ENGINEERING CLASSIFICATION of GEOLOGIC MATERIALS

DIVISION THREE

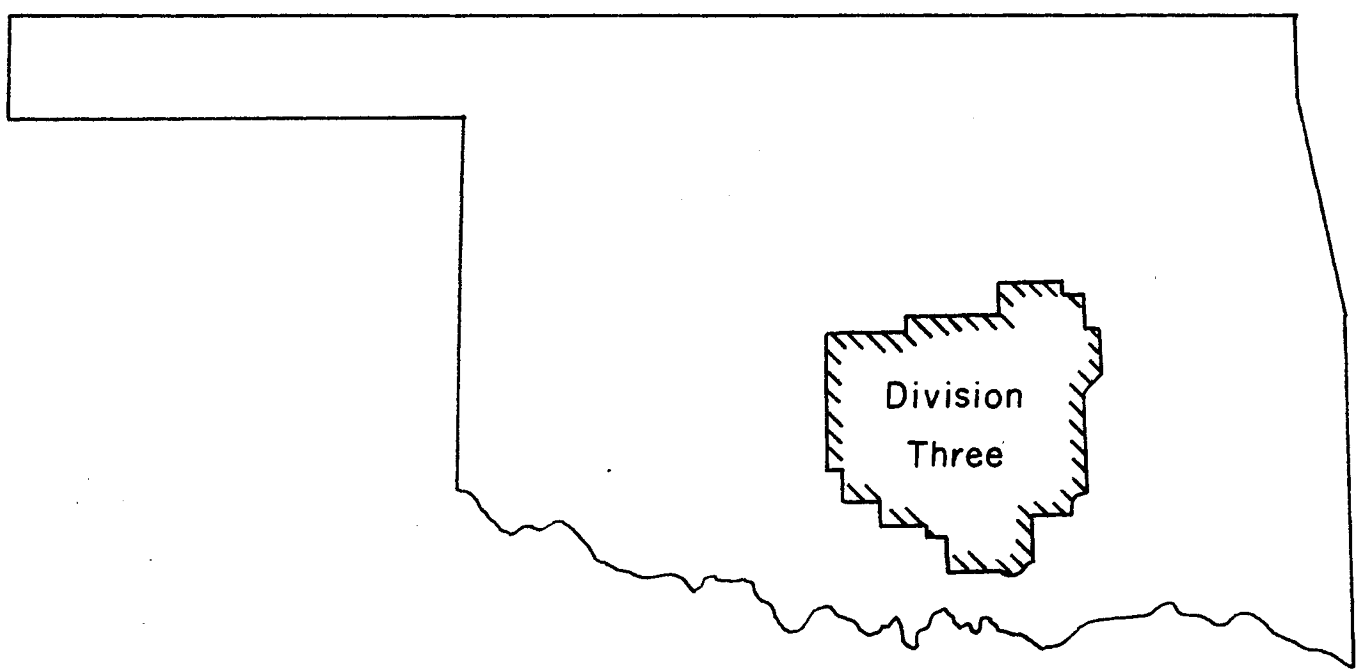
RESEARCH AND DEVELOPMENT DIVISION
OKLAHOMA HIGHWAY DEPARTMENT
In Cooperation with the
U.S. BUREAU OF PUBLIC ROADS
1968

ENGINEERING CLASSIFICATION OF GEOLOGICAL MATERIALS

AND

(RELATED SOILS)

OKLAHOMA HIGHWAY DEPARTMENT MAINTENANCE DIVISION THREE



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RESEARCH AND DEVELOPMENT DIVISION

OKLAHOMA HIGHWAY DEPARTMENT

1969

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The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Bureau of Public Roads.

FOREWORD

Geology is the science of the earth and is an organized collection of knowledge about the earth on which we live. The various rock and shale stratum that we see at the surface of the earth are all part of this organized body of knowledge. These exposures of rocks have been named and classified according to age by geologists. While these classifications serve many useful purposes, they are not particularly adaptable to the specific needs of those involved in highway design, engineering, and development. This publication is an attempt, therefore, to provide a classification system specifically designed and devoted to the needs of highway department personnel and individuals associated with the highway industry. It contains the engineering geologic classifications developed by the Research and Development Division of the Oklahoma Highway Department, in cooperation with the Bureau of Public Roads.

More detailed geologic information of specific areas may be obtained from publications listed in the bibliography.

PURPOSE AND SCOPE

The purpose of this publication is to provide a document which will serve as a comprehensive reference for Highway Department personnel concerned with engineering classifications of geologic materials found in the State of Oklahoma. The classification system described herein will assist personnel in the development of plans, designs, engineering, construction, and maintenance of our highways.

It is intended that this classification instrument be presented in such a manner that personnel with little or no understanding of geology may determine and identify the geologic materials in their respective area and operations. To simplify the classification procedure, geologic materials have been grouped into "geologic units", rather than being handled in the more sophisticated classification of ages, formations, and members. Each unit represents a specific area or locale within a county and identifies and describes the various geologic materials found therein together with the engineering characteristics encountered. Illustrations of certain geologic features (such as landslides, seepage, backslope instability, and terrace deposits) identified with each "geologic unit" are also provided. The different types and series of soils associated with geologic materials are described and illustrated together with the soil engineering characteristics.

The data presented herein represents an initial effort to provide a geologic and related soil classification reference for highway engineering. There is room for improvement and subsequent publications will include suggestions and relative field experiences. For instance, it is obvious that the boundaries of a "geologic unit" do not necessarily divide the engineering requirements. One geologic unit may need further division to best describe the engineering aspects while several geologic units within a county may be essentially the same from an engineering standpoint. It is hoped that those using this classification system will find essential information for immediate utilization and that they will record their experience associated with the various geologic units for future publication.

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GENERAL GEOLOGIC INFORMATION

AND

PROCEDURES

GENERAL GEOLOGIC INFORMATION

The information in Chapter One is intended to familiarize one with the general concepts of geology and its application to engineering. It is vital that this chapter be fully understood before proceeding to use the information contained in the rest of the publication.

For this publication, geologic materials are defined as masses and layers of rock, shale, and certain deposits of gravel, sands, silts, clays, and/or mixtures of these. Most of the geologic materials that occur at the surface are mantled with soil from a few inches thick up to as much as seven feet thick.

The geologic materials occur as two major types: (1) consolidated and (2) unconsolidated.

Consolidated Geologic Materials

Consolidated geologic materials are the various types of rocks such as limestone, sandstone, shale, chert, novaculite, gypsum, conglomerate, granite, etc. There may be soft sandstones and shales that are not in the true sense rocks, but they are classified here as such because they occur as a geologic bed or lens.

A geologic bed is one certain type of geologic material (rock) divided from other geologic materials, above and below, by a well-defined divisional plane called a bedding plane. See figure 1, page 4.

A geologic lens is one certain type of geologic material (rock), which can be easily divided from surrounding materials, but it does not have a flat-like bedding plane. It generally occurs as a body of material, which is thick in the approximate center and thins toward the edges. See figure 1, page 4.

Geologic Mass--Some rocks, such as granite, occur as rock masses. See figure 1, page 4.

Unconsolidated Geologic Materials

Unconsolidated geologic materials are the materials that have been deposited by streams, wind, and gravity. The individual grains are very loosely bound together.

Terrace deposits are deposits consisting of sand, silt, clay, gravel, or mixtures of these. These materials were deposited by streams or wind and may be found adjacent to most streams. Figure 2, page 6, shows some types of Terrace deposits.

Alluvium is the materials that have been, and are presently being, deposited by streams. Alluvium consists of sand, silt, clay, gravel, or mixtures of these. See figure 2, page 6.

Wind deposits are sand dunes, etc.

Colluvium is deposits of material occurring on slopes that have moved down, due to gravity. The deposit may consist of mixtures of sand, silt, clay, and gravel, to boulders. See figure 3, page 7.

Now that it is understood which portion of the earth materials are studied by geology and what these materials are, it can be seen how they are classified and grouped.

Classification

As a beginning toward an engineering classification of geologic materials, the present geologic classification and mapping are used with some slight changes. For the purposes of this publication, the geologic unit consists of one or more geologic materials. The outcrop (refer to figure 1, page 4) of this unit is outlined geographically on a map. In other words, it is one or more geologic materials that can be called a single unit, and this single unit is somewhat different from other units. The geologic units generally are named after some town, person, or location; for example, the McAlester Unit was named after the town of McAlester.

The outcrop portion of these geologic units of consolidated and unconsolidated types of material are shown on county geologic unit maps. Here again, it should be made clear that since the geologic units are divided according to a geologic classification, it is not intended that these units are divided completely according to what may be necessary to highway engineering. From available information at this time, it is obvious that in many cases certain engineering conditions are listed within the information of each geologic unit.

It is possible to determine the type of geologic material that is completely covered by soil by using the following criteria:

Soil Series--Certain soil series occur over certain geologic materials. Examples: Lucien occurs over sandstone; Kirkland occurs over shale. The chart on page 123 shows the relationship of the known soil series to geologic materials by counties. For identification of soil series, refer to page 128.

Vegetation--Certain types of vegetation occur on certain types of geologic materials. Oak trees grow well on sandstone. Generally, the change from sandstone to shale is evidenced by a change in vegetation from trees to grass. Persimmon sprouts and trees grow well on limestones and some shales. Generally, prairie-land areas occur over shales and some limestones. Plum thickets are generally associated with sand dunes and terrace deposits.

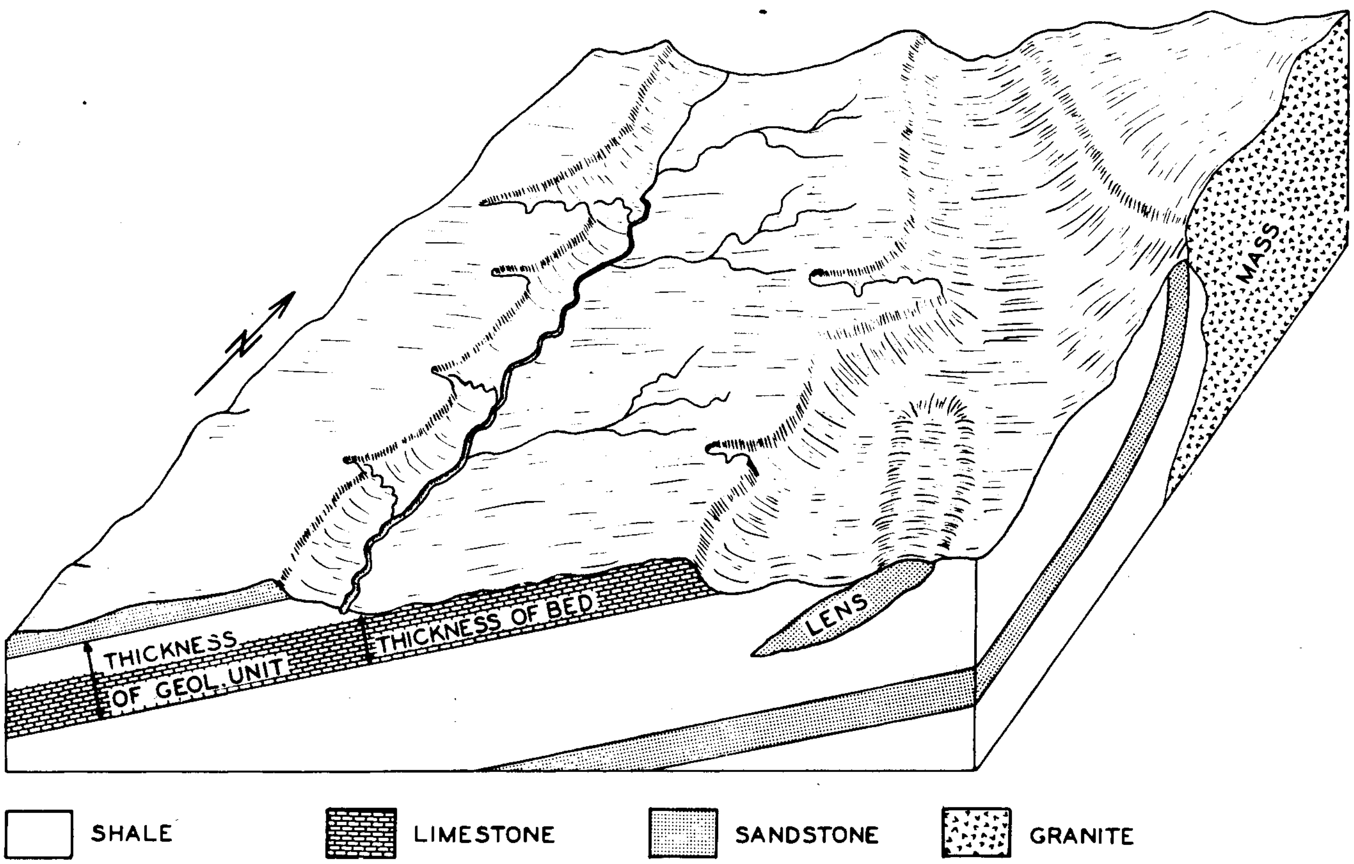


Figure 1

Explanation for figure 1 on page 5.

Explanation for figure 1:

Outcrop--These are the areas shown on the surface portion of the block diagram. The term outcrop, for the purpose of this report, is defined as the coming out at the surface of the earth of any consolidated geologic material. It is the portion of a geologic unit, bed, lens, or mass of rock that is exposed at the surface which may or may not be covered with soil and/or a thin cover of unconsolidated geologic materials.

Thickness--This is the measured distance taken at a right angle to the surface of the bedding plane.

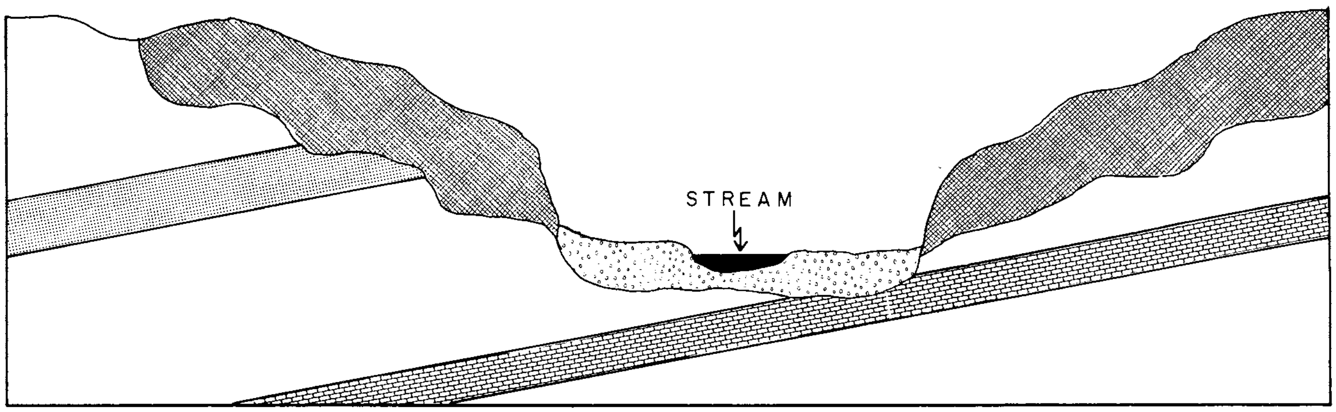
Dip of the Beds--Dip is defined as the angle at which a bed is inclined from the horizontal. The beds in this diagram are dipping west at approximately 5 degrees, or 460 feet per mile, or a 9 percent slope. A bed that outcrops here at a surface elevation of 1000 feet would be approximately 460 feet below the surface one mile west, providing the surface elevation is 1000 feet.

Geologic Lens--This is a certain type of consolidated geologic material which can be easily divided from surrounding materials, but does not have a flat-like bedding plane. It generally occurs as a body of material which is thick in the approximate center and thins toward the edges.

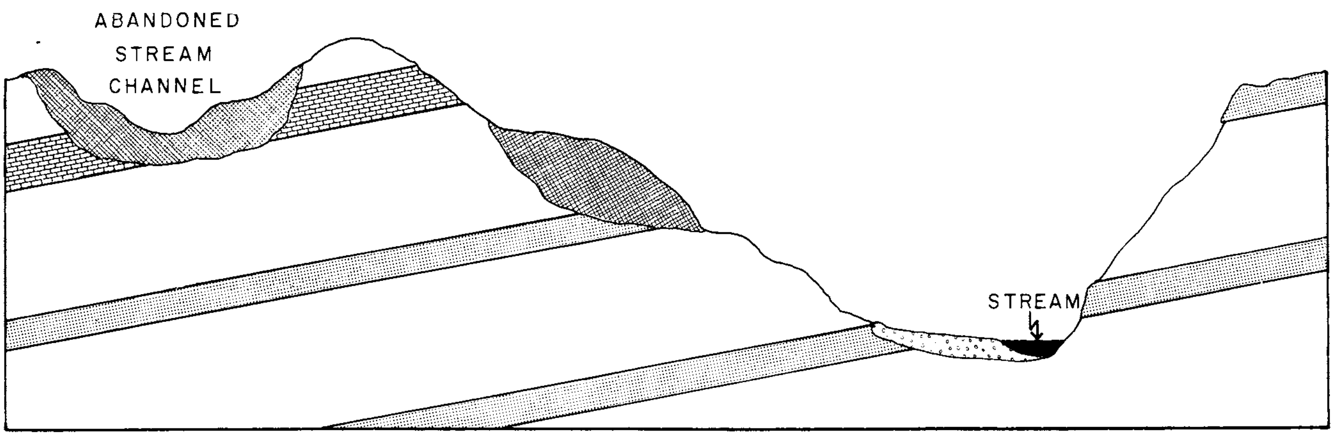
Geologic Mass--Granite and a few other rocks silimar to granite occur as masses and may be found in most any shape. This type of rock does not have a flat-like bedding plane.

The outcrop of geologic materials is generally completely overlaid by soil. Also, the unconsolidated geologic materials (wherever they occur) are laying upon outcrops of the consolidated materials, as shown in figure 3.

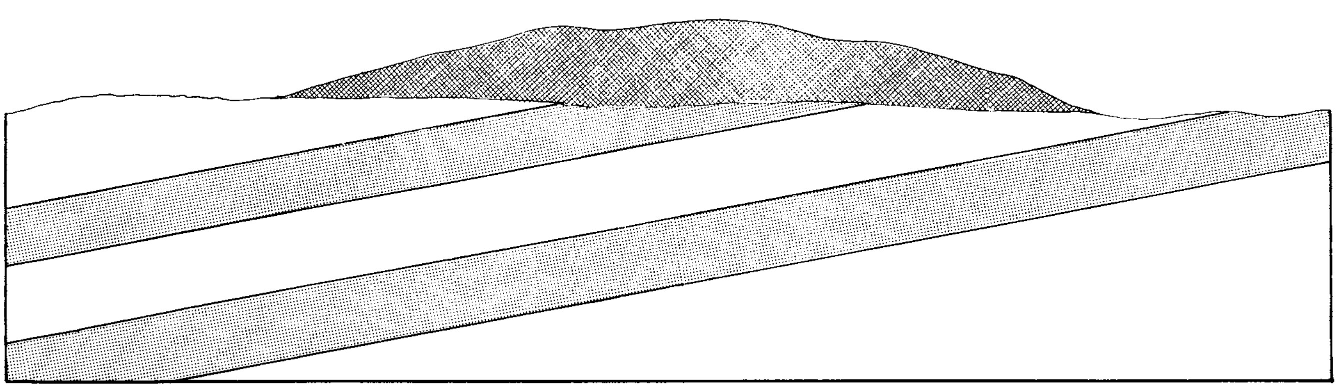
CROSS SECTIONS SHOWING TERRACE DEPOSITS



Terrace deposits that are adjacent to the stream that deposited them.



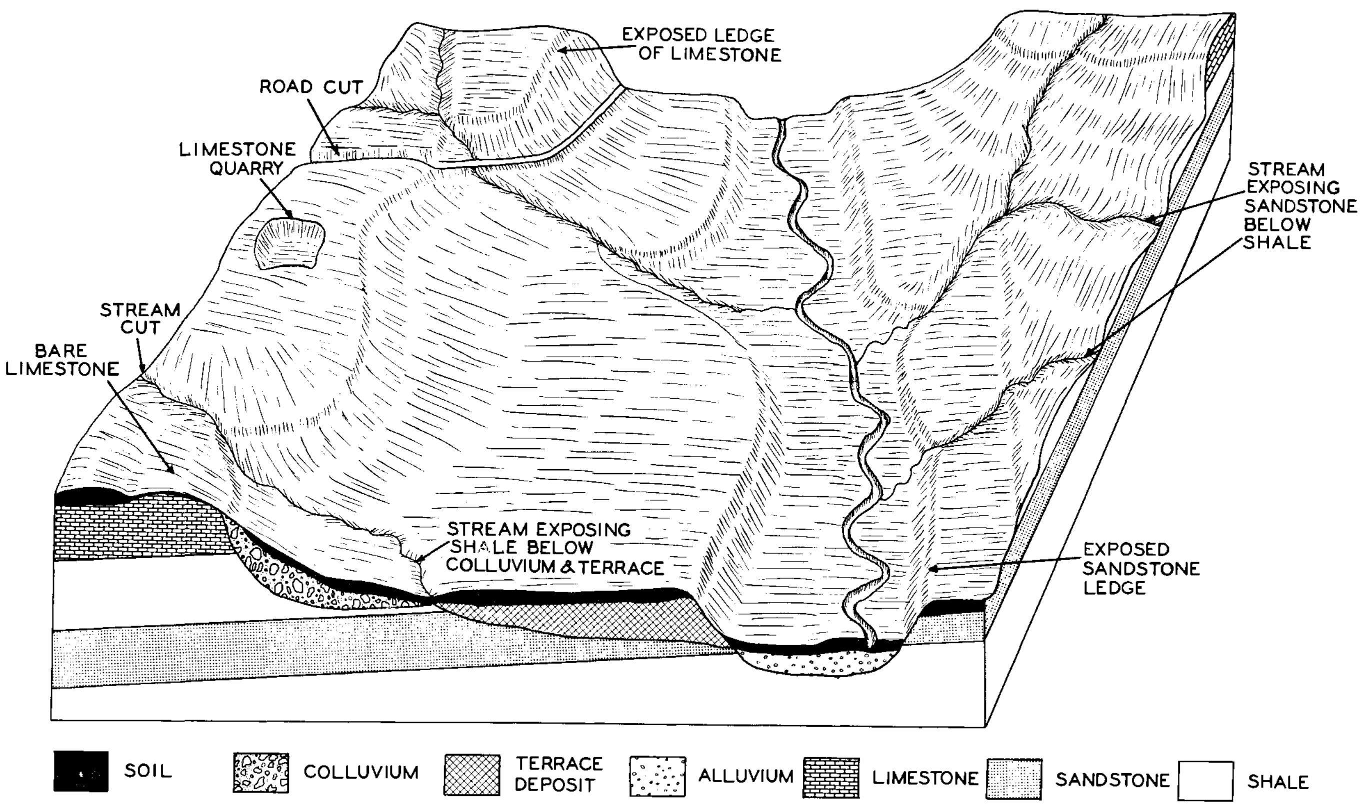
Terrace deposits that are some distance from the stream that deposited them, but generally can be recognized as being a deposit of that stream.



An upland terrace deposit that was deposited by a stream that is not presently in the same area.

Figure 2

If most outcrops are covered, the question arises, "How does one know a particular geologic unit outcrop is present where it is shown?" The following block diagram shows a few conditions that expose the geologic materials along their outcrops.



This block diagram shows the following:

1. Areas where erosion has removed the soil and exposed the geologic materials.
    a. Sheet erosion over sloping flat areas.
    b. Gullies and streams cutting through the soil into the geologic materials.
2. Areas with little or no soil development.
3. Rock ledges outcropping on hillsides.
4. Man-made cuts, quarries, pits, etc.

METHOD FOR DETERMINING ENGINEERING CHARACTERISTICS OF GEOLOGIC MATERIALS

Characteristics Determined from Field Observations and Construction

Certain qualities, such as: hardness, texture, and position of geologic materials can be directly correlated with highway engineering. Research Scientists have made field studies on the qualities of geologic materials, compiled information from highway department records, noted construction practices, and obtained information from other reliable sources. From these sources of information, estimates of material suitability, seepage characteristics, rippability, landslide characteristics, and backslope instability were made on geologic materials. This information is listed on charts in Chapter II, beginning on page 73.

Some information could not be obtained during the period of investigation by the Research Division due to the lack of sufficient precipitation to cause seepage, no construction, limited time, and/or lack of sufficient evidence.

One main purpose of this publication is to aid persons in identifying geologic materials and determining their qualities that affect highway engineering, so they can collect and correlate their own experiences with the geologic information.

Landslides

A landslide is a downward and outward movement of materials consisting of rock, soil, man-made fills, or combinations of these materials.

Known landslides are listed according to the geologic unit it occurs within, and reference to the type of landslide is made.

Figures 4, 5, 6, and 7, pages 9, 10, and 11, show some types of conditions involving landslides. It is intended that these illustrations will aid personnel in recognizing landslides and to recognize situations that may cause landslides.

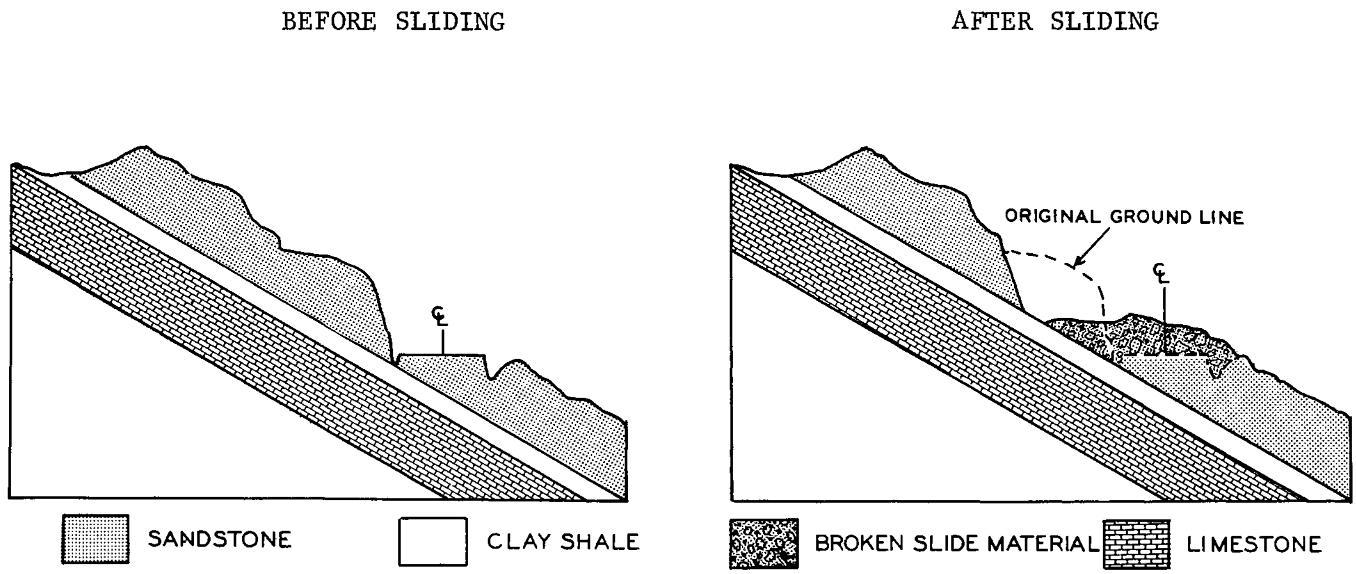


Figure 4

Figure 4 shows a condition where bedded rock dipping toward the roadway slipped, after the road cut removed support. In this condition, sandstone was laying on shale or clay. The moisture percolated through the sandstone and collected at the contact, allowing slippage after the support was removed. Generally, most any type of bedded material will slip if the dip is steep, support is lost, and if it is underlaid by a material that becomes slick when moisture is present. Each individual condition generally is different and requires a study of the factors involved.

Figure 5, page 10, illustrates the most common type of landslide in Oklahoma. The deposit of colluvium is generally an unconsolidated mass of

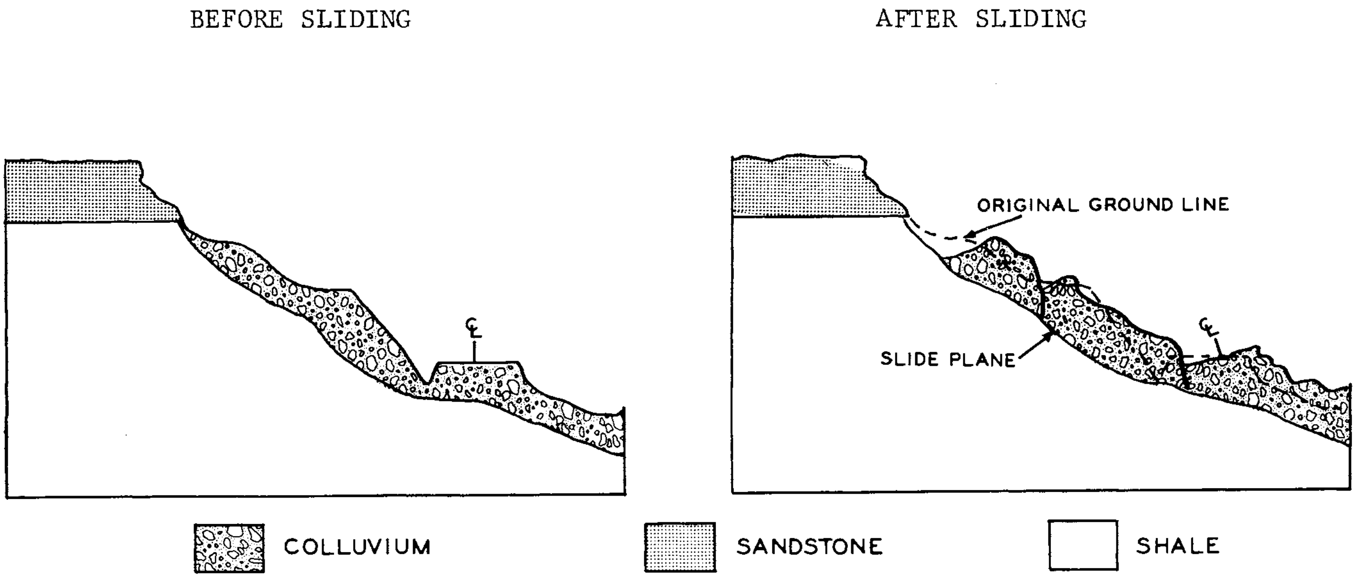


Figure 5

sand, silt, clay, and gravel to boulders. When this mass of material lays upon shale, if enough moisture collects at the contact between the materials, slippage may occur; also, loss of lateral support at some point along the slope allows slippage. Generally, both of these factors are involved. Loss of lateral support was caused by the road cut and when the material moved down upon the roadway, this additional weight moved the road.

Figure 6, page 11, shows a condition where a stream has eroded the toe of a slope of colluvium and created a landslide, which eventually migrated uphill involving the roadway.

Figure 7, page 11, shows where a road cut has caused the material to slide, and the sliding has migrated uphill involving personal property.

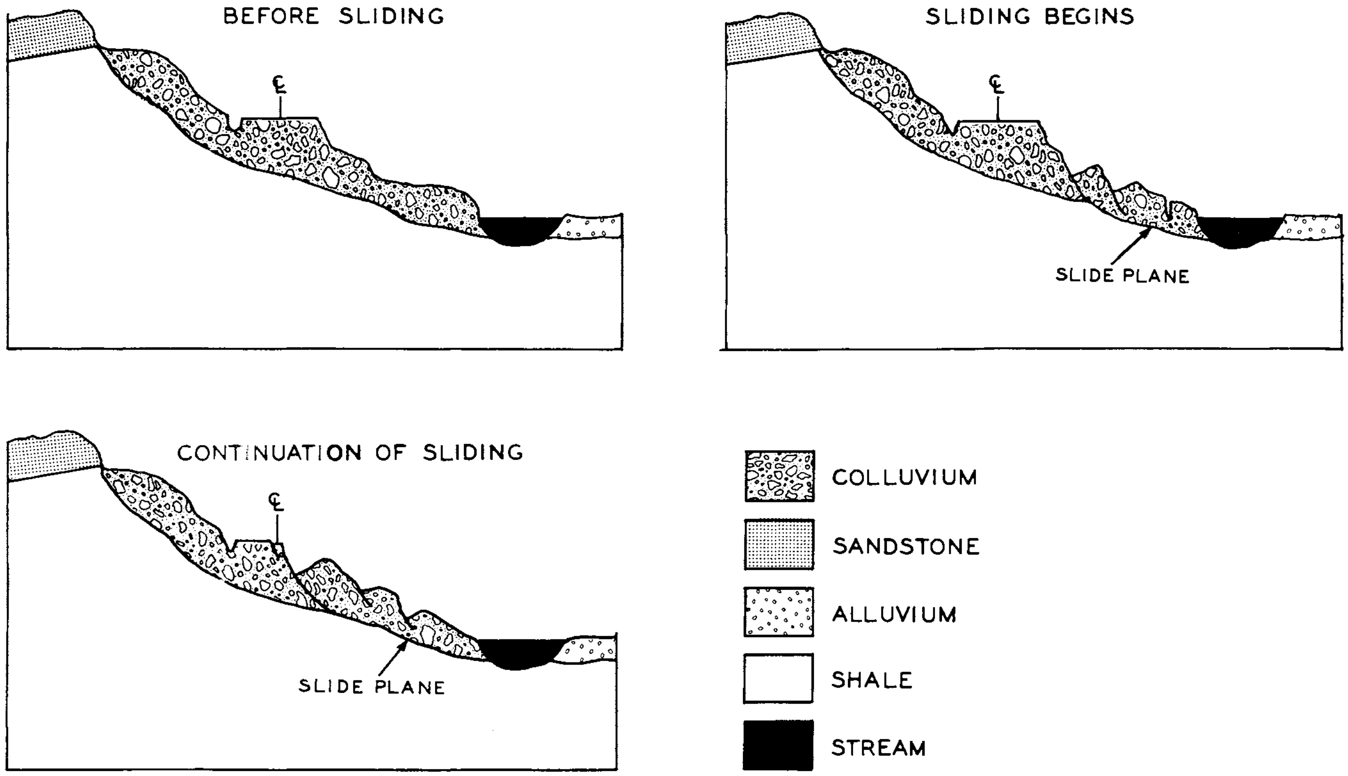


Figure 6

Figure 6 shows a condition where a stream has eroded the toe of a slope of colluvium and created a landslide, which eventually migrated uphill involving the roadway.

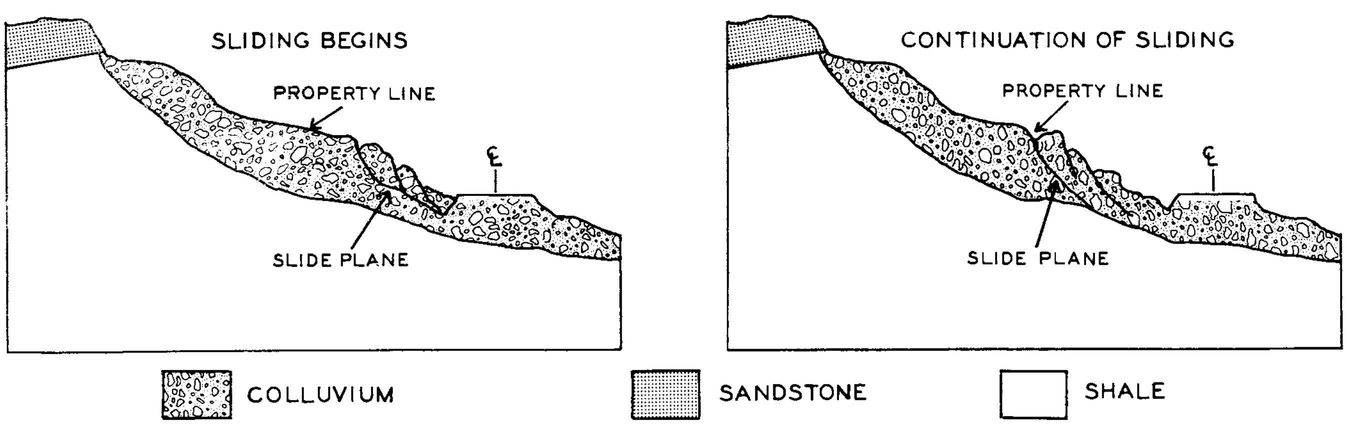


Figure 7

This figure shows where a road cut has caused the material to slide, and the sliding has migrated uphill involving personal property.

CROSS SECTIONS OF SEEPAGE CONDITIONS

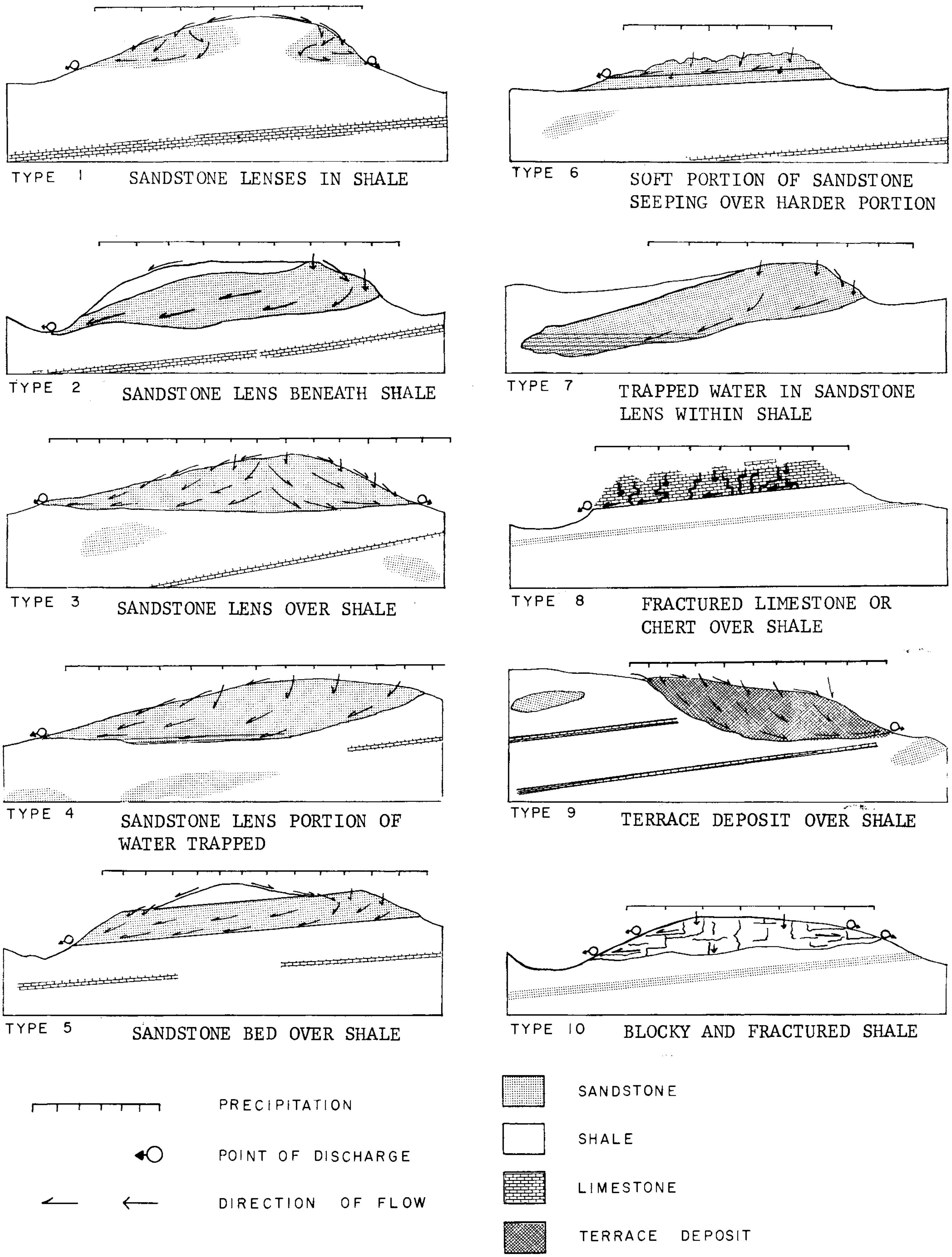


Figure 8

Characteristics of Shales Determined From Laboratory Testing

The shales were laboratory tested for sieve analysis (percent passing the numbers 10, 40, 60, and 200), plasticity index, liquid limit, volumetric change, field moisture equivalent, shrinkage limit, pH, and shrinkage ratio.

From these test results, the estimated Suitability for Subgrade, Oklahoma Subgrade Index Number, AASHO Classification with Group Index Number, Potential Vertical Rise, Percent of Asphalt for Stabilization, and Percent Cement for Stabilization were determined by use of charts. See charts 1 through 7, pages 13 through 19. Engineering characteristic charts for these shales begin on page 86 Chapter II.

STATE OF OKLAHOMA

DEPARTMENT OF HIGHWAYS

RESEARCH AND DEVELOPMENT DIVISION

ESTIMATED SUITABILITY OF MATERIALS

SUBGRADE	GOOD	FAIR	POOR
OSI	6 or less	7-16	17 or more

Chart 1

OKLAHOMA SUBGRADE INDEX NUMBERS CHART

To Use This Chart

1. Determine the percent of the soil passing the number 200 sieve and the L.L. and P.I. of the soil.
2. On the L.L. chart, find the % pass no. 200 along the bottom of the chart and move vertically up to the L.L. (sloping) line.
3. From the intersection of these lines, move horizontally to the left to determine index number.
4. Follow a similar procedure (reading down and right) and determine the index number from the P.I. chart.
5. The sum of the index numbers determined in steps 3 & 4 is the Oklahoma Subgrade Index number (O.S.I.).

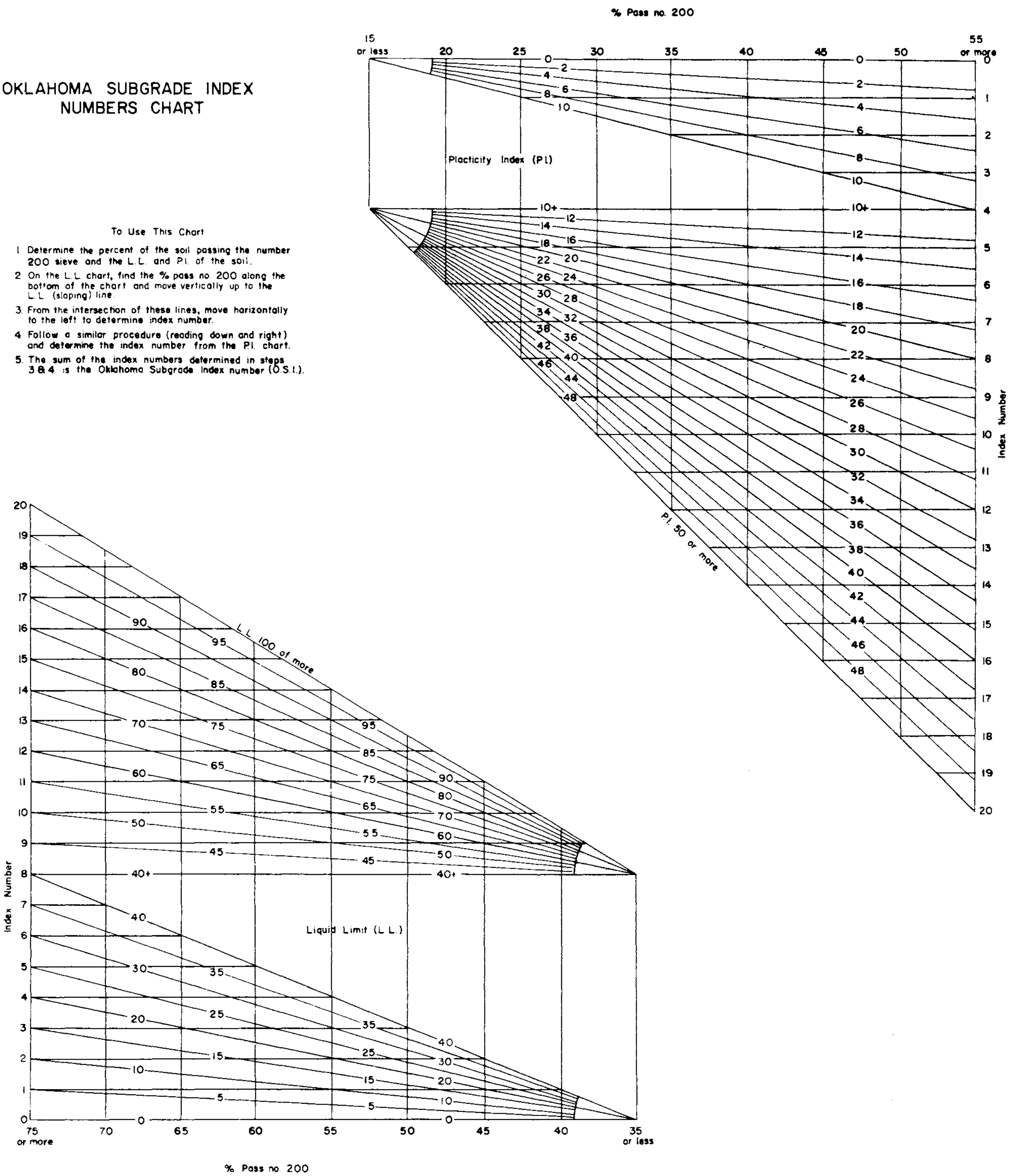


Chart 2

CLASSIFICATION OF SOILS AND SOIL-AGGREGATE MIXTURES. (WITH SUGGESTED SUBGROUPS)[1]

General Classification	GRANULAR MATERIALS (35% or less passing No. 200)							SILT-CLAY MATERIALS (More than 35% passing No. 200)			
Group Classification	A-1			A-2							A-7
	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5 A-7-6
Sieve Analysis: Percent passing:											
No. 10	50 Max.	--	--	--	--	--	--	--	--	--	--
No. 40	30 Max.	50 Max.	51 Min.	--	--	--	--	--	--	--	--
No. 200	15 Max.	25 Max.	10 Max.	35 Max.	35 Max.	35 Max.	35 Max.	36 Min	36 Min	36 Min	36 Min
Characteristics of fraction Passing No. 40:											
Liquid Limit	--		--	40 Max.	41 Min.	40 Max.	41 Min.	40 Max	41 Min	40 Max	41 Min[2]
Plasticity Index	6 Max.		NP	10 Max.	10 Max.	11 Min.	11 Min.	10 Max	10 Max	11 Min	11 Min
Usual Types of Significant Constituent Materials	Stone Fragments Sand and Gravel		Fine Sand	Silty or clayey Gravel and Sand				Silty Soils		Clayey Soils	
General Rating as Subgrade	Excellent to Good					Fair to Poor					

1. Reproduced from AASHO Designation: M 145-66I, Interim Specifications and Methods Adopted by the AASHO Committee on Materials, 1966-1967
2. Plasticity Index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity Index of A-7-6 subgroup is greater than LL minus 30.

NOTE: If a description of the classification groups is desired, reference is made to footnote No. 1 above.

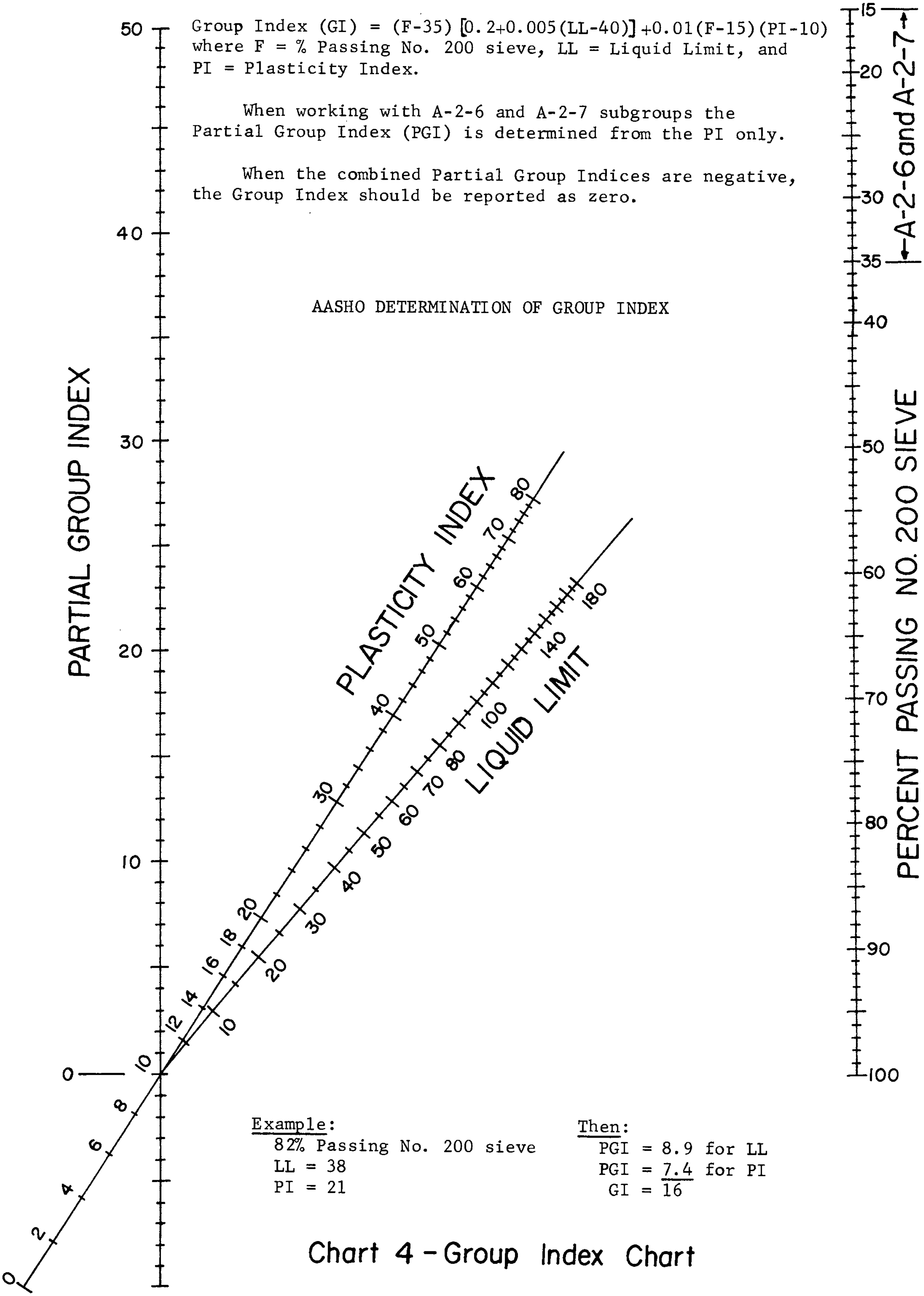
Chart 3

Group Index (GI) = $(F-35)\,[0.2+0.005(LL-40)]+0.01(F-15)(PI-10)$
where F = % Passing No. 200 sieve, LL = Liquid Limit, and PI = Plasticity Index.

When working with A-2-6 and A-2-7 subgroups the Partial Group Index (PGI) is determined from the PI only.

When the combined Partial Group Indices are negative, the Group Index should be reported as zero.

AASHO DETERMINATION OF GROUP INDEX



<u>Example:</u>
82% Passing No. 200 sieve
LL = 38
PI = 21

<u>Then:</u>
PGI = 8.9 for LL
PGI = 7.4 for PI
GI = 16

Chart 4 - Group Index Chart

Potential Vertical Rise of Dry Material In A 3 Foot Layer Under One Psi Load

Calculated From Soil Swell Pressure Slide Rule. Developed by Chester McDowell

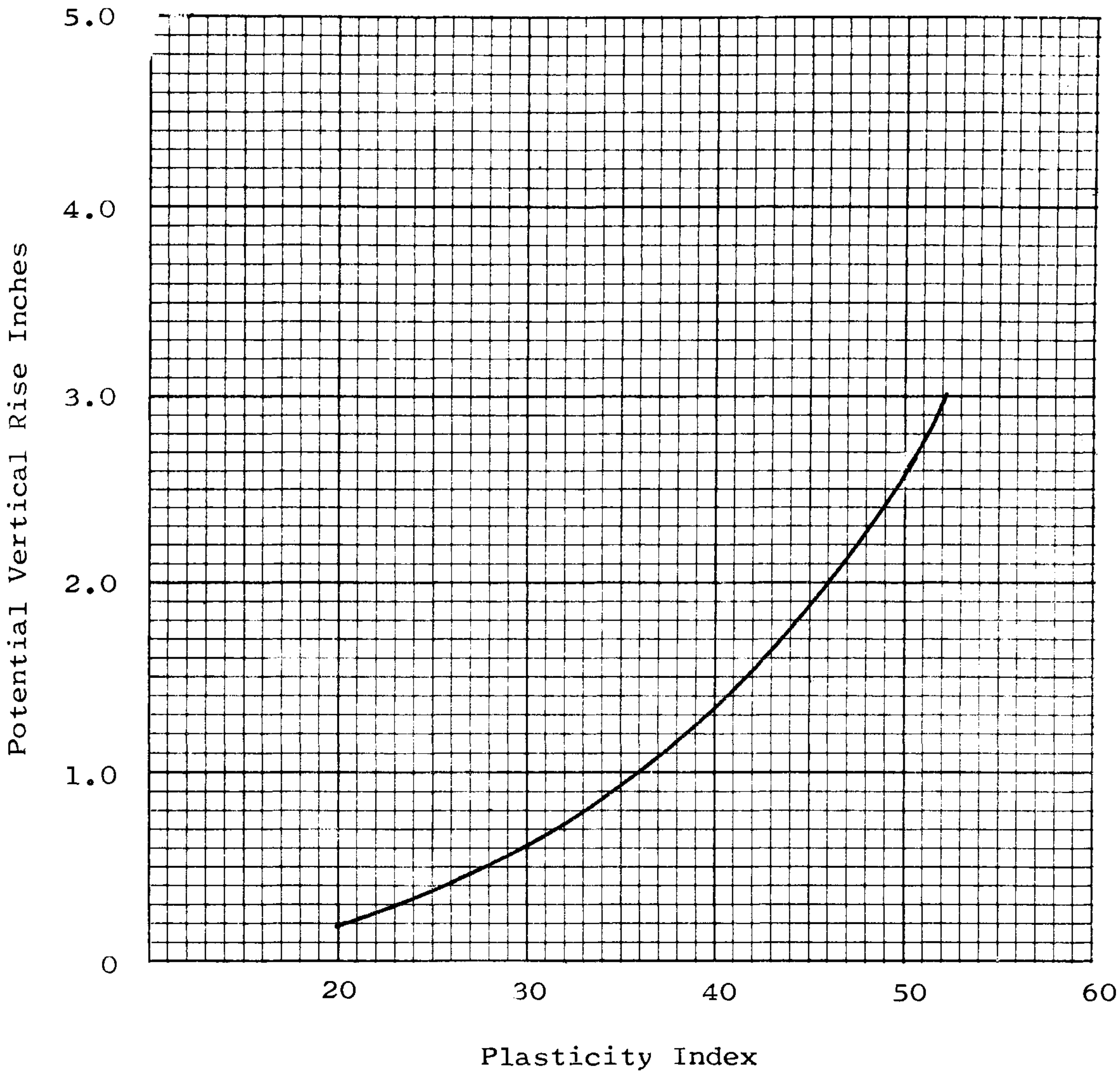


Chart 5

Taken From Graph

P. I.	Inches P. V. R.
19	.15
20	.20
21	.21
22	.24
23	.28
24	.32
25	.36
26	.39
27	.42
28	.49
29	.52
30	.58
31	.63
32	.70
33	.76
34	.83
35	.90
36	.99
37	1.06
38	1.14
39	1.21
40	1.30
41	1.42
42	1.55
43	1.68
44	1.78
45	1.90
46	2.00
47	2.15
48	2.29
49	2.43
50	2.60

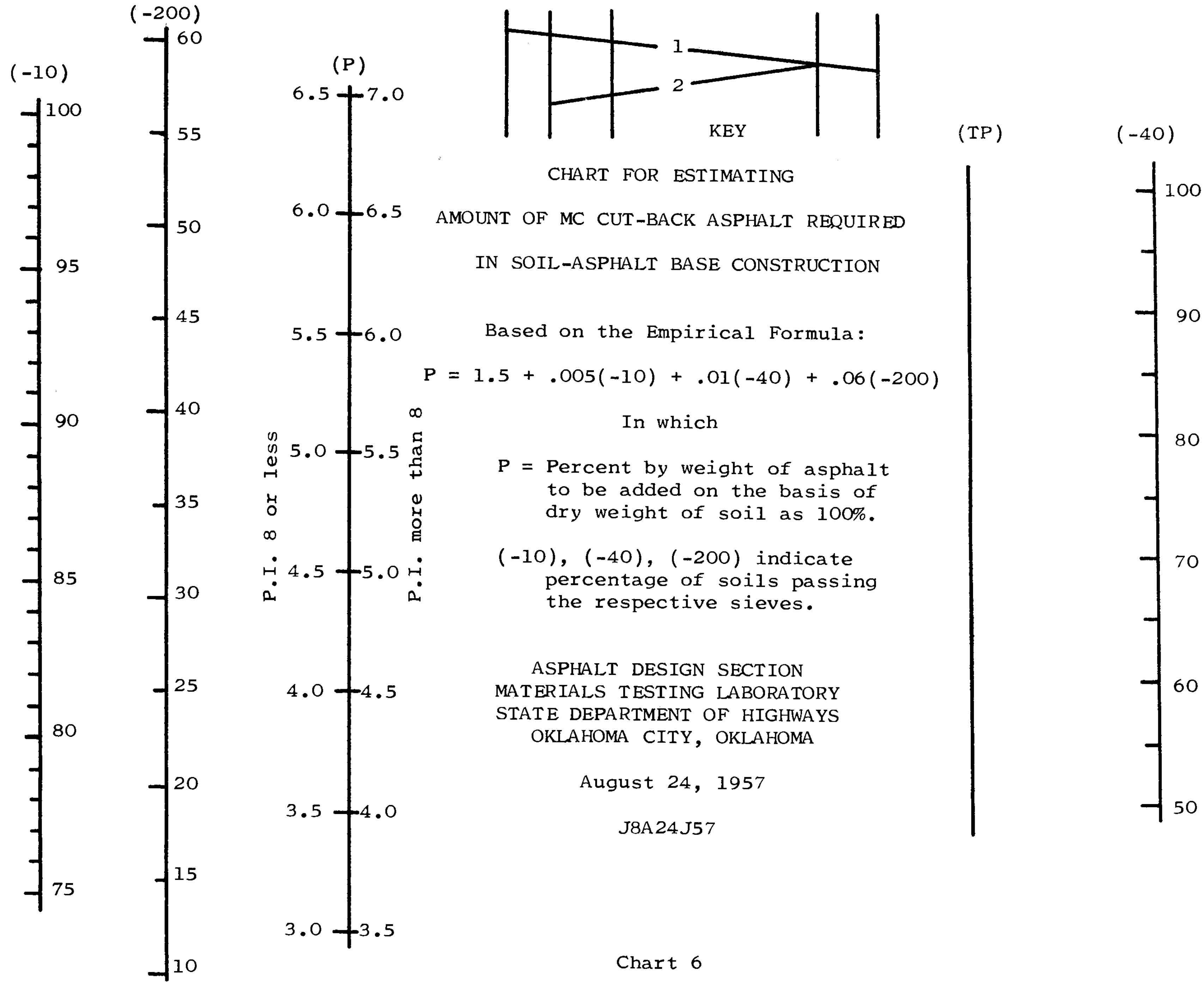


CHART FOR ESTIMATING

AMOUNT OF MC CUT-BACK ASPHALT REQUIRED

IN SOIL-ASPHALT BASE CONSTRUCTION

Based on the Empirical Formula:

$$P = 1.5 + .005(-10) + .01(-40) + .06(-200)$$

In which

P = Percent by weight of asphalt to be added on the basis of dry weight of soil as 100%.

(-10), (-40), (-200) indicate percentage of soils passing the respective sieves.

ASPHALT DESIGN SECTION
MATERIALS TESTING LABORATORY
STATE DEPARTMENT OF HIGHWAYS
OKLAHOMA CITY, OKLAHOMA

August 24, 1957

J8A24J57

Chart 6

ESTIMATED CEMENT REQUIREMENTS

FOR OKLAHOMA SOILS

AASHO	Per Cent Pass 200 Sieve							
Class	0	5	10	15	20	25	30	35
A-1-a	7	7	6	-	-	-	-	-
A-1-b	9	8	8	8	7	7	-	-
A-2-4	9	9	8	8	7	7	8	9
A-2-5	9	9	8	8	8	8	8	9
A-2-6	10	10	9	8	8	8	9	9
A-2-7	11	11	10	9	9	9	10	10

SHALES

A-1, A-2, A-3 --Add 2% cement

A-4, A-5, A-6, A-7 --Add 1% cement

	Texture				
	c	Mc	M	MF	F
A-3	8	9	10	11	12

*

	Group Index						
	0-2	3-5	6-8	9-11	12-14	15-17	18-20
A-4	9	10	11	-	-	-	-
A-5	9	10	11	11	12	-	-
A-6	10	11	12	12	13	14	-
A-7-5	11	11	12	13	13	14	16
A-7-6	11	12	13	14	14	15	17

Chart 7

*This portion of the chart is obsolete due to the change in the method of computing the AASHO Group Index number. It was intended to be used with AASHO M145-49 which has now been replaced by AASHO M145-66I.

TABLE OF TERMS, GEOLOGICAL*

AASHO Classification--A performance value determined by using the percent of soil material passing certain specific sieve sizes, liquid limit, and plasticity index in an emperical mathematical formula. Indicates the suitability of the soils as construction materials. See page 15.

Alluvium--Recent deposits of sands, silts, clays, gravels, or mixtures of these. These deposits are present along stream beds and floodplains.

Arkose (Arkosic)--A sedimentary rock composed of large grains of quartz and feldspar minerals which are derived from the disintegration of acid igneous rocks of granular texture, such as granite.

Bed--A single layer of geologic material that is divided from its neighbors above and below by a more or less well-defined divisional plane. This plane is called a bedding plane.

C--Clay, See Texture. The fine mineral soil grains, less than 0.002 mm in diameter. (Engineers define as less than 0.005 mm in diameter).

Calcareous--Containing calcium carbonate (limy).

Calcite--A mineral, calcium carbonate, Ca CO_3.

Chalk--A very soft, white to light gray unindurated limestone.

Chert--This is consolidated rock, generally very hard and brittle, and occurs in beds distributed with limestones. The grain size is extremely small and requires a microscope to see them. It is a cryptocrystalline variety of silica. It will not fizz when dilute hydrochloric acid is applied.

CL--Clay Loam, See Texture.

*For soils terms see page 381

Clay Gall--A small, generally somewhat flattened pellet or ball of hard or nearly hard clay. Usually found in sandstones or conglomerates.

Colluvium--These are unconsolidated deposits of material occurring on slopes or at the foot of excarpments that have been deposited by gravity. The deposit may consist of mixtures of sand, silt, clay, and gravel to boulders.

Conglomerate--Rock that is composed of gravel size materials that are cemented together by finer sized materials. Generally in beds or lenses.

Cuesta--A hill or ridge with a steep face on one side and gentle slope on the other.

Dip Slope--A slope of the land surface which conforms approximately to the dip of the underlying rocks.

Dolomite--A consolidated type of geologic material; generally the color may be white, cream, or pink. This rock generally occurs in beds and is very similar to limestone. Its composition is Ca Mg $(CO_3)2$. Dolomite will fizz when diluted hydrochloric acid is applied to powdered dolomite.

Escarpment (Scarp)--An extended line of cliffs, bluffs, or a definite break in a slope due to a rock ledge. An abrupt change in elevation of land form usually produced by erosion, etc.

Fault--A large crack or fracture occurring in the geologic units, where rocks on one side have moved in relation to rocks situated on the other side. Movements can be in a vertical or horizontal direction.

Field Moisture Equivalent--The minimum moisture content, expressed as a percent of oven dry soil, at which a smooth surface of soil will absorb no more water in 30 seconds.

Granite--A consolidated geologic material that occurs as a mass. It will not occur as a bed or lens. It will not fizz when dilute hydrochloric acid is applied.

Gypsum--A consolidated type of geologic material generally occurring in beds. Gypsum occurs as a pure mineral ($Ca\ SO_4 \cdot 2H_2O$), which may be alabaster, selenite, or satin spar. Rock gypsum is the impure form of these minerals. Gypsum will not fizz when dilute hydrochloric acid is applied.

Igneous Rock--Rock formed by solidification of molten or partially molten material.

Interbedded--Two or more types of geologic materials occurring in alternating beds. The types of material are in approximately equal proportions for a designated unit; such as, alternating limestones, sandstones, and shales.

L--Loam, See Texture

Limestone--A consolidated type of geologic material; generally the color is gray to dark gray. In certain areas it may occur as brown or reddish-brown. Its composition is $Ca\ CO_3$ (Calcium Carbonate), and it will fizz when diluted hydrochloric acid is applied.

Limy--A term that indicates that a geologic material contains a certain amount of lime (calcium carbonate), but is predominantly another type of material; such as, limy sandstone which is predominantly sandstone.

Liquid Limit--The moisture content, expressed as a percent of oven dry soil, at which a soil passes from a plastic to a liquid state.

LS--Loamy Sand, See Texture.

Mappable Unit--Group of beds or a single bed that can be easily outlined on aerial photographs or by ground survey. This unit may be drawn on a map to show its geographic location.

Marl (marly)--A calcareous clay or mixture of clay and particles of calcite or dolomite.

Massive--This term applies to geologic beds that are greater than 3 feet thick and consist of only one type of rock. Example: a 10-foot or more thick bed of sandstone (with no other type of geologic material within it) would be massive.

Mudstone--Shale-like strata consisting of silt and clay; a massive, hardened, strata which does not split into thin layers, as shale commonly does.

Novaculite--A very dense, even-textured, light-colored, very fine-grained rock, similar to chert.

O.S.I.--Oklahoma Subgrade Index; a modification of the AASHO group index number; a relative support value determined by using the percent of soil material passing the No. 200 sieve, liquid limit, and plasticity index in an emperical mathematical formula. An index number used to determine base thickness requirements for roadways. See page 14.

Outlier--Portions of any geologic unit which lie detached, or out from the main body, separated by erosion from the main unit to which they belong.

PH--See Table of Terms, soils

Plasticity Index--The numerical difference between liquid limit and plastic limit (LL-PL)

Plastic Limit--The moisture content, expressed as a percent of oven dry soil, at which a soil changes from a semisolid to a plastic state.

Potential Vertical Rise--A measure of vertical expansion of plastic material (soil) under one pound per square inch pressure in a three-foot layer of material, due to moisture increase.

Rippability--Susceptibility of a rock to be broken by a ripping device as pulled by a Caterpillar D9 or its equivalent.

Sand--Small rock or mineral fragments having diameters ranging from 0.05 to 2.0 mm, Also see Texture.

Sandstone--A consolidated type of geologic material that occurs as beds or lenses. Sandstone consists of sand grains cemented together forming stone. The various common cementing agents may be calcite, silica, or iron oxide. The color may be shades of red, brown, gray, and may be green.

Sandy--Indicates a portion being sandy, with the geologic material being predominantly some other type. Example: Sandy limestone contains sand grains, but is predominantly limestone.

Seepage--Act of seeping; a local spot where water slowly percolates from porous geologic material, such as a sandstone.

SC--Sandy Clay, See Texture.

SCL--Sandy Clay Loam, See Texture.

Shale--A consolidated type of geologic material which occurs in beds and lenses. Shale generally consists of clay minerals with portions of sands and silts. The color ranges from white to black; but gray, green, red, and black are very common. When weathered at the surface, shales lose their bedded structure and may become loosely compacted clays. Shales are characterized by being plastic when wet (due to the plasticity of clay minerals).

Shaly--Indicates that a portion is shale within a geologic material that is predominantly some other type. Example: Shaly sandstone.

Shrinkage Limit--The moisture content, expressed as a percent of oven dry soil, at which a wet soil stops shrinking.

Shrinkage Ratio--The volume change, expressed as a percent of the volume of the dried soil pat, divided by the moisture loss above the shrinkage limit, expressed as a percentage of the weight of the dried soil pat.

SI--Silt, See Texture. Small mineral soil grains having diameters ranging from 0.002 mm to 0.05 mm (Engineers use the limits of 0.005 mm to 0.05 mm).

SIC--Silty Clay, See Texture.

SICL--Silty Clay Loam, See Texture.

SIL--Silt Loam, See Texture.

Sieve Analysis-Percent by weight of materials (soil) passing through the sieve openings; sieve numbers represent the number of openings per linear inch.

Siliceous--Rock containing an abundance of silica ($Si\ O_2$). Example: Cherty or hard sandstones and shales cemented by silica.

Silt--Small mineral soil grains having diameters ranging from 0.002 mm to 0.05 mm. (Engineers usually use the limits of 0.005 to 0.05 mm).

Silty--Indicates that a portion is silt within a geologic material that is predominantly some other type. Example: Silty shale.

SL--Sandy Loam, See Texture.

Texture--

C--Clay. Soil material that contains 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

CL--Clay Loam. Soil material that contains 7 to 40 percent clay and 20 to 45 percent sand.

L--Loam. Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

LS--Loamy Sand. Soil material that contains at the upper limit 85 to 90 percent sand, and the percentage of silt plus 1½ times the percentage of clay is not less than 15; at the lower limit it contains not less than 70 to 85 percent sand, and the percentage of silt plus twice the percentage of clay does not exceed 30.

S--Sand. Soil material that contains 85 percent or more of sand; percentage of silt plus 1½ times the percentage of clay shall not exceed 15. (Includes coarse sand, sand, fine sand, and very fine sand.)

SC--Sandy Clay. Soil material that contains 35 percent or more clay and 45 percent or more sand.

SCL--Sand Clay Loam. Soil material that contains 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand.

SL--Sandy Loam. Soil material that contains either 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30 to 52 percent or more sand; or less than 7 percent clay, less than 50 percent silt, and between 43 and 50 percent sand. (This includes fine sandy loam and very fine sandy loam).

SI--Silt. Soil material that contains 80 percent or more silt and less than 12 percent clay.

SIC--Silty Clay. Soil material that contains 40 percent or more clay and 40 percent or more silt.

SICL--Silty Clay Loam. Soil material that contains 27 to 40 percent clay and less than 20 percent sand.

SIL--Silt Loam. Soil material that contains 50 percent or more silt and 12 to 27 percent clay (or) 50 to 80 percent silt and less than 12 percent clay.

Thick-Bedded--Beds or layers of rock that range from 1 foot to 3 feet in thickness and consist of only one kind of rock.

Thin-Bedded--Beds or layers of rock that range from 1 inch to 1 foot in thickness and consist of only one kind of rock.

Volume Change--The change in volume for a given moisture content (expressed as a percentage of the dry volume) of the soil mass when the moisture content is reduced from the stipulated percentage to the shrinkage limit.

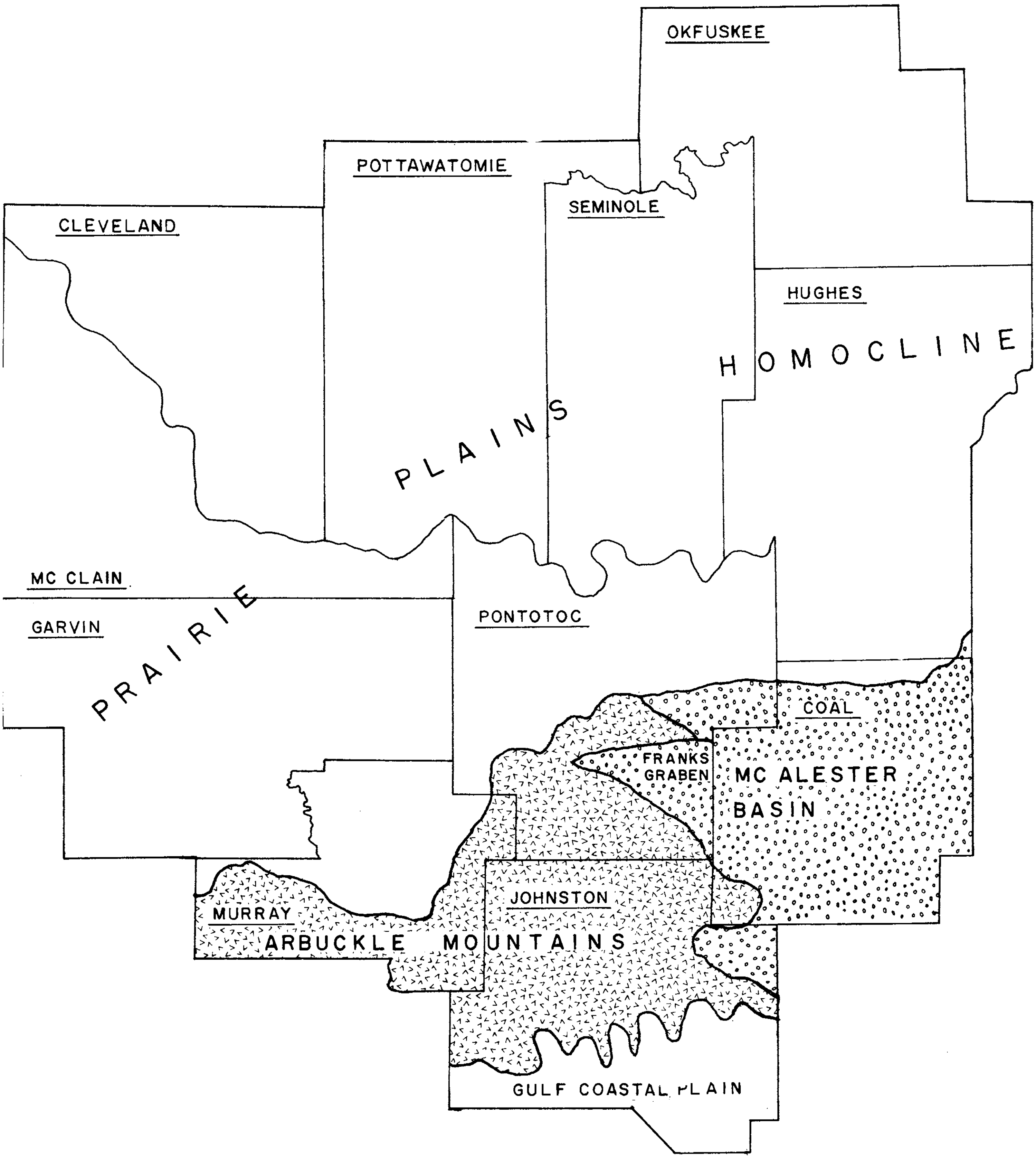
C H A P T E R I I

GEOLOGIC UNITS

IN

DIVISION THREE

GENERAL GEOLOGIC STRUCTURE MAP OF DIVISION 3



GENERAL GEOLOGY OF DIVISION THREE

Division Three is affected by a complexity of geologic events which requires the Division to be broken down into five distinct structural provinces for a better explanation of the geology. The areas to be discussed are: (1) the Arbuckle Mountain Uplift, (2) the Prairie Plains Homocline, (3) the McAlester Basin, (4) the Franks Graben, and (5) the Gulf Coastal Plain.

The Arbuckle Mountains Uplift covers extensive areas in Murray, Johnston, Pontotoc, and southwestern Coal Counties; here, the geologic beds are dissected by numerous folds and faults.

The earth movements associated with the Arbuckle Uplift varied from gentle pulsations to catastrophic movements. Some of the large faults have vertical displacements of about 1½ miles. The most severe folding and faulting occurred in Murray and western Johnston Counties where the dip of the geologic beds varies from gentle to vertical to overturned. Local areas within the Uplift received different amounts of folding and faulting. These areas are separated from one another by long nearly straight faults which strike uniformly N60° - 70°W.

The Uplift essentially has two cores. One is the Colbert Porphyry Unit's outcrop which covers a five square mile area in western Murray County. Another is the Tishomingo Granite Unit which covers many square miles across central Johnston County.

North of the Mill Creek Fault, one of the major faults which trends northwest - southeast in eastern Murray and central Johnston Counties, the geologic beds generally have dips of less than twenty degrees.

The topography of the Arbuckle Mountains varies from gently rolling hills to pronounced rounded hills. The hills are generally formed by the more resistant steeply dipping limestones and the Colbert Porphry Unit while the valleys and gently rolling terrain are formed by the less resistant shales, sandstones, granites, and gently dipping limestones and dolomites.

Prairie grass is the dominant vegetation of the Arbuckle Mountains with some cacti, prickly pears, and juniper on steep slopes where the soils are thin. Trees are uncommon except on sandstones.

An unusual topography is exhibited by the steeply dipping limestones and dolomites. Rows of beds of rock jut out from the ground level and resemble tombstones in their appearance. This phenomenon is due to differential weathering of softer thin-bedded limestones and dolomites between more resistant beds.

The Prairie Plains Homocline is a large broad structural feature involving the gently westward - dipping geologic beds of the mid-continent region west of the Ozark Dome of northern Arkansas and southern Missouri. This homocline is bound on the south by the Arbuckle Mountains and McAlester Basin. The outcrop of the Thurman Unit in eastern Pontotoc and northern Coal counties of Division Three essentially separates the homocline from the McAlester Basin. The major portion of Division Three lies on this homocline. The westward dip of the homocline is generally less than 100 feet per mile, but locally is reversed by folds and faults. The outcrops of the geologic units usually trend north-south except near the Arbuckle Mountains where the mountain building movements have interrupted the normal outcrop patterns and dip directions.

Topographically, this portion of Division Three is expressed by a series of parallel east-facing ridges or cuestas which trend essentially north-south. The cuestas are capped by resistant sandstones, conglomerates, and local limestones. These cuestas are separated by broad valleys which are underlain by less resistant sandstones and shales. Locally, this "ridge and valley" pattern is somewhat modified where changes in the regional dip of the beds are affected by folding or faulting.

Areas of oak vegetation generally denote sandstones and conglomerates, while limestones and shales promote the growth of native grasses. Thin-bedded limestones locally support the growth of trees. Large areas formerly in native grasses are now cultivated.

The McAlester Basin, sometimes called "Arkhoma Basin," is a broad area bound on the north by the Ozark Dome, on the south by the Choctaw Fault of the Ouachita Mountains of southeastern Oklahoma, and on the west by the Arbuckle Mountains. In Division Three most of Coal County and the eastern edge of Pontotoc County lie within this structural province. This portion of the basin is characterized by gentle folds, relatively few faults, and dips of less than 10 degrees.

The topography of this area is mostly gently rolling prairies which are associated with thick shale sequences. Locally, where sandstones are thick, the topography is rolling with pronounced tree covered ridges outlining the sandstone outcrop.

The Franks Graben is a large triangular shaped down thrown mass affecting many geologic units. This area, in which the villages of Fittstown and Franks are located, is bounded on the north and south by faults. These faults have allowed the graben to sink some 2500 feet. Even though the graben has dropped about ½ mile, there is only slight topographic expression. Geologic units of younger ages than the units of the adjacent Arbuckle Uplift have been protected from erosion within the graben. This feature covers several square miles in southeastern

Pontotoc County.

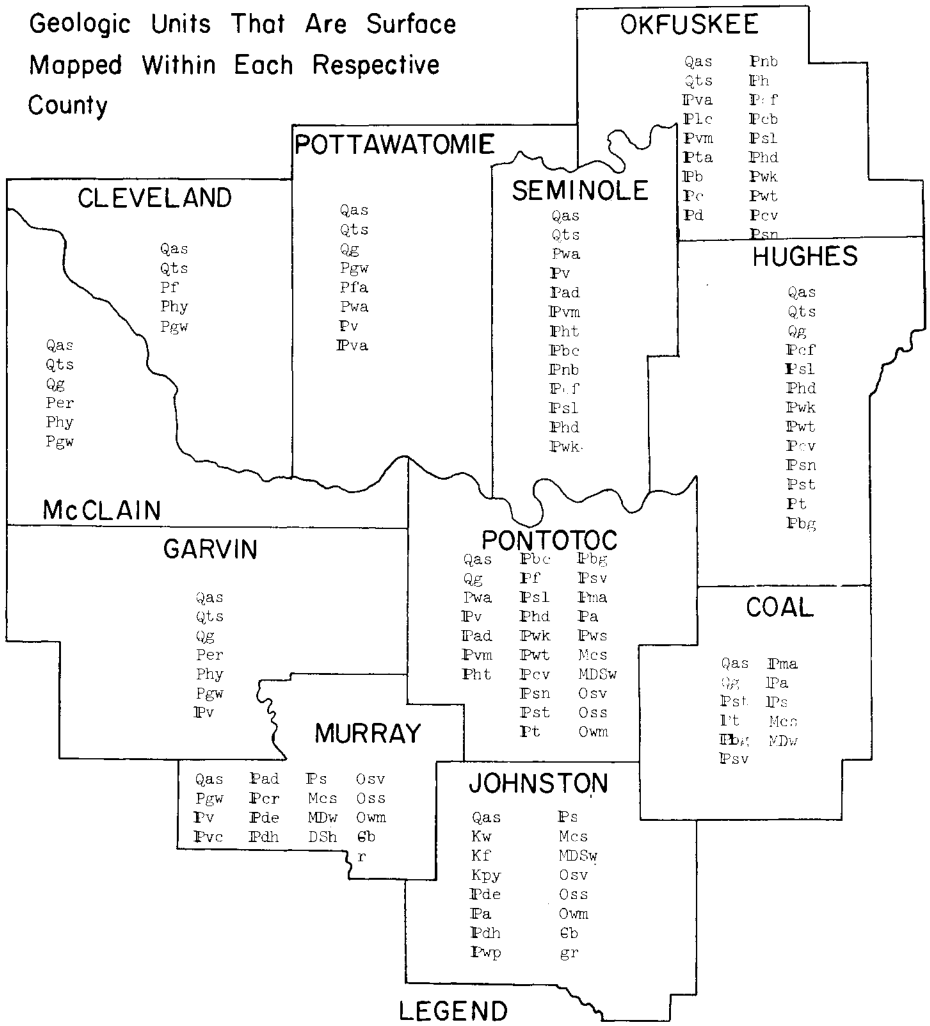
The geologic units within Franks Graben have various dip directions with most of them being less than 15 degrees. In the immediate vicinity of the boundary faults, the dip may sometimes become quite steep.

Topographically, the graben can be described as rolling with limestone conglomerates capping most ridges.

The Gulf Coastal Plain is a belt of gently southward dipping geologic units extending in an east-west direction across the southern portion of Johnston County of Division Three. This plain overlies the folding and faulting of the older geologic units of the Arbuckle Mountains.

Topographically, the Gulf Coastal Plain is generally gently rolling, although there are some prominent ridges present which are capped by thick limestones.

DIVISION THREE



LEGEND

GEOLOGIC UNIT	SYMBOL	GEOLOGIC UNIT	SYMBOL
Alluvium	Qas	Checkerboard Unit	IPcb
Terrace	Qts	Seminole Unit	IPsl
Gerty Sand	Qg	Holdenville Unit	IPhd
Washita Unit	Kw	Wewoka Unit	IPwk
Fredericksburg Unit	Kf	Wetumka Unit	IPwt
Paluxy Unit	Kpy	Calvin Unit	IPcv
El Reno Unit	Per	Deese Unit	IPde
Flowerpot Unit	Pf	Senora Unit	IPsn
Hennessey Unit	Phy	Stuart Unit	IPst
Garber-Wellington Unit	Pgw	Thurman Unit	IPt
Fallis Subunit	Pfa	Boggy Unit	IPbg
Wellington-Admire Unit	Pwa	Savanna Unit	IPsv
Vanoss Unit	IPv	McAlester Unit	IPma
Vanoss-Conglomerate Subunit	IPvc	Hartshorne Unit	IPhs
Vanoss-Ada Unit	IPva	Atoka Unit	IPa
Ada Unit	IPad	Dornick Hills Unit	IPdh
Lecompton Unit	IPlc	Wapanucka Unit	IPwp
Collings Ranch Unit	IPcr	Wapanucka-Springer Unit	IPws
Vamoosa Unit	IPvm	Springer Unit	IPs
Tallant Unit	IPta	Caney-Sycamore Unit	Mcs
Barnsdall Unit	IPb	Woodford Unit	MDw
Hilltop Unit	IPht	Woodford-Hunton Unit	MDSw
Chanute Unit	IPc	Hunton Unit	DSh
Dewey Unit	IPd	Sylvan-Viola Unit	Osv
Belle City Unit	IPbc	Simpson Unit	Oss
Nellie Bly Unit	IPnb	Upper Arbuckle Unit	Owm
Hogshooter Unit	IPh	Lower Arbuckle Unit	Єb
Coffeyville Unit	IPcf	Colbert Porphyry Unit	r
Francis Unit	IPf	Tishomingo Granite Unit	gr

DESCRIPTIONS OF CONSOLIDATED GEOLOGIC MATERIALS

ADA UNIT (IPad)

The Ada Unit consists predominantly of pastel shales and siltstones; but it also contains prominent massive bedded, moderately hard to hard sandstones and limestone conglomerates. The pastel shales are distinctive, except in northern Seminole County where they are easily confused with similar shales of the overlying Vanoss Unit. The basal member of the Ada Unit is a 10 to 20 foot thick buff, cross-bedded, and contorted sandstone. Locally, in Seminole County, it is a chert conglomerate and therefore hard to distinguish from the underlying Vamoosa Unit. Limestone conglomerates are prominent near the middle of the unit throughout Pontotoc and southern Seminole Counties. There, they occur in thicknesses up to 5 feet.

The limestone pebbles of the conglomerates have been identified as fragments of the Viola and Arbuckle Units of the Arbuckle Mountains. The fragments were eroded from the uplift and cemented in the conglomerate. No single ledge of sandstone or limestone conglomerate, other than the basal member, can be traced continuously for any great distance.

The total thickness of the unit is irregular and varies from 60 feet near Vamoosa to about 100 feet throughout Pontotoc County. In Seminole County, the Ada Unit thickens and thins irregularly from 150 to 250 feet.

The unit outcrops in a north-south band, one to four miles wide from the northeast corner of Murray County northward across Pontotoc and Seminole Counties. North of the North Canadian River, in Okfuskee and Pottawatomie Counties, the unit is indistinguishable from the overlying Vanoss Unit and the strata are mapped as the Vanoss-Ada Unit.

Topographically, the unit varies from gently rolling to rolling. The more rolling topography is prominent where the harder sandstones and limestone conglomerates cap the hills.

The Ada Unit normally overlies the Vamoosa Unit; but in Pontotoc County, due to the mountain building effect or erosion of the Arbuckles, the Ada Unit lies on a number of older geologic units.

LOWER ARBUCKLE UNIT (Єb)

This unit consists dominantly of light gray, thick-bedded to massive dolomite with limestone prominent in the western part of the Arbuckle Mountains. The base of the unit is a consistent white to gray, fine-grained, thick-bedded limestone which thins eastward from 587 feet in western Murray County to 100 feet in eastern Johnston County.

The total thickness of the unit thins from 2000 feet in the western part of the Arbuckle Mountains to 1800 feet in the eastern portion.

The Lower Arbuckle Unit outcrops in Murray and Johnston Counties of Division Three. The outcrop pattern varies with the faulting and folding of the center of the Arbuckle Uplift.

Topographically, the unit forms gently rolling, rocky, grass covered hills.

UPPER ARBUCKLE UNIT (Owm)

This unit consists dominantly of thin-bedded to massive light gray limestone with minor amounts of sand, chert, dolomite and shale in the western part of the Arbuckle Mountains. Northeastward, the limestones grade into dolomites and the amount of sand increases. In Pontotoc County, the dominant rock is dolomite.

The total thickness of the unit thins northeastward from 5,200 feet in Murray County to about 1500 feet of exposed strata in Pontotoc County.

The Unit outcrops over some 300 square miles of the Arbuckle Mountain region and dominates all other units within the Mountains. The unit outcrops in Murray, Johnston, and Pontotoc Counties of Division Three.

Topographically, the unit generally forms a high plateau which is gently rolling and supports broad prairies. Locally, the unit may be dissected by deep canyons. The unit exhibits unusual topography when the dip of the beds are steep; softer beds erode more rapidly and the harder beds protrude from the ground in rows resembling tombstones.

ATOKA UNIT (IPa)

The Atoka Unit is composed chiefly of gray shale with some interbedded moderately soft sandstones and conglomerates. A few thin impure limestones occur near its base.

The total thickness of the unit varies from about 800 feet in Pontotoc County, 500 feet in Johnston County, to about 2500 feet in southern Coal County.

In Division 3, the Atoka Unit outcrops in a narrow east-west band in Pontotoc County and a small area in northeastern Johnston County, and an extensive area in southern Coal County.

Topographically, the Atoka Unit generally forms broad gently rolling valleys with sandstones locally forming partly wooded ridges.

BARNSDALL UNIT (IPb)

The Barnsdall Unit consists of two sandstones and two shale members. The lower most member ranges from massive, soft sandstone to thin sandstones separated by thin shale partings. This sandstone member ranges in thickness from 5 to 20 feet and can be recognized by its deep-red color which is in sharp contrast to the normally light brown sandstones of other geologic units which underlie this basal member. Overlying this lower member is a deep-red to reddish brown shale. A pure-white, soft sandstone lies next above the shale. The sandstone ranges in thickness from 4 to 10 feet. The uppermost member of the unit is a bright-red shale. Near the top, there are thin zones of white shales. This red shale ranges from 25 to 40 feet in thickness.

The total thickness of the unit ranges from about 100 feet at the Creek County line to 80 feet in the south part of Okfuskee County. The southward thinning of the unit occurs due to progressive loss of exposed strata from the upper portions of the unit. The upper two members do not outcrop south of T13N, R8E.

In Division Three, the Barnsdall Unit outcrops only in Okfuskee County. Here, it outcrops in a north-south band which averages two miles in width. Southward, in Seminole County, the unit is inseparable from rock strata above and below it and is mapped within the Hilltop Unit.

Topographically, the unit is gently rolling, with the sandstones capping slight scarps and the shales forming the slopes and valleys.

BELLE CITY UNIT (IPbc)

This unit consists of upper and lower limestones separated by a dark shale. The upper limestone, at most places the thicker of the two, is commonly blue-gray, thin-bedded to massive, and weathers to a dull chalky white. It has a maximum thickness of 15 feet at the Canadian River, T5N, R6E. Southward, in Pontotoc County it thins to one foot near Byng. Northward, in Seminole County it thins slowly to less than one foot at

Wewoka Creek.

The middle shale is generally black to gray-green in color and varies from 10 to 20 feet in thickness.

The lower limestone is usually buff to pale yellow, thin-bedded, and has a maximum thickness of five feet at the Canadian River. It is usually less than three feet thick and is locally absent in southern Seminole County.

The total thickness of the unit averages about 30 feet with a maximum thickness of 36 feet.

The Belle City Unit outcrops in a narrow band northward from near Byng, Pontotoc County, to about two miles west of Cromwell, Seminole County.

Topographically, the unit caps a scarp throughout most of its outcrop. Locally, it is found on the slope of scarps capped by sandstones of the overlying Hilltop Unit.

BOGGY UNIT (IPbg)

The Boggy Unit consists dominantly of blue and gray shale but contains a number of widely spaced brown and gray irregular-bedded, moderately soft sandstones; locally, a few thin lenses of fossiliferous blue-gray marine limestone are present. At many places the shale is mottled purple, red, and gray. The sandstones are more prominent near the top of the unit and in eastern Coal County where they contain fine grained chert fragments. Coarse limestone conglomerates are prominent in the Boggy Unit adjacent to the Arbuckle Mountains in Pontotoc County.

The total thickness of the unit ranges from 1250 feet in Pontotoc County to about 2800 feet in eastern Coal County. Along much of its outcrop in Pontotoc County adjacent to the Arbuckle Uplift, the total thickness of the unit is not present.

The unit outcrops across a wide area in eastern Pontotoc and Coal Counties and the southeastern corner of Hughes County in Division 3.

The unit forms gently rolling hills and valleys throughout most of its outcrop.

CALVIN UNIT (IPcv)

The Calvin Unit consists essentially of three members along its outcrop in Division 3. (1) A lower sandstone "complex", (2) a middle shale sequence, and (3) an upper sandstone. This division of the unit exists from near Horntown, Hughes County, northward across southeastern Okfuskee County. South and west of Horntown the lower sandstone "complex" comprises the entire Calvin Unit.

The lower sandstone "complex" consists of medium-grained to silty, gray and brown, moderately hard, massive to thin-bedded sandstone with thin silty shale separating the sandstone beds. The "complex" is consistently 320 to 350 feet thick north of the Canadian River, T7N, R10E, but thins southward to about 230 feet near Gerty, Hughes County.

The "complex" continues to thin southwestward to only 40 feet in central Pontotoc County with the upper sandstones grading into shales which are evidently mapped within the Wetumka Unit. The "complex" also thins northeastward to about 60 feet in eastern Okfuskee County and grades into two to eight sandstones with thin intervening shales.

(2) The middle shale member consists mostly of brown to grayish brown shales. This sequence is usually about 125 feet thick.

(3) The upper sandstone member consists of soft friable sandstones with a hard, eleven-foot thick sandstone at the top. The member is about 50 to 75 feet thick.

The Calvin Unit thickens from about 40 feet in central Pontotoc County to a maximum of 350 feet north of the Canadian River (T7N, R10E), Hughes County, and thins from this point northward to an average of 245 feet in Okfuskee County. In Division 3, the unit outcrops in a narrow northeast trending belt in Pontotoc County, but the belt widens to about seven miles in Hughes and Okfuskee Counties where the unit is thicker.

The sandstones of the Calvin Unit cap prominent, rugged, tree covered scarps along its outcrop. Where the shales thicken, they form valleys and the steep slopes of the scarps which are capped by overlying sandstones.

CANEY-SYCAMORE UNIT (Mcs)

This unit consists dominantly of black to greenish-blue plastic shales with some thin sandstones in the upper portion. The base of the unit consists of thick-bedded to thin-bedded, blue limestone that weathers a characteristic bright yellow. This limestone thins quickly eastward from 300 feet in Murray County to six feet in Johnston County and then to less than five feet in Pontotoc County.

The total thickness of the Caney-Sycamore Unit thins eastward from 1200 feet in Murray County to about 350 feet in Pontotoc and Coal Counties.

The unit outcrops in the Arbuckle Mountains of Murray, Johnston, Coal, and Pontotoc Counties of Division 3.

Topographically, the thick shale section generally forms broad prairie valleys. In Murray County, the thick limestone at the base forms prominent ridges.

CHANUTE UNIT (ℙc)

The Chanute Unit consists of a lower sandstone member and an overlying shale member. The lower member is a light-brown to chocolate brown, moderately soft sandstone which commonly weathers dark rust-brown. It ranges in thickness from 3 to 8 feet. The sandstones thicken toward the south and become more friable. The upper member is a brownish-yellow shale which ranges in thickness from about 20 feet in southern Okfuskee County to 50 feet in the northern part of the county.

The total thickness of the unit ranges from 28 feet in southern Okfuskee County to 58 feet in the north.

In Division 3, the Chanute Unit outcrops only in Okfuskee County, Here, it outcrops in a north-south band which averages three-quarters of a mile in width. Southward, in Seminole County the unit is inseparable from rock strata above and below it, and is mapped within the Hilltop Unit.

Topographically, the lower sandstone member caps a scarp that is more pronounced in the north part of Okfuskee County than the south part. Most of the outcrop is gently rolling to rolling.

CHECKERBOARD UNIT (lPcb)

This unit consists of limestone and shale. The limestones range up to two feet thick, but are generally flaggy with numerous shale seams included. The limestones thin southward and the unit is not mapped south of a point just south of Okemah.

The total thickness of the unit varies from 8 inches to 7 feet.

The unit outcrops in Division 3 only in northern Okfuskee County.

Topographically, the Checkerboard Unit is generally found on the scarp capped by the overlying sandstones of the Coffeyville Unit.

COFFEYVILLE UNIT (IPcf)

The Coffeyville Unit consists of two sandstone members, two or more shale members, and a basal limestone member (DeNay) which is present in southern Seminole County. The base of the Coffeyville Unit is the limestone of the Checkerboard Unit in northern Okfuskee County and the DeNay limestone in Seminole County. In Hughes and southern Okfuskee Counties these limestones are absent, and the lowermost sandstone member is mapped as the base of the unit. The sandstone members are soft to moderately hard, range from 5 to 40 feet thick, are thin-bedded to massive, and are generally buff to brown but may locally contain red and yellow colors.

The shales are soft, yellowish brown to dark gray and occur in sequences up to 200 feet thick.

The DeNay limestone member in southern Seminole County, is generally about one foot thick, soft, and weathers a typical mustard yellow. It locally attains a thickness of six feet in T7N, R7E. Here it is hard and dull blue-gray in color.

The total thickness of the Coffeyville Unit is irregular and varies from 150 to 260 feet.

The unit outcrops northward from the Canadian River, across Seminole, northwestern Hughes, and Okfuskee Counties of Division 3. South of the Canadian River, in Pontotoc County, the strata are mapped within the Francis Unit.

Topographically, the sandstone members generally cap prominent eastward facing scarps with long westward dip slopes. The shales generally underlie valleys and the steep slopes of scarps that are capped by the sandstone members.

COLBERT PORPHYRY (r)

This unit consits of hard, yellowish-brown, igneous rock similar to granite, but with slightly different mineral composition and texture.

The unit outcrops only in the Arbuckle Mountains of western Murray County. Here, its outcrop trends northwest-southeast and varies from one-half to two miles wide and covers five miles in length.

Topographically, the unit is mountainous, rocky, and supports the growth of oak trees. The unit generally forms the highest elevations of the Arbuckle Mountains.

COLLINGS RANCH UNIT (IPcr)

This unit consists of a tightly cemented light gray limestone conglomerate which contains boulders of limestone up to two feet in diameter. The boulders and pebbles are derived mostly from rocks of the Upper Arbuckle Unit.

The maximum thickness of the unit is 2,000 feet.

The Collings Ranch Unit outcrops only in Murray County in a faulted area of the Arbuckle Mountains south of Davis. Here, it covers an area about four miles long and less than a mile wide.

Topographically, the unit forms steeply rolling hills covered by cedars, cacti, and short grass.

DEESE UNIT (IPde)

This unit consists dominantly of red and gray shales, but contains a considerable amount of limestone conglomerate and a minor amount of sandstone. The limestone conglomerates are up to 250 feet thick and are generally poorly cemented cobbles and pebbles derived from the rocks of the Viola Unit.

The total thickness of the unit ranges from 920 to 1950 feet. The thickness of the unit varies according to the amount of erosion to which it has been subjected.

The Deese Unit outcrops on the flanks and in faulted areas of the Arbuckle Mountains in Johnston and Murray Counties of Division 3.

Topographically, the unit forms gently rolling prairies.

DEWEY UNIT (IPd)

The Dewey Unit consists of a lower sandy limestone member and an upper shale member. The lower member is generally a bluish-gray, moderately hard limestone that weathers brownish yellow and ranges in thickness from 16 inches to 12 feet. At some places it is a dense massive limestone, but elsewhere, it is a sandy brownish-yellow shale which ranges in thickness from 25 to 52 feet.

The total thickness of the unit ranges from 30 to 60 feet.

The Dewey Unit outcrops in a north-south band which averages three-fourths of a mile wide in Okfuskee County of Division 3. Southward, in Seminole County the unit is inseparable from the rock strata above and below it and is mapped within the Hilltop Unit.

Topographically, the lower limestone member generally forms a small scarp. The upper shale member forms a valley and the slope of a scarp which is capped by the overlying Chanute Unit.

DORNICK HILLS UNIT (IPdh)

This unit consists dominantly of shale, but contains minor amounts of conglomerate, limestone, and sandstone. The Dornick Hills shales are distinguished from the darker shales of the underlying Springer Unit by a change in color from dark gray to light brownish gray. The limestones are generally less than four feet thick and thin-bedded. The sandstones are moderately hard, thick-bedded, fine-grained, dirty yellow in color, and occur in thicknesses up to 25 feet.

The total thickness of the unit is about 1500 feet.

In Division 3, the Dornick Hills Unit outcrop is a two to three mile wide band on the south flanks of the Arbuckle Mountains in southwestern Johnston County and in local areas in southeastern Murray County.

Topographically, the unit generally forms broad valleys and is difficult to distinguish from the underlying Springer Unit. Where the beds are steeply dipping, the harder sandstones and limestones form rounded hills and are good "marker beds" for distinguishing the unit. The vegetation varies from prairies on the shale sections to dense oak trees on the sandstones.

EL RENO UNIT (Per)

This unit consists mostly of reddish massive sandstone which varies from moderately soft in McClain County to hard in southwestern Garvin County and occurs in beds up to 30 feet thick. Maroon to gray sandy shales generally comprise the remainder of the unit. A few hard, limy, maroon conglomerates are present locally in Garvin County.

The total thickness of the El Reno Unit is not exposed in Division 3; the lower 150 to 300 feet is exposed in McClain and Garvin Counties. North of the Canadian River, in Cleveland County, the lower portion of the El Reno Unit is mapped as the Flowerpot Unit.

Topographically, the El Reno Unit is rolling with many deep ravines. The base of the unit forms a prominent scarp overlooking the nearly level topography of the underlying Hennessey Unit.

FALLIS SUBUNIT (Pfa)

The Fallis Subunit consists of a "zone" of sandstones and shales. The lower most sandstone's outcrop is geologically mapped in Division 3 north of the Canadian River.

The sandstones are generally orange to red, fine-grained, massive, moderately soft, and vary in thicknesses from about 5 feet to a maximum of 40 feet. The shales are mostly red and platy to blocky.

The total thickness of the Fallis Subunit varies from 290 to 320 feet in the Division.

The subunit outcrops in western Pottawatomie and eastern Cleveland Counties of Division 3. South of the Canadian River in Garvin County, the subunit is not separated from other strata of the Garber-Wellington Unit.

Topographically, the sandstones form prominent ridges and are generally covered with blackjack and scrub oak trees. These north-south ridges help form Oklahoma's "blackjack belt." The sandy soils are easily erodible and numerous gullies frequently mar the rolling topography.

The Fallis Subunit is included in the Garber-Wellington Unit.

FLOWER POT UNIT (Pf)

The unit consists of soft, massive, orange-red, fine-grained sandstone.

The Flowerpot Unit outcrops only in northwestern Cleveland County of Division 3. Here, only the lowermost 50 feet are exposed. Northwestward, in Oklahoma and Canadian Counties of Division 4, this portion of the Flowerpot Unit is equivalent to the Duncan Subunit. Southward, in McClain County, the Flowerpot Unit is mapped with the El Reno Unit.

Topographically, the basal Flowerpot Unit caps prominent rounded hills overlooking the underlying nearly level topography of the Hennessey Unit.

FRANCIS UNIT (IPf)

This unit consists dominantly of shale with considerable amounts of sandstone and conglomerate with minor amounts of limestone. The base of the unit is the DeNay limestone (a marker bed). It is about one foot thick, soft, and weathers a mustard yellow. Above the limestone is an interval of about 30 feet of dark blue and black shales. These grade upward into about 20 feet of soft buff conglomeratic sandstone. Above the sandstone member is a series of dark, sometimes calcareous, shales which are about 200 feet thick. This lower section is equivalent to the Coffeyville Unit of Seminole and Okfuskee Counties.

Above the dark shale series is a thickness of almost 100 feet within which coarse brown sandstones and chert conglomerates predominate. The sandstones are generally massive, moderately soft, buff to brown in color, cross-bedded and occur in thicknesses up to 20 feet.

The upper part of the unit is shale that is about 100 feet thick. This portion contains a few thin sandstones and one presistent conglomeratic limestone. This shale section and the underlying sandstone zone is equivalent to the Nellie Bly Unit in Seminole and Okfuskee Counties.

The total thickness of the Francis Unit is about 500 feet.

The Francis Unit is mapped only in Pontotoc County and occurs in a north-south band from near Fittshugh northward to the Canadian River. Much of the upper portion of the unit does not outcrop near its southern extend due to the overlapping nature of the Ada Unit. A small outcrop of the Francis Unit also occurs in the Franks Graben faulted area, west of Fittstown.

Topographically, the sandstones and conglomerates of the unit cap prominent scarps. The shales typically underlie the valleys and steep slopes of scarps which are capped by the sandstones and conglomerates.

FREDERICKSBURG UNIT (Kf)

This unit consists of limestone and clay shale of near equal proportions. The base of the unit consists of a prominent thin-bedded to massive, light gray limestone commonly called the Goodland limestone. This limestone is generally about 25 feet thick. The upper portion of the Fredericksburg Unit consists of dark brown to blue-gray, marly clays and shales. This portion is commonly called the Kiamichi clays and comprise a thickness of about 30 feet.

The total thickness of the unit is about 60 feet.

In Division 3, the unit outcrops only in southern Johnston County in a narrow irregular east-west band.

Topographically, the base of the unit generally caps a scarp some 75 to 100 feet above the topography of the underlying Paluxy Unit. The upper clays and shales are generally obscured by weathering and slumping. The clays form grassy slopes in a narrow band, commonly less than one-half mile paralleling the Goodland limestone. The contact with the overlying Washita Unit is nearly indistinguishable.

GARBER-WELLINGTON UNIT (Pgw)

The unit comprises much of the lower "red beds" of Division 3. The unit consists dominantly of reddish shales, but includes considerable amounts of sandstone which occurs as lenses within the shale "red beds." Conglomerates and limestones are prominent locally.

