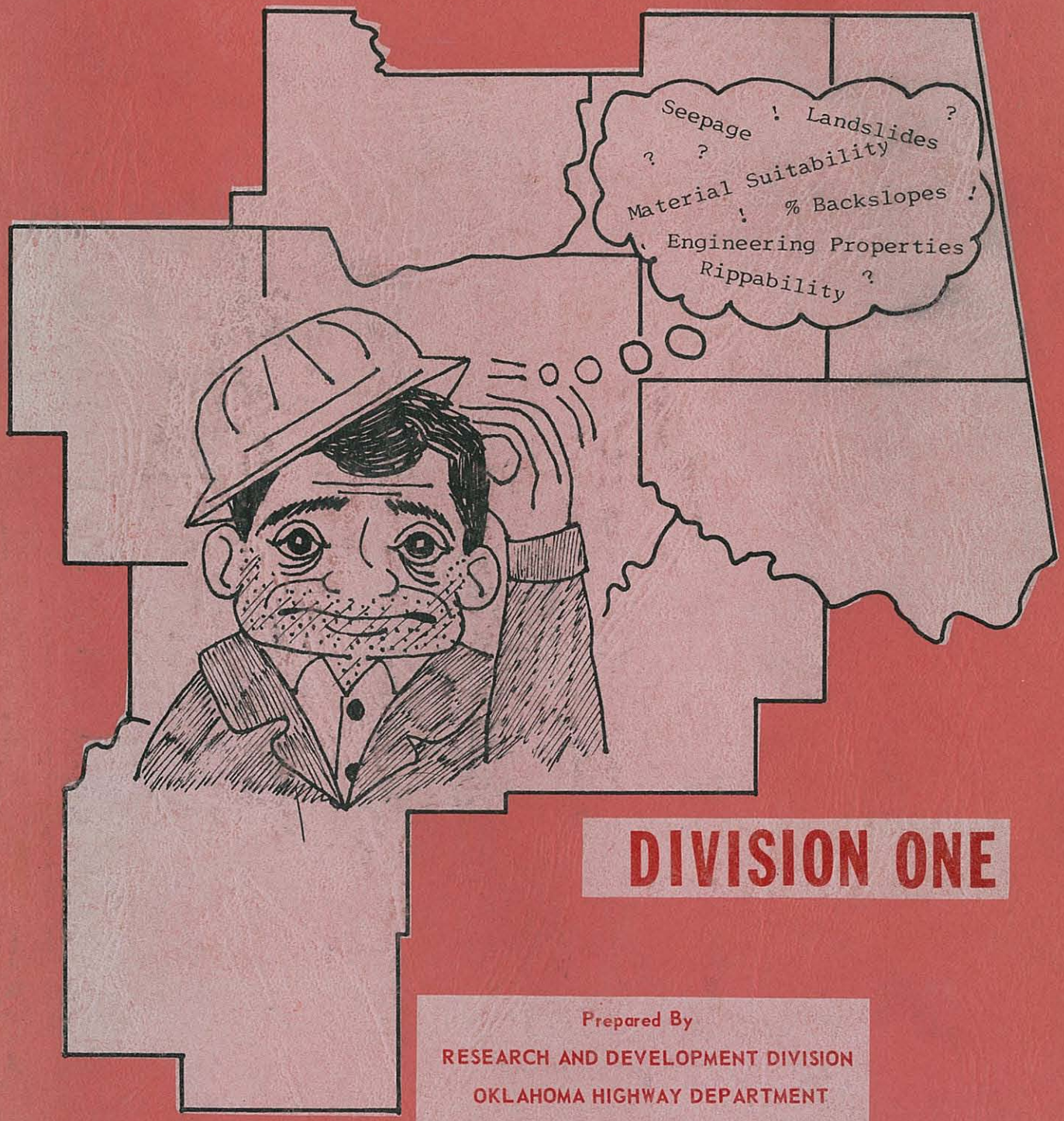
ENGINEERING CLASSIFICATION of GEOLOGIC MATERIALS



DIVISION ONE

Prepared By
RESEARCH AND DEVELOPMENT DIVISION
OKLAHOMA HIGHWAY DEPARTMENT
In Cooperation with the
U.S. BUREAU OF PUBLIC ROADS
1965

ENGINEERING CLASSIFICATION OF GEOLOGICAL MATERIALS

AND

(RELATED SOILS)

DIVISION ONE

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1965

IN COOPERATION WITH THE U.S. BUREAU OF PUBLIC ROADS

Oklahoma Research Project 61-01-1

PREPARED BY

RESEARCH AND DEVELOPMENT DIVISION

OKLAHOMA HIGHWAY DEPARTMENT

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FOREWORD

Geology is the science of the earth and is an organized body of knowledge about the globe 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 outcrops 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.

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 occuring 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 directly linked to a particular geologic unit. These 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: Darnell occurs over sandstone; Parsons occurs over shale. The chart on page 100 shows the relationship of the known soil series to geologic materials by counties. For identification of soil series, refer to page 94.

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.

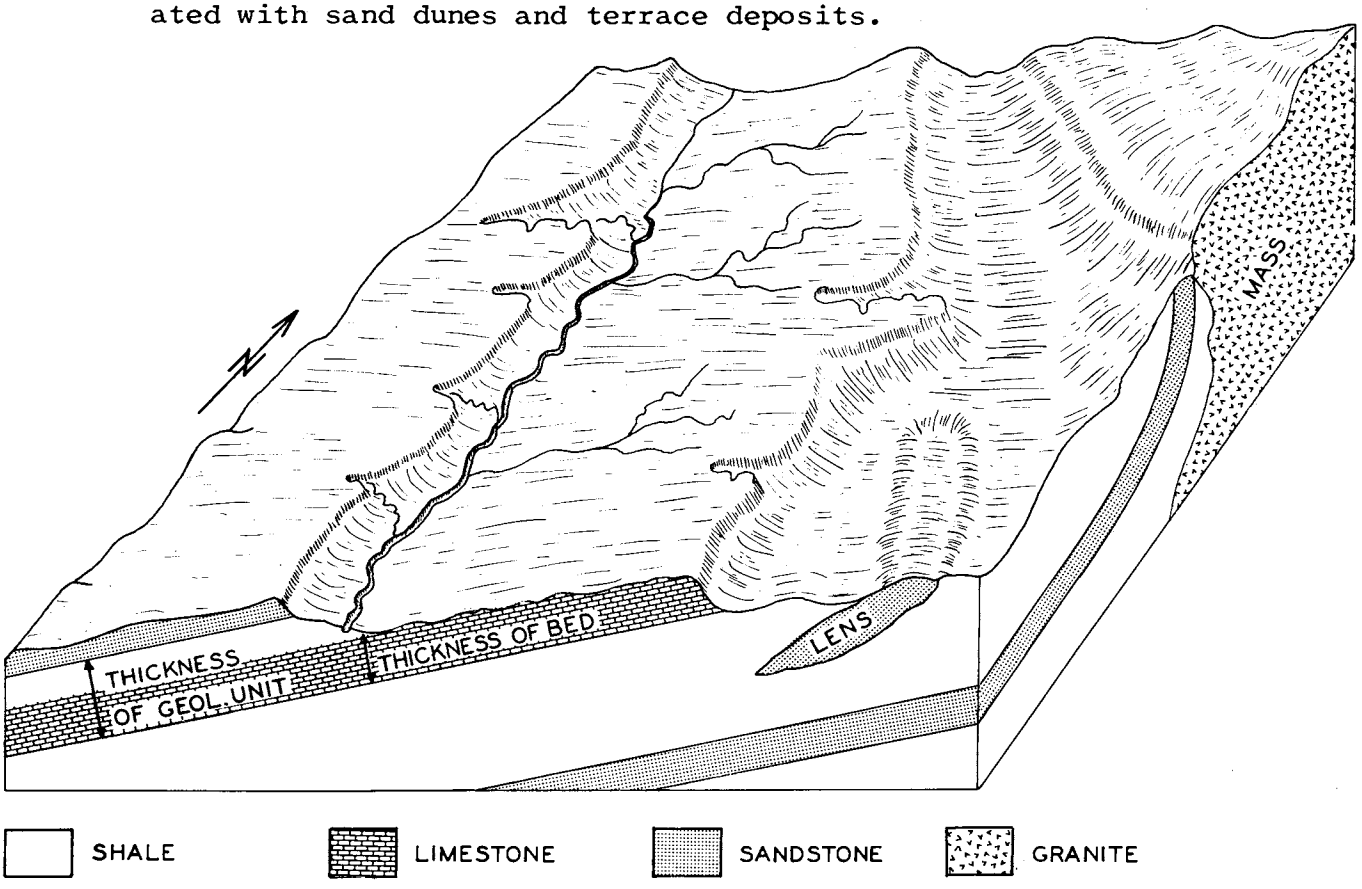


Figure 1

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.

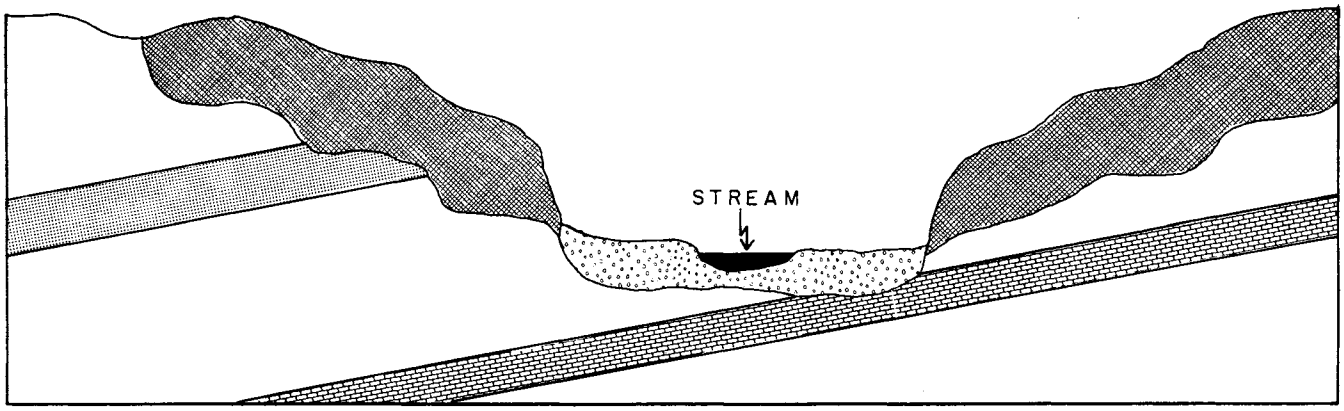
Thickness--This is the measured distance taken at a right angle to the surface of the bedding plane.

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 per cent 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.

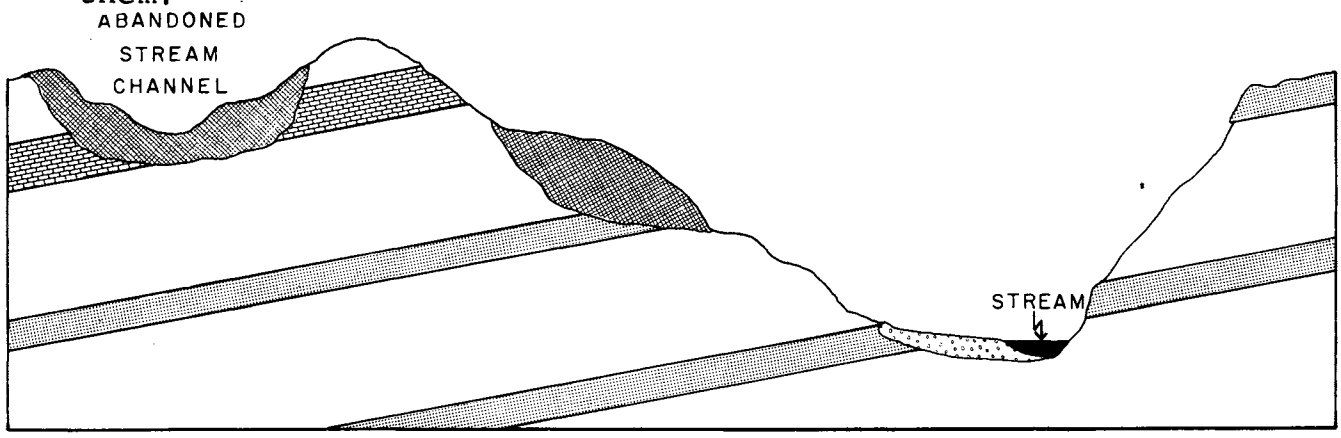
Geologic Lens--This is a certain type of consolidated geologic material which can be easily divided from surrounding materials, but does not have a flat-like bedding plane. It generally occurs as a body of material which is thick in the approximate center and thins toward the edges.

Geologic Mass--Granite and a few other rocks similar 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.

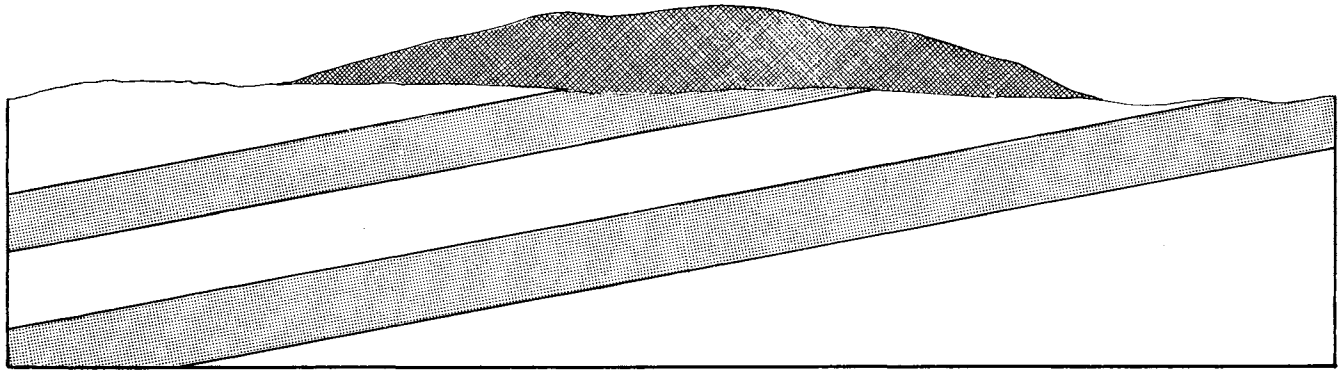
CROSS SECTIONS SHOWING TERRACE DEPOSITS



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.

TERRACE DEPOSIT
WATER
LIMESTONE
ALLUVIUM
SANDSTONE
SHALE

Figure 2

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.

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.

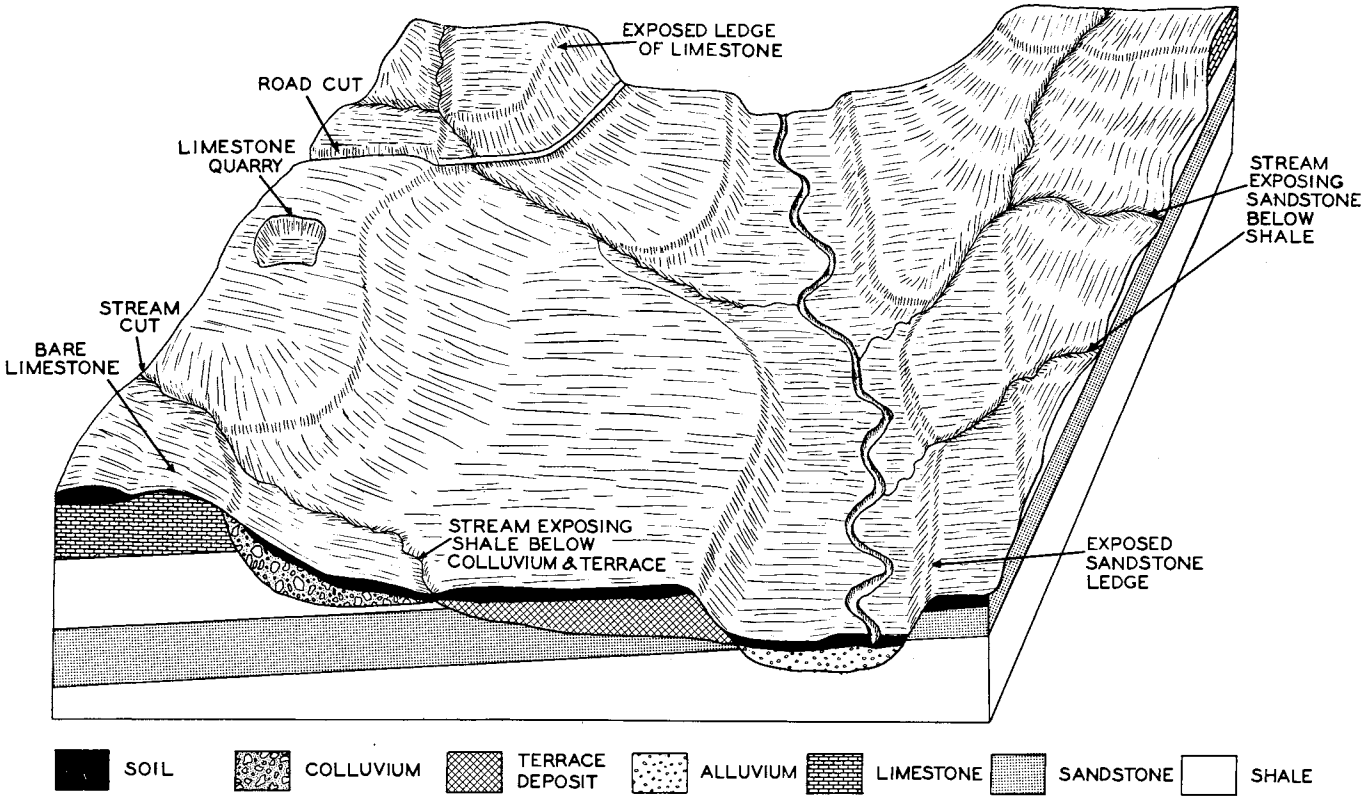


Figure 3

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.

METHODS 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 46.

Much information was not obtained during the study period 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 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.

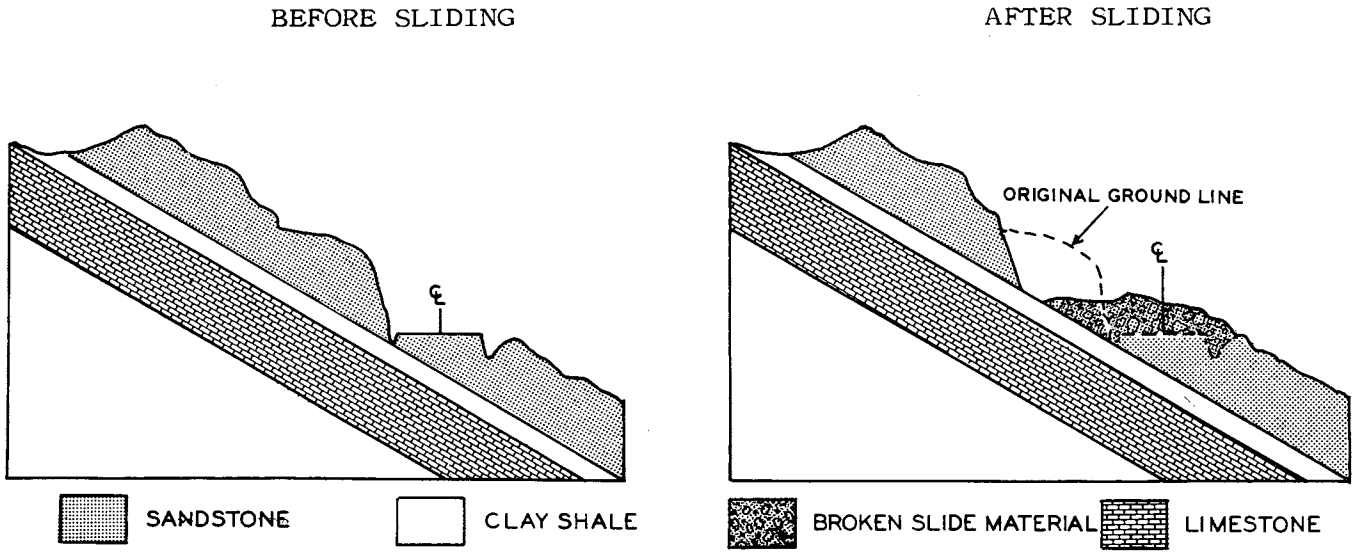


Figure 4

This figure 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; and 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.

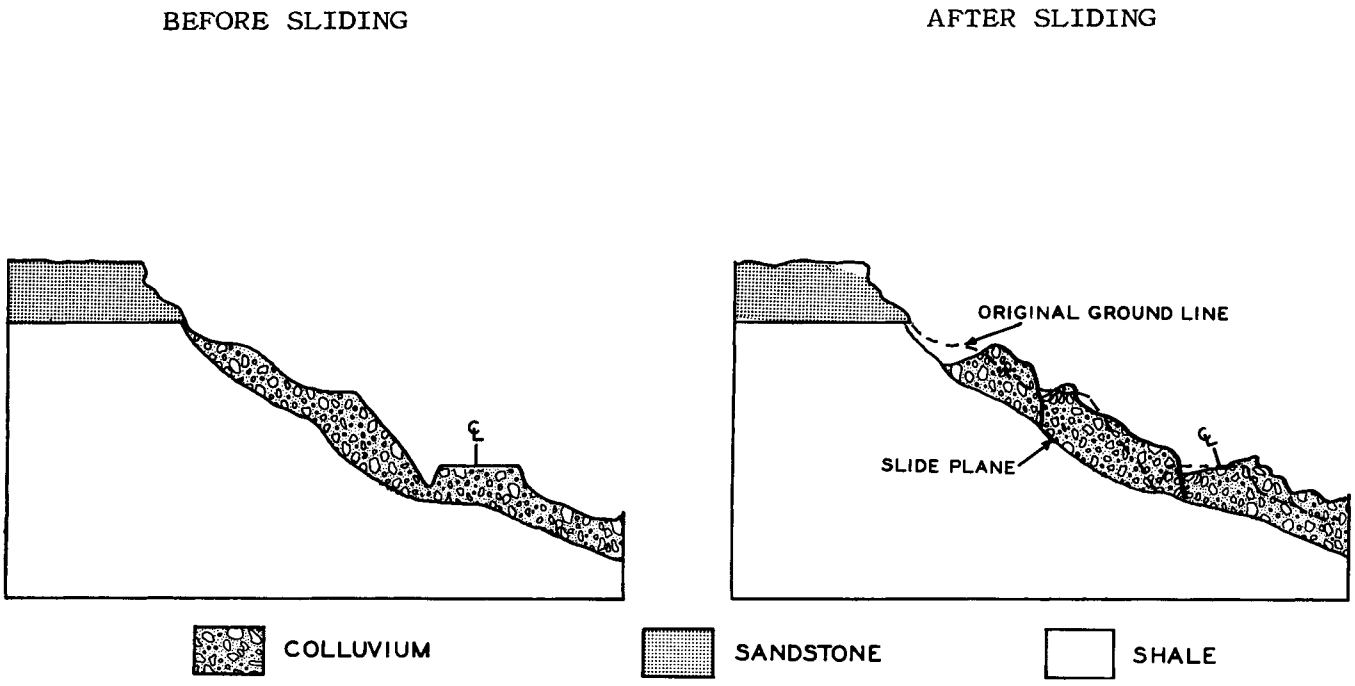


Figure 5

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

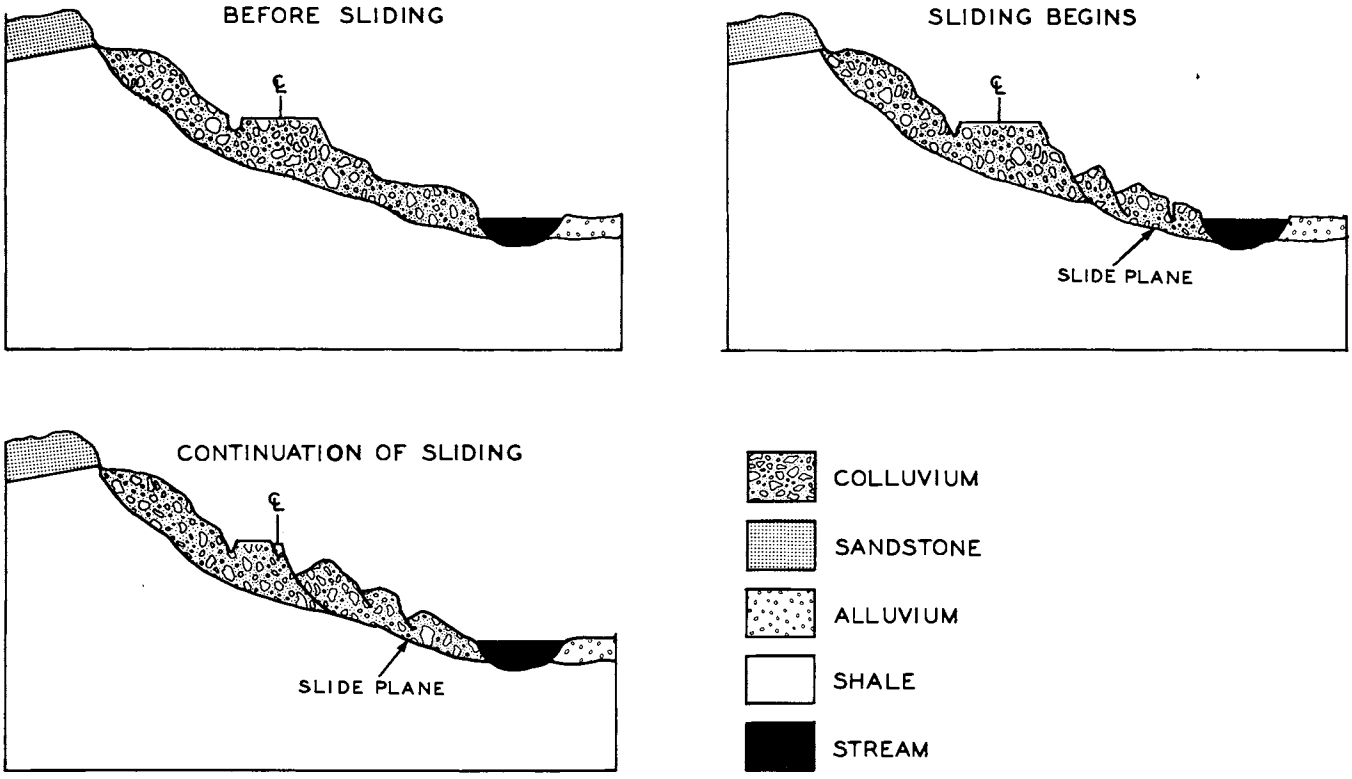


Figure 6

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.

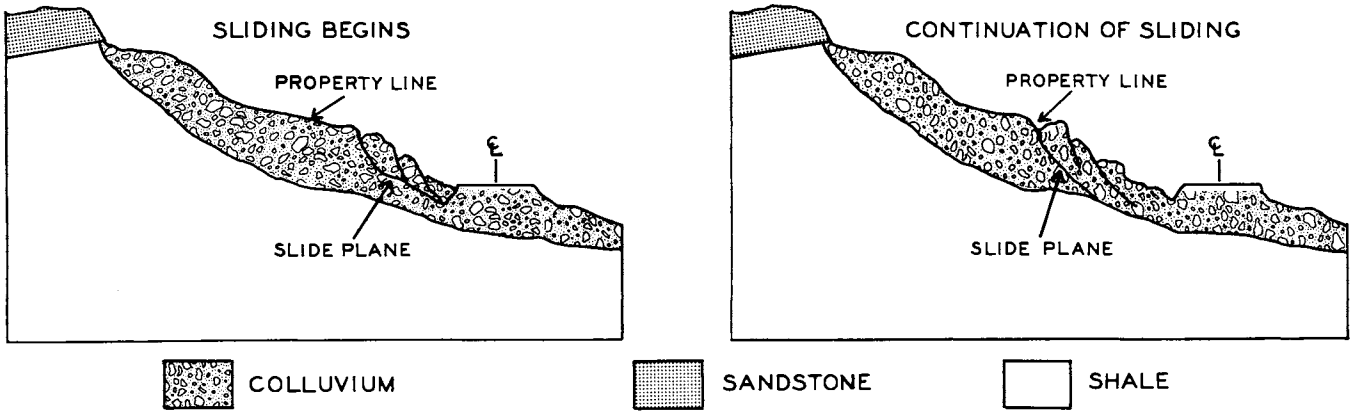


Figure 7

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

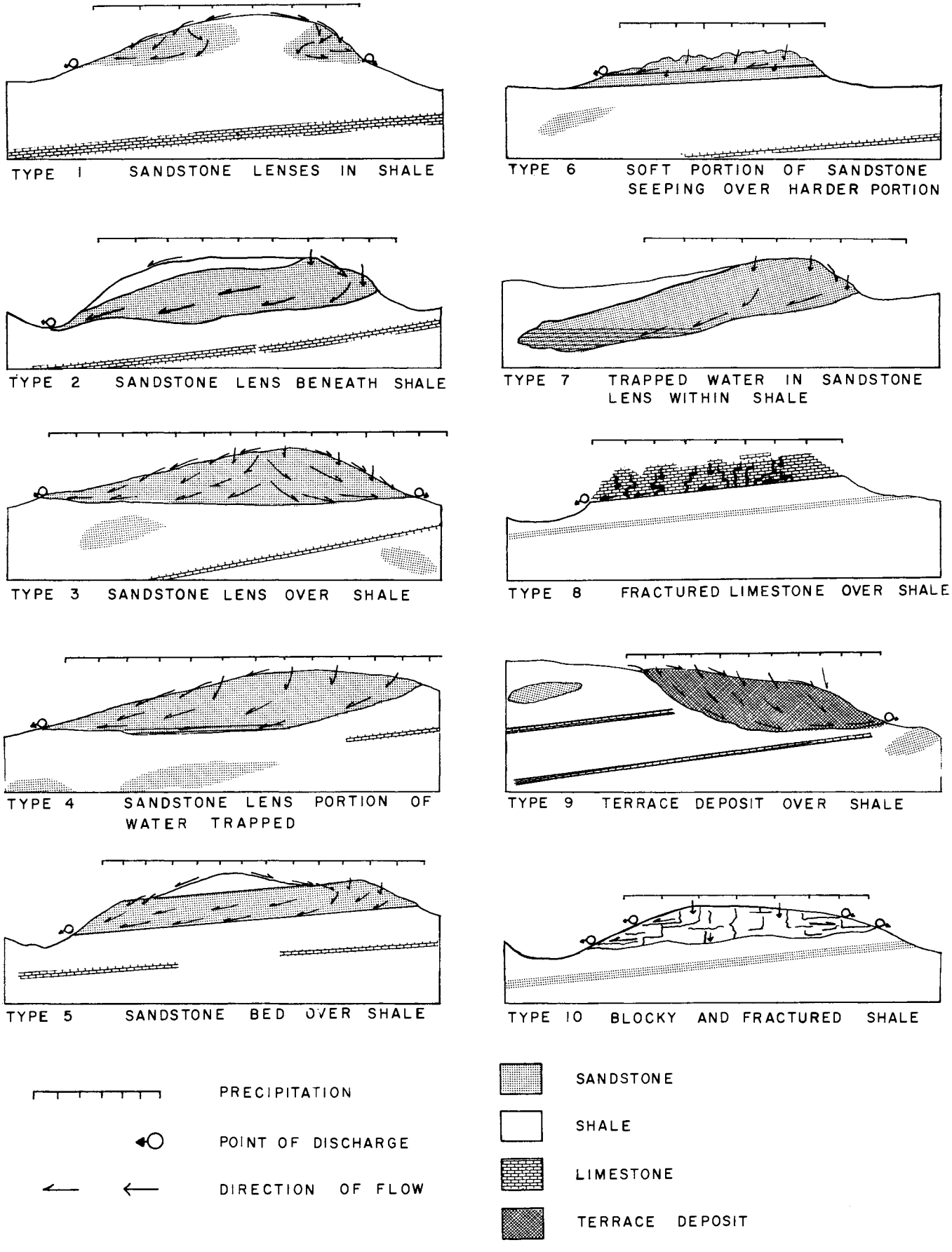


Figure 8

Characteristics of Shales Determined From Laboratory Testing

The shales from Division One were laboratory tested for sieve analysis (per cent passing the numbers 10, 40, 60, and 200), plasticity index, liquid limit, volumetric change, field moisture equivalent, shrinkage limit, 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, Per Cent of Asphalt for Stabilization, and Per Cent 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 56, Chapter II.

STATE OF OKLAHOMA

DEPARTMENT OF HIGHWAYS

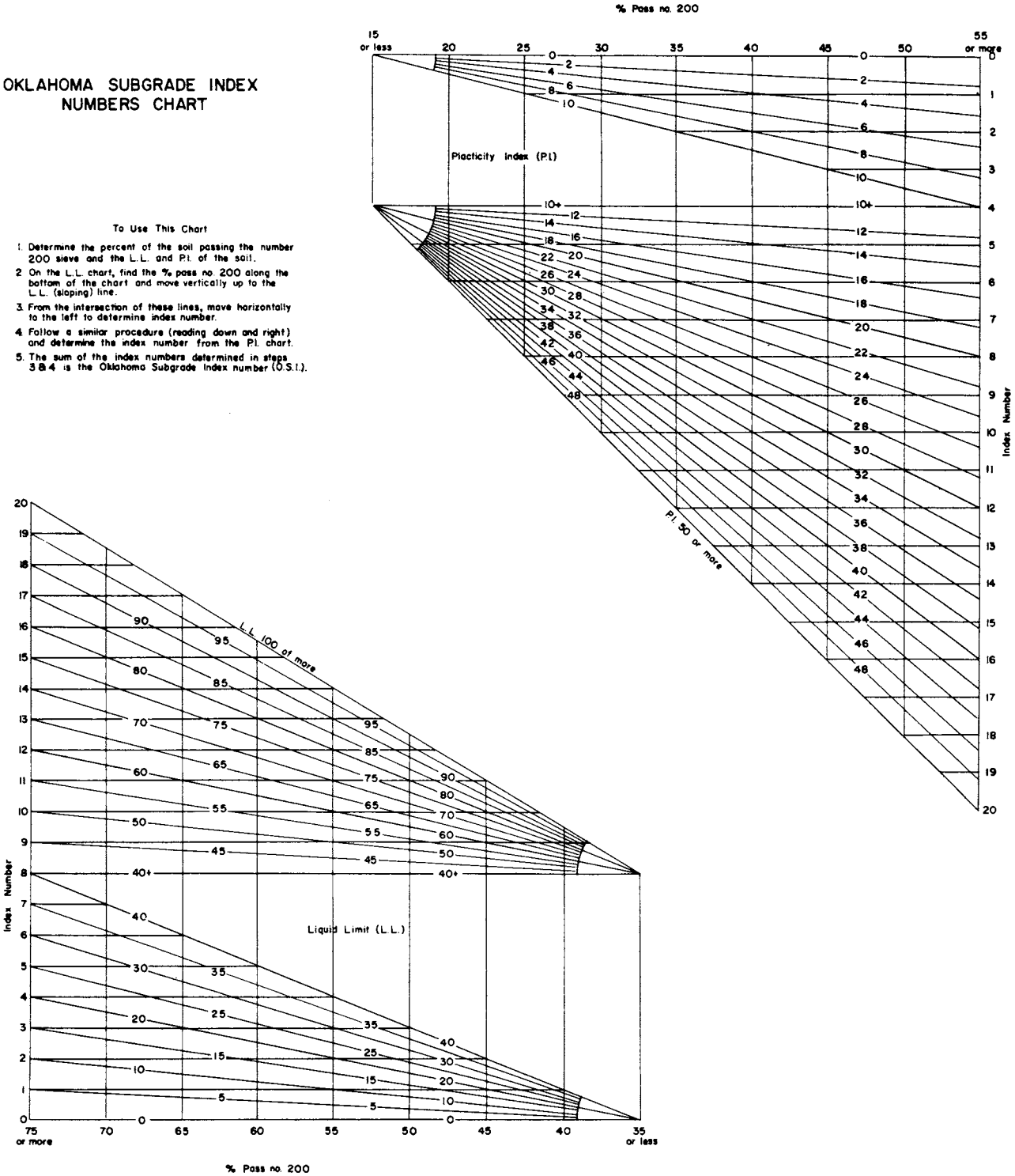
RESEARCH AND DEVELOPMENT DIVISION

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-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				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.[2]
Group Index	0		0	0		4 Max.		8 Max.	12 Max	16 Max.	20 Max.
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 145-49, Highway Materials, Part I, 7th Edition, AASHO, 1955

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

AASHO DETERMINATION OF GROUP INDEX

To use this chart:

1. Determine the per cent of the soil passing the No. 200 sieve and the L.L. and P.I. of the soil.
2. L.L. Chart: Read % passing 200 along bottom of chart and move vertically up to sloping line of L.L.
3. From intersection of the vertical and L.L. lines move left horizontally and read index number.
4. Follow a similar procedure reading down and to the 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 (AASHO Group Index Number).

