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## SUBSURFACE EXPLORATION PROGRAM

### 2.1 GENERAL

The procedures employed in any subsurface exploration program are dependent on a variety of factors which vary from site to site. However, the project design objectives and expected site soil conditions have a major influence on the subsurface explorations. Some factors that influence the extent of an exploration program include deep cuts or fills, new roadway, reconstruction of existing roadway, bridge or culvert structures, compressible soils, bedrock, etc.

### 2.2 PROGRAM PHASES

Subsurface exploration may have from one to three phases.

1. Reconnaissance - Includes a review of available topographic and geological information, soil surveys, aerial photos, data from previous investigations, and site examinations.
2. Preliminary Exploration - Includes borings to recover samples suitable for identification tests only.
3. Detailed Exploration - This is based on the analysis and recommendations of previous phases and generally includes recovery of undisturbed samples, and in some cases, field tests and observation.

### 2.3 SAMPLING

All sampling shall be performed in accordance with the appropriate AASHTO (American Association of State Highway and Transportation Officials) and ASTM (American Society for Testing Materials) designations. Representative samples of the various soil types shall be obtained by drilling soil borings along the route of the existing or proposed roadway alignment.

1. General spacings for embankment or cut borings are 200 to 400 feet with at least one boring in each soil type.
2. Depth of borings shall extend to a minimum of 5 feet below proposed subgrade elevation in shallow cuts and 5 feet below existing ground in shallow fills. In high fills, extend borings to a depth equal to twice the embankment height. In deep cuts, extend borings to a depth at least 15 feet below proposed subgrade.
3. Soft ground conditions require additional borings in order to determine boundaries. Extend all borings through unsuitable foundation strata, such as unconsolidated fill, peat, highly organic materials, soft cohesive soils and loose, coarse granular soils.

### 2.3 SAMPLING (Continued)

4. Undisturbed sampling in cohesive soils for testing should be obtained using thin-wall tube samplers (Shelby tube). Tests include in place density, unconfined compression, triaxial compression, consolidation, direct shear, etc.
5. When undisturbed sampling is not needed, auger samples may be taken for testing including proctors, Atterberg limits, sieve analysis and general identification and classification.
6. Sampling in granular soils should be obtained using thick wall, split barrel tube (split spoon) driven into the soil.

### 2.4 TESTING

All testing shall be performed in accordance with the appropriate AASHTO (American Association of State Highway and Transportation Officials) and ASTM (American Society for Testing Materials) designations. The type and number of tests to be performed shall be determined by the Project Engineer who should also consider recommendations of the Geotechnical Engineer.

1. Tests of cohesive soils for each soil type should include the following:
  - . Natural moisture content
  - . Dry density
  - . Unconfined compressive strength
  - . Atterberg limits (plastic limit and liquid limit)
  - . Sieve and hydrometer analysis
  - . Soil classification
  - . Presence of organic material
  - . Compressibility
  - . Swelling characteristics
  - . Standard proctor density
2. Tests of granular soils for each soil type should include the following:
  - . In-site density determined from the standard penetration (SPT) test
  - . Sieve analysis to determine grain-size distributions.
  - . Atterberg limits (plastic limit and liquid limit)
  - . Presence of organic materials
  - . Soil classification
  - . Standard proctor density
  - . Maximum and minimum index density

Typically, not all of the above tests will be necessary on any given soil type.

**2.4 TESTING (Continued)**

3. Determine depth to perched water tables (short term reading) and piezometric surface over site area (long term readings). In borings for ground water observations, place casing in tight contact with walls of hole.
4. If bedrock surface is to be determined and character and general location of rock is known, extend borings 5 feet into sound, unweathered rock. Where character of rock is unknown, or where boulders or irregularly weathered material overlie bedrock, core 10 feet into sound rock.