The sandstones are mostly soft, massive (up to 40 feet thick), and reddish in color. Some sandstones are arkosic in the southern part of the Division. The sandstones generally occur as lenses and are more prominent in the upper portion of the unit, especially in Cleveland County where sandstones make up some 60% of the upper portion. One prominent group of sandstone beds are mapped and described separately as the Fallis Subunit.

The limestones are prominent at the base of the unit in southwestern Pontotoc and adjacent counties. Here, the limestones (commonly called the Hart limestone) occur in thicknesses up to 15 feet and are overlain by a thick sequence of dark shales. From this locale, the limestones thin both southwestward and northward. North of the Gerty Sand Deposits (Pontotoc County) the limestones are absent and the shales are reddish in color. Here, the base of the unit is obscure but is assigned to a buff to light dirty brown or reddish purple, limy, cross-bedded sandstone.

North of the Canadian River, the base of the unit is assigned to the lowermost sandstone of the Fallis Subunit which occurs some 1100 feet above the former base of the unit. The 1100 feet of strata north of the Canadian River are mapped and described as the Wellington-Admire Unit.

This division of geologic strata changes the total thickness of the Garber-Wellington Unit from about 2100 feet south of the Canadian River to 1000 feet north of the River.

In Division 3, the unit outcrops in a north-south band 12 to 24 miles wide through Cleveland, western Pottawatomie and western Pontotoc Counties. In Garvin and northern Murray Counties the outcrop turns westward around the northern and western limits of the Arbuckle Mountains.

Topographically, the unit is usually gently rolling prairie plains. In the upper portion of the unit, where the sandstones are prominent, the topography is rolling, with the sandstone hills covered with blackjack trees. This north-south area is geographically known as the Oklahoma "blackjack belt."

HARTSHORNE UNIT (IPhs)

This unit consists of brown to whitish-gray, thin-bedded to massive, moderately soft to moderately hard sandstone with minor amounts of interbedded bluish-gray shale.

The total thickness of the unit is extremely variable. From Section 33 to Section 29, T1S, R10E, southwest of Lehigh the thickness increases from 80 feet to nearly 500 feet within a distance of 2 miles northwestward along the outcrop. Farther northwest it decreases rapidly to less than 100 feet in thickness. Generally the unit is 150 to 300 feet thick.

In Division 3, the Hartshorne Unit outcrops only in Coal County and generally in a band less than one mile wide.

Topographically, the unit generally forms ridges and supports the growth of oak trees.

HENNESSEY UNIT (Phy)

This unit consists of red platy to blocky clay shales and mudstone. The mudstones are hard and appear blocky. The red clay shale of the Hennessey Unit is characterized by numerous bands of streaks of white or light green color ranging from a few inches to four feet in thickness. Small spheres of light green color up to 10 inches in diameter are an odd characteristic of the unit.

The total thickness of the unit varies from 400 to 600 feet.

The Hennessey Unit outcrops in a 5 to 20 miles wide north-south band across Cleveland, McClain, and Garvin Counties in Division 3.

Topographically, the unit is near level to gently rolling prairies, but most of the more level outcrops of the unit are cultivated.

HILLTOP UNIT (IPht)

The Hilltop unit is a sequence of dark-blue gray shales grading upward into massive, moderately hard, buff sandstones, but contains many thin limestones near the base of the unit.

The total thickness of the unit varies from zero to 125 feet.

The unit outcrops in a narrow north-south band from near Byng, Pontotoc County, to the north edge of Seminole County where it terminates at the North Canadian River. Northward, in Okfuskee County, the Dewey, Chanute, Barnsdall, and Tallant Units are mapped as equivalents of the Hilltop Unit. The Hilltop Unit is locally absent in southern Seminole County.

The topography of the unit is gently rolling with sandstones capping the ridges and shales underlying the valleys. The shales also occupy the slopes of scarps capped by the sandstones of the unit.

HOGSHOOTER UNIT (IPh)

This unit consists of thin-bedded, yellow to bluish black limestone which locally becomes sandy and grades into limy sandstone.

The total thickness of the unit ranges from 1 to 6 feet.

In Division 3, the Hogshooter Unit outcrops only in northern Okfuskee County. The unit is not mapped south of T12N, R9E. In this township, the limestone grades to shale which is mapped within the Coffeyville Unit.

Topographically, the Hogshooter Unit generally forms a slight scarp overlooking the valleys which are formed by shales of the underlying Coffeyville Unit.

HOLDENVILLE UNIT (IPhd)

This unit consists largely of blue, gray, and yellowish-brown shales with some locally prominent sandstones and limestones. In southeastern Seminole County the sandstones develop locally into massive moderately soft chert conglomerates very similar to the conglomerates of the overlying Seminole Unit. Two thin-bedded limestones are persistent in southeastern Seminole County. One of these attains a maximum thickness of 15 feet near Sasakwa but thins rapidly both northward and southward. The other limestone is about one to three feet thick and extends into Hughes County.

The total thickness of the Holdenville Unit ranges from 185 to 280 feet throughout most of the unit's outcrop. It thins to about 100 feet near the southern limit of its outcrop near Lawrence, Pontotoc County.

The unit outcrops in a band extending from near Lawrence northeastward across Pontotoc, Seminole, Hughes, and Okfuskee Counties of Division 3. The outcrop width varies from about one-fourth mile near Lawrence up to three miles across Hughes and Okfuskee Counties. The unit also outcrops just west of Fittstown, Pontotoc County in the Franks Graben faulted area.

Topographically, the unit generally underlies valleys but where the sandstones and limestone are prominent, ridges and scarps are not uncommon.

HUNTON UNIT (Dsh)

The unit consists dominantly of thin-bedded, light-gray limestone which is commonly marly and weathers to a cream color. Some thin siltstones, shales, and cherts are present in minor amounts.

The total thickness of the unit ranges from 125 to 350 feet with an average thickness of 250 feet.

This unit is mapped in the Arbuckle Mountains, in Murray County, of Division 3 where its outcrop area is broad; but in Johnston, Coal, and Pontotoc

Counties, its narrow outcrop pattern is mapped undifferentiated from the overlying Woodford Unit and is included in the Woodford-Hunton Unit.

Topographically, the unit generally forms ridges that are less prominent than the underlying limestones of the Sylvan-Viola Unit. The Hunton Unit supports sparce grass cover with some cedar trees, prickly pears, and shrubs. Locally, the shrubs may be dense.

LECOMPTON UNIT (IP lc)

This unit consists of two thin dolomitic limestones with a gray shale between them. The lower dolomitic limestone bed is about 5 inches thick and pink to red in color. The upper bed is yellow to pink and is about a foot thick.

The total thickness of the unit ranges from three to seven feet.

The Lecompton Unit outcrops only in Okfuskee County of Division 3. South of the North Canadian River in northern Seminole County, some limy sandstone beds in the upper portion of the Vamoosa Unit are probably the equivalents of the Lecompton Unit.

Topographically, the unit usually occurs on the slope directly below scarps capped by the lower most sandstone of the Vanoss-Ada Unit. Where erosion has removed the overlying scarp, the Lecompton Unit forms two small scarps.

McALESTER UNIT (IPma)

This unit is composed mainly of blue and black shales but includes some persistent, thin-bedded, buff, moderately soft sandstones.

The total thickness of the unit varies from 1000 to 1650 feet.

The McAlester Unit outcrops in southeastern Pontotoc County and in an extensive area of Coal County of Division 3.

Topographically, the unit forms gently rolling hills and wide nearly level valleys. Locally, the sandstones form narrow persistent ridges.

NELLIE BLY UNIT (IPnb)

This unit consists of a basal sandstone member and an upper shale member in southern Seminole County. Northward, the members divide into six sandstones and six shales with only the basal sandstone being consistent across Division 3. Northward from near Castle in Okfuskee County, the base of the unit is a shale about 16 feet thick and it overlies the limestones of the Hogshooter Unit.

The basal sandstone member is 200 to 300 feet thick in southern Seminole County. Here, it consists of sandstones and chert conglomerates up to 20 feet thick. Shale intervals of various colors separate the conglomeratic sandstones. The sandstones are generally massive, moderately soft to hard, buff to brown in color, cross-bedded, and ripple-marked.

The upper shale member is dominantly shale which ranges from dark gray or green to reddish brown in color. Limestones and limestone conglomerates are prominent near the top of the unit in T6N, Seminole County. Here, they obtain thicknesses up to ten feet and are only a few feet below the limestones of the overlying Belle City Unit.

The total thickness of the Nellie Bly Unit is 300 to 400 feet in Seminole County and 450 to 475 feet in Okfuskee County.

The Nellie Bly outcrops in a north-south belt, one to 5 miles wide, from the Canadian River northward across Seminole and Okfuskee Counties of Division 3. South of the Canadian River, in Pontotoc County, the strata of the Nellie Bly Unit is mapped within the Francis Unit.

Topographically, the basal sandstones of the Nellie Bly Unit cap a prominent scarp. The shales generally underlie valleys and slopes of ridges capped by the sandstones of the unit.

PALUXY UNIT (Kpy)

The Paluxy Unit is dominantly sandstone with some interbedded clay shales. Lenses of conglomerate and limestone occur near the base of the unit. The sandstones are mostly soft, loosely cemented, and generally vary from yellow to maroon in color. The weathered sandstones are often referred to as "packsand."

A white to light gray limestone lens (Baum) is prominent in the Ravia-Mannsville area of southwestern Johnston County where it attains a maximum thickness of 73 feet. The lens varies from a limestone conglomerate with boulders one foot in diameter, to nearly pure limestone. The lens crops out over approximately 10 square miles and grades both laterally and upward into the sandstones of the unit.

The total thickness of the Paluxy Unit is about 200 feet.

In Division 3, the unit outcrops only in southern Johnston County. Here, the unit outcrops in an east-west band 5 to 12 miles wide and rests on several different geologic units including the Tishomingo granite.

The Paluxy Unit is generally highly weathered, forms gently rolling topography, and is heavily covered with vegetation. In southwestern Johnston County, the limestone lens forms a prominent, hummocky escarpment, and supports red cedar and short grass vegetation.

SAVANNA UNIT (IPsv)

This unit consists of several sandstones and shales with occasional thin, impure limestones. The shales are generally gray, platy, and make up most of the mass. The sandstones are moderately soft to moderately hard, buff to orange, massive, and more prominently exposed than the shales.

The total thickness of the unit ranges from 1300 to 1600 feet throughout most of its outcrop. Near Franks, Pontotoc County, only 400 feet of the unit is exposed; here, much of the unit is covered by the overlying geologic units.

In Division 3, the Savanna Unit outcrop begins as a narrow band about one-quarter mile wide near the village of Franks in Pontotoc County. The outcrop pattern expands eastward to cover large areas in southern Coal County.

Where steeply inclined, the sandstones form numerous rather closely spaced tree covered ridges separated by open, grassy shale valleys. Where the dip is low, the ridges are more widely spaced. The Savanna Unit typically exhibits more topographic relief than the overlying Boggy Unit and the underlying McAlester Unit.

SEMINOLE UNIT (IPsl)

This unit consists of conglomerate, sandstone and shale. The conglomerates and sandstones are most prominent in southeastern Seminole County where they comprise most of the unit. Here, the basal 40 to 50 feet of the unit is a massive conglomerate of stratified subangular chert, with a sprinkling of quartz pebbles ranging from three inches in diameter down to small sand grains. The conglomerate grades vertically into brown moderately hard sandstone which continues upward about 100 feet to the top of the unit. From this area, the conglomerates and sandstones divide and thin both northward and southward with silty gray shale separating the sandstone members and thickening northward. The grain sizes of the conglomerates diminish northward.

The division of the sandstones northward results in at least three moderately soft sandstone members and three shale members in Okfuskee County. Here, the basal sandstone is conglomeratic and varies from 4 to 17 feet in thickness. The shale sequences thicken up to 140 feet.

The total thickness of the unit increases northward from about 90 feet near Fittshugh, Pontotoc County, to about 300 feet in Hughes County and then thins to about 270 feet in Okfuskee County.

The Seminole Unit outcrops northeastward from central Pontotoc County through Seminole, Hughes, and Okfuskee Counties of Division 3. The unit also outcrops just west of Fittstown, Pontotoc County, in the Franks Graben faulted area.

Topographically, the sandstones and conglomerates cap prominent tree covered scarps. The shales generally underlie the valleys and the ridges which are capped by the sandstones.

SENORA UNIT (IPsn)

The Senora Unit consists of a lower sandstone member and an upper shale member. The lower sandstone member is about 35 feet thick near where it terminates in Pontotoc County but thickens rapidly eastward to about 350 feet in Hughes County. It consists of a series of medium grained to silty, moderately soft, generally thin-bedded, gray and light brown sandstones interbedded with silty, gray and maroon shales of irregular thicknesses. A blue-gray limestone about 3 feet thick is present in the upper portion of the member in Hughes County north of the Canadian River.

The upper shale member is about 90 feet thick in Pontotoc County and thickens northeastward to about 190 feet in Okfuskee County. It consists dominantly of gray, silty shale with numerous sandstone lenses.

The total thickness of the unit varies from about 125 feet in Pontotoc County to about 500 feet in central Hughes County.

The unit outcrops in a one to seven mile wide northeast-southwest pattern across eastern Pontotoc, Hughes, and southeastern Okfuskee Counties of Division 3.

Topographically, the lower sandstone member caps prominent tree covered ridges overlooking the valleys formed by the underlying Stuart Unit. The upper shale member generally forms valleys and slopes of scarps which are capped by the sandstones of the overlying Calvin Unit.

SIMPSON UNIT (Oss)

This unit consists of a group of alternating sandstones and limestones with shale present in minor amounts. The limestones range in character from impure and sandy to "birdseye" limestone. The "birdseye" is a building stone which is 200 - 400 feet thick, thin-bedded to massive, and contains thin green shale seams and flecks of pure calcite. The sandstones are generally soft, loosely cemented, nearly pure fine quartz grains that are used for the manufacture of glass. The sandstones occur in thicknesses up to 400 feet.

The total thickness of the Simpson Unit ranges from a maximum of 2300 feet in Murray County to 1000 feet in Pontotoc County.

In Division 3, the unit outcrops in the Arbuckle Mountains of Murray, Johnston, and Pontotoc Counties.

Topographically, the unit varies according to the lithology and dip of the geologic beds. The limestones form shrub covered ridges. The soft sandstones and shales generally form gently rolling prairie valleys.

SPRINGER UNIT (ℙs)

The unit consists of highly plastic olive to gray platy shale.

The total thickness of the unit is about 2500 feet.

The Springer Unit outcrops in the Arbuckle Mountains in Murray and Johnston Counties of Division 3. In Coal and Pontotoc Counties, the Springer is mapped within the Wapanucka-Springer Unit (ℙws).

Topographically, the unit generally forms near level prairies or cultivated valleys.

STUART UNIT (ℙst)

This unit is dominantly dark shale with minor amounts of shale ranging through green, blue, and black colors. In southeastern Hughes County, the unit contains two sandstone zones, one wedges northward and the other wedges southward. These sandstone zones are about 60 feet thick and occur near the middle of the unit. About 120-135 feet of shale overlie and underlie the sandstone zone. The sandstones are thin-bedded to massive, moderately soft, tan to buff, medium to fine-grained, and grade into siltstones near the wedges. About 100 feet below the top of the unit, a dense, light blue-gray limestone, about 3 feet thick, occurs along the south border of T4N, R9E.

The Stuart Unit is about 80 feet thick in eastern Pontotoc County and thickens eastward to a maximum of about 370 feet in Hughes County where the sandstone wedges are present. It then thins to about 300 feet near Stuart where the unit leaves Division 3.

The unit outcrops across southern Hughes, northwestern Coal, and eastern Pontotoc Counties in Division 3. It terminates at a fault in eastern Pontotoc County.

Topographically, the unit generally underlies valleys, but the sandstones in southern Hughes County cap some prominent tree covered ridges.

SYLVAN - VIOLA UNIT (Osv)

This unit consists dominantly of thick-bedded to massive, light gray limestone which makes up the lower two-thirds of the unit. It thins northeastward from 800 feet in Murray County to 400 feet in Pontotoc County. The upper third of the unit consists of green, plastic, waxy clay shale. The shale also thins northeastward from 335 feet in Murray County to 125 feet in Pontotoc County.

The total thickness of the unit varies from a maximum of 1125 feet in Murray County to a minimum of 525 feet in Pontotoc County.

The unit outcrops in various areas of the Arbuckle Mountains in Murray, Johnston, Coal, and Pontotoc Counties of Division 3.

Topographically, the limestones form the most conspicuous ridges throughout the Arbuckle Mountains. The upper portion typically forms valleys.

TALLANT UNIT (IPta)

This unit consists of a basal sandstone and an upper shale member. The basal sandstone is massive, soft, red to brownish-red and is about 25 feet thick. The upper shale member is red except for thin zones of white shale near its base.

The maximum thickness of the unit is less than 80 feet at the Creek County line and the unit thins rapidly southward in Okfuskee County. The loss of thickness southward occurs due to progressive erosion of exposed strata from the upper portions of the unit.

The Tallant Unit outcrops only in T13N, R8E, Okfuskee County, of Division 3. From this township southward the overlying conglomerates of the Vamoosa Unit rests on the underlying Barnsdall Unit.

Topographically, the Tallant Unit forms rolling hills. The soft basal sandstone does not form high escarpments.

TISHOMINGO GRANITE UNIT (gr)

This unit consists of hard pinkish igneous rock which contains an abundance of quartz and feldspar minerals. The rock typically consists of coarse grains.

The unit outcrops in Johnston County in the center of the Arbuckle Mountain Uplift. Its outcrop covers several square miles. The thickness of the unit is undetermined.

Topograhpically, the unit varies from gently rolling to highly dissected rugged rocky terrain. It locally weathers several feet deep. The unit supports both prairie vegetation and tree growth with the trees more prominent in rugged terrain.

THURMAN UNIT (IPt)

The Thurman Unit is almost entirely moderately soft, thin-bedded to massive, brown sandstone. Much of the lower portion may be conglomeratic with the size of chert and quartz pebbles measuring up to one inch in diameter. A few thin silty shales and siltstones may be interbedded with the sandstones in the upper portion.

The total thickness of the unit is about 80 feet in eastern Pontotoc County and thickens gradually eastward across Division 3 to about 250 feet in southeastern Hughes County.

In Division 3, the Thurman Unit outcrops in a one to four mile wide east-west pattern across southeastern Hughes, northern Coal, and eastern Pontotoc Counties to where it terminates at a fault east of Ada.

Topographically, the unit caps a prominent tree covered scarp overlooking the valleys formed by the underlying Boggy Unit.

VAMOOSA UNIT (IPvm)

This unit consists of a sequence of shales, sandstones, and chert conglomerates. The base of the unit is a 30 to 60 foot thick conglomerate (commonly called Boley) which is persistent throughout the unit's outcrop in Division 3. It is a massive, brown, moderately hard, coarse, conglomeratic sandstone which contains angular chert gravels which average about one inch in diameter but gravels three inches in diameter are not uncommon. Numerous coarse conglomerate zones occur above the base both in the lower and middle portions of the unit. Three conglomerate zones are continuous across Seminole County, but are discontinuous across Okfuskee County. The conglomerate zones are separated by red, brown, and orange platy shales which make up some 60% to 80% of the unit; the greater percentage of which occurs in Okfuskee County and northern Seminole County. Three buff to yellow, hard limy sandstones up to ten feet thick occur near the top of the unit in northern Seminole County and are probably equivalent to the Lecompton Unit of Okfuskee County.

The total thickness of the unit thins southward from a maximum of 690 feet in Okfuskee County to 550 feet at the North Canadian River, to 125 feet at the Canadian River, to about 30 feet near Byng, Pontotoc County, where the unit wedges out. The loss of thickness southward occurs due to progressive loss of exposed strata from the upper portions of the unit by erosion. The 30 feet thickness of the unit near Byng consists entirely of the basal conglomerate member.

The Vamoosa Unit outcrops in a north-south band from a fault near Byng, Pontotoc County, northward across Seminole and Okfuskee Counties. The outcrop pattern widens northward from about one-quarter of a mile at Byng, to two miles at the Canadian River to seven miles in Okfuskee and northern Seminole Counties.

Topographically, the hills capped by the conglomerates are rugged and covered with oaks. The majority of the unit is rolling, with hills capped by sandstones and the valleys underlain by shale.

VANOSS (IPv)

This unit consists of alternating moderately soft to moderately hard sandstones, conglomerates, shales, and a few thin limestones. The shales are multicolored and resemble those of the underlying Ada Unit. In the outcrop area adjacent to the Arbuckle Mountains and northward to about the middle of Seminole County, the sandstones and conglomerates are thicker and locally are so arkosic that at first glance a few of them might be mistaken for true granites. Commonly, the base of the unit is referred to as the lowest of the arkosic beds, but this is only true in the southern part of the unit's outcrop area. As far north as Little River, Seminole County, the base of the Vanoss Unit is the first, persistent, non-limestone conglomerate bed above the base of the Ada Unit. North of Little River, a continuous sandstone horizon marks the base.

A basal limestone conglomerate member is prominent in Murray County adjacent to the Arbuckle Mountains. It is mapped and described separately from the Vanoss Unit as the Vanoss Conglomerate subunit (IPvc).

Near the Arbuckle Mountains the total thickness of the Vanoss Unit is 1,550 feet with 650 feet assigned to the conglomerate subunit. Northward, the unit thins from 650 feet in southern Pontotoc County to 250 feet near Konowa, Seminole County. The thickness of the unit is irregular in Seminole County and varies from 140 to 500 feet, thickening southward.

The Vanoss Unit outcrops in a two to ten mile wide band around the northern and western limits of the Arbuckle Mountains in Murray and Pontotoc Counties. From here, the unit outcrops in a two to seven mile wide, north-south, strip across western Pontotoc and Seminole Counties and the eastern edge of Pottawatomie County. North of the North Canadian River, in Okfuskee and northeastern Pottawatomie Counties, the strata of the Vanoss Unit are inseparable from strata of the underlying Ada Unit and consequently the two are mapped together as the Vanoss-Ada Unit (IPva).

Topographically, the unit is gently rolling to rolling with the more rolling topography prominent where the sandstones and conglomerates are thicker.

VANOSS - ADA UNIT (IPva)

This unit consists almost entirely of brown to reddish-brown shales and a few soft massive, brown sandstones. The sandstones are generally less than ten feet thick.

The total thickness of the unit is about 350 feet.

The unit outcrops in northeastern Pottawatomie and western Okfuskee Counties of Division 3. South of the North Canadian River the rock strata are separable and are divided into the Vanoss Unit and the Ada Unit.

Topographically, the unit forms gently rolling hills and valleys. The sandstones locally support the growth of oak.

VANOSS CONGLOMERATE SUBUNIT (IPvc)

This subunit consists of hard, well-cemented, massive, light-gray limestone conglomerate. Some granite fragments are present in minor amounts.

The total thickness of the subunit is about 650 feet.

The conglomerate outcrops around the northern edge of the Arbuckle Mountains between Sulphur and Hennepin, Murray County. Northward from this locale, the conglomerate disappears by interfingering into the overlying shales. Westward and southward around the uplift, it is covered by the overlying shales.

Topographically, the unit generally forms steeply rolling prairie hills with generally stony soils.

The Vanoss Conglomerate Subunit is included in the Vanoss Unit.

WAPANUCKA UNIT (Pwp)

This unit consists of fine to coarse-grained, thin-bedded to thick-bedded, gray and pale brown limestone. The limestone locally contains smooth dark gray chert nodules.

The unit ranges from 300 to 500 feet thick.

The Wapanucka Unit is mapped only in northeastern Johnson County. Here, it is thick and easily separable from other strata. In Pontotoc and Coal Counties, the unit is thinner and is mapped as the upper portion of the Wapanucka-Springer Unit (Pws).

Topographically, the Wapanucka Unit forms a prominent, rocky, tree covered ridge.

WAPANUCKA-SPRINGER UNIT (IPws)

This unit consists dominantly of highly plastic olive to gray platy shale. The upper limit of the unit is marked by a series of limestone beds which thin from 300 feet of dominantly limestone strata in southwestern Coal County, to less than 100 feet of thin limestone beds separated by calcareous shales in Pontotoc County. Some sandstones are prominent in Pontotoc County.

The total thickness of the unit is about 2800 feet.

The Wapanucka-Springer Unit outcrops on the flank of the Arbuckle Mountains in Coal and Pontotoc Counties of Division 3. In Johnston County, the upper limestone portion thickens and is mapped separately as the Wapanucka Unit (IPwp). The lower shale section is mapped as the Springer Unit (IPs) in Johnston and Murray Counties.

Topographically, the shale section generally forms near level prairies or cultivated valleys. The limestones and sandstones generally form tree covered rudges.

WASHITA UNIT (Kw)

The Washita Unit consists dominantly of bluish-gray clay shales and marly clays with minor amounts of interbedded white, chalky limestones. The limestones are generally less than three feet thick.

The total thickness of the unit does not outcrop in Division 3. Only the lowermost 250 feet is exposed in southern Johnston County. Here, it outcrops in a triangular shaped pattern about six miles wide at the base.

Topographically, the unit is near level to gently rolling and supports broad prairie vegetation.

WELLINGTON-ADMIRE UNIT (Pwa)

This unit consists dominantly of shale, but includes considerable amounts of sandstone. Conglomerates are prominent locally.

The shales are thick and varied in color, with red predominating. The sandstones are mostly soft, massive (up to 40 feet thick), and buff in color. The base of the unit is a limy, buff to reddish purple, cross-bedded sandstone.

Conglomerates are prominent in two locales. A dark chert conglomerate is persistent from two miles east of Asher, Pottawatomie County, northeastward to about a mile west of Maud. This conglomerate (commonly called the Maud conglomerate) consists of green, blue, red, and gray chert pebbles and cobbles and occurs in thicknesses up to 20 feet. The other conglomerate (commonly called the Jarvis Church conglomerate) is persistent for four miles north of US 270, Sec. 26, T10N, R5E, western Seminole County. It occurs in thicknesses up to 10 feet and buff chert pebbles predominate although a few green, red, gray, and banded cherts are present. The two conglomerate exposures vary from loose gravel to moderately hard well cemented beds.

The total thickness of the Wellington-Admire Unit is about 1100 feet.

The Wellington-Admire Unit outcrops in a 15 mile-wide, north-south, band in Pottawatomie and western Seminole Counties of Division 3. South of the Canadian River the rock strata are mapped within the Garber-Wellington Unit.

Topographically, the unit generally forms gently rolling prairie plains. Locally, where the sandstones are thick, rolling hills covered with blackjack and oak trees interrupt the prairies.

WETUMKA (lPwt)

The Wetumka Unit consists almost entirely of blue-gray to cement-gray, sandy to silty shales. It also contains a few thin beds of sandstone which are mostly near the top and bottom where the shales grade vertically into the sandstones of the Wewoka and Calvin Units.

The total thickness of the unit is generally 120 to 150 feet in Hughes and Okfuskee Counties, but in T3N, R7E, Pontotoc County a thickness of 250 feet was measured. The apparent difference in thickness in Pontotoc County is probably due to the fact that some of the upper shaly strata of the Calvin Unit were mapped as the basal Wetumka Unit.

The unit outcrops in a northeast-southwest pattern, one-fourth mile to two miles wide across Okfuskee, Hughes, and Pontotoc Counties to where it terminates at a fault in T3N, R7E.

The unit typically forms valleys and the steep scarp slopes capped by sandstones of the overlying Wewoka Unit.

WEWOKA UNIT (lPwk)

This unit consists of at least four gray to brown, thin-bedded to massive, moderately soft to moderately hard sandstone members with thicknesses up to 130 feet in central Hughes County. The sandstone members are separated by blue and gray silty shales which range from 75 to 130 feet in thickness. In southern Hughes and eastern Pontotoc Counties the sandstones are conglomeratic and contain chert gravels up to one-half inch in diameter. In northern Hughes and Okfuskee Counties the sandstone members thin and the shale sequences thicken.

The top and the bottom of the unit are marked by sandstone members which form prominent scarps.

The total thickness of the unit thickens northward from about 400 feet in Pontotoc County to about 780 feet in Okfuskee County with an average of 680 feet in Hughes County.

The Wewoka Unit outcrops in a three to eight mile wide pattern from a fault just east of Ada, Pontotoc County. The outcrop pattern extends northeastward across southeastern Seminole, Hughes, and Okfuskee Counties of Division 3. The upper 30 to 40 feet of the unit rests on the Boggy Unit just west of Fittstown, Pontotoc County, in the Franks Graben faulted area.

Topographically, the sandstone members cap prominent scarps and the shales form the scarp slopes and valleys between the sandstone members. The scarps become less prominent northward in Okfuskee County as the sandstones thin.

WOODFORD UNIT (MDw)

This unit consists dominantly of thick platy siliceous shales and siltstones with colors varing from white, yellow, orange, and brown. Thin beds of chert are numerous.

The total thickness of the unit varies from 285 to 425 feet.

This unit is mapped in the Arbuckle Mountains in Murray County of Division 3 where outcrops are broad; but in Johnston, Coal, and Pontotoc Counties, the narrow outcrop pattern is mapped undifferentiated from the underlying Hunton Unit as the Woodford - Hunton Unit (MDSw).

Topographically, the unit forms hummocks or mounds with thin gravelly soils. Oak, bois d'arc, and sparce grass are the major vegetation.

WOODFORD - HUNTON (MDSw)

This unit comprises both the Woodford and Hunton Units undifferentiated. The upper portion or Woodford consists dominantly of thick platy siliceous shales and siltstones of colors varying from white, yellow, orange, and brown. Thin beds of chert are present in minor amounts.

The lower portion or Hunton consists dominantly of thin-bedded, light gray limestone which is commonly marly and weathers to cream color. Some thin siltstones, shales, and cherts are present in minor amounts.

The total thickness of the Woodford - Hunton Unit ranges from 600 to 750 feet.

The unit outcrops in the Arbuckle Mountains in Johnston, Coal, and Pontotoc Counties of Division 3. In Murray County, the unit is divided and mapped separately as the Woodford Unit (MDw) and the Hunton Unit (DSh).

Topographically, the shales of the upper portion form hummocks or a low scarp overlooking valleys. This portion forms thin gravelly soils that support oak, bois d'arc, and sparce grass. The limestones of the lower portion generally form a pronounced ridge overlooking the slopes of the upper portion. The limestone ridges are not as prominent as the underlying limestones of the Sylvan-Viola Unit. The limestones generally support the growth of sparce grass cover, some cedar trees, prickly pears, and shrubs.

DESCRIPTIONS OF UNCONSOLIDATED GEOLOGIC MATERIALS

ALLUVIUM (Qas)

These are deposits of sand, silt, clay, gravel, and/or combinations of materials. Alluvium is found along the flood plains (bottom land) of streams and is normally present at places along all streams. The geologic unit maps outline many deposits, but all of these deposits are not shown. Refer to figure 2, page 6.

GERTY SAND DEPOSITS (Qg)

These materials consist of sand, gravel, clay, and/or mixtures of these. In places the deposit is of even texture; but generally the sand becomes coarse downward, ending in gravel at the base. The sand and gravel are used extensively as road building materials. The sand is composed of fine white quartz which is usually more or less mixed with yellow silt. The pebbles of the gravels are well rounded and smooth, varying in size from that of a hen's egg to a sand grain. They are composed of quartz, quartzite, jasper, and chert, and vary in color from white, yellow, red, and black.

Throughout the deposits' extent, the maximum thickness is estimated at 50 feet in the central parts of its outcrop but the deposit thins rapidly toward its edges.

The Gerty Sand Deposits rest on the consolidated geologic materials in the form of an upland terrace. It occurs in a broken irregular band across eastern McClain, northeastern Garvin, southern Pottawatomie, northern Pontotoc, southern Hughes, and northeastern Coal Counties of Division 3. Small springs are numerous around the outer edge of the Gerty.

It is thought that some ancient river deposited these materials and has since cut itself down to a lower elevation and migrated to another area, possibly the Canadian River.

TERRACE DEPOSITS (Qts)

These materials consist of sand, silt, clay, gravel, and/or mixtures of these. Terrace materials occur adjacent to or near streams at higher elevations than the flood plain (bottom land). Refer to figure 2, page 6. Like alluvium, these deposits are not all shown on the geologic unit maps.

The engineering properties of the unconsolidated materials are normally the same as the "C" horizon of the overlying soil. Refer to Chapter III, Soils. Most Terrace deposits will have seepage where the underlying geologic material is less previous.

ENGINEERING CHARACTERISTICS OF GEOLOGIC UNITS DETERMINED BY FIELD OBSERVATION AND CONSTRUCTION EXPERIENCE

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		ADA UNIT (IPad)			
Pontotoc	60-100 feet	None	Numerous seeps from sandstone overlying shale	Generally rippable, limestone conglomerate is non-rippable.	None noted
Seminole	150-250 feet	"	"	Generally rippable, a few sandstones are marginal in south half	Slumps on 2 to 1 slopes noted
		LOWER ARBUCKLE UNIT (Єb)			
Johnston	1800± feet	Limestone suitable for concrete aggregate, etc., locally	Minor amounts	Non-rippable	None noted
Murray	2000± feet	"	"	"	"
		UPPER ARBUCKLE UNIT (Owm)			
Johnston	1500-5200 feet	Limestone suitable for concrete aggregate, etc. locally	Minor, occurs seasonally	Non-rippable	None noted
Murray	5200 feet	"	"	"	"
Pontotoc	1500± feet	"	"	"	"

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		ATOKA UNIT (IPa)			
Coal	800-2500 feet	None	None noted	Rippable	None noted
Johnston	500± feet	"	"	"	"
Pontotoc	800± feet	"	"	"	"
		BARNSDALL UNIT (IPb)			
Okfuskee	80-100 feet	Sandstones suitable for subbase, etc., locally	Some seeps from sandstone over shale.	Rippable	None noted
		BELLE CITY UNIT (IPbc)			
Seminole	0-36 feet	Limestone suitable for concrete aggregate, etc. locally	Seepage from thin-bedded limestone.	Rippable north of Wewoka Creek; non-rippable south.	None noted
Pontotoc	1-30 feet	"	"	Non-rippable when thicker than 3 feet	"
		BOGGY UNIT (IPbg)			
Coal	1250-2800 feet	Sandstones suitable for subbase, etc., locally	Some seeps from sandstone over shale	Generally rippable	Landslide on Highway 75 T3N, R10E.
Hughes	Upper 200 feet	None	"	"	Notes slumps on 2 to 1 shale slopes.
Pontotoc	1250± feet	"	"	"	None noted
		CALVIN UNIT (IPcv)			
Hughes	230-350 feet	Sandstones suitable for subbase, etc., locally	None noted	Generally rippable; a few massive sandstones are non-rippable	Slumps on 2 to 1 observed

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		CALVIN UNIT (IPcv) Cont.			
Okfuskee	245 feet	Sandstones suitable for subbase, etc., locally	None noted	Generally rippable; a few massive sandstones are non-rippable	None noted
Pontotoc	40-270 feet	"	"	Generally rippable; one 2 to 3 foot limy sandstone at base is non-rippable.	"
		CANEY - SYCAMORE UNIT (Mcs)			
Coal	350 feet	None	None noted	Generally rippable; basal limestone is non-rippable.	None noted
Johnston	350-1200 feet	Limestones suitable for rip-rap, etc.	"	"	"
Murray	1200 feet	Limestones suitable for concrete aggregate, etc.	"	"	"
Pontotoc	350 feet	None	"	Rippable	"
		CHANUTE UNIT (IPc)			
Okfuskee	28-58 feet	Sandstones suitable for subbase, etc. locally	Seeps from sandstones over shale noted.	Rippable	None noted
		CHECKERBOARD UNIT (IPcb)			
Okfuskee	0-7 feet	Limestone suitable for rip-rap, locally	None noted	Rippable; fractures easily by ball drop method where thicker than one foot.	None noted
		COFFEYVILLE UNIT (IPcf)			
Hughes	Lower most 100$\pm$ feet	Sandstone suitable for subbase, etc. locally	None noted	Generally rippable; locally, hard sandstones are marginal	None noted

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		COFFEYVILLE UNIT (ℙcf) Cont.			
Okfuskee	245± feet	Sandstone suitable for subbase, etc., locally	None noted	Basal sandstone had to be shot on I-40	None noted
Seminole	150-260 feet	"	"	Generally rippable; basal sandstone is marginal	"
		COLBERT PORPHYRY UNIT (r)			
Murray	Undetermined	Undetermined	None noted	Non-rippable	None noted
		COLLINGS RANCH UNIT (ℙcr)			
Murray	Up to 2000 feet	Suitable for base admix	Seepage on US 77	Non-rippable; had to be shot on I-35	None noted
		DEESE UNIT (ℙde)			
Johnston	1700-1950 feet	None	None noted	Rippable	None noted
Murray	920-1300	Some conglomerates suitable for base admix, etc., locally	"	"	"
		DEWEY UNIT (ℙd)			
Okfuskee	30-60	Limestone may be suitable for base admix, etc., locally	Seeps from sandstone over shale	Marginal	None noted
		DORNICK HILLS UNIT (ℙdh)			
Johnston	1500 feet	Sandstones suitable for subbase, etc., locally	Some seeps from sandstone over shale	Generally rippable; some sandstones and limestones are marginal	None noted

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		DORNICK HILLS UNIT (IPdh) Cont.			
Murray	1500± feet	None	None noted	Rippable	None noted
		EL RENO UNIT (Per)			
Garvin	Lower 300± feet	Sandstones suitable for rip-rap, base admix, etc. locally	Numerous seeps from sandstones over shales.	Sandstones are non-rippable to marginal	None noted
McClain	Lower 300± feet	Sandstones suitable for subbase, etc., locally	"	Rippable	"
		FALLIS SUBUNIT (Pfa)			
Cleveland	Upper 100± feet	Sandstones suitable for subbase, etc., locally	Numerous seeps from sandstones over shales	Rippable	None noted
Pottawatomie	290-320 feet	"	"	"	"
		FLOWERPOT UNIT (Pf)			
Cleveland	Lower 50± feet	Sandstones suitable for subbase, etc. locally	Some seeps from sandstones	Rippable	None noted
		FRANCIS UNIT (IPf)			
Pontotoc	500± feet	Conglomerates suitable for base admix; sandstones suitable for subbase, etc., locally	Some seeps from sandstones and conglomerates over shale.	Generally rippable; some massive sandstones are marginal	Numerous slumps on 2 to 1 slopes noted.
		FREDERICKSBURG UNIT (Kf)			
Johnston	60± feet	Limestone suitable for rip-rap, etc., locally	Some seepage from limestones at base of the unit	Non-rippable	Soils and clay-shales slump on steep slopes.

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		GARBER-WELLINGTON UNIT (Pgw)			
Cleveland	Upper 800± feet	Sandstones suitable for subbase, etc.	Numerous seeps from sandstones over shales.	Rippable	Soils over sandstones are highly erosive
Garvin	2100± feet	Conglomerates and sandstones suitable for base admix, subbase, etc. locally.	"	Generally rippable; limestone at base is marginal	None noted
Murray	Lower 200± feet	"	Numerous seeps from conglomerates and sandstones	"	"
Pontotoc	Lower 200± feet	Sandstones suitable for subbase, etc., locally	"	"	"
Pottawatomie	Lower 200± feet	"	"	Rippable	Soils over sandstones are highly erosive
		HARTSHORNE UNIT (IPhs)			
Coal	150-300 feet	Sandstones suitable for subbase, etc., locally	None noted	Rippable	None noted
		HENNESSEY UNIT (Phy)			
Cleveland	400-600	None	None noted	Rippable	None noted
Garvin	400-600	"	"	"	"
McClain	400-600	"	Local seeps from sandstones over shales.	"	"
		HILLTOP UNIT (IPht)			
Pontotoc	0-70± feet	Sandstones suitable for subbase, etc., locally	None noted	Rippable	None noted

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		HILLTOP UNIT (IPht) Cont.			
Seminole	0-125± feet	Sandstones suitable for subbase, etc., locally	some seeps from sandstone over shale	Generally rippable; massive sandstones locally are marginal	None noted
		HOGSHOOTER UNIT (IPh)			
Okfuskee	1-6 feet	None	None noted	Generally rippable	None noted
		HOLDENVILLE UNIT (IPhd)			
Hughes	250± feet	Sandstones suitable for subbase, etc., locally	Some seeps from sandstones over shale	Rippable	Slumps on 2 to 1 slopes
Okfuskee	200-800 feet	"	None noted	"	None noted
Pontotoc	100-185 feet	None	"	Limestone conglomerates are non-rippable	"
Seminole	185-235 feet	Sandstones and conglomerates suitable for subbase etc., locally	Some seepage from limestones over shale	"	"
		HUNTON UNIT (DSh)			
Murray	125-350 feet	Limestones suitable for base admix, rip-rap, etc. locally	None noted	Marly thin limestones are rippable; massive limestones are non-rippable.	None noted
		LECOMPTON UNIT (IPlc)			
Okfuskee	3-7 feet	None	None noted	Rippable	None noted
		McAlester Unit (IPma)			
Coal	1000-1650 feet	None	None noted	Rippable	None noted
Pontotoc	1000± feet	"	"	"	"

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		NELLIE BLY UNIT (ℙnb)			
Okfuskee	450-475 feet	Sandstones suitable for subbase, etc., locally	Some seeps from sandstones over shale	Generally rippable; some sandstones may be marginal.	None noted
Seminole	300-400 feet	"	"	"	Slumps on 2 to 1 slopes noted
		PALUXY UNIT (Kpy)			
Johnston	200± feet	Limestone locally suitable for rip-rap, base admix, etc. Sandstones suitable for subbase, etc., locally	Numerous seeps from sandstones over clay-shales	Limestones generally non-rippable; sandstones are rippable	None noted
		SAVANNA UNIT (ℙsv)			
Coal	1300-1600 feet	Sandstones suitable for subbase, etc., locally	Some seeps from sandstones over shale	Massive sandstones are marginal	None noted
Pontotoc	1300± feet	"	"	Rippable	"
		SEMINOLE UNIT (ℙsl)			
Hughes	300± feet	Sandstones suitable for subbase, etc., locally	Some seeps from sandstones at base of unit.	Basal sandstone had to be shot on US 270	None noted
Okfuskee	250-330 feet	"	None noted	Rippable	"
Pontotoc	90-150 feet	"	Some seeps from sandstones over shales.	"	"
Seminole	120-375 feet	"	"	"	"

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		SENORA UNIT (IPsn)			
Hughes	230-500 feet	Sandstones suitable for subbase, etc., locally	None noted	Generally rippable; limestone is non-rippable in northern portion.	Slumps on 2 to 1 slopes noted in shale section.
Okfuskee	Upper 190 feet	None	"	Rippable	"
Pontotoc	125-230 feet	Sandstones suitable for subbase, etc., locally	"	"	Slumps on 1 to 1 slopes noted.
		SIMPSON UNIT (Oss)			
Johnston	1000-1800 feet	Sandstones suitable for subbase, etc., locally	None noted	Generally rippable	None noted
Murray	1800-2300 feet	Sandstones locally suitable for subbase, etc. limestones suitable for concrete aggregate, etc., locally	Numerous seeps from limestones and sandstones	Generally rippable; limestones are non-rippable	"
Pontotoc	$1000^{\pm}$ feet	Limestones suitable for rip-rap, base-admix, etc. locally	"	"	"
		SPRINGER UNIT (IPs)			
Johnston	$2500^{\pm}$ feet	None	None noted	Rippable	Slump noted on 2 to 1 slope
Murray	$2500^{\pm}$ feet	"	"	"	"
		STUART UNIT (IPst)			
Coal	120-300 feet	Sandstones suitable for subbase, etc., locally.	Some seeps from sandstones over shales.	Rippable	Slumps on 1 to 1 slopes noted.
Hughes	300-370 feet	"	"	"	Numerous slumps on 2 to slopes noted.

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		STUART UNIT (IPst) Cont.			
Pontotoc	80-120 feet	None	None noted	Rippable	Numerous slumps on 2 to 1 slopes noted.
		SYLVAN-VIOLA UNIT (Osv)			
Coal	600± feet	Limestone quarried for concrete aggregate, etc.	None noted	Limestones are non-rippable	None noted
Johnston	800-1000 feet	Limestone suitable for concrete aggregate, etc., locally	Some seepage from limestones	"	"
Murray	1000-1125 feet	"	"	"	"
Pontotoc	525-600 feet	Limestone locally suitable for concrete aggregate, cement source, etc.	None noted	"	Slumps on 1 to 1 slopes noted in upper shale section.
		TALLANT UNIT (IPta)			
Okfuskee	80± feet	Sandstones locally suitable for subbase, etc.	Some seeps from sandstones over shale.	Rippable	Slump on 2 to 1 slope on US 62.
		TISHOMINGO GRANITE UNIT (gr)			
Johnston	Undetermined	Questionable, due to abrasiveness, massiveness	None noted	Non-rippable, deeply weathered and rippable locally	None noted
		THURMAN UNIT (IPt)			
Coal	100-200 feet	Sandstones suitable for subbase, etc., locally	None noted	Rippable	None noted
Hughes	200-250 feet	"	"	"	"
Pontotoc	80-100 feet	"	"	"	"

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		VAMOOSA UNIT (IPvm)			
Okfuskee	550-690 feet	Local gravels available from conglomerates; sandstones suitable for subbase, etc., locally.	Numerous seeps from sandstones over shale.	Rippable	Slump on 2 to 1 slope noted
Pontotoc	30-125 feet	"	"	"	None noted
Seminole	125-550 feet	"	"	Generally rippable; had to shoot sandstone on I-40	"
		VANOSS UNIT (IPv)			
Murray	650-1550 feet (including Vanoss conglomerate)	None	None noted	Generally rippable; some massive conglomeratic sandstones are marginal	None noted
Pontotoc	250-650 feet	Sandstones suitable for subbase, etc., locally.	"	"	"
Pottawatomie	Upper 50± feet	"	"	Rippable	"
Seminole	140-500 feet	"	Numerous seeps from sandstone over shale.	Had to shoot limy sandstone on SH 99	Slump on 2 to 1 slope noted.
		VANOSS - ADA UNIT (IPva)			
Okfuskee	Lower 125-200 feet	Sandstones suitable for subbase, etc., locally.	Some seeps from sandstones over shales	Rippable	Slump on 1 to 1 slope noted.
Pottawatomie	Upper 200-250 feet	"	None noted	"	None noted
		VANOSS CONGLOMERATE SUBUNIT (IPvc)			
Murray	650± feet	Conglomerate suitable for base-admix, etc., locally.	Some seepage noted.	Non-rippable	None noted

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		WAPANUCKA UNIT (ℙwp)			
Johnston	300-500 feet	Limestone suitable for concrete aggregates, etc. locally.	Numerous seeps from limestones	Non-rippable	None noted
		WAPANUCKA-SPRINGER UNIT (ℙws)			
Coal	2800± feet	None	None noted	Rippable	None noted
Pontotoc	2800± feet	Sandstones suitable for subbase, etc., locally.	"	"	"
		WASHITA UNIT (Kw)			
Johnston	Lower 250± feet	None	None noted	Generally rippable some limestones are marginal	None noted
		WELLINGTON-ADMIRE UNIT (Pwa)			
Pottawatomie	1000± feet	Conglomerates suitable for fine and coarse aggregates, locally	Numerous seeps from conglomerates and sandstones over shales	Generally rippable; locally tightly cemented conglomerates are non-rippable	Slump on 1 to 1 slope noted.
Seminole	Lower 200± Feet	Sandstones suitable for subbase, etc., locally.	Some seeps from sandstones over shales	Generally rippable; a few massive sandstones are marginal	None noted
		WETUMKA UNIT (ℙwt)			
Hughes	120-150 feet	None	None noted	Rippable	Slumps on 2 to 1 slopes noted.
Okfuskee	120-150 feet	"	"	"	"
Pontotoc	150-250 feet	"	"	"	"

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		WEWOKA UNIT (ℙwk)			
Hughes	680± feet	Sandstones suitable for subbase, etc., locally	Numerous seeps from sandstones over shales	Generally rippable; a few thin sandstones are rippable to marginal.	Slumps on 2 to 1 slopes noted
Okfuskee	680-780 feet	"	"	Rippable	Slumps on 3 to 1 slopes noted
Pontotoc	400-680 feet	"	"	Generally rippable; conglomerates are non-rippable.	Slumps on 2 to 1 slopes noted
Seminole	Upper 200±feet	"	"	Rippable	"
		WOODFORD UNIT (MDw)			
Murray	285-425 feet	None	None noted	Rippable; locally marginal	None noted
		WOODFORD-HUNTON UNIT (MDSw)			
Coal	600-750 feet	None	None noted	Rippable	None noted
Johnston	600-750 feet	"	"	Limestones are non-rippable	"
Pontotoc	600-750 feet	"	"	"	"

Highway Engineering Characteristics of Geologic Units

Geologic Unit Name & County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A.)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
ADA																							
PONTOTOC	20	A-7-6(21)	100	98	96	79					48	26	44	8	2.12	77	.39	7.3	NO	16			X
SEMINOLE	17	A-7-6(20)	100	100	99	91					45	20	40	14	1.93	50	.20	7.8	NO	15			X
ATOKA																							
COAL	19	A-7-6(25)	100	99	98	97					50	22	46	13	1.97	65	.24	7.5	NO	16			X
JOHNSTON	21	A-7-6(30)	100	99	99	95					53	27	47	10	2.00	75	.42	7.7	NO	18			X
PONTOTOC	20	A-7-6(23)	100	97	95	85					52	24	49	12	1.91	70	.32	7.3	NO	16			X
BARNSDALL																							
OKFUSKEE	15	A-7-6(17)	98	96	95	93					43	16	36	18	1.85	34	-		NO	15		X	
BELLE CITY																							
PONTOTOC	22	A-7-6(30)	100	95	94	93					56	28	49	11	1.96	73	.49	7.5	NO	18			X
BOGGY																							
COAL	15	A-6(18)	100	99	99	94					38	18	33	13	1.92	38	-	7.1	NO	14		X	
HUGHES	14	A-7-6(17)	100	99	99	97					42	15	38	14	1.88	46	-	7.5	NO	15		X	
PONTOTOC	18	A-7-6(23)	100	98	97	95					46	21	41	15	1.88	49	.21	5.4	NO	15			X

Highway Engineering Characteristics of Geologic Units

Geologic Unit Name & County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A.)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
CALVIN																							
HUGHES	13	A-6(14)	100	100	100	94					37	14	31	14	1.92	32	-	7.3	NO	13		X	
OKFUSKEE	12	A-6(12)	100	99	99	98					36	11	31	16	1.89	29	-		NO	13		X	
PONTOTOC	18	A-7-6(22)	100	98	97	89					45	23	41	12	2.01	59	.28	7.5	NO	16			X
CANEY																							
COAL	20	A-7-6(27)	100	98	97	94					49	26	46	11	2.01	71	.39	7.1	NO	16			X
JOHNSTON	21	A-7-6(30)	100	100	99	99					53	26	44	14	1.87	57	.39		NO	16			X
PONTOTOC	19	A-7-6(21)	100	97	96	84					47	24	42	9	2.06	68	.32	7.4	NO	16			X
CHANUTE																							
OKFUSKEE	12	A-6(11)	97	96	95	92					34	12	28	16	1.87	22	-		NO	13		X	
CHECKERBOARD																							
OKFUSKEE	13	A-6(15)	100	99	98	97					37	14	31	14	1.90	32	-		NO	13		X	
COFFEYVILLE																							
HUGHES	12	A-6(13)	100	100	99	96					33	13	30	12	1.93	35	-	6.5	NO	13		X	
OKFUSKEE	19	A-7-6(26)	99	98	98	98					49	23	34	16	1.86	33	.28		NO	16			X
SEMINOLE	18	A-7-6(24)	100	98	97	95					46	23	41	11	2.02	62	.28	7.9	NO	16			X

Highway Engineering Characteristics of Geologic Units

Geologic Unit Name & County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A.)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
DEWEY																							
OKFUSKEE	14	A-6(17)	99	99	98	96					38	17	31	14	1.90	33	-		NO	13		X	
DORNICK HILLS																							
JOHNSTON	11	A-6(10)	100	99	98	93					29	12	26	15	1.84	19	-	7.9	NO	13		X	
EL RENO																							
GARVIN	8	A-4(5)	100	100	100	92					27	7	-	-	-	-	-	6.7	NO	12		X	
MC CLAIN	12	A-6(13)	99	99	98	97					33	13	30	18	1.90	24	-	7.8	NO	13		X	
FRANCIS																							
PONTOTOC	23	A-7-6(34)	100	99	99	98					56	30	48	10	2.06	78	.58	7.7	NO	18			X
GARBER WELLINGTON																							
CLEVELAND	15	A-7-6(13)	100	99	99	79					43	15	41	9	2.03	65	-	7.6	NO	15		X	
GARVIN	19	A-7-6(25)	100	100	98	95					50	23	-	-	-	-	.28	7.4	NO	16			X
MC CLAIN	32	A-7-5(49)	99	99	98	95					74	44	46	13	2.03	67	1.78	7.9	NO	17			X
MURRAY	13	A-6(11)	100	96	91	79					38	14	35	15	1.86	37	-		NO	13		X	
POTTAWATOMIE	15	A-6(15)	100	100	100	87					37	18	31	1	2.33	70	-	5.1	NO	14		X	

Highway Engineering Characteristics of Geologic Units

Geologic Unit Name & County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A.)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
HENNESSEY																							
CLEVELAND	13	A-6(15)	100	100	98	94					36	15	34	11	2.04	47	-	7.9	NO	13		X	
GARVIN	12	A-6(13)	100	99	99	97					35	12	32	12	1.98	39	-	6.9	NO	13		X	
MC CLAIN	14	A-6(17)	99	98	97	96					38	17	32	14	2.01	37	-	7.8	NO	13		X	
HILLTOP																							
SEMINOLE	15	A-7-6(16)	100	98	97	89					44	16	44	17	1.83	49	-	6.7	NO	15		X	
HOLDENVILLE																							
HUGHES	12	A-6(14)	100	100	100	99					36	13	33	14	1.89	37	-	7.4	NO	13		X	
OKFUSKEE	19	A-7-5(25)	99	98	98	97					51	21	38	17	1.84	38	.21		NO	15			X
PONTOTOC	16	A-7-6(21)	100	99	99	97					46	18	43	16	1.84	51	-	7.0	NO	15		X	
SEMINOLE	19	A-7-6(25)	100	99	99	92					49	24	46	24	1.59	35	.32	7.4	NO	16			X
HUNTON																							
MURRAY	9	A-4(7)	100	97	95	89					29	9	-	-	-	-	-		NO	12		X	
LECOMPTON																							
OKFUSKEE	14	A-6(18)	100	100	100	99					38	17	28	13	1.94	29	-		NO	13		X	

Highway Engineering Characteristics of Geologic Units

Geologic Unit Name & County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A.)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
MC ALESTER																							
COAL	17	A-7-6(24)	100	100	99	99					45	21	41	15	1.87	48	.21	6.4	NO	15			X
PONTOTOC	21	A-7-6(30)	100	99	99	98					53	26	43	14	1.88	54	.39	7.4	NO	16			X
NELLIE BLY																							
OKFUSKEE	13	A-6(14)	99	98	98	97					36	14	27	13	1.92	26	-		NO	13		X	
SEMINOLE	19	A-7-6(26)	100	100	99	99					49	22	45	14	1.92	59	.24	7.7	NO	16			X
PALUXY																							
JOHNSTON	0	A-2-4(0)									25	9	23	13	1.87	19	-	7.8	NO	81	X		
SAVANNA																							
COAL	17	A-7-6(23)	100	100	100	99					46	20	41	14	1.93	52	.20	6.5	NO	15			X
PONTOTOC	21	A-7-6(28)	100	99	97	93					53	26	46	15	1.86	58	.39	4.0	NO	16			X
SEMINOLE																							
HUGHES	12	A-6(13)	100	99	98	95					34	13	32	12	1.91	38	-	6.8	NO	13		X	
OKFUSKEE	14	A-6(14)	96	93	92	89					38	15	31	15	1.87	30	-		NO	13		X	
PONTOTOC	16	A-7-6(18)	100	96	92	86					44	19	40	16	1.87	45	.15	7.2	NO	15		X	
SEMINOLE	13	A-6(14)	100	100	99	92					35	15	-	-	-	-	-	7.4	NO	13		X	

Highway Engineering Characteristics of Geologic Units

Geologic Unit Name & County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A.)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
SENORA																							
HUGHES	12	A-6(13)	100	99	98	95					36	13	32	15	1.87	31	-	7.5	NO	13		X	
OKFUSKEE	13	A-6(13)	98	98	97	95					39	12	33	18	1.84	28	-		NO	13		X	
PONTOTOC	20	A-7-6(27)	100	98	98	94					51	25	46	15	1.87	57	.36	7.5	NO	16			X
SIMPSON																							
MURRAY	12	A-6(13)	100	100	98	94					38	12	37	14	1.90	45	-		NO	13		X	
PONTOTOC	17	A-7-6(14)	100	86	80	71					44	20	41	13	1.88	52	.20	7.4	NO	15			X
SPRINGER																							
COAL	20	A-7-6(27)	100	99	99	94					50	25	43	9	2.08	71	.36	7.4	NO	16			X
JOHNSTON	22	A-7-6(31)	100	99	99	98					54	27	45	13	1.92	62	.42	6.5	NO	18			X
MURRAY	10	A-6(6)	100	97	90	63					32	13	31	9	2.03	44	-		NO	13		X	
PONTOTOC	21	A-7-6(29)	100	99	98	96					51	26	46	12	1.96	66	.39	7.7	NO	16			X
STUART																							
COAL	16	A-7-6(22)	100	100	100	99					44	19	40	20	1.76	36	.15	7.6	NO	15		X	
HUGHES	14	A-6(15)	100	98	97	92					40	14	38	16	1.78	39	-	5.9	NO	13		X	
PONTOTOC	18	A-7-6(22)	100	98	97	89					44	23	39	12	1.98	54	.28	7.5	NO	15			X

Geologic Unit Name & County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A.)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
SYLVAN																							
MURRAY	14	A-6(15)	100	98	97	94					40	14	38	15	1.85	42	-		NO	13		X	
PONTOTOC	22	A-7-6(32)	100	99	99	98					55	28	48	17	1.81	56	.49	7.5	NO	18			X
TALLANT																							
OKFUSKEE	15	A-6(18)	100	99	99	97					38	18	29	12	1.98	34	-		NO	14		X	
THURMAN																							
COAL	12	A-6(13)	100	99	99	95					31	14	28	11	1.95	33	-	7.9	NO	13		X	
HUGHES	13	A-7-6(14)	100	100	99	92					41	13	39	14	1.87	47	-	7.0	NO	15		X	
VAMOOSA																							
OKFUSKEE	18	A-7-6(24)	100	99	99	96					47	22	35	11	2.03	48	.24		NO	16			X
PONTOTOC	16	A-7-6(22)	100	100	100	99					41	20	38	15	1.93	44	.20	6.9	NO	15		X	
SEMINOLE	16	A-6(20)	100	100	100	99					40	19	38	15	1.93	44	.15	7.0	NO	14		X	
VANOSS																							
GARVIN	12	A-6(12)	100	97	95	90					34	14	33	13	1.96	39	-		NO	13		X	
MURRAY	12	A-6(11)	100	97	95	91					34	12	32	18	1.96	27	-		NO	13		X	
PONTOTOC	18	A-7-5(16)	100	99	97	76					53	19	50	15	1.88	66	.15	7.7	NO	15			X
POTTAWATOMIE	19	A-7-6(23)	100	97	95	86					47	25	43	12	1.99	62	.36		NO	16			X

Highway Engineering Characteristics of Geologic Units

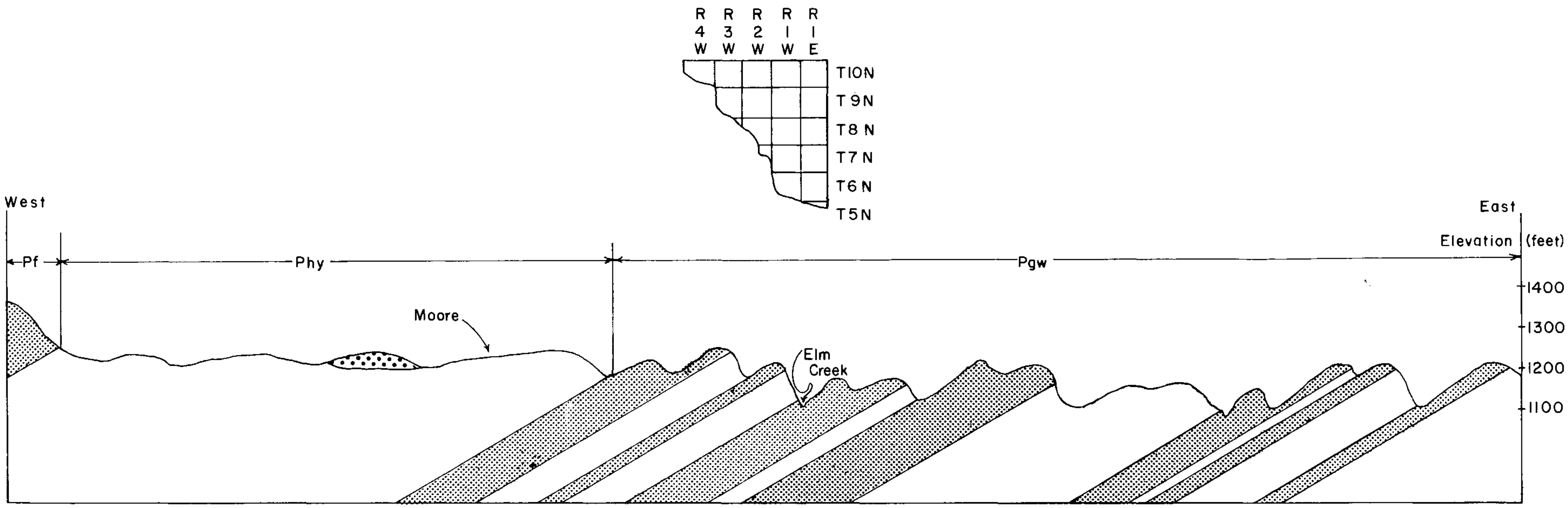
Geologic Unit Name & County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A.)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
VANOSS																							
SEMINOLE	19	A-7-6(23)	100	97	95	86					47	25	43	12	1.99	62	.36	7.3	NO	16			X
VANOSS ADA																							
OKFUSKEE	13	A-6(12)	99	97	96	88					35	14	26	14	1.95	23	-		NO	13		X	
WAPANUCKA																							
JOHNSTON	13	A-6(12)	100	95	92	85					37	14	31	22	1.62	14	-	7.5	NO	13		X	
WASHITA																							
JOHNSTON	15	A-6(16)	100	98	97	90					37	18	30	12	1.97	36	-	7.4	NO	14		X	
WELLINGTON																							
PONTOTOC	20	A-7-5(25)	100	99	99	90					55	23	50	12	1.96	74	.28	8.4	NO	15			X
POTTAWATOMIE	22	A-7-6(28)	100	99	96	89					52	29	40	5	2.23	78	.52	7.7	NO	18			X
SEMINOLE	14	A-6(14)	100	99	97	87					36	16	34	13	1.97	41	-	7.7	NO	13		X	
WETUMKA																							
HUGHES	12	A-6(13)	100	99	99	97					35	13	32	13	1.89	36	-	7.4	NO	13		X	
OKFUSKEE	19	A-7-6(26)	98	97	97	96					49	24	38	14	1.97	47	.32		NO	16			X
PONTOTOC	18	A-7-6(24)	100	100	99	97					46	22	41	15	1.91	50	.24	7.3	NO	15			X

Highway Engineering Characteristics of Geologic Units

Geologic Unit Name & County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A.)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
WEWOKA																							
HUGHES	15	A-7-6(17)	100	99	99	96					41	16	34	15	1.86	36	-	7.5	NO	15		X	
OKFUSKEE	14	A-6(16)	99	98	97	96					39	15	36	17	1.86	36	-		NO	13		X	
PONTOTOC	15	A-7-6(18)	100	100	100	93					43	17	40	17	1.81	42	-	7.4	NO	15		X	
SEMINOLE	23	A-7-6(33)	100	100	99	98					56	29	50	11	1.95	75	.52	7.4	NO	18			X
WOODFORD																							
COAL	14	A-6(18)	100	99	98	97					38	17	34	18	1.87	30	-	7.6	NO	13		X	
PONTOTOC	18	A-7-5(16)	100	93	89	78					50	19	45	22	1.60	36	.15	4.3	NO	14			X

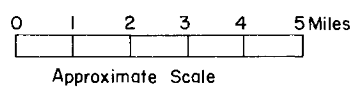
IDEALIZED CROSS SECTION

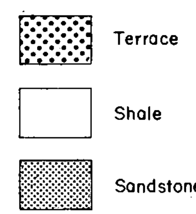
CLEVELAND COUNTY

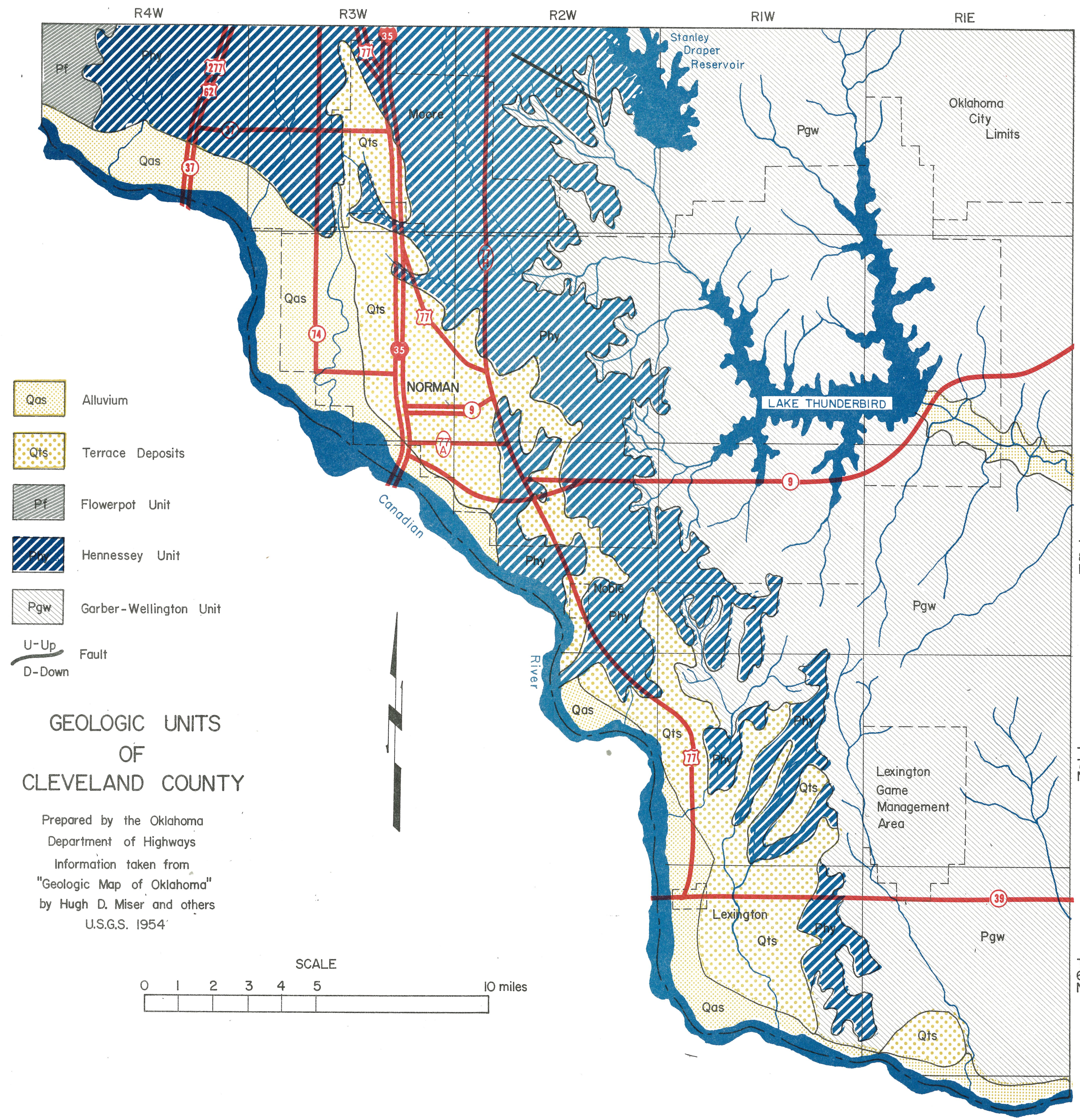


Beds generally dip westward 40 feet/mile.

GEOLOGIC UNIT	SYMBOL
Flowerpot	Pf
Hennessey	Phy
Garber—Wellington	Pgw





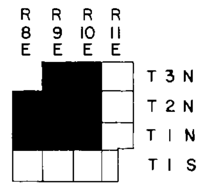


GEOLOGIC UNITS
OF
CLEVELAND COUNTY

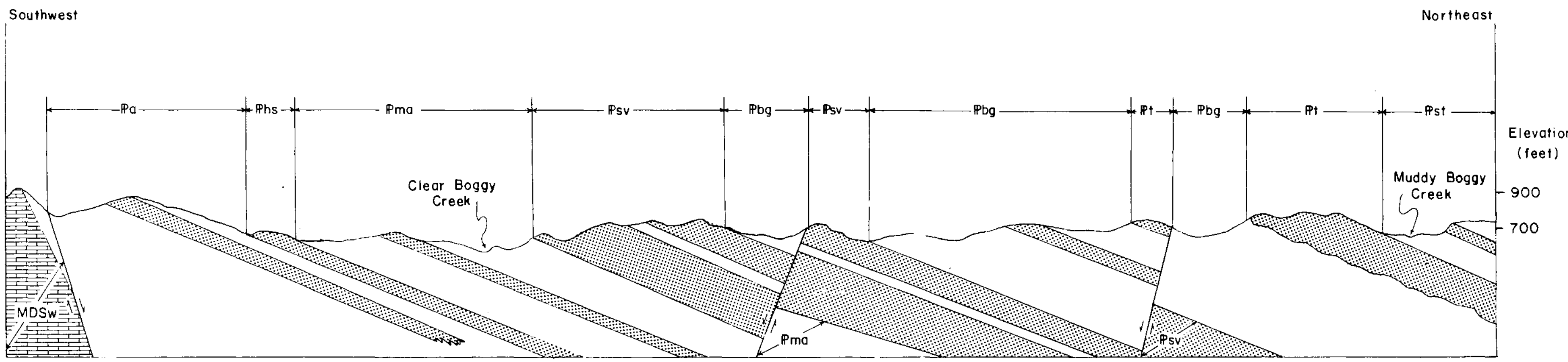
Prepared by the Oklahoma
Department of Highways
Information taken from
"Geologic Map of Oklahoma"
by Hugh D. Miser and others
U.S.G.S. 1954

IDEALIZED CROSS SECTION

COAL COUNTY
No. 1



Cross Section Illustrates Shaded Area

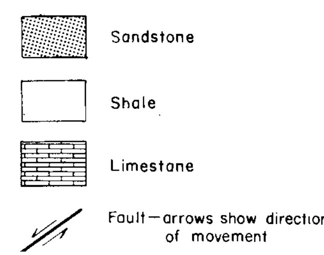


Beds generally dip northward at angles less than 15 degrees.

GEOLOGIC UNIT	SYMBOL
Stuart	₱st
Thurman	₱t
Boggy	₱bg
Savanna	₱sv
McAlester	₱ma
Hartshorne	₱hs
Atoka	₱a
Woodford-Hunton	MDSw

0 1 2 3 4 5 Miles

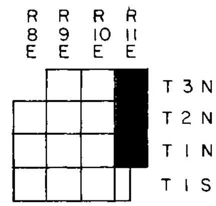
Approximate Scale



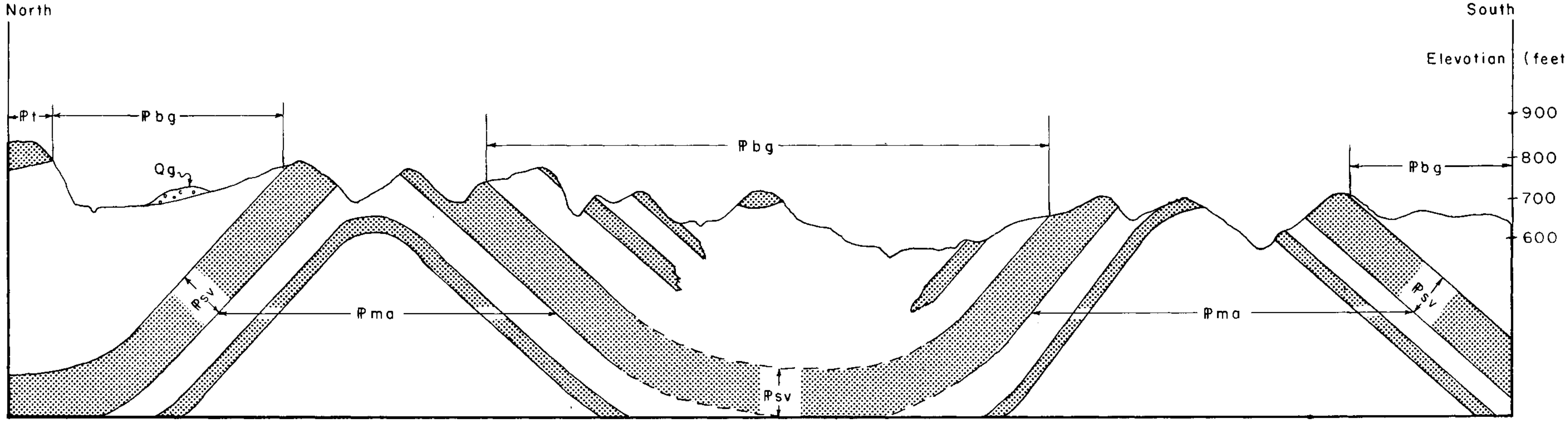
IDEALIZED CROSS SECTION

COAL COUNTY

NO. 2



Cross Section Illustrates Shaded Area



GEOLOGIC UNIT	SYMBOL
Gerty Sand	Qg
Thurman	ℙt
Boggy	ℙbg
Savanna	ℙsv
McAlester	ℙma

Beds are folded and have a maximum dip of 25 degrees on the tighter folds. More gentle dips are prominent on the wider folds.

0 1 2 3 4 5 Miles

Approximate S[illegible]

Terrace

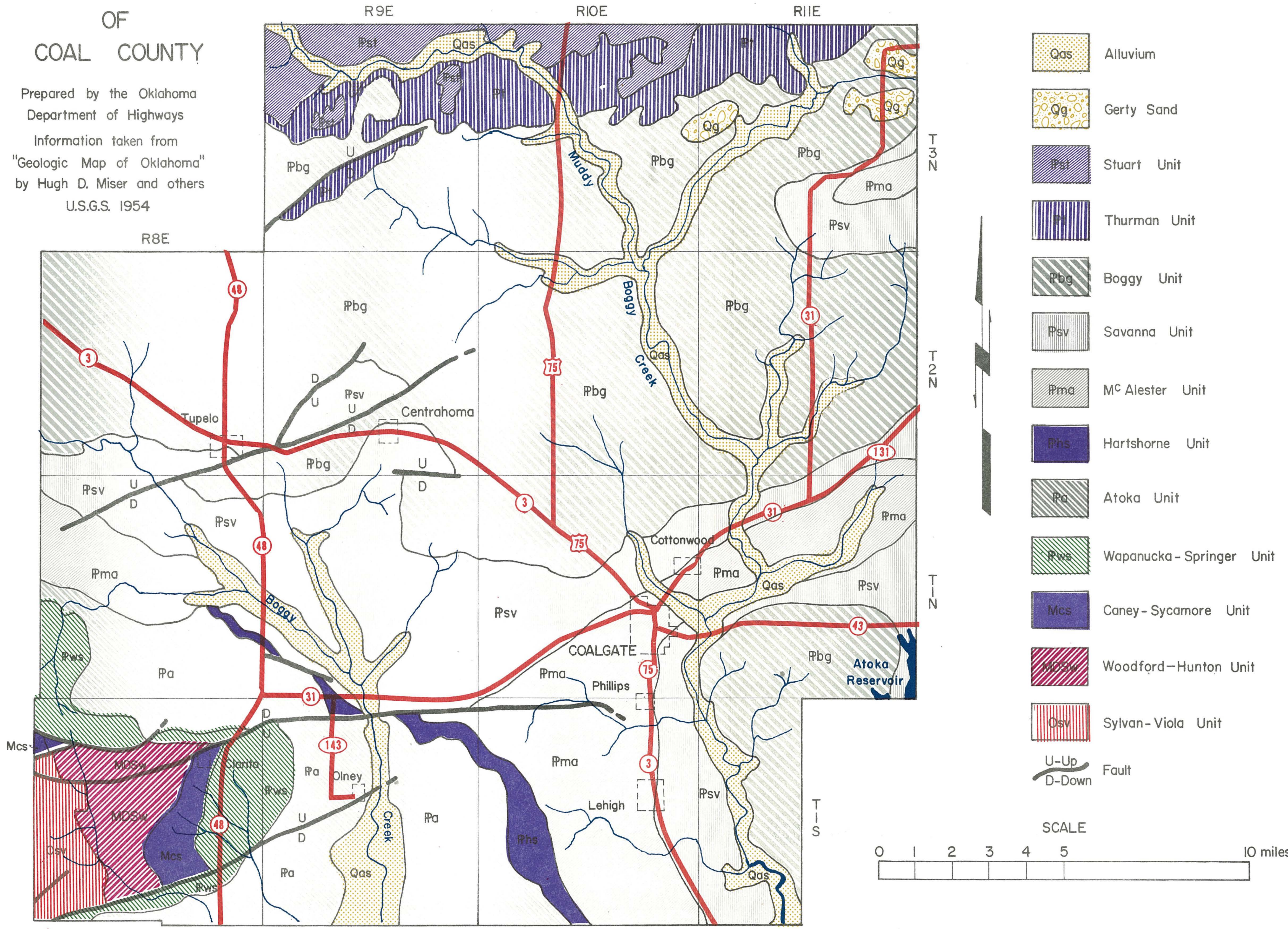
Sandstone

Shale

GEOLOGIC UNITS OF COAL COUNTY

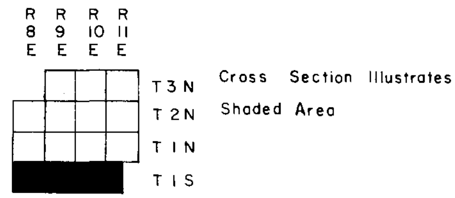
Prepared by the Oklahoma Department of Highways

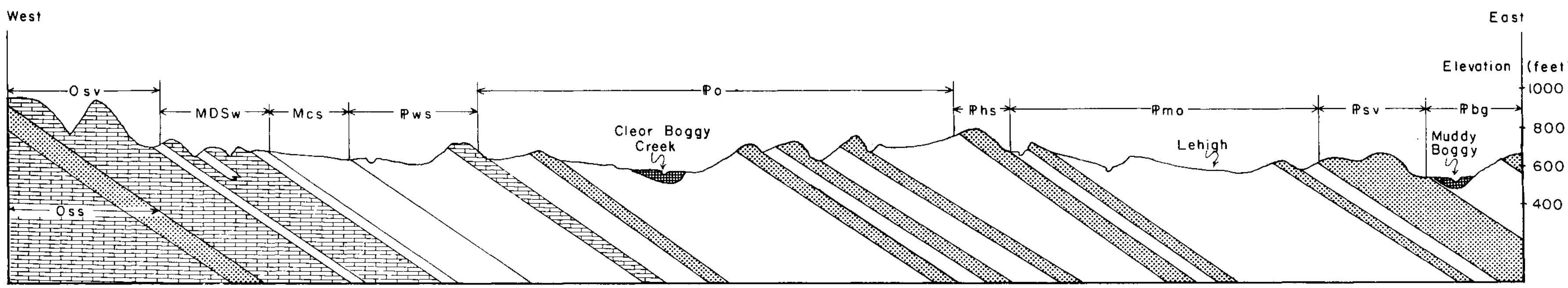
Information taken from "Geologic Map of Oklahoma" by Hugh D. Miser and others U.S.G.S. 1954



IDEALIZED CROSS SECTION

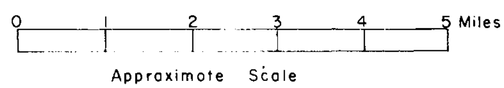
COAL COUNTY
NO. 3

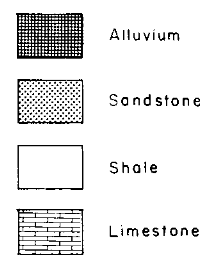




Beds generally dip less than 20 degrees eastward.

GEOLOGIC UNIT	SYMBOL
Boggy	Ᵽbg
Savanna	Ᵽsv
McAlester	Ᵽma
Hartshorne	Ᵽhs
Atoka	Ᵽa
Wapanucka-Springer	Ᵽws
Coney – Sycamore	Mcs
Woodford–Hunton	MDSw
Sylvan- Viola	Osv
Simpson	Oss

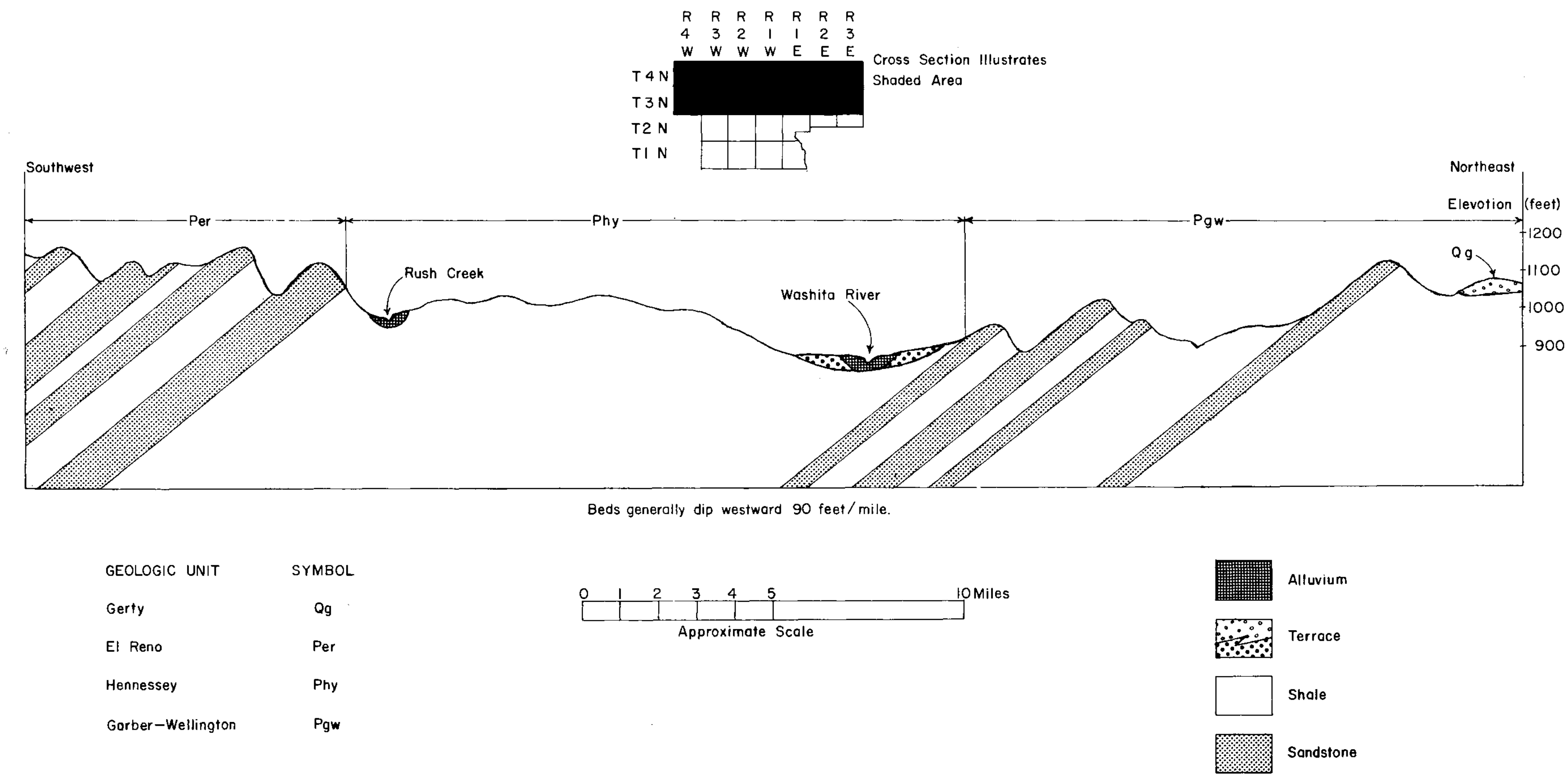




IDEALIZED CROSS SECTION

GARVIN COUNTY

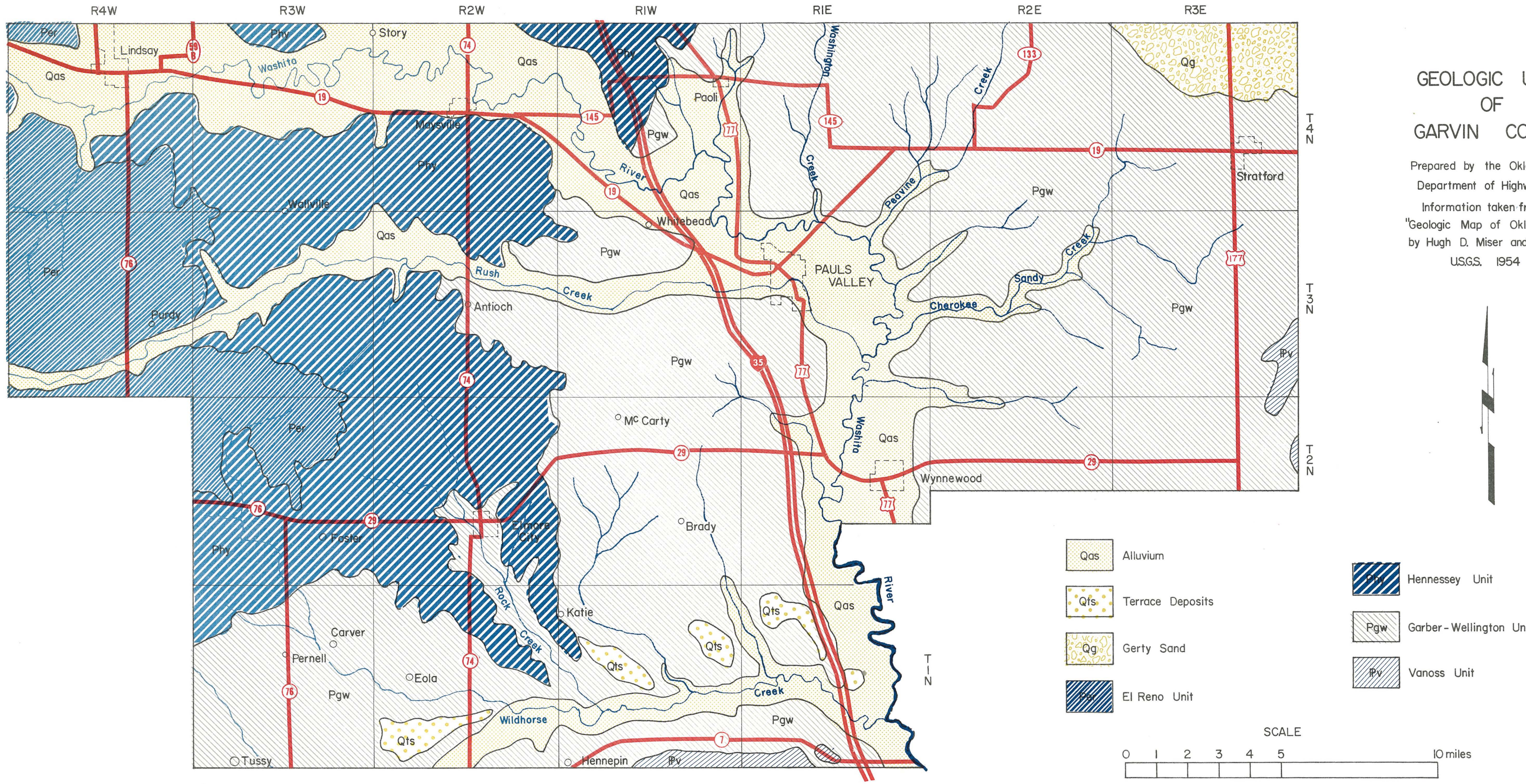
NO. 1



GEOLOGIC UNITS OF GARVIN COUNTY

Prepared by the Oklahoma Department of Highways

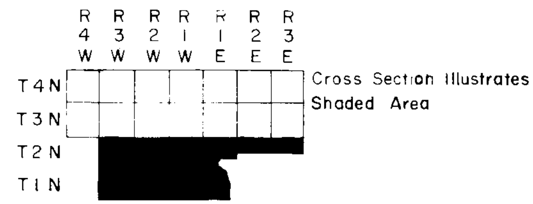
Information taken from: "Geologic Map of Oklahoma" by Hugh D. Miser and others U.S.G.S. 1954

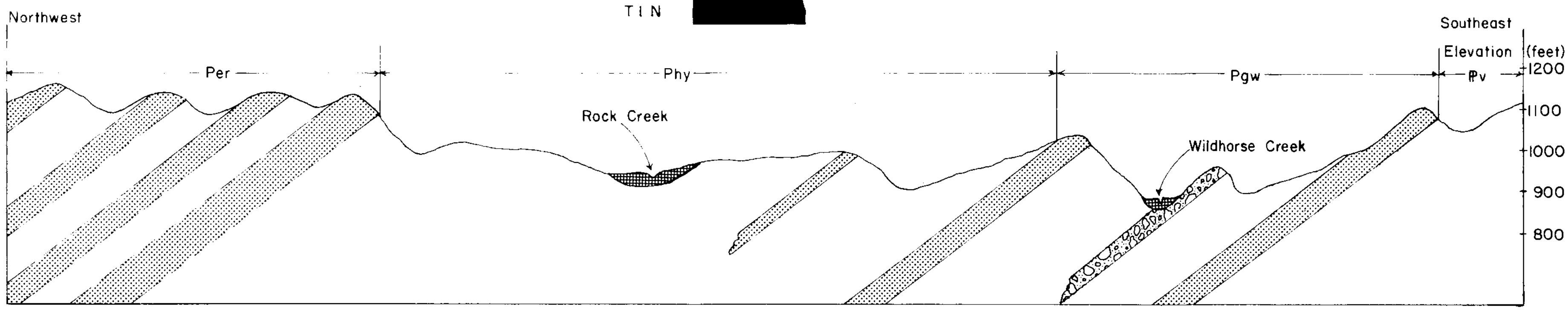


IDEALIZED CROSS SECTION

GARVIN COUNTY

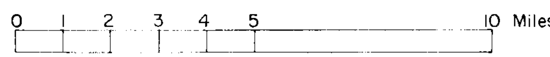
NO. 2



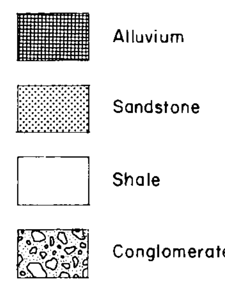


Beds generally dip northwestward 50 to 90 feet/mile.

GEOLOGIC UNIT	SYMBOL
El Reno	Per
Hennessey	Phy
Garber–Wellington	Pgw
Vanoss	₽v

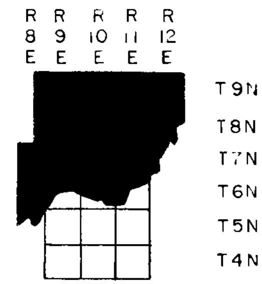


Approximate Scale

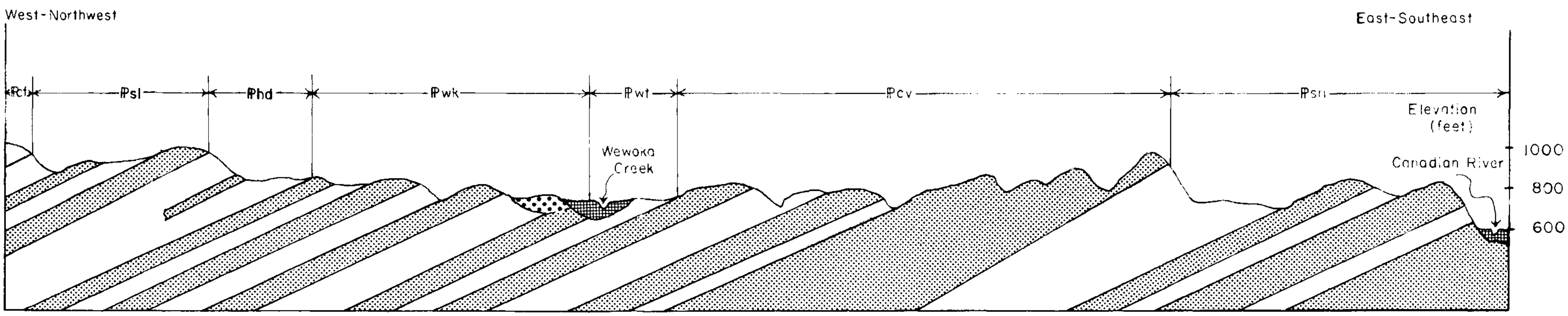


IDEALIZED CROSS SECTION

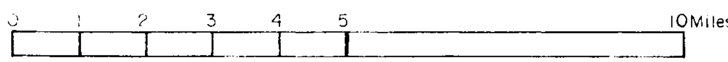
HUGHES COUNTY
NO. 1



Cross Section Illustrates Shaded Area.

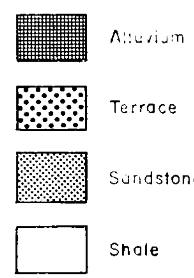


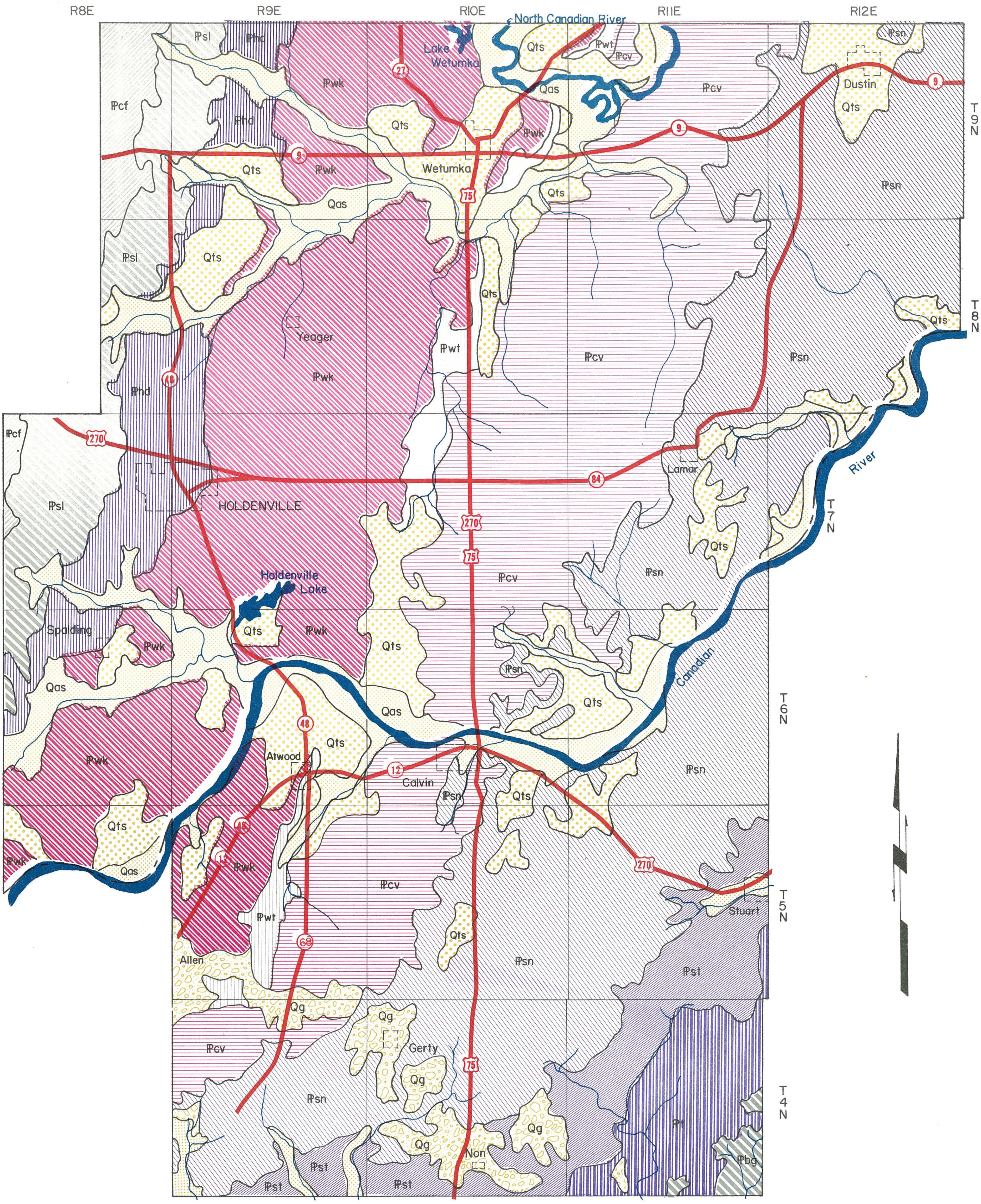
Beds generally dip northwestward approximately 70 feet/mile.



Approximate Scale

GEOLOGIC UNIT	SYMBOL
Coffeyville	₽cf
Seminole	₽sl
Holdenville	₽hd
Wewoka	₽wk
Wetumka	₽wt
Calvin	₽cv
Senora	₽sn





GEOLOGIC UNITS OF HUGHES COUNTY

Prepared by the Oklahoma Department of Highways

Information taken from "Geologic Map of Hughes County" by O. D. Weaver, Jr. O.G.S. 1954

SCALE

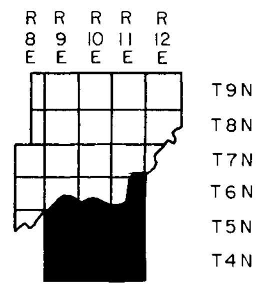
0 1 2 3 4 5 10 miles

Qas	Alluvium
Qts	Terrace Deposits
Qg	Gerty Sand
ℙcf	Coffeyville Unit
ℙsl	Seminole Unit
ℙhd	Holdenville Unit
ℙwk	Wewoka Unit
ℙwt	Wetumka Unit
ℙcv	Calvin Unit
ℙsn	Senora Unit
ℙst	Stuart Unit
ℙt	Thurman Unit
ℙbg	Boggy Unit

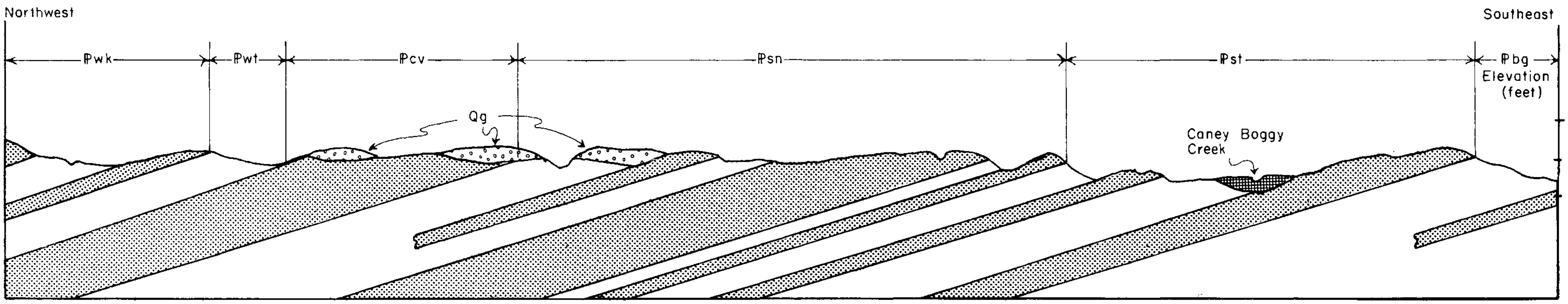
IDEALIZED CROSS SECTION

HUGHES COUNTY

NO. 2



Cross Section Illustrates Shaded Area.

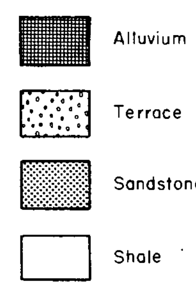


Beds generally dip northwestward about 70 feet/mile.

GEOLOGIC UNIT	SYMBOL
Gerty Sand	Qg
Wewoka	₱wk
Wetumka	₱wt
Calvin	₱cv
Senora	₱sn
Stuart	₱st
Boggy	₱bg

0 1 2 3 4 5 Miles

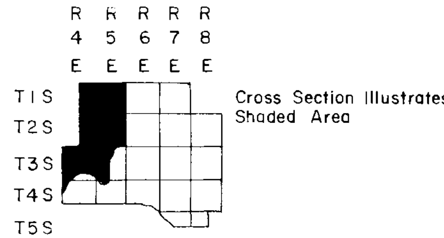
Approximate Scale

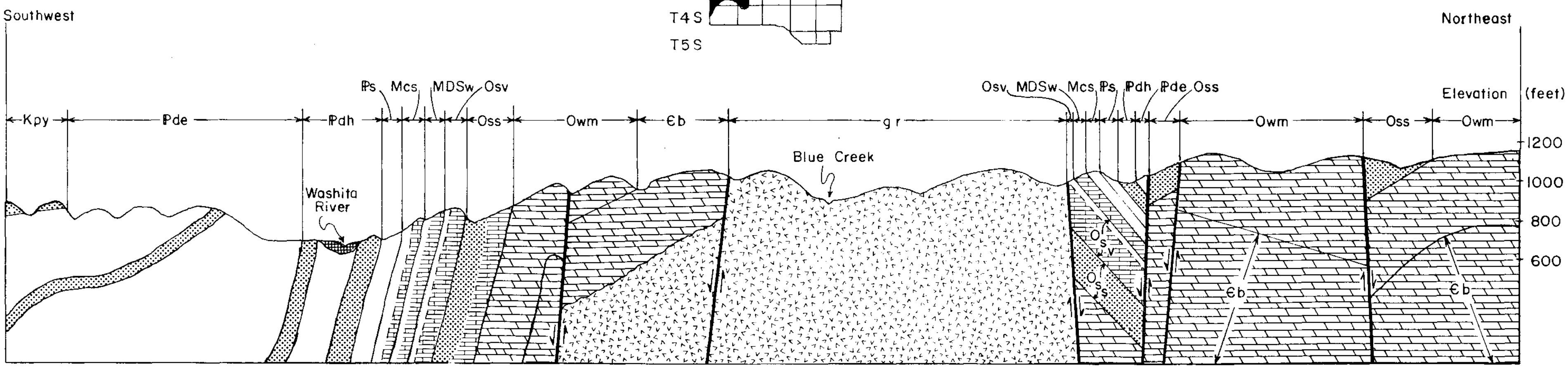


IDEALIZED CROSS SECTION

JOHNSTON COUNTY

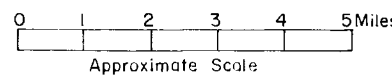
NO. 1

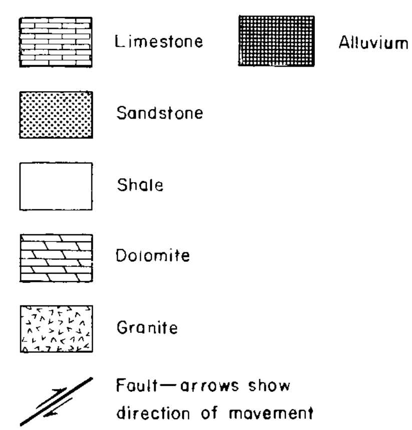


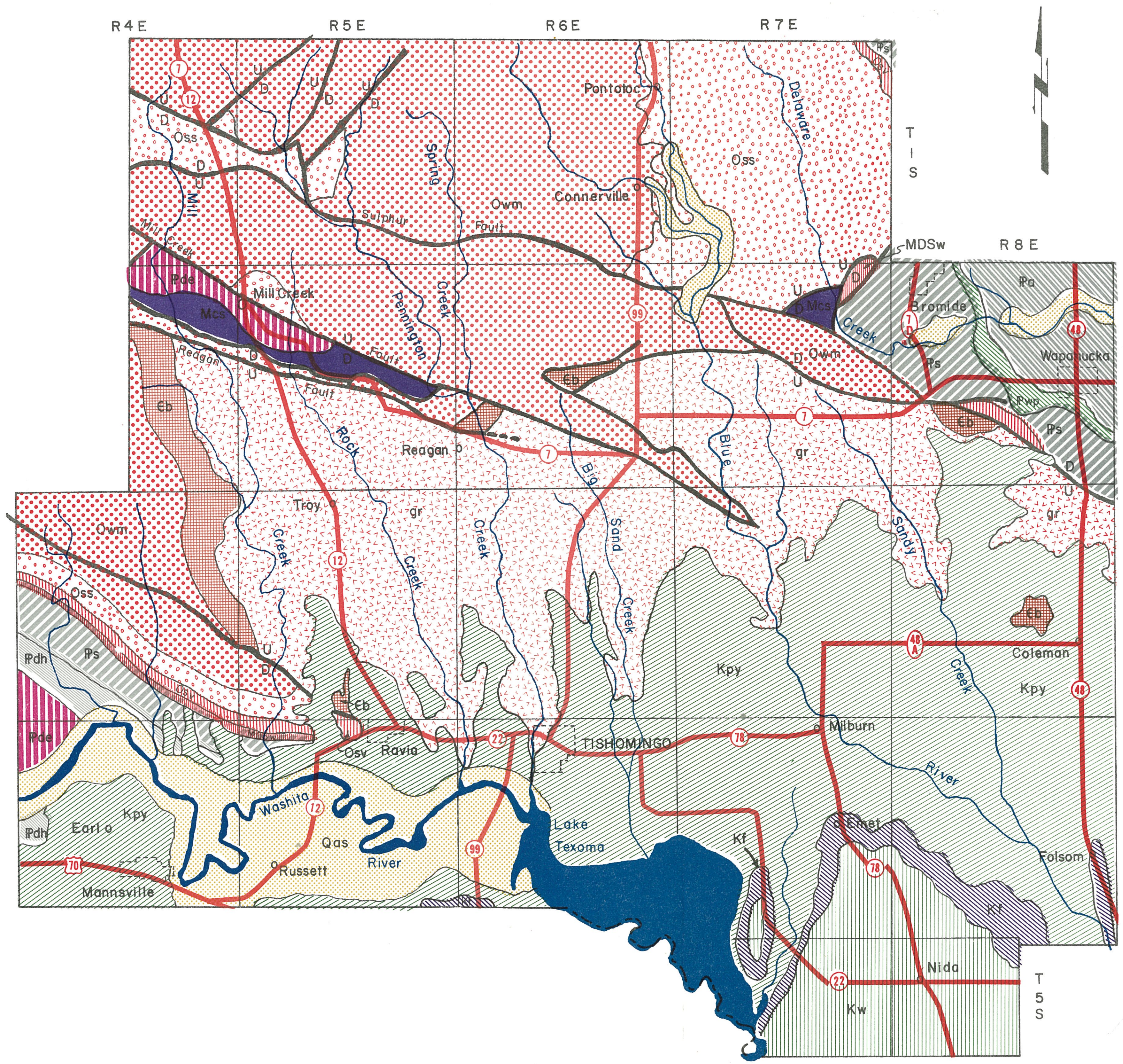


GEOLOGIC UNIT	SYMBOL
Paluxy	Kpy
Deese	Pde
Dornick Hills	Pdh
Springer	Ps
Caney–Sycamore	Mcs
Woodford–Hunton	MDSw
Sylvan–Viola	Osv
Simpson	Oss
Upper Arbuckle	Owm
Lower Arbuckle	Єb
Tishomingo granite	gr

Dips of beds vary from 10 to 50 degrees northeast of the Granite. Dips of beds vary from 10 to 80 degrees southwest of the Granite and generally in a southwestward direction.