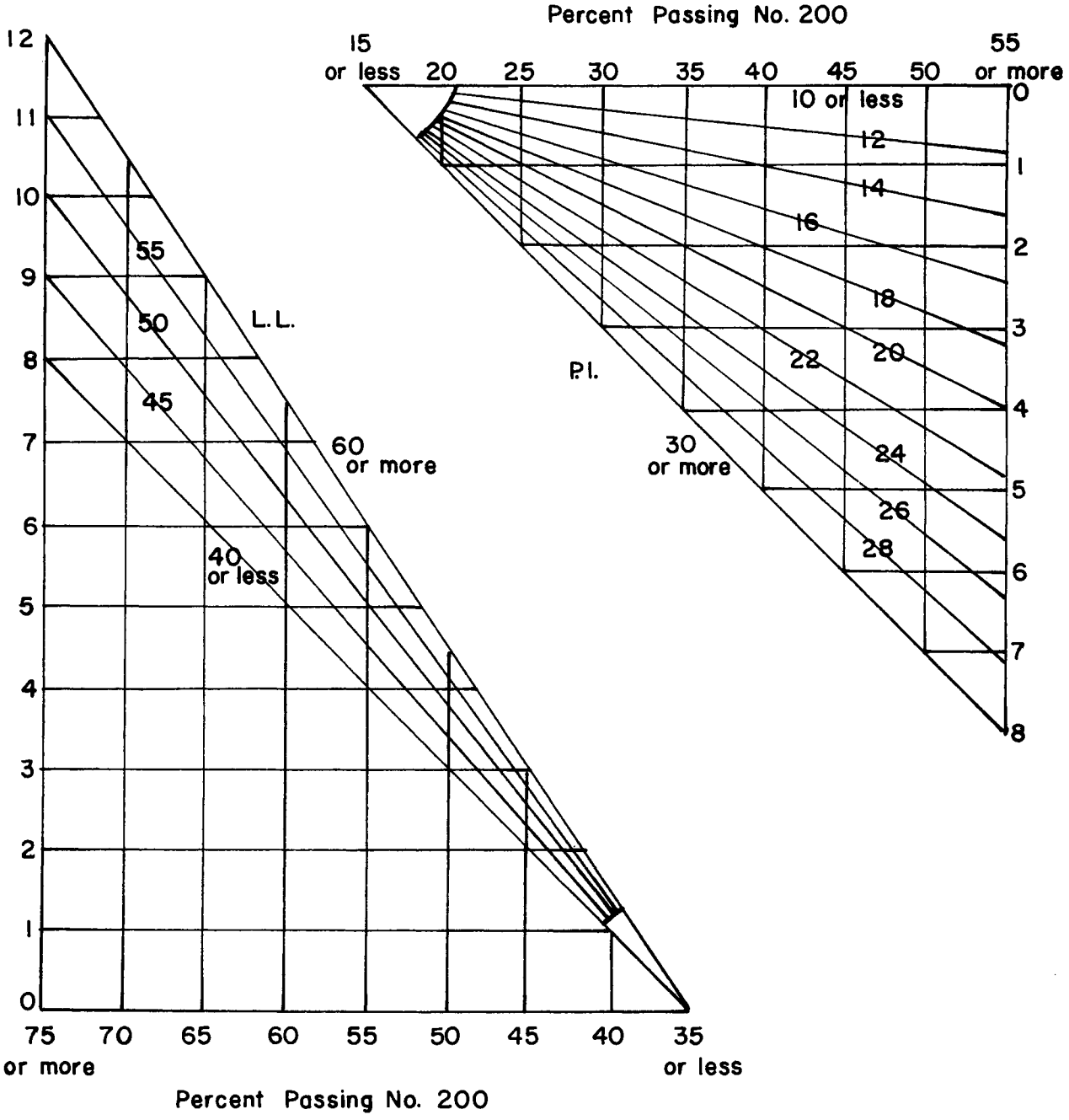


Chart 4

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

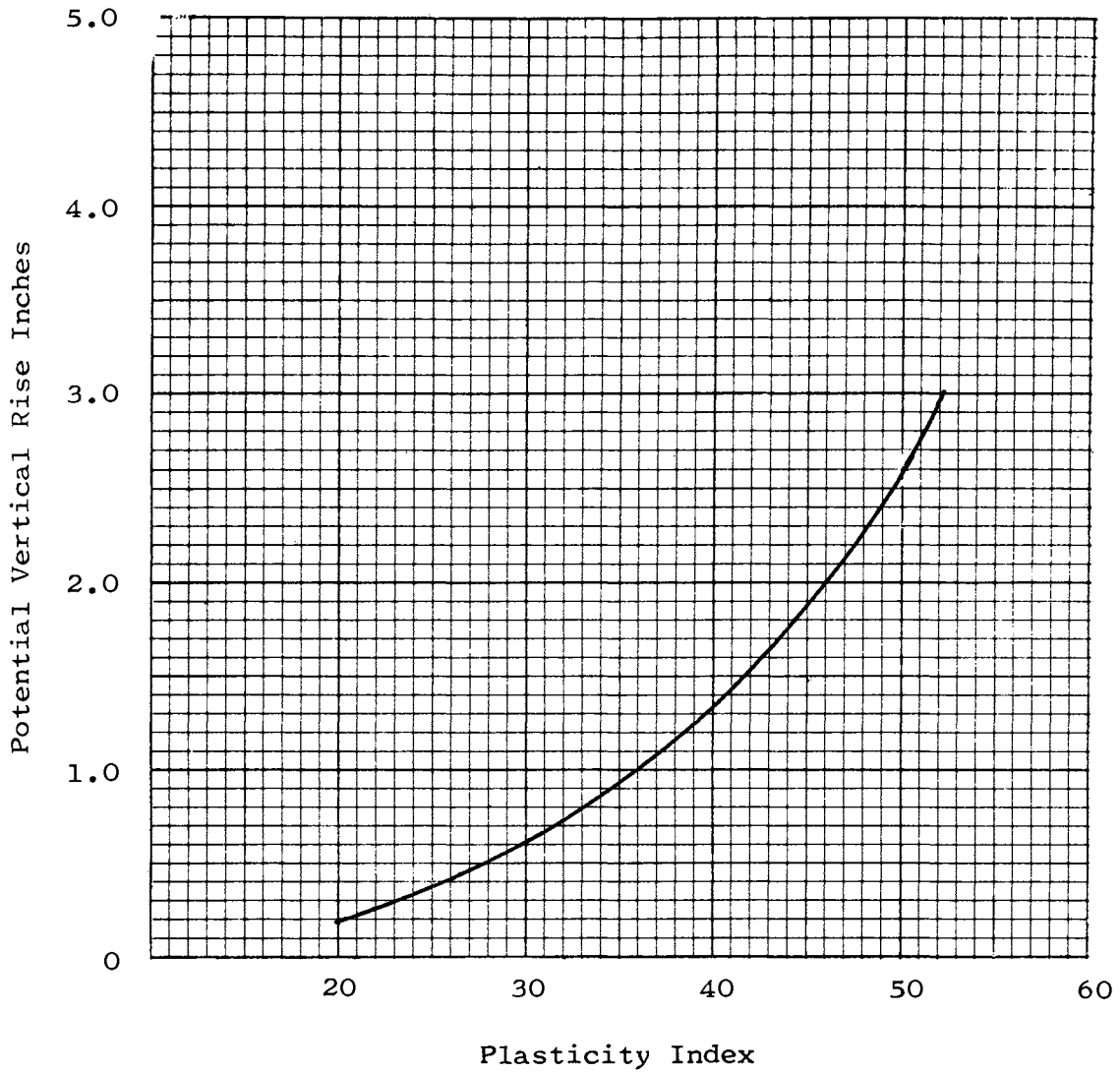


Chart 5

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

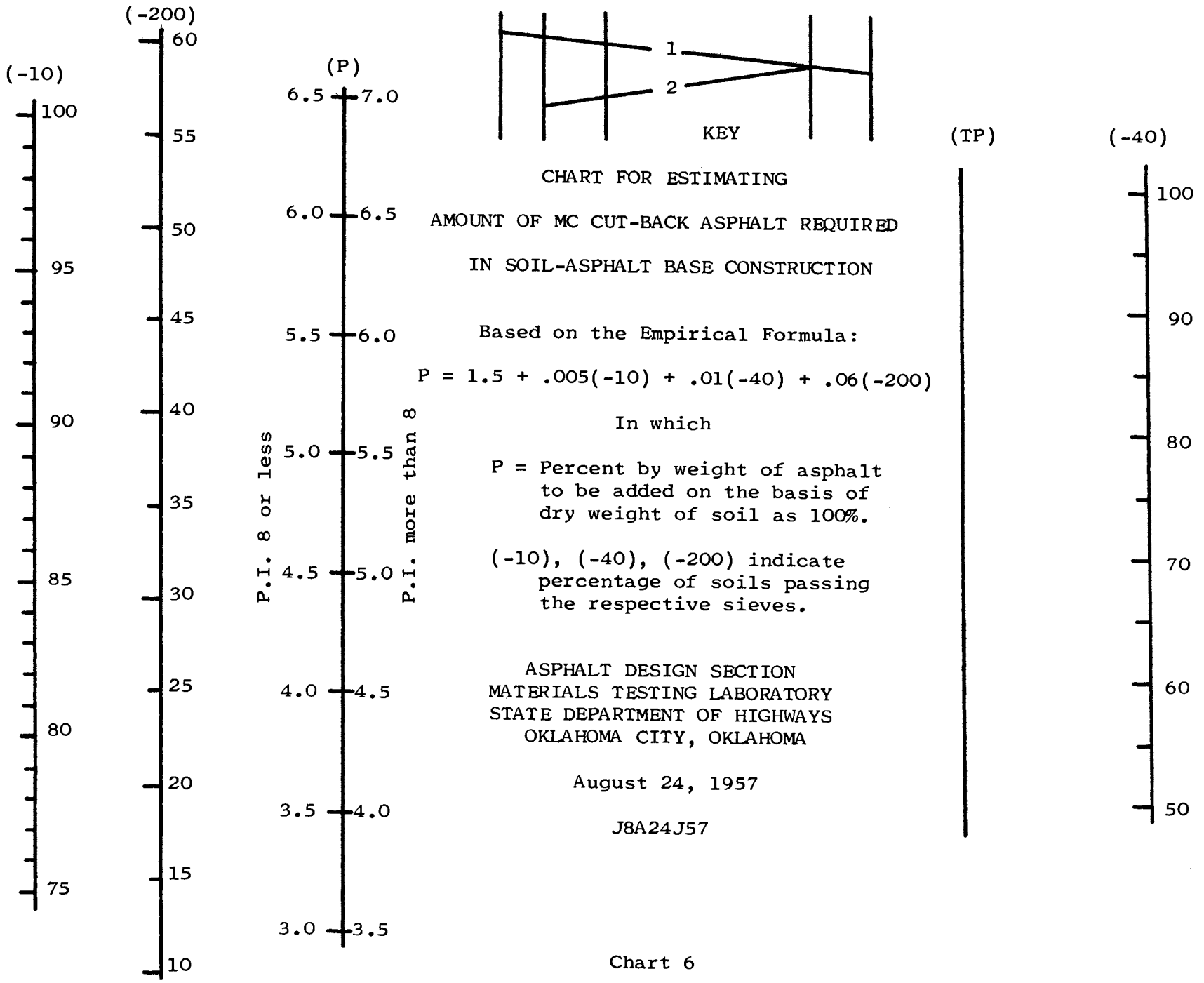


CHART FOR ESTIMATING

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

P O R T L A N D C E M E N T A S S O C I A T I O N

ESTIMATED CEMENT REQUIREMENTS

FOR OKLAHOMA SOILS

AASHO Class	Per Cent Pass 200 Sieve							
	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

TABLE OF TERMS

Alluvium--Recent deposits of sands, silts, clays, gravels, or mixtures of these. These deposits are present along stream beds and flood-plains. The deposits are classified as unconsolidated geologic materials.

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.

Calcareous--Containing calcium carbonate (lime).

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.

Colluvium--These are unconsolidated deposits of material occurring on slopes or at the foot of escarpments 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.

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 it in powdered state.

Escarpment--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.

Granite--A consolidated geologic material that occurs as a mass. It will not occur as a bed or lens.

Gypsum--A consolidated type of geologic material generally occurring in beds. Gypsum occurs as a pure mineral (Ca SO_4 $2H_2O$), which may be alabaster, selenite, or satin spar. Rock gypsum is the impure form of these minerals.

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.

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. This rock is mainly composed of crystals.

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

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.

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

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

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.

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 (lime), silica, or iron oxide. The color may be shades of red, brown, gray, and maybe 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.

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.

Siliceous--Rock containing an abundance of silica (SiO_2). Example: Cherty or hard sandstones and shales cemented by silica.

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

C H A P T E R I I

GEOLOGIC UNITS

IN

DIVISION ONE

GENERAL GEOLOGY OF DIVISION ONE

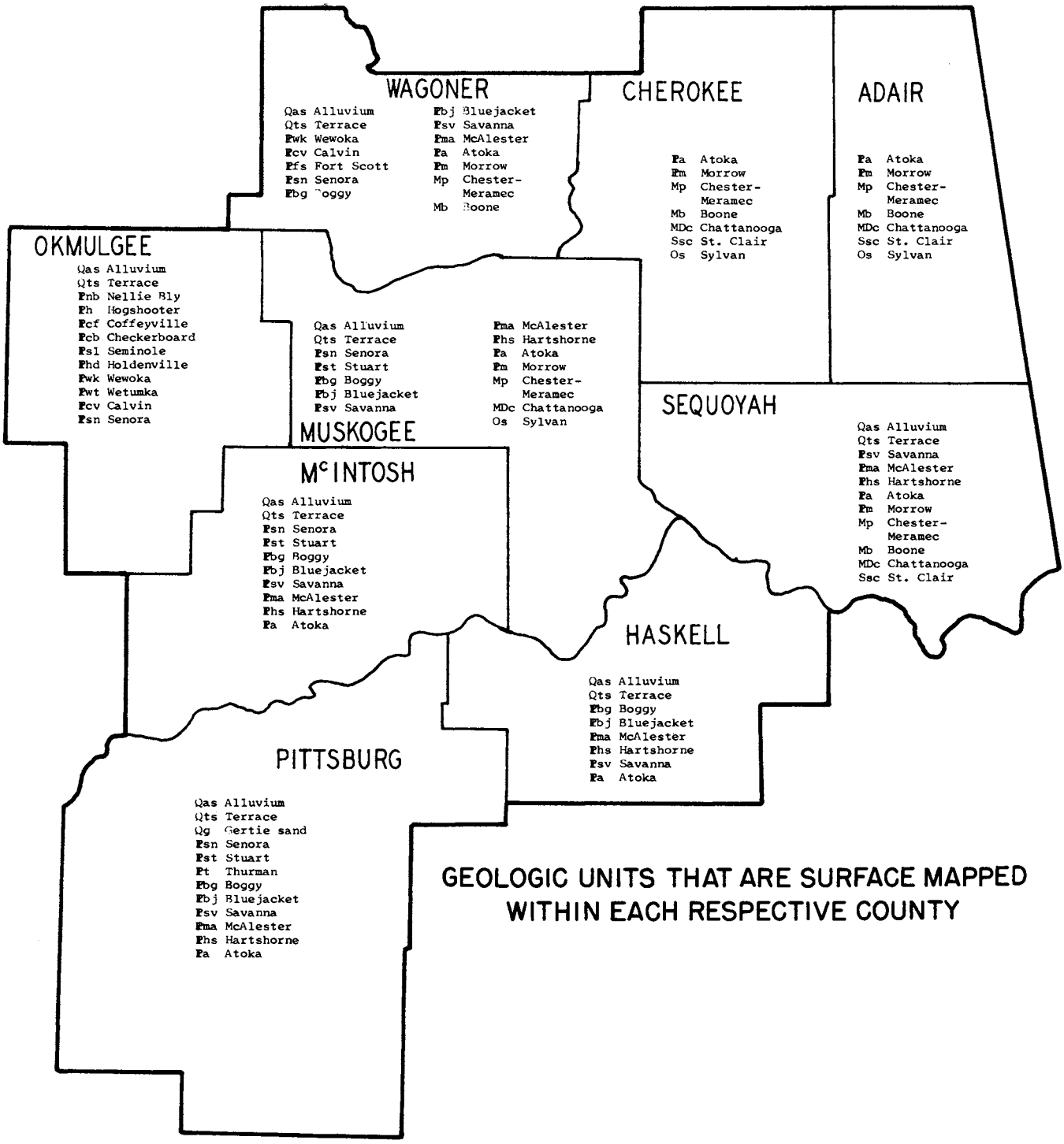
Division One is characterized by a complex of geologic events which give the geologic units great diversity in the type of materials and engineering characteristics. The northeast part of Division One lies on the west flank of the Ozark Uplift, a mountain range prominent in northern Arkansas and southern Missouri. The area is characterized by an abundance of faults and resistant materials, such as limestone and chert.

The central and western portions of Division One are characterized by few faults, gently sloping hills capped by erosional resistant sandstone or limestone, and broad valleys generally underlaid by shales and nonresistant sandstones.

The geologic units in the extreme southeast portion of Division One are affected by the mountain-building movements of the Ouachita Mountains, which are prominent in southeastern Oklahoma and southwestern Arkansas. The units in southeastern Pittsburg County have been highly thrust-faulted into steeply dipping beds with many cross faults. There, the resistant limestones, sandstones, and cherts form prominent ridges. The valleys are normally underlaid by shale and debris from the ridges. The geologic units in this area have not been thoroughly studied by the Research and Development Division. As a result, they are not mapped in this report, and only the general description of the units are given.

It should be remembered that outcrops of the geologic units may vary in width due to several factors other than the thickness of the unit. The outcrop pattern is wider when beds dip at low degrees, when erosional-resistant beds cap long gentle slopes and when there is low topographic relief.

DIVISION I



GEOLOGIC UNITS THAT ARE SURFACE MAPPED WITHIN EACH RESPECTIVE COUNTY

DESCRIPTIONS OF CONSOLIDATED GEOLOGIC MATERIALS

ATOKA UNIT (Pa)

This unit consists of sandstone, siltstone, shale, and a few thin beds of limestone. The sandstone beds are soft to hard, brown to gray in color, locally limy, and are from a few inches thick to approximately 20 feet thick with sequences of beds, separated by thin stringers of shale, up to 115 feet thick. The siltstone beds are generally hard, brown to gray in color, and usually less than one foot thick. The shales for the most part are fissile, locally clayey, brown to black in color, and range in thickness from a few inches to 300 feet or more. Generally most shale zones will contain thin siltstone, sandstone, and/or limestone beds less than one foot thick.

The Atoka unit ranges in thickness from only a few feet in the northern portion of Division One to as much as 9,000 feet in Pittsburg County.

The Atoka unit outcrops in all counties of Division One except Okmulgee. The topography of this unit is generally hills capped with sandstones and the slopes and valleys formed in the shales. Where the unit is mostly shale, prairie areas are present.

BLUEJACKET UNIT (Pbj)

This unit consists of sandstone and shale. The sandstone is soft to extremely hard, brown to gray in color, and the beds are from a few inches thick to 20 feet thick, with zones of sandstone, separated by shale stringers, as much as 150 feet thick. The shales are gray to black, generally fissile, and in zones up to 300 feet thick. The thick zones

of shale generally have thin stringers of siltstone, sandstone, and minor amounts of limestone.

The Bluejacket unit ranges in thickness from approximately 300 feet to 400 feet.

The Bluejacket unit outcrops in Haskell, McIntosh, Muskogee, Pittsburg, and Wagoner Counties within Division One. Generally the outcrop of the Bluejacket unit is an east-facing ridge, which trends in a north-south direction. The sandstone caps the ridge, and the slope below is formed on the underlying shale. On top of the ridge, a slightly rolling surface is formed on the gentle westward dip-slope of the sandstone beds.

BOGGY UNIT (Pbg)

This unit consists of shale, sandstone, siltstone, and a minor amount of limestone. The sandstone ranges from soft to hard, tan to gray in color, and in beds with thicknesses of a few inches up to 40 feet. Generally the sandstone beds average approximately 10 feet thick. Shales are mostly fissile ranging to clay shale, generally dark colored, and occur in zones up to 350 feet thick. Generally these shale zones have occasional thin stringers of sandstone, siltstone, and minor amounts of limestone.

The Boggy unit ranges in thickness from approximately 250 feet in the northern portion of the Division up to approximately 2,500 feet in Pittsburg County.

The topography formed on the outcrop of the Boggy unit is broad, flat, shale valleys and hills and ridges capped with sandstone.

BOONE UNIT (Mb)

This unit consists of chert, limestone, and shale with chert being the predominate material. It is white to buff colored, hard, massive bedded in the upper 40 to 170 feet; below this in about equal amounts 20 to 150 feet of interbedded thin to massive chert and limestone.

The limestone is hard and usually a dark blue-gray color. The lower 10 to 40 feet consists of at least two massive limestone beds with some green fissile shale.

The thickness of this unit is approximately 100 feet in Wagoner County and generally thickens to approximately 230 feet in Adair County.

The Boone unit outcrops in Division One in Adair, Cherokee, Sequoyah, and Wagoner Counties. The topography is rolling to hilly with many vertical cliffs and narrow stream valleys.

CALVIN UNIT (Pcv)

This unit consists of sandstone, shale, and a few thin stringers of siltstone.

The sandstone ranges from medium hard to hard, is generally buff colored, and occurs in beds a few inches thick to 10 feet thick and in zones up to approximately 30 feet thick.

The shale is generally gray in color, fissile, and in intervals up to 190 feet thick in the southern portion of Okmulgee County.

The Calvin unit outcrops in Division One in Okmulgee and Wagoner Counties. North of T14N, R13E, only a 10-foot bed of sandstone is present. It consists of approximately 40 feet of mostly shale in T14N, and southward it thickens to approximately 440 feet in T12N.

The topography of the outcrop of the Calvin unit is characterized by rolling ridges, generally facing eastward, capped with sandstone and valleys underlaid by shale. Normally the lower sandstone bed of the unit is a pronounced ridge former and overlooks the broad shale valleys formed by the upper shale bed of the Senora unit.

CANEY UNIT (Mc)

This unit consists of dark blue to black, fissile to flaky, shale. Locally, it is sandy and the shale is hard and brittle.

In Division One the Caney unit outcrops in only Pittsburg County. Approximately 50 feet of this unit is exposed at the surface. This unit is southeast of the Choctaw fault where the geology is very complex, so it is not outlined on the geologic unit map.

CHATTANOOGA UNIT (MDc)

This unit consists of shale and lesser amounts of sandstone and limestone. The upper 20 feet to 70 feet consists of black fissile shale. Below the black shale are 3-foot to 20-foot beds of hard white to black sandstone. Locally in Sequoyah County, this lower portion of sandstone beds is interbedded with thin limestones and a few cherts. In Muskogee County approximately 36 feet of the black shale is exposed.

Outcrops are found in Adair, Cherokee, Muskogee, and Sequoyah Counties within Division One. The exposures generally are along slopes of hills capped with the Boone unit.

CHECKERBOARD UNIT (Pcb)

This unit consists of a single bed of limestone. The limestone is from bluish-white to dark blue, hard, highly jointed and fractured, and approximately two feet thick.

The Checkerboard unit is overlaid by the Coffeyville unit. The Coffeyville unit normally caps ridges, and the Checkerboard unit forms a slight scarp that juts out on the general slope of the ridge.

Where the rock is bare the pattern of the fractures resembles a checkerboard, thus giving the unit its name. In Division One this unit is only present in Okmulgee County.

CHESTER-MERAMEC UNIT (Mp)

This unit consists of limestone, sandstone, siltstone, and shale. The limestone is gray to blue-gray, hard, in beds generally less than ten feet thick, and in zones, with thin stringers of shale, up to 35 feet thick. The shale is from gray to black, locally clayey, for the most part fissile, and in beds a few inches to 100 feet thick. Normally the top 25 to 60 feet of the Chester-Meramec unit is massive limestones, with a few thin stringers of shale; below this is approximately 36 to 100 feet of black fissile shale. Below the black shale is a sequence of limestone beds 25 to 35 feet thick, which are underlaid by approximately 15 to 20 feet of massive hard siltstone beds. The lower 50 feet

of this unit consists of interbedded cherty limestones and shales. The beds in this lower 50 feet are generally less than 5 feet thick.

The Chester-Meramec unit is present in Division One in Adair, Cherokee, Sequoyah, and Wagoner Counties. This unit underlies the Morrow unit. Together with the overlying Morrow, the Chester-Meramec forms conspicuous bluffs along major streams and around outliers resting on the underlying Boone unit. The thick black fissile shale forms grass-covered slopes between the overlying and underlying limestone beds.

CHICKACHOC UNIT (Pwc)

This unit outcrops in Division One only in Pittsburg County. It is not shown on the geologic unit map, because of the complex nature of the surface materials southeast of the Choctaw fault. The unit is mapped on the "Geologic Map of Oklahoma" by Hugh D. Miser, U.S.G.S., 1954.

The Chickachoc unit consists of shale and sponge-like spiculite cemented by siliceous limestone.

The Chickachoc unit is predominately shale, which is generally green and fissile. The total thickness of the unit is approximately 600 feet. The spiculite beds range from 10 feet at the base of the unit, 20 to 50 feet near the middle, and 30 to 120 feet at the top of the unit.

COFFEYVILLE UNIT (Pcf)

This unit consists of shale, sandstone, and a few thin beds of sandy limestone. The shale is predominate in amount, normally silty

to sandy, locally clayey, gray to brown, and in intervals of 100 feet or more. The sandstone is soft to moderately hard, buff to brown color, generally less than 10 feet thick, in sequences up to 35 feet, and locally hard and limy.

The Coffeyville unit in Division One is only present in Okmulgee County. It is 450 to 470 feet thick.

The topography is characterized by sandstone-capped escarpments which dip gently westward and shale valleys which have a large portion covered with debris from the overlying sandstones.

FORT SCOTT UNIT (Pfs)

This unit consists of limestone with thin beds of shale and siltstone less than one foot thick. The limestone is hard, gray, fractured, and in beds inches thick to 3.5 feet thick. Most of the beds are less than one foot thick. The total thickness reaches 9 feet locally.

In Division One the Fort Scott unit outcrops in Wagoner County only. The outcrop of the Fort Scott unit is readily noticable as a slight scarp overlying the broad flat shale area of the Senora unit. The surface on top of the scarp is flat to gently rolling.

HARTSHORNE UNIT (Phs)

This unit consists of sandstone and shale. The sandstone is gray to brown, mostly in beds less than one foot thick, shaly in many places, and in sequences up to 100 feet thick. Thin stringers of shale are present throughout these sequences. The shale is

normally dark colored; locally the shale is in zones up to 500 feet thick.

The Hartshorne unit is 170 to 300 feet thick in Pittsburg County, approximately 100 feet thick in Haskell and Sequoyah Counties, around 11 feet in McIntosh County, and 3 to 25 feet in Muskogee County. This unit does not outcrop in the other counties of Division One.

This unit normally stands out as a prominent ridge above the underlying shale area of the Atoka unit; locally along the outcrop, it is only slightly pronounced and is not as obvious.

HOGSHOOTER UNIT (Ph)

This unit consists of a single bed of limestone. At local areas along its outcrop, only a highly-weathered soft sandstone represents the unit. The limestone bed is 8 inches to 10 feet thick, blue-gray to white, and shaly.

The Hogshooter is very poorly exposed. It is present on the slopes of the escarpments and hills formed by the overlying Nellie Bly unit. This unit is only present in Okmulgee County of Division One.

HOLDENVILLE UNIT (Phd)

This unit consists of predominately shale, a lesser amount of sandstone, and a few thin beds of limestone. The shale is in thick intervals, usually gray, silty, and sandy. The sandstone is moderately hard to hard, buff to brown, in lenses and beds up to 20 feet

thick, but generally less than 10 feet thick. The limestone is red-brown to blue-gray, hard, and in beds a few inches thick to three feet thick. A limestone bed 3 feet thick can be traced across sections 24 and 25, T15N, R11E.

The total thickness of the Holdenville unit is from 180 feet to 280 feet. In Division One it is only present in Okmulgee County.

The topography is characterized by escarpments and hills capped with sandstone. The shale forms slopes and valleys.

JACKFORK UNIT (Pj)

This unit outcrops in Division One only in Pittsburg County. It is not shown on the geologic unit map, because of the complex nature of the surface materials southeast of the Choctaw fault. The unit is mapped on the "Geologic Map of Oklahoma" by Hugh D. Miser, U.S.G.S., 1954.

The Jackfork consists of mostly sandstone with a lesser amount of shale and some siltstone. The sandstone is generally hard, gray, and massive to thick-bedded. Many places the sandstone is thin-bedded. The shale is siliceous, and at least two of the beds contain boulders up to 7 feet in diameter encased in them.

The Jackfork unit is approximately 1,100 feet thick in this area. The beds dip steeply to the southeast, and the sandstones form prominent ridges above the shale valleys of the overlying and underlying geologic units.

JOHNS VALLEY UNIT (Pjv)

This unit outcrops in Division One only in Pittsburg County. It is not shown on the geologic unit map, because of the complex nature of the surface materials southeast of the Choctaw fault. It is mapped on the "Geologic Map of Oklahoma" by Hugh D. Miser, U.S.G.S., 1954.

The Johns Valley unit consists of light gray to tan clay shale and clay, boulders and masses of rock within the shale, a few thin beds of sandstone, and a minor amount of limestone lens.

This unit forms valleys in this area. The total thickness is 200 to 1,000 feet.

McALESTER UNIT (Pma)

This unit consists of predominately shale, a few widely spaced beds of sandstone, and possibly a few very thin limestone beds. The shale is generally dark colored, mostly silty, locally clayey, and occurs in thick intervals. The sandstone is moderately hard to hard, brown to gray, in beds a few inches thick to 10 feet thick, and in sequences up to 30 feet thick. The limestones are insignificant in this unit.

The thickness of the McAlester unit is approximately 200 to 400 feet in Muskogee County, 275 to 600 feet in McIntosh County, 500 to 700 feet in Sequoyah, 700 to 2,000 feet in Haskell County, and 1,500 to 2,800 feet in Pittsburg County. The unit thins rapidly northward in Wagoner County from about 200 feet at the south end to less than 50 feet at its northern boundary. The McAlester unit does not out-

crop in the remaining counties of Division One.

The topography of this unit is characterized by broad flat shale areas interrupted by occasional fairly prominent ridges capped by the widely-spaced sandstone beds or sequences of beds.

MORROW UNIT (Pm)

This unit consists predominantly of limestone, a lesser amount of shale, and a few beds of sandstone and siltstone. The limestone is brown to gray or black, hard, locally fractured, a few inches thick to approximately 25 feet thick, and in sequences as thick as 50 feet. The sandstone is moderately hard to hard, thin-bedded to massive, occasionally in zones up to 30 feet thick, and has a conglomerate that marks the base of this unit. The siltstone is hard, in beds less than one foot thick, and is very minor in this unit. The shale is black, brown, or greenish-gray, fissile, and occurs mostly in the upper 50 to 200 feet of the Morrow unit.

The thickness of the Morrow unit is 60 to 120 feet in Wagoner County, 120 to 220 feet in Muskogee County, 70 to 200 feet in Cherokee County, approximately 190 feet in Sequoyah County, and 200 to 300 feet in Adair County. This unit does not outcrop in the remaining counties of Division One.

The upper 50 to 225 feet of the Morrow unit consists of interbedded shale and limestone. The limestone beds are normally less than 5 feet thick and the shale beds are normally greater than 5 feet thick. The lower 60 to 100 feet of the unit is predominately thick-bedded limestone.

The upper portion of the Morrow unit typically forms grass and tree covered slopes below the cliff-forming ledges of the overlying sandstone beds of the Atoka unit. The lower portion of the Morrow unit, together with the underlying Chester-Meramec unit, forms prominent cliffs.

NELLIE BLY UNIT (Pnb)

This unit consists of sandstone and shale. The lower 50 to 80 feet consists of sandy shale with a minor amount of very thin lenses of sandstone. Above this shale is a zone of soft to moderately hard sandstone and sandy to extremely sandy shale, which is about 120 feet thick.

The lower beds of the Nellie Bly unit outcrop only in northwestern Okmulgee County in Division One. The upper beds outcrop in Creek County. The Nellie Bly unit forms a steep, generally eastward facing escarpment.

SAVANNA UNIT (Psv)

This unit consists predominately of shale, a lesser amount of sandstone, and a few thin beds of limestone and siltstone.

The shale is gray to black, fissile, locally clayey, and in intervals up to approximately 400 feet thick. The sandstone is moderately hard to hard, buff to gray, in beds a few inches to 10 feet thick and averaging 5 feet in thickness, in sequences up to 120 feet thick but normally averaging 25 feet thick. The beds of limestone and siltstone are less than one foot thick and are minor in this unit.

The thickness of the Savanna unit is approximately 50 feet in the north part of Wagoner County to 165 feet in the south part, 165 to 260 feet in Muskogee County, 150 to 300 feet in McIntosh County, estimated to be approximately 150 feet in Sequoyah County, 100 to 200 feet in the north part to 450 to 1,400 feet in the southern part of Haskell County, and 500 to 1,325 feet in Pittsburg County. This unit does not outcrop in the remaining counties of Division One.

The topography of this unit is characterized by prominent ridges capped by the sandstones with shale valleys.

SEMINOLE UNIT (Psl)

This unit consists of sandy shale, with a minor amount of clay shale; sandstone, with a minor amount of sandstone conglomerate containing chert fragments; and a very minor amount of sandy limestone beds, generally less than one foot thick. The lower 10 to 60 feet is predominately sandstone, which is soft to moderately hard and massive. Above this lower sandstone, the unit consists of interbedded shale and sandstone.

In Division One the Seminole unit outcrops in northwestern Okmulgee County. The total thickness of the unit is from 100 to 200 feet.

The topography is characterized by sandstone-capped ridges and shale valleys.

SENORA UNIT (Psn)

This unit consists of sandstone, shale, limestone, and siltstone. The sandstone is moderately hard to extremely hard, reddish-brown to

gray, and thin to massive bedded. The shale is normally gray and is present in thick intervals.

The Senora unit is divided into a lower sandy zone and an upper shaly zone.

The Senora unit outcrops in a broad pattern across eastern Okmulgee County and western Wagoner, Muskogee, McIntosh, and Pittsburg Counties. The lower 100 to 200 feet of the Senora unit outcrops in Pittsburg County and it is almost entirely sandstone. In southwestern McIntosh County, the lower 500 feet outcrops and consists of predominantly sandstone which is interbedded with sandy shale; the upper 50 to 100 feet is mostly shale. Northwestern McIntosh and western Muskogee Counties share the outcrop area with Okmulgee County. In this area the general thickness is about 800 feet, thinning northward to about 140 feet in northern Wagoner County. The upper 180 to 220 feet is mostly shale, and the lower portion is sandstone and sandy to silty shale.

In northeastern Okmulgee County near Bald Hill, a limestone interbedded with a black shale is present. The limestone is generally less than 10 feet thick and it lenses into shale southward.

The lower sandstone beds of the Senora unit form an escarpment generally facing eastward, overlooking the underlying geologic units. Westward from the face of the escarpment the sandstones cap the hills and ridges, and the shale exposures form the valleys and broad flat areas.

SPRINGER UNIT (Pwc)

In Division One, this unit outcrops in southeastern Pittsburg County only. It is not shown on the geologic unit map, because of the complex nature of the surface materials southeast of the Choctaw fault. The Springer unit is mapped on the "Geologic Map of Oklahoma", by Hugh D. Miser, U.S.G.S., 1954.

The Springer unit is almost entirely a dark-gray fissile shale. There are a few 6-inch to 4-foot beds of tan calcareous siltstone in the upper portion.

The total thickness of the Springer unit is approximately 2,500 feet thick, and it normally forms the slopes and valleys between ridges of hard rock. Generally the Springer unit is covered by debris weathering from the ridges.

ST. CLAIR UNIT (Ssc)

This unit consists entirely of massive bedded, white and pink to blue-gray hard limestone.

The St. Clair unit is exposed in limited areas in Adair, Cherokee, and Sequoyah Counties. Approximately 165 feet of limestone was measured by O.G.S. in sections 14 and 23, T14N, R23E, and 95 feet is exposed at Marble City. Prospect holes have penetrated an additional 100 feet without reaching the base in section 14, T13N, R23E. The unit thins rapidly northwestward to about 23 feet of cherty limestone near Blackgum in Sequoyah County to approximately 10 feet of cherty limestone at Qualls in Cherokee County.

STANLEY UNIT (PMs)

In Division One this unit outcrops in Pittsburg County only. It is not shown on the geologic unit map, because of the complex nature of the surface materials southeast of the Choctaw fault. The Stanley unit is mapped on the "Geologic Map of Oklahoma", by Hugh D. Miser, U.S.G.S., 1954.

The Stanley unit is predominately clay shale, with beds of siltstone up to 100 feet thick. This unit is approximately 12,000 feet thick.

The shale intervals form valleys and the siltstone beds form ridges.

STUART UNIT (Pst)

This unit consists of gray, tan, and black fissile shale which contains a few thin lenses of sandstone.

The Stuart unit outcrops in Division One in Muskogee, McIntosh, and Pittsburg Counties. The approximate thickness of the unit is 25 feet in Muskogee County, 75 feet to 310 feet in McIntosh County, and 275 feet in Pittsburg County.

The outcrop of the Stuart unit normally forms broad valleys and the steep slopes underlying the pronounced east-facing Senora escarpment.

SYLVAN UNIT (Os)

This unit consists of limestone, sandstone, shale, and dolomite. In Division One this unit outcrops in Adair, Cherokee, and Muskogee Counties.

Normally in Adair and Cherokee Counties, the upper 10 to 35 feet is a dark-green, fissile shale with few stringers of brown dolomitic sandstone. Below this shale is approximately 40 feet of light-gray to pink, hard, massive bedded, locally dolomitic limestone. Below this limestone is 75 to 100 feet of shale with a few thin beds of sandstone and limestone. The lower 70 to 100 feet is made up predominantly of massive bedded, soft, white to gray sandstone with minor amounts of shale and limestone.

The outcrop of the Sylvan unit forms the steep walls of cliffs capped by the Boone unit and the valley floors beneath the cliffs.

THURMAN UNIT (Pt)

This unit is dominantly sandstone with some shale in the upper portion. The sandstone is brown to tan, medium hard to hard, massive bedded, in sequences up to 50 feet, and conglomeritic at the base.

The Thurman unit is 290 to 335 feet thick. The unit caps a prominent eastward-facing escarpment and also caps a few outlying hills east of the scarp. In Division One this unit outcrops in Pittsburg County only.

WAPANUCKA UNIT (Pwc)

In Division One this unit outcrops in southeastern Pittsburg County only. It is not shown on the geologic unit map, because of the complex nature of the surface rocks southeast of the Choctaw fault. The Wapanucka unit is mapped on the "Geologic Map of Oklahoma" by Hugh D. Miser, U.S.G.S., 1954.

The Wapanucka consists of limestone, shale, sandstone, and minor amounts of chert. The limestone is hard, massive bedded, blue-gray, and locally grades to sandstone. The shale is gray, clayey, calcareous, and thick bedded. The sandstone is generally hard and calcareous. A black, hard, 2-10 foot thick bed of chert is present at the top of the unit.

The unit is principally a ridge former. Locally there are outcrops barely exposed in low areas. The total thickness is from 270 to 720 feet.

WETUMKA UNIT (Pwt)

This unit consists principally of greenish-gray to gray, silty shale with a few local lenses of soft, silty sandstone.

In Division One this unit outcrops in Okmulgee County only. The total thickness is 100 feet at the southern boundary, thinning to 60 feet in section 21, T12N, R12E; northward it thickens to 180 feet in the southern part of T14N. It pinches out northward in section 7, T15N, R14E.

The topography is typically characterized by a gently-rolling prairie.

WEWOKA UNIT (Pwk)

This unit consists predominantly of shale with many lensing sandstone beds and one zone of shaly siltstone.

The shale is generally gray to black, clayey to silty, and in intervals up to 150 feet thick. The sandstone is generally moderately

hard, massive bedded, normally in beds less than 10 feet thick, and in sequences up to 120 feet. The shaly siltstone is about 60 feet thick and soft.

In Division One the Wewoka unit outcrops in Okmulgee and Wagoner Counties only. The total thickness in Okmulgee County is 600 feet in the southern part and thins to 400 feet at the northern boundary. Approximately the lower 200 feet is exposed in southwest Wagoner County.

WOODFORD-PINETOP UNIT (MDw)

In Division One this unit outcrops in southeastern Pittsburg County only. It is not shown on the geologic unit map, because of the complex nature of the surface rocks southeast of the Choctaw fault. The Woodford-Pinetop is mapped on the "Geologic Map of Oklahoma", by Hugh D. Miser, U.S.G.S., 1954.

This unit consists predominantly of chert which contains a few beds and lenses of shale and limestone. The upper 60 feet is thin interbedded chert and shale. The lower approximate 50 feet is massive chert with a few lenses of limestone.

The total thickness of the Woodford-Pinetop unit is approximately 110 feet. It normally forms a conspicuous ridge.

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.

GERTIE SAND DEPOSITS (Qg)

These materials consist of sand, gravel, clay, and/or mixtures of these. Throughout its extent, the maximum thickness is estimated at 50 feet.

These deposits rest on the consolidated geologic materials in the form of an upland terrace across the central part of Pittsburg County in Division One. 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 and Gertie Sand deposits will have seepage where the underlying geologic material is less pervious.

