CHAPTER 4. LOGGING TEST HOLES

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FIGURES

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Logging is the recording of data concerning the materials and conditions in individual test holes. It is imperative that logging be accurate so that the results can be properly evaluated to provide a true concept of subsurface conditions. It is equally imperative that recorded data be concise and complete and presented in descriptive terms that are readily understood and evaluated in the field, laboratory, and design office.

The basic element of logging is a geologic description of the material between specified depths or elevations. This description includes such items as name, texture, structure, color, mineral content, moisture content, relative permeability, age, and origin. To this must be added any information that indicates the engineering properties of the material. Examples are gradation, plasticity, and the Unified soil classification symbol based on field identification. In addition, the results of any field test such as the blow count of the standard penetration test must be recorded along with the specific vertical interval that was tested.

After a hole is logged, it should be plotted graphically to scale and properly located both vertically and horizontally on the applicable cross section or profile on form SCS-35. Correlation and interpretation of these graphic logs indicate the need for any additional test holes and their location and permit the plotting of stratigraphy and structure and the development of complete geologic profiles. Analysis of the geologic profile frequently gives more information on the genesis of deposits.

Field Notes

Data from test holes can be logged directly on the standard form or in a separate notebook. Field notes should contain all the data for both graphic and written logs and also any information that is helpful to a geologist in making interpretations but that is not entered in the log.

Items to be considered in logging a test hole follow.

1. Hole No., location, and surface elevation.--Number holes in the sequence in which they are drilled within each area of investigation. These areas have been assigned standard Nos. (chapter 7). Show location by station No. or by reference to some base. Show elevation above mean sea level if it is known, otherwise elevation from an assumed datum.
2. Depth.--Record the depth to the upper and lower limits of the layer being described.
3. Name.--In unconsolidated materials, record the name of the primary constituent first, then as a modifier, the name of the second most prominent constituent, for example, sand, silty. Usually two constituents are enough. If it is desirable to call attention to a third, use the abbreviation w/________after the name, for example, sand, silty w/cbls (with cobbles).

4. Texture.--Record size, shape, and arrangement of individual minerals or grains. In consolidated rock, descriptive adjectives are usually enough. In unconsolidated material, use descriptive adjectives for size and give an average maximum size in inches or millimeters. Record shape by such terms as equidimensional, tabular, and prismatic and by the degree of roundness (chapter 1). Record arrangement by estimated relative amounts. Record the gradation for coarse-grained unconsolidated materials and the sorting for poorly graded materials.
5. Structure.--Describe any features of rock structure that you observed, such as bedding, laminations, cleavage, jointing, concretions, or cavities. Where applicable, include information on size, shape, color, composition, and spacing of structural features.
6. Color.--Record color for purposes of identification and correlation. Color may change with water content.
7. Moisture content.--Note whether the material is dry, moist, or wet.
8. Mineral content.--Record identifiable minerals and the approximate percentage of the more abundant minerals. Describe any mineral that is characteristic of a specific horizon and record its approximate percentage even though it occurs in very minor amounts. Record the kind of cement in cemented materials.
9. Permeability.--Estimate the relative permeability and record it as impermeable, slowly permeable, moderately permeable, or rapidly permeable. If a field permeability test is run, describe the test and record the results.
10. Age, name, and origin.--Record geologic age, name, and origin, for example, Jordan member, Trempeleau formation, Cambrian age; Illinoian till; Recent alluvium. Use the term "modern" for sediments resulting from culturally accelerated erosion, as established by Happ, Rittenhouse, and Dobson in 1940. Distinguish between Recent and modern deposits. For valley sediments, identify the genetic type of the deposit and the association to which it belongs. Such identification helps in correlation and in interpreting data from test holes. Similarly, knowing that a material is of lacustrine or eolian origin or that it is a part of a slump or other form of mass movement helps in evaluating a proposed dam site.
11. Strength and condition of rock.--Record rock condition by strength (chapter 1), degree of weathering, and degree of cementation.
12. Consistency and degree of compactness.--Describe consistency of fine materials as very soft, soft, medium, stiff, very stiff, and hard. Describe degree of compactness of coarse-grained soils as very loose, loose, medium, dense, and very dense (tables 2-1 and 7-2).
13. Unified soil classification symbol.--For all unconsolidated materials give the Unified soil classification symbol. In this classification, borderline materials are given hyphenated symbols, such as CL-ML and SW-SM. Ordinarily, this borderline classification cannot be determined in the field. If there is any doubt about the proper classification of material, record it as "CL or ML" and "SW or SM" and not by the borderline symbols. Record the results of field-identification tests, such as dilatance, dry strength, toughness, ribbon, shine, and odor (chapter 1).