GEOLOGIC UNITS OF JOHNSTON COUNTY

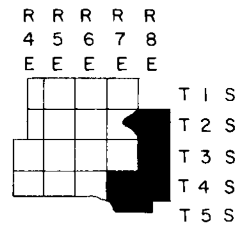
Prepared by the Oklahoma Department of Highways
Information taken from:
"Geologic Map of Arbuckle Mountains"
by William E. Ham and Myron E. McKinley and others
O.G.S. 1954 and
"Geologic Map of Oklahoma"
by Hugh D. Miser and others U.S.G.S. 1954

Scale
0 1 2 3 4 5 10 miles

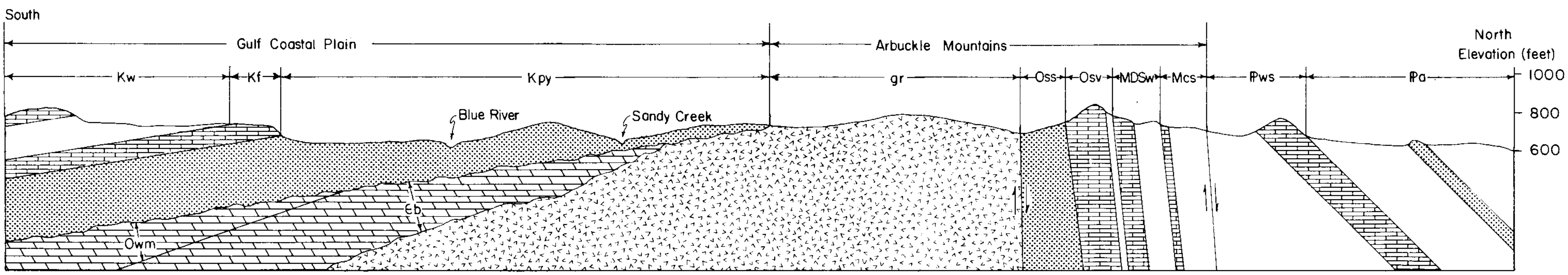
- Qas — Alluvium
- Kw — Washita Unit
- Kf — Fredericksburg Unit
- Kpy — Paluxy Unit
- IPde — Deese Unit
- IPa — Atoka Unit
- IPdh — Dornick Hills Unit
- IPwp — Wapanucka Unit
- IPs — Springer Unit
- Mcs — Caney–Sycamore Unit
- MDSw — Woodford-Hunton Unit
- Osv — Sylvan–Viola Unit
- Oss — Simpson Unit
- Owm — Upper Arbuckle Unit
- Cb — Lower Arbuckle Unit
- gr — Tishomingo Granite Unit
- U up / D down — Fault

IDEALIZED CROSS SECTION

JOHNSTON COUNTY
NO. 2

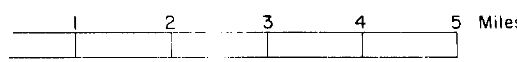


Cross Section Illustrates
Shaded Area

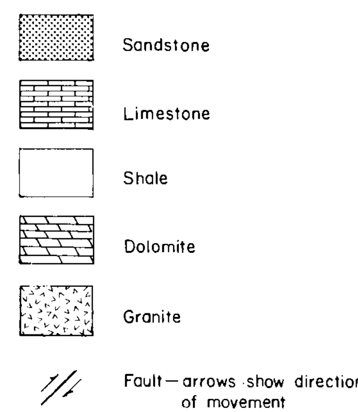


GEOLOGIC UNIT	SYMBOL
Washita	Kw
Fredericksburg	Kf
Paluxy	Kpy
Ataka	ℙa
Wapanucka–Springer	ℙws
Caney–Sycamore	Mcs
Woodford–Hunton	MDSw
Sylvan–Viola	Osv
Simpson	Oss
Upper Arbuckle	Owm
Lower Arbuckle	Єb
Tishomingo granite	gr

Beds of the Arbuckle Mountains dip varies from 15 degrees to 90 degrees.
Beds of the Gulf Coastal Plain dip southward 30 to 90 feet/mile.
Beds north of the mountains generally dip northeastward less than 20 degrees.

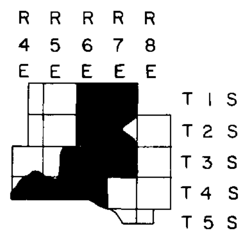


Approximate Scale

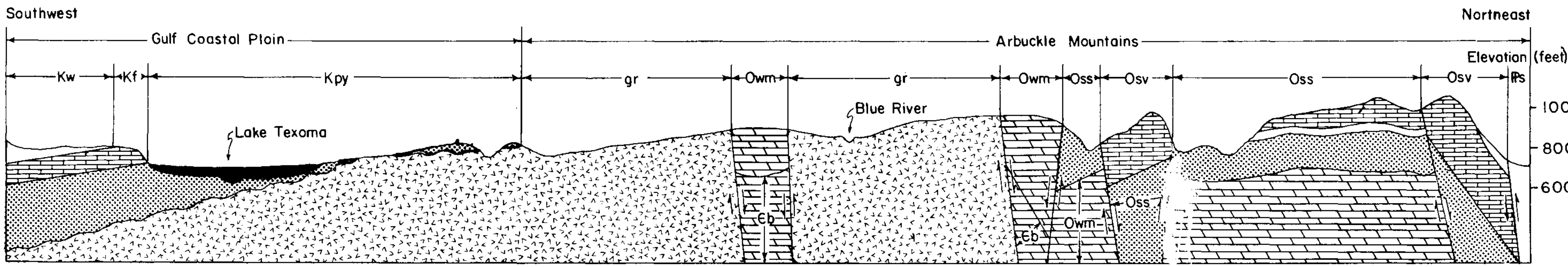


IDEALIZED CROSS SECTION

JOHNSTON COUNTY
NO.3



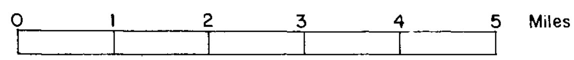
Cross Section Illustrates Shaded Area



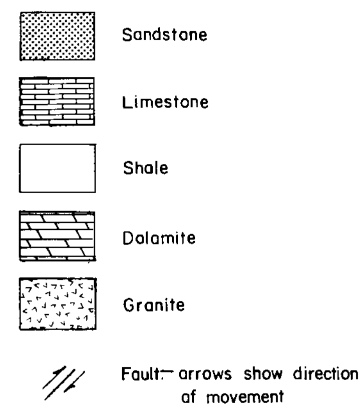
GEOLOGIC UNIT	SYMBOL
Washita	Kw
Fredericksburg	Kf
Paluxy	Kpy
Springer	IPs
Sylvan–Viola	Osv
Simpson	Oss
Upper Arbuckle	Owm
Lower Arbuckle	Ꞓb
Tishomingo granite	gr

Beds of the Gulf Coastal Plain dip southward 30 to 90 feet/mile.

Beds of the Arbuckle Mountains generally dip less than 30 degrees, but locally up to 90 degrees.

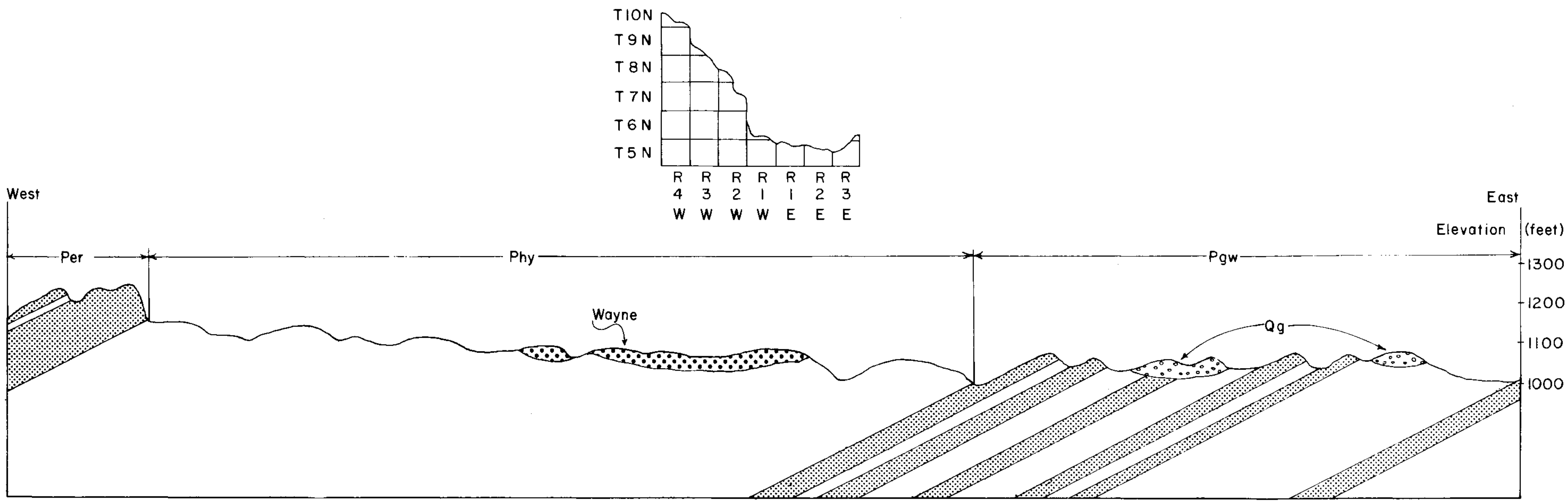


Approximate Scale



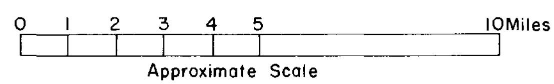
IDEALIZED CROSS SECTION

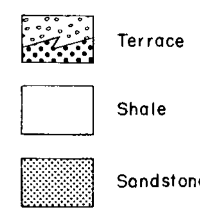
Mc CLAIN COUNTY

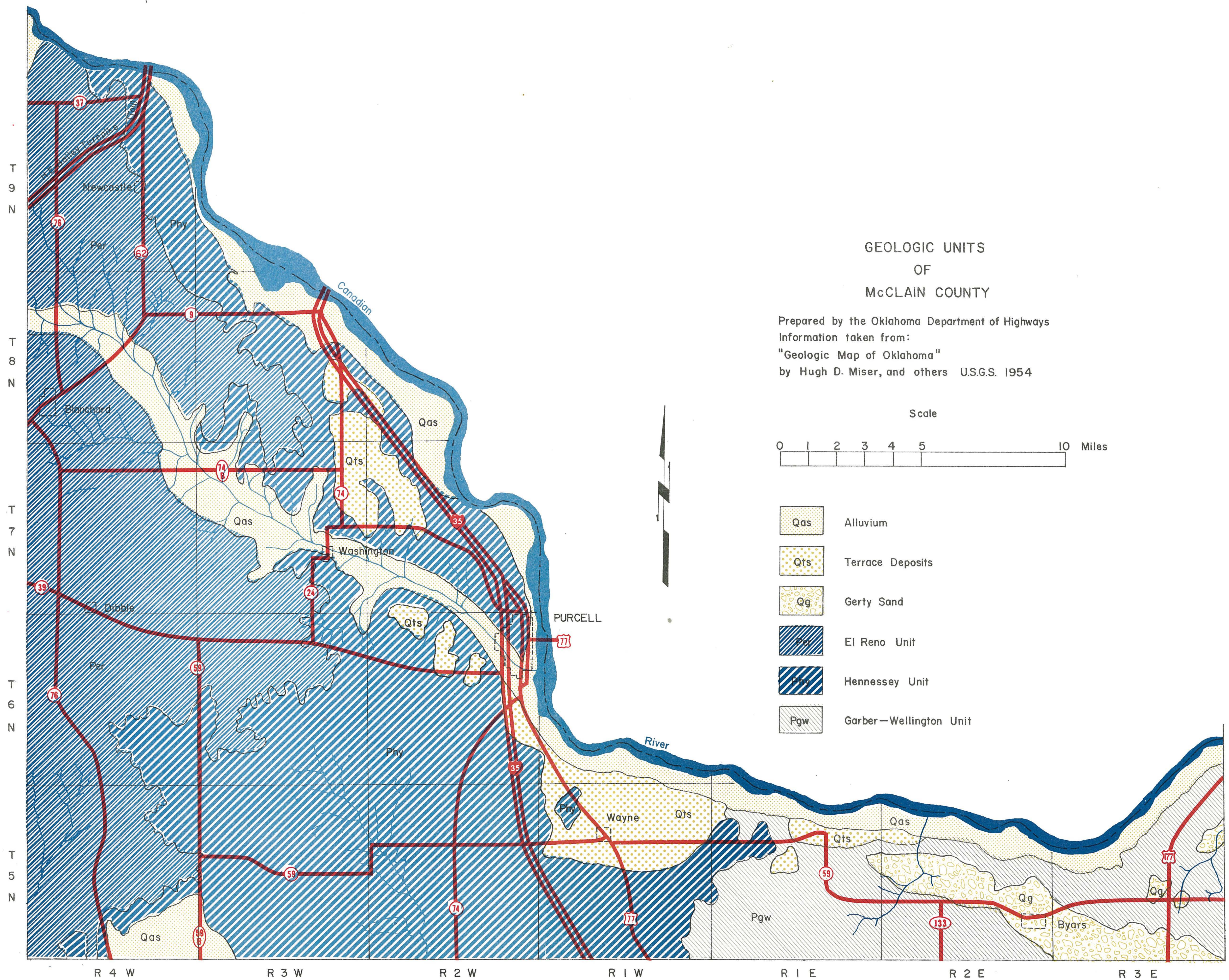


Beds generally dip westward 90 feet/mile.

GEOLOGIC UNIT	SYMBOL
Gerty	Qg
El Reno	Per
Hennessey	Phy
Garber–Wellington	Pgw





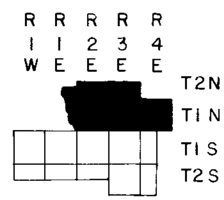


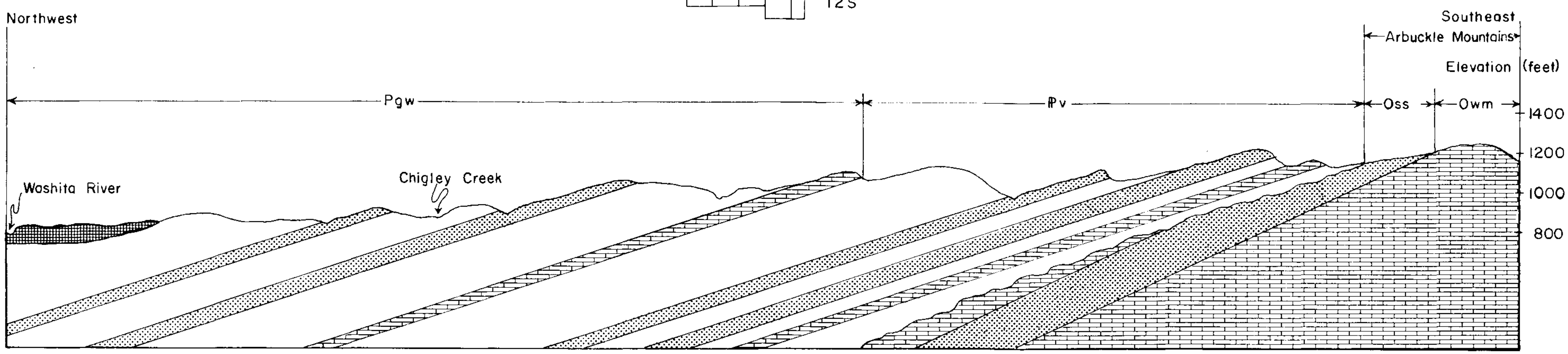
GEOLOGIC UNITS
OF
McCLAIN COUNTY
Prepared by the Oklahoma Department of Highways
Information taken from:
"Geologic Map of Oklahoma"
by Hugh D. Miser, and others U.S.G.S. 1954
Scale
0 1 2 3 4 5 10 Miles
Qas Alluvium
Qts Terrace Deposits
Qg Gerty Sand
Per El Reno Unit
Phy Hennessey Unit
Pgw Garber—Wellington Unit
Canadian
River
Newcastle
Blanchard
Washington
Dibble
PURCELL
Wayne
Byars
Qas
Qts
Qg
Per
Phy
Pgw
T 9 N
T 8 N
T 7 N
T 6 N
T 5 N
R 4 W
R 3 W
R 2 W
R 1 W
R 1 E
R 2 E
R 3 E

IDEALIZED CROSS SECTION

MURRAY COUNTY

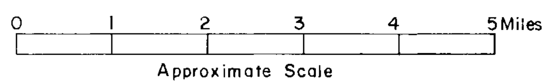
NO. 1

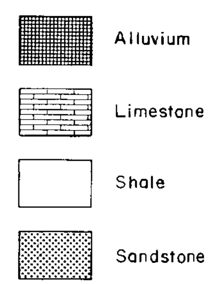




GEOLOGIC UNIT	SYMBOL
Garber—Wellington	Pgw
Vonoss	Pv
Simpson	Oss
Upper Arbuckle	Owm

Beds of the Arbuckle Mountains dip in various directions, but generally less than 20 degrees, other beds dip northwestward about 90 feet / mile.

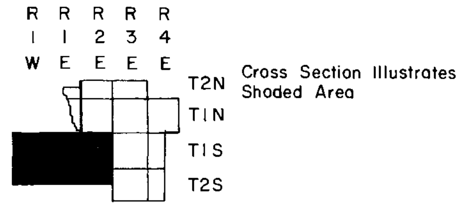


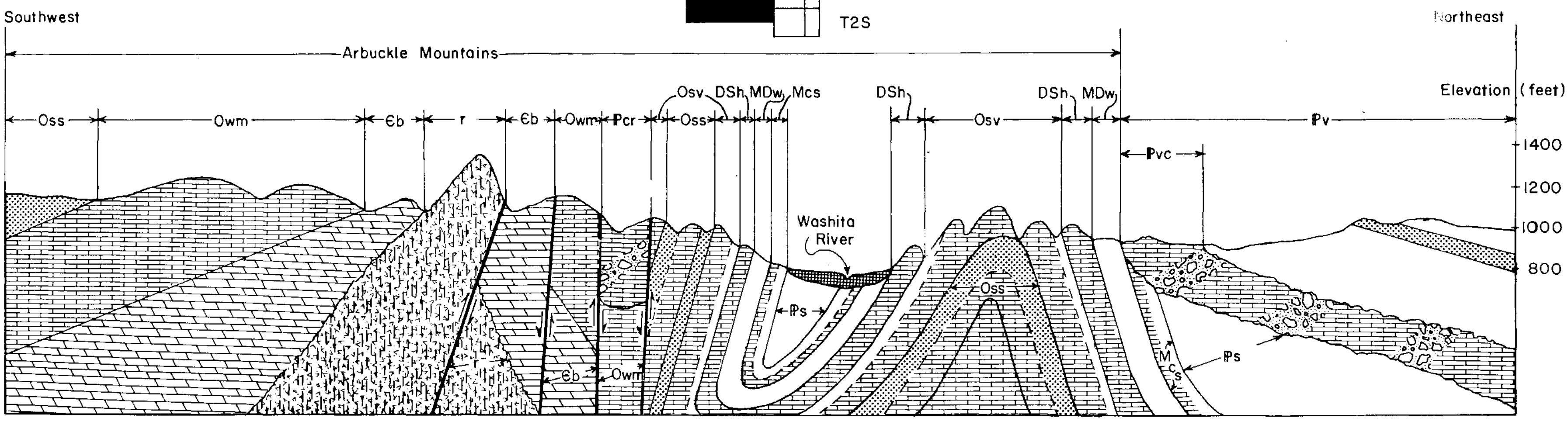


IDEALIZED CROSS SECTION

MURRAY COUNTY

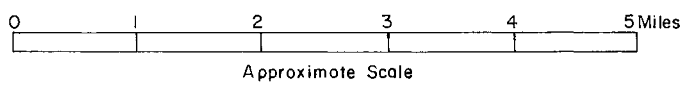
NO. 2

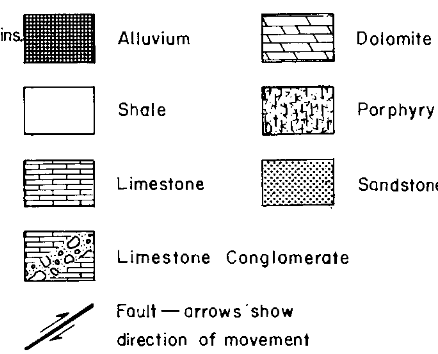




Dips of beds in the Arbuckle Mountains vary from 20 to 90 degrees, the beds between ₱cr and the Washita River are overturned and dip southward. Beds north of the Mountains generally dip less than 15 degrees away from the Mountains.

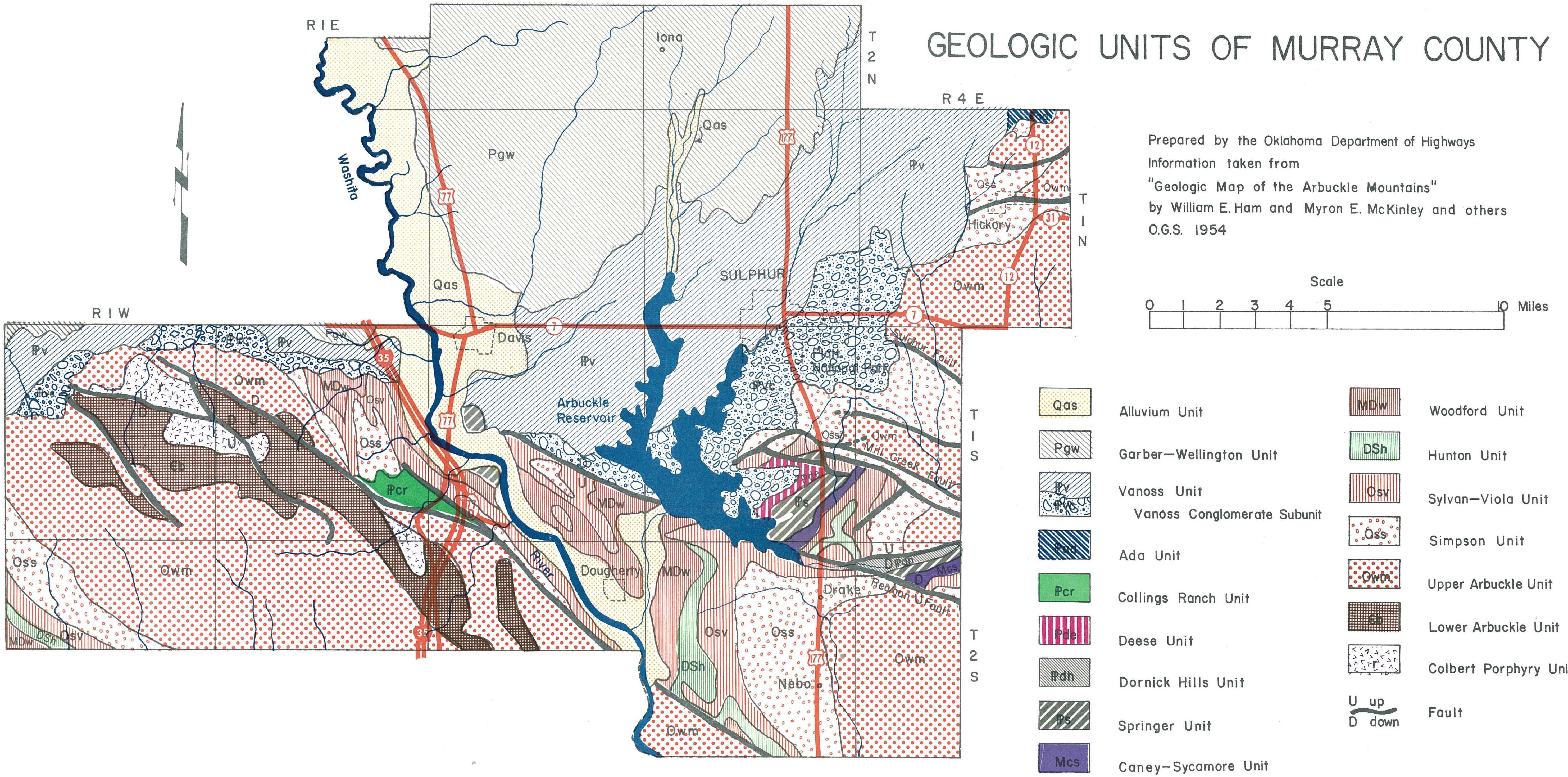
GEOLOGIC UNIT	SYMBOL
Vonoss	₱v
Vanoss Conglomerate Subunit	₱vc
Collings Ranch	₱cr
Springer	₱s
Caney—Sycamore	Mcs
Woodford	MDw
Hunton	DSh
Sylvan—Viola	Osv
Simpson	Oss
Upper Arbuckle	Owm
Lower Arbuckle	€b
Colbert Porphyry	r





GEOLOGIC UNITS OF MURRAY COUNTY

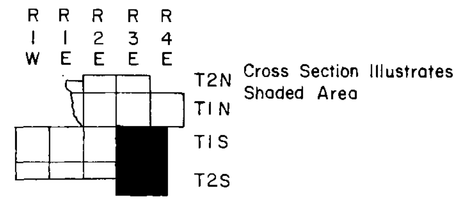
Prepared by the Oklahoma Department of Highways
Information taken from
"Geologic Map of the Arbuckle Mountains"
by William E. Ham and Myron E. McKinley and others
O.G.S. 1954

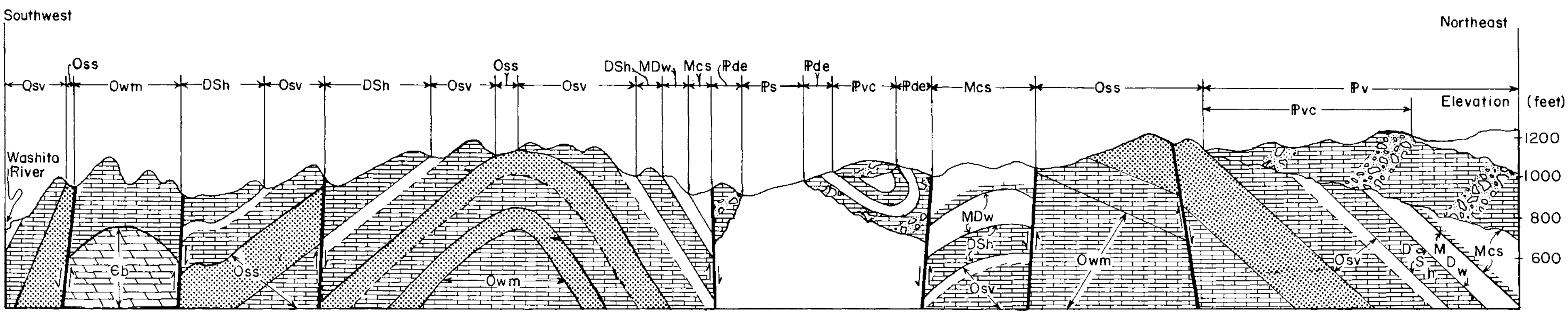


IDEALIZED CROSS SECTION

MURRAY COUNTY

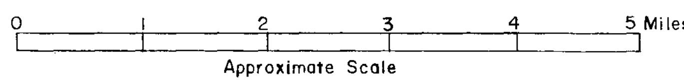
NO. 3





Beds dip in various directions 15 to 75 degrees and are dissected by numerous faults.

GEOLOGIC UNIT	SYMBOL
Vanoss	IPv
Vanoss Conglomerate Subunit	IPvc
Deese	IPde
Springer	IPs
Caney-Sycamore	Mcs
Woodford	MDw
Hunton	DSh
Sylvan-Viola	Osv
Simpson	Oss
Upper Arbuckle	Owm
Lower Arbuckle	Єb



Limestone

Dolomite

Shale

Sandstone

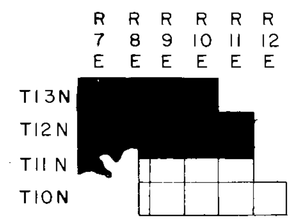
Limestone Conglomerate

Fault—arrows show direction of movement

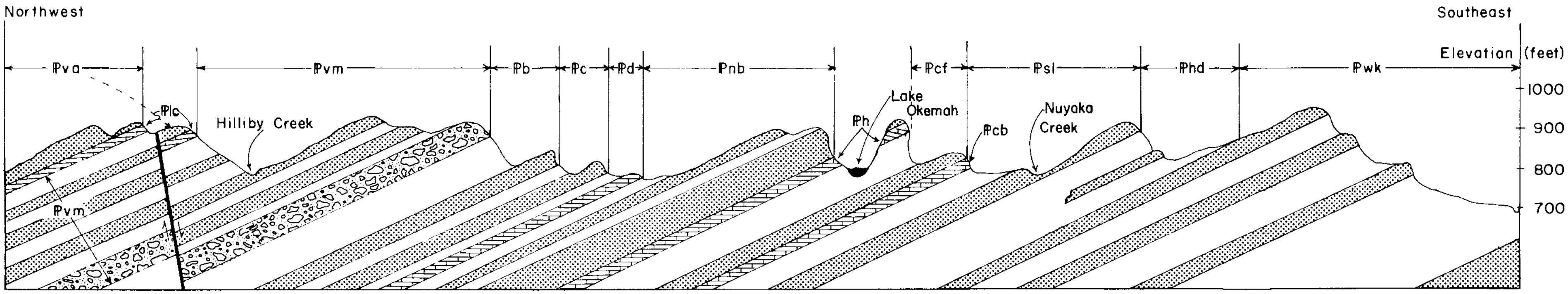
IDEALIZED CROSS SECTION

OKFUSKEE COUNTY

NO. 1

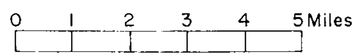


Cross Section Illustrates Shaded Area

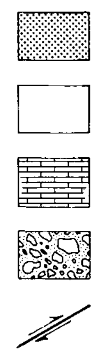


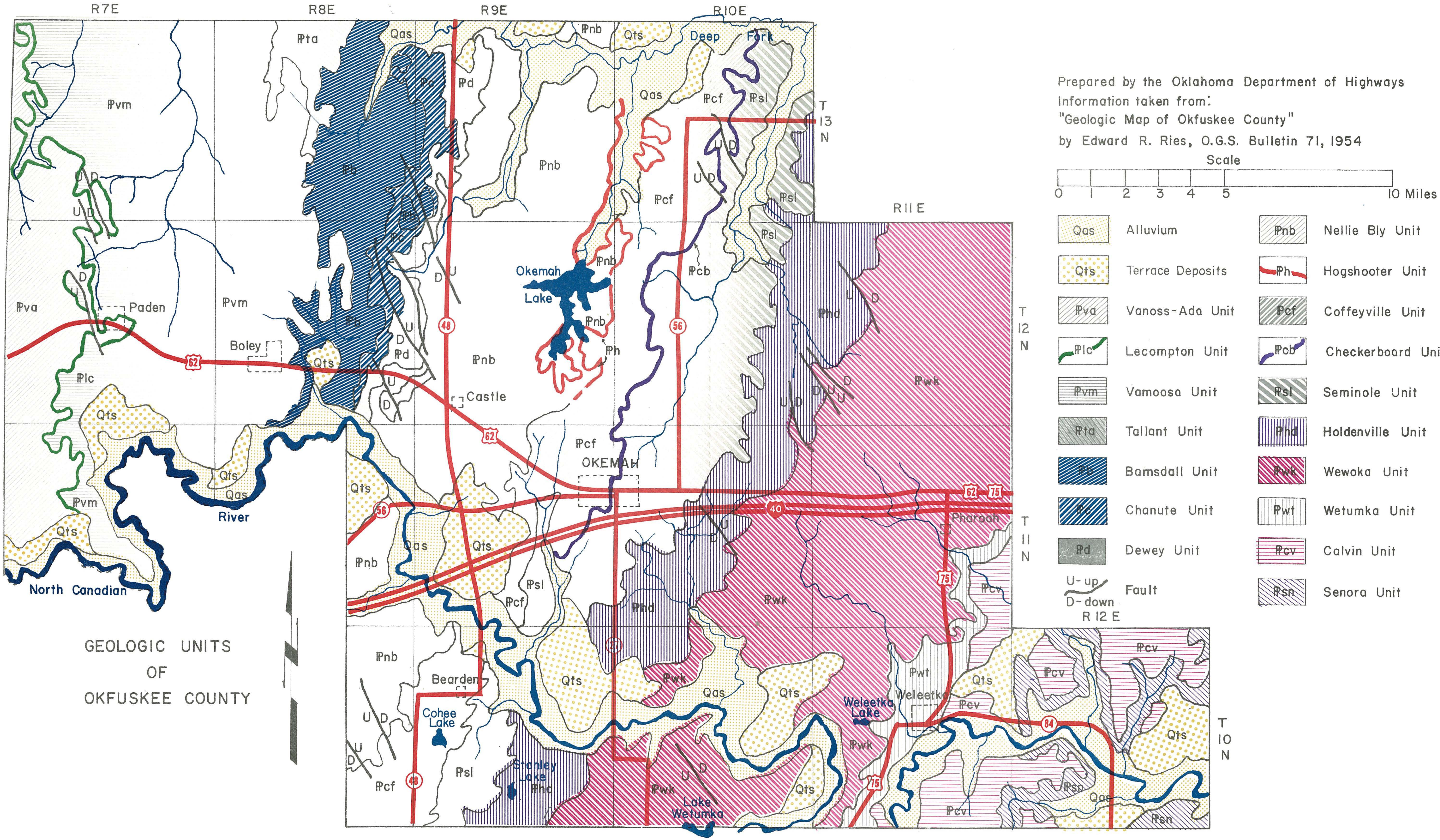
Beds generally dip westward 90 feet/mile, interrupted locally by folds and faults.

GEOLOGIC UNIT	SYMBOL
Vanoss–Ada	Pva
Lecompton	Plc
Vamoosa	Pvm
Barnsdall	Pb
Chanute	Pc
Dewey	Pd
Nellie Bly	Pnb
Hogshooter	Ph
Coffeyville	Pcf
Checkerboard	Pcb
Seminole	Psl
Holdenville	Phd
Wewoka	Pwk



Approximate Scale



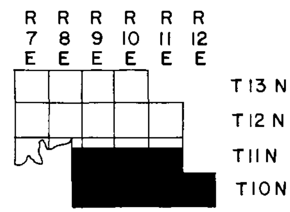


GEOLOGIC UNITS
OF
OKFUSKEE COUNTY

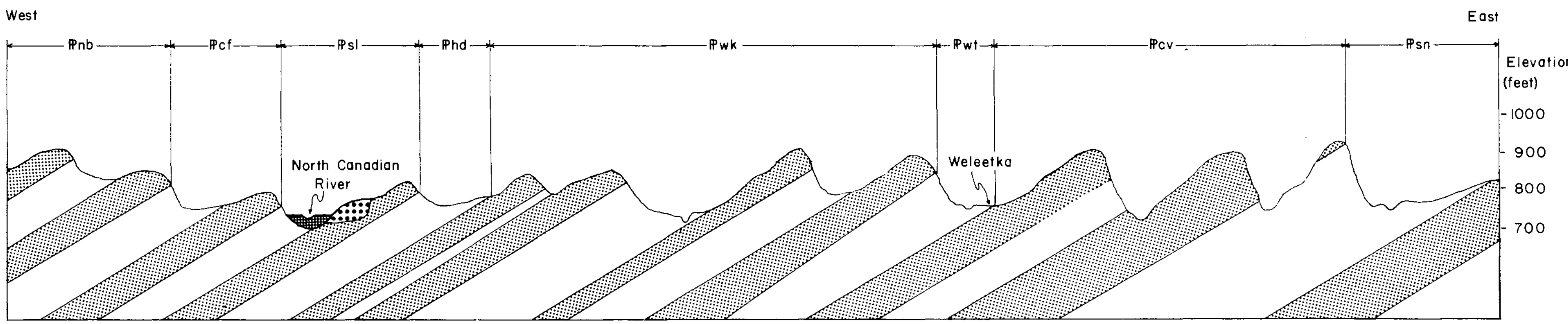
IDEALIZED CROSS SECTION

OKFUSKEE COUNTY

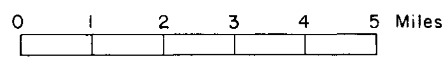
No. 2



Cross Section Illustrates Shaded Area

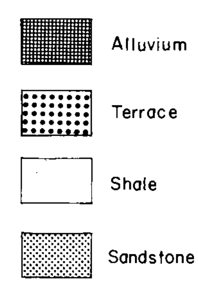


Beds generally dip westward 90 feet per mile.



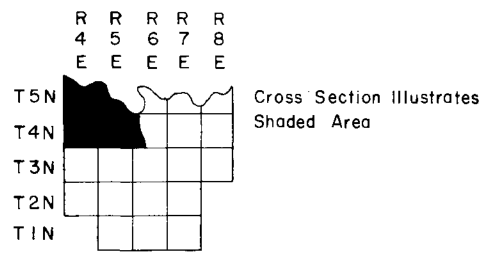
Approximate Scale

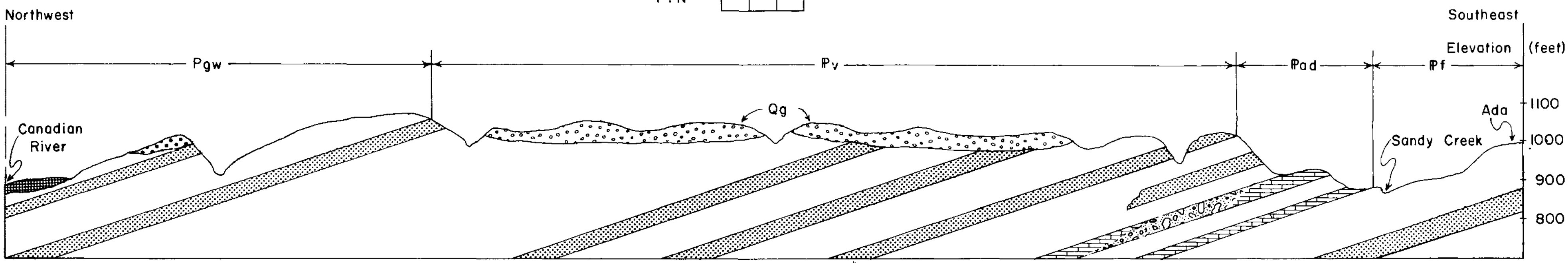
GEOLOGIC UNIT	SYMBOL
Nellie Bly	₽nb
Coffeyville	₽cf
Seminole	₽sl
Holdenville	₽hd
Wewoka	₽wk
Wetumka	₽wt
Calvin	₽cv
Senora	₽sn



IDEALIZED CROSS SECTION

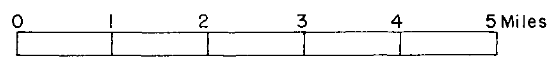
PONTOTOC COUNTY
NO. 1



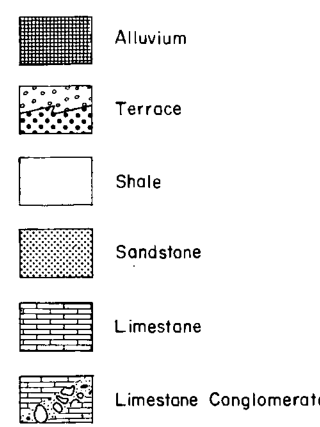


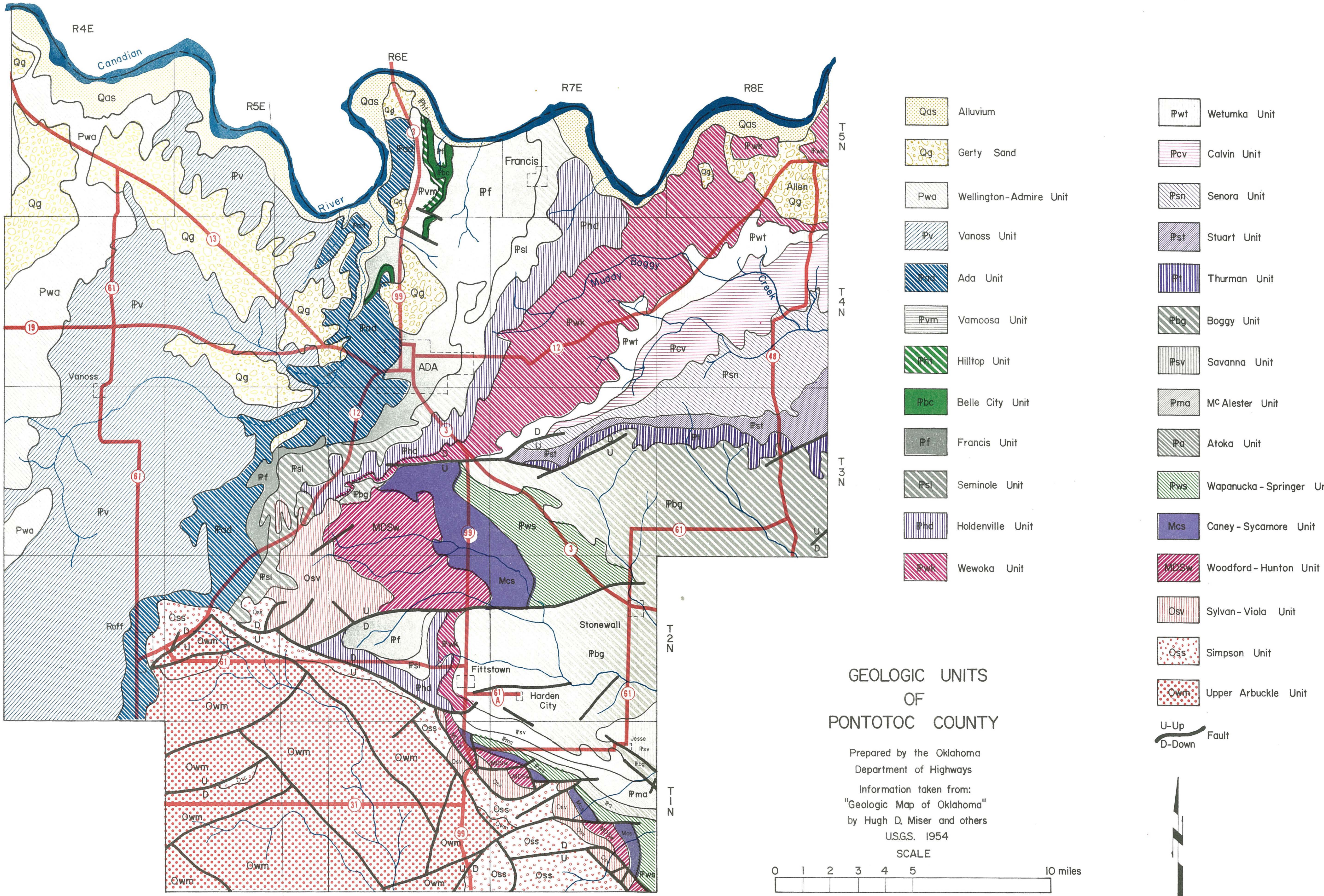
Beds generally dip northwestward 50 to 90 feet/mile.

GEOLOGIC UNIT	SYMBOL
Gerty	Qg
Garber–Wellington	Pgw
Vanoss	Pv
Ada	Pad
Francis	Pf



Approximate Scale

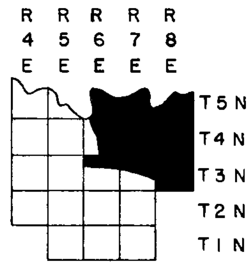



GEOLOGIC UNITS OF PONTOTOC COUNTY
Prepared by the Oklahoma Department of Highways
Information taken from: "Geologic Map of Oklahoma" by Hugh D. Miser and others U.S.G.S. 1954
SCALE
0 1 2 3 4 5 10 miles
Qas Alluvium
Qg Gerty Sand
Pwa Wellington-Admire Unit
IPv Vanoss Unit
IPad Ada Unit
IPvm Vamoosa Unit
IPht Hilltop Unit
IPbc Belle City Unit
IPf Francis Unit
IPsl Seminole Unit
IPhd Holdenville Unit
IPwk Wewoka Unit
IPwt Wetumka Unit
IPcv Calvin Unit
IPsn Senora Unit
IPst Stuart Unit
IPt Thurman Unit
IPbg Boggy Unit
IPsv Savanna Unit
IPma McAlester Unit
IPa Atoka Unit
IPws Wapanucka-Springer Unit
Mcs Caney-Sycamore Unit
MDSw Woodford-Hunton Unit
Osv Sylvan-Viola Unit
Oss Simpson Unit
Owm Upper Arbuckle Unit
U-Up D-Down Fault
R4E
R5E
R6E
R7E
R8E
T 5 N
T 4 N
T 3 N
T 2 N
T 1 N
Canadian River
Muddy Boggy Creek
Francis
ADA
Allen
Vanoss
Roff
Stonewall
Fittstown
Harden City
Jesse

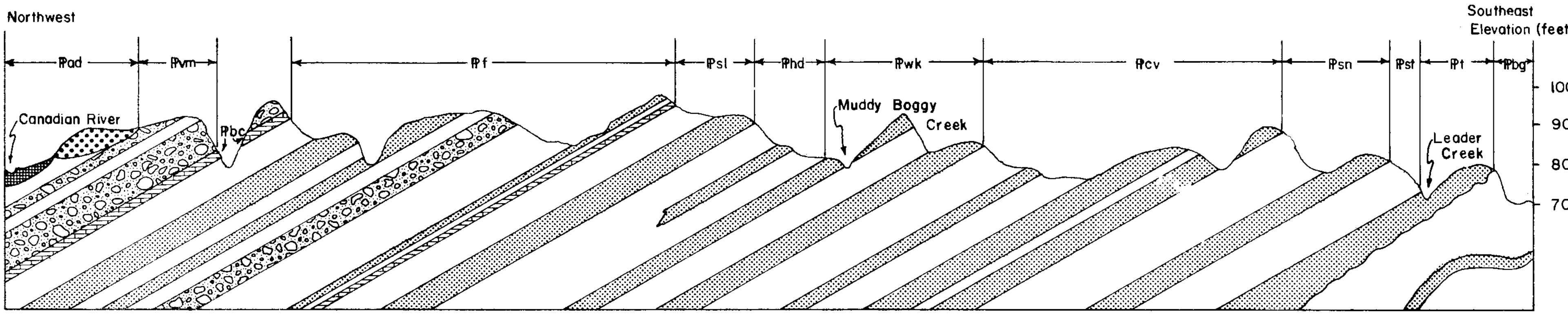
IDEALIZED CROSS SECTION

PONTOTOC COUNTY

NO. 2



Cross Section Illustrates Shaded Area

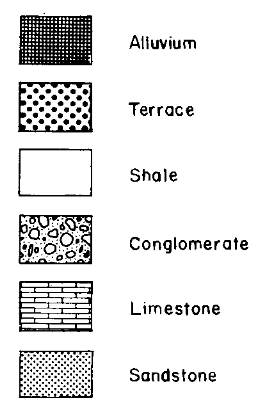


Beds generally dip northwestward 90 feet/mile; dip of IPbg varies.

GEOLOGIC UNIT	SYMBOL
Ada	IPad
Vamoosa	IPvm
Belle City	IPbc
Francis	IPf
Seminole	IPsl
Holdenville	IPhd
Wewoka	IPwk
Calvin	IPcv
Senora	IPsn
Stuart	IPst
Thurman	IPt
Boggy	IPbg

0 1 2 3 4 5 Miles

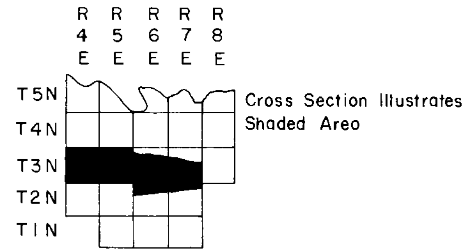
Approximate Scale

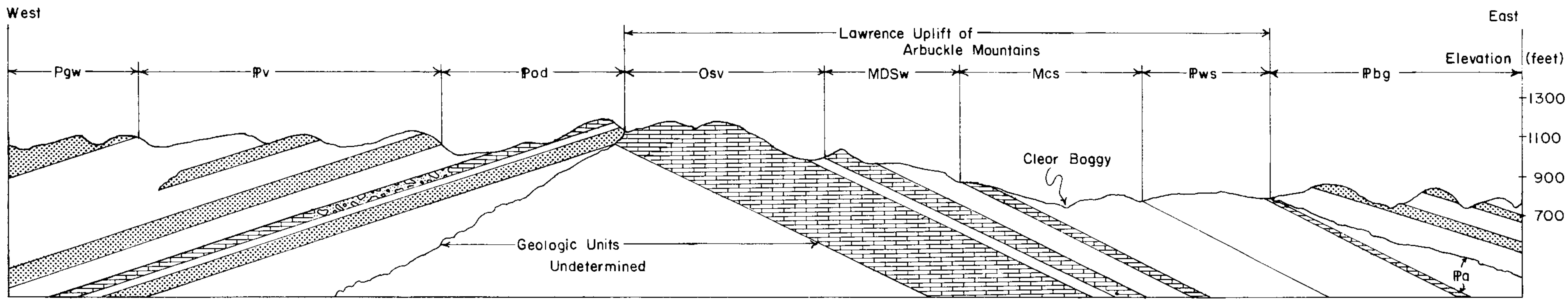


IDEALIZED CROSS SECTION

PONTOTOC COUNTY

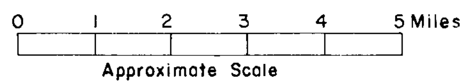
NO. 3

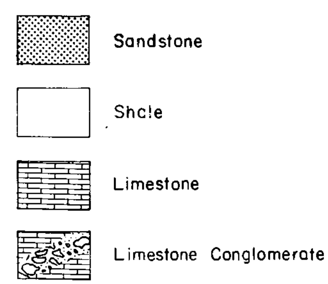




Beds of the Lawrence Uplift dip eastward about 10 degrees.
Beds west of the Uplift dip westward 50 to 100 feet/mile.
Beds east of the Uplift generally dip eastward less than 5 degrees.

GEOLOGIC UNITS	SYMBOL
Garber–Wellington	Pgw
Vanoss	Ꝑv
Ada	Ꝑad
Boggy	Ꝑbg
Atoka	Ꝑa
Wapanucka–Springer	Ꝑws
Caney–Sycamore	Mcs
Woodford–Hunton	MDSw
Sylvan–Viola	Osv



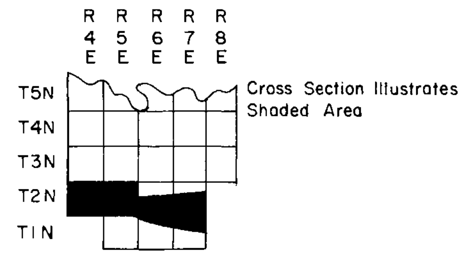


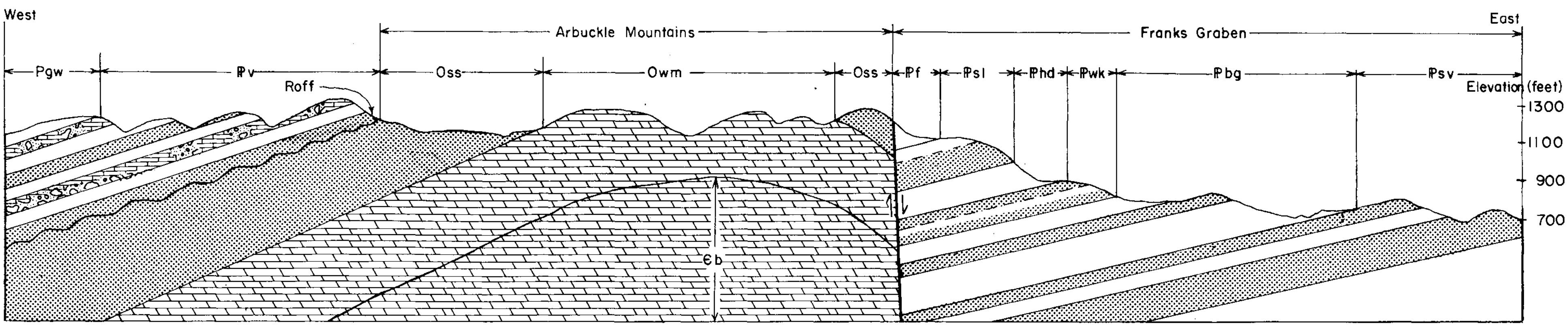
114

IDEALIZED CROSS SECTION

PONTOTOC COUNTY

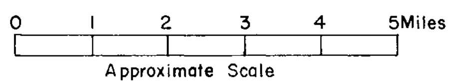
NO. 4

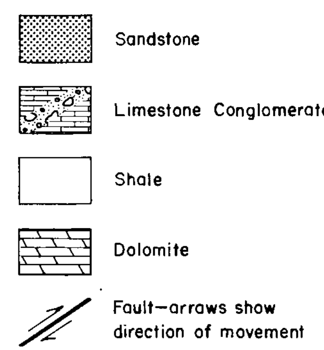




Beds west of the Arbuckle Mountains dip westward 50 to 90 feet/mile. Beds of the Arbuckle Mountains generally dip northwestward less than 20 degrees. Beds in Franks Graben dip gently westward, except near local folds & fault boundaries of the Graben.

GEOLOGIC UNIT	SYMBOL
Garber–Wellington	Pgw
Vanoss	₱v
Francis	₱f
Seminole	₱sl
Holdenville	₱hd
Wewoka	₱wk
Boggy	₱bg
Savanna	₱sv
Simpson	Oss
Upper Arbuckle	Owm
Lower Arbuckle	Єb

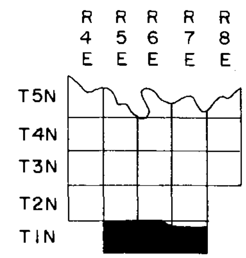


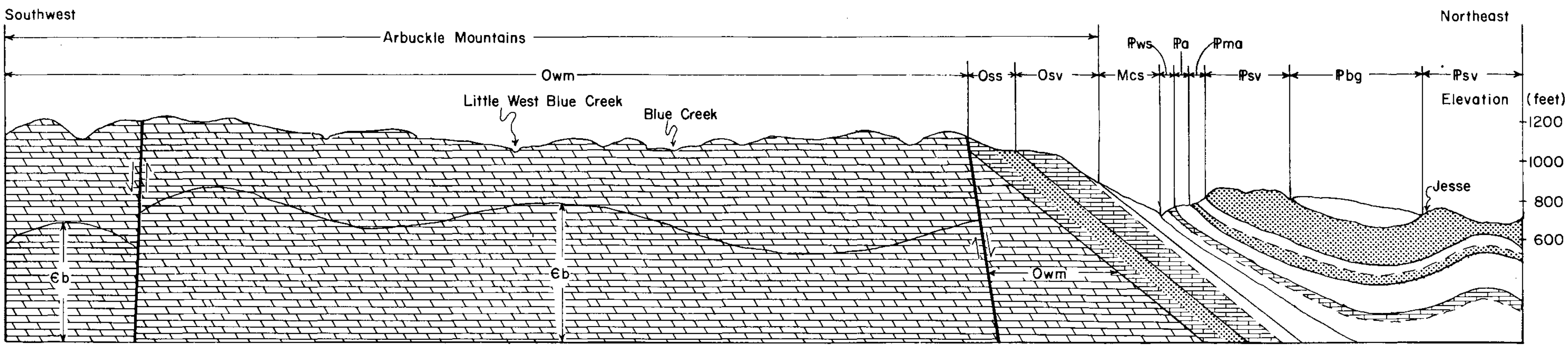


IDEALIZED CROSS SECTION

PONTOTOC COUNTY

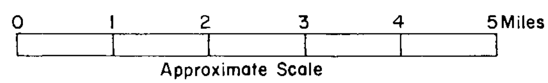
NO. 5

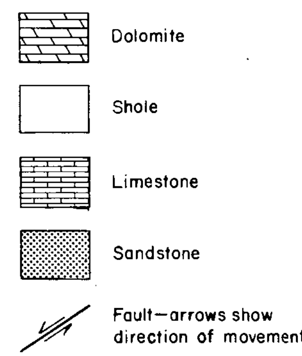




Beds in the Arbuckle Mountains generally dip less than 20 degrees, but locally up to 45 degrees. Beds east of the Mountains generally dip less than 5 degrees; dips of 30 degrees near the Mountains are common.

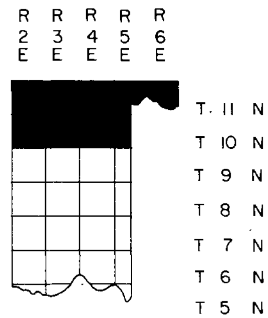
GEOLOGIC UNIT	SYMBOL
Boggy	ℙbg
Sovanna	ℙsv
Mc Alester	ℙma
Atoka	ℙa
Wapanucka–Springer	ℙws
Caney–Sycamore	Mcs
Sylvan–Viola	Osv
Simpson	Oss
Upper Arbuckle	Owm
Lower Arbuckle	Єb



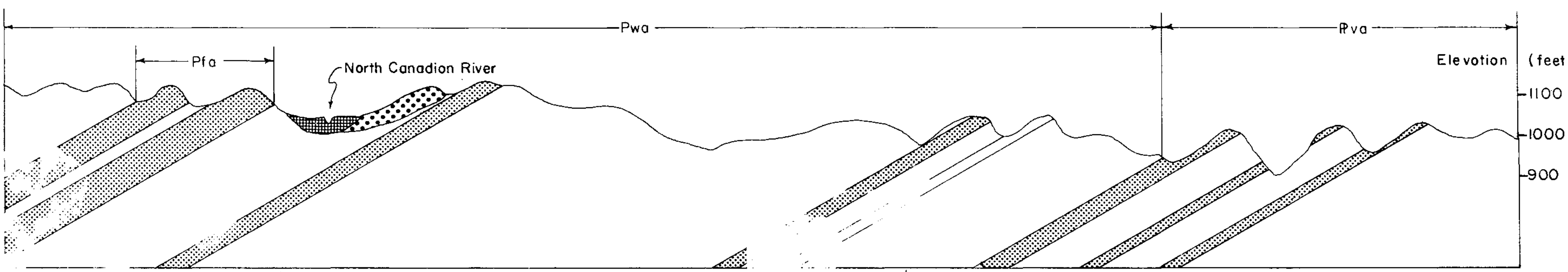


IDEALIZED CROSS SECTION

POTTAWATOMIE COUNTY NO. 1



Cross Section Illustrates Shaded Area

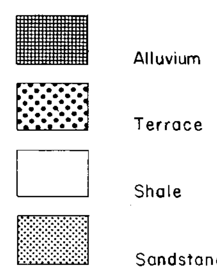


Beds generally dip westward 90 feet/mile.

GEOLOGIC UNIT	SYMBOL
Wellington–Admire	Pwa
Fallis Subunit	Pfa
Vanoss–Ada	Pva

0 1 2 3 4 5 Miles

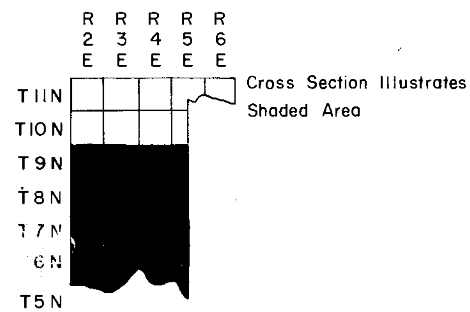
Approximate Scale

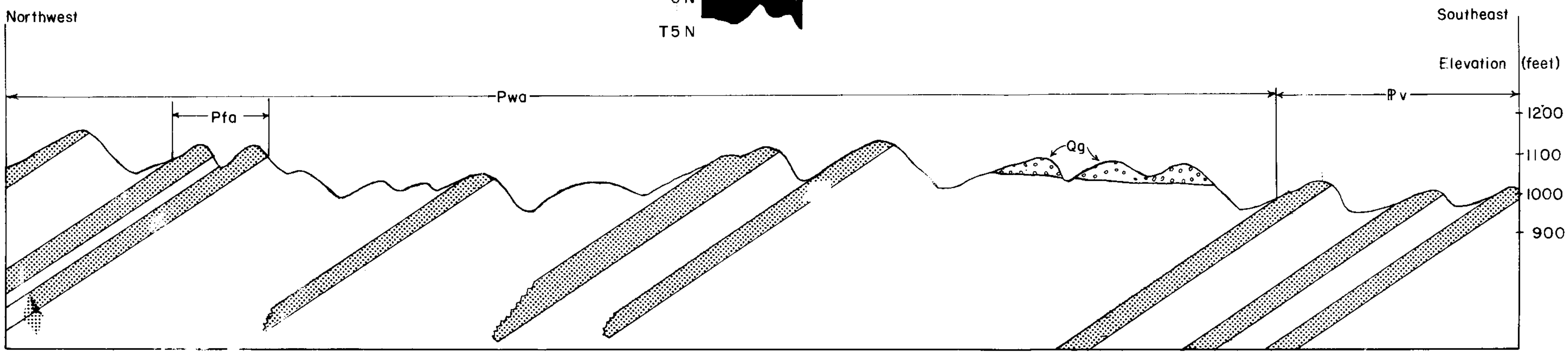


IDEALIZED CROSS SECTION

POTTAWATOMIE COUNTY

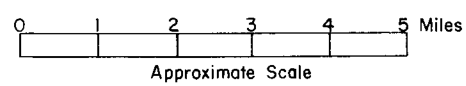
NO. 2

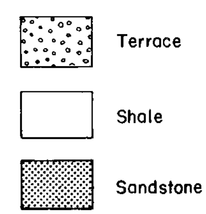




Beds generally dip westward 90 feet / mile.

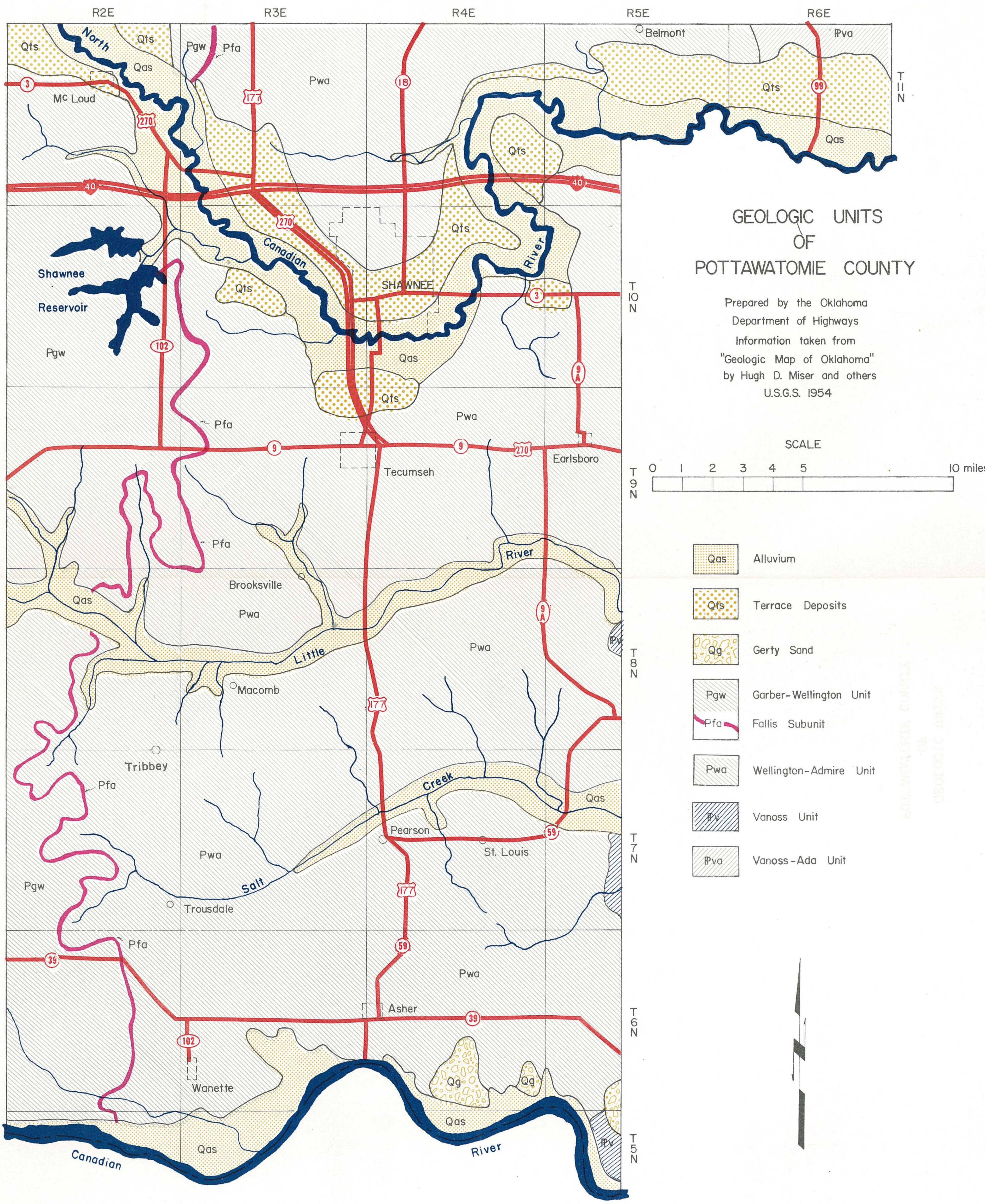
GEOLOGIC UNIT	SYMBOL
Gerty	Qg
Wellington–Admire	Pwa
Fallis Subunit	Pfa
Vanoss	₽v





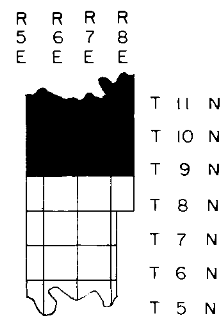
GEOLOGIC UNITS OF POTTAWATOMIE COUNTY

Prepared by the Oklahoma Department of Highways
Information taken from "Geologic Map of Oklahoma" by Hugh D. Miser and others U.S.G.S. 1954

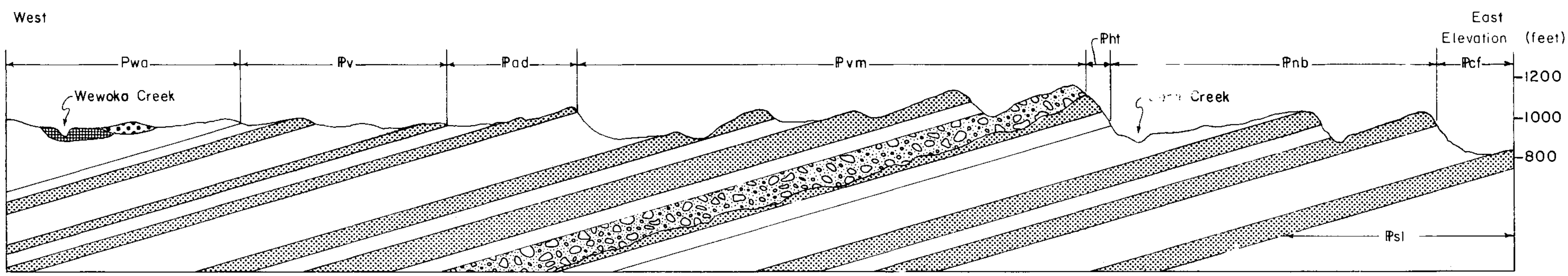


IDEALIZED CROSS SECTION

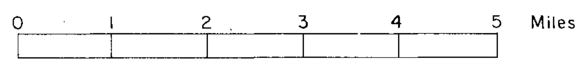
SEMINOLE COUNTY NO. 1



Cross Section Illustrates Shaded Area

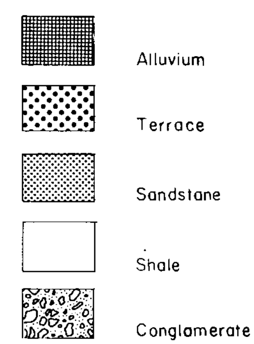


Beds generally dip northwestward 90 feet / mile.



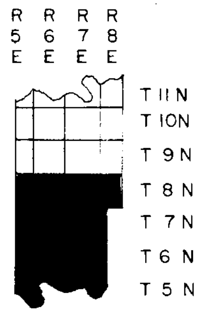
Approximate Scale

GEOLOGIC UNIT	SYMBOL
Wellington-Admire	Pwo
Vanoss	IPv
Ada	IPad
Vamoosa	IPvm
Hilltop	IPht
Nellie Bly	IPnb
Coffeyville	IPcf
Seminole	IPsl



IDEALIZED CROSS SECTION

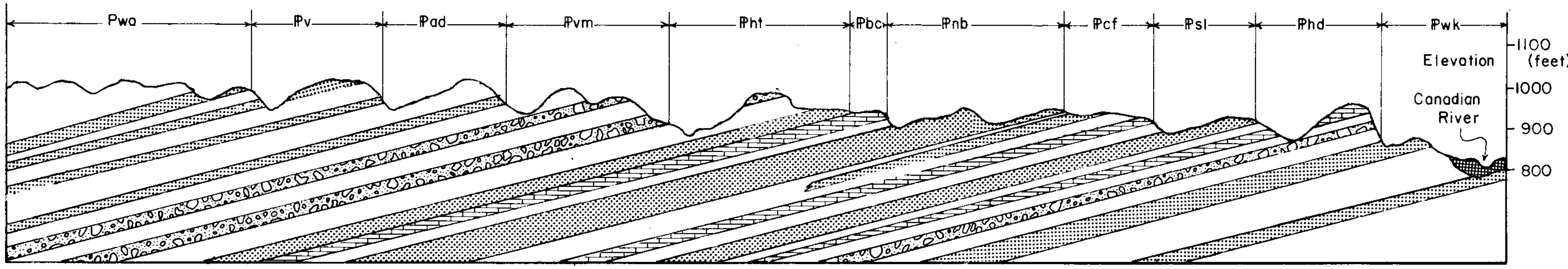
SEMINOLE COUNTY
No. 2



Cross Section Illustrates Shaded Area

Northwest

Southeast.



GEOLOGIC UNIT	SYMBOL
Wellington-Admire	Pwa
Vanoss	Pv
Ada	Pad
Vamoosa	Pvm
Hilltop	Pht
Belle City	Pbc
Nellie Bly	Pnb
Coffeyville	Pcf
Seminole	Psl
Holdenville	Phd
Wewoka	Pwk

Beds generally dip westward about 80 feet/mile.

0 1 2 3 4 5 Miles

Approximate Scale

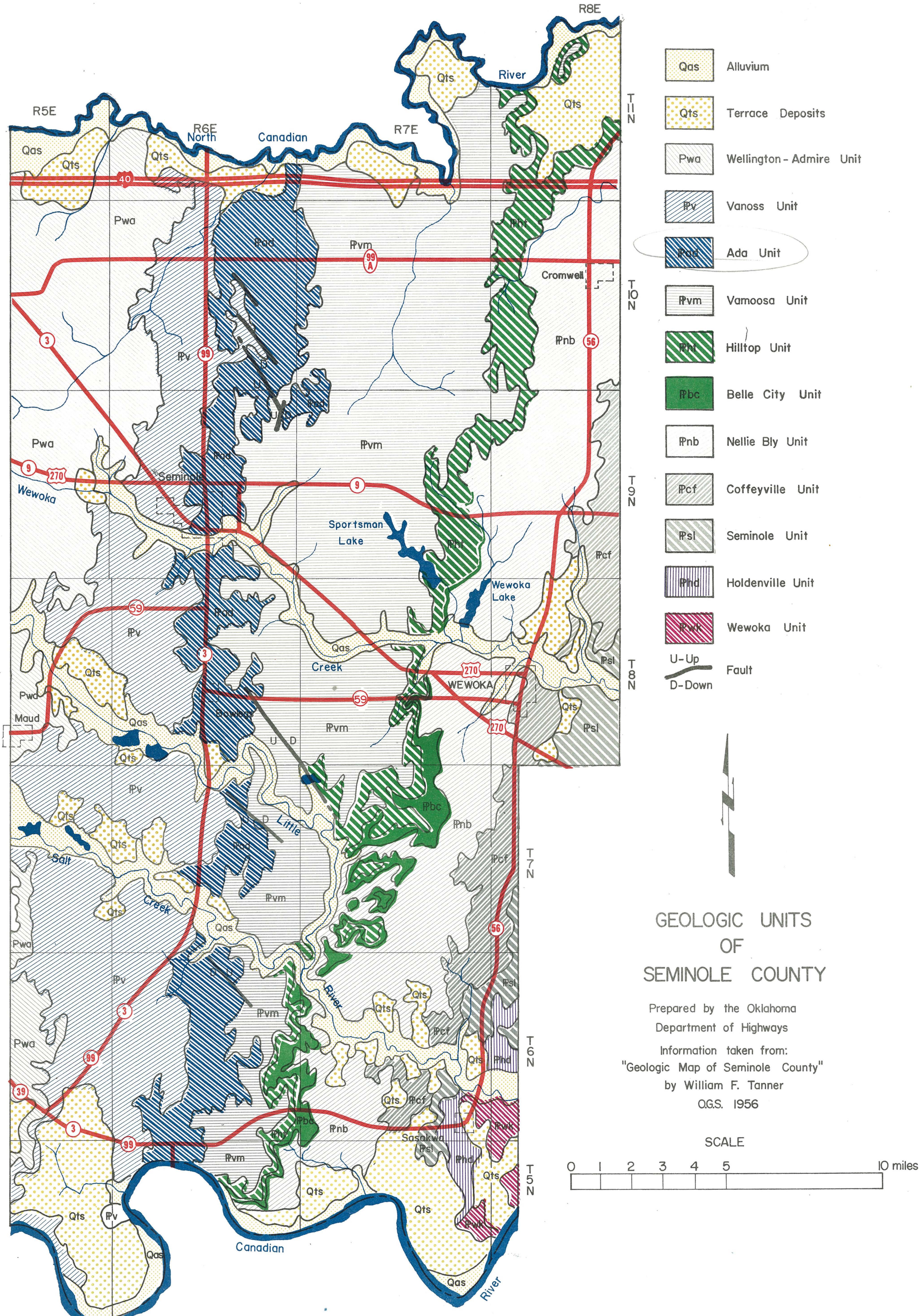
Alluvium

Conglomerate

Shale

Sandstone

Limestone



GEOLOGIC UNITS OF SEMINOLE COUNTY

Prepared by the Oklahoma Department of Highways

Information taken from: "Geologic Map of Seminole County" by William F. Tanner O.G.S. 1956

C H A P T E R I I I

SOILS

GENERAL SOILS INFORMATION

Soil is defined as a natural occurring body of unindurated earth materials consisting of sand, silt, clay, gravel, or mixtures of these. Soil is the product of the action of climate and living organisms upon the geologic materials as conditioned by local relief and time.

The Soil Conservation Service of the Department of Agriculture maps and classifies soil. The "soil series" is the basic unit used for mapping, and it may be defined as a group of soils formed on similar parent material (geologic material) and having, except for the "A" horizon, similar internal characteristics. Important internal characteristics are thickness, structure, color, and texture.

A soil horizon may be defined as a layer of soil approximately parallel to the soil surface. The "A" horizon is commonly called top soil and is the layer from the surface down to a designated depth. Below the "A" horizon is the layer called the subsoil or "B" horizon, and below the "B" horizon is the "C" horizon. At some depth, solid rock or shale will be present, and this is called the "D" or "R" layer. This sequence of soil horizons is called the soil profile. See figure 9 page 122.

Some soils do not have a "B" horizon. The "B" horizon is absent because sufficient time has not passed to allow this horizon to form. These soils may be designated as having an "A" - "C" profile or an "A", "AC", "C" profile.

Soil series are named from a location, usually a town, near where the soil was first identified and mapped; for example, Muskogee series was named from the town of Muskogee. Soil is discussed at greater length in the "Soils Manual", 1961, and "Highway Soils Technology", 1963, prepared by the Research and Development Division, Oklahoma Highway Department.

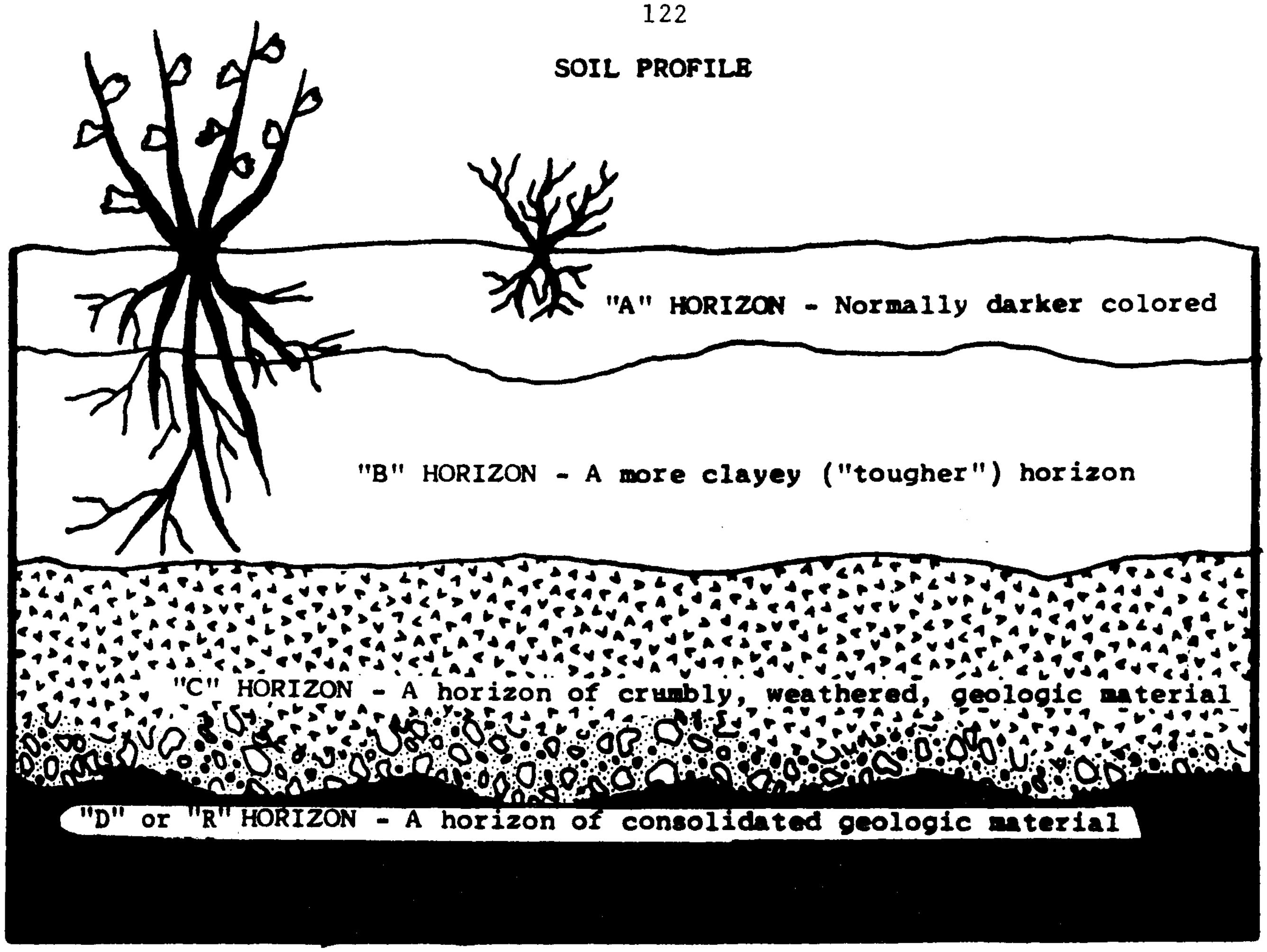


Figure 9

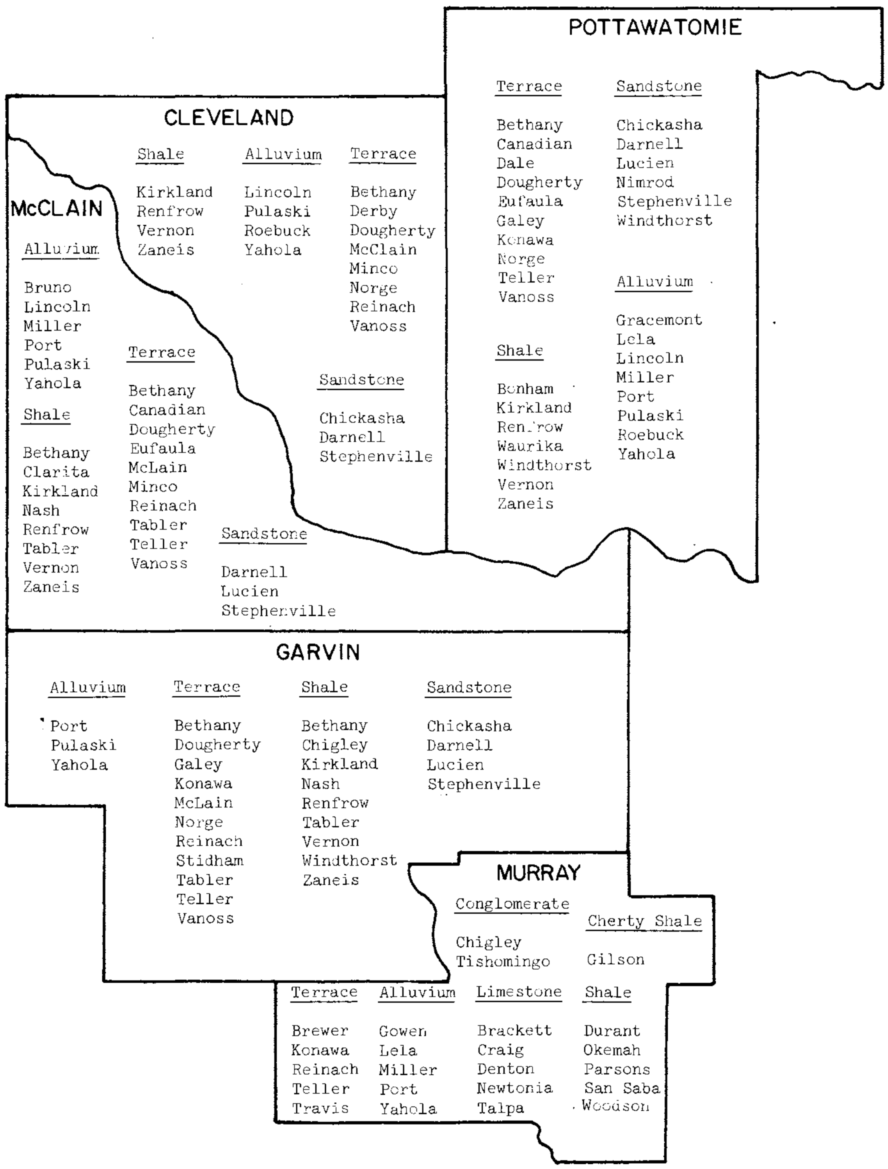
Beginning on page 125 are cross sections illustrating the topographic position, association, and geologic material on which the soil series occur.

Beginning on page 132 the descriptions of the soil series are listed in alphabetical order by name.

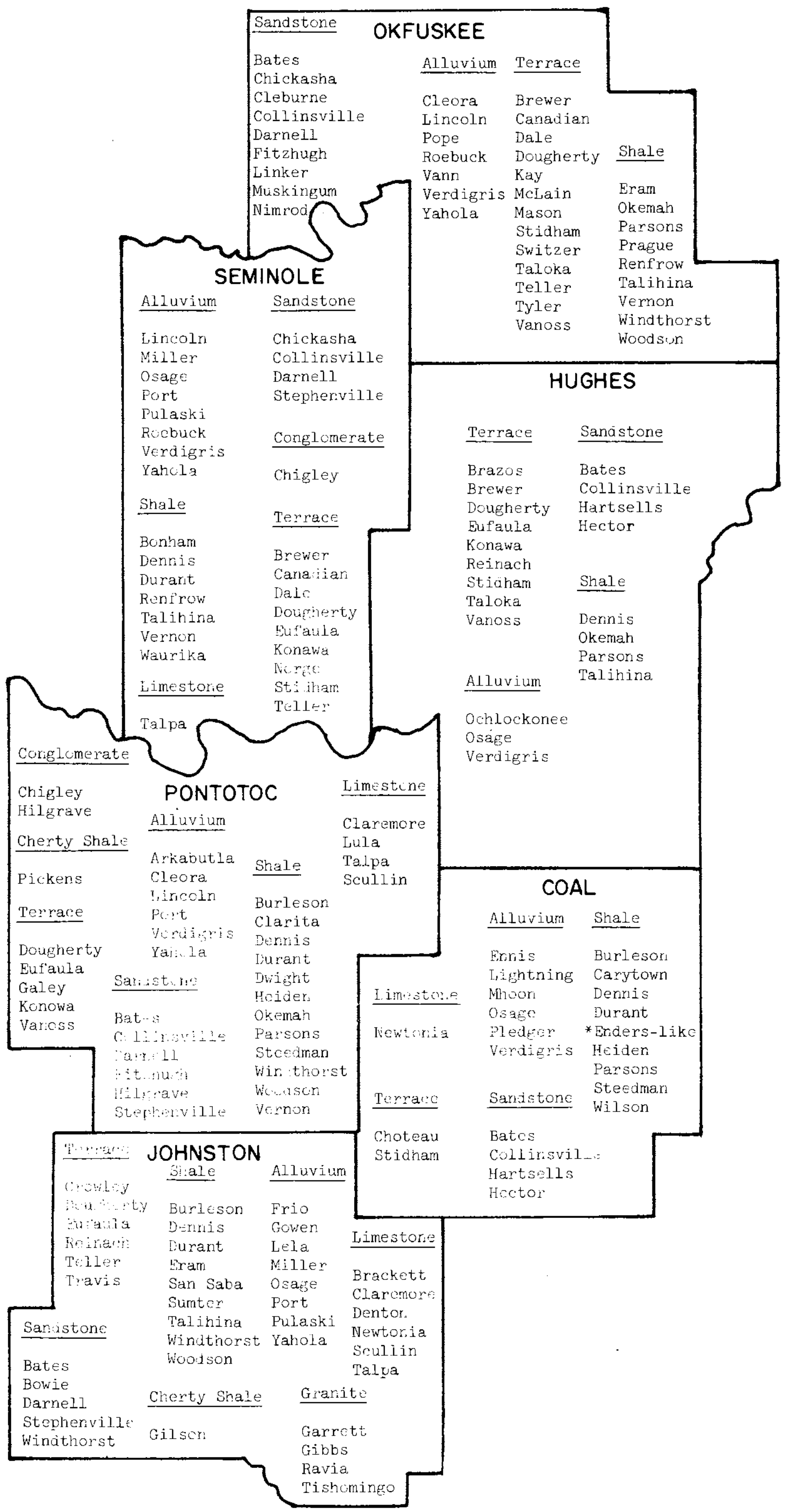
Beginning on page 329 are the charts listing the engineering characteristics of the soil series. These characteristics were determined by laboratory testing, and the methods of determination are the same as used for shales. Refer to Chapter I, page 13.

DIVISION

KNOWN SOIL SERIES AND TYPE OF GEOLOGIC MATERIAL ON WHICH THEY OCCUR

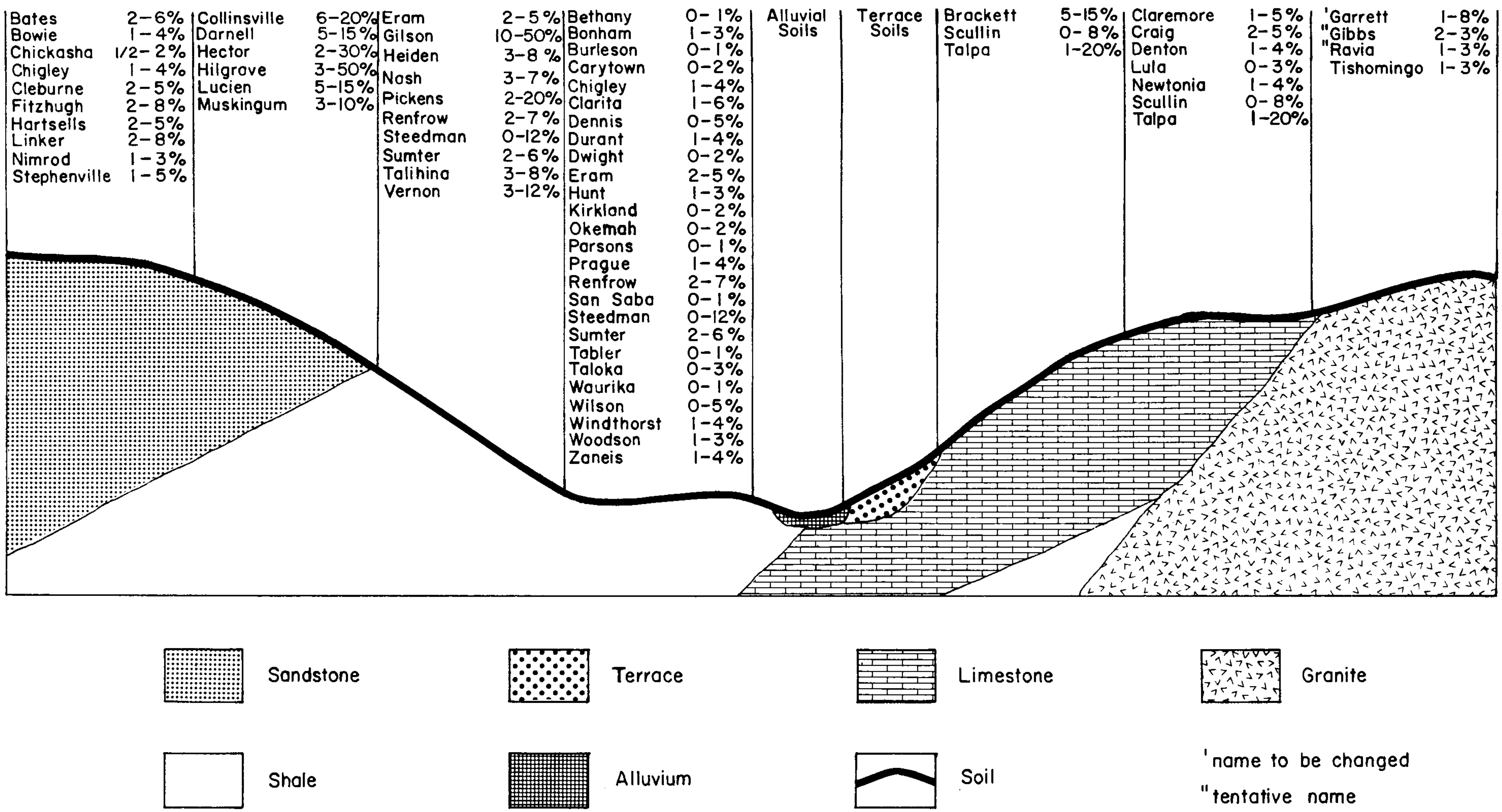


THREE

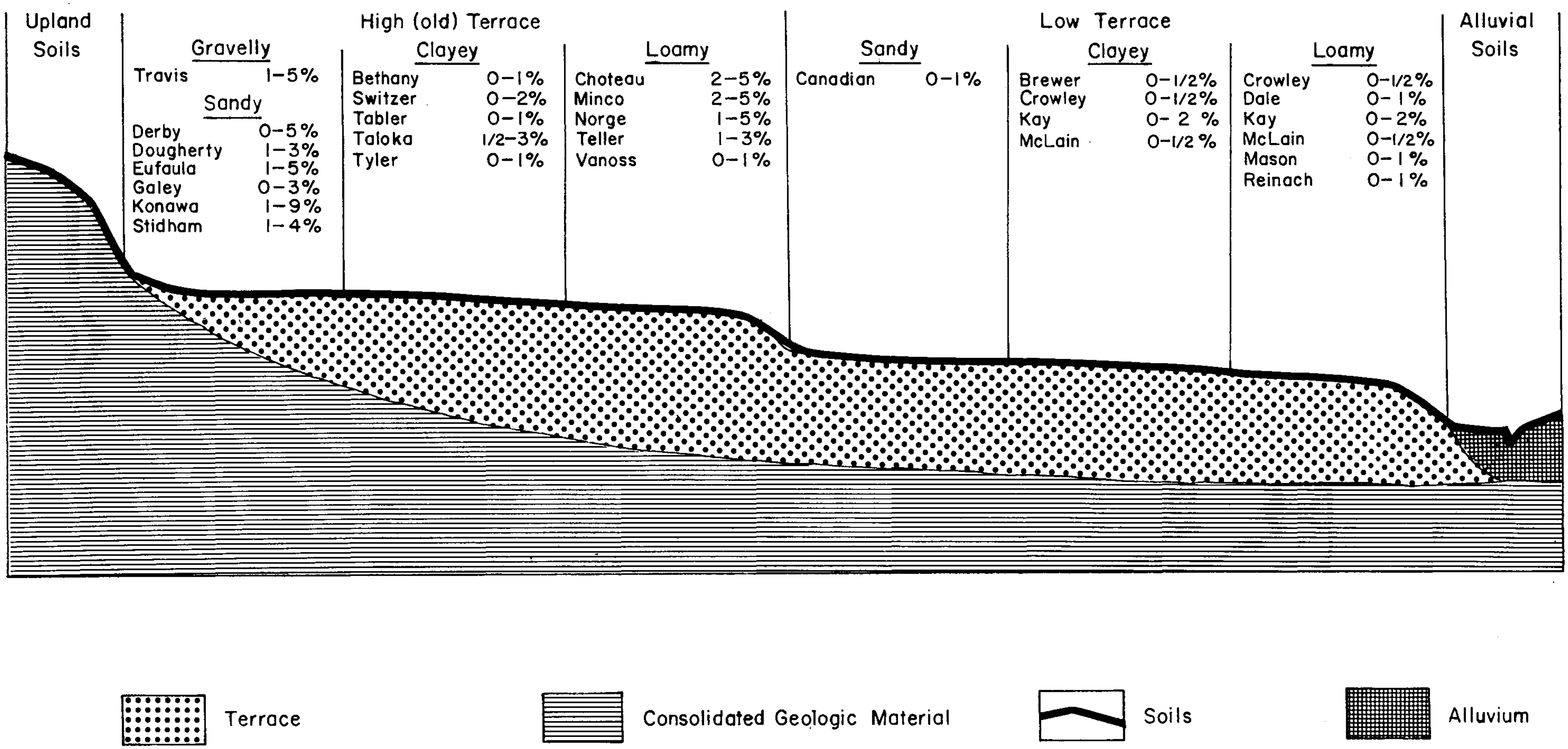


OKFUSKEE
Sandstone
Bates
Chickasha
Cleburne
Collinsville
Darnell
Fitzhugh
Linker
Muskingum
Nimrod
Alluvium
Cleora
Lincoln
Pope
Roebuck
Vann
Verdigris
Yahola
Terrace
Brewer
Canadian
Dale
Dougherty
Kay
McLain
Mason
Stidham
Switzer
Taloka
Teller
Tyler
Vanoss
Shale
Eram
Okemah
Parsons
Prague
Renfrow
Talihina
Vernon
Windthorst
Woodson
SEMINOLE
Alluvium
Lincoln
Miller
Osage
Port
Pulaski
Roebuck
Verdigris
Yahola
Shale
Bonham
Dennis
Durant
Renfrow
Talihina
Vernon
Waurika
Limestone
Talpa
Sandstone
Chickasha
Collinsville
Darnell
Stephenville
Conglomerate
Chigley
Terrace
Brewer
Canadian
Dale
Dougherty
Eufaula
Konawa
Norge
Stidham
Teller
HUGHES
Terrace
Brazos
Brewer
Dougherty
Eufaula
Konawa
Reinach
Stidham
Taloka
Vanoss
Sandstone
Bates
Collinsville
Hartsells
Hector
Shale
Dennis
Okemah
Parsons
Talihina
Alluvium
Ochlockonee
Osage
Verdigris
PONTOTOC
Conglomerate
Chigley
Hilgrave
Cherty Shale
Pickens
Terrace
Dougherty
Eufaula
Galey
Konowa
Vanoss
Alluvium
Arkabutla
Cleora
Lincoln
Port
Verdigris
Yahola
Sandstone
Bates
Collinsville
Darnell
Fitzhugh
Hilgrave
Stephenville
Shale
Burleson
Clarita
Dennis
Durant
Dwight
Heiden
Okemah
Parsons
Steedman
Windthorst
Woodson
Vernon
Limestone
Claremore
Lula
Talpa
Scullin
COAL
Limestone
Newtonia
Terrace
Choteau
Stidham
Alluvium
Ennis
Lightning
Mhoon
Osage
Pledger
Verdigris
Sandstone
Bates
Collinsville
Hartsells
Hector
Shale
Burleson
Carytown
Dennis
Durant
*Enders-like
Heiden
Parsons
Steedman
Wilson
JOHNSTON
Terrace
Crowley
Dougherty
Eufaula
Reinach
Teller
Travis
Shale
Burleson
Dennis
Durant
Eram
San Saba
Sumter
Talihina
Windthorst
Woodson
Alluvium
Frio
Gowen
Lela
Miller
Osage
Port
Pulaski
Yahola
Limestone
Brackett
Claremore
Denton
Newtonia
Scullin
Talpa
Sandstone
Bates
Bowie
Darnell
Stephenville
Windthorst
Cherty Shale
Gilson
Granite
Garrett
Gibbs
Ravia
Tishomingo

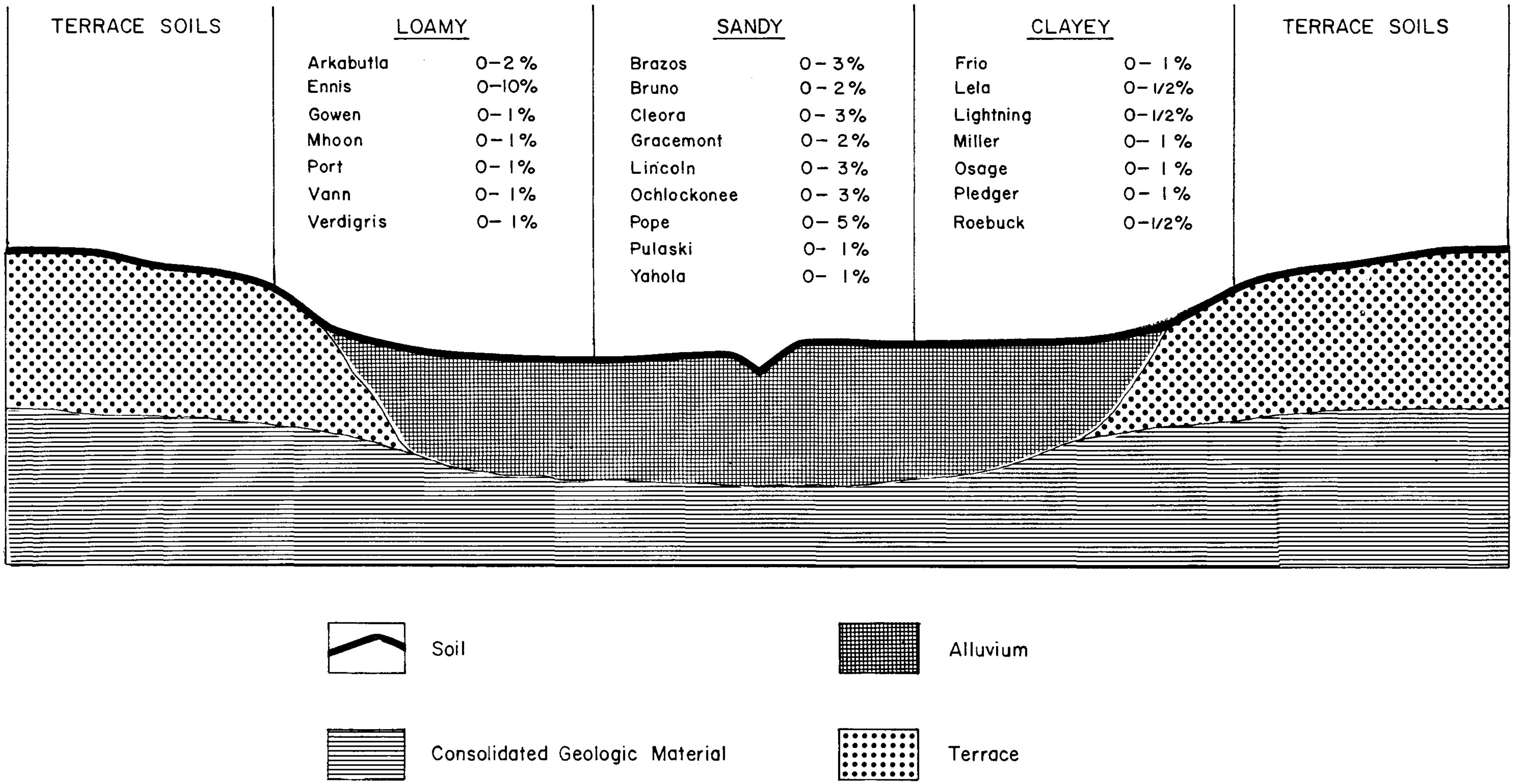
Soils - Geology - Slope (%) Relationships
of
Upland Soils
in
Division 3



Soils – Geology – Slope (%) Relationships
of
Terrace Soils
in
Division 3



Soils – Geology – Slope (%) Relationships
of
Alluvial Soils
in
Division 3



SOILS SERIES DESCRIPTIONS

The known soil series of Division Four are described on the following pages in alphabetical order. The soil series descriptions are written and published by the National Cooperative Soil Survey and U. S. Department of Agriculture. The information is written in such a manner to be used by persons familiar with soils; so for this publication, it is thought a detailed explanation is necessary.

An example description is listed below. The introductory paragraph lists the soil series broad classification name, vegetation, parent material (geologic material), the principal associated soil series, and some differences in soil series that are similar. The color code numbers are taken from the "Munsell Soil Color Charts", 1954 Edition, Munsell Color Company, Inc., Baltimore 2, Maryland, U. S. A.