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
		ATOKA UNIT (Pa)			
Adair	250 feet south, thins northward	Locally, sandstone beds appear suitable for rip-rap	Seepage was noted coming from colluvium over shale	Locally, sandstone beds do not appear rippable	Slumps of colluvium over shale were noted
Cherokee	20 - 150 feet	Marginal for use as rip-rap	----	Marginal	----
Haskell	300 feet	Sandstone beds locally appear suitable for rip-rap	----	Sandstone beds locally do not appear rippable	----
McIntosh	150 feet	----	----	Rippable	----
Muskogee	600 feet	Sandstone beds locally appear suitable for rip-rap and marginal for base admix	----	Locally the sandstones appear non-rippable	Some slumping of colluvium and weathered shale is present
Pittsburg	2000-9000 feet	"	----	"	"
Sequoyah	250 feet	Hard, gray sandstone appears suitable for base admix	Seepage from thin-bedded sandstone was noted	Most sandstone beds appear non-rippable	"
Wagoner	30 - 140 feet	Sandstone marginal for rip-rap	----	Marginal	"

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		BLUEJACKET UNIT (Pbj)			
Haskell	400 feet	Locally sandstone appears suitable as admix for all coarse aggregates	Sandstone over shale may have seepage	The hard sandstone does not appear rippable	Colluvium over shale slopes may slide
McIntosh	300 feet				
Muskogee	310 feet	Locally appears suitable for base admix and rip-rap	"	"	"
Pittsburg	345 feet				
Wagoner	300 feet				
		BOGGY UNIT (Pbg)			
Haskell	North to south 700 -1800 feet	Locally, sandstone may be suitable for rip-rap	Seepage was noted coming from shale	Locally, sandstone does not appear rippable	Backslope failure in shale was noted on SH 9
McIntosh	North - south 250 - 1300 feet	"	----	"	Backslope failures in shale during construction on US 69 Eufaula By-pass
Muskogee	500 feet	Locally, sandstone appears suitable for rip-rap & possibly base admix	----	"	----
Pittsburg	2500 feet	"	Underdrains were put in shale on US 69 near Canadian, Oklahoma	"	Backslope failures in shale and colluvial slumps were noted in many areas
Wagoner	250 feet	"	----	"	----

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
			BOONE UNIT (Mb)		
Adair Cherokee Sequoyah Wagoner	230 feet " " 110 feet 80 - 100 feet	The chert and limestone appears suitable for coarse admixes except for P.C. concrete	Numerous springs were noted at the base of the Boone unit	Does not appear rippable except where beds are 1 foot or less	----
			CALVIN UNIT (Pcv)		
Okmulgee Wagoner	North - south 10 - 440 feet 10 feet	Locally may be suitable for rip-rap	----	Locally may not be rippable	Backslope failures in shale were noted center Sec. 9, T11N, R13E and SE¼SE¼NE¼ Sec. 7, T11N, R13E
			CANEY UNIT (Mc)		
Pittsburg	50 feet	----	----	Appears rippable	----
			CHATTANOOGA UNIT (MDc)		
Adair Cherokee Muskogee Sequoyah	40 - 90 feet " " 36 feet 70 feet	----	----	Sandstone may not be rippable; shale should be rippable	----
			CHECKERBOARD UNIT (Pcb)		
Okmulgee	2 feet	May serve as a very local source for rip-rap	Fractured limestone often seeps over shale	Locally may not be rippable; generally it appears rippable	----

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		CHESTER-MERAMEC UNIT (Mp)			
Adair Cherokee Wagoner Sequoyah	150 - 245 feet " " " " " " 110 feet	Limestone appears suitable for all coarse aggregates, where the beds are of suitable thickness	----	Beds of limestone, siltstone, and sandstone that are 1 foot or thicker do not appear rippable	----
		CHICKACHOC UNIT (Pwc)			
Pittsburg	600 feet	Rip-rap	----	Does not appear rippable	----
		COFFEYVILLE UNIT (Pcf)			
Okmulgee	450 - 470 feet	Where sandstone is soft may be suitable for subbase	Seepage conditions may be present	Appears rippable	Backslope failure of colluvium in SW¼SW¼ SW¼SW¼ Sec. 9, T15N R11E
		FORT SCOTT UNIT (Pfs)			
Wagoner	2 - 9 feet	Locally may be suitable for rip-rap	----	Where limestone beds are 1 foot or thicker, they do not appear rippable	----

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		HARTSHORNE UNIT (Phs)			
Haskell	100 feet	Marginal for rip-rap	----	Marginal	----
McIntosh	11 feet	----	----	Appears rippable	----
Muskogee	3 - 25 feet	----	----	" "	----
Pittsburg	170 - 300 feet	----	----	Locally, sandstone beds may not be rippable	----
Sequoyah	100 feet	----	----	"	----
		HOGSHOOTER UNIT (Ph)			
Okmulgee	8 inches - 10 feet	----	----	Where limestone bed is 1 foot or thicker may not be rippable	----
		HOLDENVILLE UNIT (Phd)			
Okmulgee	180 to 280 feet	Beds of hard sandstone may be suitable for rip-rap	----	Beds of hard sandstone may not be rippable	----
		JACKFORK UNIT (Pj)			
Pittsburg	1100 feet	Sandstone appears suitable for rip-rap and possible for base admix	----	Sandstone does not appear rippable	----

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		JOHNS VALLEY UNIT (Pjv)			
Pittsburg	200-1000 feet	----	----	Appears rippable	----
		McALESTER UNIT (Pma)			
Haskell	700-2000 feet	Thicker beds of sandstone may be suitable for rip-rap	----	Beds of hard sandstone 1 foot or thicker do not appear rippable	Colluvial slump over shale was noted
McIntosh	275-600 feet	----	----	Appears rippable	----
Muskogee	200-400 feet	----	----	Beds of hard sandstone 1 foot or thicker do not appear rippable	----
Pittsburg	1500-2800 feet	----	----	"	Backslope failures in shale--SH 31, SE¼ Sec. 2, T5N, R15E; also, SW¼ SW¼SE¼ Sec. 6, T3N, R15E
Sequoyah	500-700 feet	Locally the hard sandstone appears suitable for rip-rap	----	The hard sandstone beds do not appear rippable	----
Wagoner	200 feet at the south border; thins rapidly northward	----	----	Rippable	----

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		MORROW UNIT (Pm)			
Adair Cherokee Muskogee Sequoyah Wagoner	200-300 feet 70-200 feet 120-220 feet 190 feet 60-120 feet	The limestone beds generally appear suitable for coarse aggregate materials	----	Limestone and sandstone beds do not appear rippable	----
		NELLIE BLY (Pnb)			
Okmulgee	170-200 feet	Soft beds of sandstone may be suitable for subbase	----	Rippable	----
		SAVANNA UNIT (Psv)			
Haskell	North 100-200 South 450-1400	Locally, sandstone may be suitable for rip-rap	----	Locally, sandstone does not appear rippable	----
McIntosh	150-300 feet	----	----	Rippable	----
Muskogee	165-260 feet	----	----	"	----
Pittsburg	500-1325 feet	Locally, sandstone may be suitable for rip-rap	----	Locally, sandstone may not be rippable	----
Sequoyah	150 feet	----	Seepage was present in fissile shale in at least one area	Rippable	Backslope failure in first cut west of Muldrow on US 64; backslope is shale and thin sandstone beds dipping toward the roadway

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
			SAVANNA UNIT, CONTD		
Wagoner	North South 50 - 165 ft.	----	----	Rippable	----
			SEMINOLE UNIT (Psl)		
Okmulgee	100 - 200 feet	Where sandstone beds are soft, they may be suitable for subbase	----	Rippable	----
			SENORA UNIT (Psn)		
McIntosh Muskogee Okmulgee Pittsburg Wagoner	500 feet 175-225 feet 650 feet 100-200 feet 140 feet	Hard sandstone beds appear suitable for rip-rap; limestones appear suitable for coarse aggregate admixes	----	Hard sandstone does not appear rippable	Colluvial landslide is present along the road in Sec. 27, T11N, R14E
			SPRINGER UNIT (Pwc)		
Pittsburg	2500 feet	----	----	Siltstone beds one foot or thicker may not be rippable	----
			ST. CLAIR UNIT (Ssc)		
Adair Cherokee Sequoyah	Up to 165 feet 10 feet 23-95 feet exposed	Limestone appears suitable for base admix and rip-rap	----	Limestone does not appear rippable	----

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		STANLEY UNIT (PMs)			
Pittsburg	12,000 feet	Siltstone may be suitable for base admix and rip-rap	----	Siltstone does not appear rippable	----
		STUART UNIT (Pst)			
McIntosh Muskogee Pittsburg	75-310 feet 25 feet 275 feet	----	----	Rippable	----
		SYLVAN UNIT (Os)			
Adair Cherokee	200-250 feet	Limestone bed may be suitable for all coarse aggregates	----	Limestone beds do not appear rippable	----
Muskogee	Only shale exposed--no thickness determined	----	----	----	----
		THURMAN UNIT (Pt)			
Pittsburg	290-335 feet	Marginal for rip-rap	----	Marginal	----

COUNTY	APPROXIMATE THICKNESS	APPARENT MATERIAL SUITABILITY	APPARENT SEEPAGE	APPARENT RIPPABILITY	LANDSLIDES OR BACKSLOPE FAILURES
		WAPANUCKA UNIT (Pwc)			
Pittsburg	270-720 feet	Limestone appears suitable for all coarse aggregates	----	Limestone, sandstone, and chert do not appear rippable	----
		WETUMKA UNIT (Pwt)			
Okmulgee	60-180 feet	----	----	Rippable	----
		WEWOKA UNIT (Pwk)			
Okmulgee Wagoner	400-600 feet 200 feet	Hard sandstone bed may be suitable for rip-rap	----	Hard sandstone beds may not be rippable	----
		WOODFORD-PINETOP UNIT (MDw)			
Pittsburg	110 feet	Chert and limestone beds may be suitable for base admix and rip-rap	----	Chert and limestone beds do not appear rippable	----

HIGHWAY ENGINEERING CHARACTERISTICS OF GEOLOGIC UNITS

GEOLOGIC UNIT NAME & COUNTY		O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
															STABILIZATION		SUBGRADE		
				NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
ATOKA																			
	Adair	7	A-4(6)	100	85	77	67	29	7	-	-	-	-	-	No	12		X	
	Cherokee	14	A-7-6(7)	100	85	80	71	41	16	39	15	1.91	46	-	No	14	X		
	Haskell	8	A-4(8)	100	86	82	75	29	6	-	-	-	-	-	No	12	X		
(Cl-sh)	McIntosh	23	A-7-5(19)	92	88	86	82	62	27	42	20	1.76	39	.42	No	17			X
	Muskogee	11	A-4(8)	100	99	98	96	37	8	33	19	1.78	25	-	No	12		X	
	Pittsburg	16	A-7-6(12)	100	98	98	96	46	18	42	15	1.89	50	-	No	15		X	
	Sequoyah	10	A-4(8)	99	96	94	89	33	8	30	15	1.91	29	-	No	12		X	
	Wagoner	15	A-7-6(11)	100	99	99	96	42	17	35	16	1.88	37	-	No	15		X	
BLUEJACKET																			
	Haskell	11	A-4(8)	100	99	98	96	35	9	-	-	-	-	-	No	12		X	
	Wagoner	4	A-4(6)	100	98	98	65	24	1	-	-	-	-	-	No	12	X		
BOGGY																			
	Haskell	17	A-7-6(13)	100	100	100	99	47	19	38	19	1.82	34	.15	No	15			X
	"	14	A-6(10)	100	100	100	99	40	15	39	17	1.89	43	-	No	13		X	
	McIntosh	11	A-4(8)	99	95	93	87	37	10	32	16	1.86	31	-	No	12		X	
	Muskogee	8	A-4(8)	100	100	99	97	27	6	24	19	1.87	10	-	No	12		X	
	"	8	A-4(8)	100	100	98	94	28	6	27	18	1.88	18	-	No	12		X	
	Pittsburg	9	A-4(8)	100	99	98	90	31	8	-	-	-	-	-	No	12		X	
	"	14	A-6(10)	100	99	98	96	40	15	35	15	1.92	38	-	No	13		X	
(Cl-sh)	"	19	A-7-5(15)	96	94	91	88	53	22	39	23	1.64	26	24	No	15			X
	Wagoner	9	A-4(8)	100	99	98	93	31	7	-	-	-	-	-	No	12		X	

(Cl-sh) Clay-shale

HIGHWAY ENGINEERING CHARACTERISTICS OF GEOLOGIC UNITS

GEOLOGIC UNIT NAME & COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
BOONE																		
Adair	10	A-4(8)	100	98	93	80	31	9	30	15	1.87	28	-	No	12		X	
(Clay) "	40	A-7-5(20)	100	100	99	98	114	67	70	24	1.56	72	5.00	No	17			X
CANEY																		
Pittsburg	23	A-7-6(20)	100	99	98	97	58	29	52	15	1.90	70	.52	No	18			X
CALVIN																		
Okmulgee	15	A-7-6(11)	98	97	96	92	43	15	18	16	1.86	34	-	No	15		X	
CHATTANOOGA																		
Adair	0	A-4(8)	100	83	75	66	NP	NP	-	-	-	-	-	No	12	X		
Cherokee	0	A-1-b(0)	100	24	19	11	NP	NP	-	-	-	-	-	No	10	X		
Sequoyah	8	A-4(8)	100	99	98	95	26	6	26	15	1.88	20	-	No	12		X	
CHESTER-MERAMEC																		
Adair	9	A-4(8)	100	100	100	98	28	9	-	-	-	-	-	No	12		X	
"	14	A-7-5(10)	100	88	83	74	44	14	35	18	1.79	31	-	No	14		X	
Cherokee	1	A-2-4(0)	100	52	41	24	33	6	-	-	-	-	-	4.0	9	X		
"	10	A-6(5)	100	79	70	59	38	12	33	18	1.78	27	-	7.0	12	X		
"	14	A-7-6(9)	100	87	80	69	42	15	38	15	1.87	42	-	No	15		X	
Muskogee	8	A-4(8)	100	100	100	98	30	6	27	17	1.84	19	-	No	12		X	
Sequoyah	9	A-4(8)	100	99	97	92	33	7	30	17	1.87	25	-	No	12		X	
"	13	A-5(7)	100	91	83	68	43	10	41	23	1.67	34	-	No	12		X	
(Clay) "	27	A-7-5(20)	100	100	99	98	67	35	44	12	2.02	65	.90	No	17			X
Wagoner	19	A-7-5(15)	100	91	85	74	54	20	43	15	1.82	51	.20	No	15			X
COFFEYVILLE																		
Okmulgee	17	A-7-6(13)	97	95	94	90	45	19	38	17	1.84	39	.15	No	15			X

HIGHWAY ENGINEERING CHARACTERISTICS OF GEOLOGIC UNITS

GEOLOGIC UNIT NAME & COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
FORT SCOTT																		
Wagoner	5	A-4(6)	100	81	74	67	25	3	-	-	-	-	-	No	12		X	
HARTSHORNE																		
Haskell	14	A-7-6(10)	100	99	99	98	41	15	32	15	1.87	32	-	No	15		X	
McIntosh	13	A-6(9)	95	90	88	82	39	13	32	22	1.70	17	-	No	13		X	
Pittsburg	11	A-4(8)	100	100	99	98	36	10	35	24	1.65	19	-	No	12		X	
Sequoyah	8	A-4(8)	100	97	95	80	27	6	24	17	1.85	14	-	No	12		X	
HOLDENVILLE																		
Okmulgee	7	A-4(8)	100	100	100	95	26	3	-	-	-	-	-	No	12		X	
JOHNSVALLEY																		
Pittsburg	22	A-7-5(19)	100	100	99	98	59	27	45	15	1.85	56	.42	No	17			X
MCALESTER																		
Haskell	8	A-4(8)	100	99	99	98	28	7	-	-	-	-	-	No	12		X	
"	10	A-4(8)	100	98	97	93	34	9	-	-	-	-	-	No	12		X	
"	11	A-4(8)	100	99	96	92	34	10	30	18	1.87	22	-	No	12		X	
McIntosh	10	A-4(8)	91	87	86	80	32	9	27	17	1.89	20	-	No	12		X	
"	11	A-6(8)	93	89	87	86	35	11	28	20	1.78	16	-	No	13		X	
"	12	A-6(9)	97	94	92	87	35	13	33	13	1.59	31	-	No	13		X	
Muskogee	10	A-4(8)	100	98	97	94	35	8	31	19	1.81	22	-	No	12		X	
Pittsburg	9	A-4(8)	100	99	99	94	30	8	-	-	-	-	-	No	12		X	
Sequoyah	8	A-4(8)	100	93	91	88	29	6	27	16	1.89	21	-	No	12		X	
"	9	A-4(8)	95	89	86	81	30	7	27	16	1.90	22	-	No	12		X	
(Clay) "	17	A-7-6(13)	100	96	95	86	47	20	36	16	1.92	40	.20	No	15			X
Wagoner	12	A-4(8)	99	98	96	87	38	10	29	16	1.84	23	-	No	12		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF GEOLOGIC UNITS

GEOLOGIC UNIT NAME & COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
MORROW																		
Adair	13	A-7-5(10)	100	100	100	97	44	12	34	15	1.92	36	-	No	14		X	
Cherokee	7	A-6(2)	100	61	53	43	36	12	34	14	1.92	37	-	5.5	11		X	
Muskogee	9	A-4(8)	100	100	99	95	31	7	27	17	1.87	18	-	No	12		X	
SAVANNA																		
Haskell	8	A-4(8)	100	100	100	99	27	6	-	-	-	-	-	No	12	X		
"	11	A-4(8)	100	97	95	93	36	10	-	-	-	-	-	No	12		X	
"	17	A-7-6(13)	100	100	100	99	48	19	36	17	1.87	35	.15	No	15			X
McIntosh	6	A-4(5)	79	67	64	59	26	6	-	-	-	-	-	6.0	11	X		
"	11	A-6(8)	94	89	87	86	35	11	31	19	1.82	22	-	No	13		X	
Muskogee	18	A-7-6(14)	100	98	97	93	43	23	35	11	2.05	49	.28	No	15			X
Sequoyah	14	A-7-5(10)	100	94	89	82	43	13	35	23	1.74	21	-	No	14		X	
"	15	A-6(11)	100	99	99	93	40	18	34	18	1.79	29	-	No	13		X	
Wagoner	13	A-6(9)	100	99	99	96	39	13	30	17	1.86	24	-	No	13		X	
SENORA																		
McIntosh	16	A-7-6(12)	98	97	95	89	44	17	33	16	1.89	33	-	No	15		X	
Muskogee	11	A-4(8)	100	100	98	93	38	8	35	22	1.70	21	-	No	12		X	
Okmulgee	15	A-7-6(11)	100	100	99	99	43	15	25	15	1.88	46	-	No	15		X	
Pittsburg	17	A-7-6(13)	100	100	98	95	47	18	38	18	1.81	37	-	No	15			X
Wagoner	11	A-4(8)	100	99	99	92	37	9	-	-	-	-	-	No	12		X	
SEMINOLE																		
Okmulgee	0	A-4(3)	100	100	100	52	NP	NP	-	-	-	-	-	6.0	11	X		

HIGHWAY ENGINEERING CHARACTERISTICS OF GEOLOGIC UNITS

GEOLOGIC UNIT NAME & COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
SPRINGER																		
Pittsburg	15	A-7-6(12)	100	100	99	98	44	17	36	18	1.85	34	-	No	15		X	
STANLEY																		
Pittsburg	11	A-4(8)	99	97	95	86	33	10	32	16	1.85	25	-	No	12		X	
STUART																		
McIntosh	15	A-7-6(11)	98	97	97	96	43	16	34	16	1.84	32	-	No	15		X	
Muskogee	19	A-7-6(15)	99	96	93	85	49	23	40	13	2.00	53	.28	No	16			X
Pittsburg	14	A-7-6(10)	100	100	100	97	41	14	34	15	1.87	36	-	No	15		X	
SYLVAN																		
Cherokee	0	A-2-3(0)	100	60	52	35	NP	NP	-	-	-	-	-	4.5	11	X		
"	13	A-6(9)	100	97	94	87	40	13	34	17	1.81	31	-	No	13		X	
THURMAN																		
Pittsburg	10	A-4(8)	99	97	96	90	32	9	29	14	1.91	28	-	No	12		X	
"	18	A-7-5(14)	100	100	100	99	50	20	42	16	1.84	47	.20	No	14			X
WETUMKA																		
Okmulgee	12	A-6(9)	98	97	94	90	37	13	16	14	1.87	30	-	No	13		X	
WEWOKA																		
Okmulgee	15	A-7-6(11)	100	99	98	97	44	16	19	15	1.85	35	-	No	15		X	
Wagoner	12	A-6(9)	100	99	98	95	36	12	31	14	1.92	33	-	No	13		X	

GEOLOGIC UNITS OF ADAIR 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
"Geologic Map of the Stilwell Area, Adair & Sequoyah Counties"
by George G. Huffman and others
O.G.S. & U.S.G.S. 1958

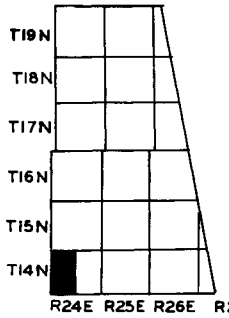
- IPa — Atoka Unit
- IPm — Morrow Unit
- Mp — Chester–Meramec Unit
- Mb — Boone Unit
- MDc — Chattanooga Unit
- Ssc — St. Clair Unit
- Os — Sylvan Unit
- U-Up / D-Down — Fault

Mb
MDc
Os
Watts
Westville
Titanic
Stilwell
Mp
Pm
Pa
Ssc
10
59
62
51
100
T 19 N
T 18 N
T 17 N
T 16 N
T 15 N
T 14 N
R 24E
R 25E
R 26E

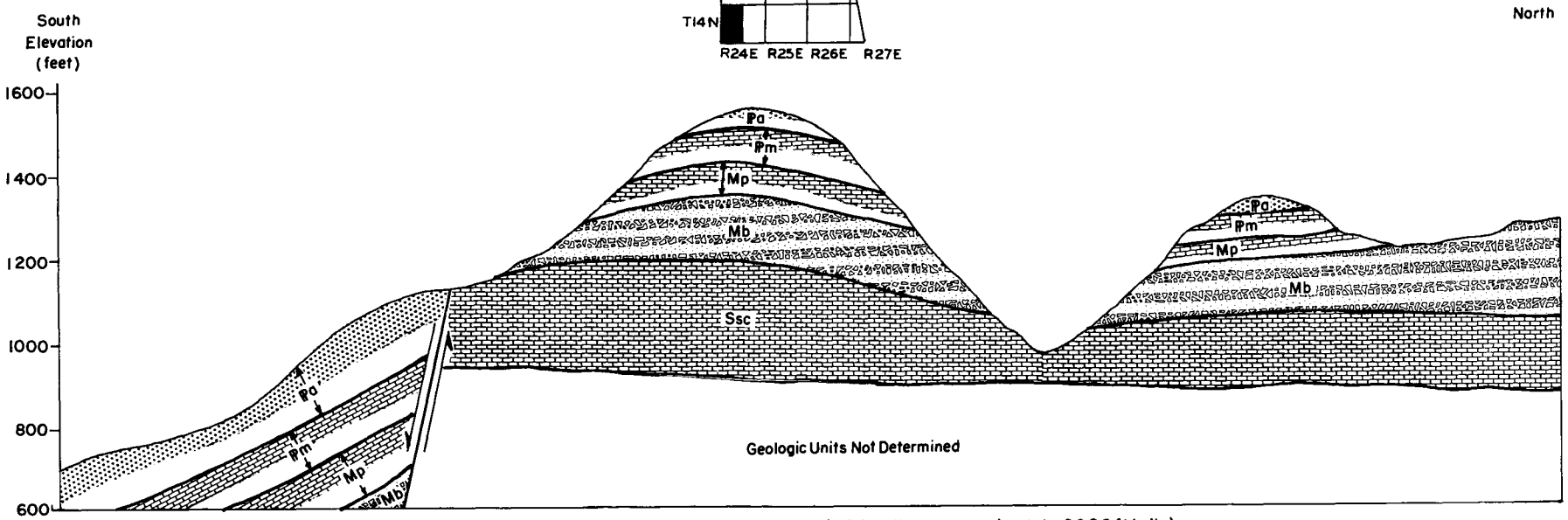
SCALE

0 1 2 3 4 5 10 MILE

IDEALIZED CROSS SECTION
ADAIR COUNTY
NO. 1



Cross Section Illustrates Shaded Area



Beds range in dip from 1° up to approximately 50° (90 ft/mile to approximately 6000 ft/mile)
Generally the dip is less than 10° (460 ft/mile)

GEOLOGIC UNIT	SYMBOL
Atoka	Pa
Morrow	Pm
Chester-Meramec	Mp
Boone	Mb
St. Clair	Ssc

0 1 2 Miles

Approximate Scale

Sandstone

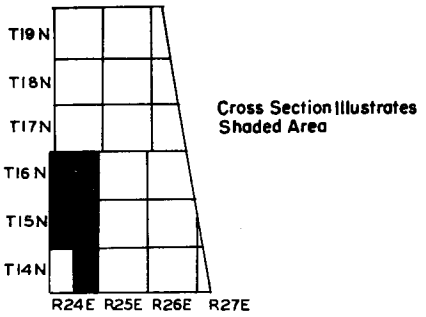
Shale

Limestone

Chert

Fault-Arrows show direction of movement

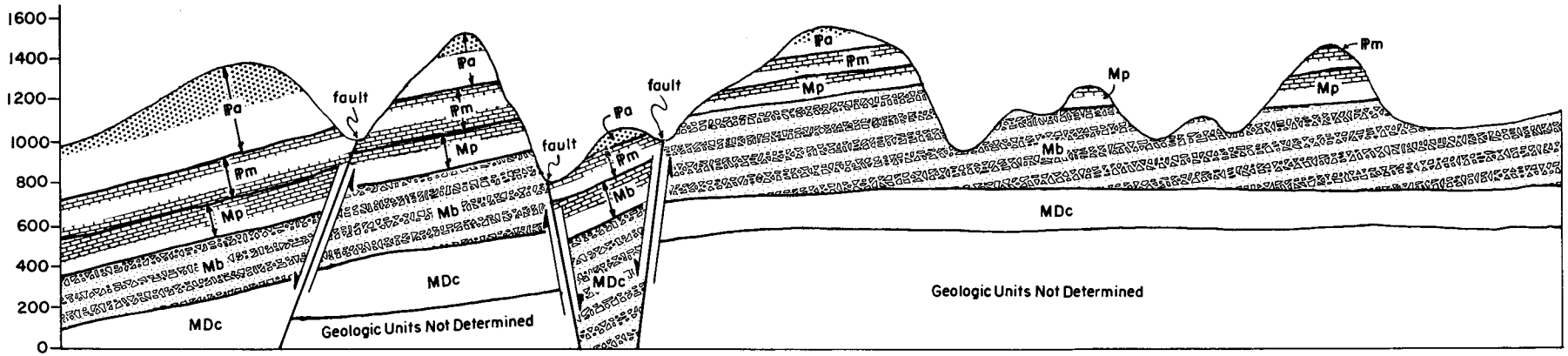
IDEALIZED CROSS SECTION
ADAIR COUNTY
NO. 2



South — Southeast

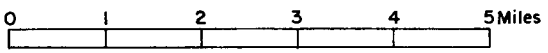
Elevation (feet)

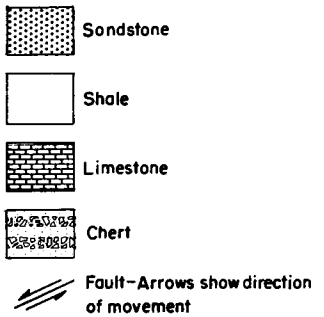
North — Northwest



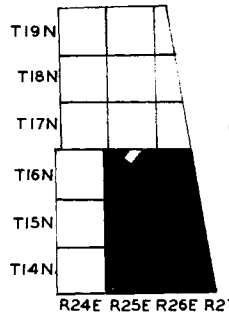
Beds range in dip from 1 degree up to approx. 12 degrees (90 ft./mile to 1100 ft./mile
Generally the dip is less than 2 degrees (185 ft./mile)

GEOLOGIC UNIT	SYMBOL
Atoka	Pa
Morrow	Pm
Chester - Meramec	Mp
Boone	Mb
Chatanooga	MDc





IDEALIZED CROSS SECTION
ADAIR COUNTY
NO. 3

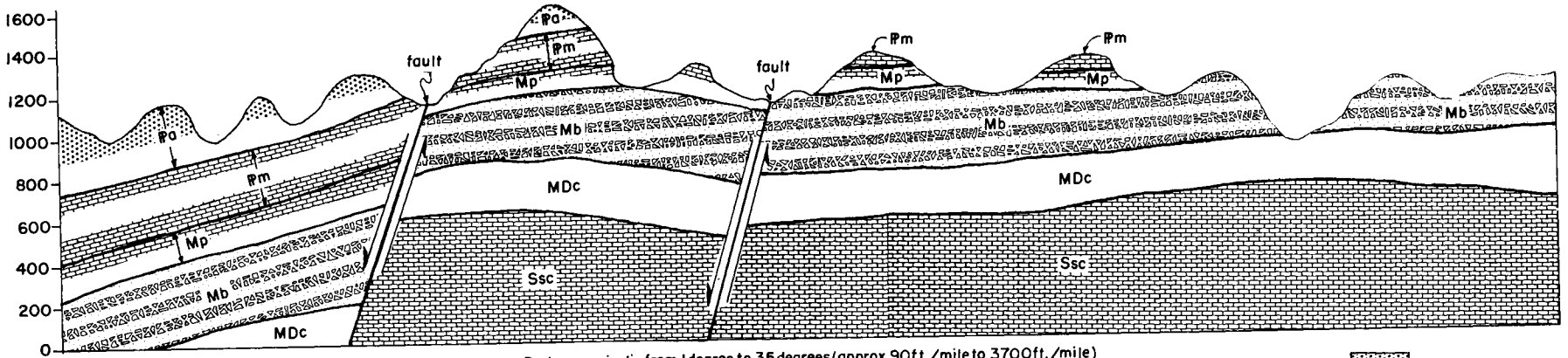


Cross Section Illustrates Shaded Area

South

North

Elevation (feet)



Beds range in dip from 1 degree to 35 degrees (approx. 90 ft./mile to 3700 ft./mile)
Generally the dip is less than 4 degrees (approx. 350 ft./mile)

GEOLOGIC UNIT	SYMBOL
Atoka	Pa
Morrow	Pm
Chester - Meramec	Mp
Boone	Mb
Chatanooga	MDc
St. Clair	Ssc

0 1 2 3 4 5 Miles

Approximate Scale

Sandstone

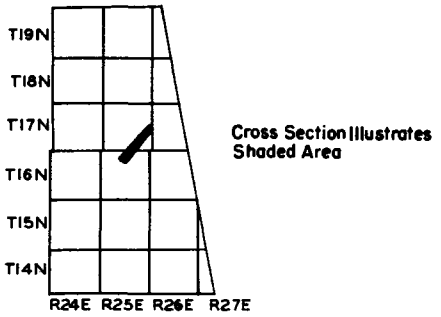
Shale

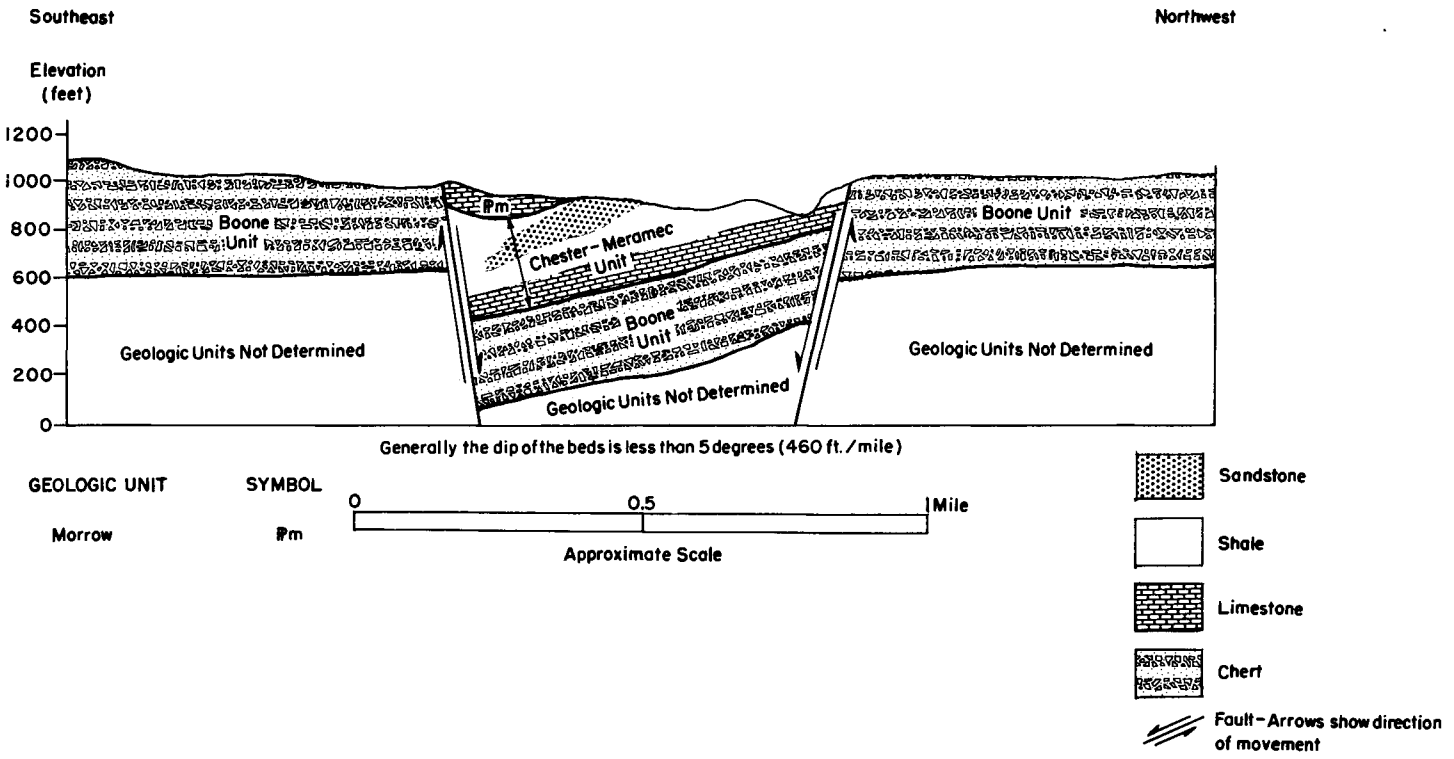
Limestone

Chert

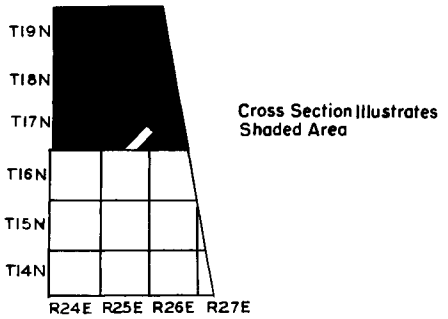
Fault - Arrows show direction of movement

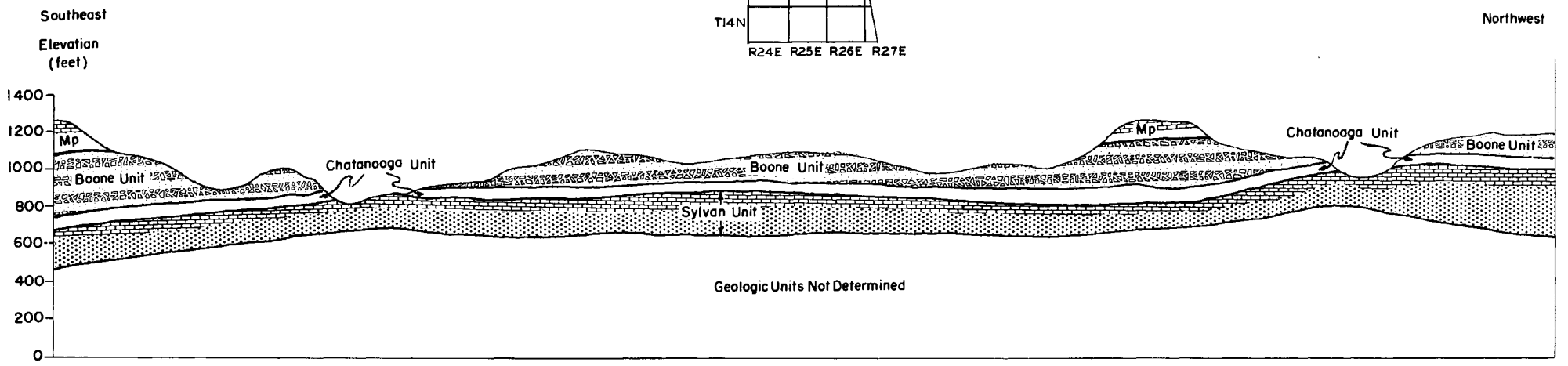
IDEALIZED CROSS SECTION
ADAIR COUNTY
NO.4





IDEALIZED CROSS SECTION
ADAIR COUNTY
NO.5





Generally the dip of the beds is less than 5 degrees (approx. 460 ft./mile)

GEOLOGIC UNIT	SYMBOL
Chester - Meramec	Mp

0 1 2 3 4 5 Miles

Approximate Scale

Sandstone

Shale

Limestone

Chert

GEOLOGIC UNITS OF CHEROKEE COUNTY

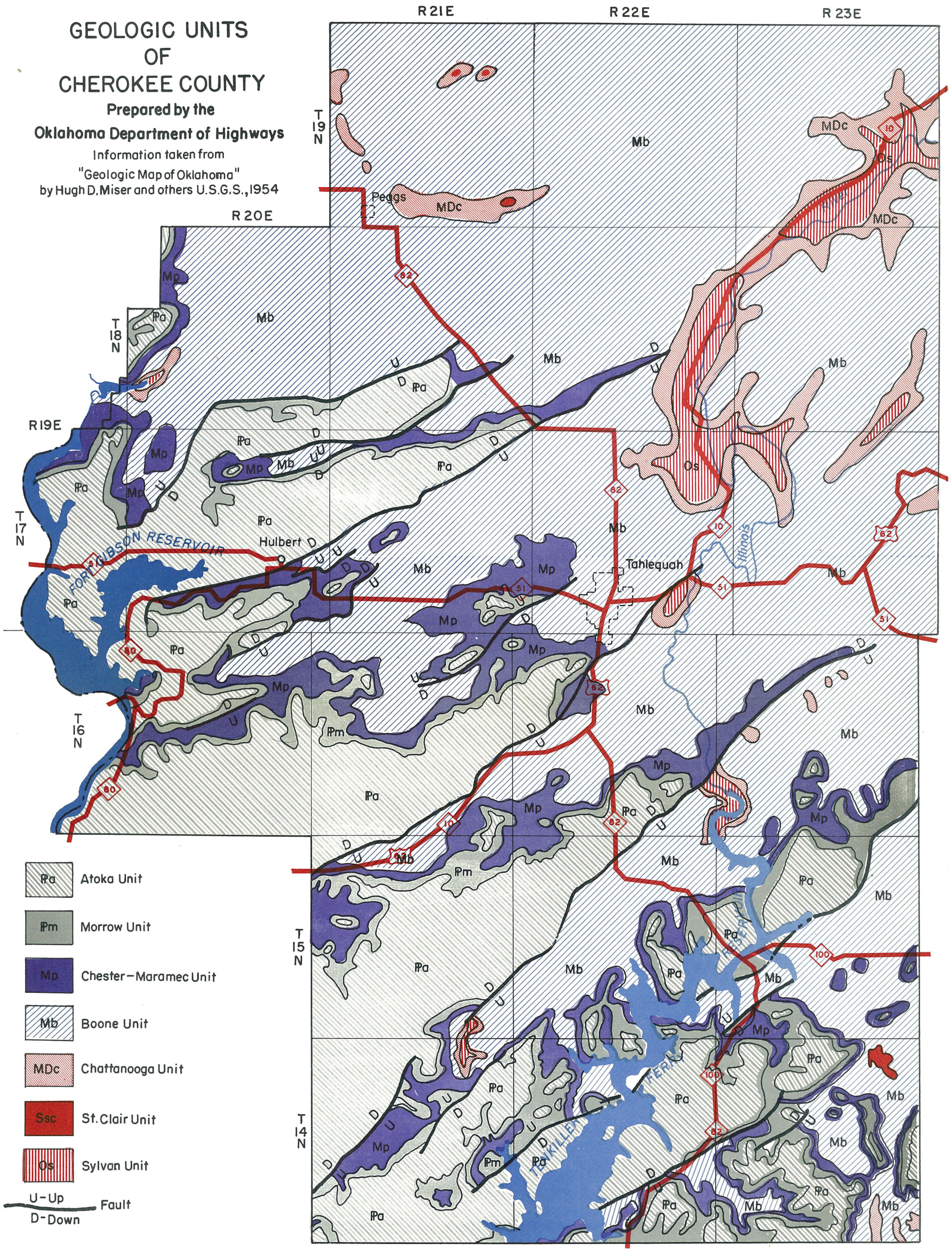
Prepared by the

Oklahoma Department of Highways

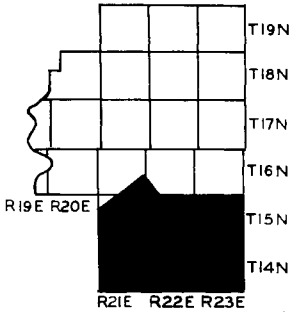
Information taken from

"Geologic Map of Oklahoma"

by Hugh D. Miser and others U.S.G.S., 1954



IDEALIZED CROSS SECTION
CHEROKEE COUNTY
NO. 1



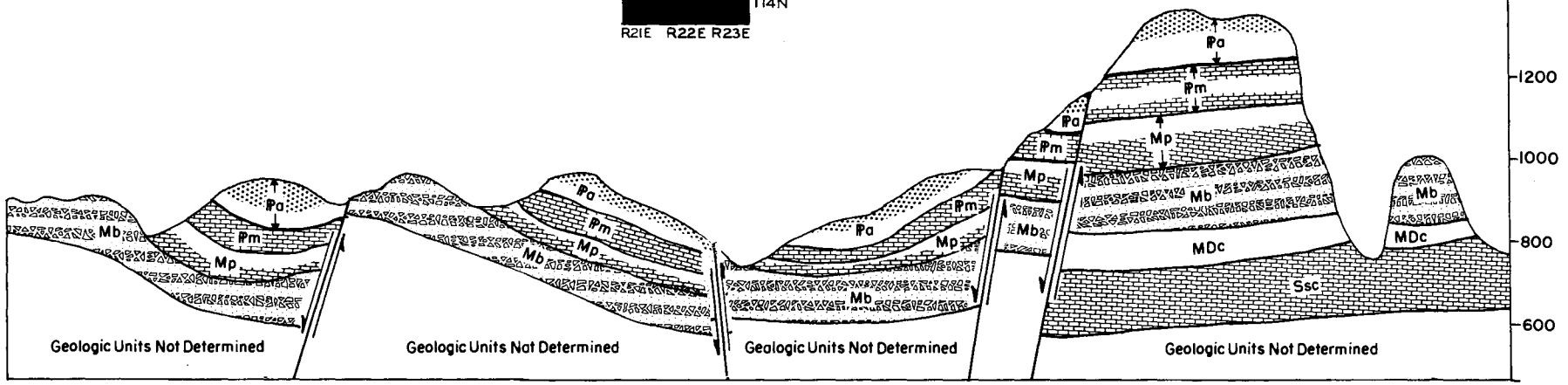
Cross Section Illustrates Shaded Area

Northwest

Southeast

Elevation (feet)

