Chapter 11
INSTRUCTIONS FOR LOGGING SOILS

General

All subsurface investigations of soils for construction materials and for most engineering purposes using test pits, trenches, auger holes, drill holes, or other exploratory methods should be logged and described using the standards in USBR 5000 [1] and 5005 [1] (Unified Soil Classification System [USCS]) in accordance with the established descriptive criteria and descriptors presented in chapter 3 and the guidelines presented in this section.

All investigations associated with land classification for irrigation suitability, as well as data collection and analyses of soil and materials related to drainage investigations, should be logged and described using the U.S. Department of Agriculture terminology outlined in appendix I to Agriculture Handbook No. 436 (Soil Taxonomy), dated December 1975 [2].

Test pits and auger holes may be logged on a form (figure 11-1), or logs may be computer generated. For metric design studies and specifications, information is to be in metric units. For specifications using English units, the written soil description should use metric units for the description of soil particle sizes (millimeters instead of inches). Example word descriptions are shown in figures 11-2 through 11-11.
Figure 11-1.—Log of test pit or auger hole.
## LOGGING SOILS

### Figure 11-2.—Clean coarse-grained soils.

<table>
<thead>
<tr>
<th>LOG OF TEST PIT OR AUGER HOLE</th>
<th>HOLE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLASSIFICATION GROUP SYMBOL</th>
<th>CLASSIFICATION AND DESCRIPTION OF MATERIAL</th>
<th>VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>NW</td>
<td>0.0 to 5.2 ft WELL-GRATED GRAVEL WITH SAND: About 70% coarse to fine, hard, subangular gravel; about 30% coarse to fine, hard, subangular sand; trace of fines; maximum size, 75 mm; moist, brown; hard to auger; no reaction with HCl.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.2 ft</td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>5.2 to 10.5 ft POORLY GRADED SAND: About 95% fine to medium sand; about 5% fines; maximum size, medium sand; wet, yellow brown; hard to auger; weak reaction with HCl.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.5 ft</td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>10.5 to 17.6 ft POORLY GRADED GRAVEL WITH SAND: About 60% predominantly fine, hard, subangular to subrounded gravel; about 40% predominantly fine sand; trace of fines; maximum size, 40 mm; dry, tan; hard to auger; no reaction with HCl.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17.6 ft</td>
<td></td>
</tr>
<tr>
<td>SW</td>
<td>17.6 to 25.3 ft WELL-GRADED SAND: About 85% coarse to fine, hard, subangular sand; about 15% coarse to fine, hard, subrounded gravel (about 1/3 of gravel particles are flat); about 5% fines; maximum size, 40 mm; wet, brown; hard to auger; weak reaction with HCl.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.3 ft</td>
<td></td>
</tr>
</tbody>
</table>
### Figure 11-3.—Fine-grained soils.

- **CL**
  - 0.0 to 4.0 ft LEAN CLAY: About 90% fines with medium plasticity, high dry strength, medium toughness; about 10% predominantly fine sand; maximum size, coarse sand; moist, brown; hard to auger; no reaction with HCl.
  - 4.7 ft

- **ML**
  - 4.3 to 13.0 ft SANDY SILT: About 70% nonplastic fines, rapid dilatancy, no dry strength; about 30% fine sand; maximum size, fine sand; wet, gray, faint organic odor; some roots present, easy to auger; weak reaction with HCl.
  - 10.0 ft

- **CH**
  - 11.0 to 17.7 ft FAT CLAY: About 90% fines with high plasticity, high to very high dry strength, high toughness; about 10% medium to fine sand; trace of gravel; maximum size, 20 mm; dry, reddish-brown; hard to auger; strong reaction with HCl.
  - 17.7 ft

- **NH**
  - 17.7 to 26.5 ft ELASTIC SILT: About 100% fines with low to medium plasticity, slow dilatancy, medium dry strength, low to medium toughness; trace of fine sand; maximum size, fine sand; wet, black; easy to auger; weak reaction with HCl.
  - 25.5 ft
## LOGGING SOILS

**Figure 11-4.**—Soil classifications based on laboratory test data.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0-3.2</td>
<td>0.0 to 3.2 ft WELL-GRADED GRAVEL WITH SAND: Sample had 64% coarse to fine, hard, subangular gravel, 34% coarse to fine, hard, subangular sand, 7% fines; maximum size, 75 mm. No reaction with HCl; Cc = 24, Cs = 1.8. In-place condition: Homogeneous, moist, brown. 3 samples from 3-1/2 x 10-inch-wide trench samples taken for test. Samples were mixed and quartered.</td>
</tr>
<tr>
<td>3.2-7.6</td>
<td>3.2 to 7.6 ft LIMN CLAY WITH SAND: Sample had 64% fines; 36% predominantly fine sand; maximum size, 0.005 mm. No reaction with HCl; Ll = 38, P = 19. In-place condition: Firm, homogeneous, moist, yellowish-brown. One 4-ft x 10-inch-wide trench sample taken at 4.7 to 6.6 ft depth.</td>
</tr>
</tbody>
</table>
**FIELD MANUAL**

**LOG OF TEST PIT OR AUGER HOLE**

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>PROJECT</th>
<th>AREA DESIGNATION</th>
<th>GROUND ELEVATION</th>
<th>AMOUNT OF MATERIAL</th>
<th>DEPTH ENCOUNTERED</th>
<th>NO.</th>
<th>DATE</th>
<th>REVIEWED BY</th>
</tr>
</thead>
</table>

**CLASIFICATION AND DESCRIPTION OF MATERIAL**

| SC | 0.0 to 9.8 ft CLAYEY SAND WITH GRAVEL: About 50% coarse to fine, hard, subangular to rounded sand; about 25% fine, hard, subangular to rounded gravel; about 25% fines with medium plasticity, high dry strength, medium toughness; maximum size, 20 mm; wet, reddish-brown; easy to auger; weak reaction with HCl.