EXAMPLE DESCRIPTION

Established Series

DENNIS SERIES

The Dennis series comprises deep well-drained prairie soils developed principally from noncalcareous silty or sandy Pennsylvanian "shales" within the grasslands (known as the Cherokee Prairies) in eastern Kansas, eastern Oklahoma, and western Missouri. They are deeply developed soils of about clay loam texture, which are very low in weatherable minerals and have montmorillonite dominant in the clay faction. The sola are generally 3½ to 6 feet deep and characterized by (1) gradational changes between all horizons, (2) relatively thick B_1 or AB horizons, and (3) yellowish B_2 horizons of relatively compact, blocky medium clay loam to light clay mottled with reddish-brown spots and lying (in uneroded areas) more than 16 inches below the surface. As the parent materials become more sandy, the Dennis series grades into Bates soils, which has a less clayey friable B horizon generally underlain by sandstone within 4 feet or less. With increased clay content and an abrupt A-B horizon boundary, the Dennis soils give way to the Parsons series, even though the B_2 horizon may be less yellowish and more clayey than in the latter soils. Dennis soils are more acid and slightly less dark and clayey than the Okemah series. The A horizon is less thick than in Choteau soils and lacks the light colored lower part, or A_2, characteristic of that series. The associated Lithosols are Talihina soils (on shale) and Collinsville soils (on sandstone).

Soil Profile: Dennis silt loam--virgin

Surface

Dry color, Number is color code

A_1 0-15" Dark grayish-brown (10YR 4/2) silt loam becoming heavy silt loam at 10 inches, very dark brown (10YR 2. 5/2) when moist; moderate medium granular structure; friable;
Mainly used for agriculture, insignificant to highways
pH 5.5; gradual boundary.
Number system indicating acidity and alkalinity, 7 is neutral, below 7 is acid, above 7 is alkaline

Down

B_1 15-20" Brown (10YR 5/3) coarse clay loam, dark brown (10YR 4/3) when moist; strong coarse granular or fine subangular blocky structure; firm; pH 5.5; gradual boundary.
Gradual change into the underlying horizon

B_2 20-40" Yellowish-brown (10YR 5/4) fine clay loam, dark yellowish-brown (10YR 4/4) when moist; much mottled with reddish-
Flecks or spots of different color
brown; strong medium irregular blocky structure becoming coarser and more cuboidal with depth; the peds coated with
Natural soil aggregate, insignificant to highways
Thin coating of clay on the peds
distinct continuous clay skins; very firm; some iron concretions present; pH 5.5 above, becoming 6.0 below;
Small pellets of iron oxide resembling buck
gradual boundary. *Shot, Normally hard and dark colored*

The letter designation is not always included - but is sometimes inferred.

Down

B_3 40-60" Coarsely mottled yellowish-brown, strong brown, and very pale brown fine clay loam or coarse clay; moderate coarse blocky structure; very firm; pH 6.0 to 6.5; diffuse boundary.
Difficult to locate

C 60-70"+ Coarsely mottled or banded yellowish-brown and pale brown compact fine clay loam showing obscure bedding planes that become more distinct with depth; noncalcareous; this
Refers to all geologic units with a (P) symbol
represents slightly altered Pennsylvania "shale". The beds are nonfissile and discolored by weathering to depths
Not splitting into thin layers
of more than 15 feet.

R At some depth firm shale would be present. If the geologic material is sandstone, chert, etc. it would also be called the "R" horizon

Range in Characteristics: Texture of A horizon ranges from silt loam to loam; of the B_2 horizon from medium clay loam to fine clay or silty clay. In uneroded areas, thickness of the A horizon ranges between about 10 and 16 inches; depth to the B_2 horizon is between about 16 and 24 inches. Thickness of the B_1 horizon ranges between 2 and 12 inches. Texture of the B_2 horizon ranges from medium clay loam to fine clay or silty clay; the color varies much in details of mottling and becomes 7.5YR hue in local places. Occasional thin layers of sandstone occur in substrata; thin lenses of limestone occur in some exceptional localities. Eroded phases are common on the stronger slopes. Except where specified moist, the colors refer to dry soil.

Topography: Undulating to rolling erosional upland. Slopes of about 1/2 to 10%, mostly 1 to 5%. Surfaces mostly convex.

Drainage and Permeability: Medium to rapid from the surface; slow or very slow internally. The ground water table remains well below the solum. Well drained.

Vegetation: Tall-grass prairie.

Use: Mostly as cropland. Principal crops are small grains, corn, alfalfa, some cotton in the southernmost areas. Moderately to highly productive where uneroded and well managed.

Distribution: Very extensive in the shale prairies of eastern Oklahoma, eastern Kansas, western Missouri, and some in Arkansas.

Type Location: Wagoner County, Oklahoma; 3½ miles NW of Wagoner; 600 feet east and 250 feet north of southwest corner of Section 29, T18N, R18E.

Series Established: Verdi-Grand SCD, Wagoner County, Oklahoma, 1941. The series name is from a village in Labette County, Kansas.

Remarks: Relatively complete analyses are available from three relatively typical profiles (53-OK-59-37, 53-OK-73-20, and 53-OK-73-23) from Pawnee and Wagoner Counties, Oklahoma.

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USA

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ARKABUTLA SERIES

The Arkabutla series is a member of the fine-silty, mixed, acid, thermic family of Aeric Fluventic Haplaquepts. These silty soils have dark brown A horizons and brown upper B horizons mottled with chroma 2 or less overlying light brownish gray lower B horizons.

Typifying Pedon: Arkabutla silt loam - cultivated
(Colors are for moist soil)

Ap 0-6" Dark brown (10YR 4/3) silt loam; common fine and medium distinct light brownish gray (10YR 6/2) mottles; weak fine granular structure; friable; few fine roots; strongly acid; abrupt smooth boundary. 4 to 8 inches thick.

B21 6-16" Dark brown (10YR 4/3) silty clay loam; common medium distinct light brownish gray (10YR 6/2) and few medium distinct brownish yellow (10YR 6/6) mottles; weak fine subangular blocky structure; friable; slightly plastic; few fine roots; few medium black concretions; strongly acid; clear smooth boundary. 8 to 12 inches thick.

B22g 16-40" Light brownish gray (10YR 6/2) heavy silt loam; common medium distinct yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; friable; slightly plastic; common medium black concretions; strongly acid; gradual wavy boundary. 15 to 30 inches thick.

B3g 40-55"+ Light brownish gray (10YR 6/2) heavy silt loam; common fine and medium distinct brown (10YR 5/3) mottles; weak medium subangular blocky structure; friable; slightly plastic; common black concretions; strongly acid.

Type Location: Pontotoc County, Mississippi. 4.5 miles southwest of Pontotoc city limits on Mississippi Highway 341, 300 feet south of Highway 341, NW¼, NE¼, Section 27, T10S, R2E.

Range in Characteristics: Solum thickness exceeds 40 inches. Reaction of the soil ranges from strongly to very strongly acid, except in areas that have had applications of lime. Some pedons below 40 inches may be medium acid. The Arkabutla soils lack a regular decrease of organic matter with depth. The A horizon is in hues of 7.5YR or 10YR, values range from 3 through 5, and chromas from 2 through 4. When moist values are 3.5 or less, the A horizon is less than 6 inches thick. Texture of the A horizon is silt loam, loam, or silty clay loam. The upper B horizon is mottled in shades of brown, yellow, and gray or has a matrix color of brown or yellowish brown with few to many mottles of chroma 2 or less. The Bg horizon has gray or light brownish gray matrix colors mottled with shades of brown and yellow or it is mottled in shades of brown, yellow, and gray. Less than 60 percent of the mass between the Ap and 30 inches has colors of chroma 2 or less. The B horizon texture is silt loam, loam or silty clay loam. Clay content of the 10 to 40 inch control section ranges from 20 to 32 percent clay. Sand content that is coarser than very fine sand is less than 15 percent. Brown and black concretions range from few to many.

Competing Series and Their Differentiae: These are the Commerce, Falaya, Houlka, Mantachie, Rosebloom, and Verona series. Commerce and Verona soils are medium acid to mildly alkaline. Falaya soils have 10 to 18 percent clay in the 10- to 40-inch control section. Houlka soils have more than 35 percent clay in the 10- to 40-inch control section. Mantachie soils have more than 15 percent sand coarser than very fine sand in the 10-to 40-inch control section. Rosebloom soils have colors in more than 60 percent of the mass between the Ap and 30 inches of chroma 2 or less in values 6 or 7 or chroma 1 in values 4 or 5.

Setting: The Arkabutla soils occur in low elevations on stream floodplains on slopes of less than 2 percent. They have formed in silty alluvium. The climate is warm and humid with average annual precipitation of 48 inches and mean annual air temperature of 62^{o}F near the type location.

Principal Associated Soils: These are the competing Falaya, Houlka, Mantachie, Rosebloom, and Commerce soils and the Cascilla, Collins, and Waverly series. The Cascilla soils are browner throughout and are on higher natural levees. Collins soils lack diagnostic subsurface horizons, have bedding planes to a depth of 20 inches and have less than 18 percent clay in the 10 to 40 inch control sections. Waverly soils are predominantly gray immediately below the Ap or A1 horizon and have less than 18 percent clay in the 10 to 40 inch control section.

Drainage and Permeability: Somewhat poorly drained. Runoff is slow. Permeability is moderate.

Use and Vegetation: Most of the Arkabutla soils have been cleared and are used for growing cotton, soybeans, corn, small grains, pasture and hay. The native vegetation is mixed hardwoods.

Distribution and Extent: Arkansas, Kentucky, Louisiana, Missouri, Mississippi, and Tennessee. The series is of large extent.

Series Established: Tate County, Mississippi, 1964.

Remarks: The series was formerly classified in the Alluvial intergrading to the Low Humic Gley great soil group.

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BATES SERIES

The Bates series includes dark-colored friable Prairie soils of the transition zone between the Prairie and Reddish-Prairie soils zones, developed principally in thinbedded sandstones with interbedded sandy and silty shales constituting a minor proportion of the formation. These soils differ primarily from those of the Dennis series in having somewhat coarser-textured subsoils and parent materials. Although in most instances the Bates soils are somewhat shallower to bedrock, they are differentiated from the Dennis soils primarily on the differences in the character of the subsoil. The associated Collinsville soils are Lithosols of the same catena. Fitzhugh soils are similar except that they have redder subsoils and are considered to be Reddish Prairie soils. Chickasha soils are similar except that they are developed on sandy materials of the Red Beds. The principal types now recognized are very fine sandy loam, loam, and fine sandy loam.

I. Soil Profile (Bates loam):

Horizon	Depth	Description	Range in thickness
1. A_1	0-10"	Dark-brown (dry) to very dark brown (moist) 1/ friable loam; crumb structure; medium to slightly acid.	8-12"
2. B_1	10-22"	Pale-brown to light yellowish-brown loam or sandy clay loam with mottles of strong brown and yellowish gray; medium to slightly acid.	10-15"
3. B_2	22-30"	Light brownish-gray friable sandy clay loam or light clay loam mottled with light yellowish brown, noncalcareous.	6-30"
4. C_1	30" +	Interbedded yellowish-brown and yellowish-gray rotten sandstone and somewhat sandy shale with occasional thin strata of siltstone; noncalcareous.	

II. Range in Characteristics: Chiefly minor variations of depth, color and texture; normal depth to layer 4 is 20 to 40 inches; in shallow phases all horizons are thinned, depth of solum is less than 20 inches, and horizon 3 is absent locally.

III. Topography: Undulating to slightly rolling uplands. Gradients commonly range from 2 to 6 percent.

IV. Drainage: Surface runoff is medium to high; permeability, moderate.

V. Vegetation: Prairie grasses, mainly big and little bluestems.

VI. Use: Mostly for growing corn, wheat, and other small grains, sorghums, and cotton. A small proportion of the soils is in native pasture.

VII. Distributed: Western Missouri and eastern Oklahoma and Kansas. Small areas have been mapped in southwestern Wisconsin.
Type location: Labette County, Kansas
Series established: Bates County, Missouri, 1908.

BETHANY SERIES

The Bethany series comprises Reddish Prairie soils of central Oklahoma and other similar grasslands that are closely related to Kirkland and Calumet but differ in having granular permeable A and upper B horizons more than 14 inches deep over dense very slowly permeable clay. They are developed in smooth well-drained areas of upland or high terrace and have substrata of calcareous or alkaline usually reddish clays, silts, or shales. Minco, Vanoss, Norge, and other series developed in aeolian or alluvial mantles are common associates.

Soil Profile: Bethany silt loam

A_1	0-14"	Dark grayish brown (10YR 4/2; 2½/2, moist) silt loam; moderate to strong medium granular; not crusty; friable; slightly acid; grades to next horizon. 10 to 18 inches thick.
B_1	14-18"	Brown (10YR 4/3; 3/2½, moist) silty clay loam; strong coarse granular; no gray film evident, firm; slightly acid to neutral; grades to horizon below. 4 to 8 inches thick.
B_2	18-30"	Brown (10YR 5/3; 3/2, moist) clay; very firm and compact; weakly blocky, the exteriors of the blocks being slightly varnished; extremely hard when dry; neutral to mildly alkaline; grades to horizon below. 10 to 15 inches thick.
B_3	30-54"	Brown (10YR 5/4; 4/3, moist) clay; very firm and compact; noncalcareous but contains a few (2%) small semi-indurated concretions of $CaCO_3$; alkaline. 15 to 30 inches thick.
C_1	54-70"	Red (3YR 5/6) clay mottled with 20% of light brownish gray (10YR or 2.5Y 6/2); slightly less compact than 30-54" layer; grades to horizon below. 10 to 20 inches thick.
C	70-90"	Red (2.5YR 5/6; 4/6, moist) silty clay loam; firm to friable; distinctly less compact than 30-54" layer; noncalcareous; pH 8.5; contains a few ferro-manganese concretions -- no conclusive evidence whether this is alluvium, loess, or residium.

Range in Characteristics: The A horizon ranges from dark grayish brown to brown and from slightly acid to neutral; depth to compact very slowly permeable clay ranges from 14 to 30 inches but generally is less than 20.

Topography: Nearly level uplandor high terrace; gradients dominantly less than 1 percent.

Drainage: Slow from the surface and internally; favorable for alfalfa and other field crops.

Vegetation: Prairie grasses, mainly bluestems.

Use: Almost entirely in cultivation and devoted mainly to wheat, cotton, corn, sorghums, and alfalfa; fertile and productive.

Distribution: Reddish Prairie soil zone; central Oklahoma.
Type location: Oklahoma County, Oklahoma (½ mile north of Wheatland)
Series established: Cleveland County, Oklahoma, 1947.

Bethany series - p.2

Remarks: Prior to establishment of the Bethany series these soils were classified as Kirkland or Galumet. Colors are described with provisional Soil Survey Color names (1947) and unless otherwise stated refer to dry soil.

EHT-HO 2/8/47

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BONHAM SERIES

The Bonham series is a member of the fine, mixed, thermic family of Aquic Argiudolls (Aquolls). These soils have a very dark grayish brown silt loam A horizon and a very dark grayish brown silty clay loam B1t horizon over a dark grayish brown silty clay B2t horizon with mottles of strong brown and grayish brown.

<u>Typifying Pedon</u>:		Bonham silt loam - pasture (Colors are for moist soils unless otherwise noted.)
A1	0-10"	Very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine granular structure; hard, friable; common worm casts; slightly acid; clear smooth boundary. (5 to 12 inches thick.)
B1t	10-17"	Very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; common fine faint brown mottles; moderate medium and fine subangular blocky structure; very hard, firm; common fine pores; distinct clay films about 1/2 value lower than ped interiors; common worm casts; medium acid; gradual wavy boundary. (5 to 10 inches thick.)
B21t	17-30"	Dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5 5/2) dry; many medium distinct mottles of strong brown (7.5YR 5/6), brown (10YR 5/3), and few medium faint mottles of grayish brown (10YR 5/2); moderate medium and fine blocky structure; very hard, very firm; common fine pores; distinct continuous clay films; few worm casts, medium acid; gradual smooth boundary. (10 to 20 inches thick.)
B22t	30-42"	Distinctly and coarsely mottled olive (5Y 5/4) and yellowish brown (10YR 5/4) silty clay; few fine distinct mottles of reddish brown (5YR 5/4); moderate fine blocky structure; extremely hard, very firm; few fine pores; distinct clay films on peds; few fine black strongly cemented FeMn concretions; medium acid; gradual wavy boundary. (8 to 15 inches thick.)
B23t	42-56"	Light olive brown (2.5Y 5/4) silty clay, light yellowish brown (2.5Y 6/4) dry; common medium faint mottles of yellowish brown (10YR 5/4) and pale yellow (5Y 7/4); moderate medium and fine blocky structure; extremely hard, very firm; thin clay films on peds; few fine black strongly cemented FeMn concretions; neutral; gradual wavy boundary. (10 to 20 inches thick.)
B3t	56-66"	Light olive brown (2.5Y 5/3) silty clay, pale yellow (2.5Y 7/3) dry; common fine faint yellow and gray mottles; weak medium and coarse blocky structure; extremely hard, very firm; patchy clay films and few shiny ped faces; few fine black weakly cemented FeMn concretions; mildly alkaline; gradual smooth boundary. (6 to 15 inches thick.)

Page 2--Bonham Series

C 66-75"+ Light olive brown (2.5Y 5/3) silty clay, pale yellow (2.5Y 7/3) dry, common medium distinct mottles of light brownish gray (10YR 6/2) and olive yellow 2.5Y 5/6); massive; extremely hard, very firm; estimated 5 percent by volume of fine and medium strongly cemented $CaCO_3$ concretions; few fine black weakly cemented FeMn concretions; matrix noncalcareous; moderately alkaline.

Type Location: Fannin County, Texas. 225 feet east of a county road, then 72 feet south, from a point 0.7 mile north of intersection of that county road and U.S. Hwy. 82, which intersection is 1.9 miles west of intersection of State Hwy. 121 and U.S. Hwy. 82 in Bonham.

Range in Characteristics: Solum thickness ranges from 60 to 75 inches. Depth to secondary carbonates in the form of soft powdery masses or as ped coatings ranges from 60 to more than 100 inches. Soil temperature ranges from 63° to 72° F. The mineralogy is mixed. The soil is not saturated during any period most years, but is not dry in the 7 to 20-inch layer for as long as 90 cumulative days in most years. The A and B1t horizons range from dark brown to black, hues of 10YR and 2.5Y, values and chromas of less than 3.5. The texture of the A horizon ranges from fine sandy loam to silty clay loam. The texture of the B1t horizon ranges from loam to silty clay loam. Reaction of the A and B1t horizons ranges from slightly to strongly acid. The B21t horizon ranges from dark grayish brown to pale olive, hues of 10YR through 5Y, values of 4 through 6, and chromas of 2 through 4, with few to common mottles of gray and grayish brown. Fine and medium mottles of yellows, browns, and reds range from few to many. The texture of the B2t horizon ranges from heavy silty clay loam to clay, with the upper 20 inches of the Bt horizon ranging from 35 to 50 percent clay. The reaction of the B21t horizon ranges from slightly to strongly acid. The B22t horizon and other lower horizons range from matrix colors of olives and browns in hues of 10YR through 5Y, chromas of 2 through 4, to a mottled matrix of olives, grays, yellows, and browns, chromas of less than 5. Fine and medium mottles with chromas of more than 5 are in some pedons. Reaction of the B22t and lower Bt horizons ranges from medium acid to mildly alkaline. The C horizon ranges from clay to clay loam, sometimes interbedded with shale. The C horizon ranges from mildly alkaline to moderately alkaline, and may be calcareous below 60 inches.

Competing Series and Their Differentiae: These are in the Bernard, Crockett, Dennis, Durant, Eram, Tabler, and Wilson series. Bernard, Crockett, Durant, and Wilson soils have a COLE of more than 0.09 and have montmorillonitic mineralogy. Crockett soils have an abrupt textural change from the A to the Bt horizon and do not have a mollic epipedon. Dennis soils have many coarse mottles with chromas of more than 5 in the lower Bt horizon. Durant and Tabler soils have secondary carbonates within 60 inches of the surface. Eram soils have a solum 20 to 40 inches deep over shale.

Setting: Bonham soils occur on nearly level to gently sloping uplands. Slopes range from 0 to 5 percent, but are dominantly less than 2. They have developed in alkaline clayey and silty sediments and clayey shales. The mean annual air temperatures are about 61° to 70° F.; average annual precipitation of 32 to 45 inches; and Thornthwaite annual P-E indices of 50 to 70.

Principal Associated Soils: These include Crockett and Wilson soils of the competing series, as well as Heiden soils. Heiden soils lack Bt horizons and have intersecting slickensides.

Drainage and Permeability: Moderately well drained. Surface runoff is slow to medium. Internal drainage is slow. Permeability is slow.

Use and Vegetation: Mainly used for growing cotton, corn, sorghums, and small grains. Native vegetation is mainly prairie grasses, such as bluestems, switchgrass, indiangrass and gramas, and scattered mesquite, elm, and hackberry trees.

Distribution and Extent: Mainly in the Blackland Prairies of Texas and southern Oklahoma. Moderately extensive, about 50,000 to 100,000 acres.

Series Established: Fannin County, Texas, 1938.

Remarks: Bonham soils were formerly classified in the Reddish Prairie great soil group. Since no water saturation data is available, the classification is questionable at this time.

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BOWIE SERIES

The Bowie series is a member of a fine-loamy, siliceous, thermic family of Plinthic Paleudults. These soils have fine sandy loam A horizons and a yellowish brown sandy clay loam upper Bt horizon over a mottled yellowish brown, red, and gray lower Bt horizon containing about 25 percent nonindurated plinthite.

Typifying Pedon:		Bowie fine sandy loam - pasture (Colors are for moist soil unless noted otherwise.)
Ap	0-6"	Dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; structureless; soft, very friable; many roots; few worm casts; slightly acid; clear smooth boundary. (2 to 8 inches thick.)
A2	6-12"	Pale brown (10YR 6/3) fine sandy loam, very pale brown (10YR 7/3) dry; structureless; soft, very friable; many roots; common fine pores; few worm casts; slightly acid; clear wavy boundary. (4 to 12 inches thick.)
B21t	12-30"	Yellowish brown (10YR 5/6) sandy clay loam, brownish yellow (10YR 6/6) dry; few fine and medium distinct strong brown and reddish yellow mottles; weak medium subangular blocky structure; hard, friable; common roots; common fine pores; thin patchy clay films on ped surfaces and in pores; few worm casts; few fine strongly cemented, pitted brown iron oxide concretions; strongly acid; gradual wavy boundary (6 to 25 inches thick.)
B22t	30-42"	Yellowish brown (10YR 5/6) sandy clay loam, brownish yellow (10YR 6/6) dry; common medium prominent red and yellowish red mottles; weak medium subangular blocky structure; very hard, friable; few roots; common fine pores; thin patchy clay films on ped surfaces and in pores; 2 percent by volume of nonindurated plinthite; few fine strongly cemented, pitted brown iron oxide concretions; few weakly cemented iron oxide concretions; strongly acid; diffuse wavy boundary. (6 to 20 inches thick.)
B23t	42-60"	Prominently mottled yellowish-brown (10YR 5/6), red (2.5YR 4/8), and gray (10YR 6/1) sandy clay loam; weak medium to coarse subangular and angular blocky structure; very hard, friable; red mottles are brittle, nonindurated plinthite comprising 25 percent of the soil volume; thin patchy gray clay films; few roots in gray areas only; very strongly acid; diffuse irregular boundary. (15 to 40 inches thick.)
B24T	60-78"	Prominently mottled light gray, red, and strong brown sandy clay loam; weak coarse blocky structure; very hard, friable; red mottles are brittle nonindurated plinthite; few clay films pores, and roots; very strongly acid.

Type Location: Panola County, Texas; 116 feet southeast of centerline of Farm Road 999; 1380 feet northeast of entrance to Daniel Memorial Baptist Encampment; 2 miles east of intersection of Farm Roads 999 and 10 in Gary; 10 miles south of Carthage.

Range in Characteristics: The solum ranges from 60 to more than 100 inches thick. Depth to horizons containing more than 5 percent nonindurated plinthite ranges from 30 to 60 inches. Mottles having chromas of 2 or less range from 30 to 60 inches below the soil surface. Strongly cemented to indurated iron oxide concretions less than 1/2 inch in diameter range from none to 5 percent in the upper part of the Bt horizon. The mineralogy of the upper B horizon ranges from 65 to 85 percent quartz and is mixed. The soil is never at the wilting point for as long as 60 con secutive or 90 cumulative days in most years. Base saturation ranges from 5 to 35 percent at 50 inches below the top of the Bt horizon. The Ap horizon ranges from pale brown to very dark grayish brown. The A2 horizon ranges from brown to very pale brown. The texture of the A horizon ranges from light loam to loamy fine sand. Reaction of the A horizon ranges from slightly to strongly acid. Texture of the Bt horizon ranges from heavy fine sandy loam to light clay loam. The upper 20 inches of the Bt horizon has 18 to 35 percent clay, 20 to 40 percent silt, and more than 15 percent sand coarser than very fine sand. The B21t and B22t horizons range from yellowish brown to yellow and strong brown. In most pedons there are few to common mottles of strong brown and red. The B23t and B24t horizons are distinctly to prominently mottled red and gray separated by yellowish brown. Content of nonindurated plinthite ranges from 10 to 35 percent. The structure of the Bt horizon ranges from weak to moderate and subangular blocky to blocky, and clay films range from patchy to nearly continuous. The reaction of the Bt horizon ranges from medium to very strongly acid in the lower part.

Competing Series and Their Differentiae: These are Carnegie, Cowarts, Dothan, and Tifton soils of the same family, varina soils of the same subgroup, and Ardilla, Beauregard, Conroe, Fuquay, Norfolk, Sawyer, and Troup soils of the same great group. Alto, Dothan, Galey, and Segno soils also compete. Carnegie and Cowarts soils have horizons containing more than 10% nonindurated plinthite at depths of less than 24 inches, and Carnegie soils also have more than 5% iron oxide concretions in the upper Bt horizons.

Tifton soils have more than 5% iron oxide concretions in the upper Bt horizons. Varina soils have more than 35% clay in the Bt horizon. Ardilla and Beauregard soils have chromas of 2 or less within 30 inches of the soil surface and Beauregard soils have less than 15% sand coarser than very fine sand in the Bt horizon. Conroe and Fuquay soils have sandy A horizons 20 to 40 inches thick and Conroe soils have more than 35% clay in the Bt horizon. Norfolk, Sawyer, and Troup soils lack horizons containing 10% nonindurated plinthite within 65 inches of the surface. Sawyer soils also have more than 35% clay in some part of the Bt horizon. Troup soils have sandy A horizons 40 to 72 inches thick. Alto, Galey, and Segno soils have more than 35% base saturation in the Bt horizons. Alto soils also have more than 35% clay in the Bt horizon. Galey soils are dry in some horizon between 10 and 40 inches for 90 to 135 cumulative days in most years. Dothan soils have fragipans and more than 5 percent plinthite.

Setting: The Bowie soils occur as nearly level to sloping uplands of the Coastal Plain with slopes generally 1 to 5 percent but ranging from 0 to 12 percent. The regolith consists of thick beds of unconsolidated sediments of sandy clay loams, sandy loams, and sandy clays. The climate is humid with an average annual rainfall ranging from 40 to 60 inches. The mean annual temperature ranges from 62° to 70° F.

Principal Associated Soils: These include Beauregard, Fuquay, Sawyer, Troup, and Alto soils of the competing series, as well as Ruston, Shubuta, Susquehanna, and Lakeland soils. Ruston soils lack plinthite and have Bt horizons with hues redder than 7.5YR. Shubuta soils also lack plinthite, have Bt horizons extending to more than 60" depth and have more than 35% clay. Susquehanna soils have more than 35% clay in the Bt horizon and have chromas of 2 or less in the upper Bt. Lakeland soils are sandy to depths of more than 72 inches.

Drainage and Permeability: Moderately well to well drained; slow to medium runoff; medium internal drainage. Permeability is moderate in the upper Bt horizon and moderately slow in the horizons containing plinthite.

Use and Vegetation: Principal use is for pasture and forest. Pastures are mainly bermudagrass. Small scattered areas are used for growing corn, peanuts, sweet potatoes, peaches, melons, and various other vegetable and fruit crops. Forest vegetation includes loblolly, shortleaf, slash, and longleaf pines, sweetgum, red oak, hickory, dogwood, and holly trees.

Distribution and Extent: Southern Coastal Plain from Texas to Florida. The series is of large extent.

Series Established: Bowie County, Texas, 1918.

Remarks: This soil was formerly classified in the Red-Yellow Podzolic great soil group.

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BRACKETT SERIES

The Brackett series is a member of the loamy, carbonatic, thermic, shallow family of Rendollic Ustochrepts. They are light colored loamy calcareous soils having a solum less than 20 inches thick over chalky limestones and calcareous earth.

Typifying Pedon: Brackett loam - rangeland
(Colors are for dry soil unless otherwise stated)

A1 0-6" Light brownish gray (2.5Y 6/2) loam; grayish brown (2.5Y 5/2) moist; moderate fine and very fine granular and subangular blocky structure, hard; firm; numerous grass roots; many wormcasts of lighter colored material from below; contains about 3 percent of limestone fragments, mostly 5 to 15 mm. in diameter, with the bulk of these on the surface as a "pavement"; estimated $CaCO_3$ equivalent of horizon is about 55 percent; calcareous; moderately alkaline; clear wavy boundary. (3 to 12 inches thick.)

B 6-16" Pale yellow (2.5Y 8/3) loam, pale yellow (2.5Y 7/3) moist; moderate very fine subangular blocky structure; hard, friable; contains many roots; contains about 5 percent, by volume, of subrounded weakly and strongly cemented limestone fragments, mostly 2 to 15 mm. in diameter; common tongues of darker soil from layer above in old root channels or cracks; calcareous, with a few soft masses of $CaCO_3$; $CaCO_3$ equivalent is about 65 percent; moderately alkaline; clear boundary. (4 to 16 inches thick.)

R+C 16-50"+ Thinly interbedded weakly and strongly cemented platy limestone and pale yellow calcareous clay loam; cleavage planes of rock structure are evident in both the limestone and in the soil; few roots in the upper part in vertical crevices of the limestone and between the horizontal plates of the limestone.

Type Location: Bell County, Texas. In a block of rangeland 125 feet north of a county road, from a point 2 miles southeast from its intersection with Farm Road 2410 at Comanche Gap, which is 5 miles southwest of its intersection with U.S. Highway 190, which is 5.3 miles west of intersection of Highway 190 and Interstate Highway 35 in Belton.

Range in Characteristics: The thickness of the solum (A and B horizons) ranges from 9 to 20 inches. Content of coarse fragments in the solum ranges from insignificant amounts of gravel-size limestone to 50 percent by volume of platy, weakly to strongly cemented limestone fragments up to 5 inches across the long axes. The soil (including the C horizon) contains 40 to more than 80 percent calcium carbonate, excluding fragments coarser than 3 inches. Average annual soil temperatures range from 66° to 71.6° F. The soil is dry for 135 to 180 cumulative days in some part below a depth of 7 inches during most years. The A horizon, when dry, ranges from brown to light gray in hues of 10YR and 2.5Y, values 5 to 7, chromas of 1.5 to 3;

texture ranges from gravelly loam to clay loam. The B horizon, when dry, ranges from grayish brown to pale yellow, in hues of 10YR and 2.5Y, values 5 to 8, chromas of 1.5 to 4; texture ranges from gravelly loam to light clay loam. Clay content is 18 to 35 percent. The C and R horizon ranges in colors of light brownish gray to very pale brown, with 25 to 50 percent of the mass made up of the limestone fragments. Mottles occur in some pedons but are not due to wetness. Texture of the fine earth portion varies from loam to light clay loam. The C and R horizon or R layer ranges from limy earths intermingles with limestone to calcareous silty shales, or marls with bedding planes.

Competing Series and Their Differentiae: These include the Altoga, Hext, Karnes, and somervell soils of the same subgroup, and the Dugout, Ector, Eddy, Penrose, and Tarrant soils. Altoga soils have more than 35 percent clay in the 10 to 40-inch control section, and have a solum thicker than 20 inches. Hext and Karnes soils have a solum thicker than 20 inches. Hext soils have less than 18 percent clay from a depth of 10 inches to the paralithic contact or to 40 inches, and have less than 40 percent of any one kind of weatherable mineral. Somervell soils have more than 50 percent of coarse fragments of limestone in the 10- to 40-inch control section. Dugout, Ector, and Tarrant soils have indurated limestone at less than 20 inches below the surface; in addition, Ector and Tarrant soils contain more than 50 percent of limestone fragments in the solum. Eddy soils lack a B horizon. Penrose soils have mean annual soil temperatures of 59° F or less.

Setting: Brackett soils occur on undulating to hilly erosional uplands with gradients ranging from 3 to 30 percent, mostly between 5 and 15 percent. The regolith is interbedded soft limestones and marly earth of the lower Cretaceous but minor areas occur over chalk, silty shales and caliche. Alternation of more resistant beds of limestone with the softer strata of marly earth gives a benched topography in many areas. The mean annual precipitation is 24 to 37 inches, annual P-E indices about 35 to 56 and mean annual air temperatures of 64° to 70° F.

Principal Associated Soils: Altoga, Bolar, Dugout, Maloterre and Tarrant soils are common associates in the soils developed in Lower Cretaceous materials. Austin soils are associates where Brackett soils developed in Upper Cretaceous materials. Bolar soils have an epipedon with moist values less than 3.5 and the solum is thicker than 20 inches. Maloterre soils have a lithic contact with limestone. Austin soils have clay contents greater than 35 percent in the control section and the solum is over 20 inches thick.

Drainage and Permeability: Well drained. Runoff is rapid. Permeability is moderately slow.

Use and Vegetation: Mainly used for grazing. Originally prairie grasses, dominantly little bluestem and grama. Woody vegetation includes juniper trees, ill-scented sumac, with scattered live oak and Spanish Oak trees.

Page 3--Brackett Series

Distribution and Extent: Texas, Grand Prairie and Edwards Plateau areas of central and south central Texas. Extensive; several hundred thousand acres.

Series Established: Kinney County, Texas (Reconnaissance Soil Survey of Southwest Texas) 1911. The name is from Bracketville, Texas.

Remarks: The Brackett soils were classified in the 1938-49 classification system in the Lithosol great soil group. Lincoln Soil Survey Laboratory data are available on two profiles: Lab. Nos. 18133-18136 in Gillespie County, Texas and Lab. Nos. 18137-140 in Blanco County, Texas.

National Cooperative Soil Survey
USA

Established Series

BRAZOS SERIES

The Brazos series is of youthful Alluvial soils weakly developed in stratified, somewhat reddish calcareous alluvium of such streams as the Brazos, Red, and Canadian Rivers of Texas and Oklahoma. These soils occur mainly in the zone of Reddish Prairie soils on low youthful terraces or high rarely-flooded bottoms of streams that drain grasslands underlain by red beds. They are closely related to Reinach soils but have more sandy loose subsoils. The surface soil is more darkened and more thoroughly leached of free carbonates than in the Lincoln and Yahola series.

Soil Profile: Brazos silt loam

A_1 0-15" Brown (7.5YR 4/3; 3/3, moist) silt loam; very friable; moderate medium granular; neutral. 12 to 25 inches thick.

C 15-50"+ Light reddish-brown (5YR 6/4; 5/4, moist) calcareous, loose loamy fine sand stratified with thin seams of silt and clay.

Range in Characteristics: Color of surface soil ranges from brown to reddish-brown (hues 5YR and 7.5YR; values 4 and 5; chromas 2 to 4) being least dark in the sandiest types; reaction of surface soil ranges from calcareous to neutral; texture of subsoil ranges from sand to loam, very fine sand.

Topography: Level and nearly level areas, mostly of convex surface, on low terraces and high bottoms, mostly along major streams.

Drainage: Slow from the surface; rapid internally; inundated rarely or at intervals averaging more than 10 years.

Vegetation: Flood-plain forest generally with considerable ground cover of coarse grasses.

Use: Largely cropland or former cropland now retired to pasture; droughty and only moderately productive owing to the very sandy subsoil of low waterholding capacity; cropland on the more sandy types is susceptible to soil blowing.

Distribution: Low terraces and high bottoms along the Red, Brazos, Canadian, and like streams in Texas and Oklahoma; mainly in the zone of Reddish Prairie Soils; relatively inextensive.

Type Location: McLennan County, Texas, in Brazos bottoms 7 miles north of Waco.

Series Established: McLennan County, Texas, 1947.

Remarks: Prior to 1947, these soils were included in the Reinach series. The series name is taken from the Brazos River. Colors are described with Provisional Soil Survey Color names (1947) and unless stated otherwise, refer to dry soil.

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USA

Established Series

BREWER SERIES

The Brewer series consists of slowly-drained, weakly-illuviated Prairie soils (Brunizems) developed in reddish, calcareous, moderately clayey sediments under tall grass vegetation and temperate, moist-subhumid, continental climate. The series occurs on undissected alluvial terraces, recent to Late Pleistocene in age, along streams that drain subhumid plains on Red Beds. The profile is comparatively youthful for the regional environment--darker, more granular, and less illuviated than prevails on nearby smooth but freely drained erosional upland. The Brewer series differs from Irving soils in having darker and less grayish (lower value, higher chroma) A and B horizons, more granular and less crusty A horizon, less textural contrast and much more gradational change between the A and B horizons, less compact or blocky B horizon, and generally more reddish substrata. The solum is darker; is darkened to greater depth; and has a slightly coarser, less blocky, and less compact B_2 horizon than the Bethany series, which occurs on older surfaces. The profile is more clayey, is less deeply leached of bases, and has more evident horizonation than the Lonoke series, which occurs under higher rainfall. Brewer soils have more of a textural profile, are darker in the A_1 horizon, are darkened to greater depths, and are deeper to calcareous material and to reddish colors than McLain soils. Commonly found in immediate association with Brewer soils are the Vanoss, Teller, Reinach, and Port series. The Brewer series is of moderate extent and agricultural importance.

Soil Profile: Brewer clay loam

A_1 0-12" Very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate to strong medium granular structure; friable; medium acid; (pH 6.0); gradual boundary.

B_{21} 12-30" Very dark grayish-brown (10YR 3/2) heavy silty clay loam, very dark brown (10YR 2/2) when moist; strong subangular blocky structure, fine in the upper part gradually coarsening to medium size in the lower half; firm; peds have lustrous exteriors and probable thin, continuous, clay films; probably slowly permeable; pores and open rootlet channels are moderately numerous; slightly acid in upper part becoming neutral at about 24 inches; gradual boundary.

B_{22} 30-50" Dark brown (7.5YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate coarse subangular blocky structure; probably thin clay films; firm; moderately alkaline; (pH about 8); gradual boundary.

B_3 50-80" Reddish-brown (5YR 4/3) heavy silty clay loam; dark reddish brown (5YR 3/3) when moist; weak coarse subangular blocky structure; firm; moderately alkaline; (pH about 8); gradual boundary.

C 80-90"+ Reddish-brown (5YR 4/4) heavy silty clay loam, dark reddish brown (5YR 3/4) when moist; firm; contains fine concretions of $CaCO_3$ but the fine earth is mostly noncalcareous.

Range in Characteristics: Texture of the A horizon is mostly silty clay loam but in many places it is clay loam, in some others, it is silt loam or loam, and probably in a few places, it is sandy loam. The plow layer of cultivated areas is generally weakly granular and dark grayish-brown. The A_1 horizon below tillage has color values of 2.5 to 4, when moist, chromas of 1.5 to 2.5 and hues of 7.5YR to 10YR. Texture of the B_2 horizon ranges from heavy clay loam to silty clay (from about 33 to 45% clay). Depth to material redder than 7.5YR hue ranges between 30 and 75 inches; to color less dark than a value of 5 or moist value of 3.5, between about 24 and 70 inches; to the uppermost lime concretions, between about 24 and 100 inches. Locally, mostly in slightly depressional sites, some mottling with grayer and browner shades occurs below 2 feet.

Topography: Nearly level low terraces and high flood plains. Surfaces plane to weakly concave. Surface gradient rarely more than 1/2%.

Drainage and Permeability: Slow from the surface and internally but generally adequate without artificial drainage for excellent yields of such crops as corn and alfalfa. The ground water table is generally within 20 feet. It rises to near the surface during occasional cool wet seasons or during the immediately following floods. Most areas lie above overflow from adjoining streams; some, however, are inundated as frequently as once per 5 years.

Vegetation: Tall grass prairie, probably dominantly of big bluestem, switch grass, and Indian grass with subordinate little bluestem and also with some slough grass in the more depressional areas.

Use: Very largely in cultivation, mainly to corn, alfalfa, small grains and (in the more southern areas) cotton. Of high natural fertility, very productive, and highly valued for cropland.

Distribution: South-central Kansas to east-central Texas along the Arkansas, Cimarron, Canadian, Washita, Red, and Brazos Rivers and various tributaries. Mainly in parts of eastern Oklahoma having annual precipitation of between 35 and 42 inches. The total extent is several hundred thousand acres.

Type Location: Pawnee County, Oklahoma; 200 feet east and 900 feet north of the SW corner of Section 29, T22N, R5E (1/2 mile north of Pawnee on east side of Oklahoma Highway 18 in northern margin of the valley floor along Black Bear Creek).

Series Established: Muskogee County, Oklahoma, 1913.

Remarks: As used in published soil survey based on work done prior to 1941, the Brewer series included a number of soils outside of the present range. These are chiefly the Lela, Lonoke, Irving, and McLain series. Virtually none of the Brewer clay of published surveys is included in the series as now defined. Excepting that shown as Kay clay, most of the soils classed as Kay series in published soil surveys would now be classed as Brewer soils.

The available analyses on Brewer soils include (1) mechanical analyses, pH and organic carbon in profile 51-OK-59-13, Brewer clay loam from Pawnee County, Oklahoma, and (2) like analyses on Kay and Brewer soils reported in the published soil surveys of Noble, Okfuskee, and Grant Counties, Oklahoma.

Bruno fine sandy loam, 0 to 1 percent slopes (15H)

The dominant soil of this mapping unit is typically calcareous and has a brown fine sandy loam A horizon that grades to a light brown loamy fine sand C horizon.

Typifying Profile:		Bruno fine sandy loam, 0 to 1 percent slopes. (15H) (Colors for dry conditions unless otherwise noted).
A1	0-15"	Brown (7.5YR 5/4) find sandy loam, dark brown (5YR 4/4) when moist; weak fine granular structure; slightly hard, very friable; calcareous; gradual boundary. 10 to 20 inches thick.
C	15-72"+	Light brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 5/4) when moist; weakly coherent massive soft; very friable; calcareous.

Typical Location: 1000 feet north and 300 feet west of the south quarter corner of Section 3, T8N, R3W on photo 2DD-109, F-5.

Range in Characteristics: A horizon: The color ranges in hues of 7.5YR and 10YR with dry values of 5 to 6 and chromas of 3 to 4. Texture is fine sandy loam or very fine sandy loam. C horizon: The color ranges in hues of 7.5YR and 10YR with dry values of 6 to 7 and chromas of 3 to 6. The texture ranges from loamy fine sand to loamy very fine sand. Locally there are thin strata, usually below 36 inches, of nearly any texture from fine sand to clay loam.

Inclusions: About 10% of a similar soil with a light reddish brown (5YR 6/4) loamy very fine sand C horizon. About 10% dunes that usually have a calcareous A horizon about 12 inches thick and a calcareous fine sand C horizon. Both horizons are usually hue of 10YR. About 5% small depressed spots 12 to 24 inches lower than the surrounding soil. These spots range in texture from fine sandy loam to clay loam and are darker in color than the typical profile.

Competing Series and their Differentiae: These include Lincoln, Canadian and Reinach. Lincoln is more sandy with thinner and lighter colored A horizon. Canadian and Reinach are less sandy.

Setting: This mapping unit consists of a nearly level low bench a few feet above overflow along the South Canadian River. Locally there is micro relief with dunes and/or potholes. The soil is developed in calcareous sandy sediments.

Principal Associated Soils: These include Canadian fine sandy loam, Reinach loam and McLain clay loam.

Bruno fine sandy loam, 0 to 1 percent slopes (15H)

Drainage and Permeability: Well drained. Moderately rapid permeability. Water table is 4 to 10 feet except in potholes and dune areas.

Use and Vegetation: Native vegetation is scattered trees such as cottonwood, elm, pecan, walnut and willow and tall grasses. Some has been cleared and a few areas have been cultivated. Mostly used for pasture.

Distribution: Parallel to the South Canadian River along the north edge of the County.

W.A.S. 1/68

BURLESON SERIES

The Burleson series comprises members of a fine montmorillonitic, thermic family of Udic Pellusterts. These clayey soils have very dark gray A horizons thicker than 12 inches over alkaline AC and C horizons that gradually become more olive with depth. Intersecting slickensides occur below 20 inches depth.

Typifying Pedon: Burleson clay - rangeland
(In microdepression, 4 feet from its center; colors are for dry soil unless otherwise noted.)

A11 0-20" Very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; gray (10YR 5/1) hard surface crust about 1/8 inch thick; weak coarse blocky structure breaking to moderate fine angular blocky; extremely hard, very firm; shiny pressure faces on peds; few very dark brown, strongly cemented FeMn concretions 1 to 3 mm. in diameter; slightly acid, diffuse wavy boundary. (6 to 30 inches thick.)

A12 20-40" Very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; common coarse intersecting slickensides breaking to moderate fine and medium angular blocky structure; extremely hard, very firm; shiny pressure faces on peds; common parallelepipeds with the long axes tilted about 45° from the horizontal; few very dark brown, strongly cemented FeMn concretions 1 to 3 mm. in diameter; slightly acid; diffuse wavy boundary. (6 to 30 inches thick.)

AC 40-55" Dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; few coarse distinct mottles of light olive gray (5Y 6/2); few streaks of very dark gray clay from horizon above; distinct intersecting grooved slickensides; distinct parallelepipeds tilted 30° to 60° from horizontal; shiny pressure faces on peds; extremely hard, very firm; few FeMn concretions as in horizon above; few fine strongly cemented $CaCO_3$ concretions; mildly alkaline and noncalcareous in matrix; diffuse wavy boundary. (8 to 40 inches thick.)

C 55-70" Distinctly and coarsely mottled light olive gray (5Y 6/2) and pale olive (5Y 6/4) clay; few distinct slickensides and parallelepipeds as in horizon above; extremely hard, very firm; few dark FeMn concretions as in horizon above; few strongly cemented $CaCO_3$ concretions; few soft masses of $CaCO_3$; calcareous in matrix; moderately alkaline.

Type Location: Burleson County, Texas. In native grass pasture, 800 feet northeast and 200 feet southeast of Snook High School, 0.5 mile southeast of intersection of F.R. 2155 and F.R. 60 in northwest edge of Snook.

Range in Characteristics: Thickness of solum ranges from 36 to 100 inches, with more than 70% of the pedon exceeding 48 inches in thickness. The soil is usually moist between depths of 7 and 20 inches, but when dry the soil has cracks 1 to 10 cm. wide at a depth of 20 inches; cracks open and close each year and remain open for 90 to 150 cumulative days during most years. In virgin areas gilgai microrelief consists of microknolls 3 to 10 inches higher than the microdepressions; distance from the center of the microknoll to the center of the microdepression ranges from about 5 to 12 feet. Intersecting slickensides begin at depths ranging from 20 to 30 inches below the soil surface. The texture is clay throughout and the clay fraction is dominated by montmorillonitio clays. Average annual soil temperatures are about 65^{o} to 71.6^{o} F. When dry, the A horizon has a gray to light gray, hard, surface crust 1/16 to 1/2 inch thick. The A horizon, when dry ranges from gray to very dark gray, hues of 10YR to 2.5Y, moist color values are 3.5 or less and chromas are less than 1.5. Thickness of the A horizon varies with the microrelief, being thinnest on the microknolls and thickest in the microdepressions. The reaction of the A horizon ranges from medium acid to moderately alkaline, but is noncalcareous in the matrix. The AC horizon, when dry, ranges from dark gray to gray and has mottles ranging from few to common, faint to distinct in shades of gray, brown, olive, and yellow. In most pedons old cracks are filled with darker material from the Al horizon. The C horizon ranges from dark gray to olive gray with mottles in shades of olives, browns, and yellows. The reaction of the AC and C horizons ranges from mildly alkaline and noncalcareous to moderately alkaline and calcareous.

Competing Series and Their Differentiae: These include Houston Black and Randall soils of the same family; San Saba and Ticocana soils of the same subgroup. Ellis, Garner, Heiden, Lake Charles, Montell, Roscoe and Wilson soils also compete. Houston Black soils are less crusty and more crumbly than Burleson soils, and are calcareous throughout below a depth of 12 inches. Randall and Tiocana soils lack the olive colors in the AC horizon and are less crusty than Burleson soils; in addition, Tiocana soils have average annual soil temperatures of more than 71.6^{o} F. San Saba soils are underlain by limestone bedrock within 40 inches. Ellis soils do not have intersecting slickensides and have an A horizon with chromas of more than 1.5. Garner soils have A horizons less than 12 inches thick if moist color values are 3.5 or less. Heiden soils have chromas of more than 1.5 in the A horizon and are calcareous throughout. Lake Charles soils do not have cracks that remain open for as long as 90 cumulative days. Montell and Roscoe soils have cracks that remain open for more than 150 cumulative days; in addition, Montell soils have average soil temperatures higher than 71.6^{o} F. and have more than 15% saturation with sodium in some horizon. Wilson soils have a Bt horizon.

Setting: Burleson soils occupy nearly level to sloping upland and stream terraces. Slopes are mainly less than 2 percent, but range up to 5 percent. The regolith consists of alkaline clayey sediments. The climate is warm and subhumid; the average annual precipitation ranges from 28 to 42 inches; the mean annual air temperatures are about 63^{o} to 70^{o} F.; and Thornthwaite P-E indices of 44 to 64.

Principal Associated Soils: These are Houston Black, Heiden, and Wilson soils.

Drainage and Permeability: Moderately well drained. Surface runoff is slow; water enters the soil rapidly when it is cracked, and very slowly when it is moist. Permeability is very slow.

Use and Vegetation: Nearly all cultivated and used for cotton, sorghums, and corn. Few areas in range grasses of buffalograss, sideoats grama, and bluestems.

Distribution and Extent: The Blackland Prairies of Texas. The series is extensive.

Series Established: Brazos County, Texas, 1951.

Remarks: Formerly classified as a Grumusol.

National Cooperative Soil Survey
USA

CANADIAN SERIES

The Canadian series comprises youthful brown or dark-brown soils having very friable subsoils in which the clay content is less than about 25%. These soils occur in the Reddish Chestnut and the western or drier part of the Reddish Prairie soil zones on low terraces along such streams as the Canadian River that flow through the Sandy Tertiary deposits of southern Kansas, western Oklahoma, and northwestern Texas. The Canadian soils are less reddish than the Reinach soils, have more sandy subsoils than the Tipton soils, and include little or no admixture of sediments form red beds.

I. Soil Profile (Canadian very fine sandy loam):

				Range in thickness
1.	A	0-15"	Brown (10YR 4/2.5; 3/2.5 moist) sandy loam; weakly granular and crushed material is less (about 1 value) dark than uncrushed; very friable; slightly alkaline but noncalcareous.	10-18"
2.	C_1	15-25"	Pale-brown (10YR 6/3; 5/4, moist) very fine sandy loam; structureless but freely permeable; very friable; generally calcareous and never acid.	0-20"
3.	C_2	25"+	Pale-yellow or very pale brown loamy fine sand stratified with more silty and sandy layers.	

II. Range in Characteristics: Very fine sandy loam, silt loam, and loam are the principal types but small areas of nearly every other texture occur; color of surface soil ranges from grayish brown (10YR 5/2) to dark brown (10YR 3/3), the heavier types being the darkest; reaction of all layers ranges from neutral to strongly alkaline.

III. Topography: Nearly level, low stream terraces; gradient of surface is generally 1% or less.

IV. Drainage: Mostly internal, which is free to rapid; depth to water table ranges from 5 to 30 feet.

V. Vegetation: Coarse bunch grasses, mainly little and big bluestem and Indian grass.

VI. Use: Almost entirely in cultivation and devoted to general farm crops, mainly cotton, corn, sorghums, wheat, oats, and alfalfa; fertile and moderately to highly productive.

VII. Distribution: Central and western Oklahoma, northwestern Texas, and southwestern Kansas; moderately extensive.

Type location: Canadian County, Oklahoma.

Series established; Roger Mills County, Oklahoma, 1914.

VIII. Remarks: Color terms used are Provisional Soil Survey color names based on Munsell Color Charts and refer to dry soil.

CARYTOWN SERIES

The Carytown series is a member of the fine, mixed, thermic family of Albic Natraqualfs (Typic Natraqualfs?). They have light colored silt loam A horizons overlying mottled clayey B2t horizons. They developed in material weathered from shale high in sodium and have neutral or alkaline lower subsoils.

Typifying Pedon: Carytown silt loam - pasture
(Colors are for moist condition unless otherwise noted.)

Ap	0-9"	Dark grayish brown (10YR 4/2) and dark gray (10YR 4/1) silt loam; light brownish gray (10YR 6/2) dry; weak thin platy structure; very firable; plentiful worm channels and casts; plentiful roots; few very fine chert; pHw 6.5, pHs 6.2; gradual smooth boundary. (4 to 10 inches thick.)
A2	9-15"	Grayish brown (10YR 5/2) silt loam with common medium faint light brownish gray (10YR 6/2) mottles; common medium distinct dark brown (10YR 4/3) and dark yellowish brown (10YR 4/4) organic stains; weak thin platy structure; very friable; vesicular; plentiful worm channels and casts; plentiful roots; plentiful small and medium iron and manganese concretions; pHw 5.8, pHs 4.5; abrupt wavy boundary. (2 to 9 inches thick.)
B21t	15-18"	Very dark grayish brown (10YR 3/2) clay with common fine prominent red (2.5YR 4/8) and a few fine faint dark gray (10YR 4/1), dark grayish brown (10YR 4/2) and very dark gray (10YR 3/1) mottles; weak coarse columnar breaking to moderate fine and very fine angular blocky structure; extremely firm; thick continuous clay films; few worm channels and casts; few roots; many fine iron concretions; few very fine chert; pHw 5.7, pHs 5.1; gradual smooth boundary. (2 to 6 inches thick.)
B22t	18-25"	Very dark grayish brown (2.5Y 3/2) and olive brown (2.5Y 4/4) clay with few fine faint very dark gray (10YR 3/1) and yellowish brown (10YR 5/8) mottles; moderate fine and very fine angular blocky structure; extremely firm; thick continuous clay films; few roots; few small iron concretions; few fery fine chert; pHw 5.9, pHs 5.8; gradual smooth boundary. (5 to 10 inches thick.)
B23t	25-36"	Olive brown (2.5Y 4/4) clay or silty clay with few fine faint very dark grayish brown (2.5Y 3/2) and yellowish brown (10YR 5/8) mottles; moderate fine angular blocky structure; extremely firm; thick continuous clay films; common slickensides; few roots; few small iron and manganese concretions; pHw 6.4, pHs 6.5; gradual smooth boundary (5 to 15 inches thick.)
C	48-72"+	Gray (5Y 5/1 to 6/1) heavy silty clay loam with few fine faint gray (N 5/) and dark gray (N 4/) and few fine distinct strong brown (7.5YR 5/8) mottles; massive; thick patchy clay films; pHw 7.8, pHs 7.2.

Page 2--Carytown Series

Type Location: Barton County, Missouri, 875 feet east and 405 feet south of the northeast corner of Section 19, T31N, R29W. About 4 miles northeast of Golden City, Missouri.

Range in Characteristics: Thickness of the solum ranges from about 40 to 60 inches. Mean soil temperature ranges from 59 degrees to about 65 degrees Fahrenheit. No horizon between depths of 10 and 40 inches is dry for 60 consecutive days during most years and no horizon within these depths is dry for 90 cumulative days during most years. Moist color of the A1 horizon ranges from dark gray to very drak grayish brown. Color values are 3 and 4, moist, and 5 and 6, dry (A1 horizons having moist values lower than 3.5 are less than 6 inches thick.) Ap horizons have moist values of more than 4. Chromas range from 1 to 2 in hues of 10YR and 2.5Y. Texture of the A1 horizon is silt loam. Reaction of this horizon ranges from strongly acid to neutral where lime has been applied. Moist color of the A2 horizon ranges from dark gray to pale brown. Color values are 4 to 6, moist, and 6 to 8, dry. Chroma ranges from 1 to 3 in hues near 10YR. This horizon is mottled with colors of lower value and higher chroma or contain iron-manganese concretions larger than 2mm. or both of these characteristics. Texture of the A2 horizon is silt loam. Reaction of the A2 horizon ranges from medium to very strongly acid. The lower boundary of the A2 horizon is abrupt or clear. In some places the depth to the subsoil, even in small flat areas, is extremely variable. Small slick spots are common. Many pedons have a thin B and A horizon. B2t horizons range from very dark gray to olive brown with values of 3 and 4, and chromas are 1 to 4 in hues of 10YR and 2.5Y. Coatings over peds in the top part, or the matrix of the B21t horizon has dominant chromas of 2 or less. The upper 20 inches of the Bt horizons averages from 45 to 60 percent clay. Reaction of the Bt horizons, down to a depth of 30 inches, ranges from medium acid to moderately alkaline. The remaining solum and horizons below the solum range from neutral to strongly alkaline.

Competing Series and Their Differentiae: Piasasa soils have darker colored surfaces and lower temperature. Huey, McCrory, Bonn, Lafe, and Verdun soils have less clayey B2t horizons. Huey soils are saturated with more than 15 percent sodium throughout. They lack the tonguing or interfingering of the albic horizon into the natric horizon that is present in the McCrory, Bonn, Lafe, and Verdun soils.

Setting: The Carytown soils occupy large broad slightly depressional low-lying upland areas that are in places connected by saddles across ridges. They are along the contact between the Mississippian and Pennsylvanian formations. Gradients seldom exceed 2 percent. The regolith is medium and fine textured residuum for either old alluvium and colluvium, or shale that have been enriched with sodium. Mean annual precipitation ranges from about 35 to 45 inches. Mean air temperature at the type location is about 58 degrees F.

Principal Associated Soils: These are the Parsons, Talokoa, Gerald, Summit, Creldon, Kenoma, and Keano soils, all of which have acid lower subsoils and lack 15 percent sodium in any part of the argillic horizon.

Drainage and Permeability: Poorly drained. Permeability is very slow and runoff is slow.

Use and Vegetation: About half of these soils are in pasture or hay. Corn, wheat, soybeans, and milo are the main crops grown on the remaining acreage. Native vegetation was tall prairie grasses.

Distribution and Extent: Southwestern Missouri, Southeastern Kansas, and possibly adjacent parts of Oklahoma and Arkansas. The series is of moderate extent.

Series Established: Jasper County, Missouri, 1941.

Remarks: Soils of the Carytown series were formerly classed as Solonetzs. Lime concretions and gypsum crystals are present in the lower part of the subsoil in most places. Further study should be made to determine if any horizon or all of the argillic horizon has 15 percent sodium measured with NaOAc.

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USA

CHICKASHA SERIES

The Chickasha series is a member of the fine-loamy, mixed, thermic family of Udic Argiustolls. They have grayish brown, loam A horizons, reddish yellow, sandy clay loam Bt horizons and sandstone bedrock at about 58 inches depth.

Typifying Pedon: Chickasha loam - native range
(Colors are for dry soil unless otherwise stated.)

A1	0-12"	Grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; medium acid; gradual smooth boundary. (8 to 16 inches thick)
B21t	12-24"	Reddish yellow (7.5YR 6/6) sandy clay loam, strong brown (7.5YR 5/6) moist; compound weak medium prismatic and weak medium subangular blocky structure; hard, friable; thin clay films on ped surfaces; medium acid; gradual smooth boundary. (10 to 20 inches thick.)
B22t	24-44"	Reddish yellow (7.5YR 6/8) sandy clay loam, strong brown (7.5YR 5/8 moist; compound weak medium prismatic and weak medium subangular blocky structure; hard, firm; thin clay films on ped surfaces; medium acid; gradual smooth boundary. (10 to 20 inches thick)
B3	44-58"	Reddish yellow (7.5YR 7/8) light sandy clay loam, reddish yellow (7.5YR 6/8) moist; weak medium subangular blocky structure; hard, friable; few thin sandstone fragments in the lower part; medium acid; abrupt wavy boundary. (0 to 20 inches thick)
R	58"	Light gray (10YR 7/2) sandstone; common medium distinct mottles of reddish yellow (7.5YR 6/8), light gray (10YR 7/2) moist; hard when dry, soft to hard when moist.

Type Location: Carter County, Oklahoma; 660 feet east, 1980 feet north of the southwest corner of the southeast 1/4, Section 6, T4S, R3W.

Range in Characteristics: These soils are dry for 90 to 135 cumulative days in some subhorizon between 4 and 12 inches depth in most years. The depth to sandstone or unconforming bedrock is 40 to about 60 inches. The reaction of the soil is neutral through the higher part of strongly acid in the upper part and medium acid to moderately alkaline in the lower part. A few areas have films and threads of carbonates in the lower part. The A1 horizon has hues of 7.5YR or 10YR, values of 3, 4 or 5 dry and 2 or 3 moist, and chromas of 2 or 3. The texture of the A1 horizon is loam or fine sandy loam. There is a B1 horizon from 3 to 10 inches thick in some of the pedons. When present the B1 horizon has hues of 7.5YR or 10YR, values of 4 through 6 dry and 3 or 4 moist and chroma of 2 through 6. The texture of the B1 horizon is loam or light sandy clay loam. The B2t horizon has hues of 7.5YR, 10YR, or 2.5Y, values of 4 through 7 dry and 3 through 6 moist and chroma of 2 through 6 in the upper part and 4 through 8 in the lower part. The texture of the B2t horizon is loam or sandy clay loam with the clay content from about 20 to 30 percent and more than 15 percent material is coarser than very fine sand The lower B2t and the B3 horizons include 5YR hues. The B3 horizon is similar to the lower B2t horizon except the structural grade is weaker, the horizon is less clayey and/or there are sandstone bits and fragments present. The R horizon is usually sandstone that is grayish, brownish or yellowish, is mainly noncalcareous but has lime in some pedons, and is hard or moderately hard when dry and hard to soft when moist. In some of the pedons the solum is over unconforming reddish or brownish clay or clay loams with rock structure and seams of sandstone or siltstone.

Competing Series and Their Differentiae: These are the Bates, Fitzhugh, Grant, Naron, Shellabarger, Teller and Zaneis soils. The Bates and the Fitzhugh soils are dry for less than 90 cumulative days in some subhorizon of the soil between 7 and 20 inches depth. In addition the Bates soils have sandstone bedrock at less than 40 inches depth. The Grant soils have less than 15 percent material coarser than very fine sand in the upper 20 inches of the argillic horizon. The Naron, Shellabarger and Teller soils formed in deep sediments and lack bedrock within about 60 inches depth. The Zaneis soils have hues of 5YR or redder in the argillic horizon and have from 30 to about 35 percent average clay content in the upper 20 inches of the Bt horizon.

Setting: The Chickasha soils are on uplands. Slope gradients are mainly between 1 and . percent but range from 0 to 10 percent. The Chickasha soils formed from noncalcareous or weakly calcareous sandstone. The climate is moist subhumid; mean annual precipitation is about 25 to 37 inches, Thornthwaite annual P-E index is about 50 to 64, and the mean annual air temperature is about 57° to 68° F.

Principal Associated Soils: These are the competing Grant and Zaneis soils and the Lucien soils. The Lucien soils have sandstone bedrock within 20 inches depth and lack argillic horizons.

Drainage and Permeability: Well drained; runoff is medium; permeability is moderate.

Use and Vegetation: Mainly cultivated to small grains, sorghums and cotton. Native vegetation was tall prairie grasses, mainly little bluestem.

Distribution and Extent: Central Oklahoma and north central Texas. Moderately extensive.

Series Established: Grady County, Oklahoma, 1939.

Remarks: These soils were formerly classified as Reddish Prairie soils.

National Cooperative Soil Survey
USA

CHIGLEY SERIES

The Chigley series comprises Red Podzolic Soils developed on freely drained surfaces from neutral to weakly calcareous gritty clays and shales under scrub oak forest in the transition between the Red and Yellow Podzolic and Reddish Prairie soil zones. The parent rocks comprise terrestrial sediments of the Pennsylvanian. (Pontotoc formation) containing a noticeable proportion of fine angular pebbles, which are slightly rounded quartz crystals, erratically interbedded with sandstone and conglomerate. Chigley soils are essentially Windthrost soils containing partly rounded quartz crystals ranging in size from coarse sand to fine gravel, and generally with thin A horizons. They differ from the associated Gilson soils in having more clayey, less gravelly subsoils that are very firm and slowly permeable.

I. Soil Profile: (Chigley sandy loam) — Range in thickness

				Range in thickness
1.	A_1	0-3"	Grayish-brown (10YR 5/2; 3/2, moist) sandy loam contianing slightly rounded quartz crystals of fine-gravel size; weakly granular; friable when moist but very hard when dry; mildly alkaline.	2-5" thick
2.	A_2	3-5"	Pale-brown (10YR 6/3; 5/4, moist) sandy loam containing quartz crystals of fine-gravel size; massive; friable when moist but very hard when dry; medium acid to neutral.	½-5" thick
3.	B_2	5-15"	Reddish-brown (5YR 4/4; 4/6, moist) heavy sandy clay containing quartz crystals of fine-gravel size; very firm and very hard; strong medium blocky; slowly permeable; strongly acid.	6-15" thick
4.	B_3	15-40"	Coarsely mottled reddish-brown and yellowish-brown heavy sandy clay containing fine gravel consisting of quartz crystals; coarse blocky; very firm and very hard; slowly or very slowly permeable; strongly acid.	15-30" thick
5.	C	40"+	Noncalcareous raw clay or shale containing erratic thin layers of sandstone or quartzitic conglomerate.	

II. Range in Characteristics: Sandy loam and gravelly loam are the principal types; thickness of the A_1 and A_2 horizons combined generally is between 4 and 7 inches, and where thin, the A_2 is inconspicuous; A_1 horizon ranges from dark grayish brown to pale brown in forested areas; surface soil is generally pale brown in cultivated areas; color of B_2 horizon ranges from reddish brown to yellowish red and red; reaction ranges from slightly acid to medium alkaline but noncalcareous in the A_1, medium acid to mildly alkaline in the A_2, very strongly to slightly acid in the B_2 and B_3, and slightly acid to weakly calcareous in the C; content of quartz crystals of fine-gravel size varies widely throughout the solum but is never sufficient in the B horizon to make the subsoils more than slowly permeable.

III. Topography: Gently rolling to rolling erosional uplands; surfaces convix to plane; gradients from ½ to 10%, mostly 1 to 4.

IV. Drainage: Free from the surface; slow internally; the ground water table is never within the solum, favorable for field crops.

V. Vegetation: Open-canopied forest of post oak and blackjack with a considerable ground cover of grasses and other herbs.

VI. Use: Three-fourths or more is uncleared forested pasture affording rather sparse grazing of mediocre quality; small areas are cultivated, mainly to sorghums, cotton, and corn, and produce low to moderate yields; very susceptible to erosion; the present agriculture on these soils is relatively unprosperous.

VII. Distribution: South-central Oklahoma, mainly on the north side of the Arbuckle Mountains; relatively inextensive.

VIII. Remarks: Present incomplete information indicates that the Chigley soils probably should be classed as types and phases of Windthorst and the name Chigley abandoned. The series has been correlated only in the Soil Survey of Murray County, Oklahoma. The series name is from a town in the northern part of that county.

Color names used herein are provisional Soil Survey color names (1946) and refer to dry soil.

Type Locality: Murray County, Oklahoma; NW¼ Sec. 26, T2N, R3E.

Series Established: Murray County, Oklahoma, 1935.

WTC:MB
1-30-40
Revised: 9-18-46
EHT

CHOTEAU SERIES

The Choteau series comprises very acid and much weathered Prairie soils developed in old loess or loamy alluvium on well-drained uplands in or near northeastern Oklahoma. It is characterized by a thick A horizon that is light colored in its lower part and very gradationally underlain, at depths varying between about 15 and 35 inches, by a yellowish and much mottled though relatively permeable B horizon of moderately firm clay loam somewhat similar to that of the Dennis soils. The principal associate, developed in similar sediments, is the Taloka series which is a Planosol with a thick A horizon and a B horizon of claypan character similar to that of Parsons series. As the sediments become more sandy, the Choteau soils grade to the Dougherty and Stidham series which are Red-Yellow Podzolic soils with thin A_1 horizons. As the humidity increases, the Taloka series seemingly grades to the Muskogee soils, a Red-Yellow Podzolic soil, with a thin A_1 horizon. Mainly because of their A_2 horizon are the Choteau soils, unlike the Peck soils. The Taloka soils are more weathered and acid than the Vanoss, Teller, or Norge soils. The pale and thick A_2 horizon distinguishes the Choteau solum from those of the Dennis and Bates series.

Soil Profile: Choteau loam--virgin

A_1	0-15"	Grayish-brown (10YR 5/2.5) loam, dark brown (10YR 3/3) when moist; high in very fine sand and coarse silt; weak medium granular structure; very friable; medium acid in the upper part grading to very strongly acid below 7 inches; gradual boundary.
A_2	15-22"	Pale brown (10YR 6.5/2.5) loam, brown (10YR 5/3) when moist; faintly mottled with browner spots; almost structureless; very friable; permeated by a network of small root channels; pH about 5.0; gradual boundary.
AB	22-28"	Light yellowish-brown (10YR 6/4) heavy loam, yellowish-brown (10YR 5/4) when moist; many strong brown to reddish mottles and veins that are more ferruginous than the matrix; weak subangular blocky structure; friable, hard; pH about 5.5; diffuse boundary.
B_2	28-50"	Brownish-yellow (10YR 6/6) clay loam, yellowish-brown (10YR 5/6) when moist; many strong brown and pale yellow mottles; nearly structureless; clay skins discontinuous; (they line the pores, abundant small root channels, and random crevices, but do not outline distinct peds); firm; pH about 6.0 becoming 6.5 toward the base; diffuse boundary.
B_3	50-70"	Mottled or reticulately veined pale yellow, reddish yellow and strong brown clay loam; nearly structureless; firm; pH about 7.0; hardly distinguishable from the B_2 but has more variegated and somewhat coarser color pattern and few pores and crevices lined with clay skins; diffuse boundary.
C	70-100"	Dominantly reddish-yellow to brownish-yellow clay loam, reticulately veined with light gray or pale yellow; noncalcareous; pH 7.0 to 7.5.

Range in Characteristics: In texture, the A_1 horizon ranges from loam to silt loam and heavy fine sandy loam; in color, from grayish-brown to dark grayish-brown; and in thickness, between about 7 and 20 inches, thinning as the areas become more sandy or eroded. Color of the A_2 horizon ranges from pale brown to very pale brown and light brownish-gray. Thickness of the light-colored horizons (combined A_2 and AB horizons) ranges between about 3 and 30 inches. Texture of the B_2 horizon ranges from clay loam to silty clay loam or heavy sandy clay loam. The crushed color of the B_2 horizon is generally brownish-yellow but ranges to yellow in gradations toward the Muskogee soils and to strong brown in gradations toward Peck series; its mottling varies widely in detail but is generally pronounced, often includes yellowish-red spots, and never includes gray colors of chroma less than 1. Structure of the B horizons varies from massive to moderate medium subangular blocky. Ferruginous veins and concretions range from slight to very abundant and pronounced. Eroded phases are common on slopes of more than about 4 percent. Solonetzic transitions occur on slopes of more than about 4 percent. Solonetzic transitions occur surrounding slick spots that are occasionally intermingled on sloping areas. Except where specified moist, the colors given are for dry soil.

Topography: Undulating to rolling erosional upland--mostly high, obscure dissected alluvial terraces or plains. Surfaces generally convex. Gradients mostly between 2 and 5 percent but ranging from about 1 to 8 percent.

Drainage and Permeability: Well drained. Moderately slow to rapid from the surface; moderate or moderately slow internally. The ground water table remains below 10 feet.

Vegetation: Primarily tall grass (mostly little bluestem). Either treeless prairie or tall-grass savannah with scattered overstory of post oak and other hardwoods. In some areas not cultivated, woody vegetation has thickened since settlement and now forms a scrub forest.

Use: Mostly in cultivation to general field crops.

Distribution: Primarily in eastern Oklahoma along the Arkansas and Canadian Rivers in localities where the annual precipitation is between 37 and 45 inches. Probably some in extreme southeastern Kansas. Total extent probably is between 50,000 and 250,000 acres.

Type Location: Wagoner County, Oklahoma; 500 feet west and 1300 feet north of the southeast corner of Section 32, T17N, R18E.

Series Established: Wagoner County, Oklahoma, (Verid-Grad SCD), 1941. The series name is from a village in Mayes County, Oklahoma.

Remarks: This series as hereby revised excludes the inextensive soils having the solum of the Dennis series (without A_2 or unusually thick A horizon) developed on terraces. In many areas along the Arkansas River, the reaction profile and presence of clay skins lining pores in the A_2 evidence thickening of the A horizon by loess deposition subsequent to formation of the B horizon. Data from mechanical analyses and determination of pH and exchangeable cations are available for 2 profiles (53-OK-73-21 and -23) of Choteau loam.

EHT: 3-30-57

National Cooperative Soil Survey
USA

CLAREMORE SERIES

The Claremore series is a member of the loamy, mixed, thermic family of Lithic Argiustolls. They have reddish brown, silt loam A horizons, reddish brown, silty clay loam B2t horizons and R horizons of limestone at about 18 inches.

Typifying Profile: Claremore silt loam - rangeland
(Colors are for dry soil unless otherwise noted.)

A1	0-8"	Reddish brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) moist; moderate medium granular structure; slightly hard, friable; medium acid; gradual smooth boundary. (5 to 10 inches thick.)
B1	8-12"	Reddish brown (5YR 4/3) light silty clay loam, dark reddish brown (5YR 3/3); moist; strong medium granular structure; hard, friable; medium acid; gradual smooth boundary. (2 to 6 inches thick.)
B2t	12-18"	Reddish brown (2.5YR 4/4) silty clay loam, dark reddish brown (2.5YR 3/4) moist; strong fine and medium subangular blocky structure; firm; hard; thin continuous clay films; medium acid; abrupt wavy boundary. (4 to 10 inches thick.)
R	18"+	Hard limestone bedrock with fractures one to two feet apart filled with reddish brown (2.5YR 4/4) silty clay loam in the upper part.

Type Location: Rogers County, Oklahoma; 2 miles south and 9 miles west of Claremore; 100 feet west and 125 feet south of the northeast corner of Section 26, T21N, R14E.

Range in Characteristics: These soils have base saturation of 80 percent or higher in all parts above the limestone bedrock. The sola range from about 12 inches to 20 inches in thickness. The B1 and B2t horizons average between 25 and 35 percent clay. The upper one-third of the solum has values of less than 3.5 moist and 5.5 dry and chroma of 2 or 3. The reaction of all horizons is medium acid to slightly acid. The A horizon has hues of 5YR through 10YR, values of 4 or 5 dry and 2 or 3 moist, and chroma of 2 or 3. The texture of the A horizon is silt loam, loam or silty clay loam. Stony and rocky phases are recognized. The B1 horizon has hues of 5YR through 10YR, values of 4 or 5 dry and 3 or 4 moist, and chroma of 2 through 4. The B1 horizon has textures of silty clay loam or heavy silt loam. The B2t horizon has hues of 2.5YR through 10YR, values of 4 or 5 dry and 3 or 4 moist, and chroma of 3 through 5. The texture of the B2t horizon is silty clay loam or clay loam, containing from 27 to about 37 percent clay. The limestone bedrock is harder than 3 on Mohs scale. It is fractured, and the upper parts of the wider cracks are filled with soil material like the B2t horizon.

Competing Series and Their Differentiae: These are the Lula, Newtonia, Scullin and Talpa soils. The Lula soils have sola thicker than 40 inches over limestone bedrock. The Newtonia soils have sola thicker than 60 inches, and the amount of clay decreases less than 20 percent from the maximum within 60 inches depth. The Scullin soils have sola between 20 and 40 inches thick over limestone and between 15 and 35 percent limestone or chert gravel in the Bt (argillic) horizon. The Talpa soils lack Bt (argillic) horizons.

Setting: The Claremore soils are on nearly level to gently sloping uplands. Slope gradients are mainly less than 3 percent. The Claremore soils formed in limestone rock. The climate is moist subhumid. Mean annual precipitation is about 33 to 44 inches, Thornthwaite annual P-E index is about 50 to 70, and the mean annual air temperature is 57° to 65° F.

Principal Associates Soils: These are the competing Lula, Newtonia and Talpa soils.

Drainage and Permeability: Well drained; runoff is medium; permeability is moderate.

Use and Vegetation: The native vegetation is tall-grass prairie. The soil is used for native range, cultivated to small grains or used for tame pastures.

Distribution and Extent: Eastern Oklahoma, southeastern Kansas, southwestern Missouri and probably northwestern Arkansas. The series is of moderate extent.

Series Established: Rogers County, Oklahoma, 1964. The name is from the county seat of Rogers County.

Remarks: The Claremore series encompasses the soils which were formerly classed as the shallow phase of the Newtonia series. They were classified as Brunizems.

National Cooperative Soil Survey
USA

CLARITA SERIES

The Clarita series is a member of the fine, montmorillonitic, thermic family of Chromudic Pellusterts. They have dark gray, clayey A horizons more than 12 inches thick, reddish brown, clayey AC Horizons, and reddish brown and gray clayey C horizons.

Typifying Pedon: Clarita clay - rangeland
(Colors refer to dry soil unless otherwise stated.)

A1 0-10" Very dark gray (10YR 3/1) clay, black (10YR 2/1 moist; strong medium and fine subangular blocky structure that breaks easily to coarse and medium granular structure; hard, very firm; mildly alkaline; gradual wavy boundary. 5 to 20 inches thick.

A12 10-22" Dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak, coarse blocky structure; some pressure faces, few slickensides that intersect in lower part of horizon; very hard, very firm; many fine soft and hard $CaCO_3$ concretions; moderately alkaline; gradual wavy boundary. 6 to 20 inches thick.

AC 22-50" Reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; common intersecting slickensides, and a few parallelepipeds which are tilted from 10 to 60 degrees from the horizontal; extremely hard, extremely firm; dark soil with moist color of (10YR 3/1) in some old cracks; soft and hard $CaCO_3$ concretions are numerous; calcareous; moderately alkaline; gradual wavy boundary. 20 to 35 inches thick.

C 50-72"+ Reddish brown (2.5YR 4/4) and gray (2.5YR 5/1) clay; massive; calcareous with many $CaCO_3$ concretions.

Type Location: Pontotoc County, Oklahoma; approximately 12 miles west of Ada; in pasture 50 feet south of Oklahoma State Highway No. 19; 800 feet west and 50 feet south of northeast corner of Section 29 T4N, R4E.

Range in Characteristics: This soil has cracks that open and close more than once during the year and remain open from 90 to 150 cumulative days during the year. Intersecting slickensides occur within 40 inches depth and commonly begin at about 24 inches. Parallelepiped shaped aggregates can be observed when the soil is nearly dry but are evident when the soil is moist. The dark A1 horizons vary in thickness from 12 to 40 inches, within a few feet horizontally. The texture throughout is heavy clay loam or heavy silty clay loam to clay with up to 60 percent clay content. The a1 horizons have hues of 10YR and 7.5YR, values of 2 to 3 moist and 3 to 5 dry, and chroma of less than 1.5. The reaction of the A1 horizons is neutral to moderately alkaline in the upper part to moderately alkaline and calcareous in the lower part. The AC horizon has hues of 2.5YR through 7.5YR, values of 3 and 4 moist and 4 through 6 dry, in chroma of 2 through 4. There are cracks filled with dark soil material from the A1 horizons. The reaction is moderately alkaline and calcareous. The C horizon is reddish brown or red, calcareous claybeds with or without gray streaks.

Competing Series and Their Differentiae: These include the Burleson, Houston Black, Heiden, Lake Charles, Randall and Roscoe soils. The Burleson, Houston Black, Lake Charles, Randall and Roscoe soils have chroma of less than 1.5 to over 40 inches or there are distinct or prominent mottles or concretions due to segregated Fe or Mn, and have AC horizons of 10YR or yellower hue. In addition, Lake Charles soils have cracks that stay open less than 90 cumulative days per year and Roscoe soils have cracks that remain open more than 150 days per year. The Heiden soils do not have A horizons as thick as 12 inches that are less than 1.5 chroma throughout.

Setting: The Clarita soils are on nearly level to gently sloping uplands. Slope gradients are from 1 to about 6 percent. Weak gilgai is present on some areas but not evident on all areas. The Clarita soils formed in reddish calcareous clays, with or without gray streaks, of the Permian red beds. The mean annual precipitation is about 28 to 40 inches, the Thornthwaite annual P-E index is from 44 to 64, and the mean annual temperature at the type location is 62° F.

Principal Associated Soils: These are the competing Burleson and the Durant and Vernon soils. Durant soils have Bt (argillic) horizons. Vernon soils lack the dark A1 horizons and have solums less than 20 inches thick over shaley clays.

Drainage and Permeability: Moderately well drained. Surface runoff is medium, water enters the soil rapidly when it is cracked and very slowly when it is moist.

Use and Vegetation: Used mainly for native range. The native vegetation is tall grass prairie.

Distribution and Extent: Known areas are in southern Oklahoma. The extent there is between 8,000 and 20,000 acres.

Series Proposed: Pontotoc County, Oklahoma, 1967. The name is from a small town in adjoining Coal County.

Remarks: This soil would have been classified as a Grumusol.

National Cooperative Soil Survey
USA

Established Series

CLEBURNE SERIES

Soils of the Cleburne series are upland zonal soils of the Red and Yellow Podzolic region. They have developed on residual material from acid sandstone. Cleburne soils are associated with soils of the Linker, Hanceville, Hector, and Muskingum series. Hector and Muskingum soils differ from Cleburne in being shallow lithosols. Linker and Hanceville soils have reddish-brown or red subsoils. Subsoil of the Cleburne series is pale brown to yellowish-brown. Cleburne soils are moderately extensive and are important agricultural soils.

Soil Profile: Cleburne fine sandy loam

A_2	0-6"	Brown (10YR 5/3), weak medium granular, medium acid, fine sandy loam. 6 to 12 inches thick.
A_3	6-12"	Yellowish-brown (10YR 5/8), moderate medium blocky, strongly acid, fine sandy loam. 3 to 6 inches thick.
B_3	12-30"	Yellowish-red (7.5YR 5/8), moderate medium blocky, strongly acid sandy clay loam. 15 to 30 inches thick.
C	40-50"	Gray, brown, and yellow mottled; medium large blocky; strongly acid; sandy loam up to 20 inches thick.
D		Sandstone.

Range in Characteristics: Surface soil varies from medium to strongly acid in reaction; very fine sandy loam to gravelly sandy loam and loamy sand in texture; brown to pale brown in color. Subsoil reaction ranges from medium to strongly acid in reaction; may have sandy clay layers from thin interbedded shales; color ranges from yellowish-brown to pale brown. A_3 horizon may be absent. In woodland, there is a surface layer of partially decomposed leaf litter and the upper 2 to 4 inches of topsoil will be dark from the content of organic matter.

Topography: Slopes range from gently undulating to rolling (1 to 10 percent). Usual gradient 2 to 5 percent.

Drainage: Surface drainage moderate to rapid; internal drainage moderate to rapid.

Vegetation: Pine, post oak, hickory, red oak, white oak, grape muscadine, huckleberry, and blackjack oak.

Use: Cotton, corn, orchards, truck crops, annual legumes, small grains, sericea lespedeza, pasture, and woodland.

Distribution: North and west Arkansas, eastern Oklahoma, southern Missouri, east Tennessee, north Alabama.
Type Location: Pope County, Arkansas.
Series Established: Arkansas, SCD8, Pope County, Arkansas, 1930.

Revised
ML
4-30-47

Division of Soil Survey
Bureau of Plant Industry, Soils, and Agricultural Engineering
U. S. Department of Agriculture

CLEORA SERIES

The Cleora series is a member of a coarse-loamy, siliceous, thermic family of Fluventic Hapludolls. These soils have dark brown moderately coarse textured A horizons less than 20 inches thick and brownish moderately coarse textured control sections.

Typifying Pedon: Cleora fine sandy loam - cultivated (Colors are for moist conditions unless otherwise stated.)

A1 0-15" Dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, friable; medium acid; gradual boundary. 10 to 20 inches thick.

AC 15-30" Brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; massive; slightly hard, very friable; contains a few thin strata of pale brown fine sandy loam; medium acid; gradual boundary. 6 to 30 inches thick.

C 30-70"+ Dark yellowish brown (10YR 4/4) find sandy loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, very friable; contains thin strata of very pale brown fine sandy loam; medium acid.

Type Location: Sequoyah County, Oklahoma. On Little Skin Bayou Creek about one-half mile west of Muldrow, Oklahoma. About 1100 feet north and 900 feet east of the southwest corner of Section 24 T11N, R25E.

Range in Characteristics: The reaction of all horizons ranges from medium acid to neutral. The organic matter content is greater than 0.5 percent at 1.25 meters depth or does not decrease regularly with depth. These soils are usually moist and are dry for less than 90 days (cumulative) in most years in some subhorizon of the soil between 10 and 40 inches, but are not continuously dry in all parts of the soil between these depths for as long as 60 consecutive days in most years. The color of the A horizon ranges in value from 3.5 to 5.5 when dry and 2 to 3.5 when moist; in chromas from 2 to 4; in hues of 10YR and 7.5YR. The organic matter content exceeds 1 percent to below 10 inches and becomes less than 1 percent within 20 inches depth. The texture of the A horizon is mainly fine sandy laom but textures from loamy fine sand to loam may occur. The color of the control section ranges in value from 4 to 6 when dry and 2 to 4 when moist; in chromas of 3 to 4, in hues of 10YR and 7.5YR. The average texture of the 10 to 40 inch control section is less than 18 percent clay and more than 15 percent coarser than very fine sand and is finer than loamy fine sand. Textures coarser or finer than those given for the average of the control section may occur in thin strata or a depths greater than 40 inches from the surface.

Competing Series and Their Differentiae: These include Lonoke, Robinsonville, Ochlockonee, Verdigris, and Pulaski. The lonoka and Verdigris soils have more clayey 10 to 40 inch control sections with more than 18 percent clay. The Robinsonville soils have lighter colored A horizons or A horizons with less than 1 percent organic matter in the upper 10 inches. The Ochlockonee soils have lighter colored A horizons and are strongly acid in reaction. The Pulaski soils are dry insome part of the 10 to 40 inch section for more than 90 days (cumulative) in most years and have lighter colored A horizons or A horizons with less than 1 percent organic matter in the upper 10 inches.

Setting: These soils occur on nearly level to undulating floodplains along small creeks and usually near the channel on larger creeks and rivers. They have developed from sediments of moderately coarse textured materials, of neutral to medium acid sandstones with minor amounts of shale. The series occurs generally east of the Thornthwaite annual P-E index of 64 and the annual rainfall is greater than about 37 inches. The mean annual air temperature at the type location is 61° F.

Principal Associated Soils: These include the competing Verdigris and Lonoke on Floodplains, and Bates, Dennis, Collinsville, Parsons, Stephenville, Darnell, Hector, Enders, and Hartsells on uplands.

Drainage and Permeability: Well drained; moderately rapid permeability; slow runoff. These soils are flooded from occasionally to frequently.

Use and Vegetation: The native vegetation is bottomland hardwoods. Mostly cleared and used for cultivated crops or tame pastures.

Distribution and Extent: In Oklahoma and Arkansas, probably Kentucky, Mississippi, and Tennessee, and possibly other states. The series is of moderate extent.

Series Established: Okfuskee County, Oklahoma. Suspended in 1964. Recommended for reactivation in 1965 in Sequoyah County, Oklahoma.

Remarks: The Cleora soils were formerly classified as Alluvial.

National Cooperative Soil Survey
USA

Established Series

COLLINSVILLE SERIES

The Collinsville series comprises acid dark colored loamy lithosols which are very shallow over acid sandstones. Characteristically, the soils have evident A_1 horizons of fair thickness grading into stony C horizons or D horizons. Closely related soils are the Darnell and Talihina series and less closely related soils are the Bates, Dennis, Hector, and Ramsey series. Darnell soils have lighter colored and thinner A_1 horizons, having been formed under forest. Talihina soils are finer textured, being derived from shale. Bates and Dennis soils have distinct B horizons of clay accumulation and are much deeper to bedrock. Hector soils are distinctly redder in color whereas Ramsey soils are deeper and have B horizons which are faint or evident in terms of color, structure, or consistence. Collinsville soils are of moderate extent and distribution and of limited importance to agriculture.

Soils Profile: Collinsville stony fine sandy loam

A_1	0-7"	Dark grayish-brown (10YR 4/2) stony fine sandy loam, very dark grayish-brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, very friable; medium acid; gradual irregular boundary. 2 to 10 inches thick.
C	7-9"	Mixture of yellowish-brown sandstone fragments and fine earth in 60:40 proportions; fine earth is brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; porous massive; slightly hard, very friable; medium acid; abrupt irregular boundary. 0 to 6 inches thick.
D_r	9"+	Partially weathered and somewhat fractured yellowish brown sandstone.

Range in Characteristics: Stony fine sandy loam and stony loam are most common with some bodies free of stones on the surface. Color of the A horizon ranges in value from 3 through 5 when dry, 2 through 3.5 when moist, and in chroma mostly near 2, but ranges to 3 in 10YR and 7.5YR hues. Reaction of the A horizon ranges from slightly through strongly acid. Color of the underlying sandstone may be in any of 5YR through 10YR hues with values of 4 through 6 when dry, values of 3 through 5 when moist, and chromas of 4 through 8. Color of the transitional layer between the two is intermediate between those of the A_1 and D_r horizons. Depth to partly weathered and fractured sandstone ranges from 4 to 15 inches. Unless specified moist, colors given are for dry conditions.

Topography: Rolling to hilly erosional upland. Convex surfaces of gradient mostly between 2 and 15 percent but ranging up to 35 percent.

Drainage and Permeability: Well drained with medium to rapid runoff, rapid permeability, and deep water table.

Vegetation: Prairie; mainly little bluestem.

Use: Chiefly as native range for grazing.

Distribution: Eastern Oklahoma, southeastern Kansas, and possibly northwestern Arkansas.

Type Location: Rogers County, Oklahoma; about 2 miles north and 1 1/2 miles east of Inola, Oklahoma; 125 feet east and 45 feet south of the north quarter corner of Section 27, T20N, R17E.

Series Established: Tulsa County, Oklahoma, 1935.

Rev. HTO
5-29-62
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National Cooperative Soil Survey
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CRAIG SERIES

The Craig series is amember of a clayey-skeletal, mixed, thermic family of Ultic Paleudalfs. They have very dark brown, granular, silt loam A1 horizons, dark yellowish brown, very cherty clay loam upper Bt horizons and yellowish red, very cherty clay loam lower B horizons that extend to more than 60 inches below the surface.

<u>Typifying Pedon</u>:		Craig silt loam - rangeland (Colors refer to moist soil unless otherwise noted.)
A11	0-7"	Very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; hard, friable; medium acid; gradual smooth boundary. (6 to 12 inches thick.)
A12	7-12"	Very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; hard, friable; a few chert fragments; strongly acid; gradual smooth boundary. (4 to 10 inches thick.)
A2	12-16"	Dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium granular structure; hard, friable; few small chert fragments; strongly acid; gradual wavy boundary. (3 to 5 inches thick.)
A3	16-21"	Brown (10YR 5/3) heavy silt loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; hard, friable; 10 percent chert fragments; common 2 to 8 millimeter iron and manganese concretions; strongly acid; gradual wavy boundary. (3 to 10 inches thick.)
B21t	21-25"	Dark yellowish brown (10YR 4/4) very cherty clay loam; yellowish brown (10YR 5/4) dry; moderate very fine blocky structure; hard; chert fragments from 2 millimeters to 4 inches in diameter make up 60-70 percent of the mass; thin clay films on ped and chert surfaces; the mass is difficult to break up when dry but is crumbly when moist; common 2 to 5 millimeter iron and manganese concretions; strongly acid; gradual wavy boundary. (4 to 16 inches thick.)
B22t	25-42"	Yellowish red (5YR 5/6) very cherty heavy clay loam, common fine to coarse reddish and brownish mottles on the chert particles; weak very fine blocky structure; hard and difficult to break up the mass when dry but not when moist; clay films on ped and chert surfaces and in pores; a few roots present; chert particles from 2 millimeters to 4 inches make up 75-85 percent of the mass; strongly acid; gradual wavy boundary. (10 to 30 inches thick.)
B3	42-60"+	Closely packed chert particles from 2 millimeters to 4 inches in diameter with about 10-15 percent yellowish red (5YR 5/6) heavy clay loam in interstices; massive; patchy clay films on chert surfaces and in pores; strongly acid. (From 1 to several feet thick.)

Page 2--Craig Series

Type Location: Craig County, Oklahoma; about 5 miles southeast of Vinita; about 0.6 mile south of the northwest corner of Section 12, T24N, R20E; from the roadbank on the east side of the road about 280 yards south of the house that is on the west side of the road.

Range in Characteristics: These soils are not dry for as much as 90 days (cumulative) in most years, in some subhorizon of the soil between 7 and 20 inches depth. The solum thickness is greater than 60 inches and the clay content does not decrease by 20 percent of the maximum clay content within 60 inches. The depth to more than 35 percent chert content ranges from 15 to about 30 inches. The upper part of the argillic horizon has from 35 to 50 percent base saturation by the NH_4OAc method; the upper 20 inches of the argillic horizon averages more than 35 percent chert and from 35 to 45 percent clay. The reaction of all horizons ranges from medium acid to very strongly acid, but a part of the argillic horizon is strongly or very strongly acid. The A1 horizons have hues of 10YR, values of 2 or 3 moist and 4 or 5 dry, and chromas of 1 through 3. The texture ranges from loam and silt loam to cherty loam and cherty silt loam. The incipient A 2 horizon is similar to the A1 horizon except that the color values are 4 or 5 moist and 5 or 6 dry. The A3 horizon has hues of 7.5YR or 10YR, values of 3 through 5 moist and 4 through 6 dry, and chromas of 2 through 4. The texture ranges from heavy loam or silt loam to light clay loam or light silty clay loam or their cherty counterparts. The chert content of the A3 horizon ranges from a little to nearly 50 percent. The B21t horizon has hues of 5YR through 10YR, values of 4 or 5 moist and 4 through 6 dry, and chromas of 3 through 6. The texture ranges from cherty or very cherty heavy loam to cherty or very cherty clay loam. The chert content ranges from 35 to about 90 percent. The B22t horizon has hues of 5YR through 10YR, values of 4 through 6 moist and 5 trough 7 dry, and chromas of 3 through 8. The texture ranges from cherty or very cherty clay loam to cherty or very cherty clay with from 35 to 90 percent chert, commonly on the higher end of the cherty content. The soil material in the B3 horizon has hues of 2.5YR through 7.5YR, values of 4 through 6 moist and 5 through 7 dry, and chromas of 5 through 8. The texture ranges from very cherty clay loam to very cherty clay. The soil material makes up from about 5 to 35 percent of this horizon. This horizon grades to cherty limestone or unconforming material at depths of 5 to 30 feet.

Competing Series and Their Differentiae: These are the Eldon, Eldorado and Florence soils. The Eldon soils have less than 35 percent chert throughout the argillic horizon. The Eldorado soils have less than 35 percent average clay content in the upper 20 inches of the argillic horizon and have more than 50 percent base saturation throughout the argillic horizon. The Florence soils are dry in some part of the 4 to 12 inch horizon for more than 90 cumulative days in most years and have sola less than 60 inches thick or the clay content decreases by more than 20 percent of the maximum clay content within 60 inches depth.

Setting: The Craig soils are on uplands. Slope gradients are from about ½ to 5 percent, mainly less than 3 percent. The Craig soils formed in materials weathered from cherty limestones (see remarks). The average annual rainfall is from about 37 to 47 inches and annual Thornthwaite P-E indices of 64 to about 80. The average annual air temperature is from 57° to about 62°F.

Principal Associated Soils: These are the competing Eldorado soils and Dennis, Parsons, and Bates soils. The Dennis, Parsons, and Bates soils contain little or no chert.

Drainage and Permeability: Well drained; runoff is medium; permeability is moderately slow.

Use and Vegetation: Mainly cultivated to small grains and sorghums. Lesser amounts are in native range of tall prairie grasses, or improved pasture. The native vegetation is tall grass prairie.

Distribution and Extent: Northeast Oklahoma and possibly in southwestern Missouri, northwestern Arkansas, and southeastern Kansas.

Series Established: Craig County, Oklahoma 1931.

Remarks: The Craig soils have been classified as Brunizems in recently completed soil surveys. The upper part of these soils to as much as 30 inches depth is believed to have formed in some cases from sandstone, siltstone, sandy shale or alluvial or aeolian sediments.

National Cooperative Soil Survey
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CROWLEY SERIES

The Crowley soils are members of a fine, montmorillonitic, thermic family of Typic Albaqualfs. They have gray A1 horizons, gray silty clay or silty clay loam Bt horizons prominently mottled with red, and an abrupt textural change between the A2 and Bt horizons.

Typifying Pedon: Crowley silt loam - rice stubble field (Colors for moist conditions)

Ap1	0-4"	Gray (10YR 5/1) silt loam; many fine distinct yellowish red streaks and stains around root channels; weak fine granular structure adhering as massive; friable; strongly acid; abrupt smooth boundary. (3 to 6 inches thick.)
Ap2	4-8"	Dark gray (10YR 4/1) silt loam; common fine distinct dark brown mottles; massive; firm; many fine soft black concretions; medium acid; clear smooth boundary. (0 to 5 inches thick.)
A2g	8-16"	Grayish brown (10YR 5/2) silt loam; few fine faint dark yellowish brown mottles; massive; friable; common fine pores; few fine brown black concretions; clay content increases in lower part of horizon; strongly acid; clear wavy boundary. (5 to 15 inches thick.)
B2gt	16-29"	Dark gray (10YR 4/1) and gray (10YR 5/1) silty clay loam to silty clay; many fine prominent red mottles; ped surfaces have continuous coatings of dark gray (10YR 4/1) in the upper part grading to gray (10YR 4/1) in the lower part; moderate fine angular blocky structure adhering as moderate medium prismatic; very firm; distinct continuous clay films; common hard black concretions; about 10 percent of horizon is vertical tongues of dary gray silt loam 1 to 2 inches in diameter; medium acid; gradual wavy boundary. (10 to 22 inches thick.)
B31gt	29-48"	Gray (10YR 5/1) silty clay loam; many medium distinct yellowish brown mottles; ped surfaces have discontinuous coatings of gray (10YR 5/1) streaked with dark gray (10YR 4/1); moderate medium subangular blocky structure adhering as moderate medium prismatic; very firm; distinct patchy clay films; common hard black concretions; tongues of dark gray silt loam as above; neutral; gradual wavy boundary. (10 to 22 inches thick.)
B32g	48-60"	Light brownish gray (10YR 6/2) silty clay loam; many fine distinct yellowish brown mottles; weak coarse subangular blocky structure; few hard black concretions; a few soft and hard carbonate concretions; mildly alkaline. (10 to 20 inches thick.)

Type Location: Acadia Parish, Louisiana; 800 feet west and 69 feet south of the NE corner NW¼ Section 3, T9S, R1W, 4.5 miles north of Eagan; 2.4 miles east of Highway 91.

Range in Characteristics: Combined thickness of the A horizons ranges from 12 to 25 inches. Solum thickness ranges from about 48 to 60 inches. The content of extractable sodium increases with depth and ranges from 5 to 15 percent of the exchange capacity in the lower part of the solum. Vertical streaks of silt loam are common throughout the B horizon that are as low or lower in value than the matrix of the B. Total sand content ranges from about 15 to 30 percent and is dominated by the very fine sand fraction. The A1 or Ap horizons are 4 or 5 in value and 1 or 2 in chroma in hues of 10YR and may range to 3 value in the lower part or in uncultivated areas. The A2g horizons are 4 to 6 value and chroma of 1 or 2 in hues of 10YR with few to common mottles of brown to yellowish browns. Silt loam is the only type known to occur. Thin transitional horizons often occur between the A2 and B2t that barely qualify as an abrupt textural change. The boundary between the A2 and B2gt horizon is abrupt to clear and smooth to wavy. Reaction of the A horizon ranges from very strongly acid to medium acid but may be neutral from addition of irrigation water. The B2gt horizons have matrix colors of 4 to 6 in value and 1 or 2 in chroma in hues of 10YR with common to many fine to medium yellowish red, dark red, or red mottles. Ped surfaces in the B2gt horizon are typically 10YR 3/1 to 10YR 4/1 but range to 10YR 5/1. Texture of the B2gt ranges from heavy silty clay loam to silty clay. Reaction ranges from very strongly acid to medium acid. The B3 horizons have values of 5 or 6 with chroma of 1 or 2 in hues of 10YR to 5Y typically mottles with yellowish brown to light olive brown but ranging to red. Clay content of the B3 horizon is slightly less than the B2gt, is typically silty clay loam but ranges to silty clay. Reaction of the B3 increases with depth and becomes neutral to moderately alkaline in the lower part.

Competing Series and Their Differentiae: These are the Carroll, Megget, Acadia, Midland, Stuttgart, Wrightsville, Zachary, Forestdale, and Patoutville. Carroll soils have less sand and lack reddish mottles. Megget soils are less acid and calcareous at shallower depth. Acadia soils lack the abrupt textural change and have transitional horizons of 3 chroma or more between A1 and B2t. Midland soils have finer textured A horizons and lack A2 horizons. Stuttgart soils have browner A horizons, Wrightsville soils have tongues of A2 extending into a B horizon without dark ped coatings. Zachary soils have thicker A horizons and less fine textured B horizons, having less than 35 percent clay. Forestdale soils lack reddish mottles and an abrupt textured change from A to B. Hillemann soils have less fine textured B horizons, having less than 35 percent clay, and exceed 15 percent sodium saturation in the lower part of the solum. Patoutville soils are less fine textured, having less than 35 percent clay.

Setting: The Crowley soils occur on nearly level to level Pleistocene terraces with flat to very slightly convex slopes. Circular mounds of about 50 to 75 feet in diameter and 15 to 30 inches high were common but most of these have been leveled. The parent material consists of a silty overburden over more clayey material presumed to be of alluvial origin. At the type location mean annual air temperature is 68° F. and average annual rainfall about 59 inches.

Principal Associated Soils: These are the Acaia soils, the better drained stuttgart soils and the more poorly drained midland soils.

Drainage and Permeability: Centers on the lower side of somewhat poorly drained and includes the upper range of poorly drained. Runoff and internal drainage are slow, permeability very slow. A perched water table occurs in the A2 horizon in wet seasons.

Use and vegetation: Native vegetation was tall prairie grasses. Most of the soils are now cultivated and used for rice, soybeans and rotation pasture with come cotton, corn, and sweet potatoes.

Distribution and Extent: Louisiana, Arkansas, and Texas. The series is extensive.

Series Established: Acadia Parish, Louisiana, 1903.

Remarks: The type location is on the lighter textured side of the range. These soils were formerly classified as Planosols. The presence of a thin transitional horizon between A2 and B2t in a number of profiles raises some question as to whether or not all soils that seem to belong in the Crowley series will have an abrupt textural change. Vertical tongues and veins of silt loam described in many pedons are typically as dark or darker than the matrix of the B horizon and are considered to be Krotovinas rather than tonguing of an Albic horizon into the Argillic horizon.

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Established Series

DALE SERIES

The Dale series comprises fertile well-drained dark youthful soils occurring in the Reddish Prairie and adjoining soil zones, mainly in east-central Oklahoma, on low terraces above overflow along the Canadian River and similar streams. The series is developed in nonreddish alkaline alluvium that is relatively high in content of plant nutrients and mostly about clay loam in texture. Dale soils are closely related to McLain but less reddish; they are darker than Canadian and Arkansas soils, and have less heavy subsoils than Brewer and Kay.

Soil Profile:		Dale silty clay loam	Range in Thickness
A_1	0-20"	Dark grayish-brown (10YR 3/2; 2/2, moist) silty clay loam; strong medium granular; friable; permeable; about neutral.	15-25"
A_3	20-30"	Brown (10YR 5/3; 4/4, moist) silty clay loam; strong medium granular; friable; neutral to alkaline.	5-25"
C	30"+	Yellowish-brown somewhat stratified alluvium averaging about clay loam in texture; becomes distinctly sandy at depths ranging from 3 to 6 feet; neutral to calcareous.	

Range in Characteristics: Color of surface soil ranges from dark grayish-brown to dark brown and grayish-brown (hues yellower than 7.5YR; values 2.5 to 4.5; chromas 1.5 to 3); horizons 1 and 2 may contain thin layers of clay or sand; decidedly sandy substrata are confined mainly to areas along through-flowing rivers, which are most extensive, and uncommon in areas on small streams; films or concretions of segregated $CaCO_3$ occur in the lower subsoil of some areas.

Topography: Level or nearly level areas on low undissected stream terraces; surfaces plane or weakly convex.

Drainage: Slow from the surface; free internally; most areas lie above the highest floods on record but some are very rarely inundated.

Vegetation: Dense hardwood forest in the more eastern areas; deciduous trees and grasses in the more western.

Use: Almost entirely in cultivation and devoted mainly to alfalfa, corn, cotton, and small grains; fertile and highly productive.

Distribution: Oklahoma and southern Kansas on low terraces mainly along the Canadian and Arkansas Rivers.

Remarks: The series name is from a village in northwestern Pottawatomie County, Oklahoma.

Type Location: Okfuskee County, Oklahoma (1/10 mile north of south quarter corner Section 32, T11N, R9E).

Series Established: Okfuskee County, Oklahoma, 1940.