1400
1200
1000
800
600



Beds range in dip from approximately 1 degree to 20 degrees (90 ft/mile to 1920 ft/mile)

GEOLOGIC UNIT	SYMBOL
Atoka	Pa
Morrow	Pm
Chester-Meramec	Mp
Boone	Mb
St. Clair	Ssc

0 1 2 3 4 5 Miles

Approximate Scale

Sandstone

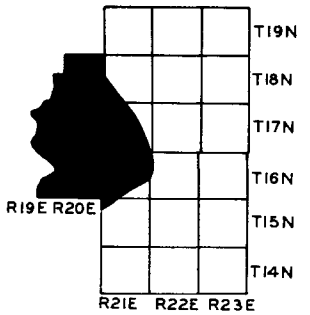
Shale

Limestone

Chert

Fault-Arrows show direction of movement

IDEALIZED CROSS SECTION
CHEROKEE COUNTY
NO. 2

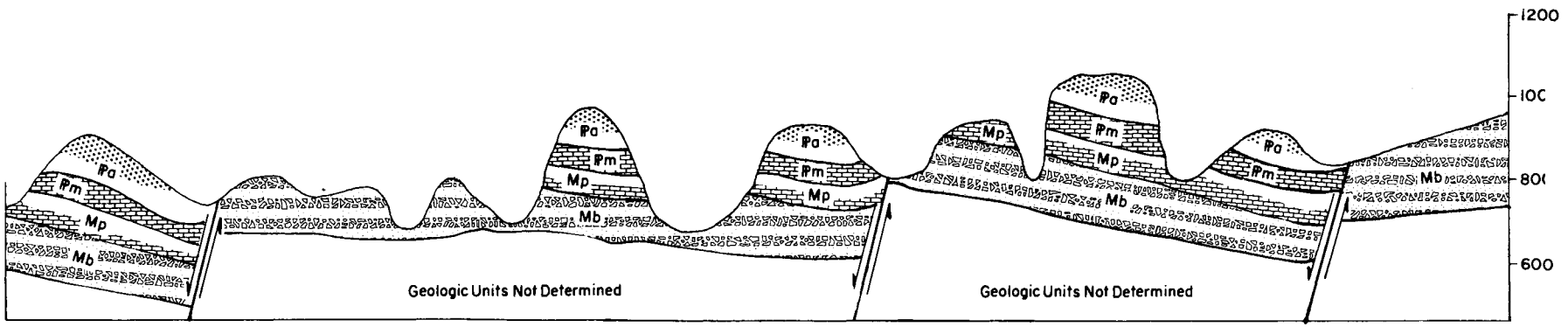


Cross Section Illustrates Shaded Area

Northwest

Southeast

Elevation (feet)



GEOLOGIC UNIT	SYMBOL
Atoka	Pa
Morrow	Pm
Chester-Meramec	Mp
Boone	Mb

0 1 2 3 4 5 Miles

Approximate Scale

Sondstone

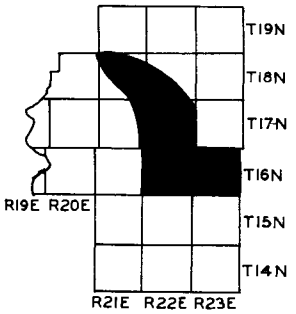
Shale

Limestone

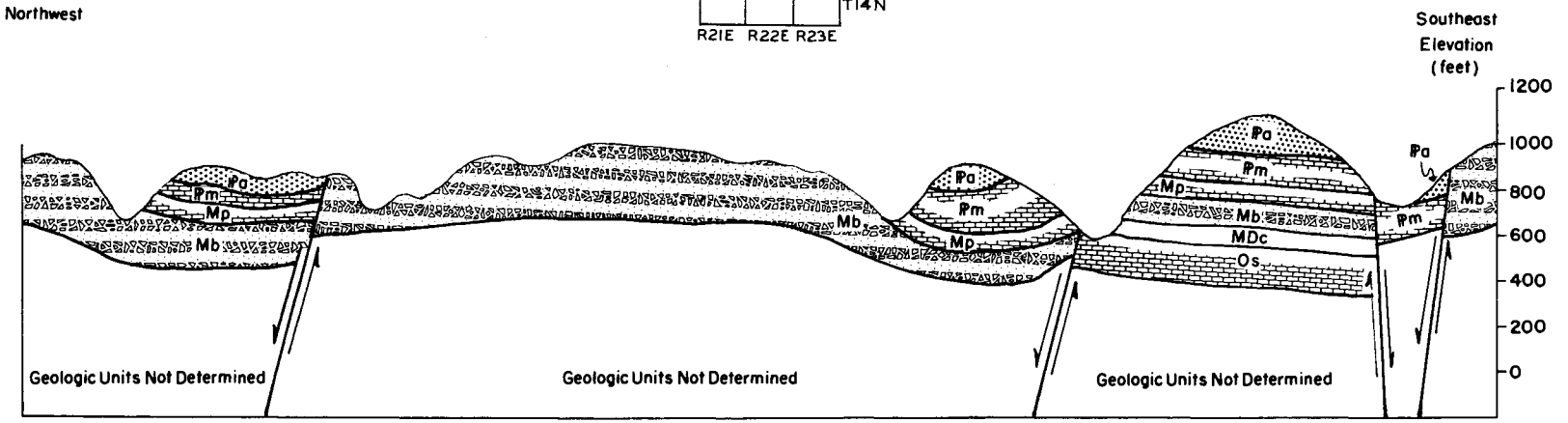
Chert

Fault-Arrows show direction of movement

IDEALIZED CROSS SECTION
CHEROKEE COUNTY
NO. 3



Cross Section Illustrates Shaded Area



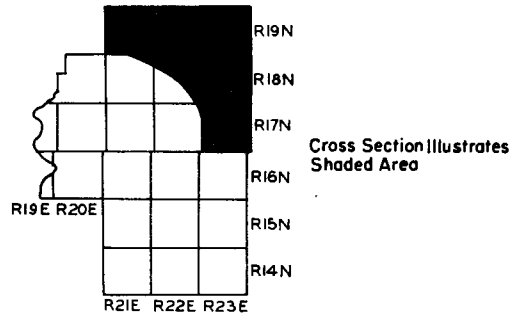
Generally the beds dip at 1 degree or less.
Locally near faults the beds dip up to approx. 15 degrees (1400 ft/mile)

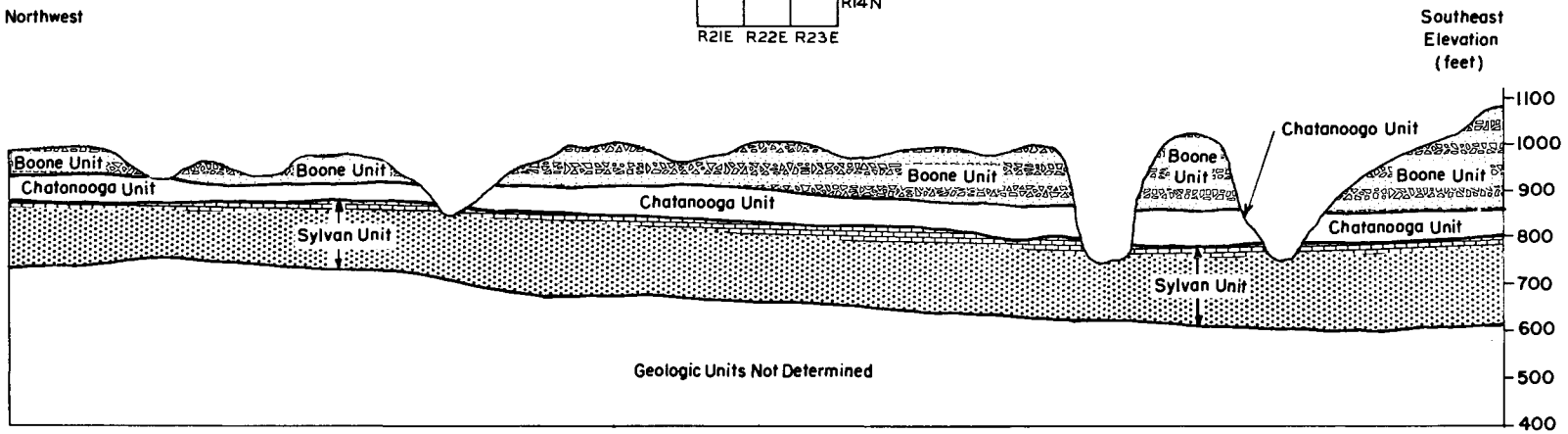
0 1 2 3 4 5 Miles
Approximate Scale

GEOLOGIC UNIT	SYMBOL
Atoka	Pa
Morrow	Pm
Chester-Meramec	Mp
Boone	Mb
Chatanooga	MDc
Sylvan	Os

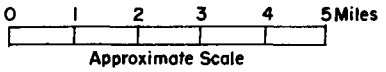
- Sandstone
- Shale
- Limestone
- Chert
- Fault-Arrows show direction of movement

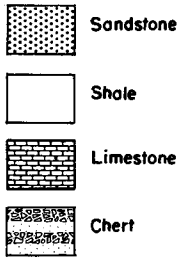
IDEALIZED CROSS SECTION
CHEROKEE COUNTY
NO.4





Beds are essentially horizontal





GEOLOGIC UNITS OF
HASKELL COUNTY

Prepared by the Oklahoma
Department of Highways

Information taken from the
"Geologic Map of Haskell County Oklahoma,"
by Malcolm C. Oakes, Q.G.S. and
M.M. Knechtel, U.S.G.S., 1948.

0 1 2 3 4 5 Miles

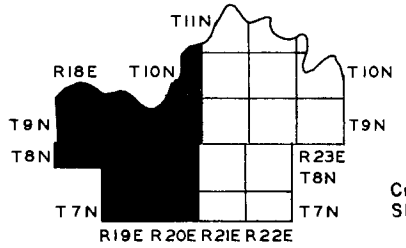
R18E R19E R20E R21E R22E R23E

T11N T10N T9N T8N T7N

Qas Alluvium
Qts Terrace deposits
Pbg Boggy units
Pbj Bluejacket unit
Psv Savanna unit
Pma Mc Alester unit
Phs Hartshorne unit
Pa Atoka unit
U-Up D-Down Fault

Tamaha Stigler Keota Kinta Lequire Mc Curtain

IDEALIZED CROSS SECTION
HASKELL COUNTY
NO. 1

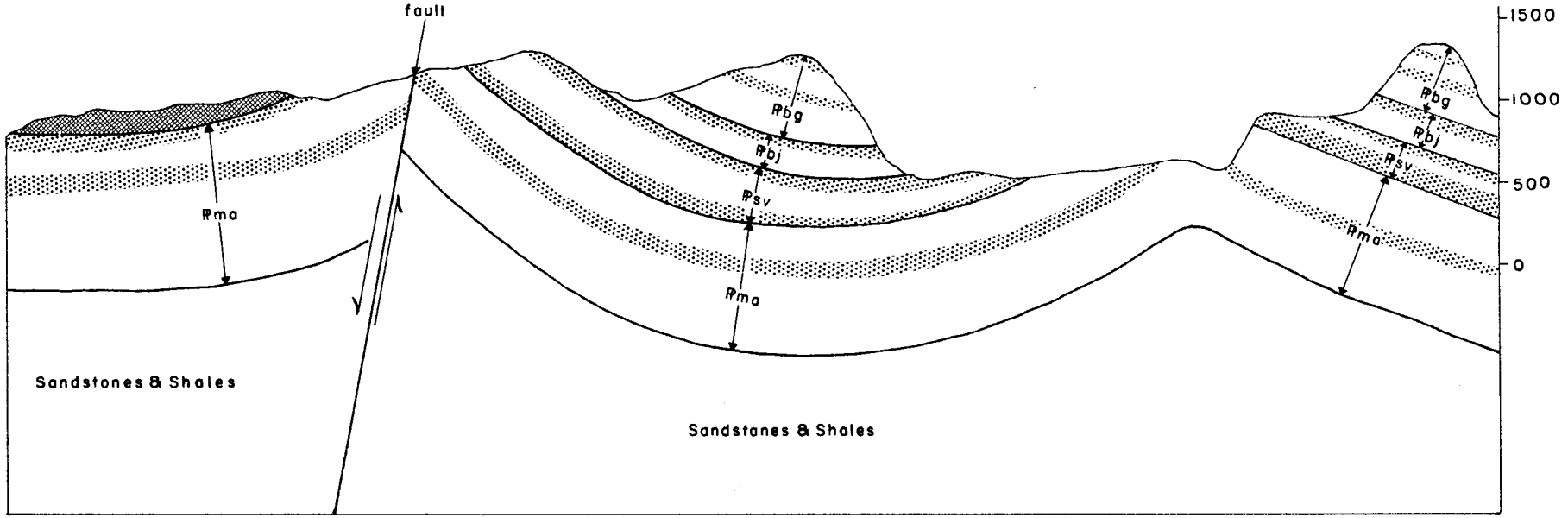


Cross Section Illustrates Shaded Area

North

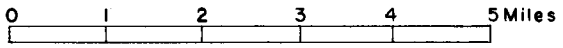
South

Elevation (feet)



Beds dip approximately from 1°(90 feet/mile) to approximately 12°(1115 feet/mile)

GEOLOGIC UNIT	SYMBOL
Boggy	Pbg
Bluejacket	Pbj
Savanna	Psv
McAlester	Pma



Approximate Scale

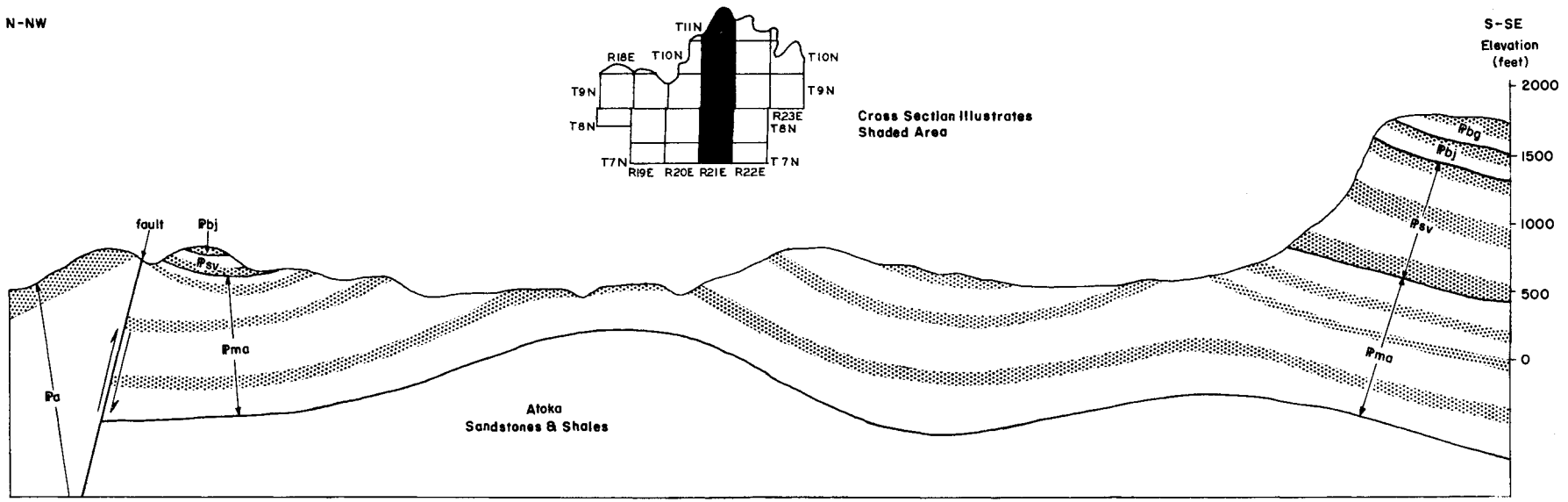
Terrace

Sandstone

Shale

Fault–Arrows show direction of movement

IDEALIZED CROSS SECTION
HASKELL COUNTY
NO.2



Beds range in dip from approximately 2° (180 feet/mile) up to appraximately 25° (2450 feet/mile)
Generally the dip is less than 10° (930 feet/mile)

GEOLOGIC UNIT	SYMBOL
Boggy	Pbg
Bluejacket	Pbj
Savanna	Psv
McAlester	Pma
Atoka	Pa

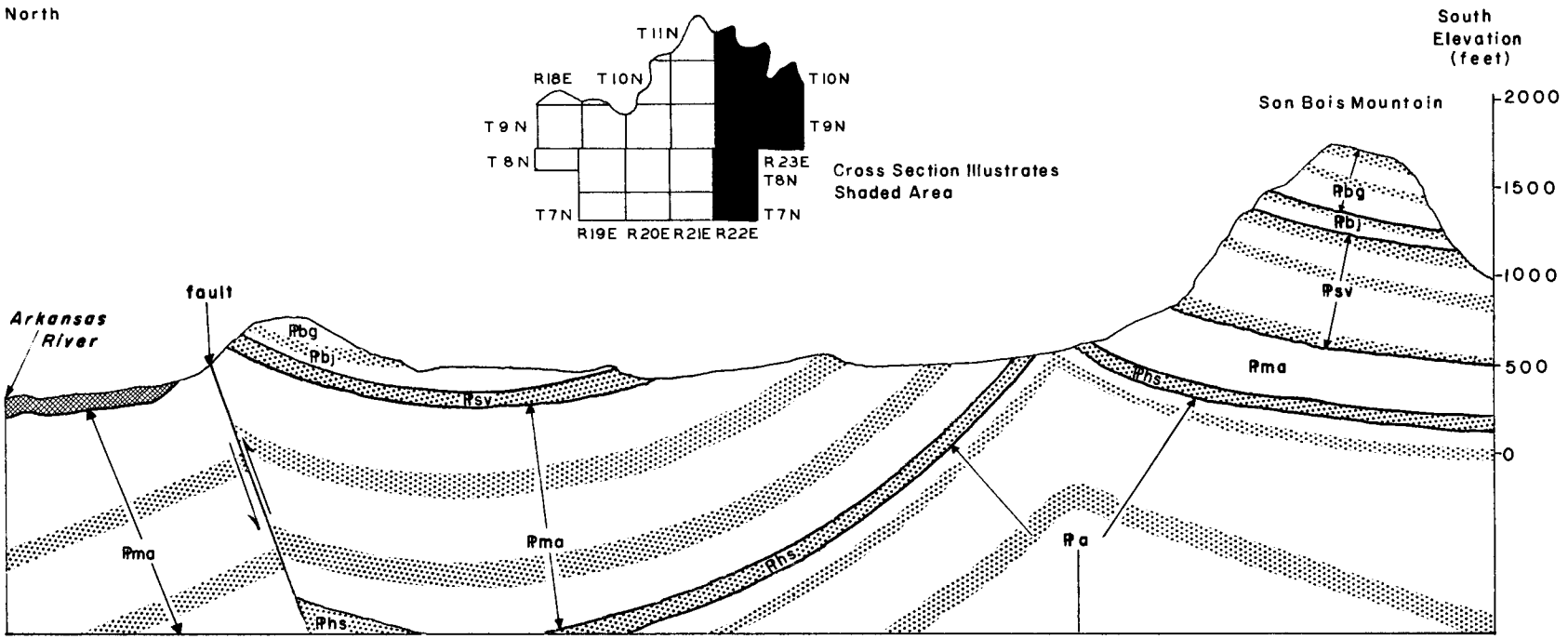
0 1 2 3 4 5 Miles

Approximate Scale

Sandstone

Shale

IDEALIZED CROSS SECTION
HASKELL COUNTY
NO. 3



GEOLOGIC UNIT	SYMBOL
Boggy	Pbg
Bluejacket	Pbj
Savanna	Psv
Mc Alester	Pma
Hartshorne	Phs
Atoka	Pa

GEOLOGIC UNITS OF Mc INTOSH COUNTY

Prepared by the Oklahoma Department of Highways

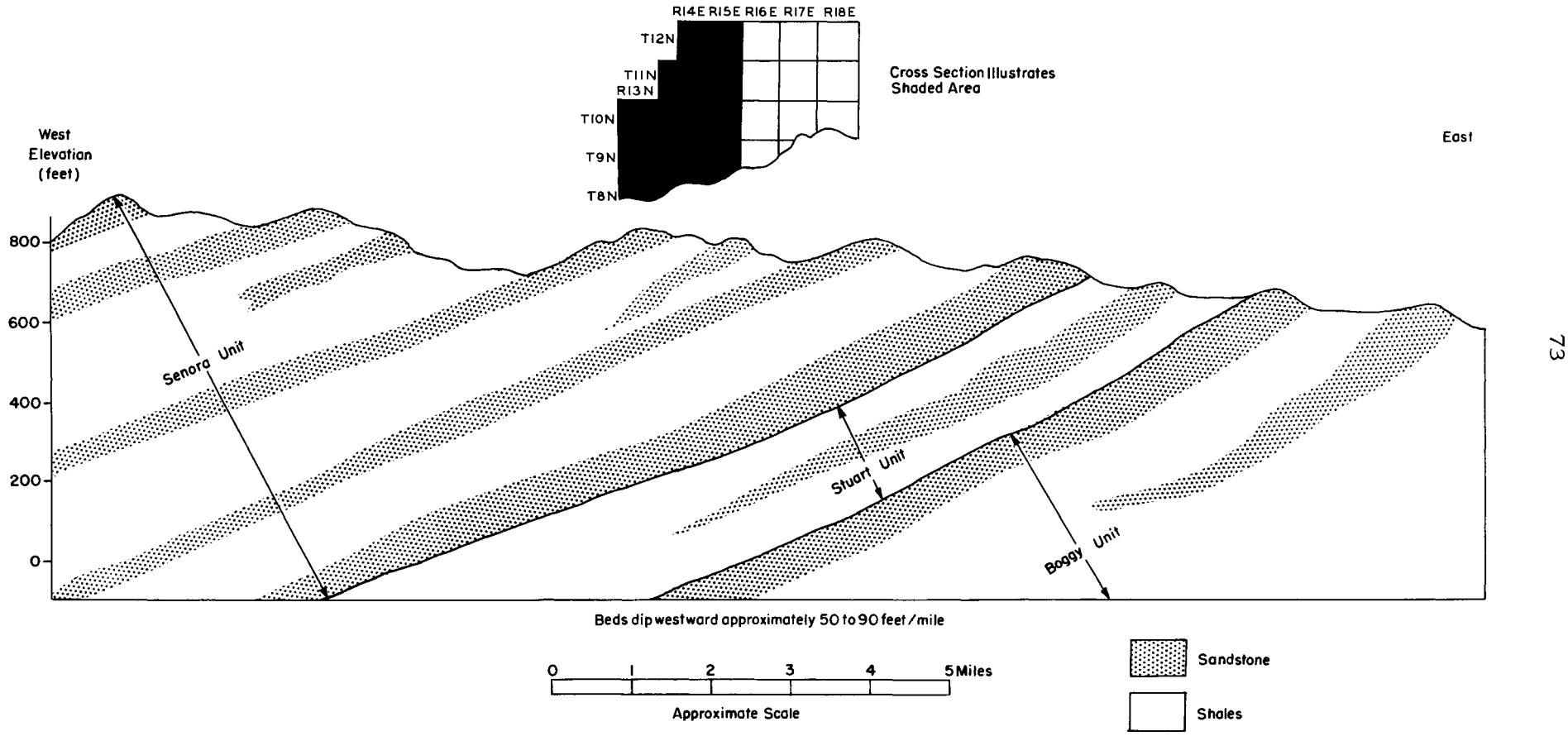
Information taken from the "Geologic Map of Oklahoma"
prepared by Hugh D. Miser and others, U.S.G.S., 1954

SCALE
0 1 2 3 4 5 10 MILES

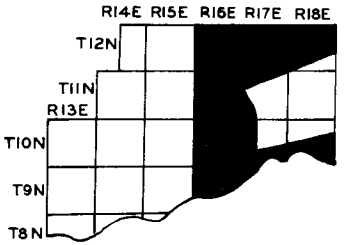
Qas Alluvium
Qts Terrace Deposit
Psn Senora Unit
Pst Stuart Unit
Pbg Boggy Unit
Pbj Bluejacket Unit
Psv Savanna Unit
Pma McAlester Unit
Phs Hartshorne Unit
Pa Atoka Unit
U-Up
D-Down
Fault

Hitchita
Rentiesville
Checotah
Onapa
Texanna
Eufaula
Hanna
Deep Fork
Canadian River
North Canadian River
South Canadian River
T 12 N
T 11 N
T 10 N
T 9 N
T 8 N
R 13 E
R 14 E
R 15 E
R 16 E
R 17 E
R 18 E
72
266
69
52
9
U
D

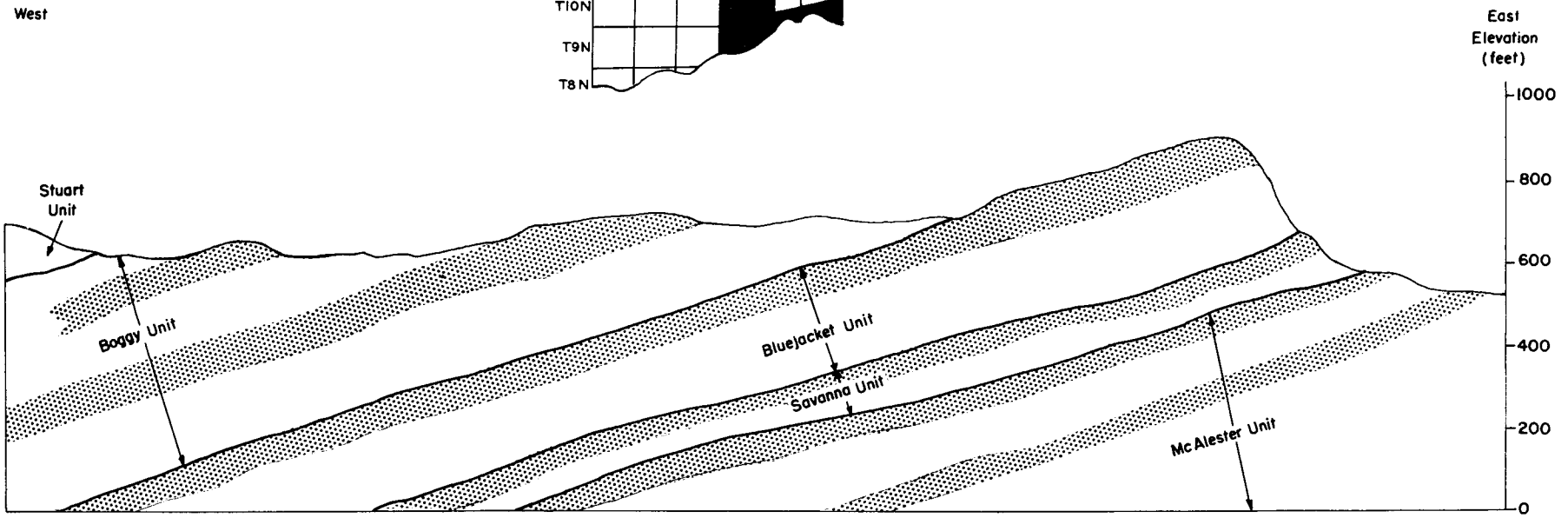
IDEALIZED CROSS SECTION
McINTOSH COUNTY
NO. 1



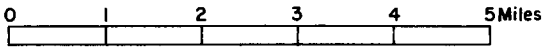
IDEALIZED CROSS SECTION
McINTOSH COUNTY
NO. 2



Cross Section Illustrates Shaded Area



Beds dip westward approximately 50/90 feet/mile

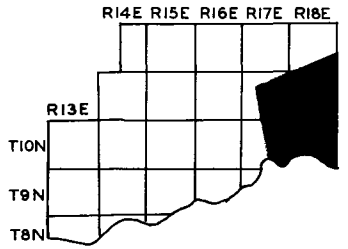


Approximate Scale

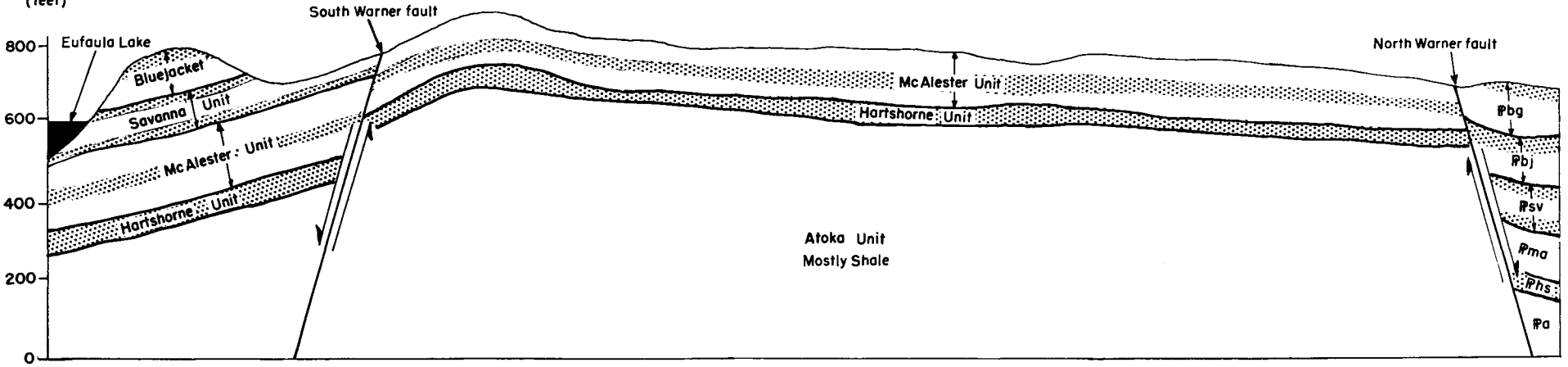
Sandstone

Shale

IDEALIZED CROSS SECTION
McINTOSH COUNTY
NO. 3



Cross Section Illustrates Shaded Area



GEOLOGIC UNIT	SYMBOL
Boggy	Pbg
Bluejacket	Pbj
Savanna	Psv
McAlester	Pma
Hartshorne	Phs
Atoka	Pa

0 1 2 Miles

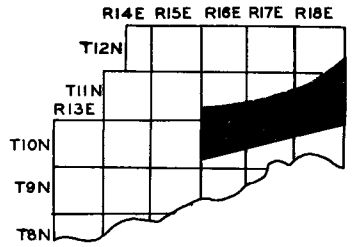
Approximate Scale

Sandstone

Shale

Fault–Arrows show direction of movement

IDEALIZED CROSS SECTION
McINTOSH COUNTY
NO.4



Cross Section Illustrates Shaded Area

West

East

Elevation (feet)

800

600

400

200

0

Boggy Unit

Bluejacket Unit

Savanna Unit

McAlester Unit

Hartshorne Unit

Atoka Unit

Sandstones & Shales

Beds generally dip west from a few feet / mile up to 90 feet / mile

0 1 2 3 4 5 Miles

Approximate Scale

Sandstone

Shale

GEOLOGIC UNITS OF MUSKOGEE COUNTY

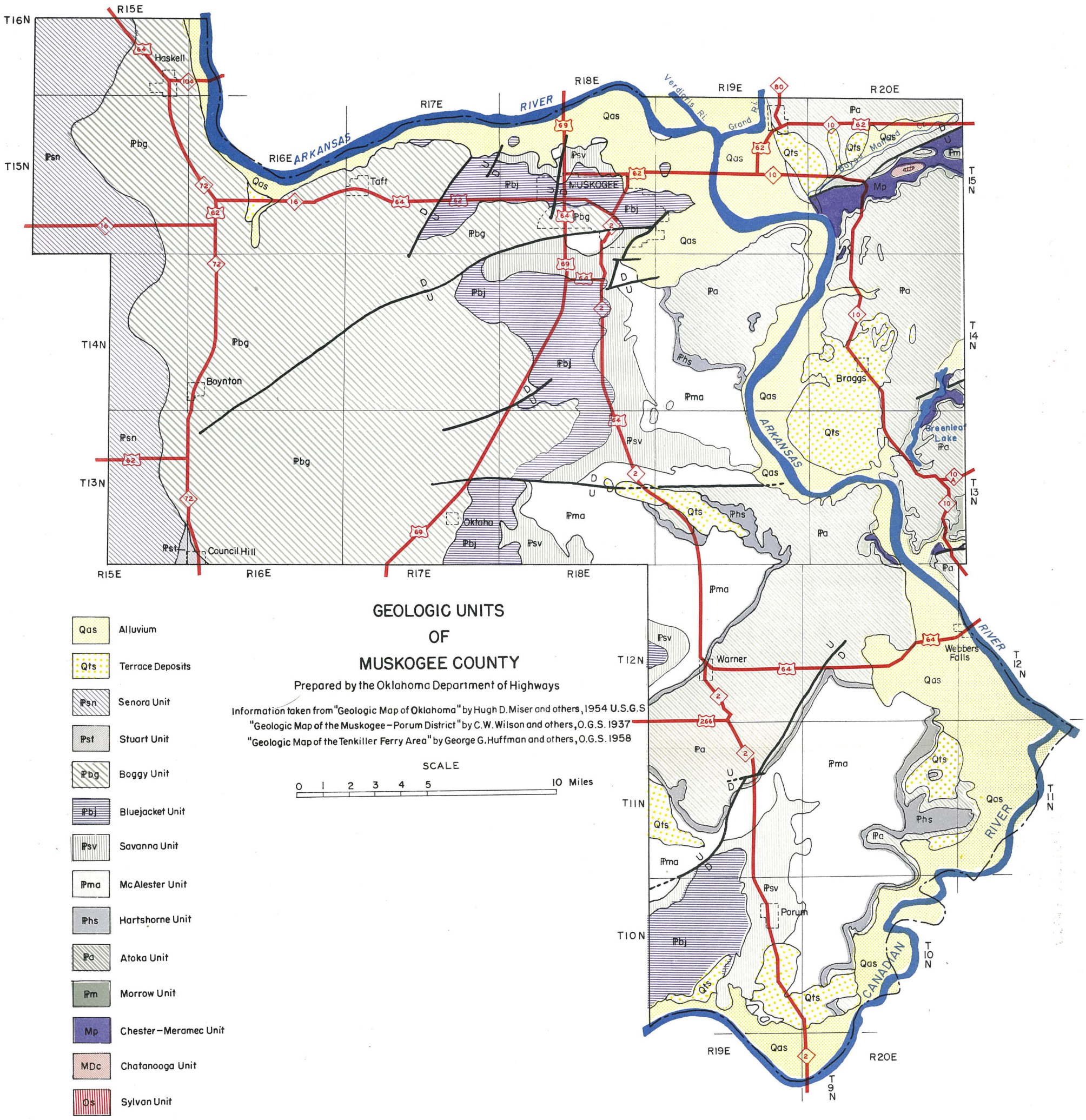
Prepared by the Oklahoma Department of Highways

Information taken from "Geologic Map of Oklahoma" by Hugh D. Miser and others, 1954 U.S.G.S
"Geologic Map of the Muskogee – Porum District" by C.W. Wilson and others, O.G.S. 1937
"Geologic Map of the Tenkiller Ferry Area" by George G. Huffman and others, O.G.S. 1958

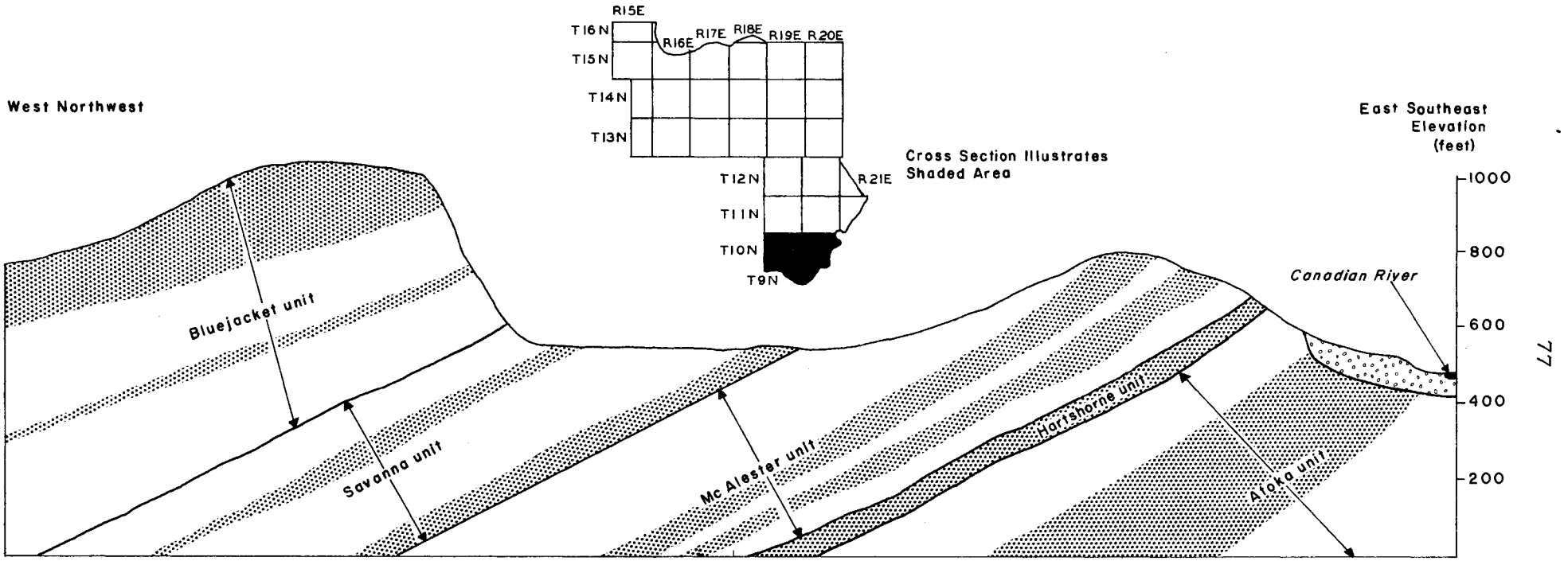
SCALE

0 1 2 3 4 5 10 Miles

- Qas Alluvium
- Qts Terrace Deposits
- Psn Senora Unit
- Pst Stuart Unit
- Pbg Boggy Unit
- Pbj Bluejacket Unit
- Psv Savanna Unit
- Pma McAlester Unit
- Phs Hartshorne Unit
- Pa Atoka Unit
- Pm Morrow Unit
- Mp Chester – Meramec Unit
- MDc Chatanooga Unit
- Os Sylvan Unit
- U-UP D-Down Fault