Two 50 lb sack samples obtained by mixing and quartering entire interval. |

9.8 ft

Other typical descriptions of sampling:
One 40-lb sack sample is all soil removed in top 2.5 ft of interval. One 40-lb sack sample is all soil removed from bottom 2.0 ft of interval.

One 50-lb sack sample obtained by mixing and quartering all soil removed from 3.4 to 7.2 ft in interval. |

**REMARKS**

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**Figure 11-5.—Auger hole with samples taken.**

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<table>
<thead>
<tr>
<th>FEATURE</th>
<th>LOG OF TEST PIT OR AUGER HOLE</th>
<th>HOLE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AREA DESIGNATION</td>
<td>LOGGED BY</td>
<td>DATE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>ORIGIN OF SUBSOIL</th>
<th>CLASSIFICATION AND DESCRIPTION OF MATERIAL</th>
<th>DATE</th>
<th>LOCATION</th>
<th>SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 to 3.2 ft poorly graded gravel with sand: About 70% coarse to fine, hard, subangular gravel; about 30% coarse to fine, hard, subangular sand; trace of fines; maximum size, 75 mm; no reaction with HCl.</td>
<td>three</td>
<td>IN-PLACE CONDITION: Homogeneous, moist, brown</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sack samples</td>
<td>LAB TEST DATA: 64% gravel, 34% sand, 2% fines, Cu = 24, Cc = 1.8. Laboratory classification is WELL-GRADED GRAVEL WITH SAND.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three 50-lbm sack samples taken for testing from 18-inch-wide sampling trench for entire depth interval on east side of trench. Samples were mixed and quartered.</td>
<td>3.2 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 to 7.6 ft lean clay: About 90% fines with medium plasticity, high dry strength, medium toughness; about 10% predominantly fine sand; maximum size coarse sand; no reaction with HCl.</td>
<td>one</td>
<td>IN-PLACE CONDITION: Firm, homogeneous, moist, yellowish-brown</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sack sample</td>
<td>LAB TEST DATA: 84% fines, 13% sand, LL = 36, P = 19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One 40-lbm sack sample taken for testing from 12-inch-wide sampling trench from 4.7 to 6.8 ft depth.</td>
<td>7.6 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 11-6.—Reporting laboratory classification in addition to visual classification.
### Figure 11-7.—Undisturbed soils.

<table>
<thead>
<tr>
<th>Classification Group Symbol</th>
<th>Classification and Description of Material</th>
<th>Depth (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL</td>
<td>0.0 to 4.2 ft LEAN CLAY: About 90% fines with medium plasticity, high dry strength, medium toughness; about 10% predominantly fine sand; maximum size, medium sand; strong reaction with HCl. IN-PLACE CONDITION: Soft, homogeneous, wet, brown GEOLOGIC INTERPRETATION: highly weathered Miocene formation</td>
<td>0.0 to 4.2 ft</td>
</tr>
<tr>
<td>SC</td>
<td>4.2 to 9.8 ft CLAYEY SAND WITH GRAVEL: About 50% coarse to fine, hard, subangular to subrounded sand; about 25% fine, hard, subangular to subrounded gravel; about 25% fines with medium plasticity, high dry strength, medium toughness; maximum size, 20 mm, weak reaction with HCl. IN-PLACE CONDITION: Firm, homogeneous except for occasional lenses of clean fine sand, 1/4 inch to 1 inch thick, moist, reddish-brown GEOLOGIC INTERPRETATION: alluvial fan</td>
<td>4.2 to 9.8 ft</td>
</tr>
</tbody>
</table>
**LOGGING SOILS**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>0.0 to 3.1 ft Silty Sand: About 70% coarse to fine, hard, angular sand; about 25% nonplastic fines, rapid dilatancy, no dry strength; about 5% fine, hard, angular gravel; maximum size, 30 mm; moist, brown, faint organic odor; some roots present, easy to auger; no reaction with HCl.</td>
</tr>
<tr>
<td>QC</td>
<td>3.1 to 6.7 ft Clayey Gravel: About 75% coarse to fine, hard, subrounded gravel; about 15% fines with medium plasticity, high dry strength, medium toughness; about 10% coarse, hard, subrounded sand; maximum size, 75 mm; dry, brown; hard to auger; strong reaction with HCl.</td>
</tr>
<tr>
<td>GC</td>
<td>6.7 to 9.8 ft Clayey Sand with Gravel: About 50% coarse to fine, hard, subangular to subrounded sand; about 25% fine, hard, subangular to subrounded gravel; about 25% fines with medium plasticity, high dry strength, medium toughness; maximum size, 20 mm; wet, reddish-brown; easy to auger; weak reaction with HCl.</td>
</tr>
</tbody>
</table>

**Figure 11-8.—Coarse-grained soils with fines.**
Figure 11-9.—Coarse-grained soils with dual symbols.
**LOGGING SOILS**

Figure 11-10.—Reporting in-place density tests and percent compaction.

