Part 650 – Engineering Field Handbook

Subpart D. Elementary Soils Engineering

IA650.30 Guidance for Soil Investigations for Engineering Projects in Iowa

IA650.31 General

The planning, design, and construction of most engineering conservation practices involve the use of soil as an important construction material. Some practices such as grassed waterways, terraces, and subsurface drains rarely require a detailed foundation investigation. However, even on these practices, the type of soil and the associated engineering properties of that soil are important for technical staff to understand in order to properly plan and design the practice.

Many conservation practices such as dams, ponds, and animal waste storage facilities require some type of foundation investigation on nearly every project. The level of investigation varies by the size, type, and complexity of the practice.

A proper and adequate foundation investigation will help insure that the practice is planned, designed, and constructed such that it will function as designed with a minimal amount of maintenance needed throughout the life of the practice. Due to the wide variety in the type, size, and complexity of practices, different levels of investigations are needed. The person responsible for performing investigations varies depending on the complexity of the project. The National Engineering Manual (NEM), Part 531, Geology, states who is qualified and authorized to make various levels of investigations.

Structures with embankments, such as ponds and earthen waste storage ponds, require foundation investigations to ensure that the embankment will be stable. Testing of materials may be required to determine soil strength and bearing capacity. This is used to calculate slope stability and other structural requirements. Embankments and pool/storage areas must be investigated to determine potential for seepage, soil dispersion, piping potential, sand lenses, impermeable layers, water table levels, etc. This information is used to design drainage systems, filters, liners, etc. Potential borrow areas must be investigated to determine the availability of borrow material and the requirements for compaction (moisture and density) control.

IA650.32 Investigation Requirements

The National Engineering Manual (NEM), Part 531, Subpart A, and the Iowa Supplement to Part 531, classifies structures as Group A, B1, or B2. The definitions of the groups are in Part 531. Specific foundation investigation requirements for each of these groups of structures are shown in the NEM, Part 531, Subpart B, Engineering Geology.

Some conservation practices, for example, practices which are part of an animal waste management system, have some specific requirements that are delineated in the Iowa Code or in Iowa Department of Natural Resources rules. Iowa Instruction 210-389 – Requirements for Subsurface Geologic Investigations for Animal Waste Storage Facilities, provides investigation requirements for the various types of practices used with animal waste management systems.

IA650.33 Soil Classification Systems

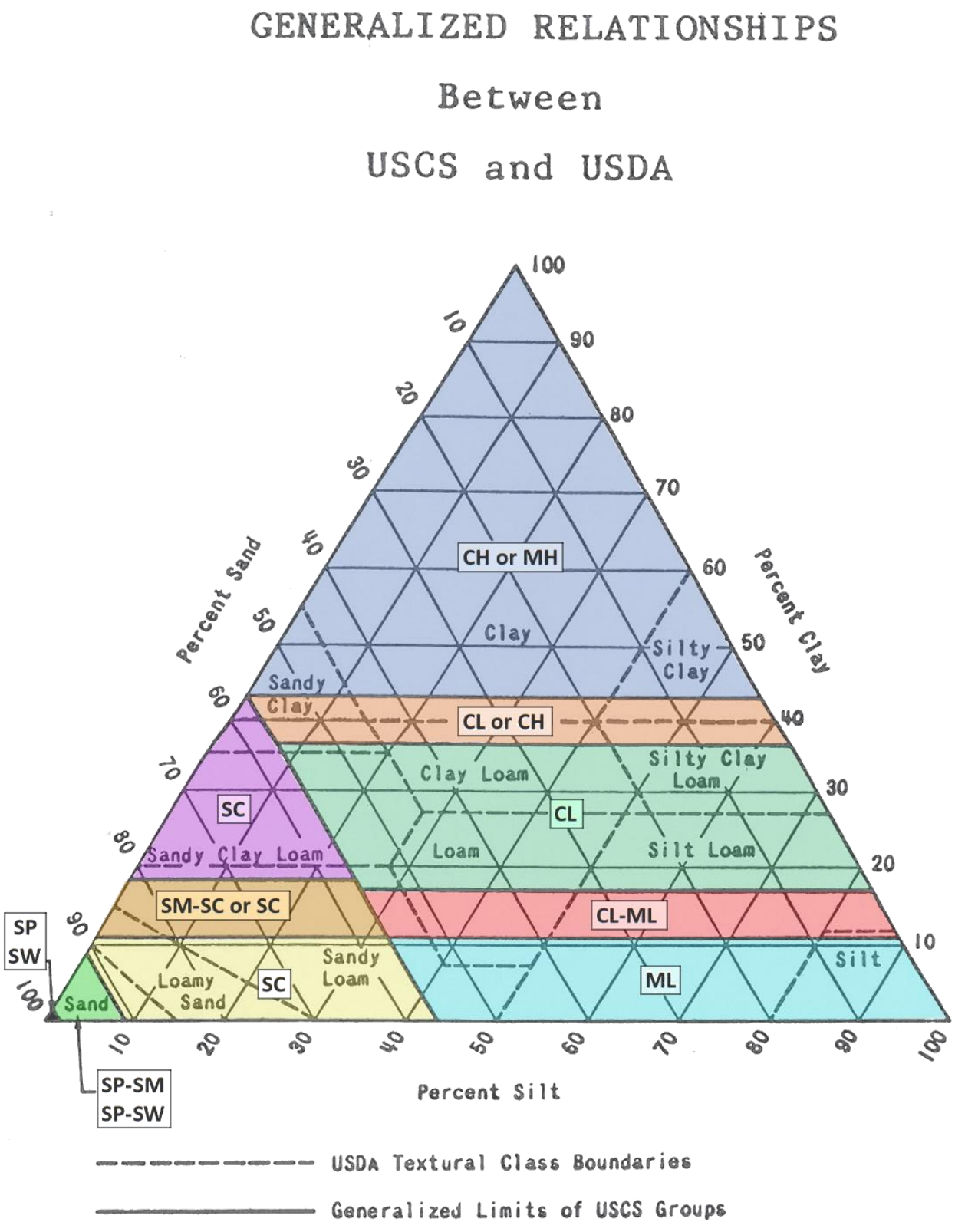
Three classification systems are commonly used for describing soil properties in the United States. These are:

1. AASHTO – American Association of State Highway and Transportation Officials
2. USCS – Unified Soil Classification System
3. USDA – United States Department of Agriculture Classification System.

The AASHTO system is rarely used in NRCS field work. The USDA system is widely used by soil scientists and all field staff when working with cooperators when doing conservation planning.

The NEM requires that NRCS engineering work utilize the USCS classification system. This makes it necessary for field staff to understand both the USDA and USCS systems. Chapter 4 of the Engineering Field Handbook (EFH) and the National Engineering Handbook, Part 631, Geology, Chapter 3, Engineering Classification of Earth Materials, provide good information for helping staff to understand both systems. Pages IA4-1(3) and (4) of this supplement provides some additional information to help provide guidance on field classification of soils.

Figure 650-D1: Generalized Relationships Between USCS and USDA



The above figure provides, Generalized Relationships Between Unified Soil Classification System Groups and USDA Textural Classes.

Figure 650-D2: Unified Soil Classification System Flow Chart

FLOW CHART UNIFIED SOIL CLASSIFICATION SYSTEM FIELD IDENTIFICATION OF COARSE and FINE GRAINED SOILS								
COARSE-GRAINED SOILS More than half of material (by weight) is of individual grains visible to the naked eye	**GRAVEL and GRAVELLY SOILS** More than half of Course Fraction (by weight) is larger than 1/4 inch size.	**CLEAN GRAVELS** Will not leave a dirt stain on a wet palm	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.					**GW**
			Predominantly one size or a range of sizes with some intermediate sizes missing.					**GP**
		DIRTY GRAVELS Will leave a dirt stain on a wet palm	Nonplastic fines or low-plasticity fines (for identification of fines see characteristics of ML below).					**GM**
			Plastic fines (for identification of fines see characteristics of CL or CH below).					**GC**
	SAND and SANDY SOILS More than half of Course Fraction (by weight) is smaller than 1/4 inch size.	**CLEAN SANDS** Will not leave a dirt stain on a wet palm	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.					**SW**
			Predominantly one size or a range of sizes with some intermediate sizes missing.					**SP**
		DIRTY SANDS Will leave a dirt stain on a wet palm	Nonplastic fines or low-plasticity fines (for identification of fines see characteristics of ML below).					**SM**
			Plastic fines (for identification of fines see characteristics of CL or CH below).					**SC**
FINE-GRAINED SOILS More than half of material (by weight) is of individual grains not visible to the naked eye.	Liquid Limit	Dilatancy	Plasticity	Toughness	Ribbon	Shine	Dry Strength	
	1. Add water to dry sample: Quick penetration = low LL Slow penetration = high LL. **2**. Cube test--flood surface and crack open: If water penetrates, sample has low LL; if not, high LL. **3**. Wet sample to putty-like consistency: The more water it takes, the higher the LL.	Take the soft, putty-like soil pat and mold into a mass in palm of hand. Strike the side of your palm several times with the other hand. In samples with rapid dilatancy, water appears quickly on the surface, and disappears quickly upon squeezing.	Dry the soil pat from previous test by adding dry soil until it reaches plastic limit, or PL (rolled thread begins to crack). The longer it takes to get to the PL, and the more times a thread can be re-rolled or a lump formed without crumbling, the higher the plasticity.	While performing the plasticity test, the more finger pressure it takes to roll a thread or form a lump, the higher the plasticity index. Low toughness = soft Medium toughness = firm High toughness = stiff	With pat of soil near the PL, form a ribbon of soil with thumb and index finger, about 1/2 inch wide and as long as possible. Hold one end and gently shake until it breaks under its own weight. Rate the ribbon strength. High plasticity soils have high ribbon strength.	With pat of soil near the PL, cut the pat with a knife blade or stroke it with a knife or fingernail. Observe the degree of shine under direct light. Soils with high plasticity are shiny, those with low plasticity are dull.	Mold moist soil into a 1/2 inch ball or cube and allow to dry completely. Evaluate by breaking dried cube with finger/thumb pressure, or against hard surface if necessary. Soils with high plasticity have high dry strength; soils with low plasticity have low dry strength.	
	SILTS & CLAYS (low LL)	Rapid	Low to Nonplastic	Low to None	None	Dull	Low	**ML**
		Medium to Slow	Low to Medium	Medium	Weak	Slight to Shiny	Medium to High	**CL**
		Slow to None	Low	Low (Spongy)	None	Dull to Slight	Medium	**OL**
	SILTS & CLAYS (high LL)	Very Slow to None	Low to High	Medium to High	Weak to Strong	Slight	Medium	**MH**
		None	Medium to High	High	Strong	Shiny	Very High	**CH**
		None	Low	Low to Medium (Spongy)	Weak	Dull to Slight	High	**OH**
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture.							**PT**