Colors are described with provisional Soil Survey color names (1946) and unless stated otherwise refer to dry soil.

EGF
9-27-40
Rev. EGF 2-11-42
Rev. EHT 2-18-47

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Established Series

DARNELL SERIES

The Darnell series comprises forested Lithosols developed on noncalcareous mostly reddish sandstones in the broad transition between the zones of Red and Yellow Podzolic and Reddish Prairie Soils. The zonal soils developed on similar materials under forest are Stephenville and Windthorst. The Darnell series is closely related to Hector, but occurs under lower rainfall and is slightly darker, less acid, and less strongly leached. The grassland analogue of Darnell is Lucien.

Soil Profile:		Darnell fine sandy loam	Range in Thickness
A_1	0-5"	Grayish-brown fine sandy loam; very weakly granular; very friable; slightly acid; grades to horizon below.	3-7"
A_2	5-12"	Light-brown light fine sandy loam structureless; very friable moist; nearly loose when dry; contains fragments of sandstone in its lower part.	6-15"
C		Yellowish-red noncalcareous sandstone.	

Range in Characteristics: Color of the surface soil ranges from grayish-brown to brown and of the A_2 from light brown to reddish-yellow or pale brown; locally there is a thin B horizon 2 to 5 inches thick of reddish-brown light loam; sandstone outcrops are common; depth to sandstone bedrock ranges from 6 to 20 inches within a distance of a few feet.

Topography: Erosional upland with gradients ranging up to about 15%.

Drainage: Rapid from the surface and internally.

Vegetation: Scrub forest of blackjack and post oak.

Use: Mainly as woodland pasture of low carrying capacity and affording forage of indifferent nutritive quality.

Distribution: Cross timbers of central Oklahoma and Texas.

Type Location: Payne County, Oklahoma.

Series Established: Payne County, Stillwater Creek Project, Oklahoma, 1937.

Remarks: Colors are approximate provisional Soil Survey colors and refer to dry soil.

EGF-MB
4-13-37
Rev. HO-EHT
1-7-47

Division of Soil Survey
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Established Series

DENNIS SERIES

The Dennis series comprises deep well-drained Prairie soils developed principally from noncalcareous silty or sandy Pennsylvanian "shales" within the grasslands, known as the Cherokee Prairies, in eastern Kansas, eastern Oklahoma and western Missouri. They are deeply developed soils formed in sediments of about clay loam texture, which are very low in weatherable minerals and have montmorillonite dominant in the clay faction. The sola are generally 3 1/2 to 6 feet deep and characterized by (1) gradational changes between all horizons, (2) relatively thick B_1 or AB horizons, and (3) yellowish B_2 horizons of relatively compact, blocky medium clay loam to light clay mottled with reddish-brown spots and lying (in uneroded areas) more than 16 inches below the surface. As the parent materials become more sandy, the Dennis series grades into Bates soils, which has a less clayey friable B horizon generally underlain by sandstone within 4 feet or less. With increased clay content and an abrupt A-B horizon boundary, the Dennis soils give way to the Parsons series, even though the B_2 horizon may be less yellowish and more clayey than in the latter soils. Dennis soils are more acid and slightly less dark and clayey than the Okemah series. The A horizon is less thick than in Choteau soils and lacks the light colored lower part, or A_2, characteristic of that series. The associated Lithosols are Talihina soils (on shale) and Collinsville soils (on sandstone).

Soil Profile: Dennis silt loam--virgin

A_1 0-15" Dark grayish-brown (10YR 4/2) silt loam becoming heavy silt loam at 10 inches, very dark brown (10YR 2.5/2) when moist; moderate medium granular structure; friable; pH 5.5; gradual boundary.

B_1 15-20" Brown (10YR 5/3) coarse clay loam, dark brown (10YR 4/3) when moist; strong coarse granular or fine subangular blocky structure; firm; pH 5.5; gradual boundary.

B_2 20-40" Yellowish-brown (10YR 5/4) fine clay loam, dark yellowish brown (10YR 4/4) when moist; much mottled with reddish brown; strong medium irregular blocky structure becoming coarser and more cuboidal with depth; the peds coated with distinct continuous clay skins; very firm; some iron concretions present; pH 5.5 above, becoming 6.0 below; gradual boundary.

B_3 40-60" Coarsely mottled yellowish-brown, strong brown, and very pale brown fine clay loam or coarse clay; moderate coarse blocky structure; very firm; pH 6.0 to 6.5; diffuse boundary.

C 60-80" Coarsely mottled or banded yellowish-brown and pale brown compact fine clay loam showing obscure bedding planes that become more distinct with depth; noncalcareous; this represents slightly altered Pennsylvanian "shale". The beds are nonfissile and discolored by weathering to depths of more than 15 feet.

Page 2--Dennis Series

Range in Characteristics: Texture of A horizon ranges from silt loam to loam; of the B_2 horizon from medium clay loam to fine clay or silty clay. In uneroded areas, thickness of the A horizon ranges between about 10 and 16 inches; depth to the B_2 horizon is between about 16 and 24 inches. Thickness of the B_1 horizon ranges between 2 and 12 inches. Texture of the B_2 horizon ranges from medium clay loam to fine clay or silty clay; the color varies much in details of mottling and becomes 7.5YR hue in local places. Occasional thin layers of sandstone occur in substrata; thin lenses of limestone occur in some exceptional localities. Eroded phases are common on the stronger slopes. Except where specified moist, the colors refer to dry soil.

Topography: Undulating to rolling erosional upland. Slopes of about 1/2 to 10%, mostly 1 to 5%. Surfaces mostly convex.

Drainage and Permeability: Medium to rapid from the surface; slow or very slow internally. The ground water table remains well below the solum. Well drained.

Vegetation: Tall-grass prairie.

Use: Mostly as cropland. Principal crops are small grains, corn, alfalfa, some cotton in the southernmost areas. Moderately to high productive where uneroded and well managed.

Distribution: Very extensive in the shale prairies of eastern Oklahoma, eastern Kansas and western Missouri; some in Arkansas.

Type Location: Wagoner County, Oklahoma; 3 1/2 miles NW of Wagoner; 600 feet east and 250 feet north of southwest corner of Section 29, T18N, R18E.

Series Established: Verdi-Grand SCD, Wagoner County, Oklahoma, 1941.

The series name is from a village in Labette County, Kansas.

Remarks: Relatively complete analyses are available from three relatively typical profiles (53-OK-59-37; 53-OK-73-20, and 53-OK-73-23) from Pawnee and Wagoner Counties, Oklahoma.

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DENTON SERIES

The Denton series includes brownish calcareous granular Rendzinas of medium depth developed from interbedded limestone and marl under a grass cover in a warm humid zone. These soils occupy very gently to moderately sloping areas associated with the San Saba soils which are darker, flatter, and less permeable, and the Blanket soils which are deeper, less sloping, and somewhat grayer. Associated Lithosols are the Brackett and Tarrant series.

I. Soil Profile (Denton clay):

	Depth	Description	Range in Thickness
1.	0-10"	Dark-brown (7.5YR 3/2; same moist) clay; strong medium granular; friable; hard; sticky and plastic when wet; calcareous; grades to	8-14"
2.	10-26"	Brown (7.5YR 4/3; dark-brown 7.5YR 3/4 moist) clay; strong medium granular; firm, very hard; sticky and plastic wet; strongly calcareous; contains a few small concretions of $CaCO_3$ in lower part.	10-20"
3.	26-34"	Brown (7.5YR 6/4; light-brown 7.5YR 5/4 moist) light clay; friable; hard; strongly calcareous; contains a large amount of small hard masses of $CaCO_3$.	6-10"
4.	34-70"+	Limestone interbedded with soft chalky marl, or broken fragments of limestone mixed with marl.	

II. Range in Characteristics: Color of horizon 1 ranges from very dark brown to grayish brown; the surface layer is either calcareous or neutral but not acid; clay is the principal texture but clay loams occur in the shallow phases and stony types. Soils with solum 10 to 18 inches deep are shallow phases; Lithosols with solum less than 10 inches deep, formerly included in the Denton series, are now classes as Tarrant.

III. Topography: Undulating to gently rolling; typically with gradient of 1 to 4 percent.

IV. Drainage: Rapid from the surface; moderate to slow internally.

V. Vegetation: Mainly tall bunch grasses with some short grasses; scattered clumps of live oak in places especially on shallow phases.

VI. Use: Largely farmed to small grains; cotton, sorghums, and corn; very fertile; some areas of normal soil and shallow phases in native grass pasture which was high carrying capacity during normal years.

VII. Distribution: Central and north-central Texas in Grand Prairie section and in southern Oklahoma.

Page 2--Denton Series

Type location: Denton County, Texas
Series established: Denton County, Texas, 1918.

VIII. Remarks: Colors are Provisional Soil Survey color names based on Munsell Color Charts and are of dry soil unless stated otherwise.

Rev. HO Division of Soil Survey, Bureau of Plant Ind., Soils, & Agr.
5-16-46 Engr., Agr. Research Adm., U. S. Department of Agriculture

DERBY SERIES

The Derby series includes sandy soils of the Reddish Prairie soils zone developed largely from old unconsolidated water-laid sandy deposits which have been more of less shifted and reworked by wind. These soils have little profile development. They are the Reddish Prairie soils-zone correlatives of the Tivoli soils which occur in the Reddish Chestnut and Reddish-Brown soils zones. They differ from Valentine soils chiefly in having a noticeably reddish tinge in the solum.

1. Soil Profile: (Derby loamy fine sand) — Range in thickness

			Range in thickness
1.	0-8"	Brown (7.5YR 4/3)/ noncalcareous loose, slightly acid loamy fine sand.	4 to 10 in.
2.	8-60"	Light-brown (7.5YR 6/4) incoherent or only slightly coherent, slightly acid, loamy fine sand. The color generally becomes slightly lighter below three feet.	Several feet thick.

II. Range in Characteristics: In some places, the reddish tinge is less pronounced and layer 2 is light yellowish brown or pale yellow.

III. Topography: Nearly level to undulating; hummocky or dune-like in places.

IV. Drainage: External drainage is good, but stream channels are poorly established as these soils rapidly absorb the rain. Internal drainage is good to excessive.

V. Vegetation: Coarse grasses and shrubs, also some scattered oak trees in places. Big bluestem is the dominant grass.

IV. Use: Chiefly for growing cotton, corn, sorghums, and sorge. Some truck crops are produces. The excessively sandy types are used mainly for pasture.

VII. Distribution: Central and central-western Oklahoma and southern Kansas.

VIII. Remarks: As originally mapped, the Derby series also included silt loam soils, with clayey but friable subsoils, developed from deeply leached loess. These soils are now called Geary series.

Type location: Grant County, Oklahoma

Series established: Wichita Area, Kansas, 1902

1/ Provisional Soil Survey color names based on Munsell color charts.

DOUGHERTY SERIES

The Dougherty series consists of Red-Yellow Podzolic soils of high base status with a B horizon of red to yellowish-red friable sandy clay loam. Dougherty soils are developed under subhumid climate and scrub-oak forest from old (mostly Plio-Pleistocene), slightly acid to weakly alkaline, moderately sandy alluvium of streams such as the Red and Canadian Rivers, which drain subhumid areas underlain in part by red beds. The Dougherty series differs from Teller soils in being more acid and leached, and in having a distinct light colored A_2 horizon. It is very closely related to the Milam series, recognized along streams south of the Red River. It differs from soils such as the Ruston, Orangeburg, Chattahoochee, and Cahaba series, which occur under more humid environment, in being less acid and of higher base status in the B and the upper C horizons. The Dougherty series is the counterpart of the Stephenville series developed in unconsolidated terrestrial sediments. This series is of moderate extent and agricultural importance.

Soil Profile: Dougherty fine sandy loam--forested

A_1	0-5"	Grayish-brown (10YR 5/2) light fine sandy loam, dark grayish-brown (10YR 4/2) when moist; very weak granular structure; very friable; slightly acid; gradual boundary. 3 to 12 inches thick.
A_2	5-14"	Light brown (7.5YR 6/4) light fine sandy loam, brown (7.5YR 5/4) when moist; very weak granular structure to massive; very friable; slightly acid; gradual boundary. 7 to 12 inches thick.
B_2	14-38"	Red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) when moist; hard, friable; medium acid; diffuse boundary. 20 to 30 inches thick.
B_3	38-60"	Reddish-yellow (5YR 6/8) sandy clay loam, yellowish-red (5YR 5/8) when moist; massive; friable; slightly acid. 15 to 30 inches thick.
C	60-80"+	Reddish-yellow (5YR 6/6) sandy alluvium, yellowish-red (5YR 5/6) when dry; thick strata of loamy fine sand to fine sandy loam interrupted by occasional more clayey strata; slightly acid to weakly alkaline.

Range in Characteristics: Fine sandy loam, very fine sandy loam, and loamy fine sand are the principal types. In cultivated areas, the A_p horizon is pale brown. In the loamy fine sand type, the depth to B horizon of sandy clay loam is 15 to 30 inches. The color of the B horizon ranges from red to yellowish-red and strong brown (hues of 2.5YR to 7.5YR); its texture, from sandy clay loam to heavy fine sandy loam (about 15 to 30% clay). Acidity of the A horizons ranges from slight to medium; of the B, from medium to strong. Locally, a few waterworn pebbles, generally quartzite or chert, occur throughout the solum. In many areas, the material below 3 or 5 feet is layered or mottled with light yellow. Eroded phases are common. Colors are for dry soil, except as otherwise indicated.

Topography: Undulating to nearly level upland comprising dissected old alluvial plains lying 30 to 200 feet above the present flood plains. Surfaces mostly convex with gradients between 1 and about 15% but mostly less than 3%.

Drainage and Permeability: Good. Medium to rapid from the surface; medium internally.

Vegetation: Mainly post oak, blackjack oak, hickory and elm, which form an open-canopied forest with considerable ground cover of little bluestem and other grasses.

Use: A half or more of the total area has at some time been cleared and cropped. Much former cropland has been abandoned. The principal cultivated crops are cotton, corn, sorghums, peanuts, vegetables, fruits, and improved pasture. Fertility is low, but physical characteristics are very favorable and responsiveness to management is very high. The environment is drier than favorable for forestry.

Distribution: Mainly in central and southern Oklahoma west of the 42-inch rainfall line on old terraces along the Red, Canadian, and Washita Rivers. Lesser areas occur in Texas along the Red River; a few small areas occur in eastern Kansas.

Type Location: Murray County, Oklahoma; middle of Section 18, T1N, R2E.

Series Established: Murray County, Oklahoma, 1935.

Remarks: So far as is now known, there is no appreciable difference between the Dougherty series and the previously established Milam series from Texas; however, the parent material of Dougherty contains a somewhat higher proportion of sediments from red beds. The parent alluvium, known as the Gertie formation, is generally classed as early Pleistocene.

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DURANT SERIES

The Durant series is a member of the fine, montmorillonitic, thermic family of Vertic Argiustolls. They have dark loam A1 horizons, and Bt horizons that are firm, heavy silty clay loam in the upper part and very firm clay in the lower part.

Typifying Pedon: Durant loam - cultivated
(Colors are for moist soil unless otherwise stated.)

A1 0-10" Very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; hard, friable; medium acid; gradual smooth boundary. (8 to 12 inches thick.)

B21t 10-18" Dark brown (10YR 3/3) heavy silty clay loam, brown (10YR 5/3) dry, common medium prominent reddish brown (5YR 4/4) mottles; moderate fine and medium subangular blocky structure; very hard, firm; medium acid; gradual smooth boundary. (3 to 10 inches thick.)

B22t 18-38" Olive brown (2.5Y 4/4) clay, light olive brown (2.5Y 5/4) dry, common medium prominent yellowish red (5YR 5/6) mottles and a few medium faint grayish brown (2.5Y 5/2) mottles in the lower part; moderate medium blocky structure; extremely hard, very firm; continuous clay films; medium acid; gradual smooth boundary. (10 to 30 inches thick.)

B23t 38-48" Olive brown (2.5Y 4/4) clay, light olive brown (2.5Y 5/4) dry, few fine prominent reddish brown and gray mottles; weak medium blocky structure; extremely hard, very firm; clay films on most ped surfaces; many small iron and manganese concretions; few hard calcium carbonate concretions; slightly acid; gradual smooth boundary. (5 to 20 inches thick.)

B3 48-60" Olive brown (2.5Y 4/4) clay, light olive brown (2.5Y 5/4) dry; weak blocky structure; extremely hard, very firm; few hard calcium carbonate concretions; neutral. (5 to 20 inches thick.)

Type Location: Bryan County, Oklahoma; about 6 miles northeast of Durant; 1000 feet west and 330 feet north of the southeast corner of Sec. 30, T5S, R10E.

Range in Characteristics: In most years, these soils are dry for less than 135 cumulative days in some subhorizon between 7 and 20 inches depth. Soft powdery lime is within 60 inches of the surface in part of the soil. The soil has cracks at some seasons in most years that are 1 cm. or more wide at a depth of 50 cm. (20 inches) and that are at least 30 cm. (12 inches) long in some part. They have a potential linear extensibility of 6 cm. or more in the top 40 inches of the soil. The sola extend to depths of more than 50 inches. The A1 horizon has hues of 10YR or 7.5YR, values of

2 or 3 moist and 4 or 5 dry, and chromas of 2 or 3. The texture is loam, silt loam, light clay loam, or light silty clay loam. The reaction is medium or slightly acid. The lower boundary is gradual or clear. In some pedons the B21t horizon has colors like the A horizon and it is considered part of the mollic epipedon. Where the A horizon is near the thick end of its range, the B21t horizon commonly has higher color values and chromas. Fine brownish or reddish mottles are few or common in the B21t horizon. The texture is heavy clay loam, heavy silty clay loam or light clay. The consistence is commonly firm, but some is very firm in the lower part. The reaction is medium or slightly acid. The B22t horizon has hues of 7.5YR through 2.5Y, and values of 3 or 4 moist and 4 or 5 dry. Where hue is 7.5YR chroma is 2 through 4 and where hue is 10YR or 2.5Y chroma is 2 through 6. The B22t horizon has few to many reddish or brownish mottles or both, and some part of the soil has few grayish brown mottles. The texture is clay. The clay content ranges from about 45 to 55 present. The consistence of the B22t horizon when moist is very firm or extremely firm. The reaction is medium acid to neutral. The B23t and B3 horizons have about the same colors and about the same clay content as the B2t horizons. The reaction of the B23t and B3 horizons is slightly acid to mildly alkaline. Hard calcium carbonate spots are in the lower part of the soil, and some of the soil contains a few soft limy spots.

Competing Series and Their Differentiae: These are the Bonham, Crockett, Dennis, Hollister, Kirkland, and Renfrow soils. The Bonham soils have B1 horizons that are less compact, less firm and less clayey than the upper part of the B2t horizons of the Durant soils. The Crockett soils lack mollic epipedons, and their A horizons are thinner, less dar, or lower in organic matter. The Dennis soils have B1 horizons, and they lack lime within 60 inches depth. The Hollister soila hve B1 horizons, and in most years they are dry for more than 135 days in some part between depths of 7 to 20 inches. The Kirkland soils have an abrupt boundary to the Bt horizons that are more compact and firmer. The Renfrow soils are of redder hue and have very firm, compact clays at less depth.

Setting: The Durant soils are on nearly level to gently sloping uplands. Slope gradients are between 1 and 5 percent. The Durant soils formed in calcareous or alkaline, clayey shales or clay beds. The Thornthwaite annual P-E index is about 50 to 70, mean annual air temperature is about 62° to 66° F., and the mean annual precipitation is about 32 to 43 inches.

Principal Associated Soils: These are the Bates, Burleson, and Woodson soils and the competing Dennis soils. The Bates soils have less than 35 percent clay in the upper 20 inches of the Bt (argillic) horizon. The Burleson soils are clayey and have intersecting slickensides. The Woodson soils are saturated with water at some season and have Bt horizons that are very firm and compact in the upper part.

Drainage and Permeability: Moderately well drained. Runoff is slow to medium; permeability is very slow.

Use and Vegetation: Used for growing cotton, small grains, sorghums, and corn, for tame pastures, and for native range. The native vegetation is tall grass prairie.

Distribution and Extent: Southeastern Oklahoma and northeastern Texas. The soil is of moderate extent.

Series Established: Bryan County, Oklahoma, 1906.

Remarks: These soils were formerly classified as Reddish Prairie soils.

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Established Series

DWIGHT SERIES

The Dwight series is of moderately dark Planosols that have unusually thin A horizons, slightly to medium acid B_2 horizons of claypan character, and mildly calcareous or alkaline silty to clayey substrata. They occur on smoothly rounded, generally narrow drainage divides in the moist subhumid shale and limestone prairies of eastern Kansas, mainly in association with the Idana, Ladysmith, Florence, Sogn, and Dennis series. Although generally underlain within 6 feet by mildly calcareous, weakly consolidated shale, the solum in the areas studied to date, seems to be wholly within a thin mantle of loess. The Dwight series is distinguished from Idana and Ladysmith by A horizon less than about 8 inches thick, abrupt boundary between the A and B horizons, and absence of any degree of granular to subangular structure in the upper part of the B.

Soil Profile: Dwight silty clay loam--virgin

A_1 0-5" Dark grayish-brown (10YR 4/1.5) dry, very dark grayish-brown (10YR 2.5/2) moist; light clay loam weakly platy structure in upper inch, very weakly granular structure below; friable; hard; pH 5.5; abrupt boundary. 4 to 6 inches thick.

B_2 5-22" Dark grayish-brown (10YR 4/2) clay, very dark grayish-brown (10YR 3/4) moist; moderate or strong medium columnar structure; when dry, structure weakening with moisture and becoming massive when wet; extremely firm; extremely hard when dry; thick conspicuous clay skins coat the peds and plug pores; the color becomes about 0.5/ in value less dark and the structure grades to moderate medium to coarse irregular blocky below 15 inches; visible pores and worm casts are wanting or sparse; pH 6.3 at 10 inches and 7.3 at 20; gradual boundary. 15 to 20 inches thick.

B_3 22-35" Brown (10YR 5.5/3) light silty clay, brown (10YR 4/3) moist; weak coarse blocky structure; very firm; clay skins are present but less pronounced than above; relatively nonporous or dense; contains a few fine soft concretions of $CaCO_3$, but otherwise noncalcareous; pH 7.8; gradual boundary. 10 to 15 inches thick.

C 35-55" Pale brown (10YR 6/3) heavy silty clay loam, brown (10YR 5/3) moist; mottled with strong brown, colors grading to mottled light brownish-gray and light yellowish-brown in the lower half; firm and relatively nonporous; noncalcareous except for a few lime concretions in the upper half. This seems to be leached and partially weathered loess. 18 to 25 inches thick.

C_u 56-70"+ Pale yellow and light brownish-gray mildly calcareous clay comprising slightly weathered weakly consolidated Pennsylvanian shale.

Range in Characteristics: The A horizon ranges from 2 to 8 inches thick where undisturbed and may be absent in eroded phases. Apart from cultivated areas which become browner, its dry color ranges from dark grayish-brown to gray (values 4 to 5, chromas 2 to 1); where the A is more than 5 inches thick, the lower inch often is slightly less dark or has gray coatings. Color of the B_2 deviates up to 2.5 in hue, 1 in value, and 1 in chroma from the above profile. Thickness of solum ranges between about 25 and 45 inches. The less clayey C horizon, interpreted as altered loess, ranges from 4 feet thick to wanting and at least part of the solum may be in residuum.

Topography: Nearly level to gently sloping convex surface in erosional upland. Mostly on narrow rounded drainage divides. Gradients of about 1/2 to 3 percent.

Drainage and Permeability: Well-drained, but droughty. Surface water does not stand; permeability of the subsoil is very slow when moist, perhaps rapid when dry and opened by contraction crevices. Apart from saturated A horizon during wet weather, no water table occurs within a depth of many feet. The geomorphology makes occurrence of ground water near the surface at any time during development of the soil improbable.

Vegetation: Prairie. In native pastures, the taller grasses, such as Indian and big bluestem, are sparse and midgrasses generally more prevalent then on associated soils without claypan so near the surface.

Use: Largely in native range. A considerable part of what has been cropped has reverted to pasture. Reportedly very droughty and relatively unproductive for warm-season crops.

Distribution: Mainly in eastern Kansas south of the Kaw Valley and east of U. S. 77, where mean annual precipitation is between 30 and 40 inches, and in northeastern Oklahoma. Total extent is of the order of 20 to 100 thousand acres. The soil generally occupies considerable bodies to the exclusion of other soils and does not have the patchy distribution usual to Solodized Solonetz.

Type Location: Southeastern Geary County, Kansas; 550 feet east and 300 feet north of the south quarter corner of Secion 10, T12S, R8E.

Series Established: Geary County, Kansas, 1956. The name is from a village in northeastern Morris County, Kansas.

Remarks: This series is intended to comprise all soils having sola of this extreme character irrespective of the character and geology of the substratum or parent material, except that these should be unconsolidated, clayey to loamy, neutral to calcareous, and of color less red than hue 5YR. The pH values given in the profile description are by hydrogen electrode potentiometer with 1 to 1 soil-water ratio. No analyses of exchangeable cations are available.

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ENDERS SERIES

The Enders series is a member of a clayey, mixed, thermic family of Typic Hapludults. These soils are very strongly acid and have brownish, loamy A horizons over yellowish-red, firm, plastic clayey B horizons. The C horizons are weathered shale.

Typifying Pedon: Enders gravelly very fine sandy loam - forest (Colors are for moist condition)

Aoo	2-0"	Leaf and twig litter.
A11	0-2"	Very dark grayish brown (10YR 3/2) gravelly very fine sandy loam; weak fine granular structure; very friable; many fine and medium roots; common shale and sandstone fragments 1/2 to 3 inches in diameter; very strongly acid; clear wavy boundary. 1 to 3 inches thick.
A12	2-5"	Dark brown (7.5YR 4/4) gravelly loam; weak medium granular structure; very friable; many fine and medium roots; common shale and sandstone fragments 1/3 to 3 inches in diameter; very strongly acid; clear wavy boundary. 2 to 5 inches thick.
B1t	5-8"	Yellowish red (5YR 4/6) silty clay loam; weak medium subangular blocky structure; friable; few sandstone and shale fragments; many fine and medium roots; very strongly acid; gradual wavy boundary. 2 to 6 inches thick.
B21T	8-22"	Yellowish red (5YR 4/8) silty clay; strong fine angular blocky structure; firm sticky, plastic; continuous thick clay film on peds; common fine roots; few fine pores; few sandstone and shale fragments; common fine pores; very strongly acid; gradual wavy boundary. 8 to 16 inches thick.
B22t	22-28"	Red (2.5YR 4/8) clay; common medium yellowish brown mottles; strong coarse subangular blocky structure that breaks to strong fine angular blocky; firm, sticky, plastic; thick continuous clay films; common fine roots; few shale fragments; few fine pores; very strongly acid; gradual wavy boundary. 0 to 8 inches thick.
B23t	38-29"	Variegated red (2.5YR 4/6) and gray (10YR 6/1) clay; strong fine angular blocky structure; firm sticky, plastic; continuous thick clay film; few fine roots; few fine pores; few shale fragments; few fine brown concretions; very strongly acid; gradual wavy boundary. 8 to 13 inches thick.
B3	39-46"	Variegated gray (10YR 6/1), red (2.5YR 4/6) and yellowish brown (10YR 5/6) silty clay; strong fine angular blocky structure; firm, sticky, plastic; 15 to 40 percent shale fragments; few hard concretions; few fine roots; very strongly acid; diffuse boundary. 5 to 8 inches thick.

C 46-62"+ Light gray (5Y 7/1) weathered shale with common coarse prominent dusky red mottles, mainly on cleavage faces; platy structure; shale fragments easily crushed; extremely acid. Grades into hard shale.

Type Location: Franklin County, Arkansas, 12 miles north of Ozark on Arkansas Highway 23, then 11.3 miles east on Barnes Road, then 100 feet north of Road. SW¼, SW¼, Sec. 25, T12N, R26W.

Range in Characteristics: Solum thickness is 32 to 58 inches, thickness of the B horizon is over 20 inches, depth to hard rock is 40 to 60 inches or deeper. Texture of the A horizons is fine sandy loam, very fine sandy loam, loam, or silt loam. Gravelly and stony phases are recognized. In cultivated areas, the Ap, about 5 inches thick, is brown (10YR 5/3). In severely eroded areas, the Ap is clay loam or silty clay loam, and has colors in hues of 7.5YR or 5YR, in value of 4 to 5, and chroma of 3 to 6. The A1 has colors in hues of 10YR, in value of 2 to 4, and in chroma of 2 or 3; but where value is 3 or less, thickness is less than 5 inches. The A12 is in hues of 10YR or 7.5YR, in value of 4 or 5, and in chroma of 3 to 6. The B1 is clay loam, silty clay loam, heavy loam, or heavy silt loam; colors are in hues of 5YR or 7.5YR, values are 4 or 5, and chromas are 4 to 8. Texture of the B2 horizon is silty clay or clay; colors are in hues of 5YR or 2.5YR, values are 4 or 5, and chromas of 6 or 8. The lower part of the B2 is usually splotched or mottled with brown and grays. Clay content in the upper 20 inches of the B horizons by weighted average is 35 to 60 percent. The B3 horizon is silty clay or clay and has a variegated or mottled color pattern of shades of reds, browns, and grays; in some pedons, the grays are lacking. Usually the C horizon has a relict rock structure. The A and upper B horizons have 2 to 15 percent shale fragments, the B3 has 15 to 40 percent fragments. Reaction is strongly acid to extremely acid throughout the profile. Cation exchange capacity per 100 grams clay is 30 to 50 milliequivalents; base saturation is less than 20 percent.

Competing Series and Their Differentiae: Within the same family as Enders are the Albertville, Conasauga, Enon, Hampshire, Kisatchie, Lockhart, Mecklenburg, and Wolfever series. With the exception of Mecklenburg all of these soils have B horizons in colors of 7.5YR or yellower. In addition, the Enon soils have Bt horizons less than 20 inches thick; Conasauga and Hampshire soils have sola less than 40 inches thick; Lockhart soils have a higher sand content, averaging textures of clay loam and sandy clay in the Bt horizons. Mecklenburg soils average pH 5.8 in the Bt horizons and base saturation is above 50 percent in the upper Bt horizons, dropping below 35 percent at about 50 inches. Competitors in related families are the Boswell, Cecil, Christian, Hayesville, Rarden, Sawyer, Sequoia, Shubuta, Townley, and Zuber series. The B horizons in Boswell soils exhibit shrink-swell features, having a coefficient of linear extensibility greater than 0.09. Cecil and Christian soils are dominated by Kaolinite, having less than 20 milliequivalents cation exchange capacity per 100 grams. Hayesville, Rarden, and Sequoia soils have average annual temperatures of less than 59° F. at a depth of 20 inches. Sawyer and Shubuta soils have Bt horizons thicker than 50 inches; in addition, the Sawyer soils are in hues yellower than 7.5YR and have chroma 2 mottles within 25 inches of the surface. Townley soils have B horizons less than 20 inches thick. Zuber soils have colors in hue

10YR, are mottles with chroma 2 or less at about 16 inches, and contain more phosphorout than Enders soil.

Setting: Enders soils are on slopes of 2 to 45 percent, in the mountain and valley areas of the Boston, sand and Cumberland Mountains. The regolith is clayey residuum over shale bedrock or interbedded shale and sandstone. Average annual air temperature at the type location is about 60^{o} F.; average annual rainfall is about 49 inches.

Principal Associated Soils: These are the competing Albertville soils and the Townley soils. Others are the Linker, Hartsells, Allen, and Holston soils which are less clayey and the Hector and Mountainburg soils which are sandier and shallow to bedrock. Montevallo soils are less clayey and contain more coarse fragments.

Drainage and Permeability: Well drained. Runoff is medium to rapid, depending on slope. Permeability is very slow.

Use and Vegetation: The principal use is woodland, but some acreage is in pasture and adapted row crops. A limited acreage is used for cotton, corn, and small grains. Native vegetation was forest of post, red, and white oak; hickory; and shortleaf pine.

Distribution and Extent: Boston Mountains in Arkansas and Oklahoma, Cumberland Plateau and Mountains and Sand Mountains areas in Alabama and Tennessee, possibly in Georgia. The series is of large extent, probably in excess of 500,000 acres.

Series Established: Pope County, Arkansas, 1938.

Remarks: The Enders series was classified in the Red-Yellow Podzolic Great Soil Group in the 1938 classification system.

Laboratory data for this series is in Lincoln Soil Survey Laboratory Report for Soils Sampled in Arkansas (1959-1960) under the series name Rarden, Laboratory samples number S60-Ark-24-1 and S60-Ark-24-2. This revision combines concepts of the Enders and the soils formerly called Rarden. The Rarden series are now confined to a mesic temperature zone.

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ENNIS SERIES

The Ennis series is a member of the fine-loamy, siliceous thermic family of Fluventic Dystrochrepts. These soils have brown silt loam A horizons, weakly developed dark yellowish-brown silt loam B horizons, and few to many chert fragments throughout.

Typifying Pedon: Ennis silt loam - cultivated
(colors are for moist soil)

Ap	0-10"	Brown (10YR 4/3) silt loam; moderate medium and fine granular structure; very friable; many roots; 5 percent by volume of chert fragments 2 mm to 50 mm in size; strongly acid; clear smooth boundary (5 to 12 inches thick.)
B21	10-18"	Dark yellowish-brown (10YR 4/4) silt loam; weak fine and medium subangular blocky structure; friable; common fine roots; 10 percent by volume of chert fragments 2 mm to 50 mm in size; strongly acid; clear smooth boundary. (8 to 15 inches thick.)
B22	18-35"	Dark yellowish-brown (10YR 4/4) silt loam; few fine pale brown mottles; weak fine and medium subangular blocky structure; friable; few fine roots; 12 percent by volume of chert fragments 2 mm to 75 mm in size; strongly acid; clear smooth boundary. (12 to 25 inches thick.)
Alb	35-45"	Dark brown (10YR 4/3) cherty silt loam; moderate medium granular structure; friable; 30 percent by volume of chert fragments 2 mm to 75 mm in size; strongly acid; clear smooth boundary. (0-12 inches thick.)
C	45-60"	Dark yellowish-brown (10YR 4/4) cherty silt loam; few fine and medium pale brown and light brownish-gray mottles; structurless; friable; 40 percent by volume of chert fragments up to 3 inches in size; strongly acid. (one to several feet thick.)

Type Location: DeKalb County, Tennessee. From Courthouse in Smithville 3.2 miles south on State Highway 56 to a gravel road turning left, then 2.2 miles on gravel road to a bridge over a creek then 100 yards down the creek to site location which is in narrow creek bottom 200 feet behind Claxton Cantrell home.

Range in Characteristics: Thickness of the solum ranges from 25 to 50 inches. Depth to bedrock ranges from 5 to 15 feet. Reaction ranges from very strongly acid through medium acid. The majority of these soils have coarse fragments of chert, gravel, or cobbles, with content of such fragments in each horizon ranging from a few percent up to 35 percent by volume. Color of the A horizon is in hue of 10YR, value is 4 or 5, and chroma ranges from 2 through 4. Surface soil textures are silt loam, loam, and rarely sandy loam. In a few of these soils the surface layer is yellowish-red silty clay loam recent overwash. The color of the B horizon is in hue of 10YR or 7.5YR, value is 4 or 5, and chroma ranges from 3 to 6. Texture of the B horizon is most commonly silt loam or loam, and rarely clay loam and silty clay loam. Clay content between a depth 10 and 40 is centered on 25 percent and ranges from 18 to 32 percent. Within these depths the sand content coarser than very fine sand is variable, ranging from 8 to 45 percent. This particle size plus coarse fragments exceeds 15 percent. The Alb horizon is not evident in all pedons, and may be at depths ranging from 25 to 50 inches below the surface. Color of the Alb ranges from dark brown to very dark grayish-brown. Color of the C horizon is in hues ranging from 2.5Y to 7.5YR, values of 3 to 5, and chroma of 2 to 6, and it may be mottled with shades of gray, yellow and brown. Textures of the C horizon ranges from sandy loam to silty clay loam with considerable chert present.

Competing Series and Their Differentiae: These are the Cascilla, Greendale, Lobelville, Neubert and Toccoa series. Cascilla soils have less than 15 percent sand plus coarse fragments between a depth of 10 and 40 inches.

Greendale soils have average annual soil temperature less than 59 degrees Fahrenheit at a depth of 20 inches. Lobelville soils have gray mottles within 20 inches of the surface. Neubert soils have A horizons with color value less than 4, also these soils have more reddish colors than Ennis soils and lack a cambic horizon. Toccoa soils contain less than 18 percent clay content within 10- to 40-inch depths and lack a cambic horizon.

Setting: Ennis soils are on bottomlands, in narrow strips along drainage-ways, and in depressions. Slopes range from 0 to 10 percent. The regolith consists of local alluvium washed from soils derived from limestone, shale, sandstone, and loess. At the site location mean annual air temperature is 59.0 degrees Fahrenheit, and average annual rainfall is 51.4 inches.

Principal Associated Soils: These are the competing Lobelville soils, and the Bodine, Dickson, Fullerton, Mountview, and Minvale soils all of which have well developed B horizons. In addition, Bodine soils have more than 35 percent coarse fragments in the solum, Dickson soils have a fragipan, Fullerton soils have a reddish clayey B horizon, Mountview soils have a yellowish silty B horizon, and Minvale soils have a reddish loamy B horizon.

Drainage and Permeability: Well drained. Runoff is slow and permeability is moderately rapid.

Use and Vegetation: Most areas are cleared and used for growing corn, cotton, tobacco, soybeans, small grains, hay, and pasture. The native vegetation was mixed hardwoods.

Distribution and Extent: The Great Valley and Highland provinces of Tennessee, Georgia, and Alabama, possibly in Arkansas and Oklahoma. The series is of moderate extent.

Series Established: Humphreys County, Tennessee, 1936.

Remarks: The Ennis series was classified in the Alluvial group in the modified 1938 yearbook classification.

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ERAM SERIES

The Eram series is a member of the clayey, mixed, thermic family of Typic Argiudolls. These soils have an A horizon of dark grayish-brown clay loam, a B horizon of grayish-brown clay containing at least 8 percent more clay than the A horizon, grading at about 30-inch depth, into gray and olive alkaline but noncalcareous shale.

Typifying Pedon: Eram clay loam - native prairie
(Colors are for dry soil unless otherwise noted.)

A1 0-10" Dark grayish-brown (10YR 4/2) clay loam, very dark grayish-brown (10YR 3/2) moist; moderate medium granular structure; hard, firm; slightly acid; gradual boundary. 6 to 14 inches thick.

B2t 10-16" Grayish-brown (2.5Y 5/2) clay near limit to clay loam, very dark grayish-brown (2.5Y 3/2) moist; moderate medium blocky structure; extremely hard, very firm; thin continuous clay films on ped faces; slightly acid; gradual boundary. 6 to 14 inches thick.

B3 16-28" Light olive brown (2.5Y 5/3) clay near limit of clay loam, containing faint mottles of slightly grayer and browner shades, olive brown (2.5Y 4/2) moist; weak coarse blocky structure; extremely hard, very firm; slightly acid; gradual boundary. 6 to 16 inches thick.

R 28-36"+ Gray and olive noncalcareous shale; slightly acid in the upper part becoming alkaline with depth.

Type Location: Okmulgee County, Oklahoma; 800 feet north and 200 feet east of the southwest corner of Section 3, T15N, R12E.

Range in Characteristics: Depth to weathered shale or other clayey bedrock is more than 20 inches and commonly less than 40 inches. Where unweathered, the parent shale is alkaline and mostly noncalcareous. The color of the A horizon ranges in hue from 10YR to 5Y, in value from 3 to 5 dry, and from 2 to 3.5 moist, and in chroma from 1.5 to 3. The B2t horizon ranges in hue from 10YR to 5Y, in value from 3.5 to 6 dry, and from 2.5 to 5 moist, and in chroma from 2 to 5. The B2t horizon centers near 40 percent in clay and ranges from about 35 to 50 percent.

Competing Series and Their Differentiae: These are in the Dennis, Okemah, Summit, and Talihina series. The Talihina series lacks an argillic horizon and is shallow over shale. The Okemah series has strong horizon expression, a very thick solum, and the regolith is more than 5 feet deep over shale or compact marine clay. The Dennis series has a B horizon that is more granular and less clayey in the upper part than that of the Eram series, and shale or other clayey bedrock is at depths greater than 40 inches. The Summit series is darker colored throughout; it has a very thick solum that is strongly granular in the upper part, and it is deep or very deep over any bedrock.

Setting: Eram soils are on nearly level to gently sloping freely drained uplands within the Cherokee Prairies of eastern Oklahoma and southeastern Kansas. Slopes range from near 0 to about 5 percent. The climate is moist subhumid. At the type location, the average annual precipitation is 37 inches and mean annual air temperature is 60° F.

Principal Associated Soils: These are in the competing Talihina, Dennis, Okemah series, and in the Woodson series.

Drainage and Permeability: Well drained; the subsoil is slowly permeable, and the substratum is almost impervious.

Use and Vegetation: Mostly in native range used for grazing bee cattle. The cultivated areas are in field crops, mostly other than corn and alfalfa. Original vegetation was tall-grass prairie.

Distribution and Extent: Eastern Oklahoma and probably southeastern Kansas. The probable extent is between 20,000 and 100,000 acres.

Series Established: Okfuskee County, Oklahoma, 1940.

Remarks: The Eram series was never placed in a great soil group in the modified 1938 yearbook classification.

National Cooperative Soil Survey
USA

EUFAULA SERIES

The Eufaula series is a member of the sandy, siliceous, thermic family of Psammentic Haplustalfs. They have thin, slightly darkened, sandy A1 horizons, thick, lighter colored, sandy A2 horizons and B2t horizons of reddish loamy fine sand lamellae in soil material like the A2 horizon.

Typifying Profile: Eufaula loamy fine sand - cultivated (Colors are for dry soil unless otherwise stated.)

Ap	0-6"	Pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist structureless, massive; slightly hard, very friable; slightly acid; clear smooth boundary. 3 to 8 inches thick.
A21	6-40"	Pink (7.5YR 7/4) fine sand; light brown (7.5YR 6/4) moist; structureless, single grain; loose; slightly acid; clear wavy boundary. 27 to 60 inches thick.
A22 and B2t	40-80"	Pink (7.5YR 7/4) fine sand; light brown (7.5YR 6/4) moist; lamellae of reddish brown (5YR 5/4) heavy loamy fine sand 1/8 to 1 inch thick and 2 to 4 inches apart; the lamellae are wavy and discontinuous; structureless, the lamellae are massive; slightly hard, friable; the lamellae have clay bridges between the sand grains; medium acid. 30 to 120 inches thick.

Type Location: Pontotoc County, Oklahoma; about 9 miles north of Ada; 4000 feet east and 350 feet north of the northwest corner of the SW¼ of Section 9, T5N, R6E.

Range in Characteristics: These soils are usually moist and are dry for 90 to about 135 days (cumulative) in most years in some subhorizon between 7 and 20 inches. The solum ranges from 6 to about 15 feet thick. The combined A1 or Ap and A2 horizons are 30 to 70 inches thick. The A1 horizon has hues of 10YR or 7.5YR, values of 4 through 7 dry and 3 through 6 moist, in chroma of 2 through 4. The texture ranges from fine sand to loamy fine sand. The structure ranges from structureless to weak granular. The consistence when moist ranges from loose to very friable. The reaction ranges from medium acid to neutral. The A2 horizon has hues of 10YR and 7.5YR, values of 6 through 8 dry and 4 through 6 moist, in chroma of 2 through 4. The textures are fine sand or light loamy fine sand. The reaction ranges from medium acid to neutral. The B2t horizon has hues of 2.5YR through 7.5YR, values of 5 or 6 dry and 4 or 5 moist, in chroma of 4 through 8. The texture averages loamy fine sand in the upper 20 inches of the B2t horizon, if that much is present. A minimum of 15 cm. (6 inches) of lamellae over 1 cm. thick are required when they are the B2t horizon. The B2t horizons that are continuous horizontally and vertically, with or without bands, are less common than B2t horizons of lamellae. When present, the upper continuous B2t horizon is loamy sand. The structure is dominantly massive, but weak subangular blocky structure may occur in thicker bands or in the continuous B2t horizons. The reaction ranges from slightly to strongly acid.

Page 2--Eufaula Series

Competing Series and Their Differentiae: These are the Arenosa, Bienville, Dougherty, Nobscot, and Stidham soils. The Arenosa soils do not have Bt (argillic) horizons. The Bienville soils occur under more humid conditions, and they are dry for less than 90 cumulative days in most years in some subhorizon of the soil between 7 and 20 inches. The Dougherty and Stidham soils have argillic horizons between 20 and 40 inches depth that have more than 18 percent clay. The Nobscot soils have argillic horizons finer than loamy fine sand and has less than 18 percent clay.

Setting: The Eufaula soils occur on sandy uplands or stream terraces. Slope gradients are between 0 and about 25 percent. The slopes range from nearly plane, to undulating, hummocky, or rolling. The soils are formed in thick, sandy sediments or aeolin materials, mainly of Pleistocene age. The average annual air temperature is from 71.6° F. The mean annual precipitation is from about 24 to 40 inches and the annual thornthwaite P-E index from about 34 to 64.

Principal Associated Soils: These include the competing Dougherty and Stidham as well as Konawa soils. The Konawa soils have Bt (argillic) horizons within 20 inches depth.

Drainage and Permeability: Somewhat excessively drained; rapidly permeable; runoff is very slow.

Use and Vegetation: Dominantly used for native range. Considerable amounts of the loamy fine sand type on lesser slopes are cropped to sorghums, small grains and peanuts, or are used for tame pastures. Native vegetation is post oak and blackjack, oak with an understory of tall grasses.

Distribution and Extent: In central Oklahoma, central Texas and south Central Kansas. The series is extensive.

Series Established: McIntosh County, Oklahoma, 1943.

Remarks: The Eufaula soils were classified as Red and Yellow Podzolic soils in recently completed surveys.

National Cooperative Soil Survey
USA

FRIO SERIES

The Frio series is in a fine, mixed, thermic family of Cumulic Haplustolls. These soils are dark grayish brown, calcareous, heavy silty clay loams or silty clays that have an irregular distribution of organic matter with depth.

Typifying Pedon: Frio silty clay loam - rangeland. (Colors are for dry soil unless otherwise noted.)

A11 0-18" Dark grayish brown (10YR 4/2) heavy silty clay loam; very dark grayish brown (10YR 3/2) moist; strong fine granular structure in the upper 6 inches, and moderate medium granular and fine subangular blocky structure below; hard; firm but crumbles easily to a mass of granules when moist; sticky and plastic; common fine roots; few films and threads of $CaCO_3$ visible in lower part when dry; calcareous; moderately alkaline; diffuse smooth boundary. (12 to 25 inches thick.)

A12 18-45" Brown (10YR 4/3) light silty clay, dark brown (10YR 3/3) moist; moderate fine and medium subangular blocky and moderate coarse granular structure; hard; firm, but crumbly moist; few roots; few films and threads of $CaCO_3$ visible when dry; few thin strata and lenses of silt loam and silty clay loam in the lower part; calcareous; moderately alkaline; diffuse smooth boundary. (15 to 30 inches thick.)

C 45-60"+ Brown (10YR 5/3) light silty clay, brown (10YR 4/3) moist; structureless; massive; hard; firm; contains a few thin strata of silty clay loam; a few bedding planes; few very dark brown stains of decaying plants; calcareous; moderately alkaline.

Type Location: Kimble County, Texas. In a pasture 300 feet south of U.S. Hwy. 290 in flood plain of Llano River; from a point 3.4 miles west of the intersection of U.S. Hwy. 290 and 377, which is on the west side of Junction.

Range in Characteristics: The soil is calcareous. The thickness of the soil to beds of gravel, sand, or limestone ranges from 6 to about 20 feet. The soils are dry in the 7 to 20-inch layer for more than 90 cumulative days most years. In some pedons the soil is moist most of the time below about 6 feet. Organic matter decreases irregularly with depth, or is more than 0.5 percent at 50 inches below the surface. Coarse fragments in the solum range from none to 35 percent by volume of rounded pebbles and cobbles of limestone and chert. The clay mineralogy is mixed. The texture of the 10- to 40-inch control section ranges from a heavy silty clay loam or clay loam to silty clay with a clay range of 35 to 50 percent. Dry color of the A horizon ranges in hue of 7.5YR or 10YR, values of 3 through 5, and chromas of 1.5 through 3. Moist color values and chromas are less than 3.5 to a depth of 20 to about 50 inches. The texture of the A horizon ranges from a silty clay loam, or clay loam to a silty clay. Structure of the A horizon ranges from strong to moderate subangular blocky and moderate granular. Below a depth of 20 inches, some pedons have a B horizon with higher values or chromas than the overlying A horizon. Stratification of silty or more clayey sediments generally occurs between depths of 30 and 50 inches.

Competing Series and Their Differentiae: These include the Asa, Bosque, Lewisville, Port, Spur, and Toyah soils. Bosque, Port and Toyah soils have less than 35 percent clay in the 10- to 40-inch control section. Lewisville soils have A horizons with values less than 5.5 dry and 3.5 moist that are less than 20 inches thick; in addition, Lewisville soils have a regular decrease in organic matter with depth. Spur and Asa soils have less than 35 percent clay in the 10- to 40-inch control section, and have mollic epipedons less than 20 inches thick.

Setting: The Frio soils occur in the nearly level flood plains of major streams that drain mostly limestone grasslands. Slopes are dominantly less than 1.0 percent but range up to about 2. The regolith consists of heavy silty clay loams and silty clays over strata of gravel and gravelly sands, 20 feet or more deep. Limestone underlies the regolith in places at depths of 6 to 20 feet. The climate is dry subhumid with a mean annual rainfall range of 18 to 36 inches and a Thornthwaite P-E index of 28 to 56. The mean annual air temperature ranges from 64^{o} to 70^{o} F.

Principal Associated Soils: These are Bosque, Denton, Dev, Lewisville, Knippa, Nuvalde, Tarrant and Valera soils. Denton soils, when dry, have cracks at least 1 cm. wide and 12 inches long at depth of 20 inches. Dev soils have more than 35 percent coarse fragments and less than 35 percent clay in the 20 to 40-inch control section. Knippa, Nuvalde and Valera soils have a calcic horizon within 40 inches of the surface. The Tarrant soils have sola less than 20 inches thick over limestone bedrock.

Drainage and Permeability: Well drained; slow runoff; moderately slow permeability. Most areas have ground water within 20 feet depth. Flooding occurs as infrequent as once in about 10 years to as often as one or two times a year.

Use and Vegetation: Mainly cultivated and used for cotton, corn and grain sorghums. Predominately used for rangeland in the western areas. Native vegetation is mainly an open-canopied deciduous forest of pecan, elm and oak in the eastern part, and an open prairie in the western part with a few pecan and elm trees near the stream channel. The main grass cover consists of Virginia wildrye, Texas wintergrass, vine mesquite in the eastern part to curlymesquite and buffalograss in the western part.

Distribution and Extent: Mainly in Texas, from the Blackland Prairie westward to the semi-arid part of the Edwards Plateau, northward into the Central Rolling Red Plains and Central Rolling Red Prairies, and southward to the Rio Grande Plain. The series is of large extent, comprising about one-half million acres.

Series Established: Reconnaissance survey of Southwest Texas, 1911.

Remarks: The Frio series was formerly included in the Alluvial group.

National Cooperative Soil Survey
USA

FITZHUGH SERIES

The Fitzhugh series is of medium-depth to deep, freely drained Reddish Prairie soils developed in residuum from yellow or gray noncalcareous, usually fine-grained or somewhat earthy sandstones, mainly of the Pennsylvanian. The catenal associates are Collinsville, which is a Lithosol, and Bates, which has yellower, less reddish subsoils.

Soil Profile: Fitzhugh fine sandy loam

A_1 0-10" Brown (7.5YR 4/3); 3/3 moist) fine sandy loam; weakly to moderately medium granular; very friable; medium to strongly acid. 7 to 12 inches thick.

A_3 10-12" Similar to horizon 1 but of reddish-brown (5YR 4/3.4; 3/4, moist) color; grades to horizon 3. 1 to 5 inches thick.

B_2 12-24" Reddish-brown (5YR 4/4, 3/4, moist) sand clay loam; friable when moist, hard when dry; freely permeable; almost massive but porous; strongly acid. 10 to 15 inches thick.

B_3 24-36" Yellowish-red (5YR 4/5; 3.5/6, moist) sandy clay loam; friable; strongly acid. 10 to 40 inches thick.

C 36"+ Partly weathered yellowish acid sandstone.

Range in Characteristics: Depth to bedrock typically ranges from about 2½ to 4 feet; color of B_2 horizon ranges from reddish-brown (hues 5YR to 7.5YR, values 3.5 to 4.5, chromas 3.5 to 5); soft ferruginous concretions occur in the B3 horizon in places.

Topography: Gently to moderately sloping erosional upland; surfaces concave; surface gradients from about 2 to 8%.

Drainage: Free from the surface and internally.

Vegetation: Tall prairie grasses; scattered oak trees occur in some areas.

Use: Largely in cultivation to cotton, corn, oats, and sorghums; yields are only moderate unless fertilized, which enable high yields.

Distribution: Eastern part of the Reddish Prairie soil from southeastern Kansas to northern Texas; relatively inextensive.

Type Location: Pontotoc County, Oklahoma.

Series Established: Pontotoc County, Oklahoma, 1936.

Remarks: Prior to recognition of this series these soils were classed as red phases of Bates. The series name is from a village in Pontotoc County, Oklahoma.

Colors are described with Provisional Soil Survey Color Names (1947) and unless stated otherwise refer to dry soil.

Rev. EHT: 9-5-47 National Cooperative Soil Survey
Mimeo., 1957

GALEY SERIES

The Galey series is a member of a fine-loamy, mixed, thermic family or Ultic Paleustalfs. These soils have light colored loamy fine sand A horizons 14 inches thick with yellowish sandy clay loam B2t horizons that grade to a yellowish fine sandy loam B3 horizon.

Typifying Pedon: Galey loamy fine sand - cultivated
(Colors for dry soils unless otherwise noted.)

Ap 0-6" Brown (10YR 5/3) loamy fine sand; brown (10YR 4/3) moist; weak fine granular structure; soft; very friable; slightly acid; clear smooth boundary. 3 to 8 inches thick.

A2 6-14" Very pale brown (10YR 7/3) loamy fine sand; brown (10YR 5/3) moist; massive; soft; very friable; slightly acid; clear smooth boundary. 4 to 17 inches thick.

B21t 14-34" Brownish yellow (10YR 6/6) sandy clay loam; yellowish brown (10YR 5/6) moist; moderate coarse prismatic breaking to weak medium subangular blocky structure; very hard; friable; clay films on ped faces, in pores, and bridging sand grains; medium acid; diffuse smooth boundary. 15 to 30 inches thick.

B226 34-52" Brownish yellow (10YR 6/6) sandy clay loam; common coarse distinct yellowish red mottles; yellowish brown (10YR 5/6) moist; moderate coarse prismatic breaking to weak medium subangular blocky structure; very hard; friable; clay films on ped faces, in pores, and bridging sand grains; medium acid; diffuse smooth boundary. 10 to 30 inches thick.

B3 52-72" Yellow (10YR 7/6) find sandy loam; common medium distinct gray, pale brown, and yellowish red mottles; brownish yellow (10YR 6/6) moist; weak coarse prismatic structure; hard; friable; patchy clay films on ped faces and bridging sand grains; medium acid. 10 to 30 inches thick.

Type Location: Pontotoc County, Oklahoma. 2300 feet south and 100 feet east of the northwest corner of Section 26-T5N-R4E. About 12 miles northwest of Ada.

Range in Characteristics: The texture of the A horizon ranges from loamy fine sand to fine sandy loam. The maximum thickness of the A horizon of the loamy find sand type is 20 inches. The color of the A1 horizon ranges in hue 10YR with dry values of 4 to 6; moist values of 3 to 5; and chromas of 2 and 3. When the moist value is 3.5 or darker, the organic matter content is less than 1.2% in the upper 4 inches. The color of the A2 horizon ranges in hue 10YR with dry values of 5 to 7; moist values of 4 to 6; and chromas of 2 to 4. The color of the B2t horizons range in hues 10YR to 7.5YR with dry values of 5 to 7; moist values of 4 to 6; and chromas of 4 to 8. Mottles with chroma of 3 or more may occur in any part of the B2t horizons but mottles with chroma of 2 or less are restricted within 30 inches of the soil surface.

The texture of the B2t horizons range from sandy clay loam and clay loam to heavy fine sandy loam with clay content of 18 to 35%. The reaction of the B2t horizons range from medium to strongly acid.

Competing Series and Their Differentiae: These include the Konawa, Dougherty, Stidham, Bowie, and Wagram series. The Konawa and Dougherty series have reddish B2t horizons. The Dougherty and Stidham series have A horizons coarser than very fine sand and more than 20 inches thick. The Bowie and Wagram series are Ultisols and have base saturation of less than 35%.

Setting: The Galey soils occur on nearly level to gently sloping uplands and are developed in medium acid to neutral sandy to moderately coarse textured sediments that are mostly old alluvium of major streams or rivers. The slopes are dominantly of gradients between 0 to 3 percent but range to about 8 percent. The climate in the area of occurrence is subhumid to moist subhumid with a Thornthwaite P-E index of 44 to 64. At the type location the average annual precipitation is about 38 inches and the mean annual temperature about 62^{o} F.

Principal Associated Soils: These include the competing Stidham, Dougherty, Konawa, as well as the Eufaula soils. The Eufaula soils have sandy A horizons more than 20 inches thick.

Drainage and Permeability: Well drained. Moderate permeability.

Use and Vegetation: Used mainly for pasture. Sorghums, small grains, and peanuts are the principal cultivated crops. The native vegetation is mainly postoak, blackjack, hickory, and elm with considerable understory of little bluestem, Indiangrass, and other grasses.

Distribution and Extent: Central and eastern Oklahoma and eastern Texas. The series will probably be of moderate extent. (100,000 acres.)

Series Proposed: Pontotoc County, Oklahoma, 1965. Source of name small village in Pontotoc County.

Remarks: This series would have been classified as Red-Yellow Podzolic soils of high base status.

National Cooperative Soil Survey
USA

GARRETT SERIES

The Garrett series includes dark-brown or dark grayish-brown claypan soils of the Prairies developed apparently from granite and limestone outwash. The soils are not true Planosols, although they occur on fairly flat surfaces. They are associated with Tishomingo soils but are developed from heavier panent materials. A few fine quartz gravel are scattered throughout the profile.

I. Soil Profile: (Garrett silty clay loam)

1. Dark-gray or dark grayish-brown faintly granular silty clay loam, about 4 to 10 inches thick, grading into
2. Dark gray, clay loam or clay with light-gray sprinkling on outside of course granules, about 2 to 4 inches thick. Rests on
3. Dark-gray heavy dense clay with reddish-brown mottling.
4. Dark-gray or gray heavy clay mottled with light gray. In places this contains calcium carbonate concretions below a depth of 4 feet. The nature of the substratum is obscure but is probably granite and limestone outwash.

II. Variations: Surface texture ranges from loam to clay. Subsoil is nearly black in places.

III. Topography: Undulating

IV. Drainage: Surface drainage slow, subsoil drainage very slow.

V. Native vegetation: Tall bunch grasses, largely bluestem.

VI. Utilization: Cotton, corn, sorghums. Some areas of abandoned land.

VII. Geographic Distribution: Johnston County, Oklahoma, in valleys and plains adjacent to granite areas.

Type location: 1 3/4 miles N of Tishomingo, Oklahoma.

Series tentatively established: Arbuckle SCD, 1940.

2-23-40
EGF

GIBBS SERIES*

Gibbs soils are dark grayish brown loamy soils developed under timber on residium from weathered granite of the Tishomingo formation.

Typifying Pedon: (native timber)

A1	0-5"	Dark grayish brown (10YR 4/2) sandy loam; (10YR 2/2) when moist; contains appreciable medium and coarse sand grains; moderate medium granular; slightly hard dry, very friable moist; considerable mica evident; pH 7.0; clear boundary.
A2	5-20"	Light brown (7.5YR 6/4) gravelly loam, brown (7.5YR 5/4) when moist; moderate medium and coarse granular; slightly hard dry, very friable moist; many roots and pores; pH 7.0; clear boundary.
B21t	20-28"	Reddish yellow (5YR 6/6) gravelly clya loam; yellowish red (5YR 4/6) when moist; weak fine subangular blocky; hard when dry, firm when moist, sticky when wet; few patchy clay film; pH 6.5 gradual boundary.
B22t	28-42"	Reddish yellow (5YR 6/6) gravelly clay; yellowish red (5YR 5/6) when moist; weak fine blocky; few patchy clay film; very hard dry; very firm moist; pH 6.5; gradual boundary.
C	42-52"	Reddish yellow (7.5YR 6/6) gravelly loam, strong brown (7.5YR 5/6) when moist; structureless; slightly hard dry, moist very friable; pH 5.5; clear boundary.
R	52"+	Same color as horizon above, weathered granite.

Location: 200' W of east quarter corner Sec. 24-3S-6E.

Parent Material: Tishomingo Granite

Slope: 2 to 3% gradient.

Note: Considerable Mica was evident in each horizon.

DLB
3-13-67

*Tentative

GILSON SERIES

The Gilson series comprises gravelly red Podzolic soils developed in residuum from interbedded calcareous cherty conglomerate, sandstone and shale of the carboniferous on the northern flank of the Ardmore uplift in the southcentral Oklahoma. The series is closely related to Chigley, the most evident difference being that the gravel is of angular fragments of chert (or novaculite?) whereas in Chigley, it is of coarse crystals of quartz from granites. The Gilson series occurs under somewhat drier climate than the Dierks series.

Soil Profile: Gilson gravelly sandy loam

A_1 0-3" Dark grayish-brown (10YR 4/2) gravelly sandy loam, very dark grayish-brown (10YR 3/2) moist; the gravel consists of angular fragments of chert, 1/4 to 1 inch in diameter; grades to horizon beneath; neutral to mildy alkaline. 2 to 4 inches thick.

A_2 3-12" Very pale brown (10YR 7/4) gravelly snady loam; yellowish brown (10YR 5/5), moist; neutral to slightly acid. 5 to 11 inches thick.

B_2 12-34" Yellowish-red (5YR 5/6) gravelly clay, yellowish-red (5YR 4/6), moist; gravel consists of chert fragments and comprises 1/2 to 2/3 of the mass; nearly massive; very hard when dry, firm when moist, sticky and plastic when wet; slowly to moderately permeable; very strongly acid. 15 to 40 inches thick.

C_1 34-60" Yellowish-red gravelly clay coarsely mottled with yellowish brown and containing some black ferruginous concretions; very strongly acid. 5 to 40 inches thick.

C_2 60"+ Gravelly or gritty clay of reaction ranging from acid to alkaline containing erratic lentils of sandstone and calcareous cherty conglomerate.

Range in Characteristics: Subsoil ranges from yellowish red to reddish brown (hues 5YR and 7.5YR) and from gravelly clay to gravelly clay loam; proportion of gravel varies widely from place to place but generally comprises more than one-third of the volume in each horizon; reaction of A_1 and A_2 probably is slightly to medium acid in many places; depth to bedrock of sandstone or conglomerate varies widely within short distances and generally ranges between 2½ and 8 feet.

Topography: Moderately sloping to steep ridges and ridge slopes in a rolling erosional upland.

Drainage: Moderate to rapid from the surface; moderate internally.

Vegetation: Scrub forest of post oak and blackjack.

Use: Less than half has been cleared and cultivated and a considerable proportion of this has been retired from cropland and is now idle or affords scant grazing; field crops grown are principally corn, cotton, and peanuts; the natural fertility is low, little fertilizer is generally used, and yields are very low; of low value for grazing or forestry.

Distribution: Southern Oklahoma on northern flank of Arbuckle Mountains in a locality where the mean annual precipitation is between 35 and 40 inches; relatively inextensive and agriculturally unimportant.

Type Location: Murray County, Oklahoma, ¼ Sec. 8, T1S, R3E.

Series Established: Murray County, Oklahoma, 1937.

Nationally Cooperative Soil Survey
USA

Rev. EHT 9-5-47

(Reproduced by the Okla. Highway Dept. Research Section)

Approved by Principal Soil Correlator
South Region TSC: 6/14/66

Established Series
Rev. WRE; GSM 6/6/66

GOWEN SERIES

The Gowen series is a member of a fine loamy, mixed, thermic family of Cumulic Hapludolls. These soils have a dark noncalcareous A horizon about 30 inches thick over a dark, stratified, loamy C horizon.

Typifying Pedon: Gowen Clay loam - pasture
(Colors refer to dry soil unless specified as moist.)

A11 0-15" Dark grayish-brown (10YR 4/2) clay loam, very dark grayish-brown (10YR 3/2) moist; moderate medim granular structure; hard, firm, sticky; contains common number of fine and medium pores; plentiful roots; neutral; clear smooth boundary. 10 to 30 inches thick.

A12 15-30" Brown (10YR 5/3) light clay loam, dark brown (10YR 3/3) moist; weak subangular blocky structure; hard, firm, sticky; contains common number of fine and medium pores and worm-casts; plentiful roots; clear smooth boundary. 0 to 25 inches thick.

C 30-60" + Dark grayish-brown (10YR 4/2) clay loam, very dark grayish-brown (10YR 3/2) moist; structureless; very hard, firm; common number of roots; contains thin strata of pale brown fine sandy loam, and lenses and thin strata of grayish-brown clay in the lower part; few very dark brown stains, apparently remnants of leaves; neutral.

Type Location: Erath County, Texas. Approximately 21 miles northwest of Stephenville; in pasture 100 feet east of road, which point is 0.2 mile south and 1.6 miles east via county road from the intersection with Texas Highway 108, this intersection being 21 miles northwest from the Erath County Courthouse in Stephenville.

Range in Characteristics: Thickness of darkened surface horizons with developed structure, at least 0.58 percent organic carbon, and moist color values of less than 3.5 ranges from 24 to about 40 inches. Dry color of the A horizon ranges from dark gray to brown, in hues of 10YR and 7.5YR; any chromas of 2 or less are not due to wetness; structure ranges from moderate to weak granular and subangular blocky. The soil is usually moist and is not dry in any part of the 10- to 40-inch control section for as long as 90 cumulative days during most years. Dry color of the C horizon ranges from dark gray to brownish-yellow in hues of 10YR and 7.5YR, and contains no mottles with chromas of 2 or less that are due to wetness. The average clay content of the 10- to 40-inch control section ranges from 18 to 35 percent clay with more than 15 percent coarser than very fine sand. The reaction of the control section varies from neutral to moderately alkaline. The soil contains from the surface downward to a depth of 40 inches less than 40 percent of any one weatherable mineral.

Competing Series and Their Differentiae: These include the Asa soils of the same subgroup. Other competitors include the Bosque, Kosse, Bunyan, Kaufman, and Frio soils. Asa soils have 10- to 40-inch control sections with less than

15 percent coarser than very fine sand. Bosque soils are calcareous throughout. Kosse soils lack an epipedon as thick as 24 inches with moist color values less than 3.5 and 0.58 percent or more of organic carbon; in addition, Kosse soils have mottles with chromas of 2 or less that are due to wetness. Bunyan soils have no epipedon with developed structure and lack moist color values of 3.5 or less, and have evident bedding planes throughout. Frio and Kaufman soils have more than 35 percent clay in the 10- to 40-inch control section.

Setting: These soils occur in the nearly level flood plains of streams that carry loamy sediments dominantly from noncalcareous soils. Flooding occurs at intervals ranging from 1 or more times per year to once about every 5 years. Mean annual air temperatures are 64° to 70° F., with 20 to 45 inches of average annual rainfall, and Thornthwaite annual P-E indices of 44 to 70.

Principal Associated Soils: The principal associated soils are the competing Bunyan, Bosque, Kosse, and Kaufman series, and to a lesser extent, the Frio series.

Drainage and Permeability: Well drained. Permeability is moderate. Surface runoff is slow to medium.

Use and Vegetation: Most areas are being farmed to peanuts, sorghums and pecan orchards. Areas that flood frequently are used mainly for bermudagrass pastures and pecan orchards. Native areas are in hardwood forest, including hackberry, elm, and pecan trees.

Distribution and Extent: This soil occurs mainly in the mixed post oak and prairie areas of central Texas, and in adjoining areas of Oklahoma. Moderate extent.

Series Established: Stephens County, Oklahoma.

Remarks: This series was classified in the Alluvial Great Soil Group in the 1938-49 Classification System.

National Cooperative Soil Survey
USA

GRACEMONT SERIES

The Gracemont series is a member of a coarse-loamy, mixed, calcareous, thermic family of Typic Udifluvents. They have dark reddish brown, moderately coarse textured A horizons and stratified, moderately coarse textured C horizons that have evident bedding planes.

Typifying Pedon: Gracemont fine sandy loam - pasture (Colors are for moist soil)

A	0-14"	Dark reddish brown (5YR 3/4) fine sandy loam; weak fine granular structure; slightly hard, very friable; calcareous; clear smooth boundary. 6 to 18 inches thick.
C1	14-34"	Dark red (2.5YR 3/6) fine sandy loam; massive; slightly hard, friable; has strata up to 3 inches thick of darker loam, that are separated from the mass with evident bedding planes; a few soft calcium carbonate spots; calcareous; clear smooth boundary. 10 to 30 inches thick.
C2	34-46"	Dark reddish brown (5YR 3/4) fine sandy loam; massive; very friable; highly stratified with browner material; common soft calcium carbonate spots; calcareous; clear smooth boundary. 10 to 20 inches thick.
Ab	46-54"+	Very dark brown (10YR 2/2) loam; massive; friable; common soft calcium carbonate spots; calcareous.

Type Location: Caddo County, Oklahoma; 1 mile north of Gracemont; 855 feet north and 90 feet east of the southwest corner of the southeast ¼ of Section 33, T9N, R10W.

Range in Characteristics: These soils are not dry in some subhorizon between 7 and 20 inches for as much as 90 cumulative days in most years. These soils have organic matter values that decrease irregularly with depth. They are calcareous in all parts of the fine earth fraction between depths of 10 and 20 inches. Buried horizons 8 inches or more thick with color values of less than 5.5 dry and 3.5 moist in chromas of less than 3.5 and more than 1 percent organic matter may occur more than 20 inches below the surface. They have evident bedding planes throughout the C horizon. The A horizon has hues of 2.5YR through 10YR, moist values from 3 through 5, and chromas of 2 through 6. A combination of characteristics where the A horizon is more than 7 inches thick, the color value is less than 5.5 dry and 3.5 moist, in chromas of less than 3.5, and the organic matter exceeds one percent, is not allowed. The principal texture of the A horizon is fine sandy loam but loamy fine sand, loam and clay loam occur. The C1 and C2 horizons have hues of 2.5YR through 10YR, moist values from 3 through 6, and chroma of 3 through 6. The texture of the 10- to 40-inch section is finer than loamy fine sand, has less than 18 percent clay and more than 15 percent material coarser than very fine sand.

Competing Series and Their Differentiae: These are the Bruno, Bunyan, Iuka, Morganfield, Norwood, Ochlockonee, Pulaski, Robinsonville, and Yahola soils. The Bruno soils average sandy textures in the 10- to 40-inch section. The Bunyan soils have more than 18 percent clay in the 10- to 40-inch section and are not calcareous in the 10 to 20 inch section. The Iuka soils have two chroma mottles within 20 inches of the soil surface and are not calcareous in the 10- to 20-inch section. The Morganfield, Ochlockonee, and Robinsonville soils are not calcareous in the 10- to 20-inch section. In addition, the Morganfield soils have less than 15 percent material coarser than very fine sand in the 10- to 40-inch section. The Norwood soils have more than 18 percent caly and less than 15 percent material coarser than very fine sand in the 10- to 40-inch section. The pulaski and Yahola soils are dry in some part of the 10- to 20-inch section for more than 90 cumulative days in most years.

Setting: These soils occur on level to nearly level floodplains. Slopes range from 0 to about 2 percent. The soils are formed in moderately coarse textured alluvium. These soils have a high water table and are saturated with water within 40 inches depth much of the year. The average annual air temperature is about 61° F and the average annual precipitation is about 29 inches at the type location.

Principal Associated Soils: These are the competing Yahola and Pulaski soils.

Drainage and Permeability: Somewhat poorly drained. Runoff is slow. Permeability is moderately rapid to the water table. The soils are flooded from frequently to occasionally.

Use and Vegetation: Used for grazing. Much of the soil is used for bermuda grass tame pastures. The native vegetation was willow, salt cedar, cottonwood, alkali sacaton and inland salt grass.

Distribution and Extent: Known acreage is in Caddo County, Oklahoma. Moderately extensive.

Series Proposed: Caddo County, Oklahoma, 1966. The name is from a small town in Caddo County.

Remarks: This soil would have been classified in the Alluvial great soil group.

National Cooperative Soil Survey
USA

HARTSELLS SERIES

The Hartsells series consists of well drained Red-Yellow Podzolic soils developed over sandstone that may contain thin beds of shale. These soils are associated with the Hanceville, Muskingum, Wellston, Tilsit, Crossville, and Linker soils and are largely confined to plateau positions. Their subsoils are not as red as those of the Hanceville and Linker series, and their profiles are not as brown as those of the Crossville series. Compared to the Muskingum series, Hartsells soils have definite continuous B horizons rather than faint ones evident mainly in color. Hartsells soils are coarser textured and much less silty than the Wellston and Tilsit soils, and they lack the fragipan of the Tilsit soils. The Hartsells soils occur in relatively large bodies and are important agriculturally.

Soil Profile: Hartsells fine sandy loam - cultivated

A_p	0-6"	Grayish brown (10YR 5/2) fine sandy loam; weak fine granular structure; very friable; medium to strongly acid; abrupt boundary. 4 to 8 inches thick.
B_1	6-18"	Yellowish brown (10YR 5/4) loam or fine sandy clay loam; weak medium subangular blocky structure; friable; medium to strongly acid; gradual boundary. 8 to 20 inches thick.
B_2	18-30"	Yellowish brown (10YR 5/6) fine sandy clay loam or fine sandy loam with few faint brown and red mottles in the lower part; weak or moderate medium subangular blocky structure; friable; few small pores; medium to strongly acid; gradual boundary. 4 to 20 inches thick.
C	30-36"	Mottled yellow (10YR 7/6), strong brown (7.5YR 5/6), and gray (10YR 6/1) sandy loam; massive in place; numerous small and large sandstone fragments; medium to strongly acid; abrupt boundary. 2 to 10 inches thick.
D_r	36"+	Acid sandstone.

Range in Characteristics: Loam, fine sandy loam, and loamy fine sand are dominant types. In some Hartsells soils the A_2 horizon is 10 or 12 inches thick. The mixed surface layer of these soils unless appreciably eroded, includes the A_1 horizon and only the upper part of the A_2 horizon. Color of the A_p horizon ranges to dark grayish brown and of the B_1 horizon to brown (10YR 5/3) or brownish yellow (10YR 6/6). Color of the B_2 horizon ranges to pale brown (10YR 6/3). A shallow phase is recognized where the bedrock is encountered at depths of about 18 inches. In places the C horizon is absent and the B_2 horizon may rest upon a yellowish red to red D_u horizon of silty clay, clay, or silty clay loam probably derived from a shale bed, or the B_2 horizon may rest directly upon the sandstone bedrock. Colors given are for moist conditions. When soil is dry, color values commonly one or more units higher.

Topography: Broad, smooth plateaus, mountain tops, or hill tops and gentle slopes, rarely exceeding 10 per cent and dominantly between 2 and 5 per cent.

Drainage and Permeability: Well drained, runoff medium; permeability moderately rapid.

Vegetation: White, red, post, black, and chestnut oaks, loblolly and shortleaf pines, tulip poplar, blackgum, and hickory.

Use: Cotton, corn, oats, sorghum, cowpeas, soybeans, sweetpotatoes, Irish potatoes, hay crops, apples, and garden vegetables.

Distribution: Southern Appalachian Mountains in Alabama, Georgia, Kentucky, Tennessee, and possibly Arkansas and Oklahoma.

Series Established: Cherokee County, Alabama, 1924.

Type Location: Cherokee County, Alabama; approximately 1 mile west of Sandrock.

Remarks: As now revised, the concept of the Hartsells series includes soils formerly classified in the Cleburne series, which has been placed on the inactive list.

Rev. IIM
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National Cooperative Soil Survey
USA

HECTOR SERIES

The Hector series is a member of a loamy, siliceous, thermic family of Lithic Dystrochrepts. These soils have dark brown, acid, gravelly fine sandy loam A horizons over thin loamy, acid B horizons that lack evidence of clay accumulation.

Typifying Pedon: Hector gravelly fine sandy loam--forested (Colors are for moist conditions unless otherwise noted)

A1 0-2" Dark brown (10YR 3/3) gravelly fine sandy loam, brown (10YR 5/3) when dry; moderate medium granular structure; very friable; many roots; sandstone fragments on surfaces and in the soil; slightly acid; clear smooth boundary.

A2 2-6" Brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) when dry; moderate medium granular structure; very friable; many roots; common sandstone fragments to 3 inches in diameter; medium acid; clear smooth boundary. 3 to 8 inches thick.

B 6-15" Strong brown (7.5YR 5/6) fine sandy loam, reddish-yellow (7.5YR 7/6) when dry; very weak medium subangular blocky structure; friable; common roots; common sandstone fragments less than 3 inches in diameter, few to 10 inches; strongly acid; abrupt irregular boundary. 4 to 10 inches thick.

R 15"+ Sandstone bedrock, hard, massive.

Type Location: Washington County, Arkansas. SE¼ SE¼ NE¼ Section 1, T15N, R33W.

Range in Characteristics: Thickness of solum and depth to bedrock is 8 to 20 inches. Stony and nongravelly types are recognized. The A1 horizon has colors of hue 10YR or 7.5YR, value 3 or 4, and chroma of 2 or 3. The A2 horizon is yellowish-brown (10YR 5/4), dark yellowish-brown (10YR 4/4), or may have the same colors as the A1. Texture of the A horizons is loam or fine sandy loam. The B horizon is yellowish-red (2.5YR 4/6) to yellowish-brown (10YR 5/6) sandy loam, loam, or light sandy clay loam. Clay content is 12 to 22 percent but evidence of clay movement is lacking. The profile may contain few to many sandstone fragments. Reaction is slightly to strongly acid in the A horizons, strongly to very strongly acid in the B horizon.

Competing Series and Their Differentiae: These include the Montevallo, Goldston, Ramsey, and Weikert series of the same subgroup, and the Mountainburg series of the Lithic Normudults. The Montevallo, Goldston, Ramsey, and Weikert soils are all skeletal, with over 50 percent of the mass in particles larger than 2mm. Mountainburg soils have argillic horizons. Darnell soils lack the cambic (color B) horizon of the Hector soils. Ramsey and Weikert soils have mean annual soil temperature of less than 59° F. Lauderdale soils are skeletal and the profile contains over 50 percent fragments larger than 2mm.

Setting: The Hector soils are on gently sloping to steep ridgetops and hillsides and have slopes of 2 to 40 percent. The regolith is sandy residuum with local colluvial influence, bedrock is sandstone. The average annual air temperature at the type location is 59.5° F., average annual rainfall is 45 inches.

Principal Associated Soils: These include the competing Mountainburg soil and the Linker, Hartsells, Apison, Allen, Jefferson, Fayetteville, and Rarden soils. These all have thicker sola and stronger profile development than the Hector soils.

Drainage and Permeability: Well drained but droughty. Runoff is slow to rapid, depending on the slope. Internal drainage and permeability are rapid.

Use and Vegetation: Vegetation is mixed hardwoods, such as upland oak, elm, and hickory, or is mixed hardwood and pine. Most areas are in forest but some are cleared and used for pasture.

Distribution and Extent: Mountain plateaus, ridges, and hillsides of the Boston Mountains, Ouachita Mountains, and Arkansas Valley of Arkansas and Oklahoma, and of the Cumberland and Sand Mountain areas of Alabama and Tennessee. This soil is of large extent, probably in excess of 800,000 acres.

Series Established: Pope County, Arkansas, 1938.

Remarks: The Hector series previously was classified in the Lithosols.

National Cooperative Soil Survey
USA

HEIDEN SERIES

The Heiden series comprises members of a montmorillonitic, thermic family of Udic Chromusterts. These soils have an A horizon of dark grayish brown calcareous clay about 22 inches thick, a thick AC horizon of calcareous olive clay having intersecting slickensides and grading to heavy calcareous shaly clay or marl at about 50 inches.

Typifying Pedon: Heiden clay - abandoned field-pasture
(Colors are for dry soil unless otherwise noted.)

Ap 0-6" Dark grayish brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; weak angular blocky structure; extremely hard, very firm, very sticky and very plastic, surface has a mulch about 1/2 inch thick of extremely hard fine discrete aggregates; few fine strongly cemented $CaCO_3$ concretions; calcareous; moderately alkaline; clear boundary. (4 to 8 inches thick.)

A1 6-22" Dark grayish brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; ped interiors are 2.5Y 3.5/2, moist; moderate fine angular blocky structure; few parallelepipeds in lower part; extremely hard, very firm, very sticky and very plastic; shiny ped faces; few strongly cemented $CaCO_3$ concretions up to about 1 cm. in diameter; calcareous; moderately alkaline; diffuse wavy boundary. (8 to 22 inches thick.)

AC 22-50" Olive (5Y 5/3) clay, olive (5Y 4/3) moist, with few faint brownish yellow mottles; ped interiors have chroma of 4; parallelepipeds about 1 to 3 inches long and axes are tilted 10 to 60 degrees from the horizontal; common number of coarse intersecting slickensides; vertical cracks are about 1 to 5 cm. wide and about 15 inches apart, extending to 50 inches; extremely hard, very firm, very sticky and very plastic; roots penetrate the angular peds; dark soil having moist color of 2.5Y 3/2 in some crevices; common number of whitish weakly and strongly cemented concretions of $CaCO_3$ that increase with depth from few in the upper part; calcareous; moderately alkaline; diffuse boundary. (20 to 40 inches thick.)

C 50-78"+ Prominently and coarsely mottled olive (5Y 5/3) and yellow (2.5Y 7/8) shaly clay with other intermingled shades of olive and yellow; rock structure with some coarse angular blocky soil structure in upper part; extremely hard, very firm; few roots between blocks of rock structure; contains a few weakly cemented concretions and soft masses of $CaCO_3$ in upper part that decrease with depth; calcareous; moderately alkaline.

Type Location: Bell County, Texas. One hundred feet south of Reids Lake Road from a point 3.7 miles west of its intersection with Texas Highway 36 at the west side of Rogers, Texas.

Page 2--Heiden Series

Range in Characteristics: Thickness of the A and AC horizons (combined) ranges from about 40 to 65 inches, and is thinnest in microknolls or microridges and thickets in centers of microdepressions or microvalleys. Average annual soil temperatures range from 64° to 68° F. The clays are dominated by montmorillonite. When dry, the soil has cracks 1 to 10 cm wide extending to at least 20 inches, and which remain open 90 to 150 cumulative days in most years. Texture throughout the soil ranges from clay to silty clay; clay content ranges from about 40 to 65 percent. Color of the A horizon, when dry, varies from gray to light olive brown in hues of 10YR to 5Y with values of 3 to 5.0 in chromas of 1 to slightly less than 4, the higher values and chromas are in cultivated pedons, or in microridges. Moist color values range from 2 to slightly less than 3.5. Where chromas are less than 1.5, the surface layer is less than 12 inches thick in more than one-half of the pedon. The A1 horizon dominantly is calcareous, but ranges to noncalcareous and mildly alkaline in the upper 12 inches. Waterworn gravel occurs as an overburden on the surface of some pedons. The color of the AC horizon varies in shades of olive and olive brown, 1 to 2 units of value higher than the A horizon, with or without yellowish mottles. The amount of weakly to strongly cemented $CaCO_3$ concretions in the AC horizon ranges from few to 2 percent. Gypsum crystals occur in the lower part of the AC horizon in some pedons. The C horizon varies from strongly weathered shaly clay to slightly weathered calcareous shales, with an intermingling of soil and rock structure.

Competing Series and Their Differentiae: These include the Crawford soils of the same subgroup; Ferris, Stamford, Tobosa and Harlingen soils of the same great group; and the Houston Black and Burleson series of the same suborder. The Houston soils also compete. Crawford soils are less than 40 inches thick over hard limestone. Stamford and Tobosa soils have cracks that remain open more than 150 days per year. Ferris and Harlingen soils have moist color values of more than 3.5 when moist and more than 5 when dry within a depth of 12 inches, and in addition Harlingen soils occur in areas having mean annual air temperatures greater than 71.6° F. Houston Black and Burleson soils have moist chromas of less than 1.5 throughout the upper 12 inches. Houston soils have cracks that remain open less than 90 cumulative days per year.

Setting: The Heiden soils occur in sloping to hilly erosional upland, mostly between 3 and 8 percent gradients but range as low as 0.5 percent and as high as 20 percent. Surfaces dominantly are convex but plane surfaces occur in some areas of low gradients. Most uncultivated areas have a microrelief of microvalleys 4 to about 12 feet wide and 3 to about 12 inches deep, and microridges about 4 to 12 feet wide that extend up and down slope. The regolith is mainly weakly consolidated Upper Cretaceous formations of calcareous marine sediments, high in montmorillonitic clays. Where developed over the Eagleford formation, calcareous sandstones about 1 inch thick and 10 inches long are on the surface in some pedons. The climate is moist subhumid with an annual precipitation of 29 to 42 inches. The mean annual air temperature range is 64 to 71.6° F, and the Thornthwaite annual P-E index ranges from 44 to 66.

Principal Associated Soils: These include the competing Ferris soils as the most common associate. Much of the Ferris series was of the Heiden series before cultivation and subsequent erosion. Other associates are the competing Houston Black and Burleson soils; and the Ellis, Crockett and Wilson soils. Ellis soils lack intersecting slickensides, Crockett and Wilson soils have Bt horizons.

Drainage and Permeability: Well drained, internal drainage is very slow, runoff is rapid. Infiltration is rapid when the soil is dry and cracked, but very slow or lacking when the soil is wet. Permeability is very slow.

Use and Vegetation: Largely for pasture and hay. Many areas have been cultivated, eroded and retired to grass. Vegetation is mainly bluestems and some buffalograss and threeawn grasses. Scattered mesquite trees occur in places. Some areas are used for growing grain sorghum and cotton.

Distribution and Extent: Central and eastern Texas. The series is of large extent comprising several hundred thousand acres.

Series Proposed: Bell County, Texas, 1966. Recommended by the Principal Soil Correlator for establishment in Bell County, Texas. The name is from the town of Heidenheimer.

Remarks: This series comprises the soils within the Blackland Prairie of Texas formerly classed as the Houston series and included in the Grumusol great soil group.

National Cooperative Soil Survey
USA

HILGRAVE SERIES

The Hillgrave series is a member of a loamy-skeletal, siliceous, thermic family of Typic Haplustalfs. These soils have an A horizon of very gravelly sandy loam, a very gravelly Bt horizon overlying a sandy C horizon; content of siliceous gravel is more than 50 percent, by volume, in at least the upper 20 inches of the Bt horizon.

Typifying Pedon: Hilgrave very gravelly sandy loam-pasture (Colors are for dry conditions unless otherwise specified.)

A1 0-8" Reddish brown (2.5YR 4/4) very gravelly sandy loam, dark reddish brown (2.5YR 3/4) moist; weak granular structure; soft, very friable; many grass roots, contains 60 percent, by volume, of waterworn siliceous gravel; slightly acid; clear smooth boundary. (6 to 10 inches thick.)

B21t 8-20" Red (2.5YR 4/6) very gravelly loam, dark red (2.5YR 3/6) moist; weak subangular blocky structure; clay bridging between sand grains is evident; soft, friable; numerous grass roots; contains 65 percent, by volume, of waterworn siliceous gravel; slightly acid; gradual smooth boundary. (6 to 14 inches thick.)

B22t 20-32" Red (2.5YR 4/6) very gravelly light sandy clay loam, dark red (2.5YR 3/6) moist weak subangular blocky structure; evident clay films and bridging between sand grains; slightly hard, friable; few grass roots; contains 75 percent by volume of waterworn siliceous gravel; mildly alkaline; abrupt smooth lower boundary. (8 to 12 inches thick.)

B3ca 32-42" Red (2.5YR 4/6) gravelly loamy sand, reddish brown (2.5YR 4/4) moist; structureless; but cohesive when dry; soft, very friable; few grass roots; contains 30 percent siliceous gravel, by volume, in upper part grading to 52 percent in lower part; few films and threads of $CaCO_3$ and some of the pebbles have thin coatings of $CaCO_3$; neutral; abrupt boundary. (6 to 13 inches thick.)

C 42-60" Reddish yellow (5YR 6/6) coarse sand, yellowish red (5YR 4/6) moist; structureless; soft, very friable; with few scattered gravel; neutral.

Type Location: Cottle County, Texas, approximately 12 miles (airline) northwest of Paducah on the Matador Wildlife Refuge. The pedon site is 30 feet west of the ranch road and 1.3 miles, via ranch road, southwest of the windmill that is beside the ranch road; this location is 12.9 miles west of the Matador Wildlife Refuge Headquarters along the ranch road.

Range in Characteristics: Thickness of the solum rnages from 20 to 50 inches. Gravel content ranges from 50 to 80 percent in at least the upper 20 inches of the Bt horizon. These soils are usually moist, but are dry in some subhorizon between depths of 10 and 40 inches below the surface for 135 to 180 cumulative days in 7 years out of 10. More than 65 percent of the fine earth from the surface to the bottom of the Bt horizon is of quartz, chert and other forms of SiO_2. The A horizon ranges in dry color in hues of 2.5YR to 7.5YR, values of 4 and 5 chromas of 3 and 4; in texture, from very gravelly sandy loam to gravelly loam; in reaction, from medium acid to moderately alkaline, but noncalcareous; content of organic matter ranges up to slightly less than 1 percent. The Bt horizon ranges from red to reddish brown in hues of 2.5YR and 5YR; in texture, from very gravelly sandy loam to very gravelly sandy clay loam with at least 3 percent more clay than the overlying A horizon; in reaction, from slightly acid to moderately alkaline, but noncalcareous in the upper part. The B3 horizon ranges from noncalcareous to calcareous in the matrix, with or without segregated $CaCO_3$ in the form of films and threads or coatings of $CaCO_3$ on the pebbles. The C horizon ranges from gravel-free sand to highly stratified gravel beds, containing strata of reddish earth.

Competing Series and Their Differentiae: These include the Springer soils of the same subgroup. Miles, Mobeetie and Gallegos series also compete. Springer and Miles soils lack 50 percent or more of gravel in the Bt horizon. Miles soils have a solum that extends to more than 50 inches below the soil surface. Mobeetie soils are calcareous throughout and lack Bt horizons and gravel contents of as much as 50 percent in the 10 to 40-inch control section. Gallegos soils lack a Bt horizon and have a calcic horizon within 40 inches of the soil surface.

Setting: Strongly sloping, severely dissected hills with gradients of 3 to 50 percent. Ridge tops are narrow and discontinuous; surfaces are convex. The soils developed in highly stratified outwash resting on clean sands or gravel beds. The localities of probable occurrence have mean annual temperatures of 57^{o} to 66^{o} F., annual precipitation of about 18 to 26 inches; and Thornthwaite annual P-E indices of about 24 to 40.

Principal Associated Soils: These mainly include soils of the Miles and Springer series.

Drainage and Permeability: Well drained; runoff is medium to rapid, depending on gradient. Permeability is moderately rapid.

Use and Vegetation: All areas are in native range. The principal grasses are little bluestem and sand dropseed, with some sideoats, blue gramma, black gramma, and threeawn. Sand sage shrub, cacti, juniper trees, mesquite trees and yucca shrub also grow on these soils. Many gravel pits are in some areas.

Distribution and Extent: Rolling Plains areas of west central Texas and possibly in similar areas of Oklahoma. Inextensive.

Series Proposed: Cottle County, Texas, 1966. The name is a coined word. Recommended for establishment by the Principal Soil Correlator.

Remarks: These soils were never classified in a great soil group in the 1938-49 Soil Classification System.

National Cooperative Soil Survey
USA

Established Series

HUNT SERIES

The Hunt series, in which there is but one type, Hunt clay, comprises very dark gray to black granular noncalcareous Rendzinas developed from marl or calcareous clay in warm-temperate humid prairies, mainly the Blackland Prairie of Texas. Hunt clay differs from Houston clay in having a neutral to slightly acid surface soil and lower content of calcium carbonate in the solum. The associated Wilson soils are Planosols and less granular.

Soil Profile:	Hunt clay		Range in Thickness
1.	0-18"	Very dark gray (10YR 3/1, 2/1, moist) clay; medium granular; firm but crumbly; very sticky and plastic when wet; neutral to slightly acid.	15-20"
2.	18-38"	Same as horizon 1, except that it is weakly coarse blocky and lower in organic matter.	10-30"
3.	38-50"	Pale olive (5Y 6/3) heavy clay of same consistence and structure as horizon 2; weakly calcareous; contains few small concretions of $CaCO_3$.	10-20"
4.	50-80"+	Olive yellow mottled with pale olive (5Y 6/6 and 6/3) strongly calcareous clay; this grades into pale olive calcareous impervious clay at a depth of 10 to 20 feet below the surface.	

Range in Characteristics: Thickness of the dark layer, horizons 1 and 2, ranges from 6 to 48 inches in relation to microrelief; color of horizon 1 ranges from black to dark gray; reaction of horizon 1 is neutral to slightly acid and of horizon 2 neutral to slightly alkaline. Locally, a few concretions of iron oxide occur on the surface and throughout the solum.

Topography: Nearly level to gently sloping upland with gradients up to about 5 percent, dominantly less than 3. Virgin areas have a microrelief of alternating depressions and knolls 6 to 10 feet in diameter and 3 to 8 inches high, the dark layer being 3 to 4 feet thick in depressions and 6 to 10 inches on the slight elevations.

Drainage: Slow to rapid from surface; slow to very slow internally; drainage is favorable for crop production; water is absorbed rapidly when soil is dry and contains cracks but runoff is rapid after the soil becomes wet and crevices closed.

Vegetation: Mainly tall prairie grasses, largely Andropogons. A few local areas developed on chalk were elm thickets.

Use: Practically all in cultivation and used for production of cotton, corn, sorghums, and some small grains; highly fertile; root rot organism reduces yields of cotton and legumes.

Distribution: Blackland Prairies of Central Texas and southern Oklahoma.

Type Location: Hunt County, Texas.

Series Established: Hunt County, Texas, 1936.

Remarks: This soil has an extremely high coefficient of expansion and contraction on wetting and drying and crevices 3 to 6 inches wide and extending to a depth of several feet form during extremely dry periods; clods in fields crumble on drying after being wet. Colors are Provisional Soil Survey Color names, based on Munsell Color Charts and are of dry soil, unless stated otherwise.

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5-23-46

Division of Soil Survey
Bureau of Plant Industry, Soils,
and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture

KAY SERIES*

The Kay series consists of dark or very dark soils of low alluvial terraces and high bottoms along streams that drain the Reddish Prairie soils of the western part of the county. These inextensive soils occupy nearly level to undulating surfaces, and runoff is slow. Drainage is not rapid but is sufficient for the production of general crops. Native vegetation was forest.

Surface soil and upper subsoil are slightly to medium acid, and the lower subsoil is neutral or slightly alkaline. The fine sandy loam and the silty clay loam are the only two types mapped in the county.

Kay silty caly loam--This very dark soil is on terraces in the western part of the county along streams that drain such Reddish Prairie soils as the Renfrow, Vernon, and Prague. The relief is nearly level, and drainage is imperfect. Some of the larger soil areas need surface drainage ditches for maximum production. Little or no erosion occurs. The water-holding capacity is high, and the soil absorbs most of the precipitation that falls.

The surface soil to a depth of 12 or 16 inches is very dark-brown nearly black friable silty clay loam. This grades into very dark-brown friable clay, which is heavier and less friable in the lower part. Below a depth of 35 or 40 inches this grades into reddish-yellow and brown mottled silty clay. The surface and upper subsoil layers are slightly acid. The substratum is calcareous below a depth of 70 or 80 inches.

Use and management--About 95 percent of Kay silty clay loam is cultivated, and most of the rest is used for woodland pasture. Approximately 40 percent of the cultivated land is cropped to corn, 20 percent to cotton, 15 percent to sorghums, 10 percent to alfalfa, and the rest to miscellaneous crops.

Crop yeilds are generally high. Under simple management average acre yields are: Corn, 22 to 26 bushels; cotton, 200 to 240 pounds of lint; sorghums, 20 to 24 bushels; and alfalfa, 3 to 3½ tons of hay. Woodland pastures have a carrying capacity of 12 to 15 acres per cow, if supplemental feed is given in winter and during extended droughts. This soil will probably continue to be productive for a long time without the use of fertilizer or soil amendments. Crop yields can probably be increased by following a crop rotation including a legume crop. Commercial fertilizer probably would not increase yields enough to pay the extra expense on general farm crops except during periods of high prices.

*Taken from the Okfuskee County Soil Survey

Established Series

KIRKLAND SERIES

The Kirkland series comprises slightly acid, moderately to highly fertile Reddish Prairie soils characterized by A horizons less than 14 inches thick, abrupt to clear boundaries between the A and B horizons, and brownish claypans not overlain by a distinct "gray layer". It is developed in alkaline, mostly reddish clays and shales, commonly of the Permian. The catenal associates are Vernon, Renfrow, and Tabler. It is the more humid equivalent of Foard, a Reddish Chestnut series that differs from Kirkland in being neutral and having a more marked and somewhat shallower carbonate horizon. Other related series are Bethany, which has a thicker A horizon and pronounced A_3 and B_1 horizons; and Calumet, the alluvial terrace equivalent of Kirkland.

Soil Profile: Kirkland silt loam

A_1 0-11" Dark brown (7.5YR 4/2; 3/2, moist) silt loam; friable; moderate medium granular; slightly acid; rests on or grades shortly to horizon beneath. 8 to 14 inches thick.

B_2 11-26" Dark brown (7.5YR 4/2; 3/2, moist) clay; blocky; very compact; slightly acid to neutral; grades indistinctly to horizon beneath. 12 to 20 inches thick.

B_3(?) 26-38" Brown (7.5YR 4.5/3; 3/3, moist) clay; massive to weak blocky; noncalcareous grades to horizon beneath. 8 to 18 inches thick.

C_{ca} 38-70" Reddish-brown clay; massive; compact; alkaline and contains a few scattered $CaCO_3$ concretions that increase with depth; soil mass noncalcareous in upper part, usually calcareous in lower. 25 to 50 inches thick.

C 70-100"+ Red or reddish-brown weakly consolidated shale; alkaline; usually weakly calcareous.

Range in Characteristics: Silt loam is the principal type, but much clay loam and some sandy loams occur in the southern half of the geographic range. The A horizon ranges from brown to dark grayish-brown (hues 7.5YR to 10YR) in color, medium acid to almost neutral in reaction, weak to moderate in degree of granulation. This horizon averages thicker and more granular in the northern areas than in the southern, and in the clay loam type, ranges from 5 to 9 inches thick. Some areas have a 1- to 2-inch transition between the A and B horizons of brown granular clay loam with or without inconspicuous grayish coatings. In many areas, no reddish coloration is reached within 4 feet and a few have nonreddish substrata.

Topography: Nearly level to very gently undulating erosional upland with gradients mostly less than 2 percent.

Drainage: Slow to moderate from the surface; very slow internally, but adequate for common field crops.

Vegetation: Tall prairie grasses, which have been largely replaced by short grasses in pastured areas.

Use: Largely in cultivation to oats, wheat, cotton, and sorghums; moderately productive.

Distribution: Reddish Prairie of north-central Texas, central Oklahoma, and southern Kansas.

Type Location: Logan County, Oklahoma; 900 feet north of south quarter corner Section 36, T16N, R4W.

Series Established: Reconnaissance Soil Survey of the Panhandle Region of Texas, 1910, for soils in the vicinity of Kirkland, Texas, that are now classed as Foard and Hollister. The series was restricted to the Reddish Prairie zone about 1919.

Remarks: Unless otherwise stated, colors refer to dry soil. Many of the areas from central Oklahoma northward, especially those with relatively thick A horizons, probably are affected by a very thin mantle of loess. The distinction of Calumet from Kirkland often is impossible with high accuracy, and the basis of that distinction is under review.

WTC:FAH:MB
4-30-40
Rev. HO:EHT
5-24-46
Rev. EHT:HO
1-16-52

Division of Soil Survey - BPISAE
ARA - U. S. Department of Agriculture

Established Series
HTO-LBJ
5-15-65

KONAWA SERIES

The Konawa series is in the fine loamy, mixed, thermic family of Udultic Haplustalfs. These soils have light colored sandy A horizons that are less than 20 inches thick over reddish moderately fine textured B2t horizons that grade to less acid, reddish, and sandy C horizons.

Typifying Pdeon: Konawa loamy fine sand
(Colors for dry conditions unless otherwise noted).

Ap 0-6" Grayish-brown (10YR 5/2) loamy fine sand, dark grayish-brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; slightly acid (pH 6.5); clear smooth boundary. 3 to 8 inches thick.

A2 6-14" Very pale brown (10YR 7/3) loamy fine sand, brown (10YR 5/3) moist; massive; soft, very friable; medium acid (pH 6.0); clear smooth boundary. 4 to 17 inches thick.

B2t 14-38" Yellowish-red (5YR 5/6) sandy clay loam, yellowish-red (5YR 4/6) moist; moderate coarse prismatic structure breaking to weak medium subangular blocky structure; very hard, friable; clay films on ped faces and bridging sand grains; medium acid (pH 5.8); diffuse smooth boundary. 15 to 35 inches thick.

B3 38-54" Yellowish-red (5YR 5/6) fine sandy loam, yellowish-red (5YR 4/6) moist; weak coarse prismatic structure; hard, friable; medium acid (pH 6.0); diffuse smooth boundary. 10 to 30 inches thick.

C 54-70"+ Yellowish-red (5YR 5/7) loamy fine sand, yellowish-red (5YR 4/8) moist; massive; slightly hard, friable; medium acid (pH 6.0).

Type Location: Pottawatomie County, Oklahoma; 700 feet south and 100 feet west of the northeast corner of Section 36, T6N, R4E.

Range in Characteristics: The A horizon ranges in thickness from 7 to 20 inches. The color of the upper A horizon ranges from pale brown to dark grayish-brown and brown in hues of 10YR and 7.5YR; of the A2 from very pale brown to light yellowish-brown and light brown in hues of 10YR and 7.5YR. The texture of the A ranges from loamy fine sand to fine sandy loam. The B2t horizon ranges in color from red to reddish-brown, yellowish-red, and reddish-yellow in hues of 2.5YR to 7.5YR; in reaction from medium to strongly acid; and in clay content from about 18 to 35 percent. The texture of the C horizon ranges from loamy fine sand to light sandy clay loam. The C horizon is less acid than the B2 horizon and reaches neutrality at about 10 feet.

Competing Series and Their Differentiae: These include the Stidham, Dougherty, Stephenville, Windthorst, and Travis series. The Stidham series has less reddish B horizons and thicker A horizons (20 to 40 inches). The Dougherty series has A horizons ranging in thickness from 20 to 40 inches. The Stephenville series has sandstone at depths less than 48 inches. The Windthorst and Travis series have fine textured B2t horizons.

Setting: The Konawa soils occur on nearly level to sloping uplands and are formed in medium acid to neutral sandy to loamy sediments. The slopes are dominantly between 1 and 9 percent. The climate is subhumid to moist subhumid (east of PE 44 isobar). At the type location, the average annual precipitation is about 35 inches and the mean annual temperature about 61^{o}F.

Principal Associated Soils: These include the Stephenville, Stidham, Eufaula, and Dougherty series. The Eufaula soils have A horizons that are more than 40 inches thick.

Drainage and Permeability: Well drained. Moderate permeability.

Use and Vegetation: Areas having slopes of less than 5 percent are largely in cultivation; sorghums, small grains, and peanuts are the main crops. Native vegetation is mainly post oak, blackjack, hickory, and elm with ground cover of little bluestem and other grasses.

Distribution and Extent: Central and eastern Oklahoma and Texas; possibly in southeastern Kansas, western Arkansas, and western Louisiana. This series is likely of large extent.

Series Established: Pottawatomie County, Oklahoma, 1965.

Remarks: This series consists of soils formerly classified in the Dougherty series but their sandy surface layers are too thin to fit the requirements of an arenic subgroup. These kinds of soils were formerly classified in the Red-Yellow Podzolic great soil group.

National Cooperative Soil Survey
USA

Established Series

LELA SERIES

The Lela series comprises imperfectly drained Grumusols developed from reddish calcareous clayey alluvium in moist-subhumid to warm-temperate grasslands (Reddish Prairie zone and transitions to Prairie and Reddish Chestnut zones) of Oklahoma, Kansas, and Texas. The series is characterized by (1) very dark color to depths of 18 or 50 inches, (2) clay texture throughout (excepting overburden of more recent sediments), (3) medium-high content of organic matter--of the order of 3% to 5% in the surface soil and decreasing slowly with depth, (4) noncalcareous and commonly about neutral in the surface soil, becoming alkaline with depth, (5) moderately granular structure and extremely sticky and plastic consistence of surface soil, which crumbles naturally on drying, (6) relatively high contents of available phosphorus, potash, and weatherable minerals, and (7) substrata of reddish calcareous clay. The parent material is old alluvium from subhumid grasslands in the Southern Great Plains underlain by Permian red beds. The Lela series occurs on younger surfaces, has somewhat cooler environment, and is higher in organic matter than the Burleson and Lake Charles soils. It has a more clayey subsoil and is more intensely darkened to greater depth than McLain series. It differs from the Brewer soils in having no genetic B horizon. The solum is less acid than in Page soil; the environment is cooler, the organic matter higher, and the frequency of flooding generally less than in Pledger soils.