<table>
<thead>
<tr>
<th>Classification Code</th>
<th>Classification and Description of Material</th>
<th>In-place Unit Weight</th>
<th>Density at Test Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL</td>
<td>0.0 to 4.3 ft lean clay: About 90% fines with medium plasticity, high dry strength, medium toughness; about 10% predominantly fine sand; maximum size, coarse sand; no reaction with HCl. In-place condition: Firm, homogeneous, moist, reddish-brown. In-place dry unit weight and moisture from test at 3.1 to 3.7 ft: 112.0 lb/ft³, 11.7%.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G2</td>
<td>4.3 to 8.2 ft clayey gravel with sand: About 85% coarse to fine, hard, angular to subangular gravel (1/4 of gravel particles are flat or elongated); about 15% fines with medium plasticity, no dilatancy, high dry strength, medium toughness; about 2% predominantly fine sand; maximum size, 75 mm; weak to strong reaction with HCl. In-place condition: Firm, homogeneous, moist, brown. In-place dry unit weight and moisture from test at 8.1 to 7.0 ft: Total 129.7 lb/ft³, 12.7%. Anus No. 4: 107.8 lb/ft³, 12.7% (90% compaction) Max. Unit Weight, Opt. 119.7 lb/ft³, 11.0%.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 11-11.—Soil with measured percentages of cobbles and boulders.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Classification and Description of Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 to 7.4</td>
<td>0.0 to 7.4 ft WELL-GRADED GRAVEL WITH SAND, COBBLES, AND Boulders: About 70% coarse to fine, hard, subrounded gravel; about 30% coarse to fine, hard, subangular sand; trace of fines; no reaction with HCl.</td>
</tr>
<tr>
<td></td>
<td>TOTAL SAMPLE (BY VOLUME): 22% 3- to 5-inch hard, subrounded cobbles; 14% 5 to 10-inch hard, rounded cobbles; 2 percent plus 12-inch hard, subrounded boulders; remainder minus 3-inch, maximum dimension, 400 cm.</td>
</tr>
<tr>
<td></td>
<td>IN-PLACE CONDITION: homogeneous, dry, brown</td>
</tr>
<tr>
<td></td>
<td>GEOLIGIC INTERPRETATION: alluvial fan</td>
</tr>
</tbody>
</table>

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LOGGING SOILS
Formats for Test Pits and Auger Hole Logs

General Instructions

The following subsection provides general instructions for log format and descriptions. Refer to chapter 3 for descriptive criteria, classification, and group names and symbols.

- Capitalize the group name. If cobbles and boulders are present, include them in the typical name.

- Describe plasticity of fines as:
  - “approximately 30 percent (%) fines with high plasticity”
  - “approximately 60% fines with low to medium plasticity”
  - “approximately 10% nonplastic fines”

- Give results of hand tests when performed.

- Use “reaction with hydrochloric acid (HCl).”

- Do not give unnecessary information such as “no odor,” “no gravel,” and “no fines.”

However, the negative result of a hand test is positive information and should be reported as “no dilatancy,” “nonplastic,” “no dry strength,” or “no reaction with HCl.”

For reporting maximum particle size, use the following:
- Fine sand
- Medium sand
- Coarse sand
  - 5-millimeter (mm) increments from 5 mm to 75 mm
  - 25-mm increments from 75 mm to 300 mm
  - 100-mm increments over 300 mm
FIELD MANUAL

For example, “maximum particle size 35 mm” or “maximum particle size 400 mm” are the correct format and size increment.

Table 11-1 is a checklist for log descriptors. Format for descriptions, results, and other information are in the following subsections.

Table 11-1.—Checklist for the description of soils in test pit and auger hole logs

1. Group symbol. - Capitalized and shown in the left-hand column.
2. Depth. - Depths of interval classified, shown in either meters or feet and tenths of units in second column from the left.
3. Identification of sample. - Type and size of sample and origin of sample, shown in third column from the left.
4. Classification and description column. -
   a. First paragraph. -
      (1) Depth of interval classified
      (2) Group name capitalized
      (3) Percent of fines sand and gravel by weight (include trace amounts but not added to percentage which must equal 100 percent)
      (4) Description of particles
         (a) Particle size range: describe as either gravel - fine or coarse, or sand—fine, medium, or coarse
         (b) Hardness of particles (coarse sand and larger)
         (c) Particle angularity (angular, subangular, sub-rounded, or rounded)
         (d) Particle shape (flat, elongated, or flat and elongated)
         (e) Maximum particle size or dimension
LOGGING SOILS

(5) Description of fines
   (a) Plasticity (nonplastic, low, medium, or high)
   (b) Dilatancy (none, slow, or rapid)
   (c) Dry strength (none, low, medium, high, or very high)
   (d) Toughness (low, medium, or high)
(6) Moisture condition (dry, moist, or wet)
(7) Color (moist color)
(8) Odor (mention only if organic or unusual)
(9) Reaction with HCl (none, weak, or strong)
b. TOTAL SAMPLE (BY VOLUME): second paragraph, if applicable - i.e., more than 50 percent plus 75-mm material
   (1) Percent of cobbles and percent of boulders
   (2) Same information as item 4.a (4)
c. IN-PLACE CONDITION: third paragraph
   (second paragraph if less than 50 percent oversize)
   (1) Consistency; fine-grained soils only (very soft, soft, firm, hard, or very hard)
   (2) Structure (stratified, lensed, slickensided, blocky, fissured, homogeneous)
   (3) Cementation (weak, moderate, strong)
   (4) Moisture (if an in-place condition paragraph is included, moisture is not described in the first paragraph)
   (5) Color (if an in-place condition paragraph is included, color is not described in the first paragraph)
   (6) Result of in-place density and/or moisture tests
d. GEOLOGIC INTERPRETATION: (fourth paragraph) geologic description including genetic name, stratigraphic name if known, and any local name.
5. **Remarks block.** - Provide additional description or remarks such as root holes, other debris found, caving, degree of difficulty to auger or excavate, reason for refusal or reached predetermined depth, and water level information or hole completion.