IDEALIZED CROSS SECTION
MUSKOGEE COUNTY
NO. 1



Cross Section Illustrates Shaded Area

0 1 2 3 Miles

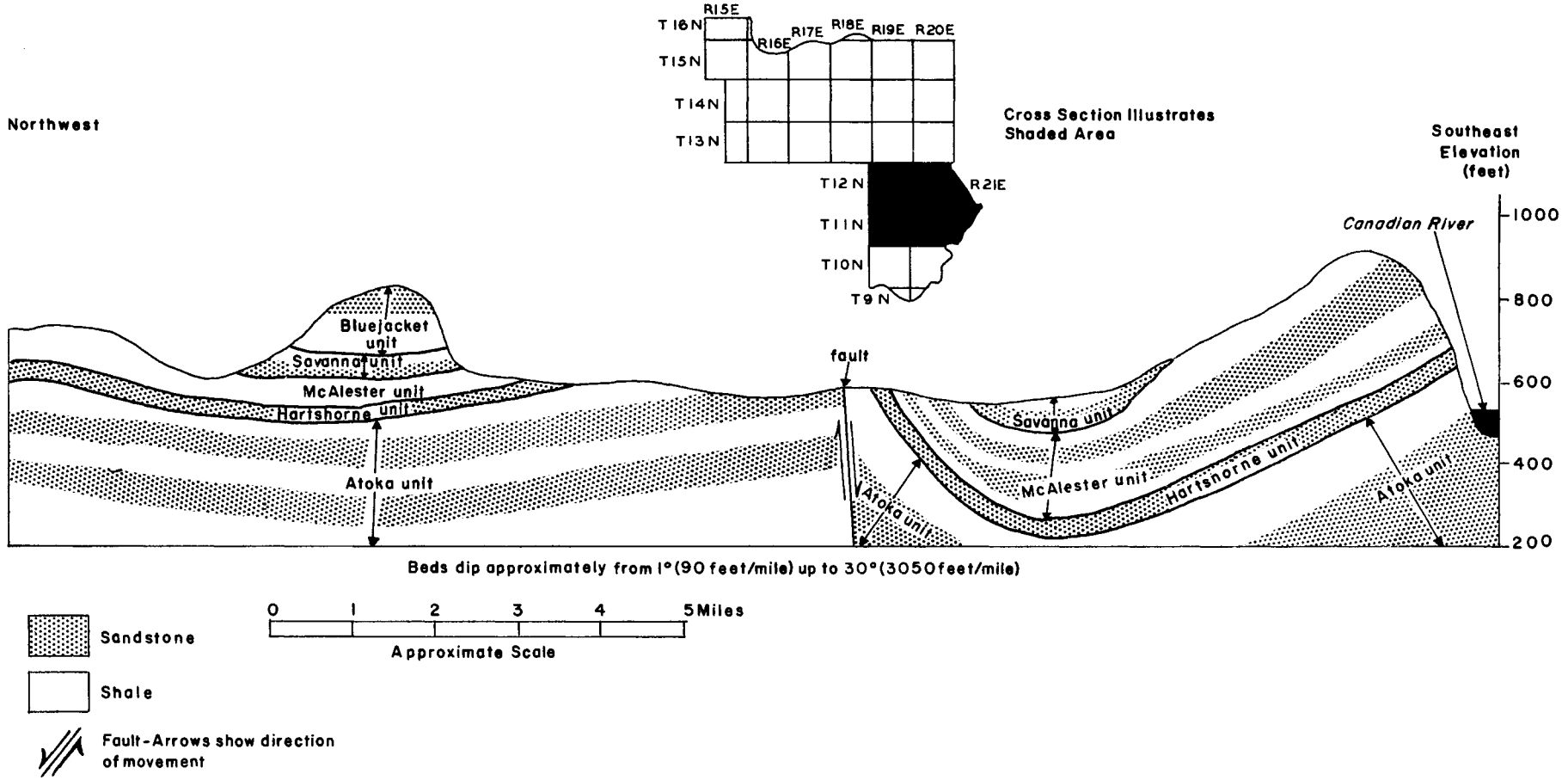
Approximate Scale

Sandstone

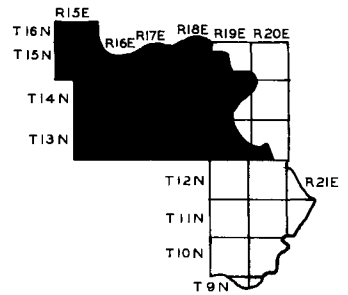
Shale

Alluvium

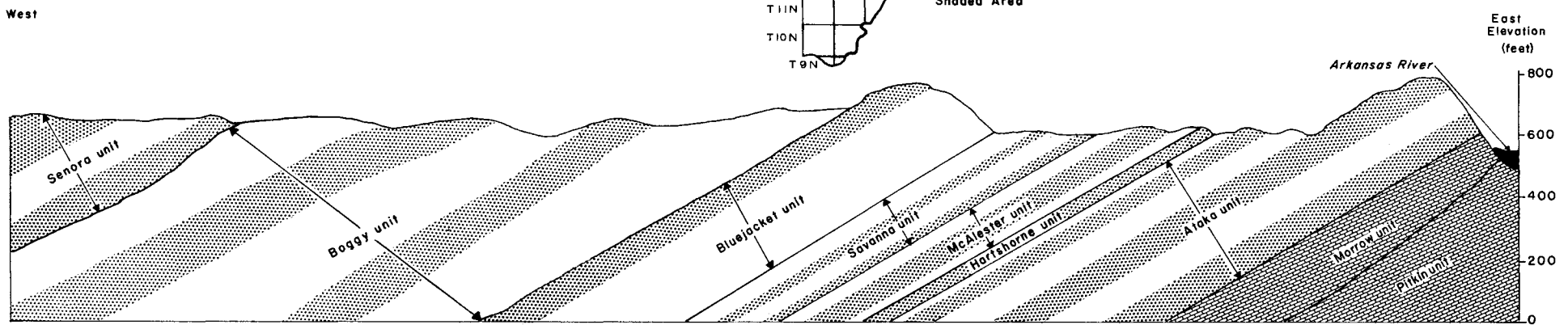
IDEALIZED CROSS SECTION
MUSKOGEE COUNTY
NO.2



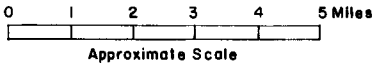
IDEALIZED CROSS SECTION
MUSKOGEE COUNTY
NO. 3

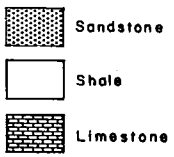


Cross Section Illustrates Shaded Area

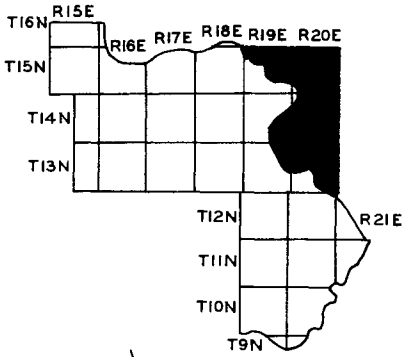


Beds dip westward approximately 1°(90 feet/mile) to 3°(275 feet/mile)





IDEALIZED CROSS SECTION
MUSKOGEE COUNTY
NO.4



Cross Section Illustrates Shaded Area

SOUTH

NORTH

Elevation (feet)

1000
800
600
400
200
0

Atoka unit
Morrow unit
Chester–Meramec unit
Chatanooga unit
Chattanooga unit
Geologic units not determined

Beds dip from approximately 1° (90ft./mile) up to 14° (1300ft./mile)

0 1 2 3 4 5 Miles

Approximate Scale

Sandstone

Shale

Limestone

Fault-Arrows show direction of movement

R11E R12E R13E R14E

T 16 N

T 15 N

T 14 N

T 13 N

T 12 N

T 11 N

R15E

R14E

Pnb Pcf Psl Phd Pwk Pcv Pwt Psn

Qts Qas

Beggs Henryetta Dewar Morris

Okmulgee Creek Fork

Lake Okmulgee Morris Lake Lake Henryetta

16 75 75 ALT. 56 62 52 266 124

Qas Alluvium

Qts Terrace deposits

Pnb Nellie Bly unit

Ph Hogshooter unit

Pcf Coffeyville unit

Pcb Checkerboard unit

Psl Seminole unit

Phd Holdenville unit

Pwk Wewoka unit

Pwt Wetumka unit

Pcv Calvin unit

Psn Senora unit

Scale

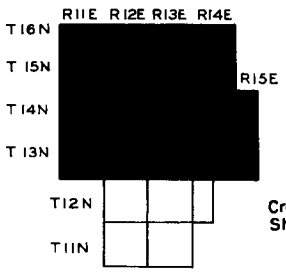
0 1 2 3 4 5 Miles

GEOLOGIC UNITS OF OKMULGEE COUNTY

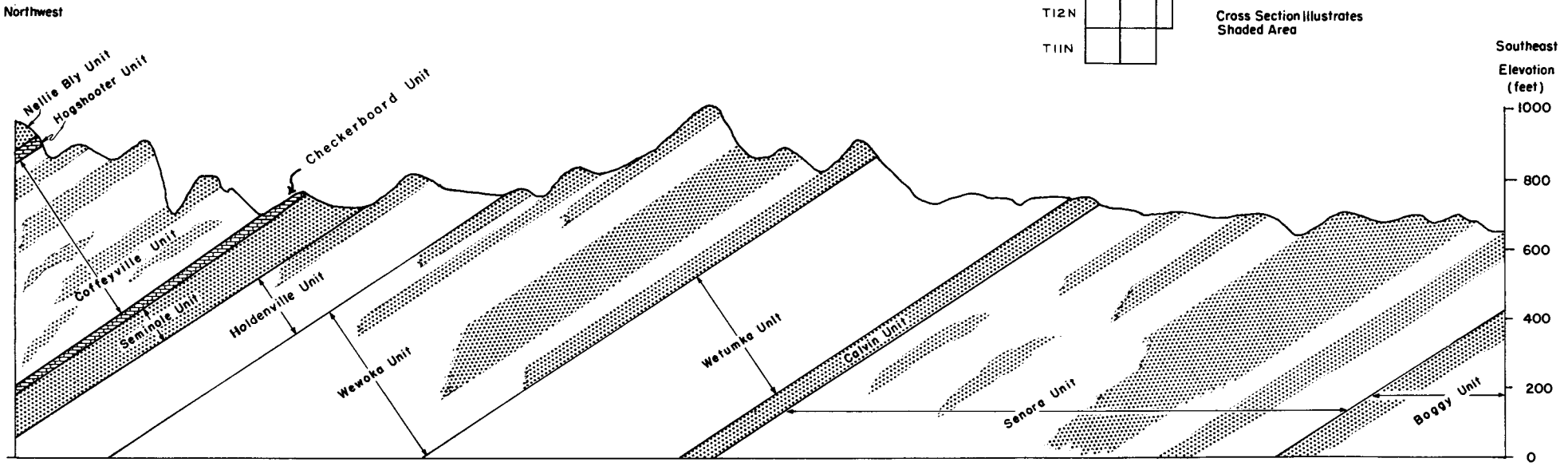
Prepared by the
Oklahoma Department of Highways

Information taken from the
"Geologic Map of Okmulgee County Oklahoma"
by Malcolm C. Oakes and others, O.G.S. 1961

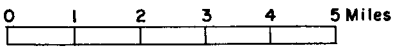
IDEALIZED CROSS SECTION
OKMULGEE COUNTY
NO. 1



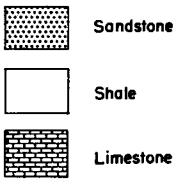
Cross Section Illustrates Shaded Area



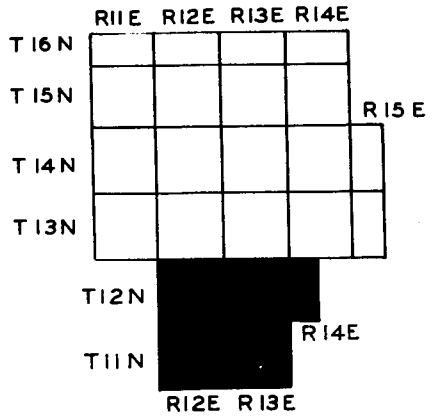
Beds Generally Dip West-Northwest From 1° to 2° (Approximately 90 to 180 Feet Per Mile), Locally Up To 6 Degrees.



Approximate Scale



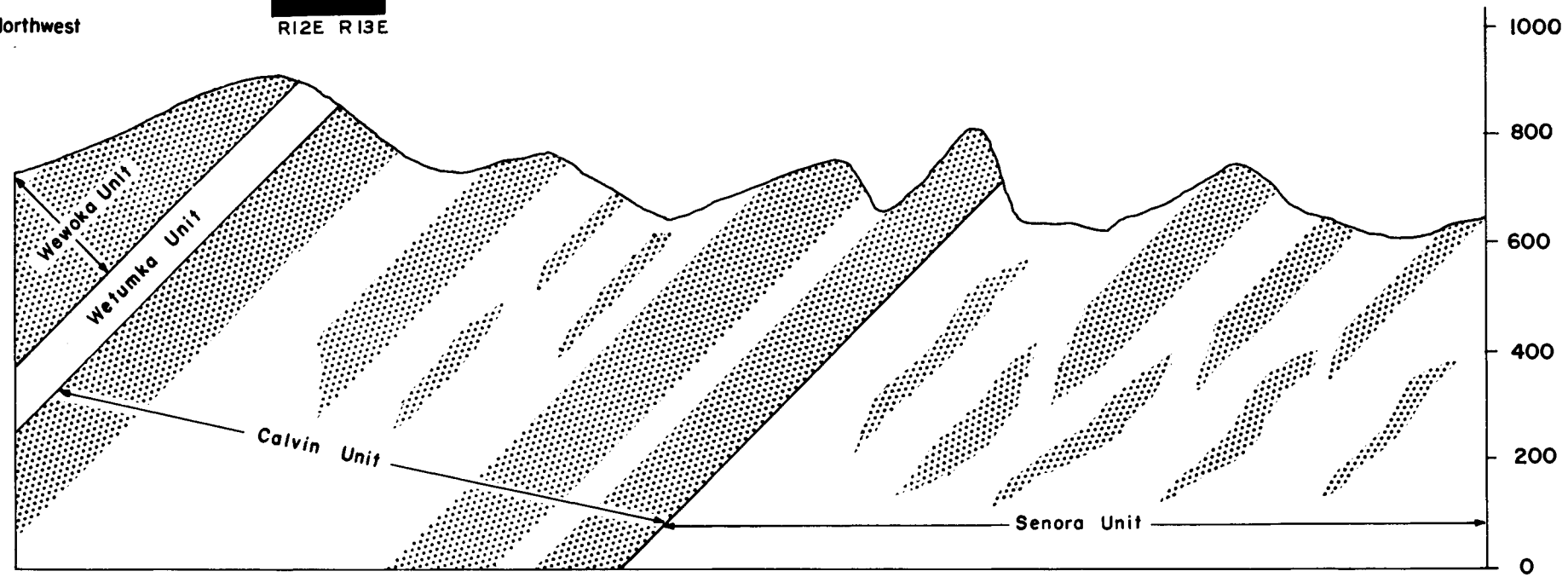
IDEALIZED CROSS SECTION
OKMULGEE COUNTY
NO. 2



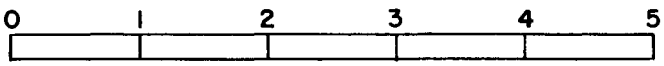
Cross Section Illustrates Shaded Area

Northwest

Southeast Elevation (feet)



Beds Generally Dip West-Northwest From 1° to 2° (Approximately 90 to 180 Feet Per Mile), Locally Up To 6 Degrees.



Approximate Scale

Sandstone

Shale

GEOLOGIC UNITS OF PITTSBURG 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

0 1 2 3 4 5 10 MILES

These Geologic Units occur in this area.

Johns Valley
Wapanucka
Chickachoc
Springer

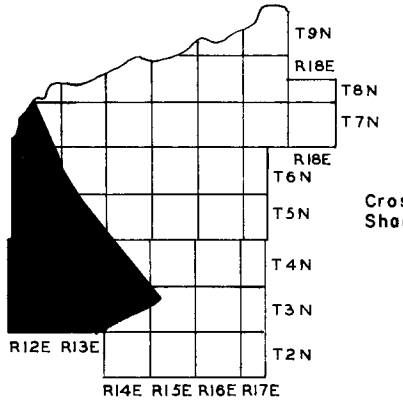
Jackfork
Stanley
Caney
Woodford-Pinetop

R12E R13E R14E R15E R16E R17E R18E

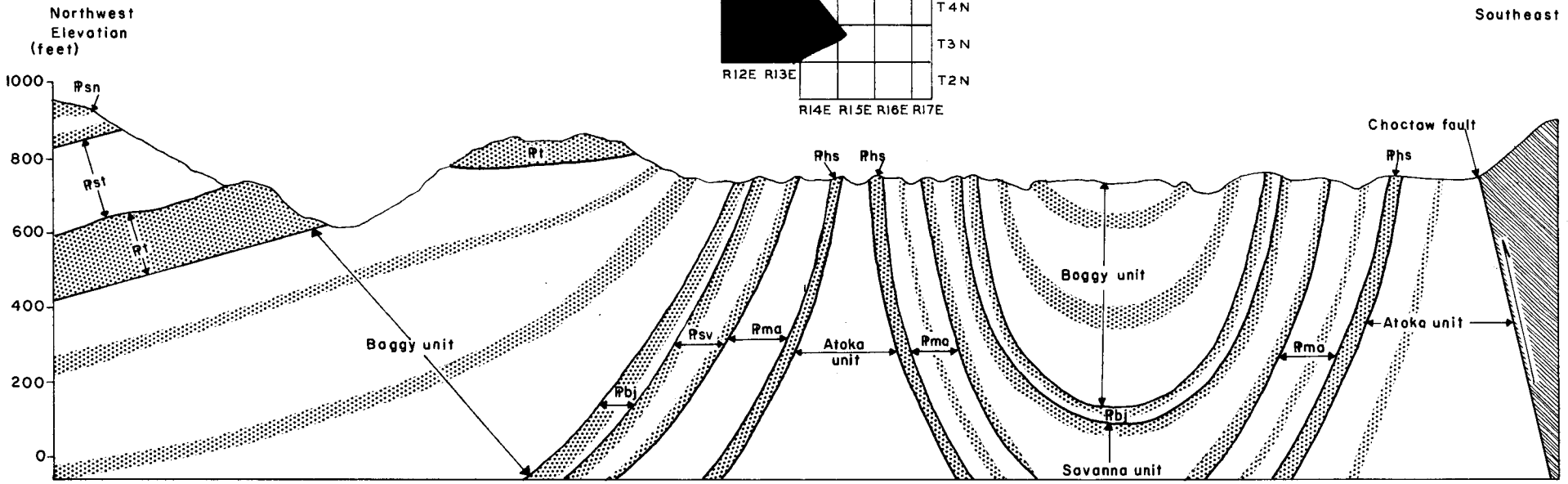
T 9 N
T 8 N
T 7 N
T 6 N
T 5 N
T 4 N
T 3 N
T 2 N

Qas Alluvium
Qts Terrace deposits
Qg Gertie sand
Psn Senora unit
Pst Stuart unit
Pt Thurman unit
Pbg Boggy unit
Pbj Bluejacket unit
Psv Savanna unit
Pma Mc Alester unit
Phs Hartshorne unit
Pa Atoka unit
U-Up
D-Down
Fault

IDEALIZED CROSS SECTION
PITTSBURG COUNTY
NO. 1



Cross Section Illustrates Shaded Area



Beds dip from 2°(180 feet/mile) up to 90°(vertical)
Generally the dip is less than 35°(3700 feet/mile)

0 1 2 3 4 5 Miles

Approximate Scale

GEOLOGIC UNIT	SYMBOL
Senora	Psn
Stuart	Pst
Thurmon	Pt
Boggy	Pbg
Bluejacket	Pbj
Savanna	Psv
McAlester	Pma
Hartshorne	Phs
Atoka	Pa

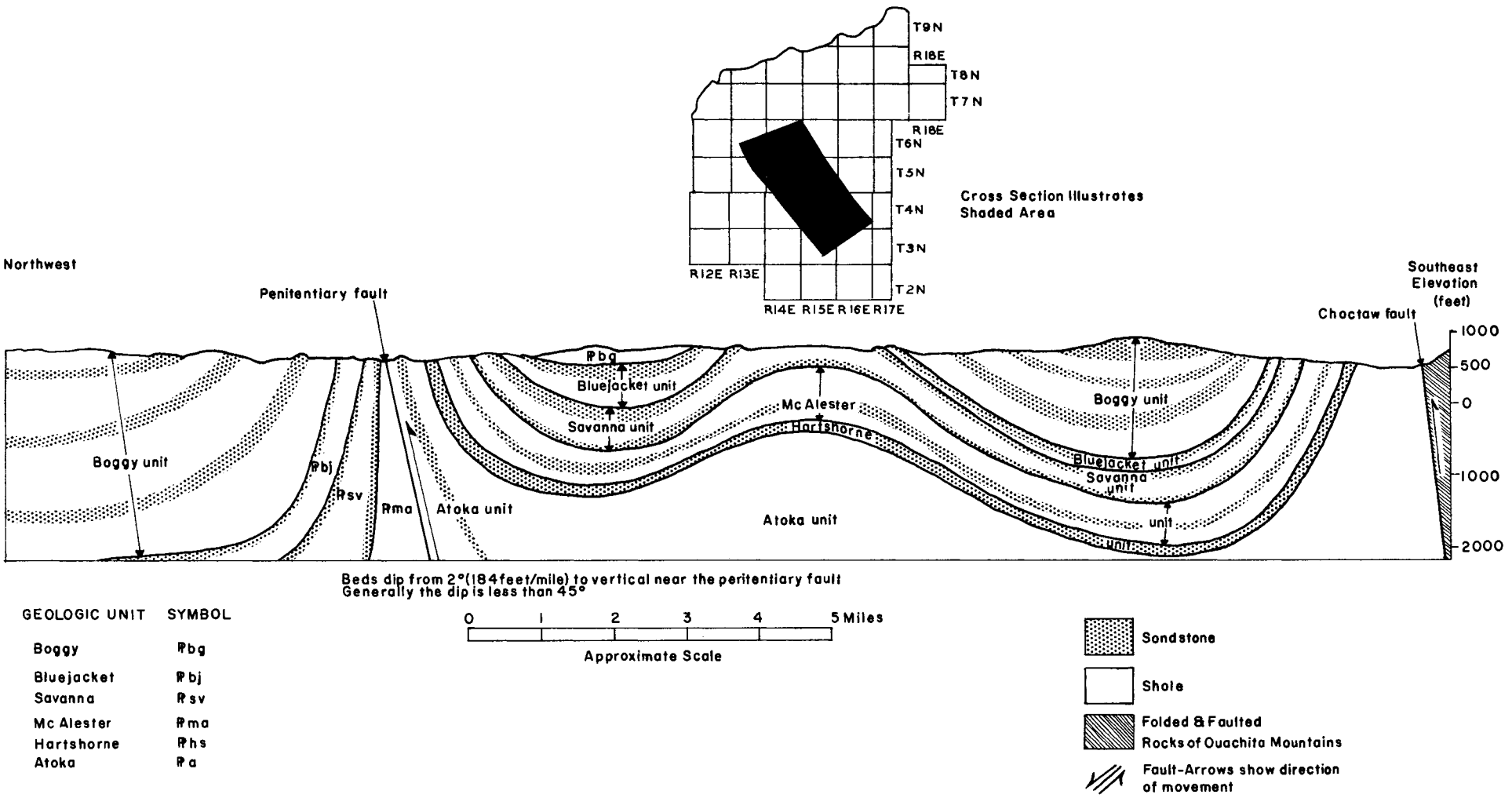
Sandstone

Shale

Folded & Faulted Rocks of Ouachita Mountains

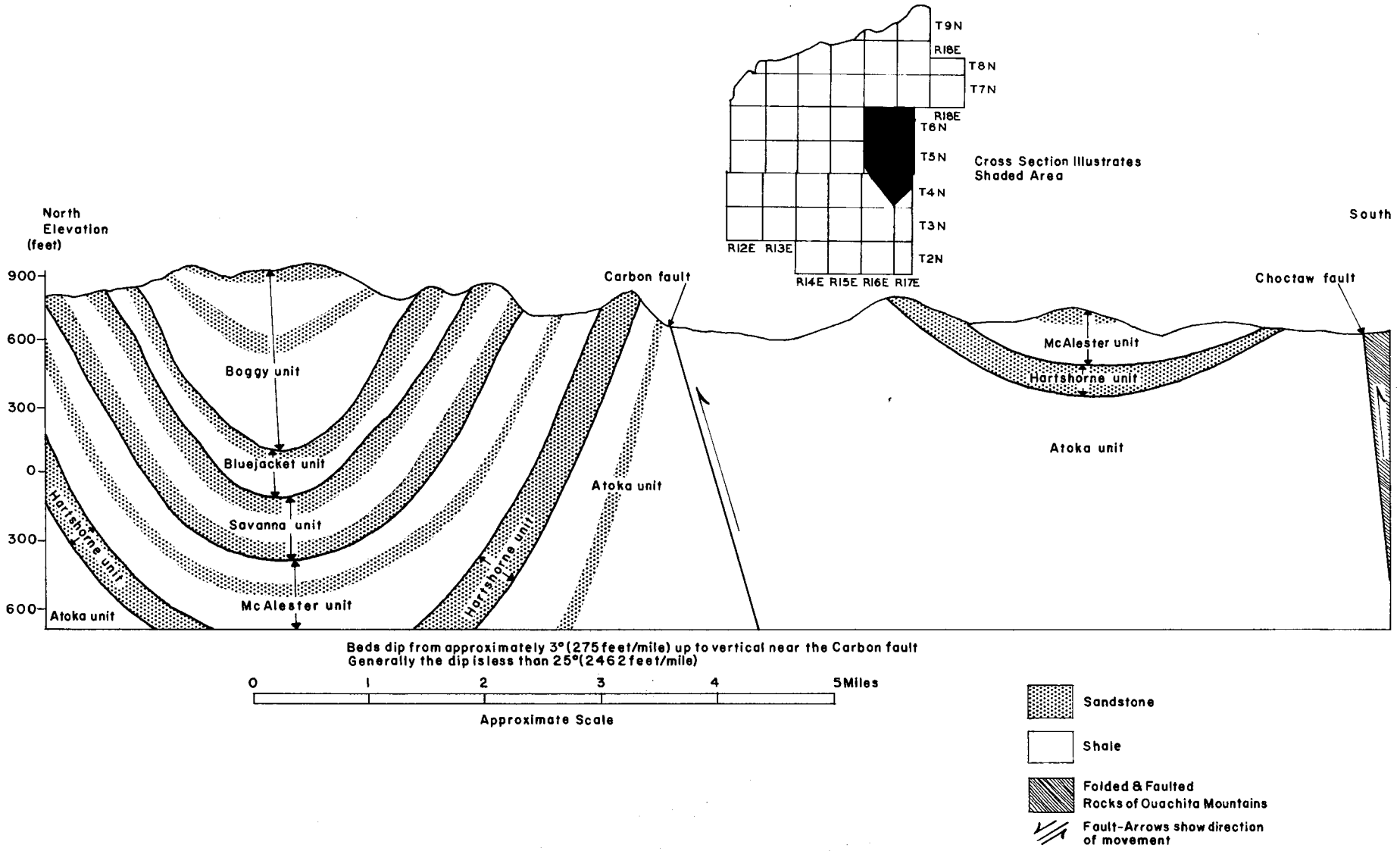
Fault - Arrows show direction of movement

IDEALIZED CROSS SECTION
PITTSBURG COUNTY
NO.2

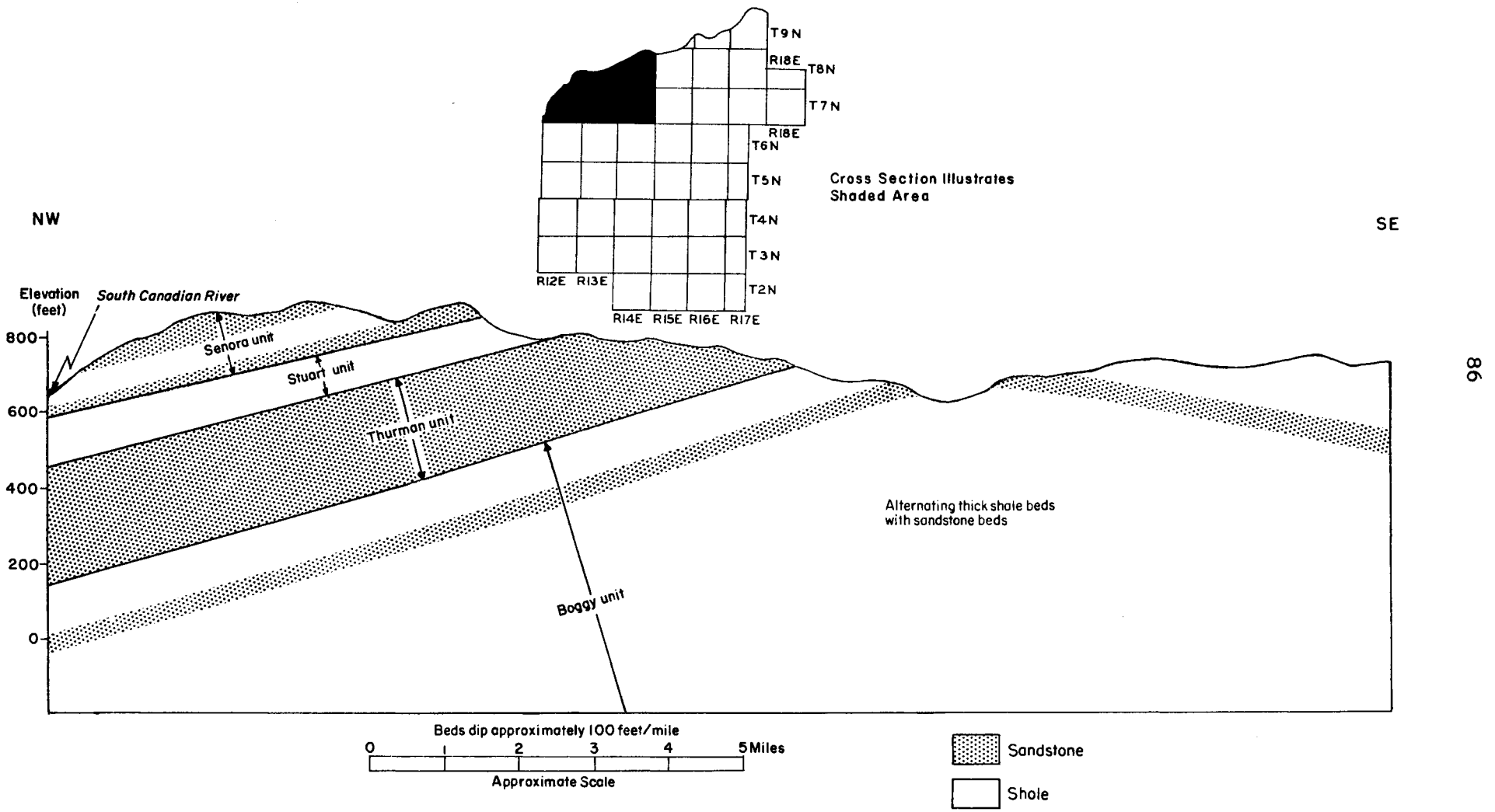


GEOLOGIC UNIT	SYMBOL
Boggy	Pbg
Bluejacket	Pbj
Savanna	Psv
Mc Alester	Pma
Hartshorne	Phs
Atoka	Pa

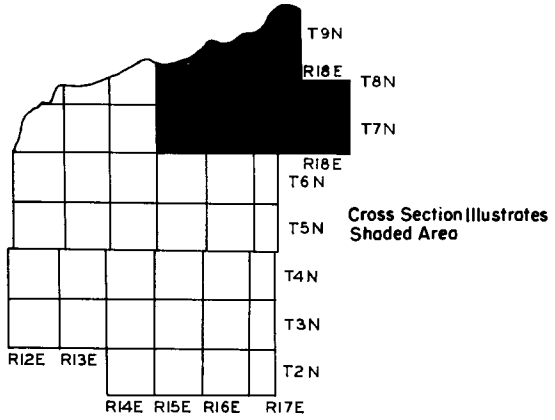
IDEALIZED CROSS SECTION
PITTSBURG COUNTY
NO. 3

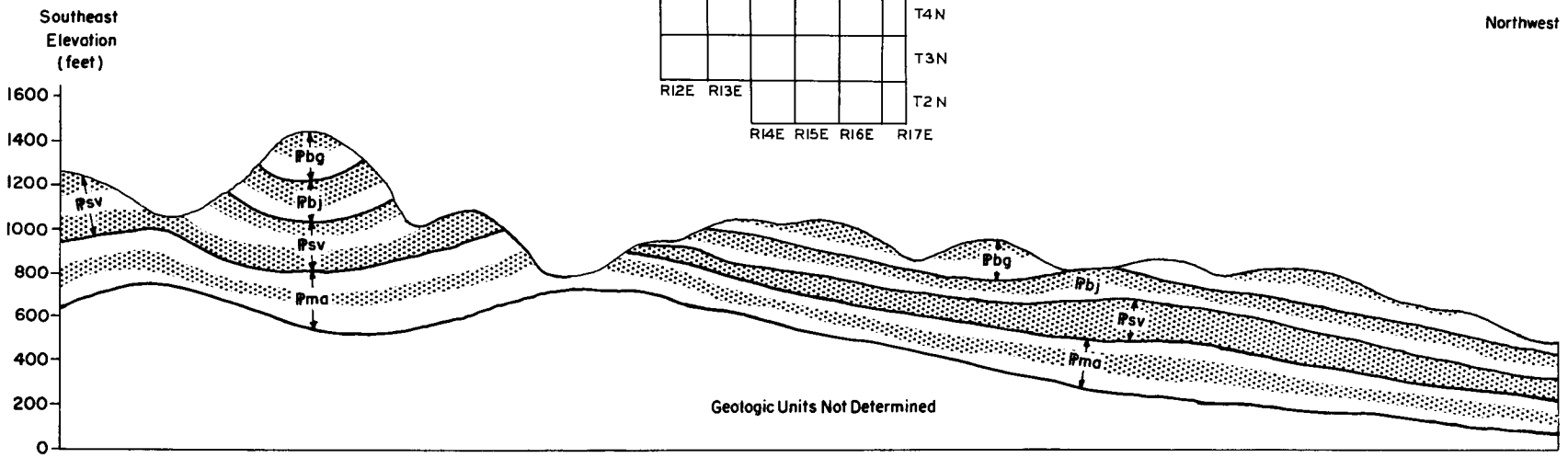


IDEALIZED CROSS SECTION
PITTSBURG COUNTY
NO.4



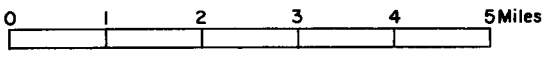
IDEALIZED CROSS SECTION
PITTSBURG COUNTY
NO.5

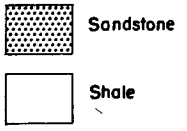




Beds range in dip from approximately 2 degrees to 15 degrees (184 ft/mile to 1400 ft/mile)

GEOLOGIC UNIT	SYMBOL
Boggy	Pbg
Bluejacket	Pbj
Savanna	Psv
Mc Alester	Pma





R 21E R 22 E R 23E R 24E R 25E R 26E R 27E

T 13N

T12N

T11N

T10N

T9N

Tenkiller Res

Qas River

Illinois River

Vian Creek

Sallisaw Creek

ARKANSAS RIVER

Marble City

Gore

Vian

Sallisaw

Muldrow

Moffett

Qas Alluvium

Qts Terrace Deposit

Psv Savanna Unit

Pma Mc Alester Unit

Phs Hartshorne Unit

Pa Atoka Unit

Pm Morrow Unit

Mp Chester–Meramec Unit

Mb Boone Unit

Mdc Chattanooga Unit

Ssc St. Clair Unit

U-Up
D-Down
Fault

GEOLOGIC UNITS OF SEQUOYAH COUNTY

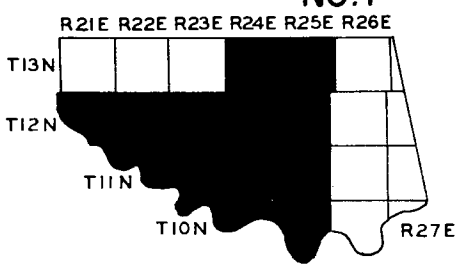
Prepared by the Oklahoma Department of Highways

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

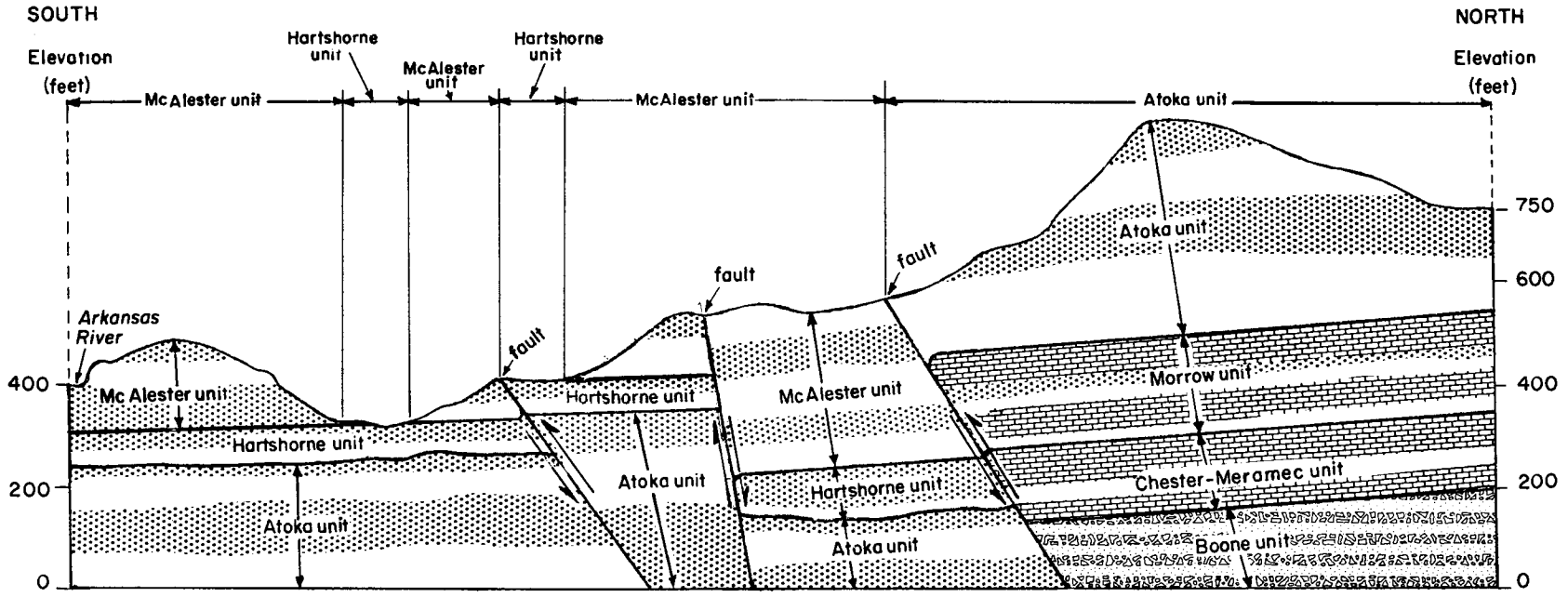
SCALE

0 1 2 3 4 5 10 MILES

IDEALIZED CROSS SECTION
SEQUOYAH COUNTY
NO. I



Cross Section Illustrates Shaded Area



0 1 2 3 4 5 Miles
Approximate Scale

Beds dip approximately 3° to 10° southward (270 ft/mile - 930 ft/mile)
The degree of dip increases northward.

