GEOTECHNICAL REPORT

3.1 GENERAL

The geotechnical report is the tool used to "communicate" the site conditions and design and construction recommendations to the roadway design, bridge, and construction engineers. Therefore, the geotechnical report should be clear, concise and accurate.

3.2 GUIDELINES FOR CONTENT

The geotechnical report should contain the following information:

1. Description of existing subsurface conditions

2. Specific engineering recommendations for design of embankments, bridges, culverts, subgrade and pavement. Recommendations should include but not be limited to settlement of subsoils, foundation stability analysis of fills when soft weak subsoils are present, and information for shallow or deep foundation design for structures.

3. Discussion of various materials and conditions which may be encountered during construction.

4. Recommendations for any anticipated design and construction problems. Table 3.1 and Table 3.2 are provided as guidelines for the Project Engineer for subgrade materials and treatment for street projects.

3.3 SUBGRADE AND PAVEMENT

The subgrade and pavement portion shall include data regarding the distribution of various subgrade materials, design soil bearing tests (such as CBR, K-value, R-value, or plate bearing) shall be made. However, in lieu of performing the soil bearing tests, the Project or Geotechnical Engineer may estimate a range for the bearing value by a general correlation of soil classifications with bearing values. This may be done using the soil-bearing-value chart, Figure 3.1. After laboratory tests are performed and the soil is classified, it is possible to estimate the bearing value. Consideration should be given for drainage, rainfall, and other factors that influence subgrade performance.

Where high ground water necessitates the need for subsurface drainage, recommendations shall be made for the design and installation of pavement subdrains where required. The pavement design may be included in this report or prepared and submitted separately by the Engineer responsible for preparation of the roadway plans.

3.4 GRADING AND FOUNDATION

The grading and foundation portion shall include data regarding the distribution and engineering characteristics of the various soil materials, data about groundwater levels, recommendations about the need for mitigation measures for special geotechnical conditions, grading criteria, foundation design criteria, and any other information the Geotechnical Engineer considers pertinent.

3.5 SPECIAL GEOTECHNICAL CONDITIONS

The special conditions portion of the report shall consider ground water, frost susceptibility, erosion potential, soils creep, landsliding, expansive soils, soil corrositivity, and any other special geotechnical conditions the Geotechnical Engineer becomes aware of.

3.6 SUBMITTAL AND APPROVAL

1. General - The geotechnical report shall be submitted in a typed, bound form. The investigation and report shall be conducted and prepared by or under the direct supervision of a Registered Professional Engineer, licensed in the State of Iowa.

2. Jurisdictional Engineer Review Process - Project Engineer initially submits three copies of the geotechnical report.

    A. Resubmittals that do not include the previous submittal with comments copy will be regarded as a new submittal.

    B. Geotechnical report approval does not constitute approval for paving: only that the proposed pavement depths are satisfactory.

    C. The soils report contains information of substantial value to the Contractor. It is to the applicant's benefit to provide the Contractor with a copy of the soils report to reduce confusion and delays in the field during construction.