Soil Profile: Lela clay

A_{11}	0-1"	Very dark gray (7.5YR 3/1) clay, very dark brown (7.5YR 2/2) when moist; strong fine granular structure when dry (the granules are discrete); extremely plastic, very firm, very hard; about neutral. 1/2 to 2 inches thick in virgin areas.
A_{12}	1-45"	Very dark gray (7.5YR 3/1) clay, very dark brown (7.5YR 2/2) when moist; compound moderate medium granular and weak irregular blocky structure, the granules gradually coarsening and becoming less distinct with depth; very firm, extremely plastic; very slowly permeable when wet; about neutral; noncalcareous; gradual boundary.
AC	45-75"	Dark reddish-brown (5YR 3/2) clay, dark reddish-brown (5YR 3/3) when moist; weak medium blocky or prismatic structure; extremely plastic, very firm; mildly alkaline; soil mass noncalcareous but a few concretions of $CaCO_3$ present; gradual boundary.
C	75-90"+	Reddish-brown (5YR 4/3) clay, dark reddish-brown (5YR 3/4) when moist; moderately alkaline (pH8); noncalcareous or mildly calcareous; scattered concretions of $CaCO_3$ present. This is old alluvium.

Range in Characteristics: Color of the A_1 horizon ranges from very dark gray to dark brown (hues of 7.5YR to 10YR; values of 2.5/ to 4/; chromas of /1 to /2). The A_1 horizon may be slightly mottled with brown or reddish-brown below 15 inches. Silted phases with more recent overwash of various textures and colors are common. Colors are for dry soil unless otherwise indicated.

Topography: Level lowlands bordering or within flood plains; gradients of 0 to 1/2%; surfaces plane or broadly concave.

Drainage and Permeability: Somewhat poorly to moderately well drained. Internal drainage is very slow or none. During cool wet seasons, the soil is saturated. Most areas receive runoff from adjoining higher areas; some are occasionally flooded from nearby streams. During dry summers, the soil dries to or below the wilting coefficient to depths of several feet; the deep substrata probably never becomes dry.

Vegetation: Tall grass with or without scattered trees.

Use: Mostly cultivated to corn, wheat, oats, cotton, and some alfalfa. Yields are mostly medium to high; natural fertility is very high. Drainage has been improved in most areas by construction of roadside borrow ditches and other shallow open drains.

Distribution: Widely scattered bodies ranging up to a thousand or more acres in size, mainly in northern and northeastern Oklahoma. The total extent probably is between 10 and 50 thousand acres.

Series Established: Pawnee County, Oklahoma, 1954. The name is taken from a village in this county.

Type Location: Noble County, Oklahoma, the west quarter corner of Section 6, T24N, R1E.

Remarks: These soils have heretofore been classed as clay types of the Kay and Brewer series.

Rev. EHT:HMG
10-6-54
Mimeo 1957

National Cooperative Soil Survey
USA

LIGHTNING SERIES

The Lightning series includes rather light-colored immature soils developing on fine-textured alluvium, chiefly in the Prairie soils zone. These soils differ from those of the Osage series in being lighter colored throughout the solum and in having more highly mottled subsoils. Their surface layers are lighter colored, the subsoil is heavier, and the drainage is poorer than in Verdigris soils.

Soil Profile: Lightning silty clay loam

0-10" Light-gray (10YR 6/1, 10YR 4/1 when moist) crumb-structured silty clay loam; moderately friable; slightly acid. 6 to 18 inches thick.

10-28" Light brownish-gray (10YR 6/2, 10YR 4/2 when moist) silty clay loam, faintly mottled with yellowish red and brown; heavy to moderately friable; breaks naturally into angular fragments and small irregularly shaped clods, medium to slightly acid. 15 to 40 inches thick.

28-40"+ Light-gray (10YR 7/1, 10YR 5/2 when moist) massive clay or heavy silty clay, mottled with yellowish red (5YR 4/6); neutral or slightly acid.

Range in Characteristics: Chief variation is in the texture of the surface layer and degree of mottling in the subsoil and substratum. In places the section includes sedimentary layers of lighter or darker material than that comprising the rest of the profile.

Topography: Flat or slightly depressed.

Drainage: External drainage very slow to ponded; internal drainage, very slow. The soils are subject either to frequent or to occasional inundation.

Vegetation: Rushes, grasses with high water requirement, and a scattering of deciduous trees.

Use: Chiefly for pasture and forest land. Some of the larger and better-drained areas are used for growing corn and forage sorghum. Yields on the cultivated areas depend largely on the drainage conditions.

Distribution: Southeastern Kansas, northeastern Oklahoma, and southwestern Missouri, mainly in the broader flood plains.

Type Location: Labette County, Kansas.

Series Established: Labette County, Kansas, 1926.

Except where specified moist, colors refer to dry soil. Symbols express Munsell notations.

EGF:FAH:MB
3-25-40
Rev. WIW
5-20-46

Division of Soil Survey
Bureau of Plant Industry, Soils, and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture

LINCOLN SERIES

The Lincoln series is a member of the sandy, mixed, thermic family of Typic Ustifluvents. They have brown, sandy, calcareous A horizons and pink, sandy, calcareous C horizons with strata of finer textured material.

Typifying Pedon: Lincoln loamy fine sand - rangeland
(Colors are for dry soil unless otherwise stated.)

A1 0-11" Brown (7.5YR 5/3) loamy fine sand, dark brown (7.5YR 4/2) moist; weak fine and medium granular structure; soft, very friable; thin strata and bodies of fine sand to loam; calcareous; moderately alkaline; clear smooth boundary. (6 to 15 inches thick.)

C 11-60" Pink (7.5YR 7/4) fine sand, light brown (7.5YR 6/4) moist; structureless, single grain; loose, very friable; very thin to 1 inch thick strata of darker colored fine sandy loam to clay loam that decrease in thickness and frequency with depth; bedding planes are evident; calcareous; moderately alkaline. (3 to several feet thick.)

Type Location: Tillman County, Oklahoma; about 2 miles west and 2 miles north of Tipton; 200 feet north and 2300 feet west of the southeast corner of Section 28, T1N, R19W.

Range in Characteristics: These soils are usually moist but are dry for 90 cumulative days or more in most years in some subhorizon between 12 and 36 inches. Usually the reaction is moderately alkaline and the soil is calcareous throughout. The upper 10 inches of the soil may be leached of lime and ranges to mildly alkaline. The 10- to 40-inch section averages fine sand or loamy fine sand with strata of material finer than loamy fine sand. The A1 horizon has hues of 5YR through 2.5Y, values of 4 through 7 dry and 3 through 6 moist, and chroma of 2 through 4. No A horizon is as much as 10 inches thick with sandy textures or 7 inches thick with loamy textures with values less than 5.5 dry and 3.5 moist and chroma of less than 3.5. The texture is mainly loamy fine sand, fine sandy loam or loam but clay loams occur in strata usually less than 5 inches thick. The A horizons are stratified with sandier and/or finer textured material. The C horizon has hues of 5YR through 2.5Y, values of 6 through 8 dry and 5 through 7 moist and chroma of 2 through 6. A few brown to strong brown mottles may occur at 3 to 4 feet below the surface. The texture of the C horizon is fine sand or loamy fine sand with strata of finer material. The finer strata are darker and contain more organic matter than the mass causing an irregular distribution of organic matter.

Competing Series and Their Differentiae: These are the Brazos, Bruno, Crevasse, Likes, Tivoli, and Yahola soils. The Bruno and Crevasse soils are dry for less than 90 cumulative days in most years in some subhorizon between 7 and 20 inches. In addition the Crevasse soils have textures of loamy fine sand or coarser in all parts of the 10- to 40-inch section. The Likes and Tivoli soils have textures of loamy fine sand or coarser in all parts of the 10- to 40-inch section. The Yahola soils average finer than loamy fine sand in the 10- to 40-inch section.

Setting: The Lincoln soils are on flood plains. Slope gradients are mainly less than 1 percent. The Lincoln soils are in recent sandy alluvial sediments. The climate is semiarid to subhumid; mean annual precipitation is about 18 to 28 inches, Thornthwaite P-E index is about 26 to 44, and the mean annual air temperature is about 57° to 70° F.

Principle Associated Soils: These are the competing Likes, Tivoli, and Yahola soils.

Drainage and Permeability: Somewhat excessively drained; runoff is slow; permeability is rapid. The water table is at 3 to 8 feet.

Use and Vegetation: Used mainly for native range with a few areas in tame pasture. The vegetation is tall grasses with varying amounts of weeds and annual grasses. A few cottonwood trees are commonly present.

Distribution and Extent: Western parts of Oklahoma and Texas and southwestern Kansas. The soil is extensive.

Series Established: Russel County (Russel Area), Kansas, 1903.

Remarks: These soils were classified as Alluvial soils in recently completed soil surveys. Reviewers were not able to satisfactorily differentiate the Brazos series.

National Cooperative Soil Survey
USA

LINKER SERIES

The Linker series consists of well drained Red-Yellow Podzolic soils developed in residuum from acid sandstones that may contain thin strata or lenses of sandy shale or siltstone. These soils occur on gentle to moderately steep slopes in association with the Enders, Hanceville, Hartsells, Hector, Muskingum, Pottsville, Rarden, Christian, Wellston, Zanesville, and Tilsit soils. The Linker soils have lighter colored A horizons and less red B horizons than the Hanceville soils which are members of the Reddish-Brown Lateritic group. They have redder B horizons than the Hartsells soils, and are deeper and have a greater degree of horizonation than the Hector, Muskingum, and Pottsville soils. Linker soils are derived from sandier parent materials and are coarser textured in the B horizon than the Christian, Rarden, Enders, Wellston, Zanesville, and Tilsit soils. They also have redder subsoils and lack the fragipans of the Zanesville and Tilsit series. Linker soils are extensive, occur in relatively large bodies, and are important to agriculture.

Soil Profile: Linker fine sandy loam--cultivated

A_p 0-6" Brown (10YR 5/3) fine sandy loam; weak fine to medium granular structure; very friable; few medium hard dark concretions; few coarse tubular pores; slightly acid; clear smooth boundary. 4 to 10 inches thick.

B_1 6-11" Yellowish-red (5YR 4/6) loam; weak to moderate fine and medium subangular blocky structure; friable; a few patchy clay films and bridges; few coarse and medium tubular pores partially lined with clay films; few vertical streaks of brown materials from the A_p horizon; few fine and medium angular sandstone fragments; few medium hard dark brown concretions; medium acid; clear wavy boundary. 5 to 10 inches thick.

B_2 11-26" Yellowish red (5YR 4/8) sandy clay loam; moderate medium angular blocky structure; friable; common patchy and few entire clay films; common fine and medium tubular pores lined with clay films; few medium sandstone fragments and medium hard dark concretions; strongly acid; clear wavy boundary. 10 to 30 inches thick.

C 26-37" Coarsely and reticulately mottled pale brown (10YR 6/3) and yellowish-red (5YR 4/6) loam; mostly friable, very hard; fine to coarse angular blocks of sandstone in various stages of weathering coated with thick films of sandy loam; few thin discontinuous clay films along some cleavage planes; common hard dark concretions as nodules in the unweathered sandstone; strongly acid; gradual wavy to irregular boundary. 0 to 20 inches thick.

D_r 37"+ Acid sandstone, slightly weathered on surface.

Range in Characteristics: Fine sandy loam, sandy loam, and loam are the dominant types. Loamy sand types and gravelly and stony phases occur. Thickness of solum ranges from 30 to 50 inches. Color of the A_p horizon ranges from grayish brown to dark brown, and this horizon may be underlain by a grayish brown or brown A_2 horizon. Forested areas have a dark grayish brown or very dark grayish brown A_1 horizon about 1 to 4 inches thick and a grayish brown or brown A_2 horizon, 4 to 10 inches thick. The B_1 horizon may be brown, strong brown, reddish brown or yellowish red in color and range from fine sandy loam to light sandy clay loam in texture. The B_2 horizon ranges from yellowish red to red and from loam to clay loam. Some profiles have yellowish red to dark red B_3 horizons of clay loam or sandy clay loam, about 3 to 8 inches thick. Sandstone fragments and dark, hard concretions commonly occur throughout the solum. Small quartz gravels occur in profiles derived partly from sandstone conglomerates. In places the C horizon is absent and the B_2 or B_3 may rest directly on the D_r horizon or on unconforming yellowish red or red sandy or silty acid shales. Reaction of any horizon may be slightly to very strongly acid. The lower part of the B_2 horizon, or the B_3 horizon when present, and the C horizon may be variegated with shades of gray, brown, red, and yellow. There are often channels filled with decomposing organic shreds. Colors given are for moist soils. Dry soil colors are one or two units higher in value.

Topography: Broad plateaus, mountain tops, hill tops, and gently sloping benches. Slopes rarely exceed 15 per cent, and are dominantly between 2 and 8 per cent.

Drainage and Permeability: Well drained, with medium runoff and medium to moderately rapid internal drainage. Permeability is moderately rapid.

Vegetation: White, red, post, and blackjack oaks; shortleaf pine; sweetgum; blackgum; and hickory species.

Use: Cotton, corn, small grains, sorghum, peaches, garden and truck vegetables, hay, and pasture crops.

Distribution: Alabama, Arkansas, Georgia, Kentucky, Oklahoma, and Tennessee; possibly Missouri and West Virginia.

Type Location: Pope County, Arkansas; 3 miles northeast from Pottsville, on Carrion Crow Mountain.

Series Established: Pope County, Arkansas, 1938.

Rev. CAM-ML

National Cooperative Soil Survey
USA

Established Series

LUCIEN SERIES

The Lucien series comprises reddish noncalcareous Lithosols of the Reddish Prairie soil zone, formed under grass in residuum from red noncalcareous soft fine-grained sandstones and sandy shales, mainly in the prairies of central Oklahoma. They are shallower and lower in phosphorus than Nash, and more sandy and friable than Vernon, the associated generally calcareous Lithosol developed in clayey materials. Lucien soils are closely related to Darnell, a forested Lithosol, but slightly darker and commonly somewhat redder.

Soil Profile:		Lucien very fine sandy loam	Range in Thickness
A_1	0-10"	Reddish-brown (2.5YR 4/3; 3/3, moist) very fine sandy loam; moderate medium granular; very friable; slightly acid; grades to horizon below.	5-14"
A_3	10-15"	Reddish-brown (2.5YR 4/4; 3/4, moist) very fine sandy loam; compound coarse prismatic and medium granular; very friable; medium acid; grades through a thin transition to material below.	0-12"
C	18-30"+	Reddish-brown (2.5YR 4/4) noncalcareous soft fine-grained sandstone often interbedded with red clay; noncalcareous; commonly neutral.	

Range in Characteristics: Very fine sandy loam is the principal type; color of the surface soil ranges from dark reddish-brown to reddish-brown, and the reaction, from neutral to medium acid; the A_3 horizon is very thin or lacking where the soils are less than about 10 inches deep; thickness of the solum is variable within short distances, and ranges from as little as 2 inches in the stony types to about 20 inches in the nonstony types.

Topography: Gently to strongly sloping erosional upland.

Drainage: Surface runoff is moderate to rapid; internal drainage is moderate; very susceptible to erosion if not carefully managed.

Vegetation: Mainly bluestem and grama grasses, which forms a moderate to thick cover.

Use: Three-fourths or more is in native pasture or meadow. The small acreages in cultivation are devoted mainly to wheat, oats, cotton, and sorghums, and are of low productivity; generally unsuited for cultivation; the native vegetation generally is relatively low in phosphorus.

Distribution: Mainly in the eastern part of the Reddish Prairie soil zone of Oklahoma; moderately extensive.

Type Location: Noble County, Oklahoma; SE quarter Section 12, T21N, R1E.

Series Established: Noble County, Oklahoma, 3-10-47.

Remarks: Prior to establishment of the Lucien series, these soils were generally classed as sandy types of Vernon. Colors are described with approximate provisional Soil Survey color names (1947) and refer to dry soil.

EGF
9-23-43
Rev. HO:EHT
3-3-48

Division of Soil Survey
Bureau of Plant Industry, Soils,
and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture

LULA SERIES

The Lula series is a member of the fine-silty, mixed, thermic family of Typic Argiudolls. They have very dark grayish brown, silt loam A1 horizons, dark reddish brown, light silty clay loam B1 horizons, dark reddish brown, sitly caly loam B2t horizons and have limestone bedrock at a depth of about 22 inches.

Typifying Pedon: Lula silt loam - rangeland
(Colors are for moist soil unless otherwise stated.)

A1 0-10" Very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; hard, friable; medium acid; gradual smooth boundary. 6 to 14 inches thick.

B1 11-18" Dark reddish brown (5YR 3/3) light silty clay loam, reddish brown (5YR 4/3) dry; strong medium granular structure; hard, friable; medium acid; 6 to 14 inches thick.

B21t 18-32" Dark reddish brown (2.5YR 3/4) silty clay loam; common fine faint dark red mottles, reddish brown (2.5YR 4/4) dry; moderate medium blocky structure; hard, firm; clay films on ped surfaces; a few fine black concretions; strongly acid; gradual smooth boundary. 10 to 28 inches thick.

B22t 32-52" Dark reddish brown (2.5YR 3/4) silty clay loam; few fine faint dark red mottles, reddish brown (2.5YR 4/4) dry; moderate medium blocky structure; very hard, firm; clay films on ped surfaces; a few fine black concretions; a few chert and limestone fragments from 2 to 25 mm. in diameter; neutral; abrupt wavy boundary. 0 to 24 inches thick.

R 52"+ Hard limestone bedrock.

Type Location: Craig County, Oklahoma; about 4 miles west and 1 mile north of Centralia; 2000 feet east and 1000 feet south of the northwest corner of Section 19-T27N-R18E.

Range in Characteristics: These soils are usually moist and are not dry for 90 cumulative days in most years in some subhorizon of the soil between 7 and 20 inches depth. The solum is more than 40 inches thick and has limestone bedrock within 60 inches depth. The dark epipedon is from 10 to 20 inches thick. The upper 20 inches of the B1 and B2t horizons averages from about 27 to 35 percent clay and less than 15 percent material coarser than very fine sand. The A1 horizon has hues of 5YR through 10YR, values of 2 or 3 moist and 4 or 5 dry, and chroma of 2 or 3. The texture is loam or silt loam. The reaction of the A1 horizon is slightly acid or medium acid. The B1 horizons have hues of 5YR through 10YR, values of 3 or 4 moist and 4 through 6 dry, and chroma of 3 or 4. The texture of the B1 horizon is heavy loam, heavy silt loam, light clay loam, or light silty clay loam. The reaction ranges from slightly acid to medium acid. The B2t horizons have hues of 2.5YR through 7.5YR, values of 3 or 4 moist and 4 or 5 dry, and chroma of 4 through 6. The texture ranges from light to medium silty clay loam in the upper part to light silty clay loam to clay in the lower part. The reaction of the B2t horizons ranges from slightly acid to strongly acid in the upper part and neutral to medium acid in the lower part.

Competing Series and Their Differentiae: These are the Caspiana, Claremore, Eldorado, Fitzhugh, Mason, Mer Rouge, Newtonia, and Scullin soils. The Caspiana, Mason and Mer Rouge soils are developed from sediments and lack hard bedrock within 60 inches depth. The Claremore soils have limestone bedrock within 20 inches of the soil surface. The Eldorado soils have more than 35 percent chert in the upper 20 inches of the Bt horizons. The Fitzhugh soils have more than 15 percent material coarser than very fine sand in the Bt horizon. The Newtonia soils have sola thicker than 60 inches and the clay content does not decrease by as much as 20 percent from the maximum within 60 inches depth. The Scullin soils have bedrock between 20 and 40 inches and have from 15 to 35 percent chert and/or limestone gravel in the upper 20 inches of the Bt horizon.

Setting: The Lula soils are on nearly level to gently sloping uplands. Slope gradients are from 0 to 8 percent but are mainly less than 3 percent. The Lula soils formed from limestones. The annual Thornthwaite P-E index is from 64 to 80; the average annual precipitation is from about 37 to 45 inches; and the average annual air temperature is from 57 to about 64° F.

Principal Associated Soils: These are the competing Claremore, Newtonia, and Scullin soils and the Summit and Talpa soils. The Summit soils have more than 35 percent clay in the upper 20 inches of the Bt horizon. The Talpa soils have sola thinner than 20 inches to limestone and lack Bt horizons.

Drainage and Permeability: Well drained; runoff is slow to medium; permeability is moderate.

Use and Vegetation: Used for native meadow or native range, cultivated to small grains or sorghums or used for tame pasture. The native vegetation is tall grass prairie.

Distribution and Extent: Eastern Oklahoma, southeastern Kansas and possibly southwestern Missouri and northwestern Arkansas. The series is of moderate extent.

Series Proposed: Pontotoc County, Oklahoma, 1967. The name is from a small town in Pontotoc County.

Remarks: This soil would have been classified as a Reddish Prairie soil and in the past has been a part of the Newtonia series.

National Cooperative Soil Survey
USA

Established Series

McLAIN SERIES

The McLain series comprises youthful Reddish Prairie Soils developed on reddish calcareous alluvium that originated mainly in warm-temperate prairies and subhumid plains underlain by red beds. The series occurs on low terraces above overflow and has a distinct color profile and free carbonates removed to a depth of several feet, but lacks a distinct textural profile. The principal catenal associate is Brewer, which is more slowly drained and less brown and has grayer heavier subsoils. McLain soils are darker and occur above overflow and under more humid climate than the Port soils; the carbonates are leached to a greater depth than in the Asa soils; and the several horizons are browner or redder than in the Kay soils, which are on alluvium having a smaller proportion of sediments from red beds.

Soil Profile: McLain silty clay loam		Range in Thickness
0-10"	Dark-brown (7.5YR 3.5/2; 2.5/2, moist) clay loam; granular; friable; about neutral; grades to horizon below.	6-15"
10-30"	Reddish-brown (5YR 4/3; 3/3, moist) heavy silty clay loam; granular; friable; hard when dry; neutral to alkaline but noncalcareous.	15-25"
30-50"	Reddish-brown (5YR 5/4; 4/4, moist) heavy silty clay loam; massive; slowly permeable; firm; weakly alkaline but noncalcareous.	15-25"
48-60"+	Yellowish-red (5YR 5/5; 4/6, moist) calcareous friable silty clay loam.	

Range in Characteristics: Types range from very fine sandy loam to silty clay but silt loam and silty clay loam are predominant; surface soil ranges from dark brown to brown and dark reddish-brown and from slightly acid to mildly alkaline; texture of subsoil as a whole ranges from clay loam to silty clay but the strata of clay are not uncommon; dark layers comprising buried soils occur at erratic depths in many areas.

Topography: Level low stream terraces lying 5 to 20 feet above present flood plains.

Drainage: Slow from the surface; moderate internally; very favorable for crops.

Vegetation: Originally forested with oak, elm, pecan, hackberry, and ash.

Use: Practically all in cultivation and devoted mainly to corn, cotton, alfalfa, small grain, sorghums, and broomcorn; very fertile and highly productive.

Distribution: Mainly in central and southern Oklahoma on terraces of the Washita, Canadian, and Red Rivers.

Type Location: Murray County, Oklahoma; SW 1/4 Section 30, T1N, R3E.

Series Established: Muskogee County, Oklahoma, 1913.

Remarks: As originally described in the Soil Survey of Muskogee County, Oklahoma, the McLain series comprised reddish soils with dark brown to black subsoils, which evidently represented a two-story soil consisting of reddish more recent sediments over a buried dark soil. This accidental soil condition, however, is very inextensive and in 1937 the series concept was modified to include the soils as now defined.

Colors are described with provisional Soil Survey color names (1946) and unless stated otherwise refer to dry soil.

Rev. EGT:WTC
5-23-38
Rev. EHT:HO
9-5-46

Division of Soil Survey
Bureau of Plant Industry, Soils, and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture

Established Series

MASON SERIES

The Mason series comprises dark, moderately well-drained, friable, non-calcareous soils developed on silty and clayey alluvium on low terraces, mainly in the Reddish Prairie soil zone. Mason lies somewhat higher than the associated Verdigris, which it resembles, but is above overflow and has a somewhat more developed texture and structure profile. Other related series are Dale, which has browner, lighter-textured, more friable subsoils; Kaw, which lacks the mottled substratum, occurs under drier climate, and is no more than slightly acid; and Neodesha, which is grayer and has strongly mottled subsoils.

Soil Profile: Mason silt loam

A_1	0-14"	Dark grayish-brown (10YR 4/2, 3/2 moist) silt loam; strong medium granular; very friable; medium acid. 10 to 18 inches thick.
B_2	14-26"	Dark grayish-brown (10YR 4/2, 3/2 moist) silty clay loam; strongly medium granular; friable; permeable; slightly acid. 10 to 24 inches thick.
B_3	26-40"	Grayish-brown (10YR 4/2.5) silty clay loam mottled with 10 to 20% of brown (7.5YR 4/4) and some yellowish and reddish-brown; massive to weakly blocky; permeable; firm to friable; slightly acid. 10 to 16 inches thick.
C	40-60"+	Mottled grayish-brown and yellowish-brown (10YR 5/2 and 5/5) silty clay loam; firm; moderately permeable; slightly acid to neutral.

Range in Characteristics: Silt loams and clay loams are the principal types; color of the surface soil ranges from grayish-brown to very dark grayish-brown, the lighter textures being the less dark; reaction ranges from medium to slightly acid; horizon 2 ranges from loam to silty clay loam, from grayish-brown to dark brown (hues of 10YR to 6.5YR), and from slightly acid to neutral; depth to the mottled horizon 3 ranges from about 20 to 44 inches; substrata below about 50 inches ranges from silty clay to weakly stratified silty and clayey alluvium, medium acid to weakly alkaline in reaction.

Topography: Nearly level low terraces lying 5 to 15 feet above normal overflow.

Drainage: Moderately slow from the surface and internally but very favorable for all common field crops, including alfalfa.

Natural Vegetation: Deciduous forest mainly of elm, oak, hackberry, and pecan.

Use: Largely cultivated and used for growing corn, cotton, oats, sorghums, and some alfalfa and lespedeza; fertile and highly productive.

Distribution: Reddish Prairie soil zone, mainly in eastern Oklahoma.
Type Location: Okfuskee County, Oklahoma, SE corner Section 20, T11N, R10E.
Series Established: Okfuskee County, Oklahoma, 1940.

Rev. 5-3-48 HO:EHT
Mimeo June 1956

Soil Survey
Soil Conservation Service
U. S. Department of Agriculture

MHOON SERIES

The Mhoon series comprises poorly to somewhat poorly drained Alluvial soils. These soils are closely associated with those of the Crevasse, Robinsonville, and Commerce series. They are more poorly drained than the Crevasse, Robinsonville, and Commerce soils, as indicated by grayer color of the deeper profile. The Mhoon soils are widely distributed in small areas and are locally important to agriculture.

Soil Profile: Mhoon silt loam

Ap	0-6"	Dark gray (10YR 4/1) silt loam; weak medium granular structure; very friable; neutral; clear smooth boundary. 4 to 8 inches thick.
C_{1g}	6-14"	Gray (10YR 5/1) silt loam with few distinct medium mottles of yellowish brown; weak fine subangular blocky structure; very friable; neutral; abrupt smooth boundary. 2 to 10 inches thick.
C_{2g}	14-20"	Dark gray (10YR 4/1) silty clay loam with few distinct medium yellowish brown mottles; weak medium angular blocky structure; firm, sticky, plastic; neutral; clear smooth boundary. 4 to 15 inches thick.
C_{3g}	20-38"	Gray (10YR 6/1) silt loam with common distinct medium and coarse mottles of yellowish brown; weak fine subangular blocky structure; very friable; neutral; abrupt smooth boundary. 10 to 30 inches thick.
C_{4g}	38-48"	Gray (10YR 5/1) silty clay with few medium distinct yellowish brown mottles; massive; very firm, very sticky, very plastic; neutral; 0 to 36 inches thick.

Range in Characteristics: Silt loam is the most common type, with silty clay loam, clay loam, sandy clay loam and sandy loam less common. The color of the Ap horizon may be light gray, very dark gray, grayish brown or dark grayish brown. Any of the subhorizons of the C horizon may be very fine sandy loam or fine sandy loam. Color of the C1g horizon may be light brownish gray or grayish brown with common gray mottles to a depth of 12 to 15 inches. Color of other C horizons ranges from light gray to dark gray with darker values generally associated with the finer textures. Mottles vary in number from few to many and in size from fine to coarse. Reaction of any horizon may range from slightly acid to mildly alkaline. Clayey lenses may be present in any position in the soil profile. The C_{4g} horizon is frequently absent or beyond reach of auger. Colors given are for moist soil. Color of dry soil will be one or two units higher in value.

Topography: Level to slightly depressed flood plains; less than 1 percent slope.

Drainage and Permeability: Poorly to somewhat poorly drained, with runoff slow or ponded, internal drainage very slow, and permeability slow to very slow.

Vegetation: Cypress, oak species, hickory, pecan, sweetgum, elm.

Use: Nearly all areas, where protected from overflow, have been cleared for crops or pasture. Crops include cotton, corn, sugar cane, annual legumes, and hay crops.

Distribution: Mississippi River flood plain in Missouri, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana.

Type Location: West Baton Rouge Parish, Louisiana; 1 mile west of Chamberlin on parish road.

Series Established: USDA Sugar Cane Experiment Station, Terrebonne Perish, Louisana, 1948.

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USA

Rev. ML
3-28-62

MILLER SERIES

The Miller series is a member of the fine, mixed, thermic family of Vertic Haplustolls. These calcareous, clayey soils have reddish brown A horizons over reddish brown to red B and C horizons.

Typifying Pedon: Miller Clay - cultivated cropland (Colors are for dry soil unless otherwise noted.)

Ap 0-5" Reddish brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; weak to moderate fine blocky structure; very hard, firm, very sticky and plastic; common fine roots; alkaline and calcareous; abrupt smooth boundary. (3 to 8 inches thick.)

A12 5-15" Reddish brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate fine blocky structure; very hard, firm, very sticky and plastic; common fine roots; shiny pressure faces on some peds; alkaline and calcareous; gradual wavy boundary. (7 to 22 inches thick.)

B2 15-50" Reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate fine blocky structure; very hard, firm, very sticky and plastic; few fine roots; shiny pressure faces on peds; few small slickensides; vertical cracks filled with material from above; few soft masses of $CaCO_3$; alkaline and calcareous; gradual wavy boundary. (20 to 40 inches thick.)

C 50-80" Red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; structureless; massive; very hard, firm, very sticky and plastic; few fine roots; few slickensides that do not intersect; few thin lenses of pale brown (10YR 6/3) silt loam; alkaline and calcareous.

Type Location: Brazos County, Texas. In Flood plain of Brazos River 200 feet south of F.R. 159 from a point 0.2 mile west of private road crossing railroad, about 3 miles east of Allentown by way of F.R. 159.

Range in Characteristics: Solum thickness ranges from 30 to 70 inches. The soil is calcareous throughout the 10- to 40-inch control section and has soft powdery carbonates within 24 inches of the soil surface. The average annual soil temperature at 20 inches ranges from 59° to 72° F. The mineralogy is mixed. The soil has an erratic distribution of organic matter within 50 inches of the surface. Cracks more than 1 cm. wide extend from the surface to depths greater than 20 inches in some season in most years. Slickensides range from few to common, but do not intersect in any horizon. The COLE is 0.09 or more in some horizon 20 inches or more thick, and the upper 40 inches of the soil has a potential linear extensibility of 6 cm. or more. The A horizon ranges from reddish brown to dark brown, hues of 5YR through 7.5YR, dry values of less than 5.5, moist values of less than 3.5, and chromas of 2 and 3. Texture of the A horizon is mainly clay, but the upper 10 inches ranges from fine sanyd loam and silt loam to clay. Structure of the A horizon ranges from weak to strong, fine to medium blocky and granular, and upon drying the soil naturally separates to a mass of fine, extremely hard aggregates. The B horizon ranges from reddish brown to red, hues of 2.5YR through 7.5YR, dry values of 4 and 5, and chromas of 3 through 6. Texture of the 10 to 40 inch control section ranges from clay to silty clay, clay content ranging from 35 to 60 percent. Structure of the B horizon ranges from weak to strong angular to subangular blocky. Color of the C horizon ranges from reddish brown to dark red. Texture of the C horizon is a clay which may contain thin strata of silt and sand.

Competing Series and Their Differentiae: Closely related or similar soils are in the Denton, Krum, Moreland, Pledger, Roebuck and Trinity series. Denton and Krum soils have a regular decrease in organic matter. Moreland soils are not calcareous throughout but have soft powdery lime accumulations below 20 inches but within 36 inches. Pledger soils do not have secondary carbonates within 24 inches of the surface. Trinity soils are black or very dark gray and are saturated with water at some season. Roebuck soils lack secondary soft $CaCO_3$ within 60 inches of the surface.

Setting: Miller soils are on nearly level flood plains of rivers carrying sediments of mixed origin. Slopes are plane and mainly less than one percent, but range up to 8 percent along some natural drains. The regolith is calcareous, reddish stratified clayey and silty sediments of mixed mineralogy. The climate is warm and subhumid. The average annual precipitation ranges from 27 to 45 inches. The average annual air temperature ranges from 57^{o} to 70^{o} F. Thornthwaite P-E indices range from 44 to 74.

Principal Associated Soils: These are Moreland, Pledger, and Roebuck soils of the competing series, as well as Crevasse, Norwood, and Yahola soils. Crevasse soils are sands or loamy sands between 10 and 40 inches. Norwood soils have 18 to 35 percent clay in the control section. Yahola soils are loamy, having less than 18 percent clay in the control section.

Drainage and Permeability: Well to moderately well drained; runoff is slow; internal drainage is slow. Permeability is very slow. Flooding occurs at intervals of once each 1 to 20 years, except where protected.

Use and Vegetation: Mainly used for cropland. Crops include cotton, corn, sorghums, soybeans, and alfalfa. Native vegetation includes elm, oak, ash, hackberry, pecan, and mesquite trees. Grasses include bluestems, buffalograss, Indiangrass, switchgrass, and gramas.

Distribution and Extent: Arkansas, Louisiana, Oklahoma, and Texas. Very extensive along the Brazos, Colorado, and Red Rivers in central Texas and Oklahoma. The series comprises about 800,000 acres.

Series Established: Miller County, Arkansas, 1903.

Remarks: Miller soils were formerly classified in the Alluvial great soil group in recently published soil surveys.

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USA

MINCO SERIES

The Minco series is a member of the coarse silty, mixed, thermic family of Typic Hapludolls. These soils have a dark brown slightly acid light silt loam A horizon, a brown neutral light silt loam B2 horizon, and a reddish-brown neutral light silt loam C horizon.

Typifying Pedon: Minco silt loam
(Colors are for dry soil unless otherwise noted.)

A1 0-14" Dark brown (7.5YR 4/2) light silt loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; soft, very friable; slightly acid; diffuse smooth boundary. 10 to 20 inches thick.

B2 14-30" Brown (7.5YR 5/4) light silt loam, dark brown (7.5YR 4/4) moist; weak medium granular structure; soft, very friable; neutral; gradual smooth boundary. 12 to 30 inches thick.

C 30-60"+ Reddish-brown (5YR 5/4) light silt loam, reddish-brown (5YR 4/4) moist; structureless, massive; soft, very friable; neutral.

Type Location: Grady County, Oklahoma; about 1 mile northeast of Minco, 1230 feet east and 150 feet north of the southwest corner of Section 15, T10N, R7W.

Range in Characteristics: The A horizon has hues centered on 7.5YR and range from dark brown to reddish-brown in color. A horizon textures are silt loam, loam, very fine sandy loam, and fine sandy loam. The A horizon ranges from medium acid to neutral in reaction. The B horizon has hues of 5YR; colors are brown, reddish-brown, and yellowish-red. The B horizon contains less than 18 percent clay and ranges in texture from silt loam to very fine sandy loam. It is slightly acid to neutral in reaction. The upper C horizon is similar in texture to the B horizon except that in some pedons it is coarser at depths below 40 inches. In some pedons the C horizon is calcareous at depths below about 3 feet.

Competing Series and Their Differentiae: These are in the Enterprise, Reinach, Teller, and Vanoss series. The Teller and Vanoss series have argillic horizons. The Enterprise series are in areas of lower rainfall and are calcareous at depths of less than three feet. The Reinach series are calcareous at depths of less than three feet.

Setting: The Minco soils are on nearly level to strongly sloping uplands generally within five miles of major river channels. The slopes are dominantly of gradients between 2 to 5 percent. They are formed in alkaline to weakly calcareous silts and very fine sands presumed to be of aeolian origin. The climate is subhumid. At the type location, the average annual precipitation is about 30 inches and the mean annual temperature about 60° F.

Principal Associates Soils: These are in Chickasha, Teller, Vanoss, and Zaneis series.

Drainage and Permeability: Well drained. Permeability is moderate.

Use and Vegetation: Most areas on slopes of less than 8 percent are now cultivated to general field crops. The original vegetation was tall grass prairie.

Distribution and Extent: Central Oklahoma, north central Texas, and south central Kansas. The series is of moderate extent.

Series Established: Grady County, Oklahoma (Washita Watershed), April 1942.

Remarks: The Minco series was formerly classified in the Reddish Prairie great soil group.

National Cooperative Survey
USA

Preliminary: Subject to Revision

MUSKINGUM SERIES

The soils of the Muskingum series occur in association with the Hartsells and Hanceville soils in the southern Appalachian region and with Zanesville and Wellston northward. These soils comprise azonal sketetal soils and are underlain by and derived from weathered sandstone and siltstone materials. They occur in the southern section of the Gray-Brown Podzolic soil region and also in the northern part of the Red and Yellow soil reion. The material is acid in reaction throughout. There are fragments of bedrock on the surface and throughout the soil mass.

I. Soil Profile: (Muskingum stoney silt loam)

1. Thin loose forest litter, typically from deciduous trees.

2. Grayish-brown silt loam, consisting of mixed siliceous mineral soil and organic matter; medium or strongly acid; ¼ to 1 inch thick.

3. Light grayish-yellow or light grayish-brown loose silt loam with sandstone or siltstone fragments throughout; thickness up to 8 or 10 inches.

4. Disintegrated parent rock, with some fine earth, and in places and incipient "B" layer; generally yellow.

5. Bedrock, consisting of noncalcareous sandstone and siltstone, with incidental interbedded shales.

II. Variations: Chiefly in thickness of weathered materials. Distinguished from the Wellston and Hartsells, with which it is associated, but its skeletal profile, greater stoniness, and steeper slopes.

III. Topography: Moderate to steep slopes in dissected terrain.

IV. Drainage: Good throughout; surface run-off rapid.

V. Natural Vegetation: Typically deciduous forest, with oaks dominant; some pine in places.

VI. Use: Generally in second-growth and brush; pasturage scanty and poor; very little cultivated; some eroded and abandoned lands.

VII. Distribution: Southeastern and south central Ohio, southern Indiana, Kentucky, Tennessee, Alabama, Georgia, Arkansas, and eastern Oklahoma.

Type Location: Dubois County, Indiana.

Series Established: Monroe County, Indiana, 1922.

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2-16-42

Soil Survey Division
Bureau of Plant Industry
U.S. Dept. of Agriculture

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NASH SERIES

The Nash series includes medium-depth Reddish Prairie Soils developed on neutral or calcareous red very fine sandy and silty shales, mainly of the Permian. These soils are intermediate in character between the Grant and Lucien or Quinlan. They are less acid than the Zaneis soils and their subsoils are less clayey and more friable than those of the Renfrow. The similar series of the Reddish Chestnut soils zone is Woodward.

I. Soil Profile (Nash very fine sandy loam):

			Range in thickness
1.	0-6"	Reddish-brown (5YR 4/4; dark reddish-brown 5YR 4/3, moist) very fine sandy loam; moderately granular; very friable; hard when dry; neutral.	4-8"
2.	6-14"	Yellowish-red (5YR 4/6; 5YR 3/6, moist) very fine sandy loam; moderately granular; very friable; hard; neutral or slightly alkaline; grades into horizon below.	4-10"
3.	14-26"	Yellowish-red (5YR 5/8; 5YR 4/8, moist) very fine sandy loam; massive; porous; very friable; neutral to alkaline.	8-12"
4.	26-36"+	Yellowish-red (5YR 5/8) neutral or calcareous partially weathered sandy shale containing a few grayish streaks or strata.	

II. Range in Characteristics: Silt loam and very fine sandy loam are the principal or only types; color of the surface soil ranges from dark reddish brown to brown; horizon 3 is a light clay loam or loam in places; thickness of solum ranges from 20 to 36 inches.

III. Topography: Gently rolling upland with gradients up to about 12 percent, dominantly 3 to 7.

IV. Drainage: Free from the surface and internally; erodes very rapidly where unprotected.

V. Vegetation: Principally bluestem, side-oats grama, blue grama, and buffalo grasses; which form a thick cover.

VI. Use: Probably about one-half of this soil is now cultivated; wheat, sorghums, and sudan grass are the principal crops. The other half is largely native prairie pasture. Moderately productive when first placed in cultivation, but deteriorates rapidly under poor management. Virgin pastures have a high carrying capacity.

VII. Distribution: Oklahoma and Kansas.
Type location: Garfield County, Oklahoma.
Series established: Garfield County, Oklahoma, 1935.

VIII. Remarks: Color terms are Provisional Soil Survey color names, based on Munsell Color Charts and unless stated otherwise refer to dry soil.

EGF-WTC-FAH-NB 5-8-42
Rev. AES:HO 5-3-46

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NEWTONIA SERIES

The Newtonia series is a member of the fine-silty, mixed, thermic family of Typic Paleudolls. They have brownish silt loam A1 horizons, brownish silt loam B1 horizons and reddish Bt horizons that are silty clay loam in the upper part and caly in the lower part.

Typifying Pedon: Newtonia silt loam - cultivated
(Colors are for moist soil unless otherwise stated.)

Ap	0-9"	Dark brown (7.5YR 3/2) silt loam, dark brown (7.5YR 4/2) dry; moderate medium granular structure; slightly hard, friable; slightly acid; gradual smooth boundary. (6 to 14 inches thick.)
B1	9-18"	Dark reddish brown (5YR 3/3) heavy silt loam, reddish brown (5YR 5/3) dry; moderate medium subangular blocky structure; hard, friable; numerous worm casts; slightly acid; gradual smooth boundary. (4 to 12 inches thick.)
B21t	18-26"	Yellowish red (5YR 4/6) silty clay loam, yellowish red (5YR 5/6) dry; moderate medium subangular blocky structure; hard, friable; thin continuous clay films on peds; strongly acid; gradual smooth boundary. (6 to 12 inches thick.)
B22t	26-40"	Dark red (2.5YR 3/6) silty clay, red (2.5YR 4/6) dry; moderate medium subangular blocky structure; very hard, firm; distinct continuous clay films on peds; strongly acid; diffuse smooth boundary. (10 to 20 inches thick.)
B23t	40-51"	Dark red (2.5YR 3/6) silty clay, red (2.5YR 4/6) dry; moderate medium subangular blocky structure; very hard, very firm; distinct continuous clay films on peds; strongly acid; gradual smooth boundary. (10 to 20 inches thick.)
B3	51-61"+	Red (2.5YR 4/6) clay, red (2.5YR 5/6) dry; weak medium subangular blocky structure; very hard, very firm; numerous iron-manganese concretions and small chert gravel; patchy clay films on peds; strongly acid. (10 to 30 inches thick.)

Type Location: Ottawa County, Oklahoma; about 4-¼ miles north of Fairland; about 300 feet north and 100 feet east of the southwest corner of the northwest ¼ of Section 21, T27N, R23E.

Range in Characteristics: These soils are not dry for as much as 90 cumulative days in any horizon between 7 and 20 inches in most years. The solum thickness is greater than 60 inches and the clay content does not decrease by 20 percent of the maximum clay content in the Bt within 60 inches depth. The upper 20 inches of argillic horizon averages from about 30 to 35 percent clay and less than 15 percent material coarser than very fine sand. The A1 or Ap horizon has hues of 5YR through 10YR, values of 2 or 3 moist and 3 to less than 5.5 dry, and chromas of 2 or 3. The dominant texture of the A horizon is silt loam although loam and silty clay loam may occur. The reaction is slightly acid to medium acid. The B1 horizon has hues of 5YR or 7.5YR, values of 3 or 4 moist and 4 or 5 dry, and chromas of 3 or 4. The texture of the B1 horizon is heavy silt loam or light silty clay loam.

Page 2--Newtonia Series

The reaction of the B1 horizon is slightly, medium or strongly acid. The B2t horizon has hues of 2.5YR or 5YR, values of 3 or 4 moist and 4 or 5 dry, and chromas of 3 through 8. The texture of the upper B2t horizon is medium to heavy silty clay loam and the texture of the lower B2t horizon is medium silty clay loam, heavy silty clay loam, silty clay or clay. The reaction of the B2t horizon is medium or strongly acid. The B3 horizon has hues of 2.5YR or 5YR, values of 3 or 4 moist and 4 or 5 dry, and chromas of 5 through 8. The texture of the B3 horizon ranges the same as the lower B2t horizon and may contain chert and/or limestone gravel. The reaction of the B3 horizon is medium or strongly acid.

Competing Series and Their Differentiae: These are the Choteau, Dennis, Eldorado, Lula and Norge soils. The Choteau and Dennis soils have Bt horizons with hues of 7.5YR or 10YR in the matrix and have more than 35 percent clay in the upper 20 inches of the argillic horizon. The Eldorado soils have more than 35 percent chert in the upper 20 inches of the Bt horizon. The Lula soils have sola less than 60 inches thick over limestone bedrock. The Norge soils are dry from 90 to 135 cumulative days in the upper 12 inches in most years.

Setting: The Newtonia soils are on uplands. Slope gradients are mainly less than 3 percent but range up to 5 percent. The Newtonia soils are mostly presumed to have been weathered from limestone rock but are not required to be underlain by limestone and other sources of sediments are not excluded. The climate is humid; mean annual precipitation is about 37 to 43 inches, Thornthwaite P-E index is 64 to 80, and the mean annual air temperature is about 57° to 62° F.

Principal Associated Soils: These are the competing Lula soils and the Claremore, Summit and Talpa soils. The Claremore and Talpa soils have hard limestone bedrock within 20 inches of the soil surface. The Summit soils have more than 35 percent clay within 10 inches of the surface, are non-reddish and have high shrinkswell potential.

Drainage and Permeability: Well drained; runoff is slow to medium depending on slopes; permeability is moderate.

Use and Vegetation: Mainly cultivated to small grains and sorghums with some tame pastures. Lesser amounts are used for native range. The native vegetation was tall grass prairie.

Distribution and Extent: Northeastern Oklahoma, southeastern Kansas, southwestern Missouri and northwestern Arkansas. The series is extensive.

Series Established: Lawrence County, Missouri, 1923.

Remarks: The Newtonia soils were classified as Reddish Prairie soils in recently completed soil surveys. Analyses are available on two profiles (60-Okla-58-1) from Ottawa County, Oklahoma and one profile (855-Kans-50-1t) from Labette County, Kansas. The colors of the epipedon were not read quite dark enough in the Ottawa County descriptions.

National Cooperative Soil Survey
USA

NIMROD SERIES

The Nimrod series is a member of a loamy, siliceous, thermic family of Paleustalfs. These soils have light colored A horizons of fine sand about 27 inches thick and gray mottled sandy clay loam Bt horizons.

Typifying Pedon: Nimrod fine sand - scruboak wooded pasture (Colors are for dry soil unless specified as moist).

A1 0-4" Grayish-brown (10YR 5/2) fine sand, dark grayish-brown (10YR 4/2) moist; structureless, single grain; loose; neutral; abrupt irregular boundary. (0 to 12 inches thick.)

A2 4-27" Very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) moist; structureless, single grain; loose; slightly acid; abrupt wavy boundary. (8 to 30 inches thick.)

B21t 27-40" Coarsely mottled light gray (10YR 7/2) reddish-yellow (7.5YR 6/6) and yellowish-brown (10YR 5/6) sandy clay loam; strong prismatic structure breaking to coarse blocky structure; extremely hard, very firm; peds are coated with gray (10YR 5/1) fine sand; distinct clay films on vertical ped surfaces; strongly acid; gradual slightly wavy boundary. (0 to 24 inches thick.)

B22t 40-53" Light gray (10YR 7/2) sandy clay loam, light brownish-gray (10YR 6/2) moist, distinct coarse mottles of olive-brown (2.5Y 4/4) and red (2.5Y 4/6); strong coarse prismatic structure breaking to weak blocky; extremely hard, very firm; distinct clay films and sandy coatings of gray (10YR 5/1) on vertical faces of prisms; few ferromanganese oxide concretions 2-5mm. in diameter; few sandstone fragments; strongly acid; gradual slightly wavy boundary. (4 to 20 inches thick.)

B3 53-68" Light gray (10YR 7/2) sandy clay loam, light grayish-brown (10YR 7/2) sandy clay loam, light grayish-brown (10YR 6/2) moist; fewer coarse red and brownish mottles than horizon above; strong coarse prismatic structure; extremely hard, very firm; ped surfaces coated with gray sand; few ferromanganese oxide concretions; few ferruginous sandstone fragments; medium acid; diffuse boundary. (8 to 20 inches thick.)

C 68-80"+ Coarsely mottled, red (2.5YR 5/6) dry and moist, and light gray (10YR 7/2) sandy loam predominantly red in the upper part and mostly gray in the lower part; weak prismatic structure in the upper part and structureless, massive below; very hard, very firm, roots peretrate to 80 inches; a slightly acid.

Type Location: Erath County, Texas; in a wooded tract 75 yards east of a farm lane; this point being 50 yards south of FM 2303; this intersection being 3.5 miles west of the intersection with FM Road 8; this point being 0.6 miles north of the intersection of FM Road 8 and Texas Highway 108 in the north outskirts of Stephenville.

Range in Characteristics: Thickness of the solum ranges from 50 to 80 inches. The soil is usually moist, but it is dry in some part of the upper 60 inches for 90 to 135 days (cumulative) during most years. Thickness of the A horizon ranges from 20 to 40 inches. The texture of the A horizon ranges from fine sand to loamy fine sand. The A1 horizon is light brown, yellowish-brown or dark grayish-brown; hues are 7.5YR or 10YR. The Bt horizon has dominant chroma of 2 or less, but it is mottled in shades of brown, red, yellow and gray. Texture of the upper 20 inches of the Bt horizon is sandy clay loam and average clay content ranges from 18 to 35 percent. Reaction of the Bt horizon ranges from strongly acid to medium acid. Underlying C horizon ranges from mottled dominantly light gray light sandy clay loam to little altered firm sands.

Competing Series and Their Differentiae: These are the Arenosa, Chaney, Demona, Dougherty, Nueces, Patilo, and Selden series. Selden soils have A horizons less than 20 inches thick. Patilo soils have A horizons 40 to 72 inches thick. Neuces soils lack mottled Bt horizons, and have mean annual soil temperatures of more than 71.6^{o} F. Dougherty soils have Bt (argillic) horizons that have dominant hues redder than 7.5YR. Demona and Chaney soils have Bt horizons containing more than 35 percent clay, and in addition, the Chaney soils have an A horizon less than 20 inches in thickness and a solum less than 50 inches in thickness. Arenosa soils lack a Bt horizon within a depth of 72 inches.

Principal Associated Soils: These are in the Competing Arenosa, Patilo and Selden soils and the Konowa and Windthorst soils. The later soils lack sandy A horizons more than 20 inches thick and mottles due to wetness of 2 chromas or less.

Drainage and Permeability: The surface horizon rapidly absorbs rainfall; internal drainage and permeability are moderately slow. For short periods following heavy rainfall, a perched water table is at the top of the B horizon.

Use and Vegetation: Largely cleared and cultivated at one time but much has reverted to forest of post oak and blackjack oak. Cultivated areas are now used mainly for growing peanuts. Original vegetation was scrub forest of post oak and blackjack oak and a heavy understory of greenbriars, little bluestem, and purple top grasses.

Distribution and Extent: Mainly in the sandy timbered areas of central Texas and southern Oklahoma. The soil is of moderate extent.

Series Established: Eastland County, Texas, 1917.

Remarks: The Nimrod series was formerly classified in the Red-Yellow Podzolic soil great soil group. A subgroup of Aquultic Arenic Paleustalfs has been proposed for soils like those of the Nimrod series.

National Cooperative Soil Survey
USA

NORGE SERIES

The Norge series is a member of the fine silty, mixed, thermic family of Typic Arguidolls. These soils have dark brown silt loam A horizons and reddish-brown to red silty clay loam B horizons that grade to reddish loamy sediments.

Typifying Pedon: Norge silt loam
(Colors for dry soil unless otherwise noted.)

A1	0-12"	Dark brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; slightly hard, friable; medium acid (pH 6.0); gradual smooth boundary. 6 to 16 inches thick.
B1	12-18"	Reddish-brown (5YR 4/3) light silty clay loam, dark reddish-brown (5YR 3/3) moist; moderate medium granular structure; hard, friable; medium acid (pH 6.0); gradual smooth boundary. 3 to 10 inches thick.
B21t	18-36"	Reddish-brown (5YR 5/4) silty clay loam, reddish-brown (5YR 4/4) moist; moderate fine subangular blocky structure; very hard, firm; distinct clay films; medium acid (pH 6.0); gradual smooth boundary. 10 to 25 inches thick.
B22t	36-48"	Red (2.5YR 5/6) silty clay loam, red (2.5YR 4/6) moist; moderate medium subangular blocky structure; very hard, firm; patchy clay films; slightly acid (pH 6/3); gradual smooth boundary. 6 to 18 inches thick.
B3	48-66"+	Red (2.5YR 5/8) light silty clay loam, red (2.5YR 4/8) moist; weak coarse subangular blocky structure; hard, firm; slightly acid (pH 6.5).

Type Location: Pawnee County, Oklahoma; about 8 miles northeast of Pawnee, 725 feet east and 150 feet south of the northwest corner of Section 9, T22N, R6E.

Range in Characteristics: The A horizon has hues of 5YR to 10YR and ranges in color from reddish-brown to dark brown. Surface soil textures are silt loam and loam. The B horizon has hues of 5 YR and 2.5YR and ranges in color from yellowish-red to red. Clay content of the B horizon ranges from about 27 to 35 percent and reaction from medium acid to about neutral.

Competing Series and Their Differentiae: These are in the Kingfisher, Teller, Vanoss, and Zaneis series. The Teller series has less clayey B horizons. The Vanoss series has less reddish B horizons. The Kingfisher and Zaneis series are underlain by hard bedrock, and the Zaneis series contains appreciable amounts of sand that is coarser than very fine sand.

Setting: The Norge soils are on nearly level to sloping uplands. The slopes range from 0 to 8 percent but are dominantly between 1 and 5 percent. They have formed in loamy unconsolidated sediments. The climate is subhumid. At the type location, the average annual precipitation is about 33 inches and the mean annual temperature about 60° F.

Principal Associated Soils: These are in the Shellabarger, Teller, Vanoss, and Zaneis series.

Drainage and Permeability: Well drained. Permeability is moderately slow.

Use and Vegetation: Largely in cultivation; small grains and sorghums are the main crops. Originally the vegetation was tall-grass prairie dominated by bluestems, Indiangrass and switchgrass.

Distribution and Extent: South central Kansas and central Oklahoma. The series is of moderate extent.

Series Established: Grady County, Oklahoma (Washita Watershed Survey), 1942.

Remarks: The Norge series was formerly classified in the Reddish Prairie great soil group.

National Cooperative Soil Survey
USA

Established Series

OCHLOCKONEE SERIES

The Ochlockonee series consists of well-drained Alluvial soils of the stream floodplains in the Atlantic and Gulf Coastal Plains. These soils are derived from recent alluvium washed chiefly from a large numer of sandy to moderately fine textured soils of the Coastal Plain uplands. The Ochlockonee series is the well-drained member of a sequence that includes the moderately well-drained Iuka, the somewhat poorly drained Mantachie, and the poorly drained Bibb series. Ochlockonee soils are free of gray mottles to a depth of 30 inches or more, whereas Iuka soils are distinctly mottled with gray below 18 inches. Ochlockonee soils are widespread and are important to agriculture.

Soil Profile: Ochlockonee fine sandy loam

Ap	0-7"	Brown (10YR 4/3) fine sandy loam; weak fine granular structure; very friable; common fine roots; medium acid; clear smooth boundary. 6 to 12 inches thick.
C1	7-40"	Brown (10YR 5/3-4/3) fine sandy loam; weak fine granular structure; friable; strongly acid; gradual smooth boundary. 20 to 40 inches thick.
C2	40-60"	Dark grayish-brown (10YR 4/2) fine sandy loam; structureless; very friable; strongly acid. Several feet thick.

Range in Characteristics: Texture of the surface layer ranges from loamy sand to silt loam inclusive, and some areas are gravelly on the surface. Stratification with sandy sediments may be evident. The Ap horizon ranges in color from dark grayish-brown (10YR 4/2) through light yellowish-brown (10YR 6/4). Color of the C1 horizon ranges from brown (10YR 5/3) to yellowish-brown (10YR 5/4) or dark yellowish-brown (10YR 4/4), inclusive. The profile is free of mottles to a depth of 30 inches or more. The C2 horizon ranges in color from dark grayish-brown (10YR 4/2) through yellowish-brown (10YR 5/6) and may be mottled with yellow (10YR 7/6) and gray (10YR 6/1). Thin strata or lenses of sandy clay loam or silty clay loam may occur below 20 inches. Reaction of the C1 and C2 horizons ranges from very strongly to medium acid, inclusive. Colors given are for moist soil. When soil is dry, color values are one or two units higher.

Topography: Nearly level flood plains and upland drainageways. Slopes range from 0 to 3 percent.

Drainage and Permeability: Well drained, but generally subject to occasional overflow. May be subject to frequent flooding. Permeability is moderate or rapid.

Vegetation: Chiefly hardwoods, such as gum, oak, maple, ash, hickory, but with some pine.

Use: Largely cultivated, with corn, sorghum, soybeans, cotton, small grains, vegetables, and hay as main crops; some pasture; some forest.

Distribution: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas, Virginia; and possibly Maryland, Oklahoma, Tennessee, and Kentucky.

Type Location: Franklin County, Alabama; 2 miles southwest of Pleasant Hill Church, along Little Bear Creek about 100 feet west of road, and 75 feet north of creek; SW$\frac{1}{4}$ NW$\frac{1}{4}$ Section 7, R12W, T8S.

Series Established: Gadsden County, Florida, 1903.

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National Cooperative Soil Survey
USA

OKEMAH SERIES

The Okemah series includes moderately well-drained, slightly acid soils that have dark, grayish, granular, silty A and B_1 horizons more than 16 inches thick over mottled olive-yellow and gray very compact clay. These soils are developed over olive and gray, mildly alkaline to slightly calcareous, weakly consolidated shales and clays, generally of the Pennsylvanian, in the more humid, eastern part of the zone of Reddish Prairie soils. The more closely related series include Dennis and Bonham, which are browner and have less compact,more silty lower subsoils; Parsons, Cherokee, Taloka, and LeFlore, which have less dark more acid A horizons resting abruptly on clay pans; Woodson, which has dark-gray subsoils and somewhat thinner and more clayey A horizons; and Bethany, which is neutral at shallower depth and has browner unmottled subsoils and reddish substrata. Areas adjoining bodies of Okemah soils generally are of the Woodson, Parsons, or Talihina series.

Soil Profile: Okemah silt loam

A_1 0-14" Dark-gray (10YR 4/1; 2/2 moist) silt loam with weak to moderate granular structure. Friable; hard when dry. Slightly acid. 10-18" thick.

A_3 14-18" Dark grayish-brown (10YR 4/2; 3/2 moist) silt loam slightly mottled with brown (10YR 5/3) which comprises no more than 3 to 5% of the mass; the aggregates have thin gray coatings (10YR 5/1); color of the soil crushed is grayish-brown (10YR 5/2) strong medium granular structure. Friable; hard when dry. Grades to horizon below. Slightly acid. 3-10" thick.

B_1 18-22" Dark grayish-brown (10YR 4/2; 3/2 moist) silty clay loam mottled with light yellowish-brown (2.5YR 6/4) and strong brown (7.5YR 5/6); the mottles comprise about 10% of the mass. Compound medium subangular blocky and medium granular structure. Crumbly and friable when moist; moderately sticky and plastic wet. Grades to horizon below. Slightly acid to neutral. 3-7" thick.

B_2 22-38" Mottled olive-yellow (2.5Y 6/6; 5/6 moist) and light gray (2.5Y 7/2; 5/2 moist) clay with weak blocky structure. Very compact; extremely hard when dry; very sticky and stiff when wet. Very slowly permeable. Grades to horizon below. Noncalcareous; mildly alkaline. 14-24" thick.

B_{22} or B_3 38-52" Mottled light gray (2.5Y 7/2; 6/2 moist), olive-yellow (2.5Y 6/8; 7/6 moist), and brownish-yellow (10YR 6/5; 5/6 moist) clay. Massive, very compact and very slowly permeable. Grades to horizon below. Noncalcareous; mildly alkaline. 10-20" thick.

C 52-90"+ Mottled light gray (5Y 7/1; 6/2 moist) and brownish-yellow (10YR 6/8; 5/6 moist) clay. Massive; compact. A few small fragments of soft partly weathered sandstone are interbedded in the lower part. Medium alkaline but not calcareous. A few to numerous small iron oxide concretions are present in horizons 4 to 6.

Range in Characteristics: Silt loam is the strongly dominant type; color of horizon 1 ranges from very dark gray (10YR 3/1) in virgin areas to gray (10YR 5/1) in the plowed layer where cultivated; horizon 2 ranges from very dark grayish-brown (10YR 3/2) to grayish-brown (10YR 5/2) with or without slight mottling of brown; the gray coating of aggregates ranges from indistinct to pronounced. Horizon 3 ranges from clay loam to silty clay with mottling ranging from 5 to 15% of the mass. Horizons 4 and 5 range from mottled olive-yellow and light gray with or without brownish-yellow mottling to light olive gray with faint to strong mottling of olive-yellow and brownish-yellow. Small concretions of $CaCO_3$ occur erratically in horizons 5 and 6; thin seams or laminae of calcareous light gray clay of soft sandstone occur in the lower subsoil and substratum. The upper surface of the heavy compact subsoil, horizon 4, is wavy or undulating in places and its depth below the surface ranges from 16 to 30 inches within a distance of 12 to 15 feet.

Topography: Nearly level to gently sloping erosional upland; surfaces weakly convex to plane; gradients range from 1 to 4% but are dominantly 1 to 3.

Drainage: Slow to moderate from the surface; very slow internally. Adequate for all crops commonly grown including alfalfa. Temporary perched water table occurs immediately above horizon 4 during extremely wet periods.

Vegetation: Thick cover of tall grasses, mainly bluestems.

Use: Mainly cultivated; principal crops are corn, cotton, and small grains; moderately fertile and productive; small areas are native prairie meadows.

Distribution: Northeastern Oklahoma and probably southeastern Kansas in the northern part of the Reddish Prairie soil zone.

Remarks: Unless stated otherwise, color descriptions refer to dry soil.

Type Location: Okfuskee County, Oklahoma, NE NW NE Section 31, T11N, R10E, 3 miles southeast of Okemah.

Series Established: Okfuskee County, Oklahoma, June 1, 1948.

HO:JT:EHT
7-8-49

Division of Soil Survey
Bureau of Plant Industry, Soils,
and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture

Established Series

OSAGE SERIES

The Osage series comprises somewhat poorly-drained, clayey Alluvial soils forming in sediments washed from Prairie soils underlain by shale and limestone. They resemble the Wabash soils in morphology, but the latter have been formed in sediments washed from loess and glacial drift. The Osage soils are therefore believed to be much lower in feldspars and other easily weatherable minerals and higher in resistant minerals. The Osage soils occur chiefly in association with the Verdigris and Lightning series in flood plains. Verdigris soils are browner, better drained, and lighter in subsoil texture, which ranges from loam to clay loam. Lightning soils are acid Planosols with eluviated gray A_2 horizons and claypan B horizons. The Osage series has moderately wide distribution but rather limited extent.

Soil Profile: Osage clay

A_1 0-21" Dark gray (10YR 4/1) light clay or silty clay, very dark gray to black (10YR 2.5/1) when moist; moderate medium subangular blocky structure; very firm; slightly acid; boundary gradual. 15 to 30 inches thick.

C 21-50"+ Dark gray (10YR 4/1) light clay or silty clay, very dark gray (10YR 3/1) when moist; common distinct fine mottlings of brown or strong brown (mottles mostly smaller than 1 mm); almost massive; very firm; noncalcareous; pH between 7 and 7.5.

Range in Characteristics: Texture of subsoil includes clays and heavy clay loams. Mottling of subsoil ranges from very faint to distinct. Dry color of the soil ranges from dark gray to black. Reaction ranges from mildly alkaline but noncalcareous to slightly acid.

Topography: Level flood plains.

Drainage: Runoff slow or very slow; internal drainage very slow. In wet years, the soils may remain saturated during winter and early spring. They are subject to frequent or occasional overflow.

Vegetation: Where uncleared, the areas are mostly forested with bottomland hardwoods which generally have a fairly dense canopy which in places becomes open and glady with considerable ground cover of grass.

Use: Field crops, improved pasture; wood lots.

Distribution: Western Missouri, eastern Kansas and eastern Oklahoma. South of the Kansas River, north of the Arbuckle uplift, within and to the east of the Flint Hills.

Type Location: Bates County, Missouri.

Series Established: Bates County, Missouri, 1908.

Rev. EHT: 1-30-57

National Cooperative Soil Survey
USA

PARSONS SERIES

The Parsons series comprises claypan Planosols having brownish but mottled B horizons, derived from very compact montmorillonitic clays, and developed under grass. The parent materials include noncalcareous gray and brown marine shales such as those of Pennsylvanian age and old clayey alluvium, which may or may not have a thin loess mantle. The principal associated soils are the Bates, Cherokee, Choteau, Dennis, Taloka, and Woodson series. Parsons soils have finer textured B horizons than Bates soils and they have abrupt rather than gradational boundaries between the A and B horizons. Also finer textured than Bates soils, Dennis and Okemah soils are Brunizems lacking the A_2 horizons and the abrupt A-B horizon boundaries of Parsons soils. Taloka soils have thick A horizons, with a minimum set at 16 inches, which is also the maximum for Parsons soils. The Choteau soils have very thick A horizons, especially A_1 horizons. Cherokee soils have light colored A_1 horizons, prominent A_2 horizons, and dull B_2 horizons. Woodson soils are dark throughout the profile and have A horizons high in clay. Dwight soils lack distinct A_2 horizons and the maximum thickness of the A horizons is 9 inches. The Parsons series is extensive, widely distributed, and important to agriculture.

Soil Profile: Parsons silt loam--native grass

A_1 0-10" Grayish-brown (10YR 5/2) silt loam, very dark grayish-brown (10YR 3/2) moist; weak medium granular structure; friable; few dark brown mottles; strongly acid; gradual boundary. 6 to 10 inches thick.

A_2 10-14" Light brownish-gray (10YR 6/2) silt loam, grayish (10YR 5/2) moist; many medium distinct dark brown mottles; weak medium granular structure becoming slightly platy or massive in lower part; friable; strongly acid; abrupt boundary. 1 to 7 inches thick.

B_2 14-28" Dark grayish-brown (10YR 4/2) clay with many medium distinct strong brown mottles; very dark grayish-brown (10YR 4/2) moist; weak coarse blocky structure; very compact, slowly permeable; sides of peds coated with light gray films; many fine black concretions; strongly acid; gradual boundary. 15 to 25 inches thick.

B_3 28-43" Light yellowish-brown (10YR 6/4) clay mottled with brown and yellowish-brown and grading to grayish-brown (10YR 5/2) in lower part, yellowish-brown (10YR 5/4) moist; coarse blocky structure; very compact; very slowly permeable; few black concretions; medium acid; diffuse boundary. 10 to 20 inches thick.

C_1 43-66" Coarsely mottled light gray, strong brown, and yellowish-brown (10YR 5/4) clay; gray, strong brown and dark yellowish brown when moist; massive; very firm; slowly permeable; some seams of sandy clay loam, some fine rounded siltstones and small pockets of gypsum crystals; medium acid; diffuse lower boundary. 15 to 40 inches thick.

C_2 66-84"+ Yellowish-brown (10YR 5/6) and gray (10YR 6/1) partially altered clay shales; massive; compact; medium acid.

Range in Characteristics: Total thickness of the A horizon ranges from 8 to 16 inches. The dry color of the A_1 or A_p horizon ranges from light brownish-gray to dark grayish-brown (dry values of 4.5/ to 6/, moist values of 3/ to 4.5/, and chromas of /1.5 to /2.5 in hues of about 10YR). Color of the parent materials includes light olive gray, pale yellow, and light yellowish-brown. Lenses of siltstone and sandy shale may be present in the weathered marine shales. Parent materials may also include a small component of loess. The reaction of the lower B and C horizons may range to slightly acid or neutral, though generally medium acid.

Topography: Nearly level upland; on gentle slopes and upland flats.

Drainage and Permeability: Somewhat poorly (imperfectly) drained. Surface runoff is medium to low; permeability is very slow. Perched water tables occur in the base of the A horizon during the wet months. Summer crops suffer from drouth.

Use: Mostly in cultivation with oats and wheat as the main crops. Cotton and corn are grown, but suffer from drouth. Cool-season grasses and legumes are commonly used for hay and pasture. Some is in native meadow.

Distribution: Eastern Oklahoma, southwestern Missouri, southeastern Kansas, and northwestern Arkansas.

Type Location: Mayes County, Oklahoma; 1 1/2 miles west of Adair, 1,280 feet west and 100 feet south of the NW corner Section 32, T23N, R19E.

Series Established: Labette County, Kansas, 1926.

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11-18-60

National Cooperative Soil Survey
USA

PICKENS SERIES

The Pickens series is a member of the loamy-skeletal, mixed, thermic family of Lithic Dystrochrepts. They have shaly, medium textured A horizons, very shaly, medium textured B2 horizons, and are underlain by very hard shale bedrock at less than 20 inches depth.

Typifying Pedon: Pickens shaly silt loam - forested (Colors are for moist soil unless other wise stated.)

A1	0-4"	Very dark grayish brown (10YR 3/2) shaly silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable; slightly acid; clear smooth boundary. 2 to 5 inches thick.
A2	4-10"	Brown (10YR 5/3) shaly silt loam, very pale brown (10YR 7/3); moderate fine granular structure; slightly hard, friable; strongly acid; diffuse wavy boundary. 3 to 9 inches thick.
B2	10-17"	Yellowish Brown (10YR 5/4) very shaly silt loam, very pale brown (10YR 7/4) dry; weak fine granular structure; slightly hard, friable; contains about 75 percent hard shale fragments; strongly acid; clear wavy boundary. 2 to 14 inches thick.
R	17-30"+	Very dark gray (10YR 3/1) very hard alkaline shale that is fractured and has less than 5 percent fines or silt siftings in fractures.

Type Location: McCurtain County, Oklahoma; 1320 feet west and 600 feet south of the northeast corner of Section 27-T2S-R23E.

Range in Characteristics: These soils are dry for less than 90 cumulative days in most years in any subhorizon of the soil between 7 inches and the lithic contact. The soil is 10 to 20 inches thick over the shale. The texture of the soil is shaly silt loam, shaly loam, shaly clay loam or shaly silty clay loam or their very shaly counterparts. Clay content is about 15 to 30 percent clay and the shale content ranges from 20 to 60 percent in the upper part and 35 to 90 percent in the lower part. The A1 horizon has hues of 7.5YR or 10YR, values of 3 or 4 moist and 5 through 7 dry, and chroma of 2 through 4. The reaction of the A1 horizon ranges from slightly to strongly acid. The A2 horizon has hues of 7.5YR or 10YR, values of 4 through 6 moist and 5 through 8 dry, and chroma of 2 through 4. The reaction of the A2 horizon ranges from medium to strongly acid. The B2 horizon has hues of 7.5YR through 2.5Y, values of 4 or 5 moist and 5 through 7 dry and chroma of 3 through 6. The reaction of the B2 horizon ranges from medium to very strongly acid. The R horizon is very hard, shale bedrock. The shale beds are tilted up to about 20 degrees from horizontal.

Competing Series and Their Differentiae: These are the Hector, Montevallo, Ramsay and Sulphura soils. The Hector soils have less than 35 percent fragments larger than 2 millimeters. The Montevallo soils are shallow over bedrock that has a hardness of less than 3 on Mohs scale. The Ramsay soils have mean annual soil temperature of less than 59° F. The Sulphura soils have Bt (argillic) horizons in part of the pedon.

Page 22-Pickens Series

Setting: The Pickens soils occur on nearly level to moderately steep uplands. Slope gradients are mainly from 2 to 20 percent. The Pickens soils formed in alkaline, very hard shales. The climate is moist, subhumid to humid. The rainfall is greater than about 37 inches and the Thornthwaite P-E index is greater than 64. The mean annual air temperature is from 57^{o} to about 70^{o} F.

Principal Associated Soils: These are the competing Hector and the Linker, Herndon and Georgeville soils. The Linker, Herndon and Georgeville soils have Bt (argillic) horizons.

Drainage and Permeability: Somewhat excessively drained; runoff is medium to rapid. Permeability is moderate.

Use and Vegetation: Used primarily as forested rangeland. The native vegetation is mainly post oak, blackjack oak, winged elm, and cedar with a few scattered hickory and pines in some areas. There is an understory of tall native grasses.

Distribution and Extent: Eastern Oklahoma and possibly other states. The series is of moderate extent.

Series Proposed: McCurtain County, Oklahoma, 1966. The name is from a settlement in that county.

Remarks: The Pickens soils were formerly classified as Lithosols.

National Cooperative Soil Survey
USA

PLEDGER SERIES

The Pledger series is a member of the fine, mixed, thermic family of Udertic Haplustolls. These soils have black, firm, noncalcareous clay A horizons 30 inches thick; dark reddish brown, calcareous Clay B horizons; and stratified C horizons at about 50 inches depth.

Typifying Pedon: Pledger clay - cropland
(Colors are for moist soil unless other wise moted.)

Ap 0-5" Black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate fine granular and fine subangular blocky structure; very hard, firm, sticky, plastic; mildly alkaline; abrupt smooth boundary. (4 to 8 inches thick.)

A1 5-30" Black (10YR 2/1), clay, very dark gray (10YR 3/1) dry; moderate medium subangular and angular blocky structure; extremely hard, very firm, very sticky, plastic; shiny pressure faces below 20 inches; mildly alkaline; gradual wavy boundary. (20 to 35 inches thick.)

B 30-50" Dark reddish brown (5YR 3/3) clay, reddish brown (5YR 4/3) dry; weak medium angular blocky structure; very hard, firm, sticky, plastic; few soft masses of $CaCO_3$; moderately alkaline and calcareous; clear wavy boundary. (7 to 30 inches thick.)

C 50-70" Reddish brown (5YR 4/3) clay and thin strata of silt loam and silty clay; structureless, massive; very hard, firm, sticky, plastic; few fine strongly cemented $CaCO_3$ concretions; moderately alkaline and calcareous.

Type Location: Fort Bent County, Texas; 75 feet west and 300 feet south of intersection of county road and F. R. 723 from a point 2.1 miles north of the intersection of F. R. 723 and U. S. 59 in Rosenberg.

Range in Characteristics: Thickness of solum ranges from 30 to 70 inches. The mineralogy of the whole soils is mixed. The solum is usually moist, and in most years the soil is not dry in any horizon between 7 and 20 inches for as long as 90 cumulative days. Cracks more than 0.4 inch wide extend from the surface to depths greater than 20 inches in some season in most years. The COLE is 0.09 or more in some horizon 20 inches or more thick, and the upper 40 inches of the soil has a potential linear extensibility of 2-1/3 or more inches. Organic matter decreases irregularly with depth. Texture of the 10- to 40-inch control section ranges from clay to silty clay containing 35 to 60 percent clay. Total thickness of the A horizon ranges from 20 to 40 inches. The A horizon ranges from black to very dark grayish brown. Hue is 7.5YR or 10YR, value is less than 3.5 moist, and chroma is 2 or less. Texture of the Ap horizon is mainly clay, but some is silty clay loam. Structure of the A1 horizon ranges from weak to moderate, angular to subangular blocky. Reaction of the A horizon ranges from slightly acid to mildly alkaline. The B horizon ranges from dark reddish brown to reddish brown or brown. Hue ranges from 2.5YR through 7.5YR, value from 2 through 4 moist, and chroma is 3 or 4. Darker colored soil extends from A horizon into the B horizon as fillings in former cracks. Soft powdery bodies of $CaCO_3$ are at some depth between 24 and 60 inches. The C horizon is clay or clay containing strata of silt and sand. Buried soils having dark A horizons are common below 40 inches. The B and C horizons are moderately alkaline and calcareous.

Competing Series and Their Differentiae: Closely related or similar soils are in the Asa, Catalpa, Gowen, Miller, Moreland, Port, and Roebuck series. Asa, Gowen and Port soils have 18 to 35 percent clay in the control section, and Asa soils have mollic epipedons less than 20 inches thick. Catalpa soils have mollic epipedons less than 24 inches thick, B horizons of 10YR to 5Y hue, and montmorillonitic mineralogy. Miller soils lack the black A horizons and have soft bodies of secondary carbonates within 24 inches of the surface. Moreland soils have mollic epipedons less than 20 inches thick, and B horizons that have chroma of 2 or less due to wetness. Roebuck soils lack soft spheroidal bodies of carbonates within 60 inches of the surface.

Setting: Pledger soils are on nearly level high flood plains. Slopes are plane and mainly less than one percent. The regolith is calcareous, reddish stratified clayey and silty sediments of mixed minerology. The climatte is warm and humid. The average annual precipitation ranges from 35 to 55 inches. The average annual temperature ranges from 65^{o} to 70^{o} F. Thornthwaite P-E indices range from 56 to 80.

Principal Associated Soils: These are the Asa, Miller and Roebuck soils of the competing series, as well as Lake Charles and Norwood soils. Lake Charles soils have intersecting slickensides and gilgai microrelief. Norwood soils have 18 to 35 percent clay in the 10- to 40-inch control section and color value of more than 3.5 moist.

Drainage and Permeability: Moderately well to somewhat poorly drained. Runoff is slow; internal drainage is slow. Permeability is very slow. The soil floods once each 5 to 25 years, except where protected.

Use and Vegetation: Mainly used for cropland and pasture. Corn, cotton, sorghums and improved pastures of Bermuda grass are grown. Native vegetation is elm, pecan, oak, ash, and hackberry trees and coarse bunch grasses.

Distribution and Extent: Mainly along the lower reaches of the Brazos and Colorado Rivers in southeastern Texas. Small areas are on the flood plain of the Red River. The series is of large extent, about 250,000 acres.

Series Established: Reconnaissance soil survey of Central Gulf Coast Area of Texas, 1910.

Remarks: In recently published soil surveys, the Pledger soils were classified in the Alluvial great soil group intergrading to Grumusols.

National Cooperative Soil Survey
USA

POPE SERIES

The Pope series consists of Alluvial soils within the northern part of the Red-Yellow Podzolic region and southern part of the Gray-Brown Podzolic region. They are derived from slightly altered sandy alluvium washed largely from Red-yellow and Gray-Brown Podzolic soils developed from acid sandstones and shales of such series as Linker, Cleburne, Enders, Hanceville, Hector, Pottsville, Montevallo, and Muskingum. Materials of glacial origin are a component of the alluvium in some areas in Ohio and Indiana. Pope soils are associated with Casa, Philo, Stendal, and Atkins soils. They are better drained and browner than Philo, Stendal, and Atkins soils, and are not red like the Casa soils. They most closely resemble the Staser soils which are less acid. They occur mainly in the better drained flood plains of small streams and along large streams. The Pope soils are extensive and are very important to agriculture.

Soil Profile: (Pope fine sandy loam)

1. 0-10" Brown 1/ (10YR 5/3) fine sandy loam; very friable; strongly acid; 8 to 12 inches thick.

2. 10-38" Brown (7.5YR 5/4) very friable fine sandy loam; moderately compact in place; massive but porous and permeable; strongly acid; 20 to 40 inches thick.

3. 38"+ Alternating layers of sandy clay loam and sandy loam with occasional lenses of gravel; strongly acid.

Range in Characteristics: Fine sandy loam is the dominant texture. Silt loam, sandy loam, and loamy sand are recognized. Color of layers 1 and 2 ranges from pale brown to brown, and layer 3 from brown to brownish yellow.

Topography: Level to gently undulating flood plain.

Drainage: Surface runoff low to medium, internal drainage moderate.

Vegetation: Species of oak, walnut, hickory, birch, sycamore, maple, bamboo, briars, and vines.

Use: Most areas of the Pope soils are cleared. They are used mostly for the production of corn, cotton, sorghums, small grains, and annual legumes.

Distribution: Pennsylvania, West Virginia, Virginia, Maryland, Tennessee, Georgia, Ohio, Indiana, Kentucky, Alabama, Arkansas and eastern Oklahoma.

Type location: In flood plain of Illinois Bayou, approximately 1/2 mile east of New Hope, Arkansas, Pope County, Arkansas.

Series established: Pope County, Arkansas, 1913.

Rev. ML:ILM:WSL
8-8-50

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Agricultural Research Administration
U. S. Department of Agriculture

1/ Soil color names adopted by 1948 Committee, color of soil moist unless otherwise stated, symbols express Munsell notations.

PORT SERIES

The Port series is a member of the fine-silty, mixed, thermic family of Cumulic Haplustolls. They have brown, medium textured A horizons and reddish brown, moderately fine textured B and C horizons.

Typifying Pedon: Port silt loam - cultiviated
(Colors are for dry soil unless otherwise noted.)

A11 0-16" Brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate medium and fine granular structure; slightly hard, friable; neutral; gradual smooth boundary. (1o to 25 inches thick.)

A12 16-27" Reddish brown (5YR 4/3) light silty clay loam, dark reddish brown (5YR 3/3) moist; moderate medium granular structure; hard, friable; mildly alkaline; diffuse boundary. (o to 20 inches thick).

B2 27-38" Reddish brown (5YR 5/3) light silty clay loam, dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; hard, friable; a few spots and films of calcium carbonate in the lower part; moderately alkaline, calcareous; gradual smooth boundary. (0 to 20 inches thick.)

C1 38-54" Reddish brown (5YR 5/4) light silty clay loam, dark reddish brown (5YR 3/4) moist; structureless, massive; hard, friable; a few spots and films of calcium carbonate; moderately alkaline, calcareous; gradual smooth boundary. (0 to 30 inches thick.)

C2 54-60" Red (2.5YR 5/6) heavy silt loam, dark red (2.5YR 3/6) moist; structureless, massive; hard, friable; a few thin strata of finer and coarser texture materials; moderately alkaline, calcareous.

Type Location: Grady County, Oklahoma; 5½ miles west of Alex, Oklahoma; 1000 feet south and 330 feet east of the northwest corner of Sec. 18, T5N, R6W.

Range in Characteristics: These soils have concentrations of soft powdery lime within depths of 60 inches or within 20 inches below the base of the B2 horizon. The depth below the surface to calcareous material ranges from 20 to 60 inches. Organic matter decreases irregularly as depth increases or the amount is more than 0.5 percent within depths of 50 inches. The A1 horizon is 20 inches to about 40 inches in total thickness. It has hues of 2.5YR through 10YR, values of 2 or 3 moist and 3 through 5 dry, and chromas of 1 through 3. Texture of the A horizon is silt loam, loam, silty clay loam, or clay loam; but soils having finer or coarser texture in the upper 10 inches are within the range of the series. The A horizon ranges from medium acid to mildly alkaline in the upper part and from neutral to moderately alkaline in the lower part. The soil commonly has a B2 horizon, but pedons lacking a B2 horizon are within the range of the series if they meet other requirements. The B2 horizon has hues of 2.5YR through 10YR, values of 3 through 6 dry and 2 through 5 moist, and chroma of 2 through 6. Textures of the B2 horizon and of the 10- to 40-inch control section are the same as for the A horizon. Average clay content ranges from 18 to 35 percent, and less than 15 percent is fine sand and coarser. Reaction of the B2 horizon ranges from neutral to moderately alkaline. The C horizon has the same colors as the B horizon. Texture of the C horizon is commonly uniform to depths of several feet, but some pedons contain strata of coarser or finer texture than the control section.

Competing Series and Their Differentiae: These are the Asa, Gowen, Norwood, Reinach, and Verdigris soils. The Asa soils have dark surface horizons ranging from 10 to 20 inches in thickness. The Gowen soils have more than 15 percent coarser than very fine sand in the 10- to 40-inch control section. The Norwood soils are calcareous to the surface and tend to be about 1 unit higher in chroma in the surface horizon. The Reinach soils have less than 18 percent clay in the 10- to 40-inch control section, and organic matter decreases regularly as depth increases and is less than 0.5 percent at depths of 50 inches. The Verdigris soils lack secondary carbonates within 60 inches.

Setting: The Port soils are on flood plains. Slopes are plane to slightly convex, and gradients range from 0 to about 2 percent. Port soils formed in calcareous, medium and moderately fine textured alluvium. Floods range from frequent to rare depending upon the soils position, size of stream and flood control structures. The mean annual air temperature ranges from 57^{o} to about 70^{o} F. The mean annual precipitation ranges from about 23 or 44 inches, and the annual Thornthwaite P-E index from about 36 to 70.

Principal Associated Soils: These are the competing Reinach soils and the Miller, Pulaski, and Yahola soils. The Miller soils have more than 35 percent clay in the 10- to 40-inch control section. The Pulaski and Yahola soils lack dark surface horizons and have less than 18 percent clay and more than 15 percent material coarser than very fine sand in the 10- to 40-inch control section.

Drainage and Permeability: Well drained. Runoff is slow, and permeability is moderate to moderately slow.

Use and Vegetation: Dominantly cultivated to alfalfa, small grains, sorghums, and cotton. Small amounts are used for range or tame pastures. The native vegetation is bottom land hardwoods.

Distribution and Extent: Central Oklahoma, south central Kansas, and Central Texas. The soil is extensive.

Series Established: Jackson County, Oklahoma, October, 1942.

Remarks: These soils were classified as Alluvial soils in recently completed soil surveys.

National Cooperative Soil Survey
USA

PRAGUE SERIES

The Prague series includes acid claypan soils of the Reddish Prairie soil zone developed in intercalated reddish and yellowish weakly calcareous to acid shales, mostly of the Pennsylvanian. These soils occur mainly in the Cross Timbers of east-central Oklahoma, within minor prairies intermingled with areas of Darnell, Strephenville, and other Red-Yellow Podzolic Soils. In color, the Prague soils are intermediate between Kirkland and Parsons. Physically, the sola of Prague are very similar to those of Parsons, but the content of phosphorus is even lower than in Parsons and the reaction becomes neutral to alkaline at shallower depths. Prague differs from Kirkland in having somewhat mottled subsoils, lower contents of organic matter and phosphorus; it occurs under somewhat more humid climate and is developed from different formations.

I. Soil Profile: (Prague very fine sandy loam)

	Horizon	Depth	Description	Range in Thickness
1.	A_1	0-8"	Dark grayish brown (10YR 4/1.5 3/1.5, moist) very fine sandy loam; weakly granular; friable; grades to horizon below; medium acid.	5-10"
2.	A_3	8-10"	Grayish-brown (10YR 5/2; 4/2, moist) weakly granular; friable; aggregates coated with light-gray films; rests on horizon below; medium acid.	1-3"
3.	B_2	10-30"	Dark grayish brown (10YR 4/2; 3/2, moist) clay mottled with yellowish red and reddish brown; weakly blocky; very compact; very hard when dry; grades to horizon below; slightly acid to neutral.	10-16"
4.	C_1	30-56"	Mottled yellowish-brown (10YR 5/4; 4/4, moist) and strong-brown (7.5YR 5/6; 4/6, moist) clay massive; very firm; slowly permeable; grades into underlying material; weakly alkaline.	20-30"
5.	C	56"	Red and olive-gray shale with interbedded layers of sandstone; mildly alkaline to weakly calcareous.	

II. Range in Characteristics: Surface soil ranges from very fine sandy loam to clay loam in texture and from grayish brown to dark grayish brown in color; the gray A_3 horizon ranges from marked to very indistinct or wanting; the mottling in horizons 3 and 4 varies considerably; locally, horizon 4 is calcareous; the parent materials are reddish or variegated reddish and light-gray alkaline to calcareous shales and clays, often with some interbedded reddish or pinkish sandstone.

III. Topography: Nearly level to gently sloping erosional upland with gradients up to about 4% but dominantly less than 2.

IV. Drainage: Slow to moderate from the surface; very slow internally adequate for field crops.

Page 2--Prague Series

V. Vegetation: Prairie grasses, chiefly bluestem and grama.

VI. Use: Very largely cultivated to oats, wheat, sorghums, and corn; only moderately productive under the prevailing system of management, of low fertility and droughty. For the most part the areas are of relatively inferior agricultural prosperity.

VII. Distribution: Eastern part of the Reddish Prairie soil zone, mainly in minor prairies within the Cross Timbers of east central Oklahoma; within the outcrop of the transition from gray to red shales in the upper Pennsylvanian; relatively extensive.

Type Location: Western Okfuskee County, Oklahoma.

Series Established: Okfuskee County, Oklahoma, 1940.

EGF 1-22-42
Revised: HO:EHT 5-6-48

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Approved by Principal Soil Correlator
South Region TSC; 3/2/66

Established Series
Rev. JDN-GEW; 2/66

PULASKI SERIES

The Pulaski series is a member of a coarse loamy, siliceous, nonacid, thermic family of Entisols. Pulaski soils have brownish, moderately coarse textured A horizons and brownish to reddish, moderately coarse textured C horizons that have bedding planes.

Typifying Pedon: Pulaski fine sandy loam - cultivated (Colors are for dry conditions unless otherwise stated.)

Ap	0-7"	Reddish-brown (5YR 5/4) fine sandy loam; reddish-brown (5YR 4/4) moist; weak fine and very fine granular structure; very friable; soft; medium acid; clear smooth boundary. 6 to 10 inches thick.
A12	7-19"	Reddish-brown (5YR 5/4) fine sandy loam; reddish-brown (5YR 4/4) moist; weak fine and very fine granular structure; very friable; slightly hard; medium acid; gradual boundary. 4 to 20 inches thick.
C1	19-44"	Yellowish-red (5YR 5/6) fine sandy loam; yellowish-red (5YR 4/6) moist; structureless; very friable; slightly hard; thin strata of darker fine sandy loam in the lower part; slightly acid; gradual boundary. 16 to 36 inches thick.
C2	44-64"+	Reddish-yellow (5YR 6/6) fine sandy loam; yellowish-red (5YR 5/6) moist; structureless; very friable; slightly hard; contains thin strata of loamy fine sand; slightly acid.

Type Location: Lincoln County, Oklahoma. Six miles north and one mile east of Chandler. One-fourth mile north, 200 feet east, and 185 feet south of the southwest corner of Section 2, T15N, R4E.

Range in Characteristics: These soils are usually moist in some part of the upper 60 inches of the soil but are dry in some part for 90 to 135 days (cumulative) in most years. The average texture of the 10 to 40 inch control section is less than 18 percent clay, has more than 15 percent material coarser than very fine sand, and is finer than loamy fine sand. Textures average fine sandy loam but range to light loams. These soils have bedding planes within 50 inches of the surface and eratic particle size distribution with depth. The thickness of the A horizons range from 6 to 24 inches. The color ranges in value from 4 to 7 when dry and 3 to 5 when moist; in chromas of 3 to 6 in hues of 2.5YR to 10YR. When the color value is less than 5.5 when dry and 3.5 when moist, in chromas of 4 or less, and more than 10 inches thick, the organic matter content is less than 1 percent. The texture of the A horizon ranges from loamy fine sand to light loam but is mainly fine sandy loam. The reaction of the A horizon is medium acid to neutral. The color of the C horizons ranges from 5 to 7 in value when dry and 4 to 6 when moist, in chromas of 4 to 8, in hues 2.5YR to 10YR. Bedding planes are evident and darker and lighter colored strata of loamy sand to clay loam are present. Textures finer or coarser than those given for the average of the control section may occur at depths greater than 40 inches from the surface. The reaction is medium acid to neutral above 40 inches but may become alkaline at greater depths.

Competing Series and their Differentiae: These include Yahola, Port, Reinach, Canadian, Cleora, Ochlockonee, Noble, and Zavala. The Yahola soils are calcareous in all parts of the fine earth fraction between 10 and 20 inches. The Cleora, Port, Reinach, and Canadian soils have A1 horizons more than 10 inches thick that have dry color values less than 5.5 and moist color values less than 3.5, in chromas of 4 or less, and organic matter contents higher than 1 percent. The Port soils also have more than 18 percent clay, and the Reinach soils have less than 15 percent material coarser than very fine sand. The Cleora and Ochlockonee soils are dry in some part for less than 90 days (cumulative) in most years. The Ochlockonee soils are strongly acid. The Noble soils are similar in texture, reaction, and color, but have distinct A1 horizons and cambic horizons. The have no bedding planes within 50 inches and occur on footslopes. The Zavala soils are dry for more than 135 days (cumulative) in most years.

Setting: Pulaski soils occur on nearly level to gently sloping floodplains along small creeks and usually near the channel on larger creeks and rivers. Slopes are mainly less than 1 percent but range up to 5 percent. They are of slightly altered, moderately coarse textured sediments from soils under scrub oak vegetation (cross timbers). The Thornthwaite annual PE index is from about 33 to 64. The mean annual air temperature is from 57 to about 70 degrees.

Principal Associated Soils: These include Stephenville, Windthorst, Darnell, and Dougherty soils, as well as the competing Noble, Yahola, Port, and Reinach soils. The Darnell soils occur on uplands and are less than 20 inches thick over sandstone. The Stephenville, Windthorst, and Doutherty soils have argillic horizons.

Drainage and Permeability: Well drained. Moderately rapid permeability. Slow runoff.

Use and Vegetation: The native vegetation is bottomland hardwoods. Mostly cleared and used for cultivated crops and tame pastures.

Distribution and Extent: In the cross-timbers of Oklahoma and Texas and minor amounts in south central Kansas. The series is extensive.

Series Established: Lonoke County, Arkansas, 1921.

Remarks: The subgroup Udic Ustifluvents has been proposed for soils having characteristics of this series. The soils were formerly classified in the Alluvial Great Soil Group.

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USA

RAVIA SERIES*

This unit consists of gradational prairie soils developed in materials weathered from Tishomingo granite. This series has a tentative status, at present, with an Aquic Argudoll Classification.

<u>Typifying Pedon</u>: Ravia loam

A1	0-6"	Dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate medium granular structure; slightly hard dry, very friable when moist; pH 6.5; gradual boundary.
B21t	6-9"	Dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist (3/3 when crushed); compound medium fine subangular and medium coarse granular structure; very hard dry, very firm when moist, slightly sticky wet; pH 6.5; gradual boundary.
B22t	9-23"	Brown (7.5YR 5/4) clay, dark brown (7.5YR 4/4) when moist; few fine distinct red mottles; moderate medium blocky structure; clay film on ped faces; extremely hard when dry; very firm when moist, sticky when wet; pH 6.5; gradual boundary.
B23t	23-42"	Light yellowish brown (10YR 6/4) clay, yellowish brown (10YR 5/4) when, moist; few medium distinct red mottles; moderate medium blocky structure; few clay film on ped faces; extremely hard fry, very friable moist; sticky when wet; pH 6.0; gradual boundary.
B24t	42-54"	Reddish brown (5YR 4/3) when moist; weak medium blocky structure; few fine yellowish brown mottles; extremely hard dry, very firm moist, sticky when wet; pH 6.5; gradual boundary.
B3	54-62"	Brown (7.5YR 5/4) gravelly clay, dark brown (7.5YR 4/4) when moist; weak blocky structure; extremely hard dry, very firm moist, sticky wet; few Ca Co_3 concretions; gravel increasing with depth; pH 7.5.

<u>Note</u>: Some 2 or 3% chert and quartz particle larger than 2 mm in all horizons.

<u>Location</u>: 300' east and 200' south of west quarter corner Sec. 7-3S-6E.

<u>Parent Material</u>: Tishomingo Granite

<u>Slope</u>: About 2% gradient

3-67
DLB

*Tentative

Established Series

REINACH SERIES

The Reinach series consists of somewhat reddish youthful soils with silty or only moderately sandy subsoils developed in calcareous reddish alluvium in the zones of Reddish Prairie and Reddish Chestnut soils. The soils occur on low terraces of streams that originate in and carry sediments mainly from subhumid plains that are largely underlain by Red Beds. The series is closely related to the Yahola series of the present flood plains but lies a few feet higher, above ordinary overflow, and has a slightly darkened generally noncalcareous surface layer. It differs from the Canadian, Dale, and Asa series mainly in being more reddish, has less sandy subsoils than Brazos, and has less dark surface soils and less clayey subsoils and free drainage than McLain and Kay.

Soil Profile: Reinach very fine sandy loam		Range in Thickness
0-18"	Reddish-brown (7.5YR 5/6; 4/6, moist) silt loam; moderate medium granular; very friable; slightly alkaline but noncalcareous; grades into horizon below.	12-20"
18-60"+	Yellowish-red (5YR 5/6; 4/6, moist) silt loam; weakly granular; very friable; calcareous.	0-20"

Range in Characteristics: Sandy loams and silt loams are predominant but other types occupy small areas; color of the surface soil ranges from brown (7.5YR 5/3) to dark reddish-brown (5YR 3/3) and of substrata from yellowish-red to reddish-brown or light brown; reaction of horizons 1 and 2 ranges from neutral to calcareous.

Topography: Nearly level low stream terraces lying a few feet above present flood plains.

Drainage: Moderate to rapid from the surface and internally; some low terraces are inundated once in 10 to 25 years.

Vegetation: Prairie grasses with scattered mesquite and elm trees in more western parts; forested with elm, hackberry, oaks, and hickory in the humid region.

Use: Largely cultivated and used for growing corn, alfalfa, small grains, cotton, and sorghums, generally with high yields.

Distribution: Oklahoma and central and northern Texas in valleys of streams, such as the Red, Canadian, and Brazos Rivers, that drain western plains partly underlain by Red Beds.

Type Location: Muskogee County, Oklahoma.

Series Established: Muskogee County, Oklahoma, 1913.

Remarks: Color terms are provisional Soil Survey color names based on Munsell Color Charts and refer to dry soil.

EGF:FAH:MB
4-22-40
Revised: HO:EHT
4-7-46
Revised: EHT
6-16-47

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Established Series

RENFROW SERIES

The Renfrow series includes normal Reddish Prairie soils developed from weakly calcareous clayey Red Beds. The principal associated series are Kirkland and Tabler, which are Planosols; Vernon, a Lithosol; and Nash, which is developed on less clayey Red Beds and has a more friable subsoil.

Soil Profile:	Renfrow silt loam	Range in Thickness
0-6"	Reddish-brown; (5YR 5/4; dark reddish-brown 5YR 3/4, moist) silt loam; weak medium granular; friable; neutral to slightly acid; grades into horizon below.	5-8"
6-10"	Reddish-brown (5YR 5/4; dark reddish-brown 5YR 3/3, moist) silty clay loam; weakly prismatic; friable; hard when dry; neutral; passes abruptly into horizon below.	3-7"
10-26"	Reddish-brown (2.5YR 5/4; 4/4, moist) clay; weak medium blocky; firm to very firm; very hard when dry; slightly alkaline; grades into horizon below.	12-20"
26-38"	Red (2.5YR 5/6; 4/6, moist) clay massive, slowly permeable; firm to very firm; very hard when dry; slightly alkaline to calcareous.	8-15"
38-50"+	Red (2.5YR 5/6) slightly calcareous clay grades into slightly calcareous red shale at depths of 3 to 5 feet.	

Range in Characteristics: Clay loams and silt loams are the principal types but small areas of clay and fine sandy loam occur; color of the surface and subsurface layers ranges from brown to dark reddish-brown; horizon 3 and 4 are calcareous where the substratum is strongly calcareous; locally the clay type is calcareous throughout.

Topography: Undulating erosional upland with gradients of about 2 to 7 percent, dominantly 2 to 4.

Drainage: Moderate to rapid from the surface; very slow internally.

Vegetation: Originally of tall prairie grasses, dominantly bluestems (Andropogon spp.) grama and buffalo grasses are predominant in pastures.

Use: Largely cultivated; wheat is the principal crop, but sorghums, oats, and Sudan grass are grown; moderately productive.

Distribution: Reddish Prairie sections of southern Kansas, Oklahoma, and central-northern Texas; very extensive.

Remarks: Color terms are Provisional Soil Survey color names based on Munsell Color Charts and unless stated otherwise, refer to dry soil.

Type Location: Garfield County, Oklahoma.

Series Established: Grant County, Oklahoma, 1931.

Rev. HO:EHT
6-7-46

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ROEBUCK SERIES

The Roebuck series is a member of the fine, montmorillonitic, thermic family of Vertic Hapludolls. They have dark brown, fine textured A horizons, dark reddish brown, fine textured B horizons with high shrink-swell potential, and moderately fine textured C horizons.

Typifying Pedon: Roebuck clay - cultivated
(Colors are for moist soil unless otherwise stated.)

A1 0-18" Dark brown (7.5YR 3/3) light clay, brown (7.5YR 4/2) dry; weak fine and medium blocky structure; very hard, firm; common fine roots; a few worm casts; noncalcareous; moderately alkaline; gradual smooth boundary; 7 to 25 inches thick.

B 18-40" Dark reddish brown (5YR 3/3) light clay, reddish brown (5YR 4/3) dry; weak medium blocky structure; very hard, firm; common fine roots through peds; a few slickensides; a few worm casts; a few fine black concretions; noncalcareous; moderately alkaline; gradual smooth boundary; 13 to 40 inches thick.

C 40-72"+ Dark red (2.5YR 3/6) clay loam, red (2.5YR 4/6) dry; structureless, massive; very hard, firm, a few root pores; a few fine black concretions; noncalcareous; moderately alkaline.

Type Location: Jefferson County, Oklahoma; about 3.5 miles east of Hastings; about 1500 feet east and 200 feet south of the northwest corner of Section 9-T4S-R8W.

Range in Characteristics: These soils are not dry for as much as 90 cumulative days in any horizon between 7 and 20 inches in most years. The reaction of all horizons is slightly acid to moderately alkaline. Secondary carbonates are absent within 60 inches of the surface or within 20 inches below the base of the cambic horizon, but in high lime sediments the matrix may be calcareous to within 20 inches of the surface so long as the lime is not due to secondary accumulation. These soils have cracks at some period in most years that are 0.4 inches or more wide at a depth of 20 inches, that are at least 12 inches long in some part, and that extend upward to the surface or to the base of the Ap horizon. The A horizon has hues of 2.5YR through 10YR, moist values of 2 or 3 and dry values of 4 or 5, and chroma of 2 or 3. The upper 10 inches of the soil may have textures of fine sandy loam to clay, but mainly the texture of the A horizon is heavy clay loam, heavy silty clay loam, silty clay, or clay with from 35 to about 60 percent clay. The B horizon has hues of 2.5YR through 7.5YR, moist values of 3 or 4, dry values of 4 or 5, and chroma of 2 through 6. Few to common gray or higher chroma mottles may be present. The texture of the B horizon is mainly clay or silty clay, but heavy clay loam or heavy silty clay loam is included. The clay content ranges from 35 to about 60 percent clay. Slickensides are present but do not intersect. The C horizon ranges from clay to stratified clay, silt and sand of red and brown colors. Buried dark horizons are not uncommon below about 2 feet.

Competing Series and Their Differentiae: These are the Buxin, Catalpa, Latanier, Lela, Miller, Moreland, Norwood, Pledger, and Port soils. Buxin soils have a dark gray Ab or Cg horizon within 30 inches depth. Catalpa soils have B horizons of 10YR to 5Y hue. Latanier soils have contrasting textures of clay over material with 25 percent less clay content within 36 inches depth. Lela soils have slickensides close enough to intersect within 40 inches depth. Miller, Moreland and Pledger soils have secondary carbonates within 60 inches depth or within 20 inches below the base of the cambic horizon. Norwood and Port soils have less than 35 percent average clay content in the 10 to 40 inch section, and in addition Norwood soils have moist color values of 3.5 or more, and are calcareous.

Setting: The Roebuck soils are on floodplains. They are mainly on the part of the floodplain farthest away from the stream or in swales or old channels and are commonly at a slightly lower elevation than the other floodplain soils. Slopes are plane, to slightly concave in small areas, and slope gradients are mainly less than 1 percent. The Roebuck soils are formed in fine textured alluvial sediments along streams carrying Permian red beds sediments. The climate is moist subhumid to humid. The soils receive extra water from runoff and flooding and have more soil moisture than soils of the surrounding upland. The mean annual precipitation of the surrounding uplands is about 28 to 45 inches; the mean annual Thornthwaite P-E index is about 44 to 78; and the mean annual air temperature is 57 to 70° F.

Principal Associated Soils: These are the competing Latanier, Norwood, and Port soils.

Drainage and Permeability: Moderately well drained to poorly drained; runoff is slow to very slow; permeability is very slow. Flooding occurs at intervals of several times in 1 year to once in 5 to 10 years, except where protected from flooding by dams or levees.