Figure 11-12 is a field form for logging soils.

**Reporting by Method of Classification**

**Preparation of Logs Based on Visual Classification.**—List fines, sand, and gravel in descending order of percent (must add up to 100 percent). For visual classification, estimate percentages to the closest 5 percent. Precede the estimated percentages with “approx.,” not “about.” If a component is present but is less than 5 percent of the total, use “trace.” “Trace” is not included in the 100 percent.

**Preparation of Logs Based on Laboratory Classification.**—When logs are prepared using laboratory classifications (based on laboratory tests), the information must be presented on the log as shown in figure 11-4. The difference between a laboratory and a visual classification is depicted in figure 11-6.

The visual classification should not be changed, nor should the estimated percentages, plasticity description, or the results of the hand tests (dry strength, dilatancy, and toughness) be changed to reflect laboratory tests results. The visual classification is based on the total material observed; whereas, the laboratory classification is based on a representative sample of the material.
# Logging Soils

**Field Form - Soil Logging**

**Date** __________  **Project** ___________________  **Feature** ___________________  **Hole No.____**  **Logged By** __________________

---

## Sample Interval and Type:

<table>
<thead>
<tr>
<th>Type</th>
<th>Moisture</th>
<th>Sample</th>
<th>Sample Weight (Lbs)</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Typical Name** __________________________________________________________

**Group Symbol** _________________________________________________________

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## Size Distribution, Characteristics:

(5-mm increments from 5 to 75 mm, 255-mm increments from 75 to 300 mm, 100-mm increments over 300 mm)

- **Boulders (>300 mm) __% (vol.)**: **Max. size (mm) ____**  **Hardness ____**  **Angularity ____**
- **Cobbles (75-300 mm) __% (vol.)**: **Max. size (mm) ____**  **Hardness ____**  **Angularity ____**
- **Gravel __%**: **Coarse (20-75 mm) ____**  **Fine (5-20 mm) ____**  **Hardness ____**  **Angularity ____**
- **Sand __%**: **Coarse ____**  **Medium ____**  **Fine ____**  **Hardness ____**  **Angularity ____**
- **Fines ____%**

**Plasticity:** Nonplastic ____  Low ____  Medium ____  High ____

**Dilatancy:** No ____  Slow ____  Rapid ____

**Dry Strength:** No ____  Low ____  Medium ____  High ____  Very High ____

**Toughness:** Low ____  Medium ____  High ____

**Maximum Size:** Fine Sand ____  Medium Sand ____  Coarse Sand ____  ____mm

**Moisture:** Dry ____  Moist ____  Wet ____

**Color** _______________  **Odor** _______________  **Organic Debris and Type** _______________

**Reaction with HCl:** None ____  Weak ____  Strong ____

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## Excavating/Auger/Drilling Conditions:

- **Hardness:** Very Soft ____  Soft ____  Hard ____  Very Hard ____
- **Penetration Action:** Smooth ____  Mod. Smooth ____  Mod. Rough ____  Rough ____
- **Penetration Rate:** Very Fast ____  Fast ____  Slow ____  Very Slow ____

---

**Figure 11-12.—Field form - soil logging.**
The specimens for testing are to be samples that represent the entire interval being described (see USBR 7000 and 7010 [1]). The material collected must be split or quartered to obtain the specimen that is to be tested in the laboratory.

Coefficients of uniformity and curvature ($C_u$ and $C_c$) are to be calculated and reported on the logs for coarse-grained materials containing 12 percent or less fines.

Laboratory gradation percentages and Atterberg limits are to be reported to the nearest whole number.

**Procedures for Reporting Laboratory Data in Addition to Visual Classification and Description**—In some instances, gradation analyses and Atterberg limit tests are performed on soil samples in conjunction with preparation of logs of test pits or auger holes. These data should be shown on the logs and clearly identified as laboratory test data.

Specimens for testing are to be from samples that represent the entire interval being described. If this is not possible, the location of the sample should be given as part of the word description. The sample taken should be split or quartered to get the specimen size required for testing (figure 11-5, interval 0.0 to 9.8 feet (ft).

Laboratory test data are to be presented in a separate paragraph. If the test results indicate a different classification, and therefore different group symbol and/or group name than the visual classification, give the laboratory classification symbol and name in this paragraph (figure 11-6).
LOGGING SOILS

Note: For logs which incorporate the test results, the statement “Classification by laboratory” should be placed in the “Remarks” portion of the log.

Coefficients of uniformity and curvature ($C_u$ and $C_c$) are to be calculated and reported on the logs for coarse-grained materials containing 12 percent or less fines.

All laboratory gradation percentages and Atterberg limits are to be reported to the nearest whole number.

**Reporting Undisturbed (In-Place) Conditions**

List in-place conditions on logs of test pits in a separate paragraph (figure 11-7). Do not give in-place soil conditions (consistency, compactness) on auger hole logs (unless the holes are large enough to inspect). Instead, describe difficulty of augering (figure 11-8). Also describe caving or any other unusual occurrences during drilling of the auger hole.