TABLE 3.1 CHARACTERISTICS OF SUBGRADE MATERIALS

CHARACTERISTICS OF SUBGRADE MATERIALS											
GENERAL CLASSIFICATION	GRANULAR MATERIALS (35 PERCENT OR LESS PASSING NO. 200 SIEVE)							SILT - CLAY MATERIALS (MORE THAN 35% PASSING NO. 200 SIEVE)			
TYPICAL SOIL SERIES	← DICKINSON →		← CHELSEA, HAGENER → ← DORCHESTER, FARRAR →					← WAUKEGAN → ← CLARION, HAYDEN, LESTER →		← LINDLEY, NICOLLET, MUSCATINE → ← TAMA, SHARPSBURG, SHELBY → ← DOWNS, FAYETTE →	← COLO →
GENERAL DESCRIPTION	UNIFORMLY GRADED GRANULA		POORLY GRADED (SILT OR CLAY) GRAVEL OR SAND				CLEAN FINE SAND OR GRAVEL	SILT OR SILT LOAM	SILT OR SILT LOAM	PLASTIC CLAY LOAM	PLASTIC CLAY
SOIL GROUPS	A-1 NON PLASTIC	A-1 PLASTIC	A-2		A-2		A-3	A-4 AND A-4-7	A-5 AND A-5-7	A-6	A-7
			A-2-4	A-2-5	A-2-6	A-2-7					
CHARACTERISTICS OF SOIL											
SIEVE ANALYSIS PERCENT PASSING: NO. 10	50 MAX										
NO. 40	30 MAX	50 MAX					51 MIN				
NO. 200	15 MAX	25 MAX	35 MAX	35 MAX	35 MAX	35 MAX	10 MAX	36 MIN	36 MIN	36 MIN	36 MIN
Grain Size I SAND	70-80		55-80		55-80		75-100	55 MAX	55 MAX	55 MAX	55 MAX
Grain Size I SILT	10-20		0-45		0-45			HIGH	MEDIUM	MEDIUM	MEDIUM
Grain Size I CLAY	5-10		0-45		0-45			LOW	LOW	30 MIN	30 MIN
CHARACTERISTICS OF FRACTION PASSING NO. 40 LIQUID LIMIT PLASTICITY INDEX	6 MAX		40 MAX 10 MAX	41 MIN 10 MAX	40 max 11 min	40 min 11 min	NONPLASTIC	40 MAX 10 MAX	41 MIN 10 MAX	40 MAX 11 MIN	41 MIN 11 MIN*
GROUP INDEX	0		0		4 MAX		0	8 MAX	12 MAX	16 MAX	20 MAX
EXPANSION	NONE		NONE		SOME		SLIGHT	VARIABLE	HIGH	MEDIUM	HIGH
ELASTICITY	NONE		NONE		SOME		NONE	VARIABLE	DETRIMENTAL	MEDIUM	HIGH
CAPILLARY RISE	LOW	HIGH	36" MAX		OVER 36"		6" MAX	HIGH	HIGH	LOW	LOW
SHRINKAGE RATIO	1.7 - 1.9		1.7 - 1.9		1.7 - 1.9		NOT ESSENTIAL	1.5 - 1.7	0.7 - 1.5	1.7 - 2.0	1.7 - 2.0
STABILITY	HIGH	HIGH WHEN DRY	HIGH		GOOD WHEN DRY		IDEAL WHEN CONFINED	GOOD WHEN DRY	NO GOOD	GOOD WHEN DRY & PROPERLY COMPACTED OR UNDISTURBED	
BASE	GOOD	FAIR	FAIR		FAIR		EXCELLENT	NO GOOD	NO GOOD	NO GOOD	NO GOOD
SUB-BASE	EXCELLENT	GOOD	EXCELLENT		GOOD		EXCELLENT	NO GOOD	NO GOOD	NO GOOD	NO GOOD
SUB-GRADE	EXCELLENT	GOOD	EXCELLENT		GOOD		EXCELLENT	FAIR WITHIN SPECIFIC LIM. WHEN PROPERLY DRAINED & COMPACTED	NO GOOD	FAIR WITHIN SPECIFIC LIMITS WHEN PROPERLY DRAINED AND COMPACTED	
DRAINAGE	DRAINS FREELY	IMPERVIOUS	FAIR TO PRACTICALLY IMPERVIOUS				DRAINS FREELY	FAIR TO IMPERVIOUS			
PUMPING ACTION	NONE	SLIGHT	NONE		SLIGHT		NONE	BAD	BAD	BAD	BAD
NORMAL FROST ACTION	SLIGHT	SUBJECT TO	SLIGHT		SUBJECT TO		NONE	VERY BAD ABSORBS WATER	VERY BAD	SLIGHT WHEN IMPERMEABLE BAD WHEN PERVIOUS	
BEARING VALUES	GOOD TO EXCELLENT	GOOD TO EXCELLENT	FAIR TO EXCELLENT					POOR TO FAIR	POOR	FAIR WHEN TREATED	
OPTMUM MOISTURE (NORMAL)	0%	0%	9-12%		9-12%		9-12%	12-17%	22-30%	12-20%	17-28%

*PI of A-7-5 subgroup equal to or less than L.L. minus 30; PI of A-7-6 subgroup greater than L.L. minus 30.