Use and Vegetation: When drained, the soils are used for growing cotton, soybeans, sorghums, and pastures, with the wetter areas used for native range and wildlife. The native vegetation is an open to thick stand of any of trees such as elm, oak, ash, hackberry, pecan and mesquite trees and tall and mid grasses.

Distribution and Extent: Central and eastern Oklahoma, eastern Texas, Arkansas, and Louisiana. The series is moderately extensive or extensive.

Series Established: Choctaw County, Oklahoma, 1940.

Remarks: These soils were classified as Alluvial soils in recently completed soil surveys. The soils are assumed to have a C.O.L.E. of .09 or more in a horizon at least 20 inches thick and have a potential linear extensibility of 2.4 inches or more in the upper 40 inches of the soil. The clay fraction is assumed to be dominated by montmorillonite.

National Cooperative Soil Survey
USA

Established Series

SAN SABA SERIES

The San Saba series includes very dark gray Rendzinas developed from limestone or limestone interbedded with marl in the warm-temperate humid region. They are associated with the Denton soils which are browner, more granular, and better drained; Crawford, which are reddish; and the Tarrant and Brackett soils, which are Lithosols.

Soil Profile:		San Saba clay	Range in Thickness
1.	0-18"	Very dark gray (2.5Y 3/1; black, 2.5Y 2/1, moist) clay; strong medium granular; crumbly and friable; very sticky and very plastic; calcareous; grades into horizon below.	10-24"
2.	18-40"	Very dark gray clay; weak coarse blocky or compound coarse granular; very firm; very sticky and stiff; strongly calcareous; contains small subrounded particles of hard $CaCO_3$; grades into horizon below.	10-30"
3.	40-54"	Olive-gray (5Y 4/2; olive 4/3, moist) clay; of same structure and consistence as layer above; contains small hard particles of $CaCO_3$.	8-20"
4.	54"+	Hard limestone or partly weathered limestone interbedded with thin seams of marl.	

Range in Characteristics: The clay is the principal or only type; color of horizon 1 ranges from dark gray to black and from calcareous to neutral; some areas are transitional toward Blanket which is a grayish-brown noncalcareous soil of the adjoining Reddish Chestnut soils zone. Areas having a solum less than 24 inches thick are classed as shallow phases; in stony types and phases, fragments of hard limestone occur on the surface and throughout the solum.

Topography: Nearly level to gently sloping concave surfaces with gradients of less than 2 percent; dominantly less than 1.

Drainage: Slow from the surface; very slow internally; generally favorable for field crops.

Vegetation: Mainly short grasses such as buffalo and gramas; some tall bunch grasses; some live oak, elm, mesquite, and sumac in places.

Use: Nearly all is cultivated and used for growing cotton, sorghums, small grains, and corn; very productive.

Distribution: Mainly in limestone prairies of central and north-central Texas and southern Oklahoma; very extensive in Grand Prairie section of Texas.

Remarks: Provisional soil color names proposed by the 1946 committee; color of soil dry unless otherwise stated. Symbols express Munsell notations.

Type Location: Bell County, Texas.

Series Established: San Saba County, Texas, 1916.

WTC
6-25-38
Rev. HO:EHT
6-10-46

Division of Soil Survey
Bureau of Plant Industry, Soils,
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U. S. Department of Agriculture

SCULLIN SERIES

The Scullin series is a member of the fine, mixed, thermic family of Udic Argiustolls. These soils have dark brown, loam A1 horizons, dark brown, gravelly, clay loam B1 horizons, dark reddish brown gravelly clay B2t horizons, and have limestone bedrock at a depth of about 30 inches.

Typifying Pedon: Scullin loam - rangeland
(Colors are for dry soil unless otherwise stated.)

A1	0-6"	Dark brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; strong medium granular structure; hard, friable; contains 10 percent hard limestone gravel; slightly acid; gradual wavy boundary. 4 to 12 inches thick.
B1	6-11"	Dark brown (7.5YR 4/2) gravelly clay loam, dark brown (7.5YR 3/2) moist; strong very fine blocky structure; hard, firm; contains 25 percent limestone and chert gravel; slightly acid; gradual wavy boundary. 2 to 12 inches thick.
B21t	11-18"	Dark reddish brown (2.5YR 3/4) clay, dark reddish brown (2.5YR 2/4) moist; strong very fine blocky structure; extremely hard, very firm; thin clay films on peds; contains 5 percent limestone and chert gravel slightly acid; gradual wavy boundary. 5 to 12 inches thick.
B22t	18-30"	Dark reddish brown (2.5YR 3/4) gravelly clay, dark reddish brown (2.5YR 2/4) moist; strong; very fine blocky structure; extremely hard, very firm; contains 50 percent limestone and chert gravel; thin clay films on peds, mildly alkaline; clear wavy boundary. 5 to 30 inches thick.
R	30"+	Limestone bedrock that is fractured at 3 to 12 inch intervals with cracks up to 2 inches wide.

Type Location: Pontotoc County, Oklahoma; about 18 miles south of Ada on State Highway 99; 810 feet north and 60 feet west of the southeast corner of Section 23-T1N-R6E.

Range in Characteristics: These soils are dry for 90 to 135 cumulative days in most years in some subhorizon of the soil between 7 and 20 inches. Depth to bedrock is 20 to 40 inches. The Na plus K saturation does not increase with depth. The upper 20 inches of the Bt (argillic) horizon averages from 35 percent to about 50 percent clay and from 15 to 35 percent chert and limestone gravel. The dark epipedon is more than 7 and less than 20 inches thick, includes the A horizon and includes the B1 horizon in part of the pedons. The epipedon has hues of 10YR through 2.5YR, values of 3 through 5 dry and 2 and 3 moist, and chroma of 2 and 3. Texture of the A horizon is loam, silt loam, gravelly loam, or gravelly silt loam. The chert and/or limestone gravel content of the A horizon ranges from 0 to 35 percent. Reaction of the A horizon is medium acid to slightly acid. Color of the B1 horizon is as given for the epipedon where it is a part of that horizon and ranges 1 value and 1 unit of chroma higher where it extends below the epipedon. Texture of the B1 horizon is heavy loam, heavy silt loam, heavy clay loam, or heavy silty clay loam or their gravelly counterparts. The limestone and/or chert gravel content ranges from 0 to 35 percent. Reaction of the B1 horizon ranges from medium acid to slightly acid. The B2t horizons have hues of 7.5YR through 2.5YR, values of 3 through 6 dry and 2 through 5 moist, and chroma of 3 through 6. Texture of the B2t horizons includes gravelly heavy clay loam, gravelly heavy silty clay loam, and gravelly clay. The limestone and/or chert gravel content ranges from 15 to about 50 percent within short distances and a subhorizon may be nearly gravel free. The reaction ranges from medium acid to mildly alkaline.

Competing Series and Their Differentiae: These are the *Bexar, Claremore, Eldorado, and *Lula soils. *Bexar soils have dark epipedons that are both massive and hard when dry. Claremore soils have limestone bedrock at less than 20 inches depth. Eldorado soils have more than 35 percent chert gravel and less than 35 percent clay in the upper 20 inches of the Bt (argillic) horizon and are dry for less than 90 cumulative days in some subhorizon of the soil between 7 and 20 inches depth in most years. *Lula soils have limestone bedrock at 40 to 60 inches and have less than 35 percent clay and very few or no gravel in the upper 20 inches of the Bt (argillic) horizon.

Setting: The Scullin soils are on uplands. Slope gradients are from 0 to about 8 percent. The Scullin soils formed in residium from limestones and dolomitic limestones that contain substantial amounts of chert. At the type location the annual Thornthwaite P-E index is about 63, the mean annual precipitation is about 39 inches, and the average annual air temperature is about 63^{o} F.

Principal Associated Soils: These are the Talpa soils that have limestone bedrock within 20 inches depth and the competing Claremore soils.

Drainage and Permeability: Well drained; runoff is slow to medium; permeability is moderately slow.

Use and Vegetation: Dominantly used for native range. The native vegetation is tall grass prairie.

Distribution and Extent: Known areas are in Pontotoc and Johnston Counties in Oklahoma and acreage is approximately 15,000 to 20,000 acres. The series is of moderate extent.

Series Proposed: Pontotoc County, Oklahoma, 1967. The name is from a small community in neighboring Murray County, Oklahoma.

Remarks: These soils would have been classified as Reddish Prairie soils under the old system.

National Cooperative Soil Survey
USA

STEEDMAN SERIES

The Steedman series is a member of the fine, montmorillonitic, thermic family of Aquic Haplustalfs. These soils have gray, silty clay loam A horizons, brownish, clay Bt horizons and C horizons of gray weakly laminar shale at about 35 inches.

Typifying Pedon:		Steedman silty clay loam - rangeland (Colors are for dry soil unless otherwise stated.)
A1	0-7"	Gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate medium granular structure; hard, firm; medium acid; gradual smooth boundary. 5 to 10 inches thick.
B21t	7-16"	Grayish brown (2.5Y 5/4) clay; few fine prominent reddish brown mottles, dark grayish brown (2.5Y 4/2) moist; moderate medium blocky structure; extremely hard, extremely firm; clay films on ped surfaces; slightly acid; gradual smooth boundary. 6 to 15 inches thick.
B22t	16-35"	Light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; moderate coarse blocky structure; extremely hard, extremely firm; clay films on ped surfaces; a few fine hard lime concretions and soft limy spots; moderately alkaline; gradual wavy boundary. 10 to 25 inches thick.
C	35-40"+	Gray (2.5Y 5/1) weakly laminar shale, dark gray (2.5Y 4/1) moist; moderately alkaline.

Type Location: Pontotoc County, Oklahoma; about 1 mile south and 8 miles east of Ada; 1120 feet west and 660 feet south of the center of section 12-T3N-R7E.

Range in Characteristics: The solum ranges from 25 to about 50 inches thick. There are secondary carbonates as soft spots or films within 60 inches depth or within 20 inches below the base of the argillic horizon. The upper 20 inches of the argillic horizon is dominated by montmorillonitic clay. These soils have cracks at some season in most years that are 1 cm or more wide at a depth of 50 cm and that are at least 30 cm long in some part. In addition, they have a potential linear extensibility of 6 cm or more in the upper 40 inches of the soil. The A horizon has hues mainly of 10YR, values of 4 or 5 dry and 2 through 4 moist, and chroma of 1 through 4. The A horizon is not more than one third of the solum thickness where the solum thickness is less than 30 inches, or more than 10 inches thick where the solum thickness exceeds 30 inches if the A horizon has values of less than 5.5 dry and 3.5 moist, and chroma of less than 3.5. The texture of the A horizon is silty clay loam, loam or clay loam. The reaction of the A horizon ranges from slightly acid to strongly acid. The B21t horizon has hues of 10YR to 5Y, values of 5 or 6 dry and 4 or 5 moist, and chroma of 2 through 4. Fine reddish brown, yellowish red, or strong brown mottles range from none to common. The texture ranges from heavy silty clay loam or heavy clay loam to clay with from 35 to about 60 percent clay. The consistence is very firm or extremely firm when moist. The reaction ranges from medium acid to neutral. The color of the B22t horizon ranges in hues similar to the B21t horizon and up to 1 color value higher and from 2 to 6 chroma. This horizon is mottled with browner and/or grayer colors in some part of the profile. Two chroma mottles are present within 30 inches of the surface. The texture of this horizon is the same as for the B21t horizon. The structure is blocky in weak or moderate grade. The consistence is very firm or extremely firm when moist. The reaction ranges from slightly acid in the upper part on the thicker solums to neutral to moderately alkaline in the lower part. The C horizon is shale with weak laminations, or compact clay beds. The reaction is mildly to moderately alkaline.

Competing Series and Their Differentiae: These include the Durant, Eram, Summit, Talihina, and Truce soils. The Durant soils have dark A horizons thicker than lo inches and have thicker solums. The Eram soils have dark A horizons thicker than one third of the solum where the solum is less than 30 inches thick and more than 10 inches thick where the solum is more than 30 inches thick. In addition, the Eram soils do not have secondary carbonates. The Summit soils have much thicker dark horizons and do not have secondary carbonates. The Talihina soils do not have Bt (argillic) horizons. The Truce soils have lighter colored lower A horizons and lack two chroma mottles within 30 inches of the surface.

Setting: The Steedman soils occur on nearly level to sloping uplands. Slope gradients are mostly from 0 to 12 percent. The Steedman soils formed in shales or compact claybeds that are alkaline or calcareous. The mean annual precipitation at the type location is about 39 inches, the Thornthwaite P-E index is about 61, and the mean annual air temperature is about 62° F.

Principal Associated Soils: These are the Dennis, Collinsville, and Bates soils have thicker dark A horizons and do not have secondary carbonates. The Collinsville soils are shallow over sandstone and do not have Bt (argillic) horizons.

Drainage and Permeability: Well drained; the runoff is slow to medium; the subsoil permeability is slow and the substratum permeability is very slow.

Use and Vegetation: The primary use is for native range. Some areas are cultivated to small grains and sorghums. The native vegetation was tall prairie grass.

Distribution and Extent: Known areas are in south central Oklahoma. The soil is moderately extensive.

Series Proposed: Pontotoc County, Oklahoma, 1967. The name is from a nearby community.

Remarks: This soil has Vertic properties but no Vertic subgroup is presently offered in Haplustalfs. This soil was part of the Eram series before the present classification system. The Eram soils are now classified as Mollisols.

National Cooperative Soil Survey
USA

Approved by Principal Soil Correlator
South Region TSC: 6/2/66

Established Series
Rev. NTO-DGB-JDN: 5/2/66

STEPHENVILLE SERIES

The Stephenville series is a member of a fine loamy, mixed, thermic family of Udultic Haplustalfs. Typically, these soils have brown, moderately coarse textured upper A horizons and light brown, moderately coarse textured lower A horizons with reddish, moderately fine textured B2t horizons. Slightly acid reddish sandstone occurs at about 34 inches.

Typifying Pedon: Stephenville fine sandy loam - rangeland
(Colors for dry conditions unless otherwise noted.)

A1 0-4" Brown (7.5YR 5/2) fine sandy loam; dark brown (7.5YR 4/2) when moist; weak fine granular structure; slightly hard; very friable; medium acid; gradual smooth boundary. 3 to 7 inches thick.

A2 4-12" Light brown (7.5YR 6/3) fine sandy loam; brown (7.5YR 5/3) when moist; massive; soft; very friable; medium acid; clear smooth boundary. 3 to 13 inches thick.

B21t 12-22" Yellowish-red (5YR 5/6) sandy clay loam; yellowish-red (5YR 4/6) when moist; weak medium subangular blocky structure; very hard; friable; clay films on ped faces and bridging sand grains; medium acid; diffuse smooth boundary. 4 to 18 inches thick.

B22t 22-34" Red (2.5YR 5/6) light sandy clay loam; red (2.5YR 4/6) when moist; weak coarse subangular blocky structure; very hard; friable; clay films bridging the sand grains; medium acid; abrupt irregular boundary. 4 to 18 inches thick.

R 34-40"+ Light red (2.5YR 6/6) slightly acid sandstone.

Type Location: Oklahoma County, Oklahoma. 2400 feet west and 400 feet north of the southeast corner of Section 25, T11N, R1E. About 7 miles south of Harrah.

Range in Characteristics: These soils are usually moist in some part of the upper 60 inches of the soil but are dry in some part for 90 to 135 days (cumulative) in most years. The reaction of all horizons range from slightly acid to strongly acid. Thickness of the A horizons range from 6 to 20 inches. The color of the A1 horizon ranges in hues 7.5YR and 10YR with dry values of 4 to 6; moist values 3 to 5; and chromas of 2 and 3. They have an A1 horizon having a moist color value not so dark as 3.5 or not containing more than 1.2 percent organic matter in the upper 4 inches. The texture of the A1 horizon is mainly fine sandy loam but loamy fine sands occur. The color of the A2 horizon ranges in hues 5YR to 10YR with dry values of 5 to 7; moist values 4 to 6; and chromas of 2 to 4. The texture of the A2 horizon is mainly fine sandy loam but loamy fine sands occur. The color of the B2t horizons range in hues 2.5YR to 7.5YR with dry values of 4 to 6; moist values 3 to 5; chromas of 4 to 8. The texture of the B2t horizons range from sandy clay loam to heavy fine sandy loam with clay content of 18 to 35 percent. The depth to sandstone ranges from 20 to 48 inches. The sandstone is hard to extremely hard when dry and on wetting it may be extremely resistant to pressure or range to weakly resistant to pressure.

Competing Series and their Differentiae: These include the Konawa, Linker, Cobb, and Windthorst soils. The Konawa soils are thicker than 48 inches. The Linker soils are typically strongly acid. They have a base saturation of less than 35 percent in some part of the argillic horizon. The Cobb soils have A1 horizons more than 6 inches thick that have dry color values less than 5.5 and moist color values less than 3.5. The Windthorst soils have more than 35 percent clay in the upper 20 inches of the argillic horizon.

Setting: The Stephenville soils occur on nearly level to gently rolling erosional uplands and are developed on neutral to slightly acid sandstone. The slopes are dominantly of gradients between 1 to 5 percent but range to about 10 percent. The climate is subhumid to moist subhumid. At the type location, the average annual precipitation is about 33 inches and the mean annual temperature about 61° F. The Thornthwaite P-E index in the area of occurrence is from 44 to 64 and the mean annual air temperature from 57° F. to about 70° F.

Principal Associated Soils: These include the Konawa, Darnell, Windthorst, and Dougherty series. The Darnell soils are less than 20 inches thick over sandstone. The Dougherty soils have combined A horizons, more than 20 inches thick, of loamy fine sand or coarser and are thicker than 48 inches.

Drainage and Permeability: Well drained. Moderate permeability. Runoff is slow to medium.

Use and Vegetation: Areas on slopes of less than 5 percent are largely in cultivation with sorghums, small grains and peanuts as the main crops. The native vegetation is mainly postoak, blackjack, hickory, and elm with considerable understory of little bluestem, Indiangrass, and other grasses.

Distribution and Extent: Central and eastern Oklahoma, north central Texas, and southeastern Kansas. This series is of large extent.

Series Established: Erath County, Texas, about 1921.

Remarks: The Stephenville was formerly classified in the Red and Yellow Podzolic Great Soil Group.

National Cooperative Soil Survey
USA

STIDHAM SERIES

The Stidham series includes well-drained Yellow Podzolic Soils with friable subsoils developed on neutral to alkaline sandy alluvium of rivers that drain subhumid plains. The series closely resembles Bowie, from which it differs principally in that the parent material is old alluvium from grasslands, nonacid in reaction, and usually somewhat reddish owing to admixture of sediments from red beds. The Stidham series differs from Dougherty, with which it is catenally associated in having a yellow upper subsoil and a coarsely mottled or splotched yellow and red lower subsoil.

Soil Profile: Stidham fine sandy loam

A_1	0-3"	Pale brown (10YR 6/3; 5/3, moist) light fine sandy loam; weakly granular; very friable; slightly acid; grades to horizon below. 2 to 5 inches thick
A_2	3-14"	Very pale brown (10YR 7/4; 6/5, moist) light fine sandy loam; massive; porous; friable; slightly acid; grades to horizon below. 10 to 15 inches thick
B_{21}	14-20"	Yellow (10YR 7/6; yellowish-brown 10YR 5/6, moist) sandy clay loam; weakly blocky porous; friable; hard when dry; strongly acid; grades to horizon below. 4 to 12 inches thick
B_{22}	20-36"	Yellow sandy clay coarsely mottled or splotched with yellowish red; friable; blocky, the exteriors of the blocks being yellow or yellowish brown; strongly acid; grades indistinctly to horizon below. 15 to 30 inches thick
C_1	36-45"+	Similar but slightly more sandy (a heavy sandy clay loam) and only slightly acid, becoming alkaline below 4 feet, and weakly calcareous below 10 or 15 feet.

Range in Characteristics: Fine sandy loam and loamy fine sand are the principal types, the loamy fine sand having a thicker A horizon, usually more than 15 inches deep over layer 3; in cultivated areas the A_1 is light brownish gray to plow depth; reaction of the A horizon ranges from acid to neutral; the subsoil ranges from brownish yellow to yellowish brown and from sandy clay loam to light sandy clay; some reddish brown splotches may occur in the lower subsoil or substratum; in many areas the substratum below about 4 feet is mottled light gray and yellow fine sandy loam or loam.

Topography: Undulating to nearly level old stream terraces lying 40 to 80 feet above the present flood plains; the modal gradient is from about 1 to 4 percent.

Drainage: Moderate to rapid from the surface; moderate internally.

Vegetation: Originally mainly post oak, blackjack, red oak, and hickory with some coarse grasses.

Use: Largely cleared and used for growing corn, cotton, sorghums, and peanuts; fertility is low but soil is very responsive to management.

Distribution: Southern and eastern Oklahoma and adjoining States; on old high dissected terraces along such streams as the Red and Arkansas Rivers, which drain subhumid and semiarid grasslands partly underlain by red beds.

Remarks: The deep sands formerly included in the Stidham series as sand types are now classed as Eufaula.

Colors are described with provisional Soil Survey Color Names (1947) and unless stated otherwise refer to dry soil.

Type location: Pontotoc County, Oklahoma.

Series Established: McIntosh County, Oklahoma, 1935.

WTC:MB 3-18-39
Rev. HO:EHT 3-5-48
Mimeo. Sept. 1960

National Cooperative Soil Survey
USA

Preliminary: Subject to Revision

SUMTER SERIES

The Sumter series comprises the light colored calcareous soils known as the Light Prairies, occurring chiefly in the prairie region of Alabama and Mississippi, in association with the Houston, Vaiden, and Eutaw soils. Sumter soils are derived from soft limestone or Selma chalk and the solum is thin. West of the Mississippi River, the soils as mapped have developed from soft marl and clays of Cretaceous age.

Soil Profile: Sumter clay

1. Light yellowish-gray, light gray, or yellowish-brown calcareous clay; moderately plastic when wet; crumbles into small granules upon drying. 3 to 6 inches thick.

2. Grayish-yellow or yellow highly calcareous heavy clay. 4 to 10 inches thick.

3. Yellowish clay mottled with light gray and creamy white; very calcareous; plastic when wet; brittle and crumbly when dry. The white mottlings are calcareous nodules; layer is 10 to 20 inches thick.

4. Soft, almost white limestone or yellow marl. In places, the soft white limestone comes to the surface and outcrops of it are common on the slopes. This chalk is not present in Texas areas.

Variations: Thickness of solum.

Topography: Undulating, gently sloping, or rolling uplands.

Drainage: Natural surface drainage is good; internal drainage fair. Erosion has removed subsoil in places, exposing white chalk or marl.

Natural Vegetation: Short grasses and legumes.

Use: Well adapted to Dallis grass and melitotus; and locally, corn, alfalfa, oats, cowpeas, velvetbeans, and some cotton are grown in Alabama, though average yields are low. In Texas, it is practically unsuited for crops, though small included spots in cultivated fields are farmed with very slight yields.

Distribution: Alabama, Mississippi, and Texas.

Type Location: Sumter County, Alabama.

Series Established: Sumter County, Alabama, 1910.

WEH-EFF-WTC-MB
2-18-43

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SWITZER SERIES

The Switzer series includes dark-colored claypan soils developed on relatively high stream terraces within the Prairie and Reddish-Prairie soils zones where drainage is from soils developed mainly on shale and limestone uplands. The Switzer resemble the Woodson soils, which are developed over bedded shales, in surface color and profile features. They are much darker in the surface layer than the Neosho soils. They differ from the Rokeby soils, which occupy similar terrace positions along streams that drain the loess-mantled uplands of the Prairie soils zone, in having more clayey parent materials.

I. Soil Profile: (Switzer silty clay loam)

			Range in Thickness
1. A_1	0-10"	Dark grayish-brown (dry) to nearly black (moist) 1/ silty clay loam of weakly granular or soft-crumb structure; slightly acid.	5-12"
2. B_{2-1}	10-28"	Dark grayish-brown (dry) to nearly black (moist) clay (claypan), faintly streaked or mottled with dark-brown; dense and compact when wet, breaks into irregular medium or large clods when dry.	16-20"
3. B_{2-2}	28-48"	Gray or yellowish-gray massive silty clay, streaked and mottled with dark brown and light yellowish brown; sprinkling of soft brown iron concretions; slightly acid.	16-24"
4. C_1		Gray and yellow massive silty clay, containing an abundance of dark-brown, reddish-brown and yellow iron stains; continues to as much as 15 feet below the surface in places.	

II. Range in Characteristics: The intensity of the dark color of topsoil varies somewhat. Switzer silt loam and clay types are also recognized.

III. Topography: Nearly level to gently sloping; gradients seldon exceed 2 percent.

IV. Drainage: Runoff low; permeability very slow.

V. Vegetation: Tall prairie grasses, chiefly bluestems.

VI. Use: Chiefly for growing small grain.

VII. Distribution: Southeastern Kansas, adjacent areas in Oklahoma, and possibly in Southwestern Missouri.

Type Location: Coffey County, Kansas.

Series Established: Okfuskee County, Oklahoma, 1940.

1/ Approximate Profisional Soil Survey color names.

BHW 5-22-40
Rev. JT 6-7-46

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TABLER SERIES

The Tabler series comprises very slowly drained soils with dark, grayish claypans. It is developed from somewhat calcareous clays or other finer textured earths in the zone of Reddish Prairie Soils. The parent material may be alluvial or eolian mantle, or residuum from red beds or other shales, but is confined to clays, clastics which form much clay upon weathering, that are comparatively rich in phosphorus and other elements needed by plants. Tabler soils are grayer and have darker subsoils than Kirkland and Renfrow, which occupy less level areas. Associated Lithosols on red beds are of the Vernon series. The Tabler series is rather closely related to the Wilson and Woodson series but is developed in somewhat different parent material. In addition, Tabler occurs under cooler or drier climate than the Wilson, and is restricted to areas west and north of the Grand Prairie of Texas.

Soil Profile: Tabler silt loam

A_1 0-10" Dark-gray (10YR 4/1; 3/1, moist) silt loam; moderate medium granular; friable; medium acid; grades indistinctly to horizon beneath. 6 to 12 inches thick.

A_2 10-12" Similar to horizon 1 except that aggregates are faintly coated with indistinct films of gray or light gray; passes shortly to horizon beneath. 0 to 4 inches thick.

B_2 12-30" Very dark gray (10YR 3/1; 2/1, moist) heavy clay; weak coarse blocky; very firm and compact; extremely hard when dry; very slowly permeable when moist; aggregates are varnished or coated with shiny films; grades indistinctly to horizon beneath; medium acid above becoming neutral below. 15 to 25 inches thick

B_3 30-50" Dark-gray (10YR 4/1.5; 3/2, moist) heavy clay; nearly massive; very compact; slightly mottled with brown and yellowish brown; fine earth is noncalcareous but horizon contains scattered hard concretions of $CaCO_3$, which have pitted or "solution" surfaces; mildly alkaline. 12 to 20 inches thick.

C_1 50-70" Brown (7.5YR 4/2) noncalcareous or weakly calcareous clay slightly mottled or streaked with grayish and reddish brown; contains a few very dark brown ferruginous concretions and films; grades indistinctly to layer beneath; alkaline. 15 to 25 inches thick.

C_2 Substrata of various characters, alternatively (a) yellowish-red or other colored, slightly calcareous, more or less clayey alluvium; (b) silty earths that may be loess or altered loess, (c) partly weathered clayey red beds or other colored shale or clay.

Range in Characteristics: Types range from fine sandy loam to clay loam; color of surface soil ranges from gray to dark gray and dark grayish brown, the clay loam type being the darkest; color of B_2 horizon ranges from dark gray to dark grayish brown and black; mottling in horizon 4 includes grays, yellowish browns, and reddish browns. A close relative with less dark, lighter gray surface soil and a more extreme A_2, which probably deserves recognition as a separate series, occupies concave more poorly drained surfaces but to date has been included in the areas mapped as Tabler.

Page 2--Tabler Series

Topography: Level upland or high terrace; plane surfaces.

Drainage: Very slow from the surface and internally; adequate for crop production and generally for good yields.

Vegetation: Prairie grasses; a few scattered trees occur in some marginal areas.

Use: Largely in cultivation and devoted mainly to wheat, oats, and sorghums; yields of small grains are high; a few areas are native meadow.

Distribution: Extensive in central Oklahoma; inextensive in central and northcentral Texas.

Type Location: Grant County, Oklahoma; large area extending east from Renfrow to Noble County line.

Series Established: Grady County (Little Washita Project), Oklahoma, 1939.

Remarks: Prior to 1939 the Tabler soils were included in the Oswego series. The series name is from a village in Grady County, Oklahoma.

Colors are described with approximate provisional Soil Survey color names and refer to dry soil.

Rev. EHT: 3-6-48
Mimeo. -1957

National Cooperative Soil Survey
USA

Established Series

TALIHINA SERIES

The Talihina series comprises olive-gray noncalcareous Lithosols on noncalcareous olive and gray shales in the eastern part of the Reddish Prairie soils zone. The principal associated series are Eram, a medium-depth soil developed on like material; Hanceville, a shallow stony soil with reddish subsoil over sandstone; and Hector, a grayish-brown Lithosol over sandstone.

Soil Profile: Talihina clay loam

A	0-10"	Olive-gray (5Y 4/2; 3/3, moist) clay loam or silty clay loam; weakly granular; crumbly and friable when moist; moderately sticky and plastic when wet; contains a few to numerous small fragments of shale and siltstone; the surface 3 to 4 inches is slightly darker than the lower part neutral to slightly acid. 5 to 15 inches thick.
C	10"+	Olive (5Y 5/4; 4/5, moist) slightly weathered shale with laminea of brown or light gray clay or silty shale; alkaline to neutral but weakly calcareous at variable depths.

Range in Characteristics: The types range from loams to clays, and some are stony; color of the surface soil ranges from dark grayish-brown to olive-gray or olive; content of shale and siltstone fragments ranges from about 5 to 25 percent of the soil mass; shale outcrops and some sandstone fragments on the surface are common in the more sloping areas.

Topography: Gently to strongly erosional upland with gradients dominantly of 3 to 8 percent.

Drainage: Moderate to rapid from the surface; very slow or lacking internally.

Vegetation: Mainly coarse prairie grasses but some areas have a scattered to moderately thick cover of elm, blackjack, haw, persimmon, and hickory trees.

Use: Native pasture of relatively low carrying capacity and grazed mainly by cattle and some sheep; the pasturage is of relatively low nutritive quality unless fertilizers are used.

Distribution: Prairies underlain by shale and sandstone in eastern and northeastern Oklahoma and adjoining parts of Kansas, Missouri, and Arkansas; moderately extensive.

Type Location: LeFlore County, Oklahoma; NW 1/4 Section 22, T8N, R25E.

Series Established: LeFlore County, Oklahoma, 1931.

EGF
2-19-38
Rev. HO:EHT
5-6-48

Division of Soil Survey
Bureau of Plant Industry, Soils, and Agricultural Engineering
Agricultural Research Administration
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Established Series

TALOKA SERIES

The Taloka series consists of moderately dark claypan Planosols similar to the Parsons soils, but having thicker A_1 and A_2 horizons over the claypan, which lies 16 to 40 inches below the surface. It is developed mainly from old loess or alluvium within the Cherokee Prairies of eastern Oklahoma and adjoining states. Cherokee soils which are more poorly drained from Taloka soils have grayer and thinner A horizons and a grayer claypan generally with 16 inches of the surface. The Choteau series with a B horizon of medium to light clay loam gradationally overlain by a very thick A horizon is the counterpart of the Taloka series. Taloka soils differ from Inola soils in having thicker A horizons and nongravelly substrata.

Soil Profile: Taloka silt loam--virgin

A_1 0-15" Grayish-brown (10YR 5/2) coarse silt loam; dark grayish brown (10YR 3.5/2) when moist; weak medium granular structure; very friable; medium to strongly acid; gradual boundary.

A_2 15-27" Very pale brown (10YR 6.5/3) coarse silt loam; pale brown (10YR 5/3) when moist; porous massive structure; very friable; strongly acid; clear boundary.

B_2 27-45" Grayish-brown (10YR 5/2) compact silty clay, dark grayish brown (10YR 4/2) when moist; many with reddish-brown and yellowish-brown mottles; strong medium blocky structure; very firm; pronounced clay skins; medium acid in upper half, becoming slightly acid below; diffuse boundary.

B_3 45-80" Brown (10YR 5/3) heavy silty clay loam, dark brown (10YR 4/3) when moist; many coarse strong brown and some very pale brown mottles; moderate coarse blocky structure; coarsening and weakening with depth; very firm; fine roots and rootlet channels are moderately abundant; pH about neutral; diffuse boundary.

C 80-100"+ Coarsely mottled pale brown (10YR 6/3) and strong brown (7.5YR 5/6) silty clay loam; nearly massive structure; firm; pH neutral. This horizon is little different from the B_3, but has little structure and few if any roots or open rootlet channels. It represents considerably altered loess or silty alluvium.

Range in Characteristics: The A horizon is generally coarse silt loam or loam. The dry color of the A_1 horizon ranges from dark grayish-brown to grayish-brown; of the A_2 horizon, from very pale brown to pale brown often approaching light brownish-gray. Thickness of the A_1 horizon ranges between about 10 and 20 inches; of the A_2, between 5 and 25 inches; of the B_2, between 12 and 24 inches. The change from the A_2 to the claypan B_2 horizon occurs at depths varying between 16 and 40 inches and varies from a quite abrupt knife-edge contact to a transition as much as 3 inches thick. The base color of the B_2 horizon ranges from grayish-brown to brown; its mottling varies much in detail and often includes yellowish-red or reddish-brown but is everywhere pronounced. Ferruginous concretions, though few and fine in the A_1 horizon are present in all horizons and often abundant and pronounced in the lower horizons. Color of the C horizon varies from unmottled to much mottled, from dominantly very pale brown to dominantly yellowish-brown. The substrata remain noncalcareous to depths below 15 feet. They include weathered loess, alluvium or (where the Pleistocene mantle is thin and wholly within the solum) Pennsylvanian shales. Where not specified moist, the colors given refer to dry soil.

Topography: Gently undulating to nearly level upland. Surfaces generally broadly convex. Prevailing gradients of about 1/2 perhaps as much as 8%; rarely more than 3%.

Drainage and Permeability: Slow (rarely medium to rapid) from the surface; very slow internally. Any ground water table generally lies below 20 feet.

Vegetation: Tall-grass prairie or savannah.

Use: Largely in cultivation, mainly to small grains.

Distribution: Extensive on eolian-mantled uplands near the Arkansas and Canadian Rivers in eastern parts of Oklahoma having more than 35 inches of annual precipitation; some in extreme southeastern Kansas, western Arkansas, and southwestern Missouri.

Series Established: Okfuskee County, Oklahoma, 1940.

Type Location: Wagoner County, Oklahoma, 275 feet SSE of the intersection of Oklahoma Highway 2 and the north line of Section 2, T16N, R18E, some 4 miles southeast of Wagoner.

Remarks: The original concept of Taloka emphasized origin of the parent material (interpreted as old alluvium of streams that drain red beds), overlooked the prevalence of local loess, and neglected the distinction from Parsons on thickness of A horizon. However, both the original Taloka and the prevailing soil in all areas correlated as Taloka accord with this description.

EHT
Rev. 7-31-57

National Cooperative Soil Survey
USA

TALPA SERIES

The Talpa series is a member of the loamy, mixed, thermic family of Lithic Haplustolls. Typically these soils have sola consisting of grayish brown, calcareous, light clay loam A horizons less than 20 inches thick. They are underlain by limestone, having thin coatings of $CaCO_3$ on the top or in the partings.

Typifying Pedon: Talpa clay loam - native range (Colors are for dry soil unless otherwise noted).

A1 0-7" Grayish brown (10YR 5/2) light clay loam; very dark grayish brown (10YR 3/2) moist; weak very fine subangular blocky and granular structure; hard, firm; few earthworm casts and insect burrows; 15 percent by volume of limestone fragments; calcareous, moderately alkaline; abrupt irregular boundary.

R 7-10"+ Hard limestone, having discontinuous coating of reprecipitated $CaCO_3$, less than 1 inch thick, on the upper surface and in cracks and crevices. Limestone has a hardness of about 3 on Moh's scale.

Type Location: Coleman County, Texas; 2.2 miles south of Talpa on a dirt road and 1,100 feet southeast, 500 feet east of the Runnels-Coleman County line in pasture.

Range in Characteristics: Thickness of the A horizon is typically 7 inches; the most common range is between 5 and 12 inches; the maximum thickness is 20 inches. The dry color ranges from grayish brown through dark grayish brown and brown; hues are near 10YR. The texture of the soil material above bedrock ranges from medium clay loam or silty clay loam through medium loam; the clay content is less than 35 percent. In some pedons the A horizon has a medium grade of structure. It contains 10 to 35 percent by volume of coarse fragments, mainly of limestone and of size as large as of stones. Carbonate content is less than 40 percent of the whole soil, excluding fragments coarser than 3 inches (7.5 cm.). Thickness of the secondary $CaCO_3$ coatings on the limestone ranges from less than 1 inch to 3 inches, but continuous layers as much as one inch thick do not extend throughout a linear distance of 25 feet.

Competing Series and Their Differentiae: These are the Ector, Kimbrough, Sogn, and Tarrant series. Ector soils contain more than 35 percent coarse fragments by volume and more than 40 percent carbonates in the whole soil excluding fragments larger than 3 inches. Kimbrough soils have petrocalcric horizons that are continuous throughout linear distances of at least 25 feet and that are typically several feet thick over a lithic contact. Sogn soils have mean annual soil temperatures ranging from 8.3^{o} to 15^{o} C. (47^{o} to 59^{o} F.) Tarrant soils contain more than 35 percent clay in the control section.

Setting: Erosional uplands on marine limestone. Slopes range from 1 to 20 percent. The underlying limestones are commonly of Permian age. They are usually somewhat dolomitic, and they are commonly less than 15 feet thick between intervening layers of calcareous shales. The climate is warm-temperate subhumid. Mean annual precipitation is 18 to 35 inches, mean annual temperature is 60° to 67° F., and the annual Thornthwaite P-E index is 25 to 46.

Principal Associated Soils: These are the Kavett, Owens, and Valera series, all of which are fine-textured and are deeper than the Talpa soils.

Drainage and Permeability: Well drained. Surface runoff is rapid. Permeability is moderate. The water table is everywhere below 20 feet and mostly below 100 feet.

Use and Vegetation: All of the soil is in native range, mainly of short grasses, some midgrasses, many forbs and low-growing shrubs, and few or no trees.

Distribution and Extent: The Rolling Plains of west-central Texas. The soil is of moderate extent.

Series Established: Coleman County, Texas, 1967. The name is from the village near the type location.

Remarks: These soils would have been classified as Lithosols in the modified 1938 yearbook classification.

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USA

Established Series

TELLER SERIES

The Teller series comprises somewhat youthful brownish neutral to slightly acid soils with friable reddish subsoils developed on stream terraces in southeastern Oklahoma and adjoining areas from calcareous, loamy or silty, reddish alluvium or eolian earths that originated largely in subhumid plains and prairies underlain by red beds. The associated older soils of the uplands are largely Red and Yellow Podzolic soils, but some of the more western areas are in the Reddish Prairie soil zone. The principal series associated with Teller on stream terraces are Vanoss, Lonoke, Brewer, Bressie, Dougherty, and Stidham. Teller differs from Dougherty in having browner, less acid, generally somewhat more loamy A horizons with no light colored A_2 and represents a less advanced stage of development.

Soil Profile:		Teller very fine sandy loam	Range in Thickness
A	0-10"	Brown (7.5YR 4/2; 3/2, moist) very fine sandy loam; very friable; weakly granular; grades to B horizon through a 2- to 4-inch transition; neutral.	8-16"
B_2	10-35"	Reddish-brown (5YR 5/4; 4/6, moist) clay loam; moderately granular; friable; permeable; neutral to slightly acid.	8-24"
C_1	35-75"	Yellowish-red (5YR 5/6; 5/8, moist) clay loam; friable; neutral to mildly alkaline but noncalcareous.	25-100"
C	75"+	Reddish-yellow (5YR 6/6) calcareous clay loam.	

Range in Characteristics: Types range from silt loam to fine sandy loam; most typically, no horizon is more than slightly acid but in the easternmost areas the B horizon becomes moderately acid in places; B horizon ranges from reddish-brown to yellowish-red (hues of 5YR to 7.5YR) and from heavy loam to light silty clay; depth to calcareous material ranges from 4 to 10 feet.

Topography: Stream terraces, mostly on surfaces with less than 3% grade but sloping phases occur on escarpments; surfaces plane to convex.

Drainage: Free from the surface and internally.

Vegetation: Deciduous forest, mainly of post oak, blackjack, red oak, pecan, and hickory.

Use: Excepting the sloping phases on escarpments, practically all is in cultivation, mainly to cotton, corn, and some alfalfa; moderately fertile and very responsive to management.

Distribution: Terraces along the Red and Canadian Rivers and their tributaries in eastern Oklahoma, Louisiana, Arkansas, and northeastern Texas, moderately extensive.

Type Location: Johnston County, Oklahoma.

Series Established: Johnston County (Tishomingo Area), Oklahoma, 1906.

Remarks: Color names used are provisional Soil Survey color names (1946) and refer to dry soil.

EGF:WTC
5-24-38
Rev. EHT
1-14-47

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TISHOMINGO SERIES

The Tishomingo series comprises shallow to very shallow Reddish Prairie soils developed mainly from granite, but in places partly from associated schists and sandstones, in south-central Oklahoma and central Texas. Associated deeper soils are largely of the Pontotoc, Pedernales, and Harley series.

I. Soil Profile (Tishomingo sandy loam):

			Range in Thickness
1.	0-8"	Brown (7.5YR 5/2; dark-brown, 7.5YR 3/2, moist) sandy loam containing a large amount of fine gravel, 15 to 30% by volume, mainly of quartz crystals; very friable; slightly acid.	5-10"
2.	8-12"	Brown (7.5YR 5/4; 3/3, moist) sandy laom of same consistence and gravel content as horizon 1; medium acid; grades through a 1- to 3-inch transition to horizon below.	3-6"
3.	12-18"	Yellowish-red (5YR 5/6; 3/6, moist) fine gravelly clay loam; massive but porous; friable; very hard when dry; medium acid; the fine gravel is of slightly grounded quartz crystals and comprises 50 percent or more of the mass; the fine earth is largely clay.	2-12"
4.	18"	Partly weathered granite; medium acid.	

II. Range in Characteristics: Texture of surface soil is generally sandy loam, coarse sandy loam, or gravelly loam; color of the surface soil ranges from reddish-brown to brown; horizon 3 ranges in color from yellowish-red to reddish-brown and is absent in minor areas; thickness of solum ranges from 5 to 20 inches; depth to solid bedrock ranges from about 2 to 5 feet.

III. Topography: Undulating to gently rolling upland with gradients of about 1 to 5 %, dominantly 1 to 3 %.

IV. Drainage: Moderate to rapid from the surface; moderate internally.

V. Vegetation: Coarse prairie grasses; scattered blackjack and post oak are common and some mesquite, mexican persimmon, lotebush, and cacti occur in the Texas areas.

VI. Use: Mainly for grazing cattle and some sheep; the native range has moderate carrying capacity and affords grazing of excellent quality. Some small areas in which the soils are more than about 15 inches deep are used for growing sorghums, peanuts, peas, corn, vegetables, and fruits and are moderately productive when rainfall is adequate.

VII. Distribution: Granitic areas of south-central Oklahoma and central Texas.

Type location: Johnston County, Oklahoma; 6 4/10 mi. North of Tishomingo on Oklahoma Highway 99.

Series established: Tishomingo Area, Indian Territory, (part of Johnston County, Oklahoma) 1906.

VIII. Remarks: In early surveys the series included deep normal soils, shallow and moderately deep gravelly and stony soils, and Lithosols; the series as now defined includes only shallow to very shallow soils.

Colors are Provisional Soil Survey color names based on Munsell color charts and unless stated otherwise refer to dry soil.

WTC
7-8-38
Rev. HO-EHT
8-19-46

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TRAVIS SERIES

Travis soils occur as remnants of old alluvium near major streams. These soils are mostly on or near the crests of hills or small divides. They are associated with Windthorst soils which are similar except are less gravelly. Dougherty soils are more sandy in the A horizon and less clayey in the B2t.

Soil Profile: Travis fine sandy loam

A1	0-6"	Reddish-brown (5YR 5/3) gravelly fine sandy loam; dark reddish-brown (5YR 3/3) when moist; moderate fine granular; friable when moist, soft when dry; clear boundary pH of 6.0.
A2	6-14"	Reddish-yellow (5YR 6/6) gravelly fine sandy loam; yellowish-red (5YR 5/6) when moist; weak fine granular; very friable when moist, soft when dry; clear boundary pH 6.5.
B2t	14-40"	Red (2.5YR 4/6) gravelly clay, becoming sandy clay with depth; dark red (2.5YR 3/6) when moist; moderate medium blocky structure; very firm moist, extremely hard dry; gradual boundary pH 6.5.
C	40-52"	Light red (2.5YR 6/8) sandy clay loam mottled with reddish-yellow; red (2.5YR 5/8) when moist; very firm when moist; very hard when dry; this appears to be part of the Trinity formation pH 7.0.

Variations: The amount of large size gravel varies with some granitic gravel in places, mostly the gravel is quartzite. Colors in this profile are more red than some, many are more brown, hues 5YR and 7.5YR. Texture of B2t varies but all contains rather high clay content.

Inclusions: Windthorst, Dougherty, and Stephenville will be the major inclusions.

Topography: Erosional upland on convex slopes on the crest of small divides.

Drainage: Well to excessively drained.

Vegetation: Blackjack and post oak with a tall grass understory.

Use: Rangeland or improved pastures.

Distribution: Near major drainage areas.

Location: Center Section 19, T7S, R7E, Marshall County, Oklahoma.

3-62
DLB

TYLER SERIES

The Tyler series includes imperfectly (somewhat poorly) drained acid soils of the Gray-Brown Podzolic Region developed upon noncalcareous clays and silts washed from upland where the soil materials are largely weathered from shales and deposited under slack water conditions. They occur in association with Holston, Monongahela, and Zoar soils in West Virginia, Pennsylvania, Ohio, Western Maryland, Kentucky. Catena: Zoar-Tyler-Purdy-Blago.

Soil Profile: Tyler silt loam.

A_0	1-0"	Forest litter, ranging up to a total thickness of about 2 inches.
A_1	0-3"	Dark grayish-brown silt loam mixed with imperfectly decomposed organic matter; fine weak crumb structure; strongly acid. 2 to 3 inches thick.
A_2	3-8"	Yellowish-gray to gray thin platy silt loam; strongly acid. 4 to 6 inches thick.
B_1	8-15"	Weak yellow heavy silt loam; medium nuciform structure; strongly acid. 6 to 8 inches thick.
B_2	15-36"	Yellowish-gray silty clay mottled with yellow and brown. In many places the yellow materials constitute a sufficiently large proportion of the mass, to give it (when dry and mixed) a yellow color; medium nuciform structure; strongly acid. 18 to 24 inches thick.
C	36"+	Yellowish-gray mottled silty clay or clay; mottled with gray and rusty brown; having a small blocky structure; grading downward, at depths differing from place to place, to stratified or laminated silts and clays. Strongly acid.

Range in Characteristics: Chiefly, the color of third layer--which ranges from light gray to light grayish-yellow or pale yellow and mottled. In many places parent material is bedded clay; in others, thin sandy strata are interbedded with the silts and clays.

Topography: Level or very gently sloping terraces.

Drainage: Imperfect (somewhat poor). External, moderate to slow; internal, slow; owing partly to flat surface and partly to heavy texture of subsoil and substratum.

Vegetation: Natural hardwoods present; mainly, oak, beech, hickory, poplar.

Use: Mowing (timothy, red top, and alsike); to a limited extent for oats, wheat, and tilled crops.

Distribution: Pennsylvania, Ohio, Southern Indiana, West Virginia, and adjacent states.

Page 2--Tyler Series

Type Location: Athens County, Ohio.

Series Established: Tyler County, West Virginia.

Remarks: Color names are from Misc. Pub. 425 and are for moist soil materials.

WJL:MB 6-24-42
WJL Rev. 1-15-48

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VANN SERIES*

The Vann series consists of dark-colored poorly drained soil of alluvial bottoms in a few small prairie areas of the central and eastern parts of the county. Artificial drainage is difficult because of lack of lower land to serve as an outlet for the water. Some areas, however, can be drained by ditches, and are moderately productive. The soil as a whole is too wet for cultivated crops and is used for woodland pasture. The silt loam is the only type mapped in the county.

Vann silt loam--This inextensive soil of broad alluvial bottoms occurs in the central and eastern parts of the county, the principal area being 2 miles south of Clearview. It occupies low areas where surface and subsoil drainage are so slow that general crops are not always successful. A few areas have been drained by ditching and are moderately productive, but many of the lower areas are difficult to drain. The soil is used for woodland pasture, but it has a very low carrying capacity because it is usually too wet for pasture. Natural vegetation is principally water elm, oak, and bois d'arc, with some undergrowth of sedges and water grasses.

The surface soil to a depth of 6 to 10 inches is dark-gray silt loam. The subsoil is dark-gray or silty clay loam mottled with brown. Below a depth of 24 or 30 inches this grades into gray or grayish-yellow silt loam mottled with brown. Soil and subsoil are about neutral in reaction.

Small areas of Vann clay and Vann silty clay loam occur but are not sufficiently important to be shown separately on the soil map.

*Taken from the Okfuskee County Soil Survey

Established Series

VANOSS SERIES

The Vanoss series comprises deep, well-drained, somewhat youthful Reddish Prairie soils developed in friable, alkaline, usually reddish, eolian or alluvial silty or loamy Pleistocene or Recent, sediments that are relatively high in weatherable minerals. The Vanoss series is less reddish than Teller and Norge, and has more friable permeable subsoils containing less clay than those of Bethany, Taloka, and Calumet and heavier subsoils than the often associated youthful Minco soils. Newkirk is a close relative of Vanoss, which is slightly more acid in reaction, has a layer of heavy clay between depths of about 3 and 7 feet, and comprises older or more weathered soils of somewhat lower inherent fertility. Vanoss differs from Lonoke in having less reddish lower subsoils and occurrence under somewhat drier climate in areas situated well above overflow.

Soil Profile:		Vanoss silt loam	Range in Thickness
A_1	0-15"	Grayish-brown (10YR 4/2; 3/2, moist) silt loam, moderate to strong medium granular; friable; grades into horizon 2; about neutral.	10-20"
B_2	15-30"	Brown (7.5YR 5/3; 4/3; moist) silty clay loam; strong coarse granular; friable; about neutral.	10-20"
B_3	30-45"	Brown (10YR 5/3; 4/3, moist) silty clay loam faintly mottled with about 5% of reddish yellow; friable to firm; contains a few black ferromagnesian (?) concretions; alkaline.	10-20"
C_1	45-70"	Light yellowish-brown (10YR 6/4) silty clay loam; friable to firm; alkaline; contains a few black ferromagnesian concretions.	18-30"
C	70"+	Yellowish-red (5YR 5/6) sandy clay; alkaline.	

Range in Characteristics: Types range from silt loam to fine sandy loam; color of surface soil ranges from brown to grayish-brown and dark grayish-brown, and reaction, from slightly acid to mildly alkaline; subsoil ranges from brown to yellowish-brown (hues of 7.5YR to 10YR) in color and from silty clay loam to sandy clay loam in texture; the substrata are calcareous in some areas but noncalcareous though alkaline in others and range from red unstratified silts in some areas of undulating upland to stratified, somewhat sandy, often yellowish alluvial sediments in areas on low terraces.

Topography: Nearly level areas in mantled erosional upland or on alluvial terraces lying above overflow; surfaces plane to weakly convex.

Drainage: Slow from the surface; free internally; very favorable for crops.

Vegetation: Tall grasses in most areas; some areas on low terraces are forested.

Use: Practically all in cultivation to cotton, alfalfa, corn, sorghums, and small grains; inherently fertile, very responsive to management, and highly productive.

Distribution: Central Oklahoma and Texas adjacent to the Brazos, Red, and Canadian and other rivers that drain subhumid plains partly underlain by Red Beds; mostly in high areas, some erosional upland and other old stream terraces, that appear to be mantled with loess; some areas occur on stream terraces only a few feet above overflow; moderately extensive.

Type Location: Cleveland County, Oklahoma; 5 miles west of Moore at SE corner Section 14, T10N, R4W.

Series Established: Pontotoc County, Oklahoma, 1936.

Remarks: The series name is from a village in Pontotoc County, Oklahoma. The soils indicated as Vanoss in the area where the series originated are slowly drained acid soils with compact subsoils and are now classed as other series.

Colors are described with provisional Soil Survey color names (1946) and unless stated otherwise, refer to dry soil.

WTC:MB
4/12/39
Rev. EHT:HO
9/3/46
Rev. EHT
1/6/47

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Established Series

VERDIGRIS SERIES

The Verdigris series consists of relatively well-drained, acid, loamy chernozemic Alluvial soils in flood plains of streams that drain the shale and sandstone prairies. The subsoil ranges from silt loam to clay loam. The Verdigris soils are less rapidly drained, less sandy, and slightly less brown than the Cleora soils, less dark and better drained than the Osage soils, and darker, less mottled and better drained than the Lightning soils. The Mason series is the more developed counterpart of the Verdigris series. It is found on rarely inundated low terraces and has a more distinct A_1 horizon with an obvious decrease of darkening at about 20 inches.

Soil Profile: Verdigris silt loam

A_1 0-15" Dark grayish-brown (10YR 4/2) silt loam, very dark grayish-brown (10YR 3/2) when moist; weak medium granular structure; friable; medium acid; gradual boundary.

AC 15-30" Grayish-brown (10YR 5/2) silt loam, dark grayish-brown (10YR 3.5/2) when moist; porous massive or very weak subangular blocky structure; friable; contains erratic layers of light clay loam that represents slightly more clayey strata; worm casts and root channels numerous; medium acid; gradual boundary.

C 30-70"+ Pale brown (10YR 6/2.5) silt loam; brown (10YR 4/3) when moist; stratified with clay loam; friable; relatively porous and permeable; medium acid.

Range in Characteristics: The texture of subsoil ranges from silt loam to clay loam or silty clay loam with the percentage of clay usually between 20 and 35. Color of A horizon ranges around dark grayish-brown (hue mostly 10YR; dry values of 3.5 to 3.0 to 5.5, moist values of 2.5 to 3.5; chroma 1.5 to 2.5) being darkest in the clay loam type. The less well-drained areas somewhat gradational to the Osage or Lightning soils the subsoil and substrata become slightly mottled with browner and grayer shades. Thickness of the A_1 and AC range between about two-thirds and one-and-one-half of those in the representative profile. Except where specified moist, the colors refer to dry soil.

Topography: Nearly level flood plain.

Drainage and Permeability: Good or moderately good. Surface runoff slow; internal drainage, medium or moderately rapid. The water table generally lies below 10 feet. Soils are occasionally to frequently flooded.

Vegetation: Deciduous lowland forest consisting of oaks, elm, ash, and pecan. There is a considerable understory of grass in westernmost areas.

Use: Mostly cropland devoted primarily to corn, alfalfa, and small grains. The more frequently flooded areas are mostly pastured woodland.

Distribution: Extensive in eastern Kansas and Oklahoma; considerable in southwestern Missouri; and some in Arkansas. This is the dominant soil series in flood plains of streams that drain the Cherokee Prairies. Its total area is of the order of a half-million acres. Occurs under mean annual precipitation of 35 to 45 inches. The divide between the Marias des Cynges and the Kaw or Missouri Rivers forms a convenient geographic boundary between the Verdigris soils and such related series as Kennebec and Hobbs, which are in alluvium mainly from loess or till. To the south, the Ouachita-Arbuckle uplift separates the area of occurrence from that of Gowen series.

Series Established: Montgomery County, Kansas, 1913. The series name is from the Verdigris River.

Type Location: Labette County, Kansas.

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National Cooperative Soil Survey
USA

VERNON SERIES

The Vernon series is a member of the fine, mixed, thermic family of Typic Ustochrepts. These soils have reddish brown, calcareous, clayey A horizon over blocky B horizons which grade into C horizons of massive clays.

Typifying Pedon: Vernon clay - cultivated
(Colors are for dry soil unless otherwise noted).

Ap	0-6"	Reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; medium blocky structure; very hard, very firm, very sticky and plastic; contains few strongly cemented $CaCO_3$ concretions 2 to 4 mm. in diameter; calcareous; moderately alkaline; abrupt smooth boundary. (0 to 10 inches thick.)
B	8-21"	Red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; weak medium blocky structure; very hard, very firm, very sticky and plastic; contains few weakly and strongly cemented $CaCO_3$ concretions 2 to 4 mm. in diameter; calcareous; moderately alkaline; diffuse smooth boundary. (10 to 20 inches thick.)
C	21-45"+	Dark red (2.5YR 3/6) clay, dark red (2.5YR 3/6) moist; massive; very hard, firm, very sticky and plastic; contains a few seams and pockets of greenish-gray shaly clay; contains a few weakly and strongly cemented $CaCO_3$ concretions; calcareous; moderately alkaline.

Type Location: Wilbarger County, Texas. In cultivated field 200 feet east of abandoned county road, 0.25 mile south of F.M. road 925, which point is 0.4 mile northeast of the Pease River highway bridge via F.M. Road 925 and U.S. Highway 287.

Range in Characteristics: Thickness of the solum varies from 14 to 30 inches. The mineralogy is mixed. Mean annual soil temperatures at 20-inch depth range from 59° to 70° F. In most years these soils are dry in some subhorizon between 4 and 12 inches for more than 90 cumulative days but are not continuously dry for as long as 60 consecutive days. Texture of the A and B horizons ranges from heavy clay loam to clay with a clay content of 35 to about 50 percent. The A horizon, or after the upper 7 inches are mixed, ranges from reddish brown to brown or red in hues of 2.5YR through 7.5YR, dry values of 4 and 5, moist values of 3 and 4, and chromas of 2 through 5. The A horizon is less than 1/3 the thickness of the solum, or the organic matter content is less than 1 percent if the moist values and chromas are less than 3.5. In some pedons the upper few inches of the A horizon are noncalcareous. Structure of the A horizon ranges from weak platy to moderate fine to medium blocky. The B horizon, when dry, ranges from red to strong brown with values of 3.5 through 5 and chromas of 3 and 4 in hues of 2.5YR through 7.5YR. Structure ranges from fine to medium blocky. Accumulations of $CaCO_3$ in the B horizon range from few strongly cemented $CaCO_3$ concretions to barely visible weakly and strongly cemented concretions and powdery masses to about 5 percent by volume, but the horizon contains less than 5 percent more than the underlying horizon. The C horizon is red to strong brown clay grading into shaly clays or weakly consolidated shales.

Page 2--Vernon Series

Competing Series and Their Differentiae: These include the Owens, Point Isabel, Quinlan, Stamford, Treadway, and Weymouth soils. Owens and Quinlan soils have sola less than 20 inches deep. Point Isabel soils have mean annual soil temperatures at 20-inch depth greater than 72° F. Stamford and Treadway soils, when dry, have cracks at least 1 cm. wide and 12 inches depth. Weymouth soils have 18 to 35 percent clay in the control section.

Setting: The Vernon soils mainly occupy gently sloping to steep areas, with slopes of about 2 to 20 percent. Soil areas are broad sloping areas or narrow footslope exposures. The regolith consists of clayey soil apparently formed from shales and clays of the Permian or Triassic geologic periods. The climate is dry subhumid, the rainfall is 22 to 40 inches, the P-E indices 33 to 64, and the mean annual air temperature 57° to 68° F.

Principal Associated Soils: These include the competing Weymouth and Owens soils, and the Wichita and Tillman soils. Tillman and Wichita soils have illuvial horizons of clay accumulation.

Drainage and Permeability: Well drained; runoff is rapid. Slowly permeable.

Use and Vegetation: Mainly as rangeland, consisting of short-grasses, mainly buffalograss, blue grama, hairy grama and tobosa, with little bluestem and sideoats grama in more humid areas. Minor areas are cultivated to cotton and grain sorghums.

Distribution and Extent: West central Texas and southwestern Oklahoma. Vernon soils are of moderate extent.

Series Established: Wilbarger County (Vernon Area), Texas 1902.

Remarks: In some published soil surveys the Vernon soils were classified as clayey Lithosols.

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USA

WAURIKA SERIES

The Waurika series comprises deep, moderately dark Planosols developed on nearly level upland or terrace from clay loam to clay sediments. It is characterized by a moderately dark A_1 horizon and a thin but distinct A_2 horizon abruptly underlain by a B horizon of dense clay. The associated Tabler and Kirkland series lack the A_2 horizon. The Parsons series is more acid and without an horizon of carbonate accumulation. The Waurika series is of limited extent and minor agricultural importance.

Soil Profile: Waurika silt loam

A_1 0-10" Dark grayish brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) moist; weak fine granular structure; friable; few fine roots; few worm casts; about neutral; gradual lower boundary. 7 to 12 inches thick.

A_2 10-12" Light brownish gray (10YR 6/2) silt loam; dark grayish brown (10YR 4/2) moist; structureless; friable; neutral; abrupt wavy lower boundary. 1 to 5 inches thick.

B_{21} 12-32" Dark grayish brown (10YR 4/2) clay; very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; very hard; very firm; distinct continuous clay films; neutral; gradual lower boundary. 15 to 25 inches thick.

B_{3ca} 32-57" Grayish brown (10YR 5/2) silty clay loam; dark grayish brown (10YR 4/2) when moist; weak medium blocky structure; very hard; firm many $CaCO_3$ concretions (about 3% of volume); few scattered ferruginous concretions; weakly calcareous; mildly alkaline; gradual lower boundary. 20 to 30 inches thick.

C 57-72"+ Light gray (10YR 7/2) clay loam coarsely streaked and mottled with yellowish red; massive; very hard; firm; calcareous.

Range in Characteristics: Silt loam is the only type recognized to date. The color of the A_1 horizon ranges between hues of 7.5YR to 2.5Y, dry values of 3/ to 4/, moist values 2/ to 3/, and chromas of /1 to /2. Depth to the clay B_2 horizon ranges between about 8 to 16 inches and averages about 12. The color of the B_2 horizon ranges between hues of 7.5YR to 2.5Y, dry values 3/ to 5/, moist values of 2.5/ to 3.5/, and chromas of /1 to /2. Colors refer to dry soil unless specified otherwise.

Topography: Nearly level upland or terrace, generally on weakly concave surfaces.

Drainage and Permeability: Very slow from the surface and internally.

Vegetation: Short and mid grasses.

Use: Mostly in cultivation to small grains, cotton, and sorghums. These soils are somewhat droughty and low producing.

Distribution: Central Oklahoma and probably northern Texas. The areas to date identified are in the warm-temperate moist-subhumid Reddish Prairies underlain by reddish somewhat saline clays of Permian age. The probable total extent is less than 50,000 acres.

Type Location: Cotton County, Oklahoma; 1 mile south and 3 miles east of Temple at the NE corner of Sec. 31, T3S, R9W.

Series Established: Jefferson County, Oklahoma, 1961. (The name is from the county seat).

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Rev. HTO-WJR-EHT
11-21-61

Reproduced by Materials Research Branch, OHD, December 27, 1961.

WINDTHORST SERIES

The Windthorst series is a member of the fine, mixed, thermic family of Ultic Paleustalfs. They have brownish loamy A horizons and calyey Bt horizons of red grading to mottled red, strong brown and reddish yellow which overlie massive clays or sandy materials.

Typifying Pedon: Windthorst fine sandy loam - open canopied forest or savannah (Colors are for dry soil unless otherwise noted.)

A1 0-4" Grayish brown (10YR 5/2) fine sandy loam; very dark grayish brown (10YR 3/2) moist; weak subangular blocky and weak granular structure; soft, very friable; slightly acid; clear smooth boundary. (2 to 7 inches thick.)

A2 4-10" Light yellowish brown (10YR 6/4) fine sandy loam; yellowish brown (10YR 5/4) moist; structureless; soft, very friable; slightly acid; abrupt smooth boundary. (2 to 12 inches thick.)

B21t 10-18" Red (2.5YR 4/6) sandy clay, red (2.5YR 4/6) moist; strong fine and medium blocky structure; extremely hard, very firm; nearly continuous clay films on most ped faces; medium acid; gradual smooth boundary. (4 to 18 inches thick.)

B22t 18-38" Yellowish red (5YR 5/6) heavy sandy clay, yellowish red (5YR 4/6) moist, with many medium faint mottles of strong brown and medium distinct brownish yellow; moderate coarse blocky structure; extremely hard, very firm; ped faces have common discontinuous clay films; medium acid; gradual wavy boundary. (6 to 22 inches thick.)

C1 38-50" Coarsely and prominently mottled red (2.5YR 4/8) yellowish brown (10YR 5/8) and pale brown (10YR 6/3) sandy clay, with thin lenses and pockets of sandy loam; massive; extremely hard, very firm; slightly acid; gradual boundary. (5 to 18 inches thick.)

C2 50-60"+ Light gray clay, with prominent coarse mottles of red and yellow; massive; slightly acid.

Type Location: Parker County, Texas. In wooded pasture 150 feet north of U.S. Highway 80, this point being 800 feet southwest of the junction with the Dennis road and 5.2 miles southwest of the Parker County Courthouse in Weatherford via U. S. Highway 80.

Range in Characteristics: Thickness of solum ranges from 35 to 70 inches. Average annual soil temperatures ranges from 64° to 68° F. The clays, from the surface to the base of the fine-textured argillic horizon, are not dominated by any one kind of clay. These soils are usually moist but are dry in some part between 10 and 40 inches for 90 to 135 cumulative days during most years. Color of the A1 horizon ranges from dark grayish brown to light yellowish brown in hues of 10YR to 2.5Y, with dry values of 4 to 5 chromas of 2 to 4. The dry color of the A2 horizon is 1 to 2 units of chromas higher than the A1 horizon. Texture of the A horizon dominantly is fine sandy loam, but ranges to loamy sand and loam; reaction ranges from slightly acid to neutral. Base saturation ranges between 35 and 80 percent, by sum of cations, in at least the lower part of the Bt horizon. The dry color of the B21t horizon ranges from dark reddish brown to yellowish red in 2.5YR to 5YR hues with values of 3 to 5 and chromas of 4 to 6. In pedons having hues of 2.5YR, the moist values are at least 4. Texture of the B21t horizon ranges from sandy clay to clay loam with clay contents of 35 to about 50 percent. Structure of the B21t horizon ranges from compound strong medium to coarse angular blocky breaking to medium or fine subangular blocky to strong coarse angular blocky; in pedons where the clay content is less than 40 percent, structure is restricted to moderate and strong grades of angular blocky. Reaction ranges from slightly acid to medium acid. Color of the B22t horizon ranges from faintly mottled to prominently mottled red, yellow and pale brown in hues of 2.5YR to 10YR. Texture ranges from clay to sandy clay loam with clay contents of 25 to about 50 percent and in some pedons becomes less clayey in the lower part. Clay content of the upper 20 inches of the Bt horizon is more than 35 percent. Structure of the B22t horizon is strong blocky to massive; reaction ranges from slightly to medium acid. The C horizon varies from massive clay to sandy clay loam or fine sandy loam.

Competing Series and Their Differentiae: These include the Travis series of the same family; the Axtell, Chaney, Hortman and Truce series of the same great group; and the Bonti and Pedernales series of the same suborder. Travis soils are unmottled to a depth of at least 36 inches. The Axtell, Chaney and Hortman soils have low chroma mottles denoting wetness in the Bt horizons. Truce soils have base saturation of more than 80 percent in all parts of the Bt horizon. Bonti and Pedernales soils lack the abrupt boundaries between the A and Bt horizons; in addition, Bonti soils are less than 40 inches thick, and Pedernales soils are dry in some part between 10 and 40 inches depth for more than 135 cumulative days in most years.

Setting: The Windthorst soils occur in broad gently sloping erosional uplands. Slopes are convex and range from 1 to 8 percent but are dominantly from 3 to 5 percent. Some of the steeper areas are dissected by gullies. The regolith consists of packsands, massive clays and loamy materials of the lower cretaceous. Limestone underlies the soil in some pedons. The climate is dry subhumid. The mean annual precipitation ranges from 25 to 33 inches, the mean annual temperature from 64 to 69.6^{o} F, and the Thornthwaite annual P-E indices from 34 to 52.

Principal Associated Soils: These include the Duffau, Nimrod and Selden soils. These soils have Bt horizons with less than 35 percent clay; in addition, Nimrod and Selden soils have low chroma mottles in the Bt horizons, denoting wetness.

Drainage and Permeability: Moderately well drained. Surface runoff is moderate to rapid, moderately slow internal drainage and permeability.

Use and Vegetation: Most of the less sloping areas are cultivated; peanuts, sorghums and small grains are the main crops. Many steep areas have gullied and are now in pasture. Native vegetation is a stand of postoak and blackjack oak trees with an understory of little bluestem, greenbriars and annual grasses.

Distribution and Extent: North central Texas and south central Oklahoma, Extensive.

Series Established: Archer County, Texas, 1912.

Remarks: Windthorst soils were placed in the Red-Yellow Podsolic soils in the 1938 classification system. Laboratory data is given in soil survey lab memo no. 2 (profile #43).

National Cooperative Soil Survey
USA

WOODSON SERIES

The Woodson series comprises planosolic Brunizems developed over olive to gray alkaline and usually mildly calcareous shale or clay. The A horizon is darker than in the Parsons, Taloka, and Cherokee series and is without an evident, lighter colored A2 horizon; the upper B2 horizon is darker, less mottled and generally somewhat less acid than in those series. The clear boundary between the A and B horizons (with less than a 2-inch transition) together with less brownish color of the B2 horizon distinguish the Woodson from the closely related Okemah series. The Woodson series closely resembles the Wilson series of more southern localities having higher temperatures but has a somewhat more granular A horizon containing about twice as much organic matter. The Woodson series is of moderate extent and agricultural importance.

Soil Profile: Woodson silt loam

A1 0-9" Dark gray (10YR 4/1) heavy silt loam; very dark gray (10YR 3/1) moist; moderate medium granular structure; hard, friable; medium acid; clear boundary. 7 to 14 inches thick.

B21 9-24" Dark gray (10YR 4/1) silty clay; very dark gray (10YR 3/1) moist; weak fine blocky structure; extremely hard; very firm; compact with few visible pores or voids; shiny surfaces on peds, few fine black concretions; slightly acid; diffuse boundary. 10 to 20 inches thick.

B22 24-33" Gray (10YR 5/1) silty clay with few fine distinct mottles of olive brown; very dark gray (10YR 3/1) moist; weak fine blocky structure, extremely hard; very firm; shiny surfaces on peds; common fine black concretions; about neutral; diffuse boundary. 7 to 14 inches thick.

B3 33-44" Gray (2.5Y 6/1) silty clay with common distinct mottles of olive yellow; dark gray (2.5Y 4/1) moist; massive; extremely hard; very firm; common fine black concretions; few $CaCO_3$ concretions; few nests of gypsum; mildly alkaline; diffuse boundary. 8 to 20 inches thick.

C 44-60"+ Gray (2.5Y 6/1) silty clay with many distinct mottles of brownish-yellow; gray (2.5Y 5/1) moist; massive; extremely hard; very firm; common fine black concretions and coarse $CaCO_3$ concretions; mildly alkaline.

Range in Characteristics: Silt loam is the more extensive type but considerable areas of silty clay loam also occur. The color of the A and upper B horizon ranges from dry values of 3 through 5, moist values of 2 through 3, and chromas of 0.5 through 1.5 in hues of 10YR to 2.5Y inclusive. The color of the lower B horizon ranges from dry values of 4 through 6, moist values of 3 through 4, and chromas of 0.5 through 1.5 in hues of 10YR to 5Y, inclusive. The color of the C horizon is mottled gray and brown or yellowish-brown. The upper B horizon may be faintly mottled. The lower B horizon is distinctly mottled. The lower part of the A horizon may have gray or light gray ped coatings. Colors are for dry conditions unless specified moist.

Topography: Level to very gently sloping upland or alluvial terrace. The surface gradient ranges from 0 to 3 per cent but is mostly less than 1 per cent.

Drainage and Permeability: Moderately well to somewhat poorly (imperfectly) drained. Runoff is slow. Permeability is very slow.

Vegetation: Originally tall-grass prairie.

Use: Mostly cultivated with small grains as the principal crops; some native meadow and pasture.

Distribution: Eastern Kansas, eastern Oklahoma north of Arbuckle uplift, and southwestern Missouri.

Type Location: Allen County, Kansas; 1500 feet west and 100 feet north of the SE corner of Section 26, T24S, R20E; 1/2 mile north of Moran.

Series Established: Neosho County, Kansas, 1930. (Name is from Woodson County).

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National Cooperative Soil Survey
USA

Approved by Principal Soil Correlator
South Region TSC: 7/5/66

Established Series
Rev. JDN-HLM: 6/28/66

YAHOLA SERIES

The Yahola series is a member of a coarse-loamy, mixed, calcareous, thermic, family of Typic Ustifluvents. Yahola soils have moderately coarse textured A horizons and reddish to brownish, moderately coarse textured subsurface horizons that lack soil structure.

Typifying Pedon: Yahola fine sandy loam - cultivated
(Colors refer to dry soil unless otherwise noted.)

A1 0-11" Reddish brown (5YR 5/4) find sandy loam; reddish brown (5YR 4/4) moist; weak fine granular structure; soft; very friable; the upper 6 inches is a plowed horizon and does not differ noticeably from the lower part of the horizon; calcareous; gradual smooth boundary. 4 to 20 inches thick.

C1 11-40 Reddish yellow (5YR 6/6 fine sandy loam; yellowish red (5YR 5/6) moist; massive; slightly hard; very friable; thin strata of loamy fine sand and silt loam in the lower part; calcareous; gradual boundary. 10 to 30 inches thick.

C2 40-56" Reddish brown (5YR 6/4) light loam; reddish brown (5YR 4/4) moist; weak fine granular structure; slightly hard; friable; calcareous; gradual boundary. 0 to 30 inches thick.

C3 56-72" Yellowish red (5YR 5/6) fine sandy loam with thin strata of loamy fine sand to clay loam; yellowish red (5YR 4/6) moist; massive; slightly hard; very friable; calcareous.

Type Location: Jefferson County, Oklahoma; approximately 4 miles west and 8½ miles south of Waurika. About 2000 feet north and 20C feet east of the southwest corner of Section 18-T6S-R8W.

Range in Characteristics: These soils are usually moist but are dry in some part of the upper 40 inches for more than 90 days (cumulative) in most years. These soils are calcareous in all parts of the fine earth fraction between 10 and 20 inches and are generally calcareous to the surface. These soils have bedding planes within 50 inches of the surface and have erratic particle size and organic matter distribution with depth. The color of the surface horizon ranges in value from 4 to 7 when dry and 3 to 5 when moist in chromas of 2 to 6 in hues of 2.5YR to 10YR. When the color value is less than 5.5 when dry and 3.5 when moist in chromas of 4 or less and the horizon is more than 10 inches thick, the organic matter content is less than 1 percent. The texture of the surfact horizon is mainly fine sandy loam but loamy fine sands to loams are common and lesser amounts of finer textures occur. The color value of the 10 to 40 inch control section ranges from 5 to 7 when dry and 4 to 6 when moist in chromas of 3 to 8 in hues of 2.5YR to 10YR. Darker colored, buried horizons may or may not be present. The texture of the 10 to 40 inch control section ranges from about 5 to less than 18 percent clay, has more than 15 percent material coarser than very fine sand and is finer than loamy fine sand. Texture classes average mainly fine sandy loams but light loams, very fine sandy loams or loamy very fine sands occur. This section is typically stratified with coarser or finer soil material. The C horizons are structureless. Textures averaging coarser, or less commonly finer, than those given for the control section may occur below 40 inches.

Competing Series and Their Differentiae: These include Canadian, Cleora, Colorado, Guadalupe, Pulaski, Reinach, and Zavala soils. The Canadian, Cleora and Reinach soils have A1 horizons more than 10 inches thick that have dry color values less than 5.5 and moist color values less than 3.5, in chromas of 4 or less and have organic matter contents higher than 1 percent. The Colorado soils have more than 18 percent clay in the 10 to 40 inch section. The Pulaski soils are neutral to medium acid in the 10 to 40 inch section. The Zavala soils are noncalcareous and have average annual soil temperatures greater than 71.6° F. The Guadalupe soils are characterized by subsurface colors that are yellower than 7.5YR hues.

Setting: These soils occur on nearly level floodplains along creeks and rivers. They are of slightly altered, moderately coarse textured, calcareous sediments. The Thornthwaite annual P-E index is from about 33 to 64. The mean annual air temperature is from about 57 to 70°F. Most areas not protected by dams or levees flood about once in 1 to 15 years.

Principal Associated Soils: These include Brazos, Crevasse, Lincoln, Port, and Miller as well as the competing Reinach and Canadian soils. The Brazos, Crevasse, and Lincoln soils have textures of loamy fine sand or coarser in the 10 to 40 inch section, the Port soils have control sections with more than 18 percent clay in the 10 to 40 inch section, and the Miller soils have fine textures in the 10 to 40 inch section.

Drainage and Permeability: Well drained. Moderately rapid permeability. Slow runoff.

Use and Vegetation: Dominantly used for cultivated crops of alfalfa, cotton, small grains, and sorghums. The native vegetation is bottomland hardwoods with cottonwood predominant in the western part of the range and elm, pecan, and cottonwood in the eastern part.

Distribution and Extent: Along streams in central Oklahoma and Texas and in South Central Kansas. The series is extensive.

Series Established: Muskogee County, Oklahoma, 1913.

Remarks: The Yahola soils were formerly classified in the Alluvial Great Soil Group.

National Cooperative Soil Survey
USA

Established Series

ZANEIS SERIES

The Zaneis series comprises Reddish Prairie soils with subsoils of red or reddish-brown granular clay or silty clay developed over noncalcareous or weakly calcareous red beds. The subsoils are less compact and more permeable than those of Renfrow soils but heavier than those of Grant. Associated Lithosols are the Vernon soils; associated Planosols are the Kirkland and Tabler soils. The Reddish Chestnut correlative of Zaneis is *Girard.

Soil Profile:		Zaneis loam	Range in Thickness
A	0-6"	Brown (dark-brown, moist) loam; moderately granular; friable; slightly acid.	4-10"
B_1	6-12"	Reddish-brown clay loam; moderate to strong granular; friable; slightly acid to neutral.	4-10"
B_2	12-42"	Red light clay or silty clay; moderate granular; friable; neutral to mildly alkaline but noncalcareous.	20-35"
C	42"+	Red shaly silty clay or interbedded shale and fine-grained sandstone; weakly calcareous to neutral.	

Range in Characteristics: Loam, silt loam, and very fine sandy loam are the principal types; color of surface soil ranges from brown to reddish-brown; colors of B horizons range from reddish-brown to red; texture of layer 3 ranges from heavy clay loam to light clay; ferruginous concretions or films often occur in lower part of layer 3; where the substrata is calcareous, a few $CaCO_3$ concretions occur in the lower part of horizon 3.

Topography: Gently rolling erosional upland; convex surfaces with gradients of 1 to about 6%, mostly 1 to 4.

Drainage: Free from the surface; moderate internally.

Vegetation: Tall grasses, mainly little bluestem.

Use: Largely in cultivation and devoted mainly to small grains, cotton, corn, and sorghums; moderately productive.

Distribution: Reddish Prairies of central Oklahoma; minor areas possibly in north central Texas; relatively inextensive.

Type Location: Carter County, Oklahoma; 200 yards south of NE corner Section 33, T4S, R3W.

Series Established: Carter County, Oklahoma, 1932.

Remarks: As originally established, the Zaneis series included both soils with granular friable subsoils, to which it is now restricted, and others with firm subsoils of heavy clay, which are Renfrow.

Colors are described with approximate provisional Soil Survey color names and refer to dry soil.

* Provisional Series

EGF
2-21-38
Rev. EGF
5-8-42
Rev. EHT-HO
9-4-46

Division of Soil Survey
Bureau of Plant Industry, Soils, and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
ARKABUTLA																							
PONTOTOC																							
A	9	A-4(6)	100	99	99	84					28	8	-	-	-	-	-	6.0	NO	11		X	
B	17	A-7-6(22)	100	99	99	96					42	21	37	11	1.97	51	.21	6.2	NO	14			X
C	19	A-7-6(26)	100	100	99	98					46	24	41	9	2.04	65	.32	6.6	NO	15			X
BATES																							
COAL																							
A	0	A-4(3)	100	100	99	52	65	28	7	SL	NP	NP	-	-	-	-	-		6.1	10	X		
B	7	A-4(7)	100	100	99	72	46	26	28	SCL	28	5	-	14	1.85	22	-		NO	11	X		
C	9	A-6(6)	100	100	100	64	54	18	28	SCL	29	11	-	14	1.83	22	-		NO	12	X		
HUGHES																							
A	4	A-4(5)	100	99	94	60	57	30	13	SL	23	2	-	19	1.76	7	-		6.6	10	X		
B	8	A-4(6)	100	98	95	66	52	26	22	SCL	27	9	-	17	1.83	17	-		NO	11	X		
C	0										NP	NP	-	-	-	-	-						X
JOHNSTON																							
A	0	A-2-4(0)	100	96	83	28					NP	NP	-	-	-	-	-	4.8	4.6	7	X		
B	5	A-6(1)	100	99	96	36					31	13	26	15	1.81	20	-	4.9	5.6	10	X		
C	0	A-2-4(0)	100	100	98	21					25	6	-	-	-	-	-	4.2	4.2	7	X		
OKFUSKEE																							
A	2	A-4(0)	100	99	98	52					25	1	-	-	-	-	-		6.1	10	X		
B	7	A-4(3)	100	96	95	56					34	9	-	-	-	-	-		6.8	10		X	
C	3	A-4(0)	76	73	72	41					30	8	-	-	-	-	-		5.0	9	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
BATES																							
PONTOTOC																							
A	3	A-4(4)	100	99	98	53	58	32	10	SL	26	2	-	21	1.69	16	-		6.1	10	X		
B	7	A-4(4)	100	100	99	55	55	23	22	SCL	29	9	-	16	1.85	24	-		6.7	10	X		
C	71	-4(4)	1	100	99	54	59	18	23	SCL	28	9	-	16	1.84	18	-		6.7	10	X		
BETHANY																							
CLEVELAND																							
A	0	A-4(0)	100	99	99	89					NP	NP	-	-	-	-	-	6.0	NO	11	X		
B	20	A-7-6(27)	100	100	99	94					50	26	47	9	2.03	78	.39	7.1	NO	15			X
C	16	A-7-6(20)	100	99	98	94					41	20	36	10	1.97	50	.20	7.9	NO	14		X	
GARVIN																							
A	8	A-4(5)	100	99	97	90					26	7	-	-	-	-	-	6.1	NO	11		X	
B	17	A-7-6(20)	100	100	99	91					43	21	-	-	-	-	.21	5.3	NO	14			X
C	14	A-6(15)	100	98	97	88					39	16	-	-	-	-	-	7.9	NO	12		X	
MC CLAIN																							
A	10	A-4(7)	100	99	98	84					33	8	-	-	-	-	-	6.8	NO	11		X	
B	14	A-6(15)	100	99	99	86					38	17	36	12	1.93	46	-	7.6	NO	12		X	
C	15	A-6(16)	100	100	99	83					39	19	36	12	1.96	47	.15	7.7	NO	13		X	
BONHAM																							
POTTAWATOMIE																							
A	6	A-4(5)	100	99	97	61	49	39	12	L	28	6	-	17	1.72	15	-		NO	10	X		
B	19	A-7-6(19)	100	100	98	79	33	27	40	C	47	25	-	9	2.02	62	.36		NO	15			X
C	19	A-7-6(19)	100	99	98	75	36	25	39	CL	46	27	-	12	1.96	51	.42		NO	15			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
BONHAM																							
SEMINOLE																							
A	7	A-4(3)	100	98	94	70					27	6	-	-	-	-	-	5.0	NO	11		X	
B	18	A-7-6(19)	100	99	96	80					46	23	42	9	2.03	67	.28	5.8	NO	15			X
C	21	A-7-6(23)	100	99	97	81					49	28	44	9	2.05	71	.49	7.9	NO	15			X
BOWIE																							
JOHNSTON																							
A	0	A-4(3)	100	99	98	50	66	30	4	SL	NP	NP	-	-	-	-	-		6.0	10	X		
B	12	A-6(9)	100	100	100	71	51	27	22	SCL	35	15	-	14	1.86	34	-		NO	12	X		
BRACKETT																							
JOHNSTON																							
A	1	A-2-4(0)	52	42	40	34					31	5	-	-	-	-	-	7.4	4.2	8	X		
C	4	A-4(0)	100	81	77	69					21	2	-	-	-	-	-	5.9	NO	11	X		
MURRAY																							
A	10	A-4(6)	87	77	74	64					38	10	35	19	1.71	27	-	7.6	NO	11		X	
C	9	A-4(7)	100	98	96	92					30	8	-	-	-	-	-	7.7	NO	11		X	
BRAZOS																							
HUGHES																							
A	5	A-4(1)	100	100	100	68					22	4	-	-	-	-	-	7.1	NO	11	X		
C	0	A-4(0)	100	100	100	58					NP	NP	-	-	-	-	-	7.3	6.4	10	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
BREWER																							
HUGHES																							
A	15	A-6(16)	100	98	94	86					40	18	35	12	1.89	43	-	5.4	NO	13		X	
B	16	A-7-6(15)	100	97	90	78					41	19	36	12	1.91	46	.15	7.0	NO	14		X	
C	8	A-6(4)	100	94	84	60					28	11	26	9	2.03	35	-	7.6	NO	12		X	
MURRAY																							
A	8	A-4(3)	100	98	94	72					26	7	-	-	-	-	-	5.9	NO	11		X	
B	16	A-7-6(16)	100	98	96	80					41	20	37	12	1.94	48	.20	6.3	NO	14		X	
C	16	A-7-6(17)	100	98	95	82					42	20	38	10	1.99	55	.20	5.5	NO	14		X	
OKFUSKEE																							
A	0	A-4(0)	100	100	99	89					NP	NP	-	-	-	-	-		NO	11	X		
B	17	A-7-6(19)	100	100	99	89					44	20	33	13	1.95	40	.20		NO	14			X
C	13	A-6(11)	100	100	90	79					36	14	31	12	1.96	37	-		NO	12		X	
SEMINOLE																							
A	16	A-7-6(21)	100	100	99	96					46	18	43	10	1.96	64	-	6.4	NO	14		X	
B	23	A-7-6(32)	100	98	96	93					56	30	49	9	2.08	84	.58	7.7	NO	17			X
C	23	A-7-6(33)	100	98	98	95					56	30	53	17	1.77	64	.58	8.0	NO	17			X
BRUNO																							
MC CLAIN																							
A	0	A-4(0)	100	100	98	52					NP	NP	-	-	-	-	-	6.2	6.1	10	X		
C	0	A-2-4(0)	100	100	90	20					NP	NP	-	-	-	-	-	5.8	4.2	7	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
BURLESON																							
COAL																							
A	20	A-7-6(25)	100	100	99	91	15	42	43	SIC	49	25	-	9	2.06	67	.36		NO	15			X
AC	23	A-7-6(30)	100	100	99	92	12	38	50	C	57	28	-	8	2.09	91	.49		NO	17			X
C	25	A-7-6(35)	100	100	99	92	17	34	49	C	59	33	-	8	2.10	78	.76		NO	17			X
JOHNSTON																							
A	15	A-7-6(13)	100	96	93	78					41	17	35	11	1.94	47	-	7.1	NO	14		X	
AC	17	A-7-6(16)	100	92	83	74					43	22	37	9	2.03	56	.24	7.2	NO	14			X
C	14	A-6(11)	100	88	84	66					40	19	33	9	2.03	49	.15	7.6	NO	12		X	
PONTOTOC																							
A	17	A-7-S(19)	98	97	96	90	17	51	32	SICL	52	16	-	19	1.71	50	-		NO	13	X		
AC	25	A-7-S(25)	100	98	95	88	17	36	47	C	63	33	-	11	1.99	72	.76		NO	16			X
C	29	A-7-S(30)	100	99	97	92	13	37	50	C	68	38	-	8	2.10	96	1.14		NO	16			X
CANADIAN																							
MC CLAIN																							
A	0	A-2-4(0)	100	99	92	35					NP	NP	-	-	-	-	-	7.6	5.0	9	X		
C	0	A-4(0)	100	100	96	42					NP	NP	-	-	-	-	-	7.9	5.5	9	X		
OKFUSKEE																							
A	0	A-4(0)	100	100	99	52					NP	NP	-	-	-	-	-		6.1	10	X		
C	0	A-4(0)	100	100	94	63					NP	NP	-	-	-	-	-		NO	11	X		
POTTAWATOMIE																							
A	7	A-4(8)	100	100	100	94	25	60	15	SIL	24	5	-	16	1.74	12	-		NO	11	X		
C	0	A-4(8)	100	100	100	89	29	59	12	SIL	NP	NP	-	-	-	-	-		NO	11	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
CANADIAN																							
SEMINOLE																							
A	0	A-4(0)	100	100	97	40					NP	NP	-	-	-	-	-	5.8	5.4	9	X		
C	0	A-4(0)	100	100	100	84					NP	NP	-	-	-	-	-	7.2	NO	11	X		
CARYTOWN																							
COAL																							
A	5	A-4(8)	100	100	97	77	38	53	9	SIL	19	3	-	16	1.80	6	-		NO	11	X		
B	15	A-6(14)	100	99	98	84	25	39	36	CL	39	19	-	9	2.05	54	.15		NO	13			X
C	14	A-6(12)	100	100	99	83	32	38	30	CL	33	18	-	10	2.02	36	-		NO	12			X
CHICKASHA																							
CLEVELAND																							
A	0	A-4(0)	100	99	98	53					NP	NP	-	-	-	-	-	5.4	6.1	10	X		
B	6	A-4(2)	100	99	99	51					29	9	-	-	-	-	-	5.9	6.5	10	X		
C	1	A-4(0)	100	100	99	38					20	1	-	-	-	-	-	6.0	5.2	9	X		
GARVIN																							
A	0	A-4(0)	100	99	95	46					NP	NP	-	-	-	-	-	6.3	5.7	10	X		
B	8	A-6(4)	100	97	93	51					31	13	-	-	-	-	-	5.5	6.5	11		X	
C	7	A-4(3)	100	99	96	55					29	9	-	-	-	-	-	4.9	6.7	10		X	
OKFUSKEE																							
A	0	A-4(0)	100	100	96	41					NP	NP	-	-	-	-	-		5.4	9	X		
B	9	A-4(5)	100	99	97	67					30	10	-	-	-	-	-		NO	11		X	
C	0	A-4(0)	100	97	96	75					NP	NP	-	-	-	-	-		NO	11	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair
CHICKASHA																						
POTTAWATOMIE																						
A	0	A-4(1)	100	99	92	40	70	20	10	SL	NP	NP	-	-	-	-	-		5.4	9	X	
B	8	A-6(4)	100	100	97	44	60	12	28	SCL	34	17	-	14	1.85	26	-		6.2	11		
C	2	A-2-4(0)	100	97	80	30	71	6	23	SCL	29	10	-	18	1.71	12	-		5.3	8	X	
SEMINOLE																						
A	0	A-2-4(0)	100	99	86	31					NP	NP	-	-	-	-	-	5.6	4.8	8	X	
B	4	A-4(1)	100	99	88	46					27	9	-	-	-	-	-	4.7	6.2	10	X	
C	2	A-4(0)	100	100	90	42					21	5	-	-	-	-	-	4.8	5.5	9	X	
CHIGLEY																						
GARVIN																						
A	3	A-4(0)	100	58	50	39					37	8	-	-	-	-	-		4.9	9	X	
B	15	A-7-6(6)	100	66	59	49					47	18	45	10	1.95	69	-	5.1	6.1	13		X
C	10	A-5(1)	86	65	51	38					42	10	-	-	-	-	-	6.9	5.3	9		X
MURRAY																						
A	2	A-4(0)	85	51	44	37					28	7	-	-	-	-	-	6.8	4.6	9	X	
B	20	A-7-5(11)	100	64	59	52					60	26	53	10	1.92	82	.39	5.3	6.2	13		
C	23	A-7-5(24)	100	91	86	77					63	27	56	13	1.87	80	.42	5.5	NO	16		
PONTOTOC																						
A	0	A-2(0)	84	59	51	28	74	16	10	SL	22	2	-	17	1.76	9	-		4.4	8	X	
B	22	A-7-5(25)	97	84	77	60	45	15	40	SC	59	27	-	11	1.96	76	.42		6.8	13		
C	16	A-7-6(9)	100	88	78	55	52	18	30	SCL	47	19	-	14	1.86	54	.15		6.7	14		
SEMINOLE																						
A	0	A-1-B(0)	51	30	28	17					NP	NP	-	-	-	-	-	5.9	3.0	8	X	
B	6	A-6(2)	83	74	70	44					33	13	32	22	1.61	16	-	4.8	5.7	11	X	
C	0	A-1-A(0)	36	22	15	5					NP	NP	-	-	-	-	-	7.0	NO	7	X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
CHOTEAU																							
COAL																							
A	0	A-4(0)	100	97	90	48					NP	NP	-	-	-	-	-	5.1	5.8	10	X		
B	14	A-6(11)	100	99	95	70					37	18	33	12	1.95	41	-	5.4	NO	12		X	
C	9	A-6(5)	100	97	80	65					27	12	26	12	1.94	27	-	6.7	NO	12		X	
CLAREMORE																							
JOHNSTON																							
A	9	A-4(4)	100	98	93	76					30	7	-	-	-	-	-	6.1	NO	11		X	
B	13	A-6(10)	100	97	91	73					35	15	31	11	1.95	40	-	5.2	NO	12		X	
PONTOTOC																							
A	10	A-6(7)	92	90	88	57					40	15	38	13	1.87	46	-	6.8	6.7	12		X	
CLARITA																							
MC CLAIN																							
A	11	A-5(3)	100	97	91	53					41	7	-	-	-	-	-	7.3	6.1	10		X	
C	15	A-7-5(11)	100	97	94	74					46	14	45	8	2.07	76	-	6.6	NO	13		X	
PONTOTOC																							
A	21	A-7-6(26)	100	99	97	90					54	25	49	10	2.00	78	.36	7.1	NO	15			X
C	16	A-7-6(16)	100	98	96	85					46	17	45	18	1.76	48	-	7.1	NO	14		X	
CLEBURNE																							
OKFUSKEE																							
A	0	A-4(0)	100	98	90	44					NP	NP	-	-	-	-	-		5.6	9	X		
B	5	A-4(2)	100	98	90	50					33	8	-	-	-	-	-		5.9	10	X		
C	4	A-4(0)	100	98	91	57					27	3	-	-	-	-	-		6.4	10	X		

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
CLEORA																							
OKFUSKEE																							
A	0	A-4(0)	100	100	100	76					NP	NP	-	-	-	-	-		NO	11	X		
C	0	A-4(0)	100	100	99	70					NP	NP	-	-	-	-	-		NO	11	X		
PONTOTOC																							
A	0	A-4(0)	100	100	97	57					NP	NP	-	-	-	-	-	5.3	6.4	10	X		
C	0	A-4(0)	100	100	98	52					NP	NP	-	-	-	-	-	4.5	6.1	10	X		
COLLINSVILLE																							
COAL																							
A	0	A-2-4(0)	100	100	99	32					NP	NP	-	-	-	-	-	4.9	4.9	8	X		
HUGHES																							
A	0	A-4(0)	100	99	96	54					NP	NP	-	-	-	-	-	5.4	6.2	10	X		
OKFUSKEE																							
A	0	A-4(0)	97	96	95	70					NP	NP	-	-	-	-	-		NO	11	X		
C	0	A-4(0)	77	74	73	49					NP	NP	-	-	-	-	-		5.5	10	X		
PONTOTOC																							
A	6	A-4(1)	100	99	97	61					27	5	-	-	-	-	-	5.6	NO	11	X		
SEMINOLE																							
A	2	A-4(0)	100	99	95	36					28	7	-	-	-	-	-	5.0	5.1	9	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	Q.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
CRAIG																							
MURRAY																							
A	5	A-6(1)	54	46	45	40					34	11	-	-	-	-	-	6.8	5.1	10	X		
B	16	A-7-5(6)	67	63	58	46					54	20	51	12	1.87	73	.20	6.9	5.7	12		X	
CROWLEY																							
JOHNSTON																							
A	0	A-4(0)	100	98	92	66					NP	NP	-	-	-	-	-	6.3	NO	11	X		
B	20	A-7-5(28)	100	99	98	96					56	23	-	-	-	-	.28		NO	14			X
C	17	A-7-6(20)	100	99	98	91					48	19	-	-	-	-	.15		NO	14			X
DALE																							
OKFUSKEE																							
A	8	A-4(5)	100	100	99	92					28	6	-	-	-	-	-		NO	11		X	
C	5	A-4(0)	100	99	97	70					25	2	-	-	-	-	-		NO	11	X		
POTTAWATOMIE																							
A	10	A-4(8)	100	100	99	85	31	49	20	L	29	10	-	15	1.78	19	-		NO	11	X		
C	0	A-4(7)	100	100	100	72	50	42	8	L	NP	NP	-	-	-	-	-		NO	11	X		
SEMINOLE																							
A	12	A-6(12)	100	99	99	96					35	12	35	18	1.72	30	-	6.7	NO	12		X	
C	18	A-7-6(25)	100	100	100	99					48	22	47	12	1.95	69	.24	7.9	NO	15			X
DARNELL																							
CLEVELAND																							
A	0	A-2-4(0)	100	99	97	15					NP	NP	-	-	-	-	-	6.5	3.8	8	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
DARNELL																							
GARVIN																							
A	0	A-2-4(0)	100	100	99	23					NP	NP	-	-	-	-	-	6.5	4.3	7	X		
C	0	A-2-4(0)	100	100	99	17					NP	NP	-	-	-	-	-	6.0	4.0	8	X		
JOHNSTON																							
A	0	A-2-4(0)	100	98	90	35					NP	NP	-	-	-	-	-	6.3	5.0	9	X		
OKFUSKEE																							
A	0	A-4(0)	100	100	99	44					NP	NP	-	-	-	-	-		5.6	9	X		
PONTOTOC																							
A	0	A-2-4(0)	100	99	96	28					NP	NP	-	-	-	-	-	5.3	4.6	7	X		
POTTAWATOMIE																							
A	0	A-2-4(0)	100	100	99	28	78	17	5	LS	NP	NP	-	-	-	-	-		4.7	8	X		
C	0	A-2-4(0)	100	96	72	16	85	6	9	LS	NP	NP	-	-	-	-	-		3.9	8	X		
SEMINOLE																							
A	0	A-2-4(0)	100	97	86	26					NP	NP	-	-	-	-	-	5.3	4.5	7	X		
DENNIS																							
COAL																							
A	8	A-4(4)	100	97	96	73					27	8	-	-	-	-	-	5.1	NO	11		X	
B	18	A-7-6(21)	100	99	98	87					46	23	41	11	1.98	60	.28	6.2	NO	15			X
C	18	A-7-6(20)	100	98	94	84					44	23	38	10	2.03	57	.28	7.2	NO	14			X
HUGHES																							
A	0	A-4(0)	100	99	95	63					NP	NP	-	-	-	-	-	5.8	NO	11	X		
B	12	A-6(10)	100	99	96	76					32	15	28	12	1.94	31	-	5.0	NO	12		X	
C	15	A-6(14)	100	99	98	79					39	19	34	14	1.81	36	.15	5.5	NO	13		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
DENNIS																							
JOHNSTON																							
A	1	A-4(0)	100	97	91	39					20	2	-	-	-	-	-	5.3	5.3	9	X		
B	16	A-7-6(10)	100	97	93	64					44	18	37	11	1.95	50	-	6.5	NO	14		X	
C	21	A-7-6(16)	100	92	89	63					51	28	26	9	2.01	33	.49	5.6	NO	15			X
PONTOTOC																							
A	9	A-4(4)	100	98	97	73					30	7	-	-	-	-	-	6.0	NO	11		X	
B	17	A-7-6(19)	100	99	99	84					45	21	42	10	2.00	63	.21	6.3	NO	14			X
C	16	A-7-6(17)	100	99	99	84					42	20	38	10	2.03	58	.20	7.5	NO	14		X	
SEMINOLE																							
A	4	A-4(0)	100	98	94	50					25	5	-	-	-	-	-	4.7	5.9	10	X		
B	17	A-7-6(16)	100	99	97	74					43	22	38	11	1.97	53	.24	6.5	NO	14			X
C	10	A-6(7)	100	99	93	64					32	14	29	13	1.91	31	-	7.1	NO	12		X	
DENTON																							
JOHNSTON																							
A	19	A-7-6(21)	100	95	93	86					49	22	45	10	1.93	68	.24	7.4	NO	15			X
B	20	A-7-6(24)	100	95	93	88					52	24	48	9	2.01	79	.32	7.6	NO	15			X
C	23	A-7-6(32)	100	97	96	94					57	29	49	9	2.01	80	.52	7.5	NO	17			X
MURRAY																							
A	5	A-4(2)	100	79	72	50					35	7	-	-	-	-	-	7.1	5.7	10	X		
B	20	A-7-6(23)	100	95	93	86					50	24	45	10	1.99	70	.32	7.9	NO	15			X
C	18	A-7-6(19)	100	95	92	84					48	20	43	10	2.07	69	.20	8.7	NO	14			X

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
DERBY																							
CLEVELAND																							
A	0	A-2-4(0)	100	98	89	18					NP	NP	-	-	-	-	-	6.8	4.0	8	X		
C	0	A-2-4(0)	100	98	78	15					NP	NP	-	-	-	-	-	6.7	3.8	8	X		
DOUGHERTY																							
CLEVELAND																							
A	0	A-4(0)	100	99	90	50					NP	NP	-	-	-	-	-	6.7	5.9	10	X		
B	7	A-4(3)	100	99	93	69					25	8	-	-	-	-	-	5.4	NO	11		X	
C	7	A-6(3)	100	98	90	48					28	13	27	13	1.88	26	-	6.3	6.3	11		X	
GARVIN																							
A	0	A-2-4(0)	100	94	72	25					NP	NP	-	-	-	-	-	5.5	4.4	7	X		
B	3	A-4(0)	100	94	76	39					30	9	-	-	-	-	-	6.2	5.7	9	X		
C	0	A-2-4(0)	100	99	90	15					NP	NP	-	-	-	-	-	5.5	3.8	8	X		
JOHNSTON																							
A	0	A-2-4(0)	100	98	84	31					NP	NP	-	-	-	-	-	6.7	4.8	8	X		
B	2	A-4(0)	100	99	88	41					21	7	-	-	-	-	-	6.1	5.4	9	X		
C	5	A-6(1)	100	98	87	40					26	11	22	14	1.84	16	-	5.2	5.8	10	X		
MC CLAIN																							
A	0	A-2-4(0)	100	91	86	26					NP	NP	-	-	-	-	-		4.4	7	X		
B	6	A-6(2)	100	95	92	46					25	11	-	-	-	-	-		6.2	11	X		
C	0	A-2-4(0)	100	93	89	20					NP	NP	-	-	-	-	-		4.1	7	X		
OKFUSKEE																							
A	0	A-2-4(0)	100	99	90	30					NP	NP	-	-	-	-	-		4.7	8	X		
B	1	A-4(0)	100	99	92	41					22	3	-	-	-	-	-		5.4	9	X		
C	0	A-2-4(0)	100	99	91	31					NP	NP	-	-	-	-	-		4.8	8	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
DOUGHERTY																							
PONTOTOC																							
A	0	A-2-4(0)	100	92	69	15					NP	NP	-	-	-	-	-	5.0	3.8	8	X		
B	0	A-2-4(0)	100	82	63	20					19	4	-	-	-	-	-	4.4	4.0	7	X		
C	0	A-2-4(0)	100	91	71	16					NP	NP	-	-	-	-	-	5.0	3.8	8	X		
POTTAWATOMIE																							
A	0	A-4(0)	100	99	92	42	80	17	3	LS	NP	NP	-	-	-	-	-		5.5	9	X		
B	1	A-4(0)	100	99	92	39	72	12	16	SL	20	4	-	19	1.84	9	-		5.4	9	X		
C	0	A-2-4(0)	100	97	80	18	91	4	5	S	NP	NP	-	-	-	-	-		4.2	7	X		
SEMINOLE																							
A	0	A-2-4(0)	100	98	80	17					NP	NP	-	-	-	-	-	5.5	4.0	8	X		
B	6	A-6(2)	100	100	90	38					34	16	31	15	1.83	30	-	3.8	5.7	10	X		
C	0	A-2-4(0)	100	100	96	15					NP	NP	-	-	-	-	-	4.6	3.9	8	X		
DURANT																							
COAL																							
A	8	A-4(3)	100	99	98	77					25	7	-	-	-	-	-	5.9	NO	11		X	
B	22	A-7-6(23)	100	98	92	77					56	28	50	9	2.07	86	.49	5.1	NO	17			X
C	22	A-7-6(29)	100	99	99	93					52	28	43	9	2.09	72	.49	7.1	NO	17			X
JOHNSTON																							
A	4	A-4(0)	100	99	90	56					23	5	-	-	-	-	-	5.5	6.3	10	X		
B	19	A-7-6(18)	100	99	94	75					49	24	41	9	1.99	64	.32	6.3	NO	15			X
C	17	A-7-6(15)	100	99	94	73					43	22	37	9	2.06	59	.24	7.7	NO	14			X
MURRAY																							
A	5	A-4(2)	100	98	96	54					25	8	-	-	-	-	-	7.6	6.2	10	X		
B	17	A-7-6(9)	100	98	95	56					45	21	41	10	1.99	63	.21	6.3	6.8	14			X
C	16	A-7-6(7)	100	97	95	54					41	19	38	9	2.03	59	.15	7.6	6.7	13		X	