In-place density tests are often performed in test pits or trenches. When a large quantity of logs are reviewed, density information on the log can save time, even though additional time is required for preparation of the log.

Results of in-place density tests that are performed in test pits or trenches are to be included on the log in the descriptive paragraph on in-place conditions, as illustrated in figure 11-10.

Results of any laboratory compaction tests (Proctor, minimum and maximum density) performed on the material from the in-place density tests or from the pit or trench are to be included on the log.
FIELD MANUAL

For pipeline investigations, the percent of the maximum dry density or the percent relative density should be in parentheses on the logs (figure 11-10).

Densities are reported to the nearest 0.1 pound per cubic foot (lb/ft$^3$) or 1 kilogram per cubic meter (kg/m$^3$). Moisture content is reported to the nearest 0.1 percent. Percent of laboratory maximum dry density or relative density is reported to the nearest whole number.

Geologic Interpretations

Geologic interpretations should be made by or under the supervision of a geologist. Give geologic interpretation in a separate paragraph (figure 11-7). Interpretation should also be included in the narrative section of the materials portion of the design data submittals.

Description Formats on Test Pit and Auger Hole Logs for Soils with Cobbles and Boulders

If the soil has less than 50 percent cobbles and boulders (by volume), give the group name of the minus 75-mm portion and include cobbles and/or boulders in the group name (figure 11-11). Use two paragraphs to describe soil. Refer to chapter 3 for a more complete discussion of classification and classification group names and symbols.

• Describe the minus 75-mm fraction in the first paragraph. These component percentages are estimated by weight.

• Describe the total sample in a second paragraph. These percentages are estimated by volume. Even if the percentage of cobbles and boulders is determined by measurement, use “approx.” in the word description.
LOGGING SOILS

If the soil has more than 50 percent cobbles and boulders (by volume), list cobbles and boulders first in the name (figure 11-13). Do not give a group symbol or group name.

- Describe the total sample in the first paragraph. Percentages are estimated by volume.

- Describe the minus 75-mm fraction in a second paragraph. Percentages are estimated by weight.

Angular particles larger than 75 mm are described as cobbles and boulders, not as rock fragments. A description of their shape should be provided in the word description.

Description of Materials Other than Natural Soils

Materials which are not natural soils are not described or classified in the same manner as natural soils. The section titled "Use of Soil Classification as Secondary Identification Methods for Materials other than Natural Soils", chapter 3, outlines the criteria to be followed and provides example descriptions for test pit and auger hole logs. Refer to appropriate sections in chapter 3 for example format and descriptions. Figures 11-14 through 11-17 show a variety of logs of test pits and auger holes reflecting miscellaneous conditions.

Format of Word Descriptions for Drill Hole Logs

The descriptions of surficial deposits and soil-like materials in geologic logs of exploration holes should use similar descriptive criteria and format established for test pits and auger holes except as noted in the following paragraphs.
Figure 11-13.—Soil with more than 50 percent cobbles and boulders.
Figure 11-14.—Borderline soils.
Figure 11-15.—Test pit with samples taken.
## LOGGING SOILS

### LOG OF TEST PIT OR AUGER HOLE

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 m</td>
<td>0.0 to 3.1 m Silty Sand: About 70% coarse to fine, hard, angular sand; about 25% nonplastic fines, rapid dilatancy, no dry strength; about 5% fine, hard, angular gravel; maximum size, 10 mm; moist, brown, faint organic odor; some roots present, easy to auger; no reaction with HCl.</td>
</tr>
<tr>
<td>6.7 m</td>
<td>3.1 to 6.7 m Clayey Gravel: About 75% coarse to fine, hard, subrounded gravel; about 15% fines with medium plasticity, high dry strength, medium toughness; about 10% coarse, hard, subrounded sand, maximum size, 75 mm; dry, brown; hard to auger; strong reaction with HCl.</td>
</tr>
<tr>
<td>9.7 m</td>
<td>6.7 to 9.7 m Silty Sand: About 55% medium to fine sand; about 45% nonplastic fines, slow dilatancy, maximum size, medium sand; wet, reddish-brown; easy to auger; no reaction with HCl.</td>
</tr>
</tbody>
</table>

### Figure 11-16.—Disturbed samples.
Figure 11-17.—Two descriptions from the same horizon. (Top) Undisturbed soil containing estimated percent of boulders. (Bottom) Disturbed soil containing trace of cobbles.
LOGGING SOILS

Exceptions to Test Pit and Auger Hole Format and Descriptions for Drill Hole Logs

Unlike test pit logs where geologic interpretations may be provided at the bottom of the log form, geologic interpretations are required on drill hole logs. The geologic classification (e.g., Quaternary Alluvium, Quaternary Glacial Outwash, Quaternary Landslide, Tertiary Basin Fill Deposits) should be provided as main headings on the geological drill hole log.

Group names are capitalized in all test pit and auger hole logs. Where capitalization of the group name would conflict with main headings on drill hole logs, capitalize only the first letter of each word of the group name and the group symbol. If the first letter of each word is not capitalized, the group name is considered informal usage only and not a classification.

Classification and word description format for drill hole logs is similar to those used for test pit logs. Also, materials recovered from drill holes are generally considered to represent in-place conditions. These criteria do not apply when samples are not recovered or when poor recovery precludes classification (figure 11-18).