TABLE 3.2 GUIDELINES FOR STREET SUBGRADE TREATMENT

SOIL GROUPS	A-1 NON-PLASTIC	A-1 PLASTIC	A-2 NON-PLASTIC	A-2 PLASTIC	A-3	A-4	A-5 AND A-7-5	A-6	A-7-6
REQUIREMENTS FOR SUBGRADE SOILS (must meet all)									
Liquid Limit in Upper 2 feet		< 25		< 25			"Unsuitable" Material		
Plastic Limit in Upper 5 feet		< 29		< 29		< 31	in no case used	< 29	< 30
Plastic Index in Upper 2 feet		< 4		< 4		> 8	in construction of embankment	> 10	> 10
Max. % Moisture in Upper 2 feet	4% Over Optimum Moisture Content (All soils over 20% must be dried to > 20%)								
Max. % Carbon in Upper 2 feet		3%		3%			3%		
Minimum Proctor Density in Upper 4 feet	90% of optimum								
Removal in Top 3 feet of cuts and 5 feet in fills (must meet above criteria)							"unsuitable"		A-7-6 (19 & 20)
TREATMENT									
Moisture & Density Control Required (95% Proctor Density)	1' in cuts and 2' in fills if no select specified. If select specified, use M & D control to depth of select.					2' in cuts and fills or to depth of select whichever is greater.			
Material as Select*	2' deep uniform soils; 15% or less silt; proctor density ≥ 110 PCF; PI ≤ 3					2' deep uniform soils; 2-3' deep non-uniform silt; 47% or less silt; proctor density ≥ 110 PCF, PI ≥ 10			
Subdrain needs**		To lower high-water table		To lower high-water table		All A-4 with a group index < 7		When A-6 or A-7 is used as select in A-4 subgrade material***	
Steel Reinforcement						May be required		May be required	
COMPACTION									
Compaction Abilities	Excellent	Excellent	Good with Specific Control		Good to excellent	Good to fair with specific control	Very Poor	Good to fair with specific control	
Compaction Methods	Type "B" Compaction						Type "A" Compaction		
SELECT TREATMENT CONDITIONS									
CONDITION	Cut through side hill creating subgrade on several types of natural soil and fill within a short space. Non-uniform support and settlement.	Rapid succession of soil types. Pockets of different soil types. Changes in soil profile or in soil structure. Non-uniform support.			Uniform silt soil types; has high capillary rise & is subject to bad frost action.			Adjacent parts of fills constructed of widely differing soil types, as where hauling is from different sources. Non-uniform support and settlement.	
TREATMENT	Remove to depth of 3' and provide a uniform layer of select material 3' deep across the weak zone. Provide outlet subdrainage for seepage following porous soil strata or moving between strata.	Manipulate soil for 2' depth and recompact to maximum density. Provide adequate subdrainage for water trapped in perches or porous pockets.			P.I. 4-8 Remove to 2' & replace with layer of select & subdrain one side of road.	P.I. 0-4 Remove to 2' & replace with layer of select & subdrain both sides of road or remove to depth of 3' & subdrain on one side		Avoid this condition if possible. If unavoidable, remove to 2-3' depth and replace with select material and recompact to maximum density. Depth depends on soils analysis, particularly silt content, P.I. carbon content, etc.	
All Select Treatment Will Require Moisture and Density Control To Depth of Select. (95% Proctor Density)									