14. Blow count.--Where the standard penetration test (chapter 2) is made, record the results and the test elevation or depth. This test shows the number of blows under standard conditions that are required to penetrate 12 inches or, with refusal, the number of inches penetrated by 100 blows. The latter is commonly recorded as 100/d, where d equals the number of inches penetrated in 100 blows.
15. Other field tests.--If other field tests are made, record the results and describe each test well enough so that there is no doubt as to what was done. Examples are vane-shear test, pressure test, field-density test, field tests for moisture content, acetone test, and the use of an indicator such as sodium fluorescein to trace the flow of ground water.
16. Miscellaneous information.--Record any drilling difficulties, core and sample recovery and reasons for losses, type and mixture of drilling mud used to prevent caving or sample loss, loss of drilling fluid, and any other information that may help in interpreting the subsurface condition.
17. Water levels.--Record the static water level and the date on which the level was measured. Wait at least 1 day after the hole has been drilled to measure the water level to allow time for stabilization.

Graphic Logs

For correlation, show individual graphic columns at their correct location and elevation on forms SCS-35A, -35B, and -35C, Plan and Profiles for Geologic Investigation. Use the geologic symbol patterns shown in the legend on form SCS-35A. It is important that graphic logs be plotted to scale and properly referenced to elevation. Use mean sea level (m.s.l.) for the reference plane if possible or an assumed datum if m.s.l. is not known. Graphic columns that are off the centerline profile may show as being above or below the ground level of the profile, depending on the ground elevation of the boring. In this event, make a notation at the top of the column that shows the location in respect to the centerline of the profile.

Indicate the location of the static water table by a tick mark at the correct elevation and record the date of measurement. Show the Unified soil classification system symbol next to each stratum on the graphic column as a further guide to interpretation and sample requirements. To the left of the graphic log, record the blow count opposite the specific horizon tested. Use adjectives and their abbreviations given in the legend on form SCS-35A for other salient features of the material, for example, wet, hard, mas. (massive). On both plans and profiles number the holes according to their location. On plans show the location of holes by the proper symbol and indicate whether the hole was sampled.

Plot the graphic log as soon as a particular hole has been drilled. Where the space provided on SCS-35A, -35B, and -35C is too small to permit plotting at a scale that shows the information legibly, use form SCS-315. An HB pencil is recommended for plotting. Keep the pencil point fairly sharp or use a thin-lead mechanical pencil. Use enough pressure to make the lines and lettering dense and opaque. Keep the work neat and accurate.

Recommended Scales

The horizontal scale used should be such that the graphic logs are spaced far enough apart for the necessary information to be shown legibly. The vertical scale used should be such that the vertical sequence can be depicted adequately. The following scales are recommended for the different features of a site.

A. Vertical--1 inch equals 10 feet. Increase it to 1 inch equals 5 feet for special situations, such as complex logs in which many thin horizons need to be delineated accurately.
B. Horizontal.
   1. Plan of site (all components)--1 inch equals 100 feet.
   2. Profiles.
      a. Centerline of dam, emergency spillway, and borrow grids--1 inch equals 100 feet.
      b. Centerline of principal spillway and the stream channel below the outlet end of the principal spillway--1 inch equals 50 feet.
      c. Centerline of foundation drains, relief-well collector lines, and sediment-pool drain lines--1 inch equals 50 feet.

      If necessary because of the size of the structures, the scales for items 1 and 2a can be reduced to 1 inch equals 200 feet, provided there is adequate space for the graphic logs.
   3. Cross section of stream channel--a scale that requires no more than 2 inches for the plotted bottom width nor more than 6 inches for the entire cross section. Usually, a scale of 1 inch equals 20 feet is practical.
   4. Cross section of emergency spillway--a scale that results in a plotted bottom width of at least 2 inches. Usually, a scale of between 1 inch equals 20 feet and 1 inch equals 100 feet is satisfactory.

Geologic Profile

Develop tentative correlation lines as soon as possible. This helps to determine where additional test holes are needed. As more graphic logs are plotted, the stratigraphic relationships become more definite. Interpretation of data in terms of the genetic classification of the deposits helps to establish correlation. Conversely, development of the geologic profile often helps to interpret the origin of the deposits. When the geologic profile is complete, it provides an interpretation of the factual information from the logs in terms of the stratigraphic and structural relationships along the plotted profile. To this profile add notations on any important condition or characteristic, such as ground-water level, permeability, density, genesis, sorting, degree of weathering or cementation, upstream and downstream continuity, mineralogy, and rock structure. Figure 4-1 shows part of the geologic profile along the centerline of a proposed structure and illustrates some of these points.