Samples Recovered from Wash Borings or as Cuttings

When drill holes are advanced with a rock bit, water jet, or other nonsampling methods, a group symbol and name or classification of the recovered materials should not be assigned, nor should in-place descriptions, such as consistency, be used. However, descriptive criteria, such as particle size, dry strength, and reaction with HCl, should be provided using the same terminology and format used for auger holes.
Figure 11-18.—Drill hole advanced by tri-cone rock bit.
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Descriptions should be preceded by “Recovered cuttings as . . .” or “Recovered wash samples as . . .” (figure 11-18, interval 0.0-11.7 ft.

Poor or Partial Recovery

Where poor or partial recovery precludes accurate classification, a primary classification should not be assigned, but as much descriptive information as possible should be provided. Recovered materials, together with drilling conditions, cuttings, and drilling fluid color or losses, may be used to interpret reasons for losses and types of materials lost. However, an appropriate subheading (i.e., “Poor Recovery”) should be used (figure 11-19, 2.1 to 3.9 ft.

Materials Other Than Soils and Special Cases

As discussed in chapter 3, “Use of Soil Classification as Secondary Identification Methods for Materials Other Than Natural Soils,” exceptions to the test pit and hole classification and format are also applicable to hole logs. These special cases include processed or manmade materials, shells, partially lithified or poorly cemented materials and decomposed bedrock, and shallow surficial deposits or soils. Other special categories of soil-like materials should be classified by USBR 5000 or USBR 5005[1]. These are soil-like slide-failure zones or planes; shear or fault zones; bedrock units which are recovered as soil-like material or consist of soil-like material; and landslides and talus (figures 11-20, 11-21, and 11-22).

Format and classification for these exceptions are described below.
Figure 11-19.—Log showing poor recovery.
Figure 11-20.—Log of landslide material (a).
Figure 11-21.—Log of landslide material (b).
Figure 11-22.—Log of bedrock.
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**Processed or Manmade Materials.**—Surficial deposits such as tailings, crushed rock, shells, or slag are assigned a genetic name such as filter, bedding, drain material, shells, tailings, or road base, and a classification group name and symbol are assigned in quotation marks, for example: Filter material, “poorly graded sand (SP-SM).” Soil descriptors are then used to describe the materials.

Where drill holes penetrate embankment materials, main headings on the drill hole logs should be a classification of the type of embankment, such as “Zone 3 Miscellaneous Embankment.” The materials recovered in each interval are classified, and group names and symbols are provided as subheadings. See 1.0- to 3.9-ft and 3.9- to 15.4-ft intervals shown in figure 11-19.

**Partially Lithified or Poorly Cemented Materials and Decomposed Rock.**—Descriptions of partially lithified or poorly cemented materials such as siltstone, claystone, sandstone, and shale or decomposed rock which are broken down during drilling or field classification testing should be classified by an appropriate rock unit name or by geologic formation name, if known, of the in-place materials. The materials are then described using descriptors for rock (chapter 4). A soil classification for the broken down materials should be reported in quotation marks on the drill logs and all figures, tables, drawings, or narrative descriptions. The disaggregating mechanism (e.g., drilling or testing) should be specified (figure 11-22, interval 17.3 to 67.9 ft).

**Shallow Surficial Deposits.**—Surficial deposits such as drill pad or dozer trench fill for drill setups, shallow slope wash, or topsoil materials which will not be used in, or influence, design or construction may be classified by genetic classification (e.g., “fill,” “slopewash,” or “topsoil”). Complete classification descriptions are not required on drill hole logs; however, a classification name and/or
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symbol may be assigned and is often desirable. Although
a complete description is not required on each log, an
adequate description of these materials should be
provided in a general legend or explanation drawing and
in the narrative of the report, if not completely described
in drill hole logs.

Slide Failure Zones or Planes, Shear or Fault
Zones, and Interbeds Recovered as Soil-like
Materials.—These features should be described using
geologic names as well as behavior and soil
classifications.

Landslides and Talus.—Surficial deposits such as
landslides and talus should be assigned their genetic
geologic name in the main headings of the drill hole log.
Landslide debris composed primarily of soils is classified
as landslides in the main heading. Soil-like materials
should be classified and group names and symbols
provided in the headings. The materials are then
described using the descriptive criteria for drill hole logs.
Where materials are predominantly rock fragments such
as talus and block slides, the materials should be logged
similar to the method used in figure 11-22.

Equipment Necessary for
Preparing the Field Log

The following is a list of equipment for field testing and
describing materials.

Required equipment:

• Small supply of water (squirt bottle)—for
  performing field tests
• Pocket knife or small spatula
• Materials for taking or preserving samples—sacks,
  jars, labels, cloth, wax, heater, etc.
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- Hammer—for hardness descriptors
- Tape measure and/or rule (engineer’s scale and metric scale)
- Petrie dish for washing specimens
- Small bottle of dilute hydrochloric acid [one part HCl (10 N) to three parts distilled water. When preparing the dilute HCl solution, slowly add acid into the water following necessary safety precautions. Handle with caution and store safely. If solution comes in contact with skin, rinse thoroughly with water.]
- Rags for cleaning hands
- Log forms

Optional apparatus:

- Small test tube and stopper or jar with lid
- Plastic bags for “calibration samples”
- Hand lens
- Color identification charts
- Paint brush and/or scrub brush and water for cleaning samples
- Marking pens
- Protractor
- Drillers’ reports for drill holes
- Comparison samples (in jars): fine gravel—3/4 inch to No. 4 sieve; medium sand—No. 4 to No. 10 sieve; and coarse sand—No. 10 to No. 40 sieve
- Small No. 4 and 200 sieves
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Example Descriptions and Format

The examples which follow illustrate the preferred format, description, and organization, and some of the more significant exceptions to typical standards.

