. The depth of first encountered free water should be indicated along with the method of determination; e.g., “37.6 ft from direct measurement after drilling to 40.0 ft”; “40.1 ft from direct measurement in 60-ft hole when boring left overnight, hole dry at end of previous shift”; or “25.0 ft based on saturated soil sample while sampling 24-26 ft.” Any other distinct water level(s) found below the first should also be described.

p. The interval by depth for each sample taken, classified, and/or retained should be noted on the log. Record the length of sampled interval, length of sample recovery, and the sampler type and size (diameter and length).

q. A record of the blow counts, hammer type and weight, and length of hammer fall for driven samplers should be made. For thin wall samplers, indicate whether the sampler was pushed or driven and the pressure/blow count per drive. Blow counts should be recorded in 150 mm (0.5 ft) foot increments when standard penetration (ASTM D 1586) samplers (35 mm [1-3/8 in.] ID X 50 mm [2 in.] OD) are used. For penetration less than a half foot, annotate the count with the distance over which the count was taken. Blow counts, in addition to their engineering significance, may be useful for stratigraphic correlation. (See Hsai-Wong Fang (1991) for interpretation of blow counts when 75-mm (3-in.) samplers are used).

r. When drilling fluid is used, a quantitative record should be maintained of fluid losses and/or gains and the interval over which they occur. Adjustment should be made for fluid losses due to spillage and intentional wasting (e.g., recirculation tank cleaning) to more closely estimate the amount of fluid lost to the subsurface environment.

s. Record the drilling fluid pressures typically used during all drilling operations (aqueous and pneumatic) and the driller's comments on drillability, drill speed, down pressure, rotation speed, etc.

t. Note the total depth of drilling and sampling on the log.

u. Record significant color changes in the drilling fluid return, even when intact soil samples or rock core are being obtained. Include the color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change.

v. Soil gas readings, if taken, should be recorded on the log. Each notation should include interval sampled and reading. A general note on the log should indicate meter manufacturer, model, serial number, and calibration material. If several meters are used, key the individual readings to the specific meter.

w. Special abbreviations used on a log and/or well diagram should be defined in the log/diagram where used.