Sandstone

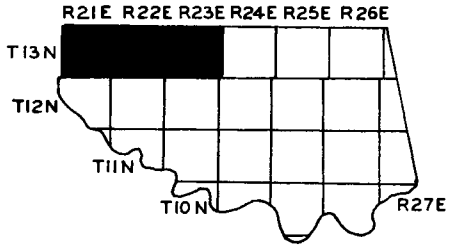
Shale

Limestone

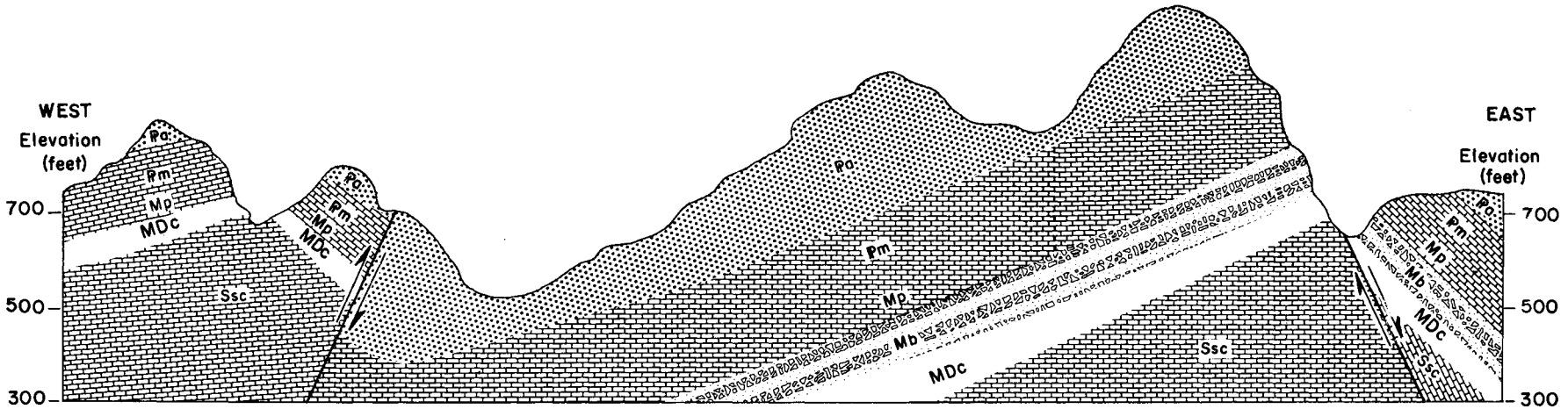
Chert

fault–arrows show direction of movement

IDEALIZED CROSS SECTION
SEQUOYAH COUNTY
NO. 2



Cross Section Illustrates Shaded Area



0 1 2 3 4 5 Miles

Approximate Scale

Beds range in dip from 1° to approximately 25° (90 ft/mile to 2450 ft/mile)

Limestone

Sandstone

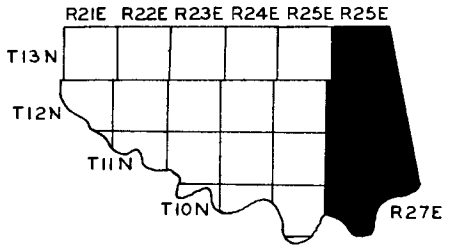
Shale

Chert

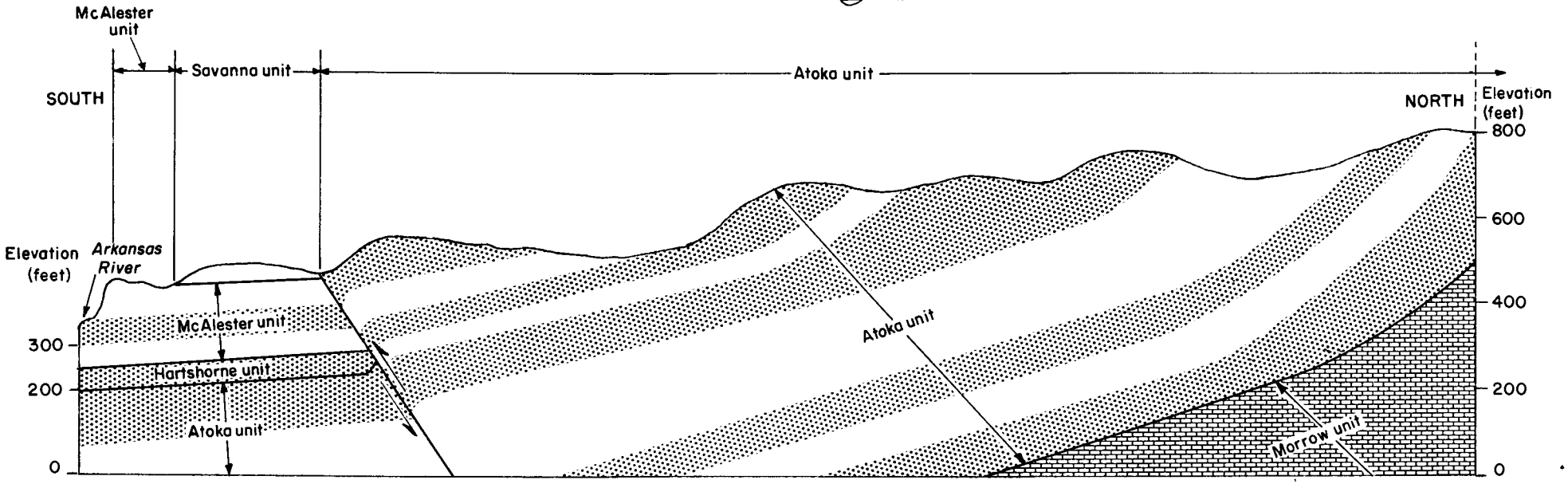
fault – arrows show direction of movement

SYMBOL	GEOLOGIC UNIT
Pa	Atoka
Pm	Morrow
Mp	Chester-Meramec
Mb	Boone
MDc	Chattanooga
Ssc	St. Clair

IDEALIZED CROSS SECTION
SEQUOYAH COUNTY
NO. 3



Cross Section Illustrates Shaded Area



GEOLOGIC UNITS OF WAGONER 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

0 1 2 3 4 5 10 MILES

R15E R16E R17E R18E R19E R20E

T 19 N
T 18 N
T 17 N
T 16 N
T 15 N

Psn Pfs Qas Qts Pbg Pbj Psv Pma Pa Pm Mp Pwk Pcv Mb

Verdigris River
Arkansas River
Ft. Gibson Reservoir

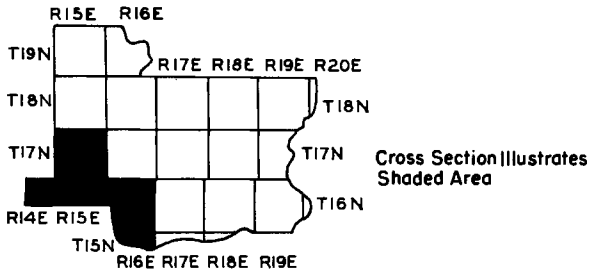
Coweta
Stone Bluff
Red Bird
Porter
Tullahassee
Wagoner
Okay

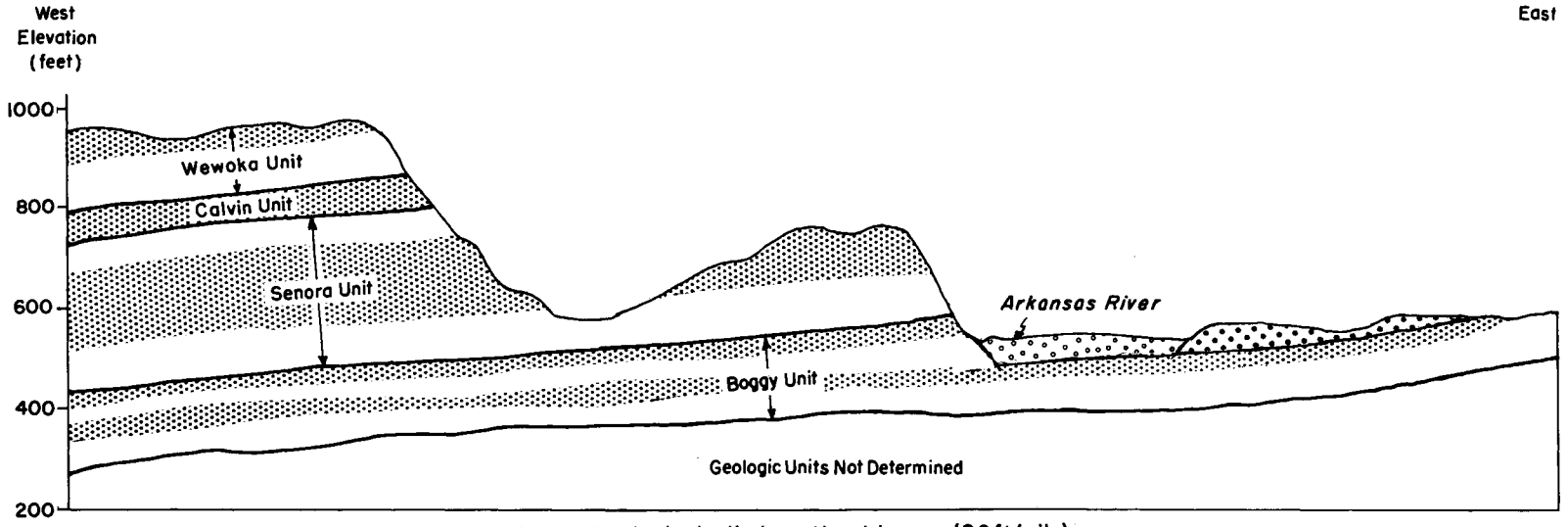
U D

- Qas Alluvium
- Qts Terrace Deposits
- Pwk Wewoka Unit
- Pcv Calvin Unit
- Pfs Fort Scott Unit
- Psn Senora Unit
- Pbg Boggy Unit
- Pbj Blue Jacket Unit
- Psv Savanna Unit
- Pma McAlester Unit
- Pa Atoka Unit
- Pm Morrow Unit
- Mp Chester–Meramec Unit
- Mb Boone Unit

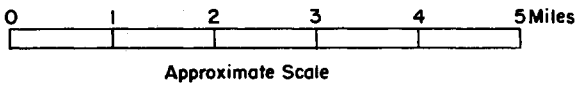
U – Up
D – Down
Fault

IDEALIZED CROSS SECTION
WAGONER COUNTY
NO. 1

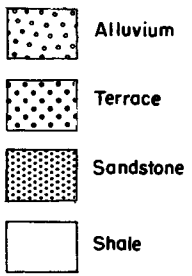




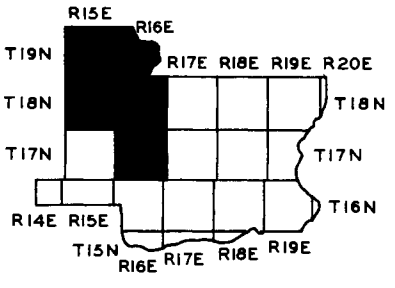
Generally the beds dip less than 1 degree (90 ft/mile)



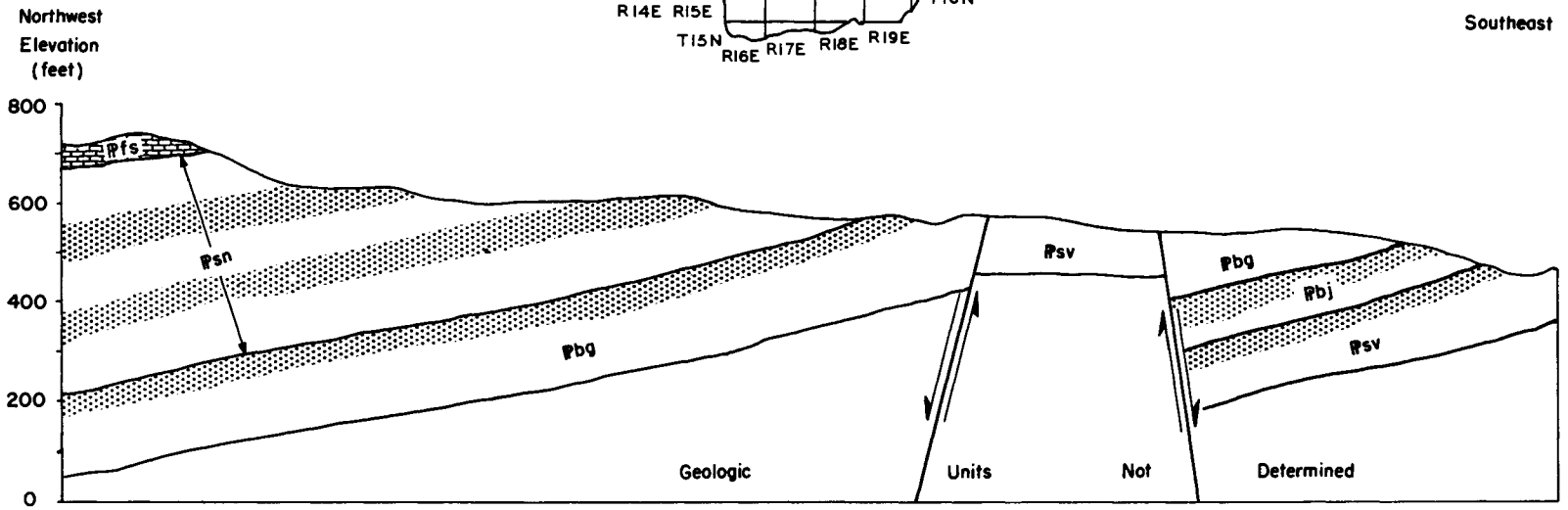
Approximate Scale



IDEALIZED CROSS SECTION
WAGONER COUNTY
NO.2

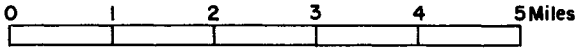


Cross Section Illustrates Shaded Area

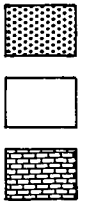


Generally The Beds Dip Less Than 1 Degree (90 ft/mile)

GEOLOGIC UNIT	SYMBOL
Fort Scott	Pfs
Senora	Psn
Boggy	Pbg
Bluejacket	Pbj
Savanna	Psv



Approximate Scale



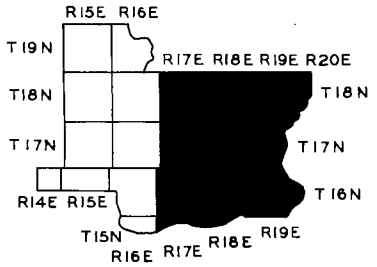
Sandstone

Shale

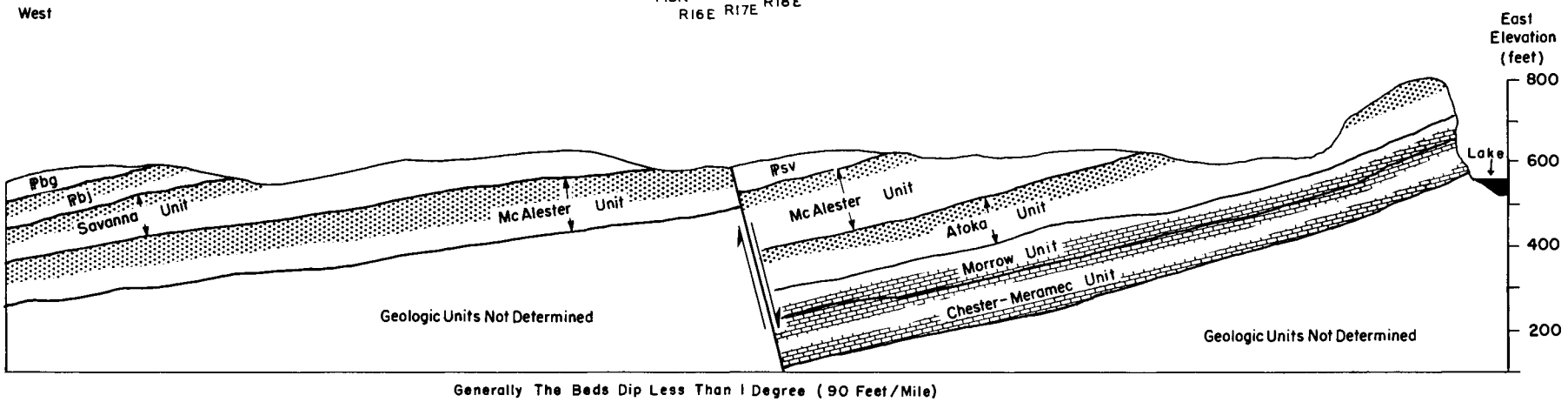
Limestone

Fault–Arrows show direction of movement

IDEALIZED CROSS SECTION
WAGONER COUNTY
NO.3

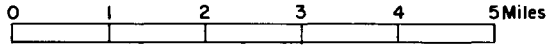


Cross Section Illustrates Shaded Area



Generally The Beds Dip Less Than 1 Degree (90 Feet/Mile)

GEOLOGIC UNIT	SYMBOL
Boggy	Pbg
Bluejacket	Pbj
Savanna	Psv



Approximate Scale

Sandstone

Shale

Limestone

Fault-Arrows show direction of movement

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 and external 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 "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 "R" layer. This sequence of soil horizons is called the soil profile. See figure 9, page 95.

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 and "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

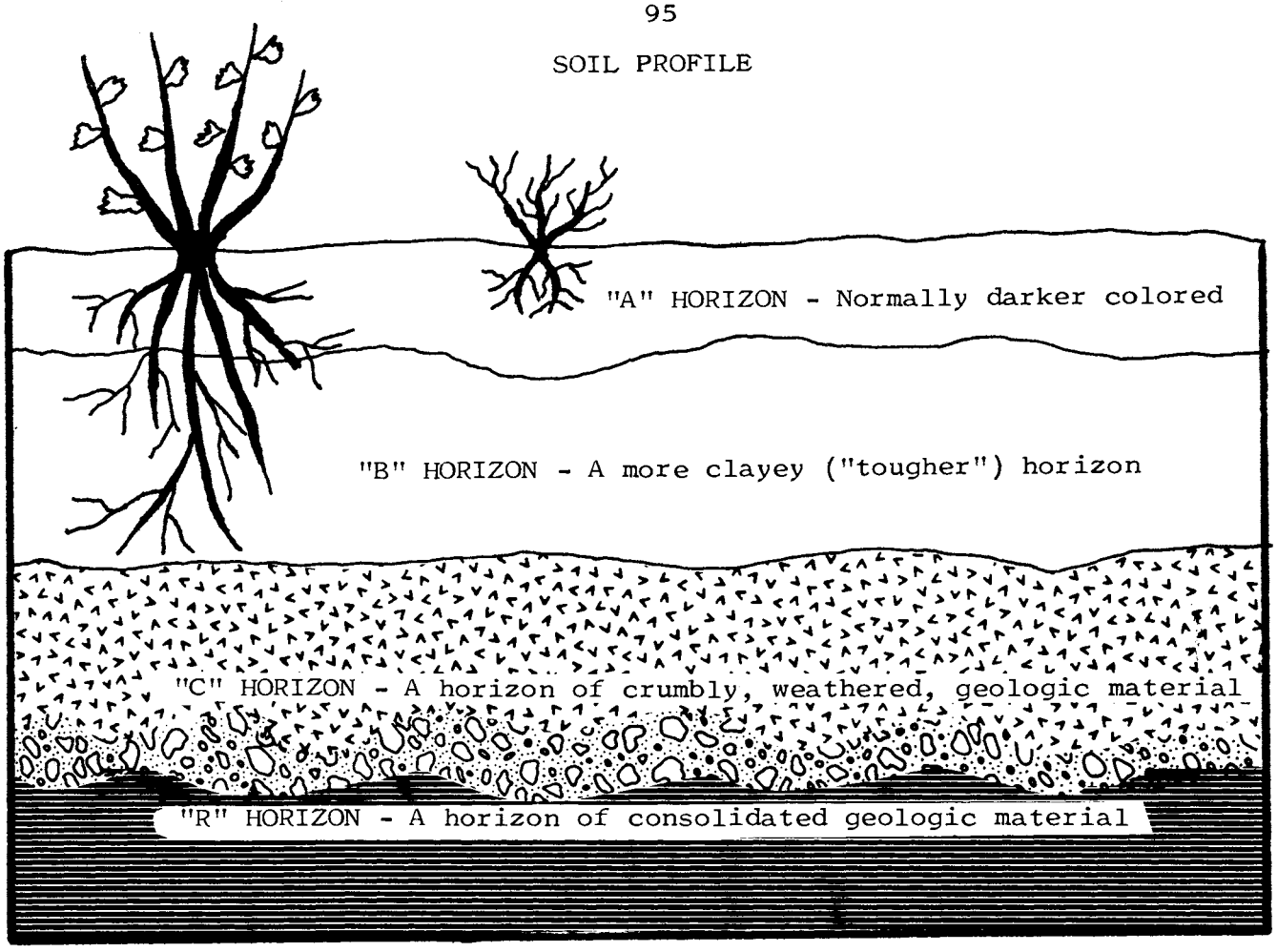


Figure 9

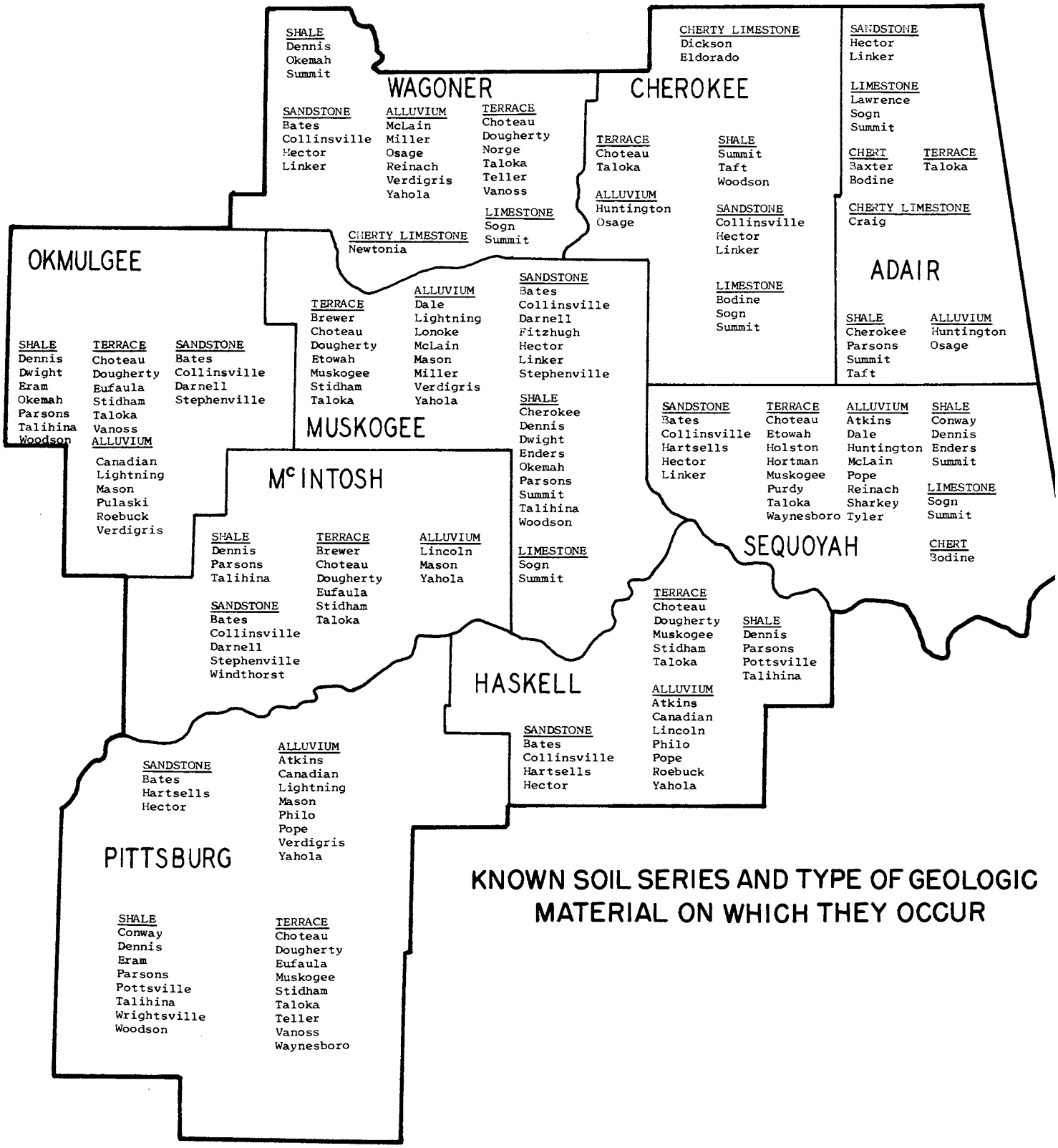
length in the "Soils Manual", 1961, and "Highway Soils Technology", 1963, prepared by the Research Division, Oklahoma Highway Department.

Beginning on page 97 are cross sections illustrating the topographic position, association, and geologic material on which the soil series occur.

Beginning on page 107, the descriptions of the soil series are listed in alphabetical order by name.

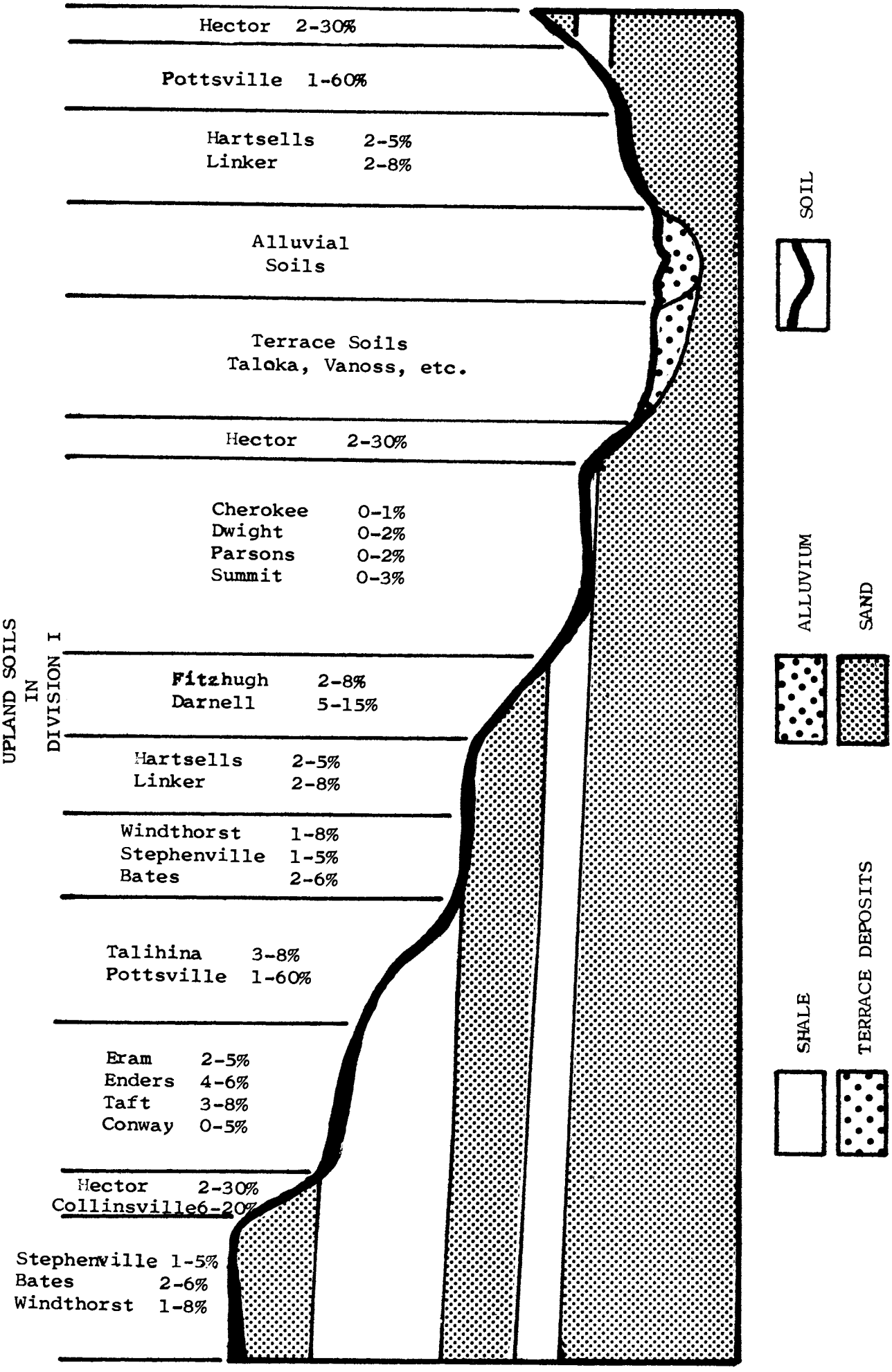
Beginning on page 212 are the charts listing the engineering characteristics of the soil series. These characteristics were determined by laboratory testing, and the methods of determination are the same as used for shales. Refer to Chapter I. page 13.

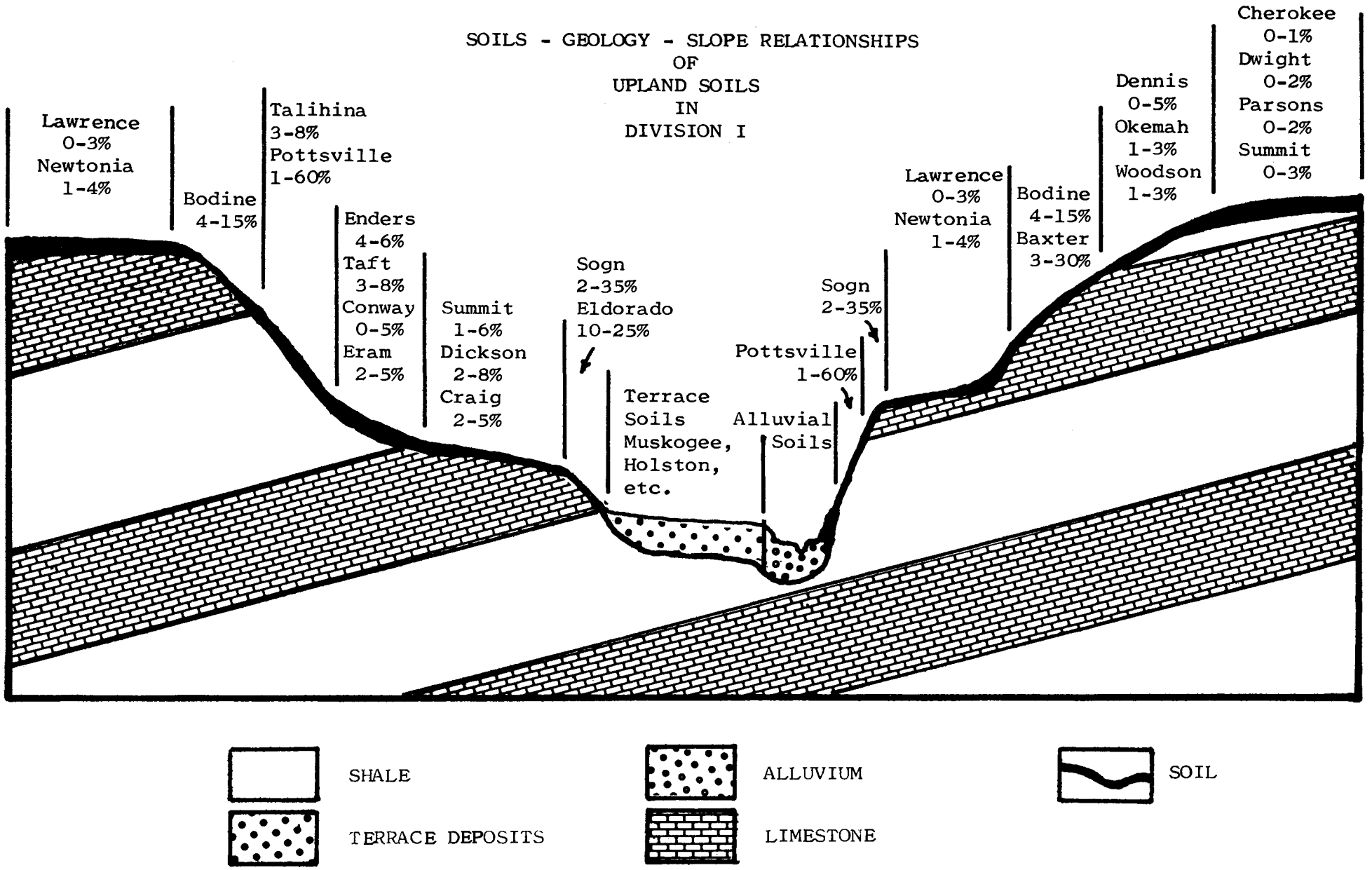
DIVISION I



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

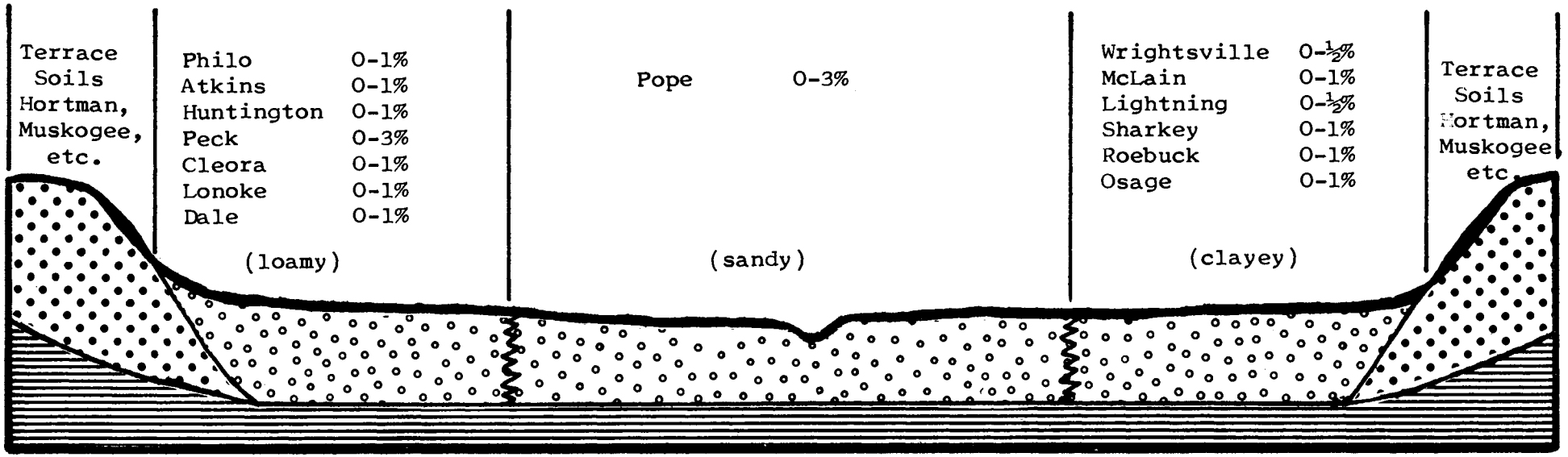
SOILS - GEOLOGY - SLOPE RELATIONSHIPS OF UPLAND SOILS IN DIVISION I

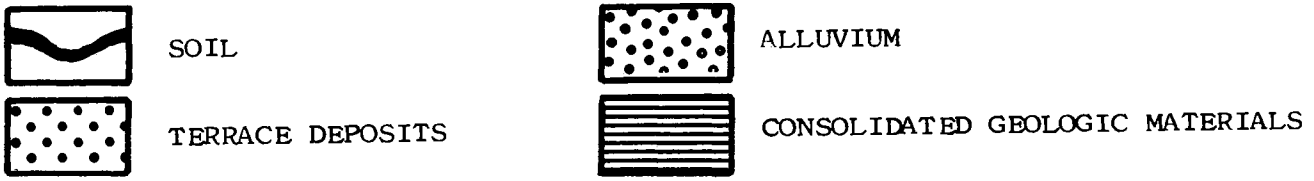



SOILS - GEOLOGY - SLOPE RELATIONSHIPS
OF
UPLAND SOILS
IN
DIVISION I
Lawrence
0-3%
Newtonia
1-4%
Bodine
4-15%
Talihina
3-8%
Pottsville
1-60%
Enders
4-6%
Taft
3-8%
Conway
0-5%
Eram
2-5%
Summit
1-6%
Dickson
2-8%
Craig
2-5%
Sogn
2-35%
Eldorado
10-25%
Terrace
Soils
Muskogee,
Holston,
etc.
Alluvial
Soils
Sogn
2-35%
Pottsville
1-60%
Lawrence
0-3%
Newtonia
1-4%
Bodine
4-15%
Baxter
3-30%
Dennis
0-5%
Okemah
1-3%
Woodson
1-3%
Cherokee
0-1%
Dwight
0-2%
Parsons
0-2%
Summit
0-3%
SHALE
TERRACE DEPOSITS
ALLUVIUM
LIMESTONE
SOIL

ALLUVIAL SOILS

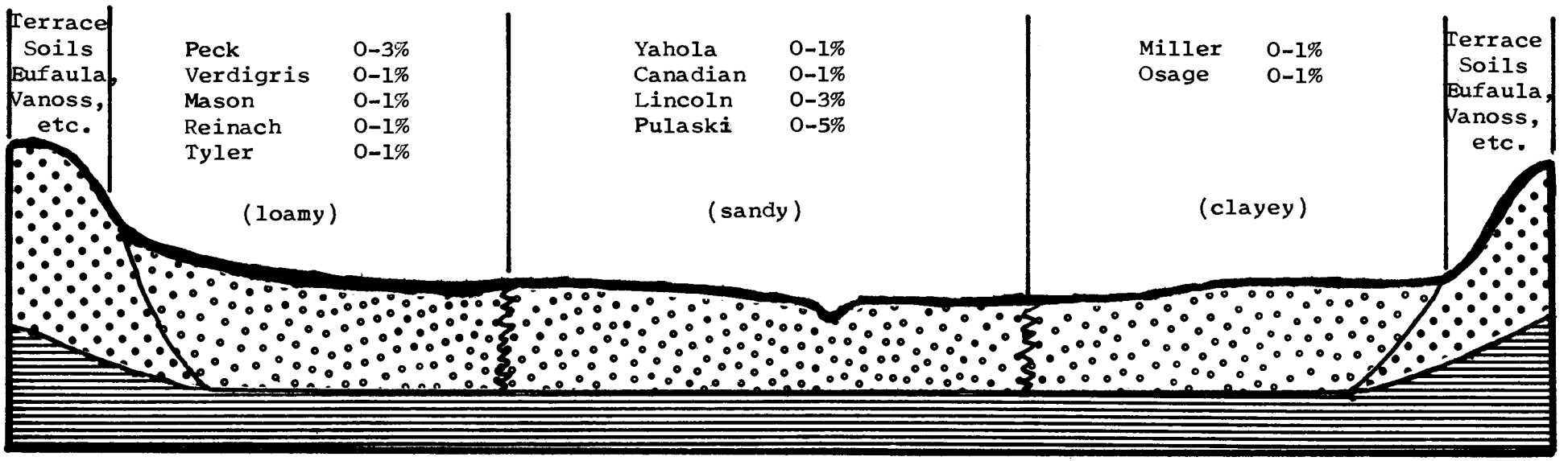
Division I - Eastern Portion

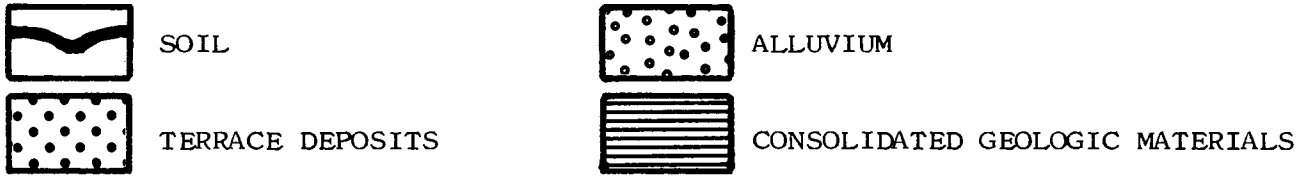




ALLUVIAL SOILS

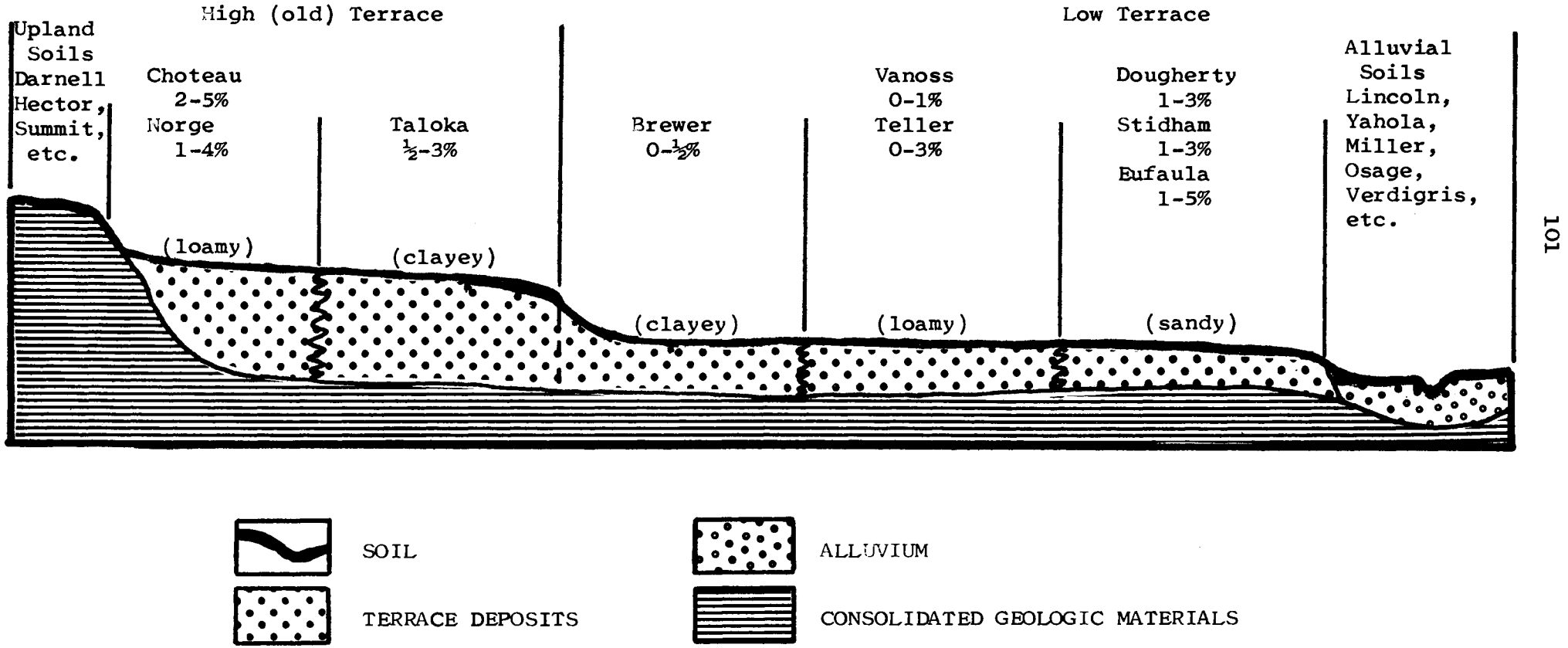
Division I - Western Portion





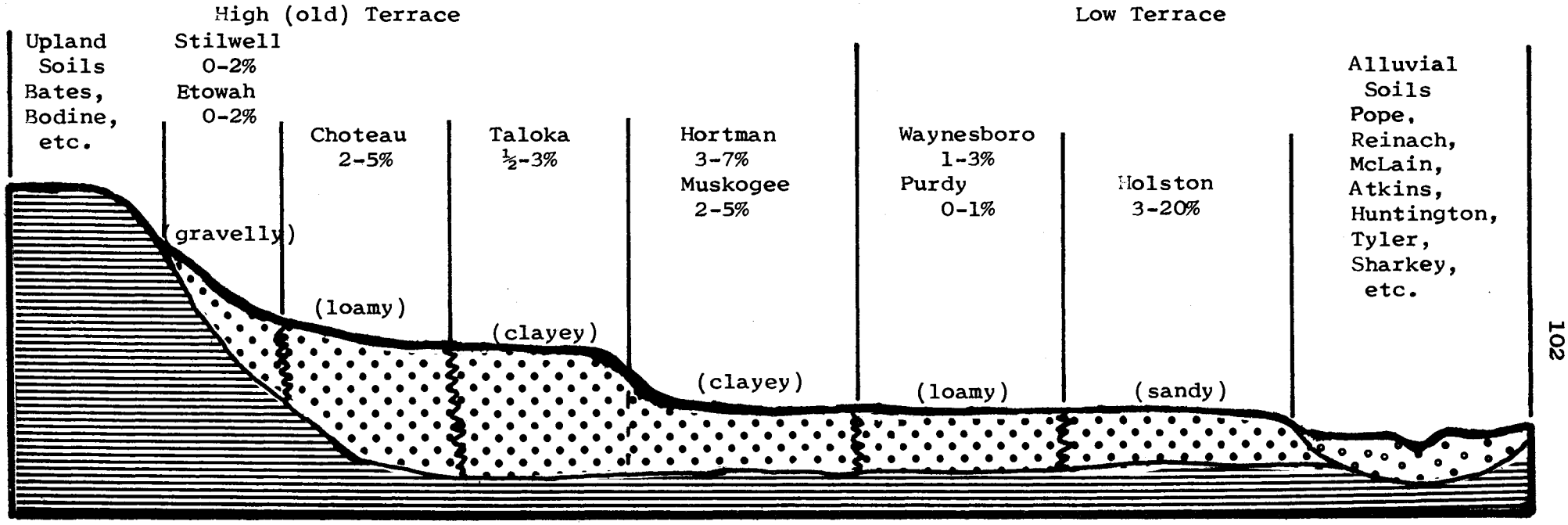
TERRACE SOILS

Division I - Western Portion



TERRACE SOILS

Division I - Eastern Portion



SOIL

TERRACE DEPOSITS

ALLUVIUM

CONSOLIDATED GEOLOGIC MATERIALS

SOILS SERIES DESCRIPTIONS

The known soil series of Division One 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 montmorrillonite 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

Surface

Down

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.