Plot profiles or sections drawn normal to the direction of streamflow as though the observer is looking downstream. Plot those drawn parallel to the direction of streamflow so that streamflow is from left to right.

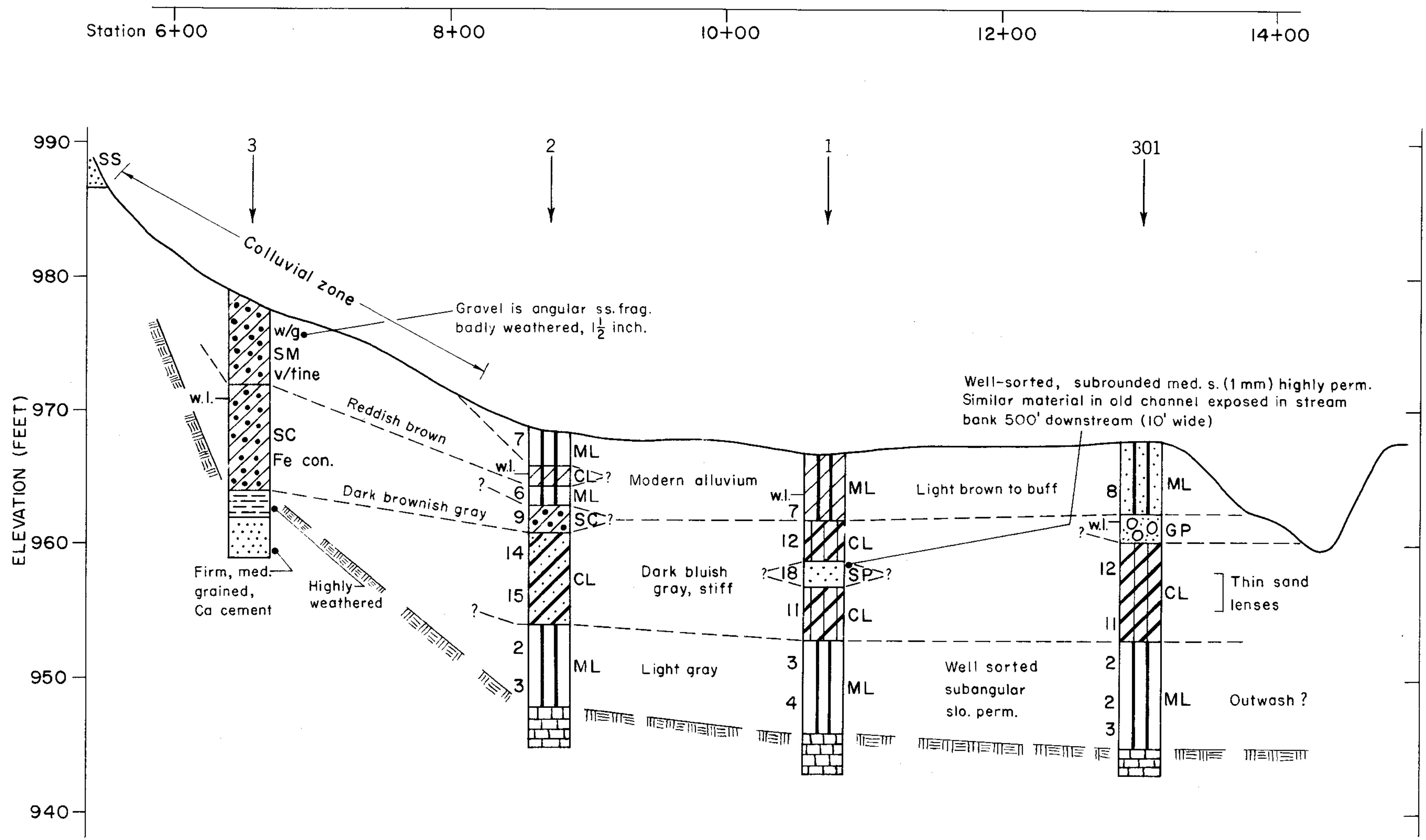

Figure 4-1.--Example of a geologic profile.

Distribution of Graphic Logs and Profiles
When a penciled draft of a field sheet is completed and checked, copies must be reproduced for various purposes. This can be done by blueline printing or photostating locally in the field or in the Cartographic Unit. Copies are needed for the geologic report, a copy of which is to go to the Engineering and Watershed Planning (EWP) Unit geologist and other copies are to accompany the design data to EWP Unit and State Design Sections. Additional copies may be needed for the geologist's files and for distribution to personnel within a State.