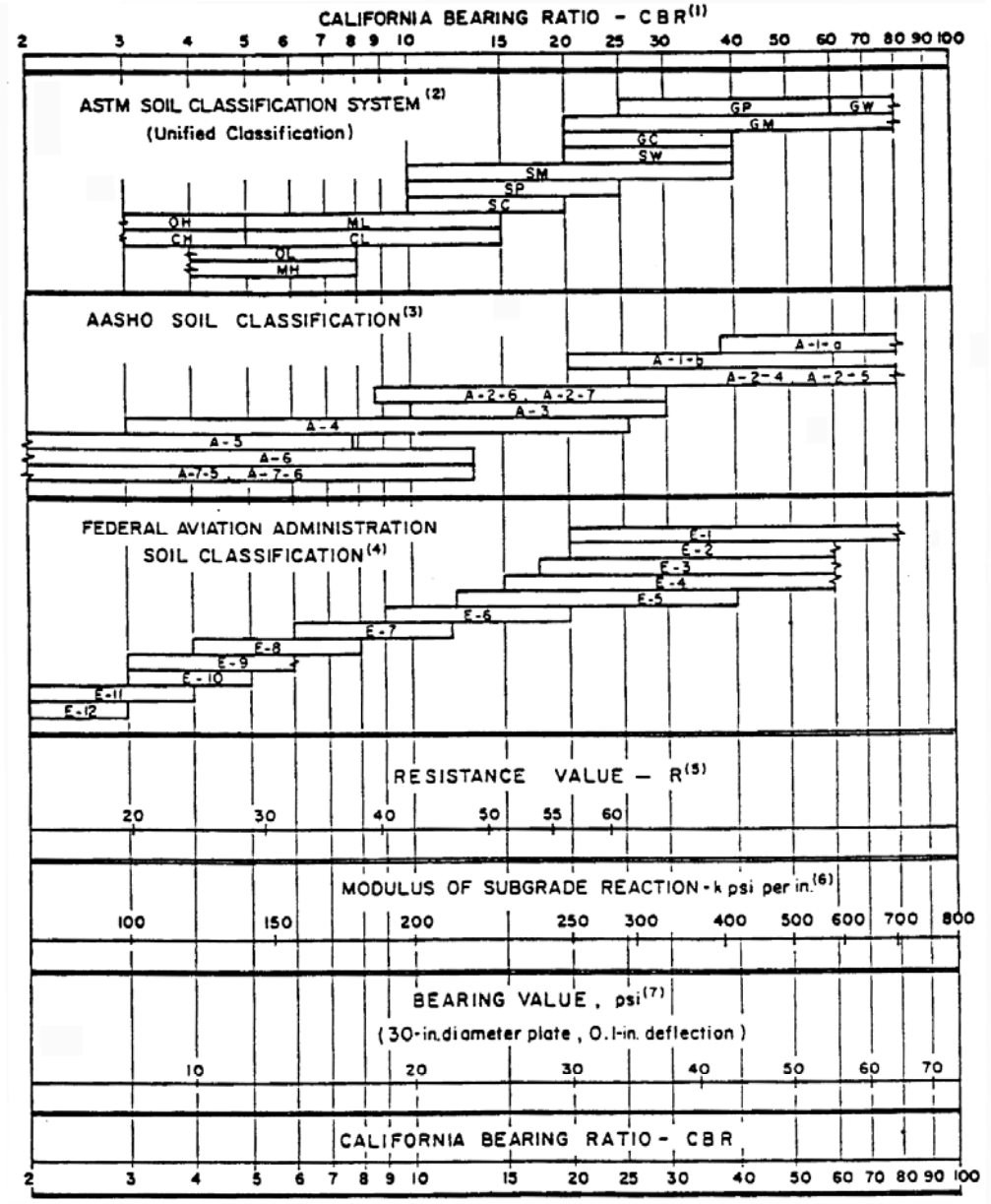
NOTE: Vibratory rollers will not be used except in sand fill areas.

* Ideal Clay Select is A-6(10) to A-6(14)

** Drainage (Subdrains or Ditching) should assure the ground water level is maintained at least 3.0' below finished subgrade. In areas where conditions are severe, or where positive drainage cannot be assured, a minimum 14" special back fill treatment should be used. Trenched granular or "special" treatments should have lateral drainage provided at low points or at maximum 500' intervals.

*** Subdrain not effective if subgrade is all A-6 or A-7 material, except in high water table areas, and high surface infiltration areas.

FIGURE 3.1 Approximate interrelationships of soil classification and bearing values.



1. For the basic idea, see O.J. Parker, "Foundations for Flexible Pavements," Highway Research Board *Proceedings of the Twenty-second Annual Meeting*, 1942, Vol. 22, pages 100-136.
2. "Characteristics of Soil Groups Pertaining to Roads and Airfields," Appendix B, *The Unified Soil Classification System, U.S.* Army Corps of Engineers, Technical Memorandum 3-357, 1953.
3. "Classification of Highway Subgrade Materials," Highway Research Board *Proceedings of the Twenty-fifth Annual Meeting*, 1945, Vol. 25, pages 376-392.
4. *Airport Paving*, U.S. Department of Commerce, Federal Aviation Agency, May 1948, pages 11-16. Estimated using values given the in FAA *Design Manual for Airport Pavements.*
5. F.N. Hveem, "A New Approach for Pavement Design," *Engineering News-Record*, Vol. 141, No. 2, July 8, 1948, pages 134-139, *R* is factor used in California Stabilometer Method of Design.
6. See T.A. Middlebrooks and G.E. Bertram, "Soil Tests for Design of Runway Pavements, "Highway Research Board *Proceedings of the Twenty-second Annual Meeting, 1942, Vol. 22, page 152. k* is factor used in Westerguard's analysis for design of concrete pavement.
7. See item 6., page 184.