Dry color, Number is color code

Mainly used for agriculture, insignificant to highways

Number system indicating acidity and alkalinity; 7 is neutral, below 7 is acid, above 7 is alkaline

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

(B2) 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

Flecks or spots of different color

Natural soil aggregate, insignificant to highways

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

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 Shot, Normally hard and dark colored
gradual boundary.

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 represents slightly altered Pennsylvania "shale". The beds are nonfissile and discolored by weathering to depths of more than 15 feet. Refers to all geologic units with a (P) symbol Not splitting into thin layers

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 high 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; 3 1/2 miles NW of Wagoner; 600 feet east and 250 feet north of southwest corner of Section 29, Township 18 North, Range 18 East.

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. SAMPLE DESCRIPTION

(53) Date (OK) Okla. (59) Pawnee County (37) Soil Sample No.

National Cooperative Soil Survey
USA

Rev. EHT
4-23-57
Mimeo. 1957

(Reproduced by the Oklahoma Highway Dept., Research Section.)

Established Series

ATKINS SERIES

The Atkins series consists of poorly drained alluvial soils in shale and sandstone areas of the Gray-Brown and Red-Yellow Podzolic regions. The sediments have been washed predominantly from soils derived from acid sandstones and acid shales but a part of the alluvium in some areas has come from other sources, such as loess. The Atkins soils are the most poorly drained of the Pope, Philo, *Nail, Atkins drainage sequence. They are more strongly acid but comparable morphologically to the Melvin and Prader series formed from less acid sediments washed partly or entirely from soils derived from limestones or other calcareous materials. The Atkins soils are moderately extensive, are widely distributed, and are of limited agricultural value.

Soil Profile: Atkins silt loam

0-10" Light gray 1/ (10YR 7/1) friable silt loam, faintly mottled with shades of yellow and brown; weak medium crumb structure; strongly acid. 6 to 16 inches thick

10-36" Light gray (10YR 7/2) silty clay loam, conspicuously mottled with shades of brown and yellow; numerous iron concretions in places; massive; strongly to very strongly acid. 12 to 30 inches thick

36-42"+ Light Gray (10YR 7/1) sandy clay loam, conspicuously mottled with shades of brown and yellow; numerous iron concretions in places; massive; slightly hard when dry; friable when moist; strongly to very strongly acid.

Range in Characteristics: The principal type is the silt loam though loam, sandy loam, silty clay loam, sandy clay loam and sandy clay types frequently occur in relatively large bodies. Silt loam, sandy loam, and sandy clay loam textures occur in layer 2; silt loam, sandy loam, and silty clay loam in layer 3. Color of layer 1 ranges from white to dark gray, layer 2 from white to pale brown, and layer 3 from light gray to pale brown.

Topography: Level to nearly level flood plains.

Drainage: Poorly drained. Surface runoff low; internal drainage slow to very slow.

Vegetation: Predominantly willow, willow oak, post oak, black gum and sweetgum.

Use: Largely woodland and pasture.

Distribution: Appalachian region from Pennsylvania to northern Alabama; southern Indiana, Missouri, Arkansas, and eastern Oklahoma

Type Location: Pope County, Arkansas.

Series Established: Pope County, Arkansas, 1913.

Rev. IIM-WSL 8/15/50

Division of Soil Survey, BPISAE
ARA - U. S. Department of Agriculture

*Tentative

1/ Soil color names adopted by 1948 Committee; color of soil moist unless otherwise stated; symbols express Munsell notations.

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 thin-bedded 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.

Soil Profile(Bates loam):			Range in Thickness
A_1	0-10"	Dark-brown (dry) to very dark brown (moist) 1/ friable loam; crumb structure; medium to slightly acid.	8-12"
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"
B_2	22-30"	Light brownish-gray friable sandy clay loam or light clay loam mottled with light yellowish brown, noncalcareous.	6-30"
C_1	30"+	Interbedded yellowish-brown and yellowish-gray rotten sandstone and somewhat sandy shale with occasional thin strata of siltstone; noncalcareous.	

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.

Topography: Undulating to slightly rolling uplands. Gradients commonly range from 2 to 6 per cent.

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

Vegetation: Prairie grasses, mainly big and little bluestems.

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

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.

1/ Provisional Soil Survey Color names. Dry soil unless otherwise specified.
JT 6-2-45
9-29-44 EDF
EHT 6-?-45
10-10-44 Rev. JT
WIW 6-10-46

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

Established Series

BAXTER SERIES

The Baxter series consists of Red-Yellow Podzolic soils which have developed in residium from moderately high grade cherty limestones. The Baxter soils occupy gently to moderately steep slopes in close geographic association with the soils of the Cookeville, Bewleyville, Bodine, Weon, Dickson, Sango, and in places with the Clarksville and Nixa series. Compared with the Cookeville series, Baxter soils contain much angular chert throughout the solum, have less red subsoils, and generally occupy steeper slopes. They differ from the Bewleyville soils in lacking a loess or loess-like component in which the upper portion of the profile is developed. The Baxter soils are redder, are usually less cherty and are more productive than the Bodine and Clarksville soils. Compared with the Weon soils they have browner A horizons, thicker B_1 horizons, coarser textured, more friable and less compact B and C horizons, and are more productive. The Baxter series is widespread, is of large total acreage, and is important agriculturally.

Soil Profile: Baxter cherty silt loam

A_1	0-2"	Dark brown (10YR 4/3-3/3) or very dark grayish-brown (10YR 3/2) cherty silt loam with weak fine granular structure; very friable; medium acid; boundary clear, smooth. 1 to 3 inches thick.
A_2	2-9"	Brown (10YR 5/3) cherty silt loam with weak fine granular and weak medium subangular blocky structure; very friable; strongly acid; boundary clear, smooth. 4 to 8 inches thick.
B_1	9-14"	Yellowish-red (5YR 5/6) or strong brown (7.5YR 5/6) cherty silty clay loam with weak to moderate medium angular blocky structure; friable; strongly acid; boundary gradual, smooth. 3 to 7 inches thick.
B_{21}	14-20"	Yellowish-red (5YR 5/6-4/6) cherty silty clay loam, with moderate to strong medium angular blocky structure and noticeable clay skins on peds; ped interiors are slightly less red; firm when moist, slightly sticky and slightly plastic when wet, hard when dry; there are a few small black concretions; strongly acid; boundary gradual, smooth. 4 to 8 inches thick.
B_{22}	20-28"	Yellowish-red (5YR 4/6) to red (2.5YR 4/6) cherty silty clay or clay, with strong fine and medium angular blocky structure and pronounced clay skins on peds; ped interiors are slightly lighter colored and are faintly variegated with yellowish brown (10YR 5/6); firm when moist, sticky and plastic when wet, hard when dry; there are a few small black concretions; strongly acid; boundary gradual, wavy. 6 to 12 inches thick.
B_3	28-40"	Mottled dark red (10R 3/6), reddish-brown (5YR 4/4), yellowish-brown (10YR 5/6), and yellow (10YR 7/8) cherty silty clay or clay; mottles are fine and medium; distinct, many; moderate to coarse angular blocky structure with noticeable clay skins on some peds; firm when moist, sticky and plastic when wet, hard when dry; strongly acid; boundary diffuse, wavy, 10 to 18 inches thick.

C	40"+	Primarily a chert bed, with interstices filled with silty clay or clay, that is mixed red, reddish-brown, strong brown, light yellowish-brown and light gray in color; some clay skins, especially on vertical faces; firm when moist, sticky and plastic when wet, and hard when dry; strongly acid. 1 or more feet thick.

Range in Characteristics: The Baxter series includes profiles which range rather widely from the typical profile described above. The depth to cherty limestone bedrock varies considerable, as does the chert content of the soil section which may range from about 15 to 50 or more per cent of the volume. The A_2 horizon ranges from pale brown (10YR 6/3) to brown (7.5YR 4/4). The B_1 horizon may be reddish-brown (5YR 4/4) or yellowish-brown (10YR 5/6). In places, the B_{21} may be strong brown (7.5YR 5/6) and may be a light silty clay in the lower part. The B_{22} may be dark red (2.5YR 3/6). In places there are pockets of fine sandy material in the B_3 and C horizons. In many places erosion has truncated the profile and altered the surface texture to a silty clay loam or silty clay. Colors given above are for moist conditions. When soil is dry, color values are one or two units higher.

Topography: Gently sloping to moderately steep, with gradients ranging from about 3 to 30 or more per cent. In places an irregular karst topography predominated.

Drainage: Well drained. Runoff is moderate to rapid; internal drainage is moderate.

Vegetation: Hardwood species, chiefly oaks, hickory, elm, maple, dogwood, hackberry and black walnut; in places there are a few red cedars and Virginia pines.

Use: General farm crops, tobacco and alfalfa, and a wide variety of grasses and legumes; pasture; many of the steeper areas are in woods.

Distribution: Mississippian Plateau of Tennessee and Kentucky, northern Alabama, southern Missouri, southern Indiana and northern Arkansas.

Type Location: Barren County, Kentucky; 3 miles west of Glasgow on U. S. Highway 68.

Series Established: Cooper County, Missouri, 1909.

Rev. JHW
12-19-55

Soil Survey - Soil Conservation Service
U. S. Department of Agriculture

Remarks: There has been question about identity at the series level of soils correlated in the Baxter series east and west of the Mississippi River. Some question remains about full identity of the soils. Available information indicates that the series as now defined does occur in both regions.

BODINE SERIES

The Bodine series comprises strongly weathered regosolic soils, mainly in the Red-Yellow Podzolic region. These soils have been developed in residuum from very cherty (low-grade) limestone on dominantly strong to steep slopes. They occur in close geographic association with the Baxter, Clarksville, Mountview, Westmoreland, Sulphura, Frankstown, and Nixa series. The Bodine soils lack the distinct B horizons, are coarser textured, and are more yellow in color than the Baxter and Frankstown soils. Bodine soils are more cherty and lack the evident B horizon of the Mountview profile and lack the chert pans characteristic of the Nixa series. The cherty parent materials reflected in chertiness of the profile, distinguish the Bodine soils from the Westmoreland soils, formed from interbedded limestones, shales, and sandstones, and the Sulphura series, formed from blue-gray shales underlying the cherty materials at shallow depths. Compared to the Clarksville series, the Bodine soils have B horizons that are faint or lack B horizons, whereas the B horizons of Clarksville soils are definite and continuous. The Bodine soils contain more chert which is typically more porous and less dense and flinty than that in Clarksville soils. Moreover, the surface layers of Bodine soils seem browner, as a rule than those of Clarksville soils, especially in areas where a small component of loess is present in the Bodine profile, as in western Tennessee. The Bodine series is widely distributed and extensive. Chertiness and relatively low fertility combined with strong slopes limit agricultural importance of the soils.

Soil Profile: Bodine cherty silt loam

A_{00} A_0	2-0"	Forest litter and partially decomposed organic matter. 1/2 to 3 inches thick.
A_1	0-2"	Dark grayish brown (10YR 4/2) silt loam with weak fine and medium granular structure; very friable; angular chert fragments, chiefly from 1/2 to 3 inches across are common; strongly acid; boundary abrupt, smooth. 1 to 3 inches thick.
A_2	2-8"	Brown (10YR 5/3) or grayish brown (10YR 5/2) cherty silt loam with weak fine and medium granular structure; very friable; common to many angular chert fragments; very strongly to strongly acid; boundary clear or gradual, wavy. 4 to 8 inches thick.
BC	8-20"	Brownish yellow (10YR 6/6) to yellowish brown (10YR 5/6-5/8) very cherty silt loam or silty clay loam faintly variegated with gray and yellowish red; massive; friable; angular chert fragments are 1/2 or more of horizons; some highly weathered and many coated with pale brown silt; very strongly to strongly acid; boundary gradual, wavy. 8 to 24 inches thick.
C	20-50"	Chert bed with interstices occupied by yellow (10YR 7/6) to brownish yellow (10YR 6/6) silty clay loam or silty clay usually variegated with strong brown, yellowish red, and gray; massive; firm; angular chert fragments are 3/4 of the soil mass; very strongly to strongly acid. 1 to 10 or more feet thick.

Range in Characteristics: Cherty silt loam is the dominant type in the series. Thickness of the regolith ranges from 2-1/2 to 50 feet, possibly more, whereas the thickness of profile above chert beds commonly ranges from 1 foot to a few feet. Locally, the soil may contain some fine sand where the chert beds are underlain at shallow depths by unconforming fine-grained sandstone. The chert is flaggy in some profiles, but more commonly it is highly weathered, brownish (10YR 6/6-6/8) and of low density. The high content of chert is a major factor of the soils and tends to obscure other morphology, though there is generally a gradual increase in clay with depth. Estimated chert contents ranges from 20 to 75 per cent in the upper part of the profile and from 50 to 90 per cent in the lower part. The A_1 may range in color from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2), the A_2 from yellowish brown (10YR 5/4) to light brownish gray (10YR 6/2), and the BC horizon from brownish yellow (10YR 6/6) through yellowish brown (10YR 6/4) to strong brown (7.5YR 5/8). Color patterns may also be so finely variegated that no one hue is dominant in the mass. Colors given are for moist conditions. When soil is dry, color values are one or two units higher.

Topography: Dominantly strongly sloping to steep; gradients usually range from about 15 to 50 per cent, with a few gentler ridge tops ranging from about 3 to 4 or 15 per cent.

Drainage and Permeability: Well drained to excessively drained. Runoff is medium to slow, depending on slope and cover, and permeability is rapid or very rapid.

Vegetation: Chiefly hardwoods such as oak species, hickory, maple, blackgum, and a few pines.

Use: Mostly in forest but with a considerable total acreage in pasture, or idle. Some cleared areas are used for crops such as corn, tobacco, small grains, hay, and truck.

Distribution: The Highland Rim region in Tennessee and Alabama; the Pennyroyal region of Kentucky; the Ozark region of Arkansas, Missouri, and Oklahoma.

Type Location: Humphreys County, Tennessee, 3/4 mile north of Hurrican Mill.

Series Established: Humphreys County, Tennessee, 1938.

Rev. JHW WSL-RWS
1-24-58

National Cooperative Soil Survey
USA

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 (7.5 YR 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 ft. east and 900 ft. 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.

Established Series

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 from red beds.

Soil Profile:		Canadian very fine sandy loam	Range in Thickness
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"
C_1	12-25"	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"
C_2	25"+	Pale-yellow or very pale brown loamy fine sand stratified with more silty and sandy layers.	

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.

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

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

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

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.

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

Type Location: Canadian County, Oklahoma

Series Established: Roger Mills County, Oklahoma, 1914.

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

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CHEROKEE SERIES

The Cherokee soils are Planosols developed on fine-grained shales on flat upland areas under conditions of excessive moisture. The surface layers are lighter in color and the claypan is denser and more impervious than the corresponding layers of the Parsons and Woodson soils. All layers of the Cherokee soils are acid, usually ranging from a pH of 4.5 to 5.5.

Soil Profile: Cherokee silt loam

0-6" Light grayish-brown[1]/ (10YR 6/2 dry) faintly phylliform silt loam, with a pale yellowish-brown or reddish-brown specks. 4 to 10 inches thick.

6-12" Light ash-gray or nearly white (10YR 8/2 dry) porous phylliform silt loam, containing a few rust-colored specks. Changes abruptly to claypan below. 4 to 8 inches thick.

12-22" Dark grayish-brown or olive-drab dense claypan; massive or irregular coarse blocky structure. A few rust-colored mottlings occur. 8 to 12 inches thick.

22-36" Grayish-brown or olive-brown clay (10YR 4/2), less dense than the material above. Mottled with yellowish-brown or rust colored spots (10YR 6/6 dry); gypsum crystals are present in places; generally lighter colored below 36 inches. 12 to 20 inches thick.

Bluish-gray noncalcareous weathered clay shale may occur at a depth of 40 or 50 inches.

Range In Characteristics: Chiefly in depth to claypan, which varies from 8 to about 18 inches. The contact line between the light gray layer and the claypan is abrupt but is undulating unconformable with the surface relief.

Topography: Nearly level uplands.

Drainage: Surface and subsoil drainage very slow.

Vegetation: Mainly prairie grasses, with bluestems dominant.

Use: A large part of these soils is used for the production of prairie hay and considerable acreage is in pasture. Wheat, barley, flax, sorgo, and oats are grown on the cultivated areas. Yields for all crops are low generally unless lime carbonate and other soil amendments are used. Crop yields are generally reduced because of the soil's unfavorable moisture relationships. They are generally too wet during seasons of abundant rainfall and too dry during seasons of deficient rainfall. These soils require well distributed rainfall if good yields are to be obtained.

Distribution: Eastern Oklahoma, southeastern Kansas, and southwestern Missouri.

Type Location: Cherokee County, Kansas

Series Established: Cherokee County, Kansas, 1912.

Remarks: As mapped, the Cherokee soils include comparatively large areas in in which the claypan is being broken down by the podsolization process. These areas have a transitional layer of 2 to 8 inches thick between the very light colored subsurface and heavy claypan. This transitional layer is weakly granular and is very light gray and mottled with brown. These included areas have better moisture relationships and produce higher yields than true Cherokee soils. It is expected that they will be separated and recognized as a new series.

1/ Provisional Soil Survey color names, based on Munsell color charts.

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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 soils, 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 distinguished 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.

Page 2--Choteau Series

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 per cent. Solonetzic transitions occur on slopes of more than about 4 per cent. 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 per cent but ranging from about 1 to 8 per cent.

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, (Verdi-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

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 per cent but ranging up to 35 per cent.

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.

Page 2--Collinsville Series

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.

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CONWAY SERIES

Soils of the Conway series are zonal soils of the Red and Yellow Podzolic region. They have developed on residual material derived from acid shales. Thin sandstone members may occur in the shale formations. The Conway soils are associated with Enders and Pottsville series. Pottsville soils are shallow Lithosols from shale. The Enders soils have reddish or brown upper subsoil. The Conway soils are pale brown to yellowish-brown in the subsoil. Conway soils occur in large areas and are large in total area. They are important soils in agriculture.

Soil Profile: Conway silt loam

A_2	0-6"	Brown (10YR 4/3), weak medium granular, strongly acid, silt loam. 6 to 10 inches thick.
B_2	6-30"	Yellowish-brown (10YR 5/6), moderate medium blocky, very strongly acid, silty clay loam. 15 to 30 inches thick.
B_3	30-36"	Yellowish-brown and gray mottled and streaked, moderate coarse blocky, strongly acid, silty clay. 6 to 10 inches thick.
C		Yellow, gray and red mottled and splotched, moderate coarse blocky, strongly acid, silty clay. 10 to 30 inches thick.
D		Acid shale.

Range in Characteristics: The A horizon is darker where organic matter has not been destroyed and in woods there is a cover of leaf litter. Reaction of the A horizon may be medium acid. Texture ranges from silt loam to sandy loam. Brown concretions may be numerous. Reaction of B horizon may be strongly acid. On nearly level areas small mottlings may occur throughout the upper B horizon. Color of B ranges from pale brown to yellowish-brown. Salt spots occur occasionally in small areas, especially where seep water comes to the surface.

Topography: Level to gently undulating; 0 to 5 per cent slope. Usual slope about 2 per cent. Mounds, 5 to 30 feet in diameter and up to 3 feet in height, are common and may occupy up to 80 per cent of the area.

Drainage: Surface drainage ponded to moderately rapid; internal drainage slow.

Vegetation: Willow oak, sweetgum, blackgum, post oak, hickory, and elm.

Use: Cotton, corn, annual legumes, small grain, pasture, woodland. Artificial drainage on level areas is beneficial.

Distribution: North and western Arkansas, eastern Oklahoma, east Tennessee and north Alabama.

Type Location: Faulkner County, Arkansas, near Conway.

Series Established: Conway County, Arkansas, 1907.

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Established Series

CRAIG SERIES

The Craig series are Prairie Soils developed over residuum from cherty limestone on freely drained surfaces in the Ozark Plateau. Where typically developed the soils are underlain by a "chertpan" (abundant chert embedded in subsidiary mottled clay or clay loam, which is extremely hard and stonelike when dry but which is readily penetrable by moisture and friable when moist) at a depth of about 21 inches. The principal series associated with Craig and Parsons and Gerald, which are prairie Planosols developed in associated more shaly materials; Eldorado, which comprises dark-colored Lithosols over cherty residuum occurring in prairies; and Bodine, which is of forested cherty Lithosols.

Soil Profile:		Craig silt loam	Range in Thickness
A_{11}	0-6"	Dark grayish-brown (10YR 3/1.5) silt loam free from chert; moderate medium granular; friable; medium to strongly acid.	5-8"
A_{12}	6-14"	Dark grayish-brown (10YR 5/1.5) heavy silt loam; brown in the lower third; medium to coarse granular; friable; grades to horizon below; strongly acid.	6-10"
B_2	14-20"	Brown (7.5YR 4/2) silty clay finely mottled with reddish brown and pale brown; contains some chert; strong subangular blocky; friable; strongly to medium acid.	4-12"
B_3	20-40"	"Chertpan" consisting of chert embedded in subsidiary reddish-brown (5YR 4/3) silty clay that is mottled with red and light yellowish brown; very hard and stonelike when dry but friable when moist; readily permeable to moisture; medium to slightly acid.	15-25"
C	40"+	Residuum from cherty limestone consisting of a mixture of chert fragments and a relatively minor proportion of mottled pale yellow and reddish yellow silty acid to neutral silty clay. This layer extends to a depth ranging from 8 to 20 feet and grades into cherty limestone.	

Range in Characteristics: Silt loam and cherty silt loam are the principal types; depth to very cherty material ranges from 15 to 25 inches in modal soils, and from 25 to 40 inches in deep phases, which have a B_2 horizon of medium blocky firm clay; color of surface soil ranges from dark grayish brown to dark brown; mottling of the upper B horizon ranges from slight to moderate.

Topography: Erosional upland; surfaces mostly convex; gradients from 1 to 8%, mostly 2 to 5.

Drainage: Free from the surface; moderate internally.

Vegetation: Prairie grasses, largely bluestem.

Use: Largely in cultivation; mainly corn, small grains, lespedeza, and fruit trees; moderately productive.

Page 2--Craig Series

Distribution: Prairies of the Ozark Plateau, mainly in northeastern Oklahoma, southwestern Missouri and northwestern Arkansas; moderately extensive.

Type Location: Craig County, Oklahoma, NE 1/4 Sec. 11, T24N, R20E.

Series Established: Craig County, Oklahoma, 1931.

Remarks: Some authorities state that the "chertpan" (horizon 3) is cemented with materials other than colloidal clay, probably with silica, and is a true hardpan; others were unable to detect cementation. Similarly, some believe the chert-free A horizon has resulted from complete removal of the chert by leaching, whereas others are of the opinion the chert-free layer has resulted from a thin mantling with loess.

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

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2-15-40
Revision proposed: 3-5-40
FAH
Rev. EHT-EDF
10-8-46

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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.

Page 2--Dale Series

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

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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.

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Rev. HO-EHT
1-7-47

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Established Series

DENNIS SERIES

The Dennis series comprises deep well-drained Prairie soils developed principally from noncalcareous silty or sandy Pennsylvania "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 montmorrillonite 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 Pennsylvania "shale". The beds are nonfissile and discolored by weathering to depths of more than 15 feet.

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 7.5 YR 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.

Rev. EHT
4-23-57
Mimeo. 1957

National Cooperative Soil Survey
USA

Established Series

DICKSON SERIES

The Dickson series consists of Red-Yellow Podzolic soils with fragipans which have developed in residuum from low grade or moderately low grade cherty limestones often capped with shallow loess. These soils are moderately well to well drained and typically occupy gentle or moderate slopes in close geographical association with the soils of the Bodine, Mountview, Baxter, Cookeville, Sango, Lawrence and Guthrie series. The Dickson soils resemble the Mountview but differ from them in having very definite fragipans. They are better drained, having weaker fragipans, and browner, less mottled subsoils than the Sango, Lawrence, and Guthrie soils. They resemble and grade toward the Russellville soils, which are developed in residuum from high grade or moderately high grade limestones, usually capped with shallow loess; but they are not so brown as the Russellville soils, particularly in the surface soil, and are less productive. Dickson soils are extensive and important agricultural soils in the regions of their occurrence. The silt loam is the dominant type.

Soil Profile: Dickson silt loam

A_1	0-2"	Grayish-brown (10YR 5/2 - 2.5Y 5/2) silt loam with weak fine granular structure; very friable; strongly acid; boundary clear, smooth. 1 to 3 inches thick.
A_2	2-8"	Brown (10YR 5/3) to yellowish-brown (10YR 5/4) silt loam with weak fine granular structure; very friable; very strongly acid; boundary gradual, smooth. 5 to 10 inches thick.
B_1	8-12"	Yellowish-brown (10YR 5/4-5/6) silt loam with weak medium and fine subangular blocky structure; friable; there are a few small round dark brown concretions; very strongly acid; boundary gradual, smooth. 3 to 8 inches thick.
B_2	12-23"	Yellowish-brown (10YR 5/4-5/8) to light yellowish-brown (10YR 6.4) heavy silt loam or light silty clay loam with moderate medium angular or subangular blocky structure; friable but slightly compact; a few small concretions; very strongly acid; boundary gradual, smooth. 5 to 14 inches thick.
B_3	23-27"	Mottled light yellowish-brown (10YR 6/4) to (2.5Y 6/4) and gray (10YR 6/1) silt loam; mottles many, medium, distinct; moderate medium angular blocky and subangular blocky structure; friable; a few medium dark brown concretions; very strongly acid; boundary gradual, wavy. 2 to 6 inches thick.
B_{3m}	27-40"	Light yellowish-brown (2.5Y 6/4) light silty clay loam or heavy silt loam, with many fine distinct mottles and ped coatings of light gray (2.5Y 7/2); moderate medium and coarse angular blocky structure; firm, compact, brittle; a few medium sized dark brown round concretions; very strongly acid; boundary clear, smooth. 8 to 18 inches thick.

C 40"+ Mottled yellow, gray and red silty clay loam; mottles are many, medium, distinct; moderate medium to coarse angular blocky structure; firm; many angular chert fragments about 1/4 to 3 inches across, chert content increases with depth; gradual boundary.

D_r Cherty limestone at depth of several feet.

Range in Characteristics: There is considerable variation in depth, thickness, and degree of development of the B_{3m}, or fragipan horizon. The depth varies from about 20 to 30 or more inches; the thickness ranges from a few inches to two or more feet locally; and the development ranges from slight compaction to pronounced fragipan. In places the upper part of the solum has developed in a thin loess mantle which overlies the cherty limestone residuum. In some other areas the parent material contains enough very fine sand to affect the soil texture, particularly of the B_{3m} and C horizons. Locally, color of the C horizon may range to predominately red, and texture to as heavy as a silty clay or clay. Colors given above are for moist conditions. When soil is dry, color values are one or two units higher.

Topography: Typically gently sloping to sloping broad ridges with some areas nearly level and a few strongly sloping.

Drainage: Moderately well drained to well drained. Surface run-off is moderate and internal drainage is moderate to slow.

Natural Vegetation: Hardwoods consisting of oak species; white, post, Spanish, red, and black jack; hickory, poplar, sour and sweet gum and maple; a few cedars.

Use: General farm crops including corn, tobacco, cotton, small grains and some legumes; pasture; vegetables; fruit trees; an appreciable acreage is in forest.

Distribution: The Highland Rim of Tennessee; the Pennyroyal of Kentucky; northern Alabama; and the Ozark region of Missouri and Arkansas.

Type Location: Coffee County, Tennessee, State Highway 53, 2 miles south of Pocahontas Road.

Series Established: Dickson County, Tennessee, 1923.

Rev. JHW
9-8-55

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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.

Page 2--Dougherty Series

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.

Rev. EHT-HO
4-23-59

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ELDORADO SERIES

The Eldorado series includes lithosolic soils developed in residuum from cherty limestone, mainly in prairies within the Ozark Plateau. These soils are rapidly drained and as a rule, are associated with the zonal Craig soils. They commonly occur on relatively steep slopes or on top of narrow ridges in prairies underlain by very cherty limestone. Cherty and stony silt loam are the chief types.

Soil Profile:		Eldorado cherty silt loam	Range in Thickness
A_1	0-5"	Dark-brown (7.5YR 3/2; 2/2, moist) silt loam intermixed with 10 to 50% of chert fragments; friable; strong medium granular; slightly to medium acid.	4-6"
A_3	5-12"	Brown (7.5YR 4/2) cherty silt loam; strong medium granular; friable; slightly to medium acid.	2-8"
C	12"+	Disintegrated and weathered chert beds of the cherty limestone formation extending to a depth of several feet before bedrock is encountered.	

Range in Characteristics: Chiefly in thickness and darkness of the surface layer and the amount of rock on the surface.

Topography: Erosional upland; mostly on gradients of 10 to 25 per cent, although some areas on narrow ridge tops and knobs are nearly level.

Drainage: Rapid from the surface; free internally.

Vegetation: Prairie grasses, mainly Andropogons.

Use: Mainly as native pasture, which affords good grazing when moisture supply is adequate. Owing to the shallowness of the solum and chertiness of the soil, very little is cultivated.

Distribution: Chiefly in northeastern Oklahoma, southeastern Kansas, northwestern Arkansas, and southwestern Missouri in the Region of Prairie Soils.

Type Location: Craig County, Oklahoma.

Series Established: Cedar County, Missouri, 1909.

EDF:MB
4-5-44

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ENDERS SERIES

The Enders series consists of well-drained Red-Yellow Podzolic soils developed in residuum from acid shales, siltstones, and thin-bedded sandstones. These soils are associated with the Townley, Albertville, Montevallo, Hector, Rarden, Hartsells, Linker, Hanceville, Tilsit, Zanesville, and Wellston soils. The Townley soils have thinner B2t horizons (3-12"), thinner solums (18-26") and less depth to bedrock (20-30"). The Albertville soils are less well drained and have less red subsoils. The lithosolic Montevallo and Hector soils are less deeply weathered and lack Bt horizons. Rarden soils have subsoils that are finer in texture, redder, and more plastic. The Hartsells, Linker, and Hanceville soils have subsoils of coarser texture and those of the Linker and Hanceville soils are redder. The Tilsit and Zanesville soils, which have fragipans, and the Wellston soils are typically derived in part from loess, are generally more yellow, and have coarser-textured Bt horizons. Enders soils are in relatively large bodies, of large total acreage, and important to agriculture.

Soil Profile: Enders very fine sandy loam - forested

O1	2-0"	Leaf and twig litter.
A1	0-1"	Finely variegated very dark grayish brown (10YR 3/2) and dark gray (10YR 4/1) very fine sandy loam; moderate fine granular structure; very friable; matted with fine roots; common fine and medium pores; many worm casts; few small sandstone pebbles; strongly acid; abrupt wavy boundary. 1/2 to 3 inches thick.
A2	1-7"	Yellowish brown (10YR 5/6) very fine sandy loam; weak medium subangular blocky structure; friable; common fine and medium roots; common medium pores; few worm casts; few fine black concretions; common sandstone pebbles; very strongly acid; clear wavy boundary. 4 to 8 inches thick.
B1	7-11"	Yellowish red (5YR 5/8) loam; weak medium subangular blocky structure; friable, slightly plastic; few clay bridges; common roots; common medium and coarse pores, some containing organic shreds; few fine black concretions; common sandstone fragments; very strongly acid; clear wavy boundary. 2 to 6 inches thick.
B2t	11-26"	Yellowish red (5YR 4/8) silty clay; yellowish red (5YR 5/8) crushed; few fine distinct reddish yellow (7.5YR 6/8) and yellowish brown (10YR 5/8) mottles; few flecks of red and dark red; strong medium subangular blocky structure; hard, firm, slightly plastic, slightly sticky; clay films continuous on most peds and as linings in common fine pores; few roots; few fine black concretions; few flaggy sandstone and siltstone fragments; extremely acid; clear irregular boundary. 12 to 24 inches thick.

B3	26-34"	Finely variegated colors of yellowish red (5YR 5/8), yellowish brown (10YR 5/8), and strong brown (7.5YR 5/8); silty clay; few medium distinct grayish brown (10YR 5/2) mottles; weak medium platy structure that breaks down to weak medium angular blocks; firm, slightly plastic, slightly sticky; many patches of clay films on ped faces; common medium and fine pores, many with clay linings; many peds are pseudomorphs of shale fragments; many soft shale fragments; very strongly acid; gradual wavy boundary. 4 to 10 inches thick.
C	34-42"+	Strong brown (7.5YR 5/8) silty clay variegated with red (2.5YR 4/8), grayish brown (10YR 5/2), and intermediate colors; medium and coarse platy structure representing relict shale and siltstone stratification; firm; many fine shale and siltstone fragments; extremely acid. 2 to 30 inches thick.

Range in Characteristics: Silt loam, loam, fine sandy loam, very fine sandy loam, and sandy loam are the dominant types. Gravelly and stony phases are common. Thickness of the solum ranges from 30 to 42 inches. In cultivated areas, the Ap horizon ranges from grayish brown through dark brown, and the A2 and B1 horizons may be evident only as remnants. The A2 horizon ranges in color from reddish yellow through shades of brown and yellow. The B1 horizon ranges from yellowish brown through yellowish red in color and from fine sandy loam through silty clay loam in texture. The B2t horizon ranges from yellowish red through reddish brown and may be free of yellowish and brownish mottles. Texture of the B2t is centered on silty clay and sandy clay, but may extend into the finer range of clay loam and silty clay loam, and the coarser range of clay. The B3 and C horizons may be finely or coarsely variegated with shales of red, brown, yellow, and gray, the red decreasing and gray increasing with depth. The boundary between B3 and C may diffuse or irregular. Either of these horizons, and rarely both, may be absent and the solum may rest directly on an R horizon of acid shales or on contrasting sandstone. Reaction of the A horizon ranges from medium acid through strongly acid and of the B and C horizons from strongly acid through extremely acid. Colors given are for moist soil. Dry soil colors are one or two units higher in value, lower in chroma, or both.

Topography: Undulating to rolling uplands. Slopes range from about 2 to 30 per cent, but mostly are between 3 and 8 per cent.

Drainage and Permeability: Well drained, with medium to rapid runoff and medium internal drainage. Permeability is slow.

Vegetation: White, post, red, and blackjack oaks; shortleaf pine, and hickory species. Understory of bush huckleberry, sumac, grapevine, and smilax species.

Use: Cotton, corn, small grains, sorghum, vegetables, and hay and pasture crops.

Distribution: Alabama, Arkansas, Kentucky, and Tennessee; possibly Georgia, Missouri, and Oklahoma.

Page 3--Enders Series

Type Location: Cleburne County, Arkansas; 1.1 miles east of VanBurean-Cleburne County line on Arkansas Highway 124, 50 feet southeast of highway right-of-way.

Series Established: Pope County, Arkansas, 1938.

Remarks: The Enders and Sequoia series seem to be closely similar.

Rev. CAM-ML-WSL
8-13-63

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ERAM SERIES

The Eram series comprises acid medium-depth soils developed from olive and gray shales on freely drained surfaces in the prairies of northeastern Oklahoma and vicinity, which lie in the northern part of the Reddish Prairie soil zone. The shales giving rise to these soils generally are of the Pennsylvanian, range from mildly alkaline to weakly calcareous, and quite commonly are thinly interbedded with fine-grained sandstones or siltstones. The Eram series is less deep, generally more sloping, and has more granular less grayish upper subsoils and more olive-colored lower subsoils than Woodson. The Lithosols associated with Eram are Talihina; other common associates are Parsons, which occupies smoother areas, and Bates and Dennis, which are developed in less clayey residuum.

Soil Profile:		Eram silty clay loam	Range in Thickness
A_1	0-8"	Dark grayish-brown (2.5Y 4/2; 3/2, moist) silty clay loam; moderate medium granular; medium to strongly acid.	4-10"
B_2	8-16"	Yellowish-brown (2.5Y 4/3; 4/4, moist) silty clay; strong, medium or coarse granular; firm but crumbly; medium to strongly acid.	4-20"
B_3	16-30"	Olive or olive-gray clay; very firm, plastic, compact and very slowly permeable; weakly blocky; slightly acid.	10-20"
C	30"+	Olive and gray shale generally containing silty and sandy seams; mildly alkaline to weakly calcareous.	

Range in Characteristics: Thickness of horizons vary widely within short distances; horizons 2 and 3 may be somewhat mottled with other shades of brown or gray; depth to shale ranges from about 24 to 40 inches; scattered fragments of sandstone or siltstone on the surface or in the soil are common.

Topography: Erosional upland; mostly on long gentle slopes with grades of 2 to 5%.

Drainage: Free from the surface; very slow internally.

Vegetation: Prairie grasses.

Use: Largely in cultivation to corn, small grains, cotton, and sorghums; generally produces only moderate to low yields; very susceptible to erosion.

Distribution: Shale and sandstone prairies of east-central and northeastern Oklahoma and adjoining parts of Kansas, Missouri, and Arkansas.

Type Location: McIntosh County, Oklahoma.

Series Established: Okfuskee County, Oklahoma, 1940.

Page 2--Eram Series

Remarks: Prior to establishment of the Eram series, these soils generally were classed as Bates silty clay loam. The series name is from a village in Okmulgee County, Oklahoma, where the series was first proposed.

Colors are described with provisional Soil Survey color names (1947) and refer to dry soil.

EDF
2-19-42
Revised: 3-26-47
EHT

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Established Series

EUFAULA SERIES

The Eufaula series includes light-colored acid deep loose sands of the western or drier part of the zone of Red and Yellow Podzolic Soils. The series differs from Stidham and Nimrod in having no distinctly loamy subsoil, or heavier layer, to a depth of more than 3 feet. The series is related to Derby, but is developed under forest instead of grass and is lighter-colored.