Laboratory Classifications in Addition to Visual Classifications

In some instances, laboratory classifications may be determined in addition to the field visual classification. This may be done to confirm the visual classification, particularly when starting work in a new location or because the classification may be critical.

The laboratory data used must be reported in a separate paragraph at the end of the work description, as shown in the examples in figure 11-23. If the laboratory classification is different from the visual classification, as in the upper example, give the group symbol in the left-hand column and the group name in the paragraph on the laboratory data.

DO NOT CHANGE THE VISUAL CLASSIFICATION OR DESCRIPTION. The visual classification is based on a widely observed area in the excavation, whereas the laboratory classification is based on a sample of the material.

If the visual classification was the best judgment of an experienced classifier, both are correct in what they represent.
Figure 11-23.—Geologic interpretation in test pit (sheet 1).
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Word Descriptions for Various Soil Classifications

Figures 11-6 to 11-17 illustrate some typical word descriptions based on the soil classifications.

Logs are generally typed and single spaced. The examples in this manual are presented double spaced for legibility.

Samples Taken

In addition to the brief description of the samples taken under the “classification group symbol” column, a more complete description of any samples taken from each depth interval is included in the word descriptions. The description should include the size of the sample, the location represented by the sample, and how the sample was obtained (e.g., quartering and splitting).

Examples of how to report the sample information for a pit or trench are shown in figures 11-24 through 11-33.

Some examples use the abbreviated method of indicating the group name with the group symbol. This abbreviated method is described in appendix X5 in USBR 5000, “Determining Unified Soil Classification (Laboratory Method)”[1] and chapter 3.

Reporting Laboratory Data

Classifications Based on Laboratory Data

If the soil classification reported on the logs is based on laboratory data and not a visual classification, this should be clearly and distinctly reflected on the log.
Figure 11-24.—Geologic interpretation in test pit (sheet 2).
Figure 11-25.—Geologic interpretation in test pit using a geologic profile (1).
### Table: Geologic Interpretation in Test Pit

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0-0.5</td>
<td>Gravel sand with gravel and trace of cobbles: About 50% coarse to fine, angular to subangular; about 35% coarse to fine, angular to subangular, brittle to hard gravel with weak surface coating; 15% fines with medium plasticity, allow to no difficulty, medium toughness, median dry strength; max. size 300 mm; string reaction with RCI.</td>
</tr>
<tr>
<td>10-0.3</td>
<td>In-place condition: Loose, homogenous, root holes, weak cementation, dry, brown.</td>
</tr>
<tr>
<td>Labor Test Data</td>
<td>418 sand, 351 gravel, 244 fines, LI=36, PI=18.</td>
</tr>
<tr>
<td>Geologic Interpretation</td>
<td>Quaternary alluvial (Qau)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5-1.5</td>
<td>Adhesive; Dry gray, porphyritic, intensely to moderately weathered; non-porous; weak reaction with RCI on core and core, string reaction with carbonate coatings on fracture surfaces. See &quot;Geologic Profile of Test Pit No. 11-2-TN&quot; for more detailed hardness, weathering, fracture density, and joint descriptions. Very difficult to excavate below 0.5 feet. Excavated materials broken down as follows:</td>
</tr>
<tr>
<td></td>
<td>Fossil gravel gravel with soil, sand and cobbles: About 40% coarse to fine, angular to subangular; brittle to hard gravel with weak surface coating; about 15% fines with low plasticity, allow to no difficulty, low toughness, low dry strength; string reaction with RCI.</td>
</tr>
<tr>
<td></td>
<td>Total Sample (dry volume): About 40% 75 to 125 mm brittle to hard, angular to subangular cobbles; trace of plus 125 mm brittle to hard, angular to subangular cobbles; remaining about 75 mm, max. elevation 150 mm.</td>
</tr>
</tbody>
</table>

**Notes:** Considerable ground cover of magnesium and paloverde trees, grassland bushes, and corti. Maximum size cobbles taken from excavation was 200x200x200 mm. Stopped test pit at 2.5 feet, unable to excavate further with backhoe.

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Figure 11-26.—Geologic interpretation in test pit (sheet 3).
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**Figure 11-27.**—Geologic interpretation in test pit (sheet 4).

### LOG OF TEST PIT OR AUGER HOLE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SP</strong></td>
<td>0-2.0 ft.</td>
<td>Poorly graded sand with silt, gravel and cobble. About 55% coarse to fine, angular to subangular sand; about 35% coarse to fine, angular to subangular, brittle to hard gravel with moderate surficial coatings; about 10% fines with low plasticity, rapid dilation, low toughness, low dry strength; strong reaction with HCl.</td>
</tr>
<tr>
<td><strong>SOIL</strong></td>
<td>2.0-10.0 ft.</td>
<td>Silty sand with gravel and trace of cobble. About 65% coarse to fine, angular to subangular sand; about 25% coarse to fine, angular to subangular, brittle to hard gravel with moderate surficial coatings; about 10% fines with low plasticity, rapid dilation, low toughness, low dry strength; strong reaction with HCl.</td>
</tr>
</tbody>
</table>

*Note:* Moderate ground cover of mesquite and paloverde trees, greenbrush bushed and maximum size cobble taken from excavation was 600x300x300 mm. Stopped test pit at 10.0 feet, unable to excavate further with backhoe.
Figure 11-28.—Geologic interpretation in test pit using a geologic profile (2).
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Figure 11-29.—Geologic interpretation in test pit (sheet 5).
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Figure 11-30.—Geologic interpretation in test pit (sheet 6).