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
DURANT																							
PONTOTOC																							
A	11	A-4(8)	100	98	95	76	36	39	25	L	36	10	-	16	1.82	32	-		NO	11	X		
B	23	A-7-5(22)	100	99	97	87	22	31	47	C	57	27	-	9	2.03	80	.42		NO	16			X
C	18	A-7-6(15)	96	91	89	79	26	37	37	CL	47	22	-	10	2.03	70	.24		NO	14			X
SEMINOLE																							
A	9	A-4(5)	100	99	99	87					29	7	-	-	-	-	-		NO	11		X	
B	20	A-7-5(26)	100	100	99	92					54	24	-	-	-	-	.32		NO	14			X
C	18	A-7-6(18)	100	98	97	77					48	22	-	-	-	-	.24		NO	15			X
DWIGHT																							
PONTOTOC																							
A	11	A-6(9)	100	99	97	83					22	16	-	-	-	-	-	5.5	NO	12		X	
B	19	A-7-6(24)	100	100	99	91					49	23	45	9	2.03	74	.28	6.4	NO	15			X
C	14	A-6(12)	100	99	97	77					37	16	33	12	1.95	41	-	7.3	NO	12		X	
ENDERS-LIKE																							
COAL																							
A	0	A-4(4)	100	99	91	53	59	40	1	SL	NP	NP	-	-	-	-	-		6.2	10	X		
B	15	A-6(12)	100	99	94	77	38	23	39	CL	40	18	-	13	1.90	39	-		NO	12			X
C	10	A-6(7)	100	100	93	61	47	23	30	SCL	32	14	-	13	1.94	27	-		NO	12	X		
ENNIS																							
COAL																							
A	4	A-4(1)	100	100	99	54					22	6	-	-	-	-	-	5.6	6.2	10	X		
C	7	A-4(3)	100	100	99	82					24	6	-	-	-	-	-	5.6	NO	11		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
ERAM																							
JOHNSTON																							
A	15	A-7-6(13)	100	96	94	78					41	16	37	12	1.87	47	-	7.3	NO	14		X	
B	20	A-7-6(27)	100	99	98	95					49	25	-	-	-	-	.36	6.0	NO	15			X
C	27	A-7-6(35)	100	97	95	88					62	36	50	7	2.06	88	.99	6.6	NO	17			X
OKFUSKEE																							
A	11	A-4(7)	100	98	97	76					35	10	-	-	-	-	-	6.9	NO	11		X	
B	23	A-7-6(30)	100	98	98	96					57	29	57	9	2.07	99	.52	8.3	NO	17			X
C	24	A-7-6(31)	100	98	98	89					57	31	57	8	2.11	103	.63	8.3	NO	17			X
EUFAULA																							
HUGHES																							
A	0	A-2-4(0)	100	98	63	18	87	9	4	S	NP	NP	-	-	-	-	-		4.0	7	X		
B	0	A-2-4(0)	100	97	72	16	87	9	4	S	NP	NP	-	-	-	-	-		3.9	8	X		
C	0	A-3(0)	100	98	66	10	92	4	4	S	NP	NP	-	-	-	-	-		3.6	8	X		
JOHNSTON																							
A	0	A-2-4(0)	100	99	87	13					NP	NP	-	-	-	-	-	6.5	3.7	8	X		
B	0	A-2-4(0)	100	98	87	22					NP	NP	-	-	-	-	-	5.5	4.3	7	X		
C	0	A-2-4(0)	100	99	81	19					NP	NP	-	-	-	-	-	5.6	4.1	8	X		
PONTOTOC																							
A	0	A-2-4(0)	100	96	79	29					NP	NP	-	-	-	-	-	5.6	4.7	7	X		
C	0	A-2-4(0)	100	95	76	18					NP	NP	-	-	-	-	-	5.5	4.0	8	X		
POTTAWATOMIE																							
A	0	A-2-4(0)	100	95	68	24	84	14	2	LS	NP	NP	-	-	-	-	-		4.4	7	X		
B	0	A-2-4(0)	100	95	66	13	93	4	3	S	NP	NP	-	-	-	-	-		3.7	8	X		
C	0	A-3(0)	100	92	67	8	95	3	2	S	NP	NP	-	-	-	-	-		3.5	10	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
EUFAULA																							
SEMINOLE																							
A	0	A-2-4(0)	100	97	79	14					NP	NP	-	-	-	-	-	6.6	3.8	8	X		
C	0	A-2-4(0)	100	97	80	21					NP	NP	-	-	-	-	-	5.1	4.2	7	X		
FITZHUGH																							
OKFUSKEE																							
A	0	A-2-4(0)	100	99	95	33					NP	NP	-	-	-	-	-	6.9	4.9	8	X		
B	4	A-4(0)	100	100	97	46					25	7	-	-	-	-	-	6.4	5.7	10	X		
C	0	A-2-4(0)	100	99	91	27					22	4	-	-	-	-	-	8.1	4.6	7	X		
PONTOTOC																							
A	6	A-4(2)	100	98	94	55					24	9	-	-	-	-	-	4.8	6.7	10	X		
B	10	A-6(6)	100	98	95	58					34	14	33	12	1.95	42	-	4.9	6.9	12		X	
C	5	A-6(1)	100	99	96	40					27	11	26	14	1.88	23	-	5.1	5.8	10	X		
FRIO																							
JOHNSTON																							
A	9	A-6(5)	100	99	95	69					28	11	25	13	1.88	23	-	7.3	NO	12		X	
AC	10	A-6(6)	100	100	98	72					28	11	26	15	1.79	20	-	7.1	NO	12		X	
C	1	A-4(0)	100	99	92	37					19	3	-	-	-	-	-	7.3	5.2	9	X		
GALEY																							
GARVIN																							
A	0	A-2-4(0)	100	91	63	15					NP	NP	-	-	-	-	-	5.9	3.8	8	X		
B	4	A-4(1)	100	94	88	45					27	9	-	-	-	-	-	4.8	6.1	9	X		
C	0	A-2-4(0)	100	93	73	34					NP	NP	-	-	-	-	-	4.4	4.9	8	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
GALEY																							
PONTOTOC																							
A	0	A-4(0)	100	93	78	38					NP	NP	-	-	-	-	-	5.8	5.2	9	X		
B	8	A-6(4)	100	95	85	60					25	11	24	12	1.95	23	-	5.3	NO	12		X	
C	6	A-6(2)	100	94	80	46					28	11	26	12	1.92	26	-	4.6	6.2	11	X		
POTTAWATOMIE																							
A	0	A-4(4)	100	99	92	54	58	35	7	SL	NP	NP	-	-	-	-	-		6.2	10	X		
B	8	A-6(5)	100	99	92	54	55	24	21	SCL	27	13	-	12	1.93	25	-		6.7	11	X		
C	0	A-2-4(0)	100	100	91	23	84	2	14	LS	27	4	-	16	1.78	6	-		4.4	7	X		
GARRETT																							
JOHNSTON																							
A	9	A-4(8)	100	91	85	77	35	60	5	SL	33	6	-	24	1.52	10	-		NO	11	X		
B	21	A-7-6(21)	100	89	85	76	29	38	33	CL	50	28	-	9	2.05	54	.49		NO	15			X
C	12	A-6(8)	100	86	81	71	35	30	35	CL	38	12	-	21	1.65	26	-		NO	12	X		
GIBBS																							
JOHNSTON																							
A	3	A-4(2)	86	62	56	46	67	29	4	SL	30	6	-	21	1.56	10	-		5.3	9	X		
B	15	A-7-5(3)	65	52	48	39	63	21	16	SL	48	18	-	17	1.76	50	-		NO	11			X
C	14	A-2-7(3)	61	43	38	28	72	20	8	SL	52	29	-	9	2.04	63	.52		NO	10			X
GILSON																							
JOHNSTON																							
A	0	A-2-4(0)	90	78	58	16					NP	NP	-	-	-	-	-	5.8	3.6	8	X		
B	5	A-6(1)	80	72	64	41					29	12	27	12	1.91	28	-	4.3	5.5	10	X		
C	16	A-7-6(11)	76	74	72	68					46	17	43	21	1.63	36	-	4.2	NO	14		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
GILSON																							
MURRAY																							
A	14	A-7-5(8)	79	76	74	67					43	13	41	20	1.71	37	-	7.5	NO	13		X	
B	11	A-6(8)	87	81	79	74					32	13	31	13	1.95	36	-	7.7	NO	12		X	
C	6	A-6(2)	61	54	51	46					29	11	26	13	1.93	25	-	7.5	5.6	11	X		
GOWEN																							
JOHNSTON																							
A	10	A-4(9)	100	99	99	92					32	10	31	14	1.77	29	-	6.6	NO	11		X	
C	12	A-6(11)	100	94	90	82					34	14	33	12	1.94	41	-	5.5	NO	12		X	
MURRAY																							
A	17	A-7-6(20)	100	100	99	89					45	20	40	14	1.87	48	.20	7.0	NO	14			X
C	15	A-7-6(19)	100	100	100	98					42	17	37	18	1.73	33	-	7.0	NO	14		X	
GRACEMONT																							
POTTAWATOMIE																							
A	0	A-2-4(0)	100	100	95	30					NP	NP	-	-	-	-	-		4.8	8	X		
C	0	A-2-4(0)	100	99	95	33					NP	NP	-	-	-	-	-		4.9	8	X		
HARTSELLS																							
COAL																							
A	0	A-2-4(0)	100	99	88	32	80	18	2	LS	NP	NP	-	-	-	-	-		4.8	8	X		
B	3	A-4(2)	100	99	91	44	63	19	18	SL	22	8	-	14	1.90	11	-		5.6	9	X		
C	6	A-6(3)	100	100	91	48	60	26	14	SL	26	11	-	14	1.90	18	-		6.4	11	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
HARTSELLS																							
HUGHES																							
A	0	A-4(3)	100	99	94	48	66	25	9	SL	NP	NP	-	-	-	-	-		5.9	10	X		
B	4	A-4(3)	100	99	93	52	65	18	17	SL	22	4	-	17	1.78	8	-		6.1	10	X		
C	17	A-7-6(13)	93	91	89	75	48	24	28	SCL	45	19	-	12	1.95	48	.15		NO	14			X
HECTOR																							
COAL																							
A	0	A-4(0)	100	99	95	37	75	23	2	LS	NP	NP	-	-	-	-	-		5.2	9	X		
B	0	A-2-4(0)	100	99	95	34	75	21	4	LS	NP	NP	-	-	-	-	-		5.0	9	X		
HUGHES																							
A	0	A-4(0)	100	98	95	41					NP	NP	-	-	-	-	-	5.0	5.4	9	X		
B	17	A-7-5(18)	100	99	99	85					49	18	48	12	1.92	69	-	4.0	NO	13			X
HEIDEN																							
PONTOTOC																							
A	13	A-6(10)	100	99	94	72					38	15	35	12	1.88	42	-	6.5	NO	12		X	
C	22	A-7-6(28)	100	99	98	90					56	27	52	8	2.04	89	.42	7.0	NO	17			X
HILGRAVE																							
PONTOTOC																							
A	0	A-2-4(0)	72	60	55	33					NP	NP	-	-	-	-	-	6.5	4.4	8	X		
B	15	A-7-6(8)	92	83	78	59					41	16	40	11	1.97	58	-	5.4	6.8	13		X	
C	0	A-1-B(0)	48	39	35	16					18	2	-	-	-	-	-	5.4	3.0	8	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
KAY																							
OKFUSKEE																							
A	7	A-4(3)	100	100	99	89					26	4	-	-	-	-	-		NO	11		X	
B	14	A-6(16)	100	100	99	92					39	16	33	14	1.92	36	-		NO	12		X	
C	12	A-6(11)	100	99	98	88					34	13	30	4	1.89	50	-		NO	12		X	
KIRKLAND																							
CLEVELAND																							
A	6	A-4(2)	100	98	97	90					26	3	-	-	-	-	-	6.1	NO	11	X		
B	21	A-7-6(28)	100	99	97	93					53	26	48	9	2.04	80	.39	6.8	NO	15			X
C	18	A-7-6(21)	100	98	95	87					44	23	40	8	2.07	66	.28	7.7	NO	14			X
GARVIN																							
A	7	A-4(2)	100	99	98	90					25	4	-	-	-	-	-	6.6	NO	11		X	
B	19	A-7-6(24)	100	97	96	91					46	25	35	15	1.99	39	.36	7.6	NO	15			X
C	16	A-6(19)	100	99	99	90					40	21	31	11	1.99	40	.21	7.2	NO	13		X	
MC CLAIN																							
A	5	A-4(1)	100	100	99	94					23	2	-	-	-	-	-	6.6	NO	11	X		
B	18	A-7-6(24)	100	100	99	94					44	24	36	16	1.97	40	.32	6.9	NO	15			X
C	22	A-7-6(29)	99	98	98	92					49	30	36	11	2.04	50	.58	7.7	NO	17			X
POTTAWATOMIE																							
A	7	A-4(8)	100	99	96	76	37	50	13	SIL	25	4	-	17	1.74	12	-		NO	11	X		
B	23	A-7-6(24)	100	100	98	87	18	37	45	C	52	31	-	7	2.15	83	.63		NO	17			X
C	18	A-7-6(16)	100	99	96	73	36	27	37	CL	41	24	-	8	2.08	54	.32		NO	14			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
KONAWA																							
GARVIN																							
A	0	A-2-4(0)	100	93	77	29					NP	NP	-	-	-	-	-	5.8	4.6	7	X		
B	9	A-6(5)	100	95	84	56					33	13	31	10	1.95	40	-	6.0	6.8	12		X	
C	0	A-2-4(0)	100	99	95	34					NP	NP	-	-	-	-	-	5.7	5.0	8	X		
HUGHES																							
A	0	A-4(8)	100	99	92	79	39	52	9	SIL	NP	NP	-	-	-	-	-		NO	11	X		
B	9	A-4(8)	100	98	95	80	37	43	20	L	27	7	-	17	1.80	18	-		NO	11	X		
C	5	A-4(6)	100	98	91	66	53	30	17	SL	23	4	-	16	1.81	13	-		NO	11	X		
MC CLAIN																							
A	0	A-2-4(0)	100	91	67	26					NP	NP	-	-	-	-	-	6.5	4.4	7	X		
B	6	A-6(2)	100	92	76	46					25	11	-	-	-	-	-	5.8	6.1	11	X		
C	0	A-2-4(0)	100	89	65	20					NP	NP	-	-	-	-	-	6.0	4.0	7	X		
MURRAY																							
A	0	A-4(0)	100	98	92	62					NP	NP	-	-	-	-	-	6.3	NO	11	X		
B	9	A-4(4)	100	99	96	73					26	9	-	-	-	-	-	6.2	NO	11		X	
C	4	A-4(0)	100	99	93	55					21	4	-	-	-	-	-	6.0	6.2	10	X		
PONTOTOC																							
A	0	A-2-4(0)	100	97	86	26	87	10	3	S	NP	NP	-	-	-	-	-		4.6	7	X		
B	7	A-6(4)	100	99	92	50	64	8	28	SCL	35	13	-	15	1.84	31	-		6.4	11	X		
C	0	A-2-4(0)	100	98	84	22	85	6	9	LS	NP	NP	-	-	-	-	-		4.3	7	X		
POTTAWATOMIE																							
A	0	A-4(0)	100	99	92	42					NP	NP	-	-	-	-	-		5.5	9	X		
B	1	A-4(0)	100	99	92	39					20	4	-	-	-	-	-		5.3	9	X		
C	0	A-2-4(0)	100	97	80	18					NP	NP	-	-	-	-	-		4.0	8	X		

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
KONAWA																							
SEMINOLE																							
A	0	A-2-4(0)	100	99	95	27					NP	NP	-	-	-	-	-	6.1	4.6	7	X		
B	6	A-6(2)	100	100	96	44					29	13	25	15	1.85	19	-	5.2	6.1	11	X		
C	0	A-2-4(0)	100	100	100	16					NP	NP	-	-	-	-	-	4.5	3.9	8	X		
LELA																							
JOHNSTON																							
A	20	A-7-6(27)	100	99	98	93					50	26	43	11	1.95	63	.39	6.5	NO	15			X
AC	21	A-7-6(30)	100	99	98	95					53	27	-	-	-	-	.42	7.6	NO	17			X
C	15	A-6(18)	100	100	99	94					38	19	33	12	1.92	41	.15	6.9	NO	13		X	
MURRAY																							
A	12	A-6(9)	100	97	92	79					36	11	-	-	-	-	-	7.7	NO	12		X	
C	13	A-6(11)	100	99	96	79					36	15	36	11	1.97	49	-	7.5	NO	12		X	
POTTAWATOMIE																							
A	23	A-7-6(33)	100	100	100	97	10	44	46	SIC	56	29	-	11	1.95	73	.52		NO	17			X
C	30	A-7-5(48)	100	100	100	99	2	40	58	SIC	71	39	-	11	1.94	92	1.21		NO	16			X
LIGHTNING																							
COAL																							
A	6	A-4(8)	100	98	96	90	21	71	8	SIL	24	3	-	21	1.68	6	-		NO	11	X		
B	16	A-7-6(21)	100	100	99	98	3	57	40	SIC	43	20	-	9	2.02	57	.20		NO	14			X
C	16	A-6(20)	100	100	99	99	3	59	38	SICL	39	19	-	10	2.04	47	.15		NO	13			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing)				Particle Sizes			Texture (U.S.D.A)	Soil Constants						Potential Vertical Rise	pH	Suitability				
																			Stabilization		Subgrade		
			No. 10	No. 40	No. 60	No. 200	% Sand	% Silt	% Clay		Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change			% Asphalt	% Cement	Good	Fair	Poor
LINCOLN																							
CLEVELAND																							
A	0	A-4(0)	100	99	98	56					NP	NP	-	-	-	-	-	7.7	6.3	10	X		
C	0	A-2-4(0)	100	100	98	29					NP	NP	-	-	-	-	-	8.7	4.7	7	X		
MC CLAIN																							
A	0	A-2-4(0)	100	100	93	25					NP	NP	-	-	-	-	-	7.5	4.5	7	X		
C	0	A-4(0)	100	100	96	39					NP	NP	-	-	-	-	-	8.5	5.3	9	X		
OKFUSKEE																							
A	0	A-2-4(0)	100	100	94	31					NP	NP	-	-	-	-	-		4.8	8	X		
C	0	A-4(0)	100	100	100	81					NP	NP	-	-	-	-	-		NO	11	X		
PONTOTOC																							
A	0	A-2-4(0)	100	100	96	25					NP	NP	-	-	-	-	-	7.4	4.5	7	X		
C	0	A-3(0)	100	99	89	9					NP	NP	-	-	-	-	-	7.5	3.5	12	X		
POTTAWATOMIE																							
A	0	A-2-4(0)	100	100	99	33	86	10	4	LS	NP	NP	-	-	-	-	-		4.9	9	X		
C	0	A-4(0)	100	100	96	36	83	14	3	LS	NP	NP	-	-	-	-	-		5.2	9	X		
SEMINOLE																							
A	0	A-4(0)	100	100	100	55					NP	NP	-	-	-	-	-	7.9	6.3	10	X		
C	0	A-3(0)	100	100	97	10					NP	NP	-	-	-	-	-	8.2	3.6	12	X		
LINKER																							
OKFUSKEE																							
A	0	A-4(0)	100	98	97	85					NP	NP	-	-	-	-	-	6.3	NO	11	X		
B	11	A-6(8)	100	97	97	77					33	12	32	14	1.87	34	-	5.8	NO	12		X	
C	9	A-4(5)	100	90	88	65					31	10	-	-	-	-	-	6.2	NO	11		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
LUCIEN																							
GARVIN																							
A	0	A-4(0)	100	100	100	53					NP	NP	-	-	-	-	-	6.8	6.1	10	X		
C	5	A-4(1)	100	99	98	67					23	4	-	-	-	-	-	7.8	NO	11	X		
MC CLAIN																							
A	3	A-4(0)	100	100	100	56					23	1	-	-	-	-	-	6.4	6.3	10	X		
C	0	A-4(0)	100	99	99	39					NP	NP	-	-	-	-	-	6.8	5.3	9	X		
POTTAWATOMIE																							
A	0	A-2-4(0)	100	99	84	27	77	17	6	LS	NP	NP	-	-	-	-	-		4.6	7	X		
C	0	A-2-4(0)	100	100	75	17	84	9	7	LS	NP	NP	-	-	-	-	-		4.0	8	X		
LULA																							
PONTOTOC																							
A	7	A-4(7)	100	99	97	72	40	43	17	L	25	6	-	18	1.80	10	-		NO	11	X		
B	13	A-6(9)	100	100	97	76	34	28	38	CL	39	13	-	13	1.94	45	-		NO	12	X		
MASON																							
OKFUSKEE																							
A	8	A-4(4)	100	99	98	93					26	6	-	-	-	-	-		NO	11		X	
B	16	A-6(20)	100	99	98	94					38	21	28	14	1.92	27	.21		NO	13		X	
C	16	A-6(19)	100	98	98	92					36	21	31	6	1.95	49	.21		NO	13		X	
MC LAIN																							
CLEVELAND																							
A	11	A-6(11)	100	100	99	92					33	12	32	14	1.86	33	-	7.5	NO	12		X	
B	14	A-7-6(13)	100	100	99	88					42	13	40	23	1.86	52	-	7.3	NO	14		X	
C	7	A-4(3)	100	100	99	62					25	9	-	-	-	-	-	8.1	NO	11		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
MC CLAIN																							
GARVIN																							
A	9	A-4(7)	100	100	100	96					31	7	-	-	-	-	-	6.4	NO	11		X	
B	14	A-6(17)	100	100	100	98					38	16	35	12	1.89	43	-	6.5	NO	12		X	
C	8	A-4(4)	100	100	100	92					28	5	-	-	-	-	-	7.6	NO	11		X	
MC CLAIN																							
A	14	A-6(16)	100	99	99	92					40	16	34	13	1.85	38	-	6.4	NO	12		X	
B	20	A-7-6(28)	100	100	100	97					52	24	46	11	1.97	69	.32	6.1	NO	15			X
C	14	A-6(18)	100	100	100	99					40	16	36	14	1.88	42	-	5.9	NO	12		X	
OKFUSKEE																							
A	2	A-4(0)	100	100	98	45					23	4	-	-	-	-	-	6.8	5.7	9	X		
B	12	A-6(11)	100	100	100	91					34	12	34	15	1.83	34	-	6.9	NO	12		X	
C	14	A-6(16)	100	100	100	92					40	16	39	14	1.91	49	-	6.8	NO	12		X	
MHOON																							
COAL																							
A	8	A-4(5)	100	99	99	93					27	6	-	-	-	-	-	5.3	NO	11		X	
B	13	A-6(16)	100	100	99	96					35	16	32	13	1.93	37	-	5.0	NO	12		X	
C	13	A-6(16)	100	100	99	97					34	16	31	14	1.90	33	-	5.0	NO	12		X	
MILLER																							
JOHNSTON																							
A	21	A-7-6(29)	100	99	98	96					54	26	48	8	2.03	81	.39	7.3	NO	17			X
B	23	A-7-6(35)	100	99	99	98					57	30	50	9	2.01	82	.58	7.4	NO	17			X
C	20	A-7-6(27)	100	99	98	94					50	25	41	10	2.02	63	.36	7.4	NO	15			X

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
MILLER																							
MC CLAIN																							
A	28	A-7-6(44)	100	100	100	98					65	38	42	13	2.01	58	1.14	7.5	NO	17			X
B	29	A-7-6(45)	100	100	100	97					67	40	42	12	2.05	62	1.30	7.9	NO	17			X
C	33	A-7-6(52)	100	99	98	96					74	46	43	12	2.00	61	2.00	8.2	NO	17			X
MURRAY																							
A	18	A-7-6(23)	100	98	97	93					49	21	45	10	1.97	69	.21	7.5	NO	15			X
C	24	A-7-5(34)	100	98	97	95					61	30	56	10	2.02	92	.58	7.8	NO	16			X
POTTAWATOMIE																							
A	20	A-7-6(27)	100	99	98	94	10	40	50	SIC	49	27	-	11	1.97	56	.42		NO	15			X
B	24	A-7-6(33)	100	99	99	97					51	31	-	10	2.01	69	.63		NO	17			X
C	24	A-7-6(36)	100	100	100	98	4	51	45	SIC	55	32	-	10	2.03	71	.70		NO	17			X
SEMINOLE																							
A	21	A-7-6(29)	100	99	98	96					53	26	-	-	-	-	.39		NO	15			X
B	22	A-7-6(30)	100	99	98	95					54	27	-	-	-	-	.42		NO	17			X
C	20	A-7-6(27)	100	99	97	96					52	24	-	-	-	-	.32		NO	15			X
MINCO																							
CLEVELAND																							
A	0	A-4(0)	100	96	79	38					NP	NP	-	-	-	-	-	5.4	5.2	9	X		
B	4	A-4(0)	100	97	86	56					21	4	-	-	-	-	-	6.0	6.3	10	X		
C	11	A-6(8)	100	98	92	75					30	13	29	13	1.92	31	-	6.4	NO	12		X	
MC CLAIN																							
A	6	A-4(1)	100	100	99	90					24	2	-	-	-	-	-	6.4	NO	11	X		
B	9	A-4(6)	100	99	97	84					29	9	-	-	-	-	-	7.0	NO	11		X	
C	9	A-4(6)	100	98	95	87					28	8	-	-	-	-	-	7.1	NO	11		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
MUSKINGUM																							
OKFUSKEE																							
A	0	A-4(0)	100	99	98	93					NP	NP	-	-	-	-	-	5.6	NO	11	X		
C	0	A-4(0)	100	95	77	36					NP	NP	-	-	-	-	-	5.8	5.1	9	X		
NASH																							
GARVIN																							
A	0	A-4(0)	100	100	99	54					NP	NP	-	-	-	-	-	6.4	6.2	10	X		
C	0	A-2-4(0)	100	99	94	33					NP	NP	-	-	-	-	-	5.9	4.9	8	X		
MC CLAIN																							
A	8	A-4(4)	100	99	90	70					31	7	-	-	-	-	-	7.0	NO	11		X	
B	8	A-4(5)	100	100	99	83					30	6	-	-	-	-	-	7.3	NO	11		X	
NEWTONIA																							
COAL																							
A	8	A-4(5)	100	98	96	89					28	7	-	-	-	-	-	6.4	NO	11		X	
B	14	A-6(14)	100	98	96	89					37	16	34	14	1.95	39	-	4.5	NO	12		X	
JOHNSTON																							
A	10	A-4(7)	100	99	97	91					34	7	-	-	-	-	-	5.7	NO	11		X	
B	18	A-7-6(20)	100	99	96	85					41	24	36	11	1.97	50	.32	5.1	NO	14			X
MURRAY																							
A	10	A-4(8)	100	99	97	84					34	9	-	-	-	-	-	6.5	NO	11		X	
B	12	A-6(11)	100	99	97	87					35	13	32	16	1.85	29	-	5.5	NO	12		X	

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
NIMROD																							
OKFUSKEE																							
A	0	A-2-4(0)	100	99	91	30					NP	NP	-	-	-	-	-		4.7	8	X		
B	6	A-6(2)	100	99	88	41					33	13	-	-	-	-	-		5.9	10	X		
C	0	A-4(0)	100	98	90	37					NP	NP	-	-	-	-	-		5.2	9	X		
POTTAWATOMIE																							
A	0	A-2-4(0)	100	99	89	26	82	14	4	LS	NP	NP	-	-	-	-	-		4.5	7	X		
B	6	A-6(2)	100	99	91	38	66	9	25	SCL	32	15	-	16	1.79	22	-		5.8	10	X		
C	0	A-2-4(0)	100	99	91	25	81	8	11	LS	NP	NP	-	-	-	-	-		4.4	7	X		
NORGE																							
CLEVELAND																							
A	6	A-4(1)	100	99	98	71					25	4	-	-	-	-	-	7.4	NO	11	X		
B	11	A-6(7)	100	99	99	71					32	12	32	14	1.86	34	-	7.0	NO	12		X	
C	8	A-4(4)	100	99	98	69					28	9	-	-	-	-	-	7.5	NO	11		X	
GARVIN																							
A	5	A-4(1)	100	100	99	59					24	6	-	-	-	-	-	6.2	NO	10	X		
B	11	A-6(10)	100	100	100	86					31	13	30	13	1.90	32	-	5.3	NO	12		X	
C	8	A-4(4)	100	100	100	75					26	8	-	-	-	-	-	5.6	NO	11		X	
POTTAWATOMIE																							
A	6	A-4(6)	100	100	97	64	52	35	13	SL	27	6	-	18	1.72	14	-		NO	11	X		
B	12	A-6(8)	100	100	97	73	42	31	27	CL	31	14	-	14	1.83	25	-		NO	12	X		
C	10	A-6(8)	100	100	97	66	50	23	27	SCL	30	14	-	15	1.81	23	-		NO	12	X		
SEMINOLE																							
A	11	A-4(8)	100	99	98	82					35	9	-	-	-	-	-		NO	11		X	
B	15	A-6(16)	100	100	99	83					39	19	-	-	-	-	.15		NO	13		X	
C	14	A-6(12)	100	99	99	75					36	18	-	-	-	-	-		NO	13		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
OCHOLOCKONEE																							
HUGHES																							
A	0	A-4(5)	100	100	98	63	55	38	7	SL	NP	NP	-	-	-	-	-		NO	10	X		
B	5	A-4(6)	100	100	99	66	50	32	18	L	22	5	-	15	1.83	14	-		NO	11	X		
C	7	A-4(7)	100	100	98	69	49	31	20	L	24	7	-	15	1.86	18	-		NO	11	X		
OKEMAH																							
HUGHES																							
A	7	A-4(3)	100	99	98	90					23	5	-	-	-	-	-	5.0	NO	11		X	
B	16	A-7-6(21)	100	99	99	95					42	20	37	9	2.02	57	.20	5.9	NO	14		X	
C	18	A-7-6(23)	100	99	99	94					44	23	35	11	1.94	48	.28	6.3	NO	14			X
MURRAY																							
A	8	A-4(4)	100	99	96	70					27	9	-	-	-	-	-	6.0	NO	11		X	
B	16	A-7-6(14)	100	99	97	75					41	19	35	10	2.03	51	.15	6.1	NO	14		X	
C	17	A-7-6(17)	100	98	96	79					42	22	36	9	2.06	56	.24	7.4	NO	14			X
OKFUSKEE																							
A	11	A-4(10)	100	99	98	92					36	10	-	-	-	-	-		NO	11		X	
B	23	A-7-6(31)	100	99	98	93					55	29	-	-	-	-	.52		NO	17			X
C	22	A-7-6(30)	100	99	99	93					52	29	35	6	2.02	58	.52		NO	17			X
OSAGE																							
COAL																							
A	15	A-6(17)	100	99	99	94					40	17	37	22	1.66	25	-	6.2	NO	12		X	
C	25	A-7-6(36)	100	100	100	96					60	32	54	8	2.07	95	.70	6.7	NO	17			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
OSAGE																							
HUGHES																							
A	23	A-7-6(27)	100	100	100	98	5	49	46	SIC	57	28	-	10	2.04	67	.49		NO	17			X
AC	23	A-7-6(27)	100	100	99	98	5	46	49	SIC	56	28	-	9	2.07	80	.49		NO	17			X
C	23	A-7-6(27)	100	100	100	97	9	41	50	SIC	58	29	-	9	2.07	82	.52		NO	17			X
JOHNSTON																							
A	16	A-7-6(20)	100	99	99	96					43	19	39	11	1.92	54	.15	5.6	NO	14		X	
AC	19	A-7-6(25)	100	99	98	93					46	25	38	10	1.99	56	.36	5.8	NO	15			X
C	20	A-7-6(27)	100	98	97	93					50	26	42	9	2.04	68	.39	7.1	NO	15			X
SEMINOLE																							
A	14	A-6(15)	100	99	98	93					40	14	39	15	1.79	42	-	6.4	NO	12		X	
C	15	A-7-6(20)	100	100	99	98					41	18	39	13	1.91	50	-	7.4	NO	14		X	
PARSONS																							
COAL																							
A	5	A-4(0)	100	98	96	75					21	3	-	-	-	-	-	5.3	NO	11	X		
B	22	A-7-6(26)	100	99	97	86					52	28	44	7	2.10	77	.49	5.7	NO	17			X
C	20	A-7-6(22)	100	99	96	82					49	26	44	9	2.06	71	.39	5.6	NO	15			X
HUGHES																							
A	5	A-4(8)	100	99	98	86	28	59	13	SIL	23	2	-	20	1.69	2	-		NO	11	X		
B	17	A-7-6(19)	100	100	99	94	14	51	35	SICL	44	21	-	11	1.96	48	.21		NO	14			X
C	19	A-7-6(20)	100	99	99	92	17	45	38	SICL	47	25	-	11	1.98	54	.36		NO	15			X
MURRAY																							
A	5	A-4(0)	100	99	96	69					20	4	-	-	-	-	-	5.9	NO	11	X		
B	17	A-7-6(17)	100	99	97	81					43	21	39	8	2.06	65	.21	6.5	NO	14			X
C	17	A-7-6(16)	100	98	97	80					41	21	37	8	2.08	60	.21	7.4	NO	14			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
PARSONS																							
OKFUSKEE																							
A	8	A-4(4)	100	99	99	90					29	5	-	-	-	-	-		NO	11		X	
B	20	A-7-6(26)	100	96	96	93					50	25	39	11	2.05	57	.36		NO	15			X
C	23	A-7-6(31)	100	97	97	92					52	31	37	10	2.05	55	.63		NO	17			X
PONTOTOC																							
A	8	A-4(4)	100	97	86	75					28	7	-	-	-	-	-	6.2	NO	11		X	
B	21	A-7-6(26)	100	97	95	86					50	28	45	19	2.03	52	.49	6.3	NO	17			X
C	17	A-7-6(10)	100	95	84	60					42	21	39	9	2.04	61	.21	7.5	NO	14			X
PICKENS																							
PONTOTOC																							
A	11	A-4(7)	100	94	90	81					39	7	-	-	-	-	-	6.7	NO	11		X	
C	18	A-7-5(16)	100	93	89	78					50	19	45	22	1.60	36	.15	4.3	NO	13			X
PLEDGER																							
COAL																							
A	16	A-7-6(21)	100	99	99	94	12	56	32	SICL	44	19	-	14	1.88	45	.15		NO	14			X
B	15	A-6(16)	100	100	99	91	16	52	32	SICL	39	17	-	12	1.94	48	-		NO	12			X
C	15	A-6(14)	100	100	99	88	22	48	30	CL	37	17	-	11	1.97	41	-		NO	12			X
POPE																							
OKFUSKEE																							
A	11	A-4(9)	100	98	97	92					33	10	-	-	-	-	-	7.5	NO	11		X	
AC	0	A-4(0)	100	95	83	41					NP	NP	-	-	-	-	-	6.3	5.4	9	X		
C	8	A-4(5)	100	99	98	84					27	7	-	-	-	-	-	7.0	NO	11		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
PORT																							
GARVIN																							
A	6	A-4(1)	100	100	99	71					22	4	-	-	-	-	-	7.1	NO	11	X		
B	5	A-4(0)	100	100	100	71					20	3	-	-	-	-	-	7.0	NO	11	X		
C	7	A-4(3)	100	100	99	83					24	6	-	-	-	-	-	7.2	NO	11		X	
JOHNSTON																							
A	4	A-4(0)	100	99	99	61					22	4	-	-	-	-	-	7.0	NO	11	X		
B	7	A-4(2)	100	100	95	71					26	6	-	-	-	-	-	6.0	NO	11		X	
C	16	A-6(19)	100	99	99	95					40	19	35	12	1.93	45	.15	7.5	NO	13		X	
MC CLAIN																							
A	8	A-4(5)	100	100	100	84					27	7	-	-	-	-	-	7.1	NO	11		X	
C	7	A-4(2)	100	100	99	86					23	5	-	-	-	-	-	7.8	NO	11		X	
MURRAY																							
A	14	A-6(16)	100	100	99	91					40	16	33	16	1.80	30	-	6.1	NO	12		X	
C	13	A-6(13)	100	100	99	91					34	15	30	13	1.88	32	-	7.0	NO	12		X	
PONTOTOC																							
A	12	A-6(11)	100	100	100	95	13	65	22	SIL	35	11	-	21	1.70	18	-		NO	12	X		
B	11	A-6(11)	100	100	99	96	15	62	23	SIL	32	11	-	18	1.77	21	-		NO	12	X		
C	12	A-6(14)	100	99	99	96	10	65	25	SIL	33	15	-	14	1.85	24	-		NO	12	X		
POTTAWATOMIE																							
A	11	A-6(9)	100	100	98	81	36	44	20	L	30	12	-	15	1.79	21	-		NO	12	X		
C	5	A-4(5)	100	100	100	62	61	23	16	SL	24	6	-	16	1.78	11	-		NO	10	X		
SEMINOLE																							
A	12	A-6(11)	100	99	98	82					31	15	-	-	-		-		NO	12		X	
B	11	A-6(8)	100	99	96	78					29	13	-	-	-	-	-		NO	12		X	
C	13	A-6(12)	100	98	96	81					34	16	-	-	-	-	-		NO	12		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
PRAGUE																							
OKFUSKEE																							
A	0	A-4(0)	100	99	97	47					NP	NP	-	-	-	-	-	6.1	5.8	10	X		
B	18	A-7-6(15)	100	100	99	69					47	23	42	11	1.97	61	.28	6.8	NO	14			X
C	21	A-7-6(20)	100	100	99	74					51	27	47	10	2.01	74	.42	8.3	NO	15			X
PULASKI																							
CLEVELAND																							
A	0	A-4(0)	100	100	99	45					NP	NP	-	-	-	-	-	6.9	5.7	9	X		
C	0	A-4(0)	100	100	99	40					NP	NP	-	-	-	-	-	7.2	5.4	9	X		
GARVIN																							
A	0	A-4(0)	100	100	99	53					NP	NP	-	-	-	-	-	6.6	6.1	10	X		
C	0	A-2-4(0)	100	100	90	14					NP	NP	-	-	-	-	-	7.2	3.8	8	X		
JOHNSTON																							
A	0	A-4(0)	100	100	99	36					NP	NP	-	-	-	-	-	5.4	5.1	9	X		
C	0	A-4(0)	100	100	100	44					NP	NP	-	-	-	-	-	5.5	5.6	9	X		
POTTAWATOMIE																							
A	0	A-4(1)	100	100	97	41	78	14	8	LS	NP	NP	-	-	-	-	-		5.5	9	X		
C	0	A-2-4(0)	100	100	94	21	88	10	2	S	NP	NP	-	-	-	-	-		4.3	7	X		
SEMINOLE																							
A	3	A-4(0)	100	100	98	50					23	5	-	-	-	-	-	5.6	6.0	10	X		
C	4	A-4(0)	100	99	96	54					21	4	-	-	-	-	-	6.1	6.2	10	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
RAVIA																							
JOHNSTON																							
A	8	A-4(7)	100	85	80	69	40	49	11	L	29	8	-	18	1.68	15	-		NO	11	X		
B	27	A-7-5(31)	97	90	87	82	23	27	50	C	65	34	-	10	2.00	86	.83		NO	16			X
REINACH																							
CLEVELAND																							
A	0	A-4(0)	100	98	96	37					NP	NP	-	-	-	-	-	7.3	5.2	9	X		
C	0	A-4(0)	100	100	99	67					NP	NP	-	-	-	-	-	7.9	NO	11	X		
GARVIN																							
A	6	A-4(2)	100	100	100	88					23	4	-	-	-	-	-	6.9	NO	11	X		
C	8	A-4(5)	100	100	100	97					26	6	-	-	-	-	-	7.5	NO	11		X	
HUGHES																							
A	5	A-4(0)	100	100	100	66					23	3	-	-	-	-	-	7.0	NO	11	X		
C	0	A-4(0)	100	100	100	69					NP	NP	-	-	-	-	-	7.4	NO	11	X		
JOHNSTON																							
A	0	A-2-4(0)	100	91	55	20					NP	NP	-	-	-	-	-	5.6	4.1	7	X		
B	0	A-2-4(0)	100	95	61	28					24	3	-	-	-	-	-	5.6	4.6	7	X		
C	0	A-2-4(0)	100	94	58	20					NP	NP	-	-	-	-	-	5.6	4.1	7	X		
MC CLAIN																							
A	9	A-4(5)	100	100	100	86					29	7	-	-	-	-	-	7.0	NO	11		X	
C	9	A-4(5)	100	100	94	79					27	8	-	-	-	-	-	7.7	NO	11		X	
MURRAY																							
A	9	A-4(6)	100	99	99	87					28	8	-	-	-	-	-	6.4	NO	11		X	
C	9	A-4(7)	100	99	99	87					29	9	-	-	-	-	-	7.5	NO	11		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
RENFROW																							
CLEVELAND																							
A	9	A-4(5)	100	98	98	87					32	6	-	-	-	-	-	7.3	NO	11		X	
B	18	A-7-6(21)	100	99	97	89					45	22	44	10	2.01	69	.24	6.9	NO	14			X
C	17	A-7-6(21)	100	98	98	92					45	21	40	9	2.06	65	.21	7.7	NO	14			X
GARVIN																							
A	10	A-4(7)	100	99	97	78					30	10	-	-	-	-	-	6.0	NO	11		X	
B	14	A-6(14)	100	100	98	83					37	17	32	16	1.87	30	-	5.4	NO	12		X	
C	14	A-6(16)	100	100	99	91					37	17	32	15	1.80	30	-	6.0	NO	12		X	
MC CLAIN																							
A	10	A-4(9)	100	99	99	91					32	10	29	26	1.87	6	-	6.7	NO	11		X	
B	21	A-7-6(29)	100	100	100	96					50	27	41	11	2.00	60	.42	7.4	NO	15			X
C	20	A-7-6(25)	99	98	98	92					46	26	35	9	2.05	53	.39	7.6	NO	15			X
OKFUSKEE																							
A	8	A-4(3)	100	100	100	75					29	6	-	-	-	-	-		NO	11		X	
B	19	A-7-6(22)	100	100	100	87					47	23	33	12	2.01	43	.28		NO	15			X
C	20	A-7-6(29)	100	99	99	97					50	26	38	8	1.95	59	.39		NO	15			X
POTTAWATOMIE																							
A	13	A-6(9)	100	98	91	69	43	33	24	L	37	16	-	14	1.83	32	-		NO	12	X		
B	20	A-7-6(22)	100	99	94	82	25	30	45	C	50	25	-	9	2.04	68	.36		NO	15			X
C	22	A-7-6(29)	100	99	96	89	15	33	52	C	52	29	-	5	2.23	78	.52		NO	17			X
SEMINOLE																							
A	12	A-6(9)	100	99	98	80					38	11	-	-	-	-	-	6.2	NO	12		X	
B	21	A-7-6(28)	100	99	98	94					51	26	47	9	2.11	81	.39	8.5	NO	15			X
C	20	A-7-6(25)	100	99	98	89					51	25	43	9	2.11	73	.36	7.8	NO	15			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
ROEBUCK																							
CLEVELAND																							
A	16	A-7-6(20)	100	99	99	93					44	19	40	11	2.02	60	.15	7.7	NO	14		X	
C	21	A-7-6(30)	100	99	99	97					53	27	47	9	2.12	81	.42	7.8	NO	17			X
OKFUSKEE																							
A	17	A-7-6(23)	100	100	100	98					45	21	37	4	1.94	64	.21		NO	14			X
B	22	A-7-6(31)	100	100	99	96					51	29	40	5	2.01	93	.52		NO	17			X
C	14	A-6(14)	100	99	96	84					38	17	30	12	1.98	35	-		NO	12		X	
POTTAWATOMIE																							
A	17	A-7-6(23)	100	99	98	98	3	53	44	SIC	44	21	-	11	1.94	54	.21		NO	14			X
B	18	A-7-6(23)	100	99	99	90					43	22	-	10	2.02	53	.24		NO	14			X
C	18	A-7-6(23)	100	99	99	90	4	50	46	SIC	43	23	-	10	2.02	53	.28		NO	14			X
SEMINOLE																							
A	26	A-7-5(40)	100	100	100	99					65	33	61	11	2.03	102	.76	7.4	NO	16			X
C	22	A-7-6(32)	100	99	99	96					53	29	50	8	2.12	89	.52	7.8	NO	17			X
SAN SABA																							
JOHNSTON																							
A	27	A-7-5(42)	100	100	98	98					66	35	-	-	-	-	.90	7.4	NO	16			X
AC	25	A-7-5(36)	100	98	97	94					62	32	52	8	2.06	91	.70	7.6	NO	16			X
C	26	A-7-6(36)	100	97	96	93					60	34	51	7	2.09	92	.83	6.3	NO	17			X
MURRAY																							
A	16	A-7-5(13)	100	91	81	73					51	15	48	16	1.68	53	-	8.0	NO	13		X	
AC	24	A-7-5(25)	100	92	87	77					61	30	51	11	2.02	81	.58	6.6	NO	16			X
C	25	A-7-5(29)	100	92	90	83					61	31	57	7	2.02	100	.63	7.4	NO	16			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
SCULLIN																							
JOHNSTON																							
A	14	A-7-6(10)	100	95	92	72					41	15	35	14	1.79	37	-	5.4	NO	14		X	
B	12	A-2-7(0)									47	19	44	12	1.87	60	.15	5.0	NO	11		X	
STEEDMAN																							
COAL																							
A	15	A-7-6(15)	100	97	95	88	24	53	23	SIL	41	16	-	17	1.74	32	-		NO	14	X		
B	25	A-7-5(37)	100	99	99	97	7	36	57	C	64	31	-	10	2.01	87	.63		NO	16			X
C	26	A-7-6(40)	100	99	99	98	5	38	57	C	63	34	-	9	2.08	85	.83		NO	17			X
PONTOTOC																							
A	7	A-4(3)	100	79	74	65					31	6	-	-	-	-	-	5.5	NO	11		X	
B	18	A-7-6(19)	100	98	97	81					50	21	45	12	1.94	64	.21	7.1	NO	15			X
C	20	A-7-6(27)	100	97	96	93					51	25	45	10	2.04	72	.36	7.6	NO	15			X
STEPHENVILLE																							
CLEVELAND																							
A	0	A-2-4(0)	100	99	96	31					NP	NP	-	-	-	-	-	7.3	4.8	8	X		
B	1	A-2-4(0)	100	100	95	32					27	6	-	-	-	-	-	5.2	4.9	8	X		
R	0	A-2-4(0)	100	100	96	35					NP	NP	-	-	-	-	-	5.2	5.1	9	X		
GARVIN																							
A	0	A-4(0)	100	99	97	40					NP	NP	-	-	-	-	-	5.7	5.3	9	X		
B	2	A-4(0)	100	98	94	41					22	5	-	-	-	-	-	5.1	5.4	9	X		
R	1	A-2-4(0)	100	100	96	29					21	4	-	-	-	-	-	4.2	4.7	7	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
STEPHENVILLE																							
JOHNSTON																							
A	1	A-4(0)	100	99	93	42					17	3	-	-	-	-	-	5.4	5.5	9	X		
B	10	A-6(7)	100	98	93	61					34	15	30	11	1.94	37	-	5.0	NO	12		X	
R	6	A-4(2)	100	98	93	51					24	10	23	11	1.95	23	-	4.3	6.5	10	X		
MC CLAIN																							
A	0	A-2-4(0)	100	100	98	32					NP	NP	-	-	-	-	-	5.9	4.9	8	X		
B	2	A-4(0)	100	100	98	46					23	3	-	-	-	-	-	5.7	5.7	10	X		
R	3	A-4(0)	100	100	99	48					24	3	-	-	-	-	-	6.0	5.8	10	X		
PONTOTOC																							
A	0	A-2-4(0)	100	99	95	29					NP	NP	-	-	-	-	-	5.2	4.7	7	X		
B	2	A-2-4(0)	100	99	96	34					29	10	-	-	-	-	-	5.5	5.5	8	X		
POTTAWATOMIE																							
A	0	A-2-4(0)	100	100	92	33	77	16	7	LS	NP	NP	-	-	-	-	-		4.9	9	X		
B	8	A-6(4)	100	99	93	45	62	12	26	SCL	34	17	-	14	1.83	27	-		6.2	11			X
R	1	A-2-4(0)	100	100	95	33	71	8	21	SCL	27	8	-	17	1.77	12	-		5.0	9	X		
SEMINOLE																							
A	0	A-2-4(0)	100	99	86	26					NP	NP	-	-	-	-	-	4.3	4.5	7	X		
B	6	A-6(2)	100	99	88	42					29	13	26	15	1.86	21	-	4.0	6.0	11	X		
STIDHAM																							
COAL																							
A	0	A-2-4(0)	100	92	64	19					NP	NP	-	-	-	-	-	5.2	4.0	8	X		
B	5	A-6(1)	100	94	71	37					30	13	27	15	1.87	22	-	4.0	5.6	10	X		
C	1	A-2-4(0)	100	93	63	22					22	8	-	-	-	-	-	4.1	4.2	7	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
STIDHAM																							
GARVIN																							
A	0	A-2-4(0)	100	87	58	12					NP	NP	-	-	-	-	-	5.4	3.5	8	X		
B	3	A-4(0)	100	95	79	42					26	7	-	-	-	-	-	4.9	5.4	9	X		
C	0	A-4(0)	100	95	88	46					NP	NP	-	-	-	-	-	5.0	5.7	10	X		
HUGHES																							
A	0	A-2-4(0)	100	94	76	35					NP	NP	-	-	-	-	-	5.2	5.0	9	X		
B	2	A-4(0)	100	96	80	41					22	6	-	-	-	-	-	5.1	5.4	9	X		
C	1	A-2-4(0)	100	96	79	33					21	6	-	-	-	-	-	5.0	4.9	8	X		
OKFUSKEE																							
A	0	A-4(0)	100	99	96	68					NP	NP	-	-	-	-	-		NO	11	X		
B	5	A-4(0)	100	99	96	72					22	3	-	-	-	-	-		NO	11	X		
C	0	A-4(0)	100	99	96	73					NP	NP	-	-	-	-	-		NO	11	X		
SEMINOLE																							
A	0	A-2-4(0)	100	98	89	34					NP	NP	-	-	-	-	-		5.0	8	X		
B	7	A-6(3)	100	91	87	53					27	11	-	-	-	-	-		6.5	11		X	
C	1	A-2-4(0)	100	88	80	29					25	9	-	-	-	-	-		5.1	7	X		
SUMTER																							
JOHNSTON																							
A	17	A-7-6(19)	100	94	92	87					44	20	38	9	2.00	58	.20	7.7	NO	14			X
C	22	A-7-6(30)	100	96	96	94					52	28	42	9	2.06	69	.49	7.8	NO	17			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
SWITZER																							
OKFUSKEE																							
A	10	A-4(9)	100	98	96	91					32	10	-	-	-	-	-	6.0	NO	11		X	
B	16	A-7-6(20)	100	99	98	94					43	19	42	11	1.97	62	.15	6.0	NO	14		X	
C	15	A-6(15)	100	99	98	86					39	17	38	11	1.99	54	-	6.6	NO	12		X	
TABLER																							
GARVIN																							
A	8	A-4(5)	100	100	99	91					25	7	-	-	-	-	-	5.7	NO	11		X	
B	19	A-7-6(24)	100	99	99	94					45	24	35	8	2.03	54	.32	6.4	NO	15			X
C	16	A-7-6(20)	100	100	99	94					42	19	37	9	2.01	57	.15	6.2	NO	14		X	
MC CLAIN																							
A	7	A-4(3)	100	99	99	87					29	3	-	-	-	-	-	7.2	NO	11		X	
B	20	A-7-6(27)	100	99	99	94					50	26	43	10	2.01	66	.39	7.3	NO	15			X
C	16	A-7-6(19)	100	90	98	96					42	20	41	11	1.96	58	.20	7.6	NO	14		X	
TALIHINA																							
HUGHES																							
A	11	A-4(8)	100	96	94	80					34	10	-	-	-	-	-	5.1	NO	11		X	
C	19	A-7-6(26)	100	98	98	95					48	24	39	18	1.74	37	.32	5.1	NO	15			X
JOHNSTON																							
A	20	A-7-5(18)	91	83	81	76					54	22	49	13	1.85	67	.24	6.6	NO	14			X
C	20	A-7-6(25)	100	95	93	89					51	25	44	13	1.90	58	.36	7.5	NO	15			X
OKFUSKEE																							
A	13	A-6(15)	100	100	100	95					38	14	-	-	-	-	-		NO	12		X	
C	21	A-7-6(31)	100	100	100	99					52	27	36	12	1.92	46	.42		NO	17			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
TALIHINA																							
SEMINOLE																							
A	20	A-7-6(27)	100	99	98	96					52	24	48	12	1.94	71	.32	7.2	NO	15			X
C	23	A-7-6(33)	100	100	99	98					56	29	50	11	1.95	75	.52	7.4	NO	17			X
TALOKA																							
HUGHES																							
A	5	A-4(8)	98	96	94	78	38	51	11	SIL	23	2	-	21	1.71	5	-		NO	11	X		
B	26	A-7-5(25)	97	94	93	86	25	32	43	C	62	35	-	10	2.00	66	.90		NO	16			X
C	22	A-7-6(24)	92	86	85	77	30	35	35	CL	53	30	-	11	2.01	62	.58		NO	17			X
OKFUSKEE																							
A	5	A-4(0)	100	99	98	88					24	1	-	-	-	-	-		NO	11	X		
B	23	A-7-6(31)	100	100	99	93					53	30	39	3	1.95	71	.58		NO	17			X
C	19	A-7-6(26)	100	100	99	94					47	25	36	13	1.96	45	.36		NO	15			X
TALPA																							
JOHNSTON																							
A	6	A-4(1)	98	85	80	58					27	6	-	-	-	-	-	5.3	6.3	10	X		
MURRAY																							
A	6	A-4(2)	72	71	68	49					32	10	-	-	-	-	-	6.6	6.0	10	X		
PONTOTOC																							
A	8	A-4(3)	100	99	91	67					30	7	-	-	-	-	-	6.7	NO	11		X	
SEMINOLE																							
A	14	A-6(11)	100	98	95	79					40	14	37	16	1.84	38	-	6.6	NO	12		X	

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
TELLER																							
GARVIN																							
A	0	A-4(0)	100	100	97	49					NP	NP	-	-	-	-	-	7.1	5.9	10	X		
B	4	A-4(0)	100	100	98	53					22	5	-	-	-	-	-	6.9	6.1	10	X		
C	6	A-4(1)	100	100	99	67					23	5	-	-	-	-	-	6.7	NO	11	X		
JOHNSTON																							
A	0	A-4(0)	100	98	90	47					NP	NP	-	-	-	-	-	5.9	5.8	10	X		
B	4	A-4(0)	100	98	92	57					20	5	-	-	-	-	-	5.1	6.4	10	X		
C	0	A-4(0)	100	96	91	36					NP	NP	-	-	-	-	-	5.0	5.1	9	X		
MC CLAIN																							
A	5	A-4(1)	100	99	98	53					29	6	-	-	-	-	-	6.7	6.1	10	X		
B	12	A-6(8)	100	100	90	75					33	13	32	15	1.82	31	-	7.0	NO	12		X	
C	11	A-6(9)	100	100	100	86					31	12	27	15	1.84	22	-	7.5	NO	12		X	
MURRAY																							
A	3	A-4(0)	100	98	97	53					21	4	-	-	-	-	-	7.0	6.1	10	X		
B	10	A-6(6)	100	99	98	66					32	12	29	15	1.86	27	-	5.5	NO	12		X	
C	6	A-4(2)	100	98	77	53					27	9	-	-	-	-	-	4.9	6.6	10	X		
OKFUSKEE																							
A	0	A-4(0)	100	99	95	47					NP	NP	-	-	-	-	-	7.0	5.8	10	X		
B	8	A-4(4)	100	100	98	70					26	8	-	-	-	-	-	7.4	NO	11		X	
C	3	A-4(0)	100	100	97	49					20	4	-	-	-	-	-	7.7	5.9	10	X		
POTTAWATOMIE																							
A	0	A-4(1)	100	96	84	42	72	21	7	SL	NP	NP	-	-	-	-	-		5.5	9	X		
B	6	A-6(2)	100	92	79	43	66	13	21	SCL	27	12	-	19	1.71	9	-		6.0	10	X		
C	0	A-2-4(0)	100	89	63	21	82	7	11	SL	NP	NP	-	-	-	-	-		4.1	7	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
TELLER																							
SEMINOLE																							
A	10	A-4(6)	100	98	95	72					35	9	-	-	-	-	-	6.0	NO	11		X	
B	12	A-6(10)	100	99	97	79					36	13	35	13	1.87	40	-	5.7	NO	12		X	
C	14	A-6(12)	100	100	97	77					38	17	36	13	1.89	43	-	6.5	NO	12		X	
TISHOMINGO																							
JOHNSTON																							
A	6	A-4(6)	100	87	77	63	45	46	9	L	27	5	-	19	1.63	10	-		NO	11	X		
B	0	A-2-4(0)	63	41	36	26	75	15	10	SL	36	8	-	20	1.67	21	-		NO	7	X		
MURRAY																							
A	0	A-2-4(0)	61	28	23	13					31	9	-	-	-	-	-	5.1	NO	8	X		
B	13	A-2-7(0)	73	42	36	27					47	16	46	-	-	-	-	4.6	4.4	9		X	
C	6	A-4(2)	59	58	56	47					39	10	-	-	-	-	-	4.2	5.6	10	X		
TRAVIS																							
JOHNSTON																							
A	0	A-1-B(0)	69	40	34	16					NP	NP	-	-	-	-	-	5.9	3.2	8	X		
B	4	A-2-6(0)	86	61	53	22					27	11	-	-	-	-	-	6.5	4.3	8	X		
C	0	A-1-B(0)	73	46	41	18					18	2	-	-	-	-	-	5.0	3.4	8	X		
MURRAY																							
A	0	A-1-B(0)	75	41	33	14					NP	NP	-	-	-	-	-	6.2	3.1	8	X		
B	13	A-2-7(0)	75	45	40	30					43	19	40	13	1.90	51	.15	6.0	4.6	10		X	
C	4	A-2-6(0)	51	33	28	20					37	16	34	14	1.83	37	-	6.1	3.7	8	X		

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
TYLER																							
OKFUSKEE																							
A	8	A-4(4)	100	99	96	83					27	6	-	-	-	-	-		NO	11		X	
B	22	A-7-6(28)	100	99	97	91					55	27	-	-	-	-	.42		NO	17			X
C	20	A-7-6(23)	100	99	98	83					52	25	-	-	-	-	.36		NO	15			X
VANN																							
OKFUSKEE																							
A	10	A-4(8)	100	99	98	96					34	7	-	-	-	-	-	7.0	NO	11		X	
B	21	A-7-6(21)	100	100	99	77					51	27	46	10	2.01	73	.42	8.0	NO	15			X
C	16	A-6(19)	100	99	99	95					40	19	39	11	2.00	56	.15	7.2	NO	13		X	
VANOSS																							
CLEVELAND																							
A	8	A-4(3)	100	98	93	68					29	7	-	-	-	-	-	7.5	NO	11		X	
B	11	A-6(8)	100	99	94	67					34	14	33	14	1.88	36	-	6.9	NO	12		X	
C	4	A-4(0)	100	96	91	59					22	4	-	-	-	-	-	7.8	6.5	10	X		
GARVIN																							
A	0	A-4(0)	100	100	99	61					NP	NP	-	-	-	-	-	6.0	NO	11	X		
B	12	A-6(8)	100	100	99	73					32	14	28	13	1.91	29	-	5.8	NO	12		X	
C	12	A-6(9)	100	100	99	78					35	12	30	11	1.93	36	-	6.0	NO	12		X	
HUGHES																							
A	0	A-4(0)	100	96	86	62					NP	NP	-	-	-	-	-	4.9	NO	11	X		
B	8	A-4(4)	100	96	88	67					26	10	24	16	1.78	15	-	5.0	NO	11		X	
C	7	A-4(3)	100	95	85	61					23	9	-	-	-	-	-	5.2	NO	11		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
VANOSS																							
MC CLAIN																							
A	3	A-4(0)	100	97	88	65					19	1	-	-	-	-	-	6.8	NO	11	X		
B	9	A-4(6)	100	98	94	87					27	8	26	12	1.97	27	-	7.5	NO	11		X	
C	10	A-6(7)	100	98	93	76					29	11	26	15	1.87	21	-	7.8	NO	12		X	
OKFUSKEE																							
A	0	A-4(0)	100	100	99	59					NP	NP	-	-	-	-	-		NO	10	X		
B	12	A-6(8)	100	99	99	65					34	16	-	-	-	-	-		NO	12		X	
C	5	A-4(1)	100	100	97	72					21	4	-	-	-	-	-		NO	11	X		
PONTOTOC																							
A	0	A-4(0)	100	100	99	93					NP	NP	-	-	-	-	-	5.0	NO	11	X		
B	9	A-4(6)	100	99	98	92					28	8	-	-	-	-	-	6.1	NO	11		X	
C	11	A-6(10)	100	99	97	88					31	13	28	14	1.84	26	-	4.9	NO	12		X	
CREEK																							
A	7	A-4(8)	100	99	95	78	44	41	2	L	23	5	-	14	1.82	12	-		NO	11	X		
POTTAWATOMIE																							
B	17	A-7-6(12)	100	99	94	71	32	38	30	CL	42	21	-	12	1.94	48	.21		NO	14			X
C	10	A-4(3)	100	98	90	50	63	21	16	SL	24	8	-	16	1.79	12	-		5.9	10	X		
VERDIGRIS																							
COAL																							
A	13	A-6(14)	100	100	99	94					35	14	32	18	1.83	26	-	5.5	NO	12		X	
AC	7	A-4(2)	100	100	100	76					23	6	-	-	-	-	-	5.6	NO	11		X	
C	5	A-4(0)	100	100	100	79					21	3	-	-	-	-	-	5.9	NO	11	X		

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
VERDIGRIS																							
HUGHES																							
A	9	A-4(6)	100	100	99	93					27	8	-	-	-	-	-	5.7	NO	11		X	
C	8	A-4(5)	100	100	100	91					25	7	-	-	-	-	-	5.4	NO	11		X	
OKFUSKEE																							
A	7	A-4(4)	100	100	100	94					26	5	-	-	-	-	-		NO	11		X	
AC	10	A-4(9)	100	100	99	96					33	9	-	-	-	-	-		NO	11		X	
C	10	A-4(10)	100	100	100	96					31	10	28	11	1.83	30	-		NO	11		X	
PONTOTOC																							
A	9	A-4(6)	100	100	99	93					29	7	-	-	-	-	-	5.5	NO	11		X	
C	8	A-4(5)	100	100	99	95					27	6	-	-	-	-	-	4.5	NO	11		X	
SEMINOLE																							
A	11	A-6(11)	100	99	99	95					33	11	31	16	1.82	28	-	7.0	NO	12		X	
C	14	A-6(16)	100	99	98	91					38	17	34	14	1.89	39	-	5.9	NO	12		X	
VERNON																							
CLEVELAND																							
A	9	A-6(6)	100	100	99	67					31	11	30	13	1.88	32	-	7.7	NO	12		X	
C	13	A-6(15)	100	100	98	94					36	15	34	11	2.04	47	-	7.9	NO	12		X	
GARVIN																							
A	18	A-7-6(18)	100	97	94	81					46	21	39	8	2.07	65	.21	7.7	NO	14			X
C	16	A-7-6(18)	100	96	95	87					46	18	41	9	2.06	67	-	8.1	NO	14		X	
MC CLAIN																							
A	0	A-4(0)	99	99	99	95					NP	NP	46	14	1.95	63	-	7.4	NO	11	X		
C	20	A-7-6(27)	99	97	97	94					49	26	41	11	2.10	63	.39	7.9	NO	15			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
VERNON																							
OKFUSKEE																							
A	17	A-7-6(21)	100	99	99	94					43	21	34	2	2.06	66	.21		NO	14			X
C	15	A-7-6(19)	100	100	99	95					41	18	30	2	2.09	59	-		NO	14		X	
PONTOTOC																							
A	21	A-7-6(25)	100	94	92	85					53	26	51	9	1.98	84	.39	7.3	NO	15			X
C	24	A-7-6(31)	100	93	92	88					57	32	51	8	2.09	89	.70	7.2	NO	17			X
POTTAWATOMIE																							
A	22	A-7-6(34)	100	99	99	98	4	43	53	SIC	56	28	-	9	1.97	75	.49		NO	17			X
B	26	A-7-6(34)	100	99	98	90					60	35	-	7	2.10	90	.90		NO	17			X
C	27	A-7-6(35)	100	99	97	89	17	38	45	C	62	37	-	7	2.14	91	1.06		NO	17			X
SEMINOLE																							
A	21	A-7-5(20)	100	92	87	76					55	25	50	11	2.03	80	.36	7.2	NO	14			X
C	18	A-7-6(21)	100	96	95	91					46	21	42	13	1.92	55	.21	7.6	NO	14			X
WAURIKA																							
POTTAWATOMIE																							
A	14	A-6(13)	100	100	98	82	32	48	20	L	35	18	-	11	1.95	39	-		NO	12			X
B	21	A-7-6(24)	100	99	98	82	23	37	40	C	49	29	-	9	2.05	63	.52		NO	15			X
C	21	A-7-6(26)	100	100	100	86	22	38	40	C	48	29	-	7	2.10	64	.52		NO	15			X
SEMINOLE																							
A	9	A-4(5)	100	99	97	78					30	7	-	-	-	-	-	4.8	NO	11		X	
B	21	A-7-6(28)	100	100	99	91					50	28	45	8	2.07	76	.49	6.4	NO	17			X
C	21	A-7-6(26)	100	99	98	86					51	28	47	10	2.05	77	.49	7.4	NO	17			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
WILSON																							
COAL																							
A	9	A-4(7)	100	99	98	92					28	9	-	-	-	-	-	5.1	NO	11		X	
B	25	A-7-6(36)	100	99	98	95					60	32	51	9	2.07	86	.70	4.7	NO	17			X
C	23	A-7-6(32)	100	99	98	94					54	30	48	8	2.10	83	.58	6.6	NO	17			X
WINDTHORST																							
GARVIN																							
A	0	A-2-4(0)	100	100	99	26					NP	NP	-	-	-	-	-	7.1	4.5	7	X		
B	21	A-7-5(15)	100	98	96	60					57	27	-	-	-	-	.42	6.5	NO	13			X
C	18	A-7-6(11)	100	98	91	58					50	21	-	-	-	-	.21	6.6	6.9	14			X
JOHNSTON																							
A	0	A-4(0)	100	95	92	55					NP	NP	-	-	-	-	-	6.3	6.2	10	X		
B	19	A-7-6(11)	100	98	91	53					54	26	-	-	-	-	.39	6.4	6.6	14			X
C	16	A-7-5(7)	100	98	88	49					49	19	-	-	-	-	.15	6.5	6.4	12		X	
OKFUSKEE																							
A	0	A-2-4(0)	100	99	87	19					NP	NP	-	-	-	-	-	5.6	4.1	8	X		
B	7	A-6(3)	100	99	89	47					34	12	32	14	1.86	34	-	5.6	6.3	11		X	
C	10	A-6(6)	100	100	94	53					36	16	35	15	1.82	36	-	6.8	6.6	12		X	
PONTOTOC																							
A	9	A-4(8)	100	99	98	81	59	18	23	SCL	27	7	-	17	1.78	17	-		NO	11	X		
B	16	A-7-6(12)	100	100	99	77	38	19	43	C	44	17	-	13	1.89	49	-		NO	14			X
C	14	A-6(10)	100	100	100	73	47	20	33	SCL	39	16	-	14	1.85	39	-		NO	12	X		
POTTAWATOMIE																							
A	0	A-4(1)	100	99	92	41	73	23	4	SL	NP	NP	-	-	-	-	-		5.4	9	X		
B	11	A-6(8)	100	100	97	66	46	22	32	SCL	32	16	-	14	1.85	25	-		NO	12	X		
C	15	A-6(15)	100	100	100	87	22	44	34	CL	37	18	-	14	1.88	32	-		NO	12			X

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
WOODSON																							
JOHNSTON																							
A	9	A-4(6)	100	99	97	81					28	9	-	-	-	-	-	5.3	NO	11		X	
B	22	A-7-6(27)	100	97	97	89					55	27	46	8	2.08	80	.42	4.8	NO	17			X
C	21	A-7-6(27)	100	97	96	90					53	27	43	7	2.11	75	.42	6.9	NO	17			X
MURRAY																							
A	7	A-4(2)	100	99	96	73					25	6	-	-	-	-	-	5.8	NO	11		X	
B	20	A-7-6(21)	100	99	96	80					49	25	42	8	2.08	70	.36	6.6	NO	15			X
C	16	A-7-6(14)	100	98	95	73					42	20	37	10	2.02	55	.20	7.5	NO	14		X	
OKFUSKEE																							
A	10	A-4(9)	100	98	97	93					32	9	-	-	-	-	-		NO	11		X	
B	20	A-7-6(28)	100	99	98	96					48	26	39	3	2.00	71	.39		NO	15			X
C	22	A-7-6(32)	100	99	98	97					53	29	40	7	2.01	66	.52		NO	17			X
PONTOTOC																							
A	11	A-6(10)	100	99	98	93					32	11	32	16	1.76	28	-	5.8	NO	12		X	
B	21	A-7-6(29)	100	99	98	94					51	28	45	9	2.04	74	.49	5.6	NO	17			X
C	22	A-7-6(31)	100	99	98	94					51	30	45	9	2.08	75	.58	7.2	NO	17			X
YAHOLA																							
CLEVELAND																							
A	9	A-4(8)	100	100	100	92					29	9	-	-	-	-	-	7.4	NO	11		X	
C	6	A-4(1)	100	99	101	89					23	3	-	-	-	-	-	7.7	NO	11	X		
GARVIN																							
A	0	A-2-4(0)	100	100	100	32					NP	NP	-	-	-	-	-	7.2	4.9	8	X		
C	0	A-4(0)	100	100	100	39					NP	NP	-	-	-	-	-	7.3	5.3	9	X		

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
YAHOLA																							
JOHNSTON																							
A	0	A-4(0)	100	100	99	55					NP	NP	-	-	-	-	-	7.4	6.3	10	X		
C	0	A-2-4(0)	100	100	98	30					NP	NP	-	-	-	-	-	7.5	4.8	8	X		
MURRAY																							
A	0	A-4(0)	100	99	99	36					NP	NP	-	-	-	-	-	7.5	5.1	9	X		
C	0	A-4(0)	100	100	100	41					NP	NP	-	-	-	-	-	7.3	5.4	9	X		
OKFUSKEE																							
A	6	A-4(0)	100	100	99	74					26	2	-	-	-	-	-		NO	11	X		
C	0	A-4(0)	100	100	100	72					NP	NP	-	-	-	-	-		NO	11	X		
PONTOTOC																							
A	0	A-4(0)	100	100	99	65					NP	NP	-	-	-	-	-	5.4	NO	11	X		
C	0	A-4(0)	100	100	100	48					NP	NP	-	-	-	-	-	7.1	5.8	10	X		
POTTAWATOMIE																							
A	0	A-2-4(0)	100	100	96	30	77	14	9	SL	NP	NP	-	-	-	-	-		4.7	8	X		
C	0	A-2-4(0)	100	99	95	33	76	12	12	SL	NP	NP	-	-	-	-	-		4.9	9	X		
SEMINOLE																							
A	5	A-4(1)	100	100	98	57					25	5	-	-	-	-	-	7.3	6.4	10	X		
C	0	A-2-4(0)	100	97	82	16					NP	NP	-	-	-	-	-	7.2	3.9	8	X		
ZANEIS																							
CLEVELAND																							
A	0	A-4(0)	100	99	98	64					NP	NP	-	-	-	-	-	7.6	NO	11	X		
B	14	A-6(13)	100	100	99	83					38	16	38	10	2.02	57	-	6.9	NO	12		X	
C	13	A-6(10)	100	99	98	73					35	16	31	11	1.96	38	-	7.6	NO	12		X	

Highway Engineering Characteristics of Soil Series

Soil Series & Horizons by County	O.S.I.	AASHO Classification	Sieve Analysis (% Passing) No. 10	No. 40	No. 60	No. 200	Particle Sizes % Sand	% Silt	% Clay	Texture (U.S.D.A)	Soil Constants Liquid Limit	Plastic Index	Field Moisture Equivalent	Shrinkage Limit	Shrinkage Ratio	Volumetric Change	Potential Vertical Rise	pH	Suitability Stabilization % Asphalt	% Cement	Subgrade Good	Fair	Poor
ZANEIS																							
GARVIN																							
A	0	A-4(0)	100	99	99	70					NP	NP	-	-	-	-	-	7.1	NO	11	X		
B	9	A-4(6)	100	100	99	74					28	10	26	14	1.88	22	-	6.4	NO	11		X	
C	11	A-6(7)	100	100	99	67					33	14	29	13	1.90	30	-	5.8	NO	12		X	
MC CLAIN																							
A	3	A-4(0)	100	100	100	54					24	3	-	-	-	-	-	6.3	6.2	10	X		
B	8	A-4(4)	100	100	100	62					32	10	-	-	-	-	-	7.3	NO	11		X	
C	2	A-4(0)	100	100	100	43					24	2	-	-	-	-	-	7.3	5.5	9	X		
POTTAWATOMIE																							
A	12	A-6(8)	100	98	94	70	41	41	18	L	35	14	-	18	1.70	24	-		NO	12	X		
B	19	A-7-6(17)	100	99	96	78	30	33	37	CL	46	24	-	11	1.99	55	.32		NO				X
C	9	A-4(8)	100	100	97	75	40	30	30	CL	27	10	-	14	1.81	20	-		NO		X		

TABLE OF TERMS, SOILS*

A HORIZON--See HORIZON, SOIL.

AASHO--American Association of State Highway Officials; a performance value determined by using the percent of soil material passing certain specific sieve sizes, liquid limit, and plasticity index in an emperical mathematical formula. Indicates the suitability of the soils as construction materials. See page 15.

ABC SOIL--A soil with a complete profile, including clearly developed A, B, and C horizons.

AC SOIL--A soil having only A and C horizons developed; no clearly developed B horizon.

ACID SOIL--A soil that gives an acid reaction (precisely, below pH 7.0; practically, below pH 6.6).

AEOLIAN--Wind-transported materials, including wind-blown sands, wind-blown silt, and wind-carried volcanic ash. (Eolian).

ALKALI SOIL--A soil in which soldium occupies 15 percent or more of the total exchange capacity (usually indicated by a pH value of 8.5 or higher).

ALLUVIAL SOILS--1. Soils developed from relatively recently deposited materials, transported by flowing water.
2. A Great Soil Group (taxonomic unit) which is comprised of azonal soils developed from transported and recently deposited alluvium characterized by a weak modification (or none) of the original soil-forming processes. "Alluvial" is capitalized when used with this meaning.

ALLUVIUM--Fine material; such as sand, mud, or other sediments deposited on land by streams. Stratification is a common characteristic.

AZONAL--A soil that does not have a strongly developed profile because of extreme youth, strong relief, or unusually stony parent material.

B. HORIZON--See HORIZON, SOIL.

BEDROCK--The solid rock underlying soils or other superficial formation.

BLOCKY (OR BLOCK-LIKE) STRUCTURE--See STRUCTURE, SOIL.

BRITTLE--See CONSISTENCE.

BRUNIZEM SOILS--The name used for Prairie Soils by Simonson, et al, (see PRAIRIE SOILS).

C--Clay, See TEXTURE.

C HORIZON--See HORIZON, SOIL.

*For Geological terms see page 20.

CALCAREOUS SOIL--Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid. Soil alkaline in reaction, owing to the presence of free calcium carbonate.

CATENA--A group of soil series within any one soil zone developed from similar parent material, but with contrasting characteristics of the solum due to differences in relief or drainage.

CHERNOZEM SOILS--A zonal group of soils having a deep, dark-colored to nearly-black surface horizon, rich in organic matter, which grades below into lighter-colored soil and finally into a layer of lime accumulation; developed under tall and mixed grasses in a temperate to cool subhumid climate.

CL--Clay Loam, See TEXTURE.

CLAY--See SEPARATE and TEXTURE.

CLAYPAN--A compact soil horizon or layer rich in clay and separated more or less abruptly from the overlying horizon; hard when dry, and plastic or stiff when wet. Probably formed in part by the accumulation of clay from the upper horizons.

COLUMNAR STRUCTURE--See STRUCTURE, SOIL.

COMPACT--See CONSISTENCE.

COMPLEX, SOIL--A soil association composed of such an intimate mixture or areas of soil series, types, or phases that these cannot be indicated separately upon maps of the scale used, so that the association is mapped as a unit.

CONCRETIONS--Hardened local concentrations of certain chemical compounds, such as calcium carbonate and iron and manganese oxides, that form indurated grains or nodules of various sizes, shapes, and colors.

CONCRETIONS, LIME--Usually lime concretions consist of calcium carbonate and other included soil constituents. They vary greatly in size, from very small particles up to two feet in diameter. They take many shapes, with spheres, rough tubular or branched tubular, and rough plates being the common forms.

Iron and Manganese--Often called "shot." These are indurated accumulations of iron and manganese oxides. They are commonly in the form of spherical pellets.

CONSISTENCE, SOIL--The relative mutual attraction of the particles in the whole soil mass or their resistance to separation of deformation (as evidenced in cohesion and plasticity). The terms used in soil descriptions for consistence as given in the Soil Survey Manual follow:

WHEN DRY--

LOOSE--Noncoherent.

SOFT--Soil mass is very weakly coherent and fragile; breaks to powder or individual grains under very slight pressure.

SLIGHTLY HARD--Weakly resistant to pressure; easily broken between thumb and forefinger.

HARD--Moderately resistant to pressure; can be broken in the hands without difficulty, but is barely breakable between thumb and forefinger.

VERY HARD--Very resistant to pressure; can be broken in the hands only with difficulty; not breakable between thumb and forefinger.

EXTREMELY HARD--Extremely resistant to pressure; cannot be broken in the hands.

WHEN MOIST--

LOOSE--Noncoherent.

VERY FRIABLE--Soil material crushes under very gentle pressure, but coheres when pressed together.

FRIABLE--Soil material crushes easily under gentle to moderate pressure between thumb and forefinger, and coheres when pressed together.

FIRM--Soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

VERY FIRM--Soil material crushes under strong pressure; barely crushable between thumb and forefinger.

EXTREMELY FIRM--Soil material crushes only under very strong pressure; cannot be crushed between thumb and forefinger and must be broken apart bit by bit.

COMPACT--A combination of firm consistence and close packing or arrangement of particles.

WHEN WET--Determined when the moisture of the soil material is at or slightly above field capacity.

PLASTICITY--The ability to change shape continuously under the influence of applied stress and to retain the new shape upon removal of the stress. For field determination of plasticity, roll the soil material between thumb and finger and observe whether or not a wire or thin rod of soil can be formed. Express degree of resistance to deformation at a moisture content at or slightly above field capacity as follows:

NONPLASTIC--No wire is formable.

SLIGHTLY PLASTIC--Wire formable, but soil mass easily deformable.

PLASTIC--Wire formable and moderate pressure required for deformation of the soil mass.

VERY PLASTIC--Wire formable and much pressure required for deformation of the soil mass.

CRUMB STRUCTURE--See STRUCTURE, SOIL.

DEGRADATION--Change of a soil type to one more highly leached.

DRAINAGE, SOIL--Refers to the rapidity and extent of the removal of water from the soil, in relation to additions, especially by surface runoff and by flow through the soil.

Permeability--That quality of the soil that enables it to transmit water or air. It is measured in terms of rate of flow through a unit cross section of saturated soil in unit time.

EOLIAN--See AEOLIAN.

FERRUNGINOUS--Iron-bearing; usually refers to material of comparatively high iron oxide content.

FIELD MOISTURE EQUIVALENT--The minimum moisture content, expressed as a percent of oven dry soil, at which a smooth surface of soil will absorb no more water in 30 seconds. "Procedure: AASHO T93-54."

FIRM--See CONSISTENCE WHEN MOIST.

FLOURY--Fine-textured soil consisting predominantly of silt, or silt-size aggregates of clay particles, which is incoherent when dry, smooth, and dust-like.

FLUFFY--See CONSISTENCE.

FRAGIPANS--Compact horizons, rich in silt, sand, or both, and usually low in clay. When dry, the horizon appears to be indurated, but the apparent induration disappears upon moistening. Undisturbed fragipans are nearly impermeable to water.

FRIABLE--See CONSISTENCE WHEN MOIST.

GLEIZATION--A general term for the process of soil formation leading to the development, under the influence of excessive moistening, of a glei (gley) horizon in the lower part of the solum. A soil horizon in which the material ordinarily is bluish-gray or olive-gray, more or less sticky, compact, and often structureless, is called a glei horizon and is developed under the influence of excessive moistening.

GRANULAR STRUCTURE--See STRUCTURE.

GRAY-BROWN PODZOLIC SOILS--A zonal group of soils having a comparatively thin organic covering and organic-mineral layers over a grayish-brown leached layer resting upon a brown, blocky, illuvial B horizon; developed under deciduous forest in a temperate, moist climate.

GREAT SOIL GROUP (SOIL CLASSIFICATION)--A group of soils having common internal soil characteristics; includes one or more families of soils. Among the zonal soils, each great soil group includes the soils having common internal characteristics developed through the influence of environmental forces of broad geographic significance, especially vegetation and climate; among the intrazonal soils, each great soil group includes the soils having common internal characteristics developed through the influence of environmental forces of both broad and local significance; among the azonal soils, each great soil group includes similar soils that are without developed characteristics, owing to the influence of some local condition of parent material or relief. (See AZONAL SOIL, INTRAZONAL SOIL, ZONAL SOIL.)

GRITTY--Containing enough angular particles of sand that they dominate the feel. Usually applied to soils where the actual quantity of sand is small.

HARD--See CONSISTENCE WHEN DRY.

HARDPAN--A hardened or cemented soil horizon. The term should not be applied to hard clay layers that are not cememted. (See CLAYPAN.) The soil may have any texture and is compacted or cemented by iron oxide, organic matter, silica, calcium carbonate, or other substances.

HEAVY--Applied to fine-textured soils in which clay predominates, with a firm to compact consistence, that are heavy to work. A term not used in literature at the present time.

HORIZON, SOIL--A layer of soil approximately parallel to the land surface with characteristics produced by soil-forming processes.

ILLITE (HYDROUS MICA)--One of the three major groups of silicate clay minerals. The crystals are built up of units of three alternating sheets, two silica sheets to one alumina or a 2-to-1 lattice. The units are bonded together by potassium atoms, which exert a stabilizing effect on the crystal lattice. The illites may expand slightly, but rarely enough to be of significance. (See KAOLINITE and MONTMORILLONITE.)

INDURATED--Mass is very strongly cemented; brittle, does not soften under prolonged wetting and is so extremely hard that a sharp blow with a hammer is required to break; hammer generally rings as a result of the blow.

INTRAZONAL--A soil that has well-developed characteristics, but the influence of climate and vegetation is over shadowed by slope and/or parent material.

KAOLINITE--One of the three major groups of silicate clay minerals. The crystals are plate-like and roughly hexagonal in shape. The crystals are built up of flat crystal units, each unit being composed of alternate layers of silica and alumina sheets. There is one alumina sheet for each silica sheet of a 1-to-1 lattice. The kaolinite crystals are the most stable of the layer silicate clay minerals; the bonding between the units is firm, and they offer less surface area than the other clay minerals. The kaolinites exhibit few colloidal properties. (See ILLITE and MONT-MORILLONITE.)

L--Loam, See TEXTURE.

LEACHING--Removal of materials in solution.

LIGHT--Applied to soils that are easy to work, usually of medium to coarse texture with low silt and clay content, incoherent single-grained structure. A term not used in literature at the present time.

LIQUID LIMIT--The moisture content, expressed as a percent of oven dry soil, at which a soil passes from a plastic to a liquid state. "Procedure: AASHO T89-67I .

LITHOSOLS--Azonal soils having no clearly expressed soil morphology and consisting of a freshly and imperfectly weathered mass of rock fragments; largely confined to steeply sloping land.

LOAM--A soil that has roughly equal percentages of sand and silt and a small amount of clay. (See CLASS, SOIL, TEXTURE.)

LOESS--Soil material consisting primarily of uniform silt that was transported and deposited by wind.

LOOSE--See CONSISTENCE WHEN DRY.

LS--Loamy Sand, See TEXTURE.

MASSIVE STRUCTURE--See STRUCTURE, SOIL.

MATURE SOIL--A soil with well-developed characteristics produced by the natural processes of soil formation, and in equilibrium with its environment.

MEALY--See CONSISTENCE, SOIL.

MELLOW--See CONSISTENCE, SOIL.

MONTMORILLONITE--One of the three major groups of silicate clay minerals. The crystals are built of units of three alternating sheets, two silica sheets to an alumina, magnesium, or iron sheet or a 2-to-1 lattice. The units are bonded together by weak oxygen-to-cation-to-oxygen linkages, which allows the crystal lattice to absorb water on the internal surfaces. This condition gives the montmorillonite high swelling and shrinkage properties. The crystals are much smaller than the crystals of illite and kaolinite. Montmorillonite is noted for its high plasticity and cohesion. (Bentonite is a rock formed from volcanic ash that has been weathered to montmorillonite.)

MOTTLED--Irregularly marked with spots of different colors.

NEUTRAL SOIL--A soil that is not acid or alkaline; practically, one having a pH between 6.6 and 7.3.

NUT STRUCTURE--See STRUCTURE, SOIL.

ORGANIC MATTER--Soil carbonaceous material consisting of the remains of plants and animals and their decomposition products.

O.S.I.--Oklahoma Subgrade Index; a modification of the AASHO group index number; a relative support value determined by using the percent of soil material passing the No. 200 sieve, liquid limit, and plasticity index in an emperical mathematical formula. An index number used to determine base thickness requirements for roadways. See page 14.

PARENT MATERIAL--The relatively unaltered, unconsolidated material beneath the solum (the A and B horizons) from which the soil is formed.

PARENT ROCK--The rock from which the parent material is formed, the "D" or "R" horizon.

PERCOLATION--The process of water filtering through the soil mass.

PERMEABILITY--See DRAINAGE, SOIL.

pH--A notation used to designate the degree of acidity or alkalinity of a system, the common logarithm of the reciprocal of the hydrogen-ion concentration. pH of 7 is neutral, lower values indicate acidity, and higher values indicate alkalinity. "Procedure: Beckman Glass Electrode."

PHASE, SOIL--That part of a soil unit or soil type having minor variations in characteristics used in soil classification from the characteristics normal for the type. Although minor, these variations may be of great practical importance. The variations are chiefly in such external characteristics as relief, stoniness, or accelerated erosion.

PLANOSOL SOILS--An intrazonal group of soils with eluviated surface horizons underlain by B horizons more strongly illuviated, cemented, or compacted than associated normal soils, developed upon nearly flat, upland surface under grass or forest vegetation in a humid or subhumid climate.

PLASTIC--Capable of being molded without rupture.

PLASTICITY INDEX--The numerical difference between liquid limit and plastic limit (LL-PL). "Procedure: AASHO T90-67I."

PLASTIC LIMIT--The moisture content, expressed as a percent of oven dry soil, at which a soil changes from a semisolid to a plastic state.

PLATY STRUCTURE--See STRUCTURE, SOIL.

PODZOL SOILS--A zonal group of soils having an organic mat and a very thin organic mineral layer above a gray leached layer, which rests upon an illuvial dark-brown horizon, developed under coniferous, mixed forest, or under heath vegetation in a temperate to cold, moist climate. Iron oxide and alumina, and sometimes organic matter, have been removed from the A and deposited in the B horizon.

PODZOLIZATION--A general term referring to that process (or those processes) by which soils are depleted of bases, become acid, and have developed eluvial A horizons (surface layers of removal) and illuvial B horizons (lower horizons of accumulation). Specifically, the term refers to the process by which a podzol is developed, including the more rapid removal of iron and alumina than of silica from the surface horizons; but it is also used to include similar processes operative in the formation of certain other soils of humid regions.

POROSITY--The degree to which the soil mass is permeated with pores or cavities. It is expressed as the percentage of the whole volume of the soil that is unoccupied by solid particles.

POTENTIAL VERTICAL RISE--A measure of vertical expansion of plastic material (soil) under one-pound-per-square-inch pressure in a three-foot layer of material, due to moisture increase.

PRAIRIE SOILS--The zonal group of soils having a very dark-brown or grayish-brown surface horizon, grading through brown soil to lighter-colored parent material at 2 to 5 feet, developed under tall grasses, in a temperate, relatively humid climate. The term has a restricted meaning in soil science and is not applied to all dark-colored soils of the treeless plains, but only to those in which carbonates have not been concentrated in any part of the profile by the soil-forming processes.

PRISMATIC STRUCTURE--See STRUCTURE, SOIL.

PROFILE, SOIL--A vertical section of the soil through all its horizons and extending into the parent material.

RECENT SOIL--Relatively unweathered or immature soil, without definite horizons. (This term is becoming obsolete.)

REDDISH-BROWN SOILS--A zonal group of soils with a light-brown surface horizon of a slightly reddish cast, which grades into dull reddish-brown or red material heavier than the surface soil, thence into a horizon of whitish or pinkish lime accumulation. Developed under shrub and short-grass vegetation of warm-temperate to tropical regions of semi-arid climate.

REDDISH CHESTNUT SOILS--A zonal group of soils with dark-brown, tinted pinkish, or reddish surface soils up to 2 feet thick over heavier, reddish-brown soil over grayish or pinkish lime accumulation; developed under warm-temperate semi-arid climate and mixed grass vegetation with some shrubs. Approximately equivalent to southern chernozem.

REDDISH PRAIRIE SOILS--A zonal group of soils with dark reddish-brown, slightly to medium acid surface soils grading through somewhat heavier reddish material to the parent material; developed under warm-temperate humid to subhumid climate and tall-grass vegetation.

REGOLITH--All of the unconsolidated material above the bed rock.

REGOSOLS--Azonal soils that consist mainly of soft or unconsolidated mineral materials in which there is no clearly developed soil morphology. They include relatively fresh glacial debris, beach sand, sand dunes, and recent accumulations of volcanic ash.

RENDZINA SOILS--An intrazonal group of soils, usually with brown or black friable surface horizons underlain by light-gray or yellowish calcareous material; developed under grass vegetation or mixed grasses and forest in humid and semi-arid regions from relatively soft calcareous parent material.

RESIDUAL MATERIAL--Soil material formed in place, presumably from the same rock on which it lies.

RIPPABILITY--Susceptibility of a rock to be broken by a ripping device. A rock may be rippable for one type of machine and not for another.

S--Sand. See TEXTURE and SEPARATE.

SALINE SOIL--A soil containing an excess of soluble salts yet which is not excessively alkaline. Saline soils may contain carbonates, sulfates, or chlorides.

SAND--See TEXTURE and SEPARATE.

SC--Sandy Clay. See TEXTURE.

SCL--Sandy Clay Loam. See TEXTURE.

SEEPAGE--Act of seeping; a local spot where water slowly percolates from porous geologic material, such as a sandstone.

SEPARATE, SOIL--A group of mineral particles of a specific size range. A soil sample will always contain more than one separate. (See TEXTURE.)

SAND SEPARATE--Small rock or mineral fragments having diameters ranging from 0.05 to 2.0 mm.

SILT SEPARATE--Small mineral soil grains having diameters ranging from 0.002 to 0.05 mm. (Engineers usually use the limits of 0.005 to 0.05 mm.)

CLAY SEPARATE--The fine mineral soil grains, less than 0.002 mm in diameter. (Engineers usually define as less than 0.005 mm in diameter.)

SERIES, SOIL--A group of soils developed from the same parent material, having similar soil horizons, and having essentially the same characteristics throughout the profile except for the texture of the A, or surface horizon.

SESQUIOXIDE--Fe_2O_3 and/or Al_2O_3.

SHOT--Concretions of iron and manganese oxides in the form of indurated spherical pellets.

SHRINKAGE LIMIT--The moisture content, expressed as a percent of oven dry soil, at which a wet soil stops shrinking. "Procedure AASHO T92-60."

SHRINKAGE RATIO--The volume change, expressed as a percent of the volume of the dried soil pat, divided by the moisture loss above the shrinkage limit, expressed as a percentage of the weight of the dried soil pat. "Procedure: AASHO T92-60."

SI--Silt. See TEXTURE and SEPARATE.

SIC--Silty Clay. See TEXTURE.

SICL--Silty Clay Loam. See TEXTURE.

SIEROZEM SOILS--A zonal group of soils having a brownish-gray surface horizon that grades through lighter-colored material into a layer of carbonate accumulation and frequently into a hardpan layer, developed under mixed shrub vegetation in a temperate to cool, arid climate.

SIEVE ANALYSIS--Percent by weight of materials (soil) passing through the sieve openings; sieve numbers represent the number of openings per square inch. "Procedure: AASHO T88-67Interim."

SIL--Silt Loam. See TEXTURE.

SILT--See SEPARATE and TEXTURE.

SINGLE-GRAIN STRUCTURE--See STRUCTURE, SOIL.

SL--Sandy Loam. See TEXTURE.

SLOPE, SOIL--Refers to the incline of the surface of the soil area. Slopes may be defined as single or complex. Slope names and the ranges in slope percent as defined in the Soil Survey Manual are as follows:

Slope Range (%)	Slope Name	Slope Type
0-3	Level	Single or complex
1-8	Gently sloping	Single
1-8	Undulating	Complex
5-16	Sloping	Single
5-16	Rolling	Complex
10-30	Moderately steep	Single
10-30	Hilly	Complex
20-65	Steep	Single or complex
45-65	Very steep	Single or complex

SMOOTH SOIL--Used to modify textural term. No abrasive feel.

SOFT--See CONSISTENCE WHEN DRY.

SOLUM--That part of the soil profile, above the parent material, in which the processes of soil formation are taking place. In mature soils, this includes the A and B horizons, and the character of the material may be greatly unlike that of the parent material.

STONE--Rock fragments larger than 10 inches in diameter, if rounded; and longer than 15 inches along the longer axis, if flat.

STRATIFIED--Composed of, or arranged in, layers. The term is applied to geological materials, as stratified alluvium. Those layers in soils that are produced by the soil-forming processes are called horizons, while those inherited from the parent material are called strata.

STRUCTURE, SOIL--The aggregation of soil particles into clusters of particles, which are separated from adjoining aggregates by surfaces of weakness.

BLOCK-LIKE (OR BLOCKY)--The soil aggregates have a blocky shape, irregularly six-faced, and with the three dimensions nearly equal. The size of these aggregates ranges from a fraction of an inch to 3 or 4 inches in thickness. This structure is found in the B horizon of many soils. When the edges of the cubes are sharp and rectangular faces are distinct, the type is identified as blocky or angular blocky. If sub-rounding is apparent, the aggregates are identified as nut-like, nuciform, or subangular blocky.

COLUMNAR--Structure with the vertical axis of aggregates longer than the horizontal and with rounded tops. When the tops are level and clean cut, the structure is identified as prismatic. Found in the B horizon, when present.

CRUMB--Small, soft, porous aggregates irregular in shape and rarely larger than 1/3 inch in size. If the aggregates are relatively nonporous, they are identified as granular. Both types are found in surface soils, especially those high in organic matter.

GRANULAR--See CRUMB.

LAMINATED--Platy structure with the plates or very thin layers lying horizontal or parallel to the surface. See PLATE-LIKE.

MASSIVE--Large uniform masses of cohesive soil, structureless.

NUT OR NUCIFORM--See BLOCK-LIKE.

PLATE-LIKE (PLATY)--Flat aggregates with vertical dimension much less than the horizontal dimensions, found most often in surface horizons, but may be found in the subsoil as it is often inherited from the parent materials.

PRISMATIC--Elongated column structure with level and clean-cut tops. If the tops are rounded, the structure is identified as columnar. Found in the B horizon, when present.

SINGLE-GRAIN--No aggregation of the particles, such as in dune sand.

SUBSOIL--Refers to the B horizon of soils with distinct profiles. In soils with weak profiles, it is the soil below the surface soil. It is a poor term.

SUBSTRATUM--Any layer below the true soil (solum) such as the C horizon, or it may be distinctly different from the parent material of the soil.

SUBSURFACE SOIL--Refers to that part of the A horizon below the surface soil.

SURFACE SOIL--The soil ordinarily disturbed by tillage or its equivalent depth in uncultivated soils, about 5 to 8 inches.

TEXTURE--The relative proportion of the various particle-size groups of individual grains; the coarseness or fineness of the soil.

C--Clay. Soil material that contains 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. (AASHO - smaller than .005 mm, USDA - smaller than .002 mm)

CL--Clay Loam. Soil material that contains 27 to 40 percent clay and 20 to 45 percent sand.

L--Loam. Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

LS--Loamy Sand. Soil material that contains at the upper limit 85 to 90 percent sand, and the percentage of silt plus $1\frac{1}{2}$ times the percentage of clay is not less than 15; at the lower limit it contains not less than 70 to 85 percent sand, and the percentage of silt plus twice the percentage of clay does not exceed 30.

S--Sand. Soil material that contains 85 percent or more of sand; percentage of silt plus $1\frac{1}{2}$ times the percentage of clay shall not exceed 15. Includes coarse sand, sand, fine sand, and very fine sand. (AASHO - #200 sieve to #10, USDA - #270 sieve to #10.)

SC--Sandy Clay. Soil material that contains 35 percent or more clay and 45 percent or more sand.

SCL--Sandy Clay Loam. Soil material that contains 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand.

SL--Sandy Loam. Soil material that contains either 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30 to 52 percent or more sand; or less than 7 percent clay, less than 50 percent silt, and between 43 and 50 percent sand. (This includes fine sandy loam and very fine sandy loam.)

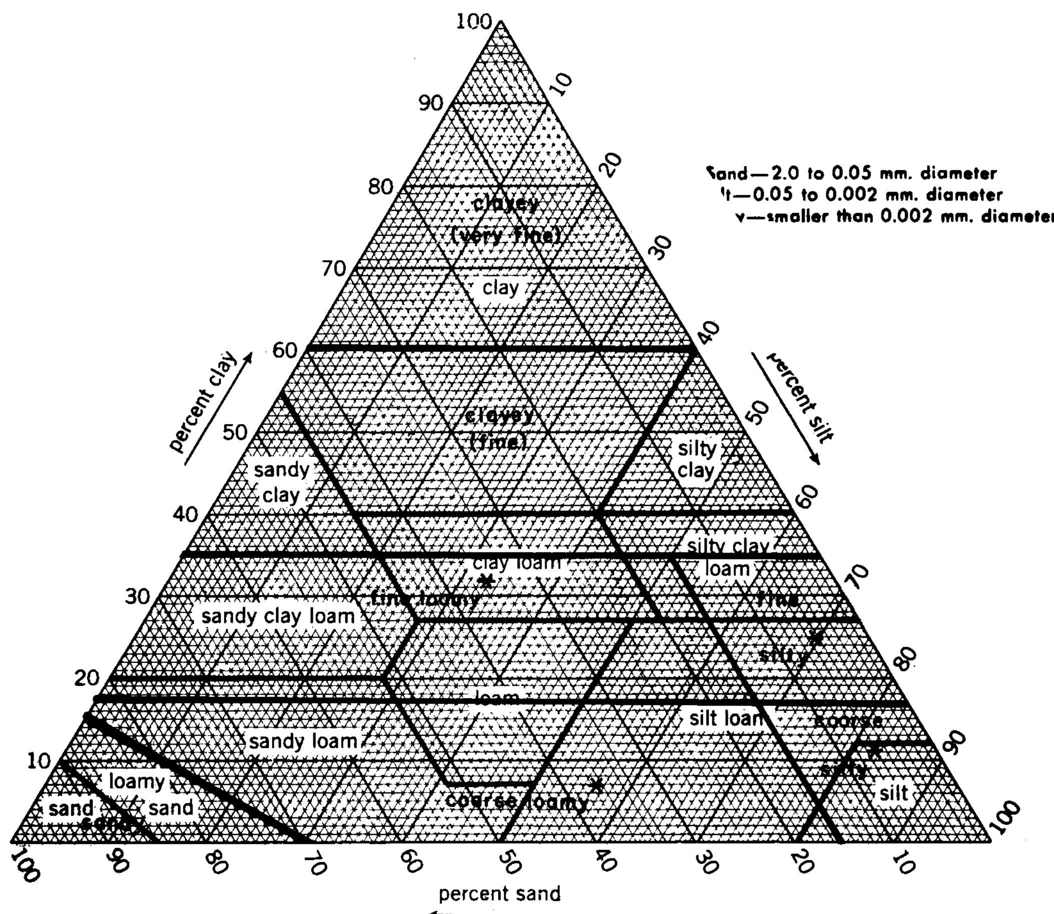
SI--Silt. Soil material that contains 80 percent or more silt and less than 12 percent clay. (AASHO - .005 to #200 sieve, USDA - .002 to #270 sieve.)

SIC--Silty Clay. Soil material that contains 40 percent or more clay and 40 percent or more silt.

SICL--Silty Clay Loam. Soil material that contains 27 to 40 percent clay and less than 20 percent sand.

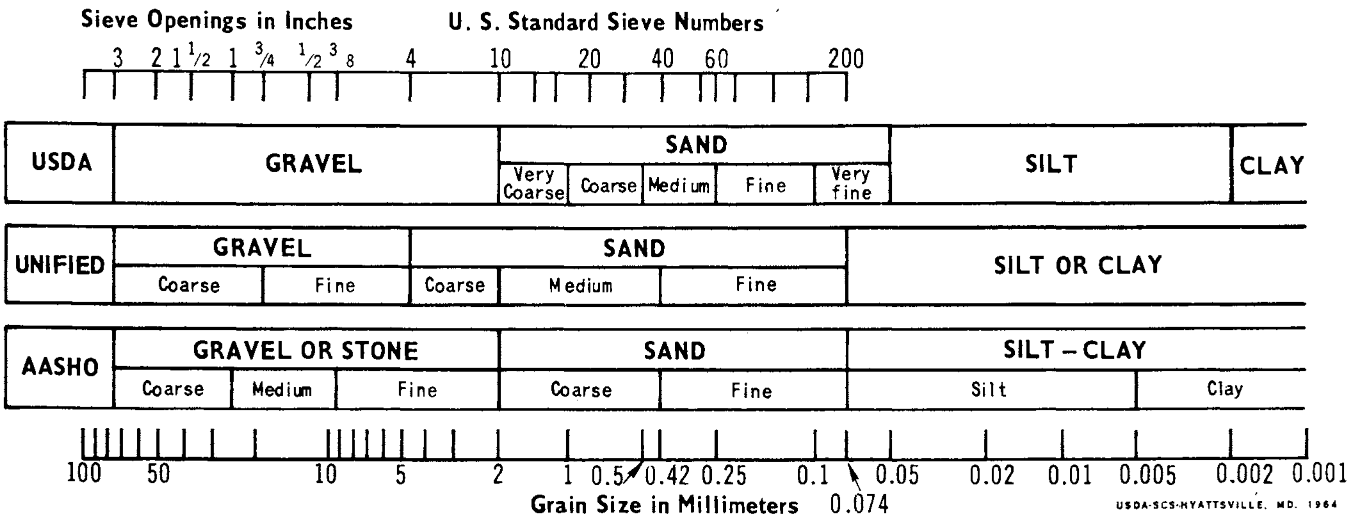
SIL--Silt Loam. Soil material that contains 50 percent or more silt and 12 to 27 percent clay (or) 50 to 80 percent silt and less than 12 percent clay.

GUIDE FOR TEXTURAL CLASSIFICATION IN SOIL FAMILIES



* Very fine sand (0.05 – 0.1) is treated as silt for family groupings coarse fragments are considered the equivalent of coarse sand in the boundary between the silty and loamy classes.

COMPARISON OF PARTICLE SIZE SCALES



TIGHT--A term applied to a horizon or layer that is compact, impervious, tenacious, and usually plastic.

TOPSOIL--A general term used in at least four senses: (1) For the plow layer; (2) for the A_1 horizon, and therefore, exceedingly variable in depth for different soils; (3) for the full A horizon; and (4) for presumed fertile soil, usually of high organic content.

TOUGH--Resistant to rupture. An auger can be readily bored into a layer referred to as tough, but will require much force in shearing loose and pulling out the core of soil.

VOLUME CHANGE--The change in volume for a given moisture content (expressed as a percentage of the dry volume) of the soil mass when the moisture content is reduced from the stipulated percentage to the shrinkage limit.

WEATHERING--The physical and chemical disintegration and decomposition of rocks and minerals by natural processes; such as oxidation, reduction, hydration, solution, carbonation, and freezing and thawing.

YELLOW PODZOLIC SOILS--A zonal group of soils having thin, organic and organic-mineral layers over a grayish-yellow, leached layer resting on a yellow horizon, developed under the coniferous or mixed forest in a warm-temperate moist climate. Equivalent to yellow soils.

ZONAL--Soils that have well-developed soil characteristics that are due mainly to the influence of climate and vegetation.

The descriptions for the table of terms were taken from the "Highway Research Board Special Report 25, Glossary of Pedological (Soils) and Landform Terminology."

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*These texts will aid in a better understanding and application of the information presented in this publication.