When samples are sent to the Soil Mechanics Laboratory or to the EWP Unit Materials Testing Section for analysis, the laboratory needs one transparency and one working copy, either blueline print or photostat, of the field sheet. These must be submitted as soon as the samples are sent to avoid delay in soil mechanics analysis and interpretations. If these copies cannot be obtained locally, send the field sheets to the Cartographic Unit and ask them to prepare the required copies and to forward them immediately to the Soil Mechanics Laboratory or the EWP Unit Materials Testing Section, or both. Send a copy of the transmittal letter to the head of the EWP Unit and a copy to the Soil Mechanics Laboratory. At this time, indicate the number of copies needed by the geologist.

The final drafting of plans and profiles, if they are to accompany final construction plans and specifications, usually is done by the Design Section serving a State. The copy of plans and profiles attached to the geologic report accompanying the design data can be used for this purpose. Lumarith stickups of standard geologic symbols are stocked in the various Cartographic Units to facilitate final drafting of plans and profiles.

Written Logs

Form SCS-533
For written logs for engineering purposes, use form SCS-533, Log of Test Holes, and form SCS-533A, Continuation Sheet. These logs are prepared from field notes and are limited to factual items. These detailed logs include common narrative descriptions of the material. Use terms that can be easily understood.

Form SCS-533 provides space for the test hole No., location, and surface elevation. Several logs may be shown on each sheet of form SCS-533. Where natural outcrops, streambanks, and gullies are used for logging and sampling, determine the elevation of the top of the outcrop and the location of the outcrop.

For "Hole Depth" show the depth in feet from the surface (0.0) to the bottom of the first stratum, or the depth from top to bottom of any underlying stratum.

The description of materials should be complete, clear, and concise. Give the geologic designation that corresponds to the standard pattern used on the graphic log first and underline it, for example, Gravel, silty.

If they can be identified by eye, describe individual particles by size, shape, and composition. Include the approximate diameter of the average maximum-size particle. If possible, indicate the relative proportion of gravel, sand, silt, and clay. Describe particle shape by such terms as angular, subangular, and rounded. Note the principal constituents of the larger particles, such as gneiss, limestone, granite, sandstone, and quartz. Indicate the presence of diatoms, gypsum, iron oxides, organic matter, platy minerals such as micas, and other materials that have an influence on engineering properties. Record color, consistency, and hardness. For fine-grained soils, note relative plasticity, dry strength, and toughness. Indicate the relationships shown by stratification, for example, "varved clay," "interbedded sand and gravel." Indicate the presence of joints and their kind, spacing, and attitude if they can be determined. Indicate consistency or degree of compactness of the materials. Record the standard blow count. Where possible, note the genesis, such as alluvium, lake deposits, and till.

For consolidated rock, include kind of rock, degree of weathering, cementation, and structural and other features in the description. Include the geologic name and age of the formation if it is known. Use the scale of rock strength (chapter 1) to describe the ease of excavation.

Show the Unified soil classification symbol as determined by field tests.

A column is provided for a description of the type and size of tool used for sampling or advancing a hole. Examples are bucket auger, Shelby tube, stationary-piston sampler, double-tube soil-core barrel (Denison type), or double-tube rock-core barrel. The abbreviations[1] that should be used for the different types of samplers are given in the following list.

Bucket auger..................................	BA
Thin-wall open-drive (Shelby)................	S
Split-tube sampling spoon....................	SpT
Stationary piston............................	Ps
Piston (Osterberg type)......................	Pf
Dry barrel...................................	DB
Double-tube soil-core barrel (Denison).......	D
Single-tube rock-core barrel.................	RCs
Double-tube rock-core barrel.................	RCd
Hand cut.....................................	HC

Columns are provided for sample data. It is important to show the sampling horizon and whether the sample is "disturbed" (D), "undisturbed" (U), or "rock core" (R). Show the sample recovery ratio (S), which is equal to L/H where L is the length of sample recovered and H is the length of penetration, as a percentage. Thus, if the sampler penetrates a distance of 18 inches and the sample contained therein amounts to 16 inches,

[1] Show OD size after the abbreviation, as D-5 for 5-inch Denison.

$(S) = \frac{16}{18} \times 100 = 89$ percent. This may be an important factor in the determination of fissures, cavities, or soft interbedded materials in consolidated rock.

Distribution

Distribution of completed written logs is to be the same as that for graphic logs. In copying written logs, make enough carbon copies to supply distribution needs.