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Figure 11-31.—Geologic interpretation in test pit (sheet 7).
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**Figure 11-32.—Geologic interpretation in test pit (sheet 8).**
Figure 11-33.—Geologic interpretation in test pit using a geologic profile (3).
The laboratory data should be reported on the log form as shown in the examples in figure 11-4.

The location of the sample and any laboratory tests performed need to be clearly described.

The coefficients of uniformity and curvature ($C_u$, $C_c$) are to be calculated and reported for coarse-grained soils containing 12 percent fines or less.

Gradation percentages and Atterberg limits are to be reported to the nearest whole number.

The fact that the classification is a laboratory classification needs to be indicated in the “classification group symbol” column.

The words “about” or “approximately” are not used in the word description.

Soils with More Than 50 Percent Cobbles and Boulders

If the soil contains more than 50 percent (by volume) cobbles and/or boulders:

1. The first paragraph describes the total sample and includes the information on the cobbles and boulders. The information in the paragraph is the same as described previously for cobbles and boulders.

2. The words “COBBLES” or “COBBLES AND BOULDERS” are listed first in the classification group name.
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COBBLES WITH POORLY GRADED GRAVEL
COBBLES AND BOULDERS WITH SILTY GRAVEL

3. A classification symbol is not given. Where a report or form requires a classification symbol, use the words “cobbles” or “cobbles and boulders” instead.

An example of a word description for a soil with more than 50 percent cobbles and boulders is shown in figure 11-13.

Special Cases for USCS Classification

Some materials that require a classification and description according to USCS should not have a heading that is a classification group name. When these materials will be used in, or have influence on, design and construction, they should be described according to the criteria for logs of tests pits and auger holes, and the classification symbol and group name should be in quotation marks. The heading should be as follows:

TOPSOIL
DRILL PAD
GRAVEL ROAD SURFACING
MINE TAILINGS
UNCOMPACTED FILL
FILL

For example:

<table>
<thead>
<tr>
<th>Classification symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOPSOIL</td>
<td>0.0 to 1.6-ft TOPSOIL—would be classified as “ORGANIC SOIL (OL/OH).” About 90%</td>
</tr>
</tbody>
</table>

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fines with low plasticity, slow dilatancy, low dry strength, and low toughness; about 10% fine to medium sand; soft, wet, dark brown, organic odor; roots present throughout strata; weak reaction with HCl.

Reporting In-Place Density Tests

In-place density tests are sometimes performed in test pits in borrow areas so that in-place densities can be compared with the expected compacted densities for the embankment. The required volume of material needed from the borrow area can also be calculated. The in-place density is also used to evaluate the expansion or collapse potential for certain soils.

The density should be reported in the paragraph on in-place condition. Examples of the format are shown in figure 11-10. The upper example is used when only the density is determined. The lower example is used when a laboratory compaction test is also performed to calculate the percent compaction (or D value if rapid method is used) (USBR 7240, [1]). For cohesionless soils, similar information is reported for the maximum index density, the minimum index density, and the percent relative density.

If the in-place density test hole spans two (or more) depth intervals of classification, the data and comments for the test should be placed in the interval description corresponding to the top of the test hole. At the end of the information reported, the comment (in all capital letters) must be added: "NOTE: TEST EXTENDED INTO UNDERLYING INTERVAL." An in-place density test should not span different materials or layers.
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Because the laboratory compaction test is generally performed on the material removed from the test hole, note that the data are for a mixture of intervals by adding, "NOTE: COMPACTION TEST PERFORMED ON MATERIAL MIXED FROM TWO DIFFERENT INTERVALS."

The density units are lb/ft$^3$ or kilonewtons per cubic meter (kN/m$^3$).

Samples Taken

In addition to the brief description of the samples taken under the “Classification Group Symbol” column, a more complete description of any samples taken from each depth interval is included in the word description. The description should include the size of the sample, the location represented by the sample, and for each sample, how the sample was obtained (e.g., quartering and splitting).

An example of how to report the sample information for an auger hole is shown in figure 11-17. An example of how to report the sample information for a test pit or trench is shown in the section on word descriptions of undisturbed samples.

The approximate weight of samples should be stated.

Measured Percentages of Cobbles and Boulders

If the percentages of the plus 3-inch particles are measured, not estimated, the percentages are reported to the nearest 1 percent. In the word description for the plus 3-inch particles, do not use the term “about” before the percentages.
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The procedure for measuring the percent by volume of cobbles and boulders is given in the test procedure, USBR 7000, "Performing Disturbed Soil Sampling in Test Pits"[1]. This method is rarely used; percentages are usually estimated. It is not recommended that the percentages be measured for auger holes, since the mass of material recovered is generally insufficient to obtain a reliable gradation of plus 3-inch particles.

Figures 11-23 through 11-33 show a variety of logs of test pits using both the USCS and the geologic interpretation of the parent material. Note that USCS indicates that bedrock has been altered or weathered to a soil-like material. For engineering considerations, use the USCS but present the rock conditions as well.

BIBLIOGRAPHY