Soil Profile: Eufaula fine sand		Range in Thickness
0- 3"	Pale-brown (10YR 6/3; 5/3, moist) fine sand; loose; slightly acid.	2-5"
3-30"	Very pale brown (10YR 8/3; 7/4, moist) fine sand; loose; medium to slightly acid.	10-30"
30-50"+	Fine sand or loamy fine sand slightly yellower (10YR 8/4; 7/4, moist) and more acid than layer 2.	

Range in Characteristics: Color of soil below the thin darkened surface layer ranges from very pale brown to pale yellow; fine sand and loamy fine sand are the principal types; most typically, loose very sandy material continues to a depth of 6 feet and more but below 3 feet some areas have a thin illuviated B horizon of strongly acid friable sandy clay loam or sandy loam, generally brownish yellow splotched with yellowish red and about one foot thick grading below into more sandy material.

Topography: Upland, mostly nearly level; very little on slopes of more than 5%.

Drainage: Rapid; mostly internal.

Vegetation: Deciduous scrub forest of post oak, blackjack, and some hickory.

Use: Mainly relatively unproductive pastured woodland or abandoned fields; where cultivated, the principal crops are peanuts, fruits, cotton, and corn; of low inherent fertility and susceptible to soil blowing and loss of nutrients by leaching.

Distribution: Eastern Oklahoma and Texas.

Type Location: McIntosh County, Oklahoma, Section 18, T10N, R17E.

Series Established: McIntosh County, Oklahoma, 1943.

Remarks: The soils to date correlated in this series are on high old terraces of the Canadian, Red, Brazos, and like rivers that drain the southern Great Plains. The parent materials probably were alkaline when deposited but are leached and acid to depths of more than 8 feet.

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

WTC:EHT:EGF
6-16-44
Revised: 2-22-47
EHT

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Established Series

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 2 1/2 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 B_3 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
Mimeo., 1957

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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.

Page 2--Hartsells Series

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
2-4-59

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USA

Established Series

HECTOR SERIES

The Hector series includes Lithosols on the uplands in the Red and Yellow Podzolic region. These soils consist of residual material derived from acid sandstones. The Hector soils are associated with the Linker, Hanceville, Cleburne, Hartsells, and Muskingum soils. They differ from the Linker, Hanceville, Hartsells, and Cleburne soils in being shallow and having little or no horizon development. They show more horizon development, mainly in the stronger brown or reddish colors in the deeper horizons, than the Muskingum soils. Hector soils are extensive in area and distribution, but are low in agricultural value.

Soil Profile: Hector gravelly fine sandy loam			Range in Thickness
A_{00}, A_0	1-0"	Partially decomposed forest litter.	1-2"
A_1	0-2"	Dark-brown (7.5YR 3/2), 1/ gravelly sandy loam.	1-3"
A_2	2-14"	Brown (10YR 5/3), loose gravelly fine sandy loam, medium acid.	6-24"
C_1	14-18"	Yellowish-red (7.5YR 5/8), partially decomposed acid sandstone.	2-10"
C_2	18"+	Gray to red acid sandstone.	

Range in Characteristics: The A_1 horizon may be absent, but where present soon loses its identification when cultivated. The texture of the A_1 and A_2 horizons ranges from fine sandy loam to stony loam and the color from grayish brown to reddish brown. In places, a very thin sandy clay loam B horizon may be present. The soil is medium to strongly acid in reaction.

Topography: Undulating to steep (2 to 30 per cent). Common slope, 12 per cent.

Drainage: Surface drainage moderately rapid to excessive. Internal drainage moderately rapid.

Vegetation: Pine, post oak, hickory, blackjack oak, cedar, huckleberry, and hawthorn.

Use: Mainly pasture and woodland; small grains, annual legumes, early truck crops to a limited extent.

Distribution: Northern and western Arkansas, eastern Oklahoma, southern Missouri, eastern Tennessee, eastern Kentucky, northern Alabama, and northwest Georgia.

Type Location: Pope County, Arkansas, in the vicinity of the town of Hector.

Series Established: Pope County, Arkansas, 1938.

1/ Provisional soil color names proposed by the 1946 Committee; color of soil moist unless otherwise stated.

Rev. ML-ILM
3-16-48

Division of Soil Survey
Bureau of Plant Industry, Soils,
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Agricultural Research Administration
U. S. Department of Agriculture

Established Series

HOLSTON SERIES

The Holston series consists of well drained Red-Yellow Podzolic soils developed in old alluvium on higher river terraces. The alluvium has washed from soils developed in residuum predominantly from acid sandstones and shales. The Holston series is the well drained member of the Holston-Monongahela-Tyler-Purdy catena. Holston soils lack the strong mottling and fragipan development characteristic of the lower B horizon of the Monongahela soils. The Holston soils occupy nearly level to strongly sloping areas in close geographic association with the soils of the Nolichucky, Waynesboro, Allegheny, Sequatchie, and Jefferson series. They differ from the Jefferson soils in being developed in old, more homogeneous general alluvium rather than in local alluvium. The Holston soils differ from the Nolichucky and Waynesboro soils in being yellowish brown rather than red in the B horizon. Compared with the Allegheny and Sequatchie soils (gray-brown Podzolic), the Holston soils are older, more leached, have lighter-colored A horizons and yellower, less brown B horizons of higher chroma. The Holston soils are widely distributed, of moderate total acreage, and are fairly important to agriculture.

Soil Profile: Holston fine sandy loam--forested.

A_0	1-0"	Forest litter, partially decomposed.
A_1	0-1"	Dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) fine sandy loam with weak fine crumb structure; very friable; strongly acid; boundary clear, smooth. 1 to 2 inches thick.
A_2	1-9"	Pale brown (10YR 6/3) or light yellowish-brown (10YR 6/4) fine sandy loam with weak fine crumb structure; very friable; strongly to very strongly acid; boundary clear, smooth. 5 to 10 inches thick.
B_1	9-15"	Yellowish-brown (10YR 5/4-5/6) fine sandy clay loam or fine sandy loam with weak to moderate medium subangular blocky structure; friable, strongly to very strongly acid; boundary clear, smooth. 3 to 12 inches thick.
B_{21}	15-25"	Yellowish-brown (10YR 5/6-5/8) to brownish-yellow (10YR 6/6) fine sandy clay loam or clay loam, with dominantly moderate medium subangular blocky structure; few thin patchy clay skins; friable to slightly firm when moist, slightly sticky when wet; very strongly or strongly acid; boundary gradual to clear, smooth. 8 to 12 inches thick.
B_{22}	25-38"	Yellowish-brown (10YR 5/6-7/8), brownish-yellow (10YR 6/6) or light yellowish-brown (10YR 6/4) fine sandy clay loam or clay loam, with moderate to strong medium and coarse angular blocky and some subangular blocky structure; clay skins noticeable on some peds, especially in pits, pores, and root channels; some peds have black coatings; firm when moist, sticky and plastic when wet, hard when dry; this horizon is variegated or mottled in lower part with yellowish-red, strong brown and light brownish gray or gray; very strongly to strongly acid; boundary clear, smooth. 10 to 16 inches thick.

C 38-60" Stratified beds and pockets of weathered old alluvium, consisting of pockets of fine sandy clay loam, clay loam, and sandy loam, somewhat variegated or mottled yellow, yellowish-brown, strong brown, yellowish-red, and light gray; massive, or nearly so; slightly firm when moist, slightly sticky when wet, hard when dry. 10 to 40 inches thick.

Range in Characteristics: Thickness of the alluvium ranges from 3 feet to a probable maximum of 12 feet. Generally solum thickness ranges from 34 to 54 inches; in places, on steeper slopes, the profile may be truncated by severe erosion. Types recognized are sandy loam, fine sandy loam, very fine sandy loam, and silt loam, with some gravelly types. The silt loam usually has a silty clay loam B horizon, and is normally more silty in the C horizon than the sandier types. In places, the B_2 horizon may range to strong brown (7.5YR 5/6-5/8) and in small inclusions, may be a fine sandy loam. A thin variegated B_3 horizon, about 4 to 12 inches thick, occurs in places. Pockets of gravel, sandy strata, and beds of gravel occur erratically but are most common in the C horizon. In places, a thin or very weak fragipan may form deep in the profile, usually below 30 inches. Colors given above are for moist conditions. When soil is dry, color values are one or two units higher.

Topography: Nearly level to strongly sloping, rarely moderately steep, stream terraces, usually rather high above the flood plains. Some areas are rather dissected. Gradients range from about 3 to 20 per cent.

Drainage: Well drained. Runoff is medium to rapid, and internal drainage is medium.

Vegetation: Mixed growth consisting chiefly of oak species, hickory, dogwood, yellow poplar, elm, hop hornbeam, beech, box elder, and short leaf, loblolly and Virginia pine; in places, hemlock and white pine.

Use: Mostly cleared and largely in cultivation, some in pasture; a small amount is in forest or is idle. In the northerly end of the geographic range the Holston soils are used chiefly for corn, small grains, soybeans and hay; in the southern part they are also used for cowpeas, tobacco, and cotton.

Distribution: Kentucky, Tennessee, Pennsylvania, Maryland, West Virginia, Virginia, southern Ohio, Missouri, northern Alabama, northwestern Georgia, and Arkansas.

Type Location: Hawkins County, Tennessee; along State Highway 70, about one mile south of bridge over Holston River.

Series Established: Grainger County, Tennessee, 1905.

Rev. JHW 1-27-56
Mimeo. 1957

National Cooperative Soil Survey
USA

Established Series

HORTMAN SERIES

The Hortman series includes moderately well-drained acid timbered soils developed on high stream terraces from old alluvium along the Red and Arkansas and other rivers that carry similar sediments originating partly or wholly in grasslands underlain by red beds. In color and texture of surface and subsoil horizons, the Hortman series closely resembles Boswell, but differs from it in having parent material of old (usually early to middle Pleistocene) mostly clayey alluvium that is somewhat reddish and alkaline or calcareous in reaction. The usual catenal associates are Axtell, which is more slowly drained, Wrightsville, the gray poorly drained member of the catena, which occupies wet flats or slight depressions; and Muskogee, which has yellower less plastic subsoils and usually somewhat more sandy parent materials.

Soil Profile: Hortman fine sandy loam

A_1 & A_2	0-8"	Pale-brown (10YR 6/3; 5/3, moist) fine sandy loam; structureless; very friable; medium to strongly acid; in undisturbed areas the A_1 and A_2 horizons are distinct, the A_1 being grayish-brown, weakly granular, neutral to slightly acid, and 2 to 4 inches thick. 5 to 12 inches thick.
B_2	8-18"	Red (2.5YR 4/8; 3/8, moist) clay; moderate medium blocky, very firm; very hard when dry; medium to strongly acid; grades to horizon below. 5 to 15 inches thick.
B_3	18-35"	Mottled red (2.5YR 4/6) yellow (2.5YR 7/6), and light gray (2.5Y 7/2) clay, the red decreasing with depth; blocky; slowly permeable; very sticky and plastic when wet; medium acid. 15 to 25 inches thick.
C_1	35-50"	Mottled yellow (2.5Y 7/6) and light gray (2.5Y 7/2) sandy clay coarsely mottled with 5 to 20% of red and yellowish red; weakly stratified with reddish yellow loamy sand or sandy loam in lower part, neutral to weakly alkaline. 10 to 20 inches thick.
C	50-70"+	Old alluvium of reddish calcareous clay somewhat stratified with sandy or silty layers; usually contains scattered concretions of $CaCO_3$.

Range in Characteristics: Sandy loams are the principal types; color of the A_1 ranges from grayish brown to brown and of the A_2 from brown to very pale brown; color of the B_2 ranges from red to yellowish red or reddish brown; and of the B_3, from red with slight mottling; depth to alkaline or calcareous material varies between about 3 and 12 feet, increasing with the rainfall and age of the terrace and decreasing with greater slope or more clayey, less permeable substrata.

Topography: Gently sloping to sloping convex surfaces with gradients of about 3 to 7%; usually on old high much dissected terraces with a few or no undissected remnants of the depositional surface remaining.

Drainage: Runoff is moderate to rapid; internal drainage is slow.

Vegetation: Post oak and blackjack in the more western drier areas; oak-pin forest in the more eastern and more humid areas.

Page 2--Hortman Series

Use: Mainly forest but small areas are cleared and used for producing corn, cotton, and sorghums.

Distribution: Mainly in Texas, Oklahoma, Arkansas, and Louisiana along through-flowing streams such as the Red and Arkansas Rivers which originate in the plains of western Texas and Oklahoma.

Type Location: McLennan County, Texas.

Series Established: McLennan County, Texas, 3-12-45.

Rev. HO-EHT 3-2-48
Mimeo. 1957

National Cooperative Soil Survey
USA

Preliminary: Subject to Revision

HUNTINGTON SERIES

Huntington soils occur on well-drained first bottoms in the region of Gray-Brown Podzolic soils and the northern part of the region of Red and Yellow soils. They are developed from materials collected largely from limestone residuum, together with a minor constituent of materials from sandstones, shales, and locally igneous rocks. With Lindside, Melvin, and Dunning soils, they form a catena of first bottom soils. They range from slightly acid to mildly alkaline.

Soil Profile: Huntington silt loam

> Dark-brown or brown silt loam; mellow and friable; 8 to 12 inches thick.
>
> Brown or light-brown, locally slightly reddish-brown, silt loam or silty clay loam, 20 to 30 inches thick.
>
> Brown silt loam or laminated layers of silt loam and very fine sandy loam, usually mottled with rust brown.

Variations: Along the Cumberland and Tennessee Rivers, a dark grayish-brown silty clay loam occurs locally about 10 or 12 inches below the surface. This material evidently represents the original surface soil before accelerated erosion took place on the sloping areas. Texture varies from very fine sandy loam to silty clay loam. Other variations due to the composition of the soil materials; materials from Maury soils of the uplands are relatively high in phosphorus.

Topography: Nearly level or slightly undulating areas in first bottoms.

Drainage: Surface drainage normally good, but subject to flooding in variable degrees. Internal drainage good.

Natural Vegetation: Deciduous forest, with sycamore, sweetgum, tulip, poplar are prominent; thick canebrakes in the South.

Use: Limited by susceptibility to flooding. Used chiefly for corn; yields 50 to 80 bushels per acre without fertilizer. Excellent pasture and hay land; alfalfa in the broad bottom lands of southern Indiana.

Distribution: Pennsylvania, Maryland, Virginia, West Virginia, southeastern Ohio, Kentucky, southern Indiana, northern Georgia, northern Alabama, and Tennessee.

Type Location: Franklin County, Pennsylvania.

Series Established: Wheeling Area, West Virginia, 1906.

WEH-MB
5-23-40

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LAWRENCE SERIES

The Lawrence series includes Planosols in the region of Gray-Brown Podzolic soils and the northern part of the region of Red-Yellow Podzolic soils, developed on limestone. Lawrence soils are the imperfectly drained member of the soil catena that also includes the well drained Hagerstown, moderately well drained Bedford, poorly drained Guthrie, and the very poorly drained dark-colored Burgin soils. Lawrence soils are also the imperfectly drained member of the Frederick catena. Lawrence soils differ from Bedford soils in that they lack the uniform yellow color in the upper B horizon, the surface soil grading at a depth of about 9 inches to mottled material. The A and B horizons are less gray than corresponding horizons of the Guthrie soils.

Soil Profile: Lawrence silt loam

A_0		Accumulated layer of forest litter from deciduous trees. 1/2 to 2 inches thick.
A_1	0-2"	Dark gray (10YR 4/1 moist) friable silt loam; organic content medium to high; fine crumb structure; medium acid. 1 to 3 inches thick.
A_2	2-9"	Light yellowish-brown (10YR 6/4 to 2.5Y 6/4 moist) friable silt loam with thin platy structure; contains considerable small rounded dark brown to black iron and manganese concretions; medium to strongly acid. 6 to 9 inches thick.
B_1	9-16"	Mottled yellowish-brown (10YR 5/6 moist) and light gray (10YR 7/2 moist) heavy silt loam; fine subangular blocky structure; contains some small rounded iron and manganese concretions; strongly acid. 5 to 9 inches thick.
B_{21}	16-27"	Mottled light gray (10YR 7/2 moist) pale yellow (2.5Y 7/2 moist), and yellowish-brown (10YR 5/6 moist) silty clay loam; medium subangular blocky structure; strongly to very strongly acid. 8 to 18 inches thick.
B_{22}	27-40"	Mottled light gray and pale yellow heavy silty clay loam to silty clay; well developed coarse to very coarse prismatic structure; aggregate faces have thin coating of light gray silty material; strongly to very strongly acid. 10 to 20 inches thick.
B_{23}	40-96"	Mottled light gray and pale yellow, with a gradual change to reddish brown below depths of 50 to 60 inches; usually somewhat more friable than above horizon; very coarse to coarse blocky structure; lower part variable, depending upon character of underlying limestone; strongly to very strongly acid in upper part; grades downward to slightly acid or neutral in lower few inches. 30 to 80 inches thick.
D_r	96"+	Bedrock of limestone.

Range in Characteristics: Variations are chiefly in depth to mottling, depth to bedrock, and in the character of the residuum, which in turn depends upon the composition of the hard rock. Lawrence soils associated with Frederick and Dickson soils often have somewhat cherty lower subsoils.

In Indiana, and commonly in Kentucky and Tennessee, the upper part of the solum is developed in shallow loess (1 to 3 feet thick).

Topography: Nearly level to very gently undulating areas on upland plains and divides.

Drainage: Imperfectly drained. Surface runoff is low; internal drainage is slow. The upper solum is saturated during periods of abundant rainfall and becomes very dry during droughty periods.

Vegetation: Deciduous forest, consisting principally of beech, sweet gum, black gum, soft maple, ash, and oaks.

Use: Cleared areas are used chiefly for general farming, including small grains, corn, soybeans, and hay.

Distribution: Southern Indiana, southern Ohio, Kentucky, Tennessee, Missouri, Alabama, Georgia, and probably Virginia.

Type Location: Lawrence County, Indiana.

Series Established: Lawrence County, Indiana, 1922.

Source of Name: Named for Lawrence County, Indiana.

Remarks: Colors according to March, 1948, Soil Survey color names.

MB 6/22/40
OCR EDF Rev. 3/12/50
OCR 5/52

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ARA - U. S. Department of Agriculture

Established Series

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

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Established Series

LINCOLN SERIES

The Lincoln series comprises pale-brown to light yellowish-brown and brown calcareous Alluvial Soils, mainly of the Reddish Chestnut and Reddish Prairie soil zones that have very sandy subsoils. These soils are subject to recurrent flooding and deposition of fresh material and consist of little altered sandy alluvium, generally from the extensive Tertiary deposits of western Oklahoma, Kansas, and Texas. The Lincoln soils have sandier subsoils and somewhat less dark surface soils than the Sweetwater soils, less reddish than the Yahola, more alkaline than the Coleta and Pulaski, and without the subsoil mottling characteristic of the Las Animas soil.

Soil Profile: Lincoln loamy fine sand		Range in Thickness
0-15"	Pale-brown (10YR 6/3; 5/3, moist) loamy fine sand; single grain to very weakly granular; nearly loose; calcareous.	10-20"
15-50"+	Light yellowish-brown (10YR 6/4; 5/4, moist) loamy fine sand; calcareous; commonly stratified with sand below 30 inches.	

Range in Characteristics: Types ranging from fine sand to fine sandy loam are dominant but minor areas of clay loam and clay (which have grayish-brown surface soils) occur; surface soil ranges from pale brown to light yellowish-brown, pale yellow, and light brownish-gray; subsoil is loamy fine sand or coarser below 15 inches; a few areas contain thin seams of fine gravel; saline phases occur.

Topography: Level to undulating flood plains.

Drainage: Slow from the surface; very rapid internally; the ground water table commonly lies at a depth ranging between 4 and 20 feet.

Vegetation: Tall grasses (mainly bluestems, Indian, and dropseeds); alkali sacaton and salt grass occur on saline phases; a few cottonwood trees are commonly present.

Use: The sands and loamy sands are of low fertility, susceptible to soil blowing, and mainly in native pasture or meadow; the less inextensive heavier types are somewhat more fertile but droughty.

Distribution: Western parts of Oklahoma, Texas, and Kansas, mainly in flood plains of streams that rise in or west of the High Plains; moderately extensive.

Type Location: Woodward County, Oklahoma.

Series Established: Russel County (Russel Area), Kansas, 1903.

Remarks: In the past some soils with loamy subsoils of good moisture holding capacity that would now be classed as Arkansas have been included in the Lincoln series. Color names used are provisional Soil Survey color names (1946) and refer to dry soil.

Rev. JT
6-5-46
Rev. EHT
10-4-46

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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

LONOKE SERIES

The Lonoke series is comprised of Alluvial soils of the Red-Yellow Podzolic zone. The series occurs in flood plains of rivers which have brought in sediments from the plains to the west. The Lonoke soils are well drained and differ in this respect from the poorly drained, gray Perry soils and the very dark, somewhat poorly drained Brewer soils. They are darker and less sandy than the Pulaski series, darker and less alkaline than the Yahola series, not as fine textured as the associated reddish calcareous Miller series, and better drained and coarser textured than the Portland series. The Lonoke series is of limited distribution and extent but is locally important to agriculture.

Soil Profile: Lonoke very fine sandy loam

0-12" Dark-brown (7.5YR 3/2) very friable very fine sandy loam; weak medium granular structure; slightly acid. 6 to 15 inches thick.

12-30" Dark-brown to brown (7.5YR 3/2-4/2) friable silt loam with weak medium granular structure; slightly acid. 12 to 20 inches thick.

30-40" Brown (7.5YR 4/3) friable silty clay loam with weak coarse blocky structure; slightly acid. 10 to 20 inches thick.

40-50" Reddish-brown (5YR 4/4) to brown (10YR 4/4) stratified silty clay, silty clay loam, and fine sandy loam; slightly acid. Several feet thick.

Range in Characteristics: Types in the series are silt loam, very fine sandy loam, and sandy loam with the sandier soils generally being lighter in color than the silt loam. The soil commonly ranges from slightly acid to mildly alkaline in reaction but may be medium acid in the upper layers. Texture of layers 2 and 3 commonly range from very fine sandy loam to silty clay loam; whereas, the underlying sediments are commonly stratified and include the entire texture range. Some faint gray mottling may occur in the lower part of the second layer.

Topography: Level to very gently undulating with slopes generally less than 1%.

Drainage: Well drained with low runoff and moderate internal drainage. A majority of the areas lie above normal overflow.

Vegetation: Largely deciduous trees such as white oak, pecan, hickory, and overcup oak with some vines and bamboo canes.

Use: Practically all areas are cleared, and most of them are in cultivation with corn, cotton, alfalfa, small grains, and legumes as the chief crops. Occasional areas are used for pasture.

Distribution: Along larger rivers in Arkansas, and eastern Oklahoma.

Type Location: Lonoke County, Arkansas.

Series Established: Lonoke County, Arkansas, 1907.
Soil color names adopted by 1948 Committee; color of soil moist unless otherwise stated; symbols express Munsell notations.

Rev. ML:RWS:IIM 2-15-49
Mimeo. 1957

National Cooperative Soil Survey
USA

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; strong 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.

Page 2--Mason Series

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

Established Series

MC LAIN 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. EGF:WTC
5-23-38
Rev. EHT:HO
9-5-46

Division of Soil Survey
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Agricultural Research Administration
U. S. Department of Agriculture

Established Series

MILLER SERIES

The Miller series consists of reddish calcareous Alluvial soils with clay subsoils. They occur mainly within the Reddish Prairie and Red-Yellow Podzolic regions and are concentrated in the floodplains of rivers that drain areas in Texas and Oklahoma underlain by red beds. The associated poorly drained soil having a somewhat mottled subsoil is the Roebuck series. Other commonly associated soils are the Yahola series with sandy subsoil and the Norwood series with silty or loamy subsoil. Miller soils resemble the Treadway series in color, texture and reaction but are of more weathered alluvium. They are higher in organic matter, have more developed structure, are more porous and permeable and are higher in fertility than soils of the Treadway series which is of relatively unaltered alluvium from raw outcrops of red beds.

Soil Profile: Miller clay

A_1	0-15"	Reddish brown (5YR 4/3) clay; dark reddish brown (5YR 3/3) moist; moderate to strong fine blocky and granular structure; crumbly and friable when moist; very sticky and plastic when wet; on drying the soil naturally separates to a mass of fine extremely hard aggregates; calcareous; gradual wavy boundary.
AC	15-40"	Reddish-brown (5YR 4/4) clay; dark reddish-brown (5YR 3/4) moist; moderate fine blocky structure; firm; very sticky and plastic when wet; few fine pores; strongly calcareous; gradual smooth boundary.
C	40-80"+	Red (2.5YR 4/6) clay; dark red (2.5YR 3/6) moist; massive; very firm and very plastic; apparently very slowly permeable; calcareous.

Range in Characteristics: Clay is the dominant type but there is also a large total area of other types including fine sandy loam, silt loam and clay loam. Color of the surface soil ranges from weak red to brown, the finer textures are the darkest. All horizons are dominantly calcareous, although in some areas they are noncalcareous but are alkaline. Locally some stratification with fine sandy loam or clay loam occurs in the C horizon.

Topography: Nearly level flood plains; weak gilgai microrelief in most undisturbed areas.

Drainage and Permeability: Very slow from the surface and internally but usually adequate for field crops except in local weakly depressed areas that need surface drainage for best yields. Deep cracks form when the soil is extremely dry and aid in internal drainage and water penetration. Rarely to frequently flooded.

Vegetation: Forested with elm, ash, hackberry, oak, pecan and other hardwoods in the Humid region; mainly mesquite, elm and buffalo grass in subhumid areas.

Use: Largely cultivated except in some narrow frequently flooded areas, cotton, corn, grain sorghums, sorgo, alfalfa and oats are the principal crops. High yields are obtained except during extremely wet or extremely dry years.

Distribution: Texas, Oklahoma, Arkansas, and Louisiana. Very extensive in flood plains of the Brazos, Red, and Colorado Rivers.

Type Location: Three miles east of Allenfarm, Brazos County, Texas.

Series Established: Miller County, Arkansas, 1903.

Rev. HO-EHT
5-15-57
Mimeo. 1957

National Cooperative Soil Survey
USA

Established Series

MUSKOGEE SERIES

The soils of the Muskogee series are moderately well-drained Planosolic soils occurring on stream terraces in the Red-Yellow Podzolic region. These soils are confined to the borders of streams that carry or have carried sediments derived in part from the Red Beds of the Western Plains. The Muskogee soils are better drained and have more yellowish subsoils than the Wrightsville soils, and lack the mottled upper subsoils of the Almont* soils. They are frequently associated with the Hortman soils, which have red clay subsoils and the Stidham soils, which have yellow friable sandy clay loam subsoils. The Muskogee soils occur in relatively broad areas and are important to agriculture.

Soil Profile: Muskogee silt loam

A	0-10"	Brown [1]/ (10YR 5/3) pale brown (10YR 6/3, dry) silt loam; very friable; essentially structureless; slightly acid; 6 to 14 inches thick.
B_1	10-24"	Yellowish-brown (10YR 5/6) light yellowish-brown (10YR 6/4, dry) silty clay loam; weak medium to coarse blocky structure; very plastic when wet, hard when dry; faintly mottled with splotches of pale yellow in the lower part; strongly acid; 8 to 20 inches thick.
B_2	24-36"	Strong brown (7.5YR 5/6) light brown (7.5YR 6/4, dry) clay; conspicuously mottled with light gray (2.5Y 7/2) massive; very plastic when wet, firm when moist, very hard when dry; digs out into large irregular lumps; very strongly acid; 6 to 20 inches thick.
C_1	36-60"	Light gray (10YR 7/1) mottled light yellowish-brown (10YR 6/4, dry) clay; massive; very plastic when wet, firm when moist, very hard when dry; strongly acid; 15 to 40 inches thick.
C_2	60-70"+	Red (2.5YR 4/6) clay; weak medium to coarse blocky structure; slightly acid to alkaline; usually several feet thick.

Range in Characteristics: In some areas a light-colored A_2 horizon may be present. The color of layer 1 ranges from pale yellow to brown; reaction from slightly acid to neutral. Layer 2 ranges from yellowish-brown to browish-yellow and from medium to very strongly acid. Layer 3 ranges from strong brown to red with mottlings of various shades of red, brown, yellow, and gray. Layer 4 ranges from strongly acid to neutral, and layer 5 from slightly acid to calcareous. The principal type is silt loam, but very fine sandy loam and loam types occur. The texture of layer 2 ranges from silty clay loam to light clay, and layer 5 from clay to loamy sand or stratified alluvium.

Topography: Nearly level to undulating stream terraces with gradients ranging from 2 to 10 per cent, with the majority of the areas ranging between 2 and 5 per cent.

Drainage: Moderately well drained with low to high surface runoff and medium to slow internal drainage.

Vegetation: Predominantly black oak, hickory, and elm.

Page 2--Muskogee Series

Use: Mainly forest but considerable areas are cleared and cultivated. Corn and cotton are the principal crops. Production, low to moderate.

Distribution: Arkansas, Louisiana, Oklahoma, and Texas.

Type Location: Pope County, Arkansas, 4 miles due north of Bank Hill, Arkansas.

Series Established: Muskogee County, Oklahoma, 1913.

*Tentative

1/ Soil color names adopted by 1948 Committee, color of soil moist unless otherwise stated; symbols express Munsell notations.

Rev. ILM 10-22-48
Mimeo 1957

National Cooperative Soil Survey
USA

Established Series

NEWTONIA SERIES

The Newtonia series includes Reddish Prairie soils developed in clayey materials weathered from limestone and cherty limestone, intercallated with reddish shales. They are redder than the Labette soils and differ from Crawford soils in having granular less clayey subsoils.

Soil Profile:		Newtonia silt loam	Range in Thickness
A_1-1	0-5"	Reddish-brown (5YR 5/4 dry or moist) weakly granular, friable silt loam; slightly to medium acid.	5-8"
A_1-2	5-9"	Reddish-yellow (5YR 6/6 dry) to dark reddish-brown (5YR 3/3 moist) friable granular silt loam or light silty clay loam; slightly acid.	3-8"
B_1	9-18"	Reddish-brown (5YR 4/4 dry) to dark reddish-brown (5YR 3/4 moist) friable granular silty clay loam; slightly acid.	6-10"
B_2	18-36"	Red (2.5YR 5/6 dry to 2.5YR 3/6 moist) granular silty clay loam, containing a few fragments of limestone or chert below a depth of about two feet, slightly acid.	12-24"
	36"+	Intercallated limestone or cherty limestone and shales.	

Range in Characteristics: The depth of bedrock may vary somewhat more than indicated in the profile description. Bedrock may lie as deep as 8 feet below the surface and locally may be somewhat less than 20 inches and may be limestone, cherty limestone, or limestone intercallated with marl, clay, or shales. In the latter case, shallow phases are recognized. In many places the uppermost 2 horizons have been eroded away.

Topography: Undulating and gently rolling uplands.

Drainage: External, moderate to rapid; internal; moderate to rapid. These soils have a tendency to be droughty, especially the shallower members.

Vegetation: Dominantly tall prairie grasses; some broadleafed timber in places.

Use: For producing corn, small grains, clover, cotton, and apples.

Distribution: Western Missouri and eastern parts of Kansas and Oklahoma, and northwestern Arkansas.

Type Location: Lawrence County, Missouri

Series Established: Lawrence County, Missouri, 1923.

Page 2--Newtonia Series

Remarks: Newtonia soils occur in the warner parts of the Prairie soils zone as well as in the Reddish Prairie soils zone.

1/ Provisional Soil Survey color names, based on Munsell color charts.

FAH:MB
3-18-40
Rev. FAH
4-30-41
Rev. WIW:JT
5-30-46
Rev. WIW:JT
6-29-46

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Established Series

NORGE SERIES

The Norge series comprises freely drained Reddish Prairie Soils developed in calcareous or alkaline old alluvium in central Oklahoma and Texas. The catenal associates on calcareous alluvium are Lewisville, Payne, and Irving. The reddish subsoils of Norge contain more clay and are less friable than those of the Polo, Teller, Bastrop, and Vanoss series. The surface soil is darker than in the Travis Dougherty, and Milam soils which are associated Red Podzolic Soils.

Soil Profile: Norge fine sandy loam

			Range in Thickness
A	0-12"	Reddish-brown (5YR 4/4; 3/4, moist) fine sandy loam; weakly granular; friable; about neutral; grades to horizon below.	8-14"
B_2	12-38"	Red (2.5YR 4/6; 3.5/6, moist) sandy clay; massive to very weakly blocky; firm, very hard when dry; medium acid; grades to horizon below.	20-30"
C_1	38-60"	Yellowish-red (5YR 5/8; same color, moist) sandy clay; massive; porous; friable; very hard when dry; about neutral.	15-30"
C	60-100"+	Reddish-yellow (5YR 6/8); friable sandy earths of more or less stratified sandy clay and sandy loam; weakly calcareous with a few small concretions of $CaCO_3$.	

Range in Characteristics: Types range from fine sandy loam to clay loam; color of the surface soil ranges from brown to reddish-brown, and of horizon 2, from yellowish-red to red encompassing values of 4 to 5, hues of 2.5YR to 7.5YR, and chromas of 6 to 8; reaction of horizon 1 ranges from medium to slightly acid, and of horizon 3, from slightly acid to weakly alkaline; a few waterworn pebbles of quartz or quartzite usually occur in all horizons.

Topography: Nearly level to gently sloping erosional upland comprising remnants of old alluvial plains on stream divides; surfaces convex with gradients of 1 to 7%, dominantly 1 to 4.

Drainage: Moderate to rapid from the surface; moderate internally.

Vegetation: Originally mainly coarse grasses, mainly little bluestem. The less sloping areas are largely farmed to cotton, corn, sorghums, oats, peanuts, and sudan grass; some used for vegetable crops and fruits; of only moderate fertility but very responsive to management; very susceptible to erosion under usual cultural practices.

Distribution: Reddish Prairie sections of Oklahoma and Texas; dissected remnants of high stream terraces or alluvial plains; inextensive.

Type Location: McLennan County, Texas; 2 miles south of Waco on U. S. Highway 81, one mile south of highway circle.

Series Established: Grady County, (Washita Watershed Survey) Oklahoma, 1942.

Page 2--Norge Series

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

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

EGF
5-8-40
Rev. WTC
2-27-41
Rev. HO:EHT
8-22-46

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Established Series

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 (2.5Y 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. Non-calcareous; 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.

Page 2--Okemah Series

Range in Characteristics: Silt loam is the strongly dominant type; color or 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, or 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

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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.

Page 2--Parsons Series

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.

Rev. FG-EHT
11-18-60

National Cooperative Soil Survey
USA

PHILO SERIES

The Philo series consists of moderately well drained Alluvial soils occurring in the Gray-Brown Podzolic and Red-Yellow Podzolic soil regions. Philo soils are formed in alluvium washed from soils derived mainly from sandstones, siltstones, and shales, and occur in flood plains. The parent alluvium may include minor components from loess, till, or other sources. Related soils, members of a drainage sequence from the same parent materials, are the Pope, Stendahl, Atkins, and Elkins series. Pope soils are well drained and are free of mottling to greater depths than Philo soils. Stendahl soils are somewhat poorly drained and show mottling and gray colors at shallow depths. Atkins and Elkins soils are poorly or very poorly drained. Less closely related soils are the Whitwell and Cotaco series, formed from similar parent materials, and the Eel, Lobdell, Lindside, Wilbur, and Adler series. The Whitwell and Cotaco soils have evident B horizons which distinguish them from Philo soils. The other five series are comparable in drainage but are less acid (less acid than pH 5.5) than Philo soils and are also formed from alluvium derived from source rocks other than sandstones, siltstones and shales. Similarly, Obelville and Collins soils are comparable to Philo soils in drainage but are formed in alluvial sediments from cherty limestones and loess, respectively. Philo soils are widely distributed, extensive, and important agriculturally.

Soil Profile: Philo silt loam--cultivated

A_p	0-7"	Dark grayish-brown (10YR 4/2) silt loam; weak fine granular structure; very friable; many roots; strongly acid; clear smooth boundary. 6 to 10 inches thick.
C_1	7-14"	Dark yellowish-brown (10YR 4/4) silt loam; weak medium granular structure; very friable; common roots; strongly acid; gradual smooth boundary. 5 to 12 inches thick.
C_2	14-25"	Yellowish-brown (10YR 5/4) silt loam; few medium distinct mottles of strong brown (7.5YR 5/6) and light brownish gray (10YR 6/2); weak medium granular structure; friable; common roots; strongly acid; clear smooth boundary. 10 to 14 inches thick.
C_g	25-48"+	Light brownish-gray (2.5Y 6/2) heavy silt loam; common medium distinct mottles of light olive brown (2.5Y 5/4) and pale olive (5Y 6/3); massive; friable; few roots; few to common small black and very dark brown concretions; strongly acid. 1 to several feet thick.

Range in Characteristics: Silt loam is believed to be the dominant type but, because of stratification, each horizon can range from sandy loam to silty clay loam. In places, mica flakes are common. Color of the A_p horizon generally ranges to brown (10YR 5/3-4/3) of dark yellowish-brown (10YR 3/4-4/4) in places, it may be very dark grayish-brown (10YR 3/2) or black (10YR 2/1) because of additions of finely divided coal dust.

Established Series

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

0-10"	Brown 1/ (10YR 5/3) fine sandy loam; very friable; strongly acid. 8 to 12 inches thick.
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.
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.

1/ Soil color names adopted by 1948 Committee, color of soil moist unless otherwise stated, symbols express Munsell notations.

Rev. ML:ILM:WSL
8-8-50

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Established Series

POTTSVILLE SERIES

The Pottsville series include Lithosols of the Red and Yellow Podzolic region. These soils consist of material derived from acid thin bedded shales and sandstones, and are associated with Enders, Conway, and Montevallo soils. The Enders and Conway series are both zonal soils developed from shale and have a much higher degree of horizon differentiation than that of the Pottsville soils. The Pottsville soils are derived from interbedded sandstones and shales, whereas the Montevallo soils are derived from thick beds of shales. Pottsville soils cover a large area but are low in value to agriculture.

Soil Profile:		Pottsville gravelly fine sandy loam	Range in Thickness
A_{00}, A_0	1-0"	Partially decomposed leaf litter.	
A_1	0-4"	Brown (10YR 5/3)1/) loose gravelly fine sandy loam.	
A_2	4-14"	Yellowish-brown (10YR 5/4) friable gravelly sandy loam, strongly acid.	4-16"
C	14"+	Partially weathered shale or sandstone, gradually grading into unweathered shale or sandstone.	

Range in Characteristics: The texture of the A_1 horizon ranges from stony sandy loam to silty clay loam with stone and sand particles inherited from former overlying sandstone strata. A faint B horizon may be present in some profiles, and where it does occur it ranges in texture from sandy clay loam to silty clay and in color from yellowish-brown to reddish-brown. The B horizon, where it does occur, is very thin. The C horizon is seldom thick, with total depth to bedrock commonly ranging from 8 to 20 inches. Reaction of the soil is from medium to strongly acid.

Topography: Undulating to steep (1 to 60 per cent). Common gradient 10 per cent.

Drainage: Surface drainage rapid to excessive. Internal drainage slow.

Vegetation: Blackjack oak, pine, hickory, post oak, prickly pear, cedar, huckleberry, hawthorne.

Use: Mainly in pasture and woodland; occasional areas are used for small grain, annual legumes, and cotton.

Distribution: Northern and western Arkansas, eastern Oklahoma, southern Missouri, eastern Tennessee, and northern Alabama.

Type Location: Pope County, Arkansas, near town of Pottsville.

Series Established: Pope County, Arkansas, 1938.

1/ Provisional soil color names by the 1946 Committee; color of soil moist unless otherwise stated.

Rev. ML-ILM
7-18-47

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Established Series

PULASKI SERIES

The Pulaski series consists of Alluvial soils on the flood plains of streams which carry considerable amounts of material from the Reddish Prairie soils in their sediments. Other material included in the sediments is predominantly from Red-Yellow Podzolic soils derived from sandstone and shale, limestone and dolomite, or Coastal Plain deposits. Acid clay soils associated with the Pulaski series are the poorly drained Perry series and the somewhat poorly to moderately well-drained Portland series. The Gallion soils closely resemble the Pulaski soils but have finer-textured horizons within the profile. The Lonoke soils occur in close association with the Pulaski series but are brown and dark brown instead of reddish in color. The Lonoke soils also have more evidence of a B horizon and some mottling in the lower part of the profile. The Lincoln soils associated with the Pulaski are alkaline or calcareous coarse or moderately coarse textured soils. The alkaline or calcareous, fine textured Miller soils and the alkaline, sandy Yahola soils are on the same flood plains as the Pulaski series, usually at lower elevations near the channel. The Pulaski soils are extensive, occur in large bodies, and are important to agriculture.

Soil Profile: Pulaski fine sandy loam--cultivated

A_p	0-8"	Reddish-brown (5YR 5/3) fine sandy loam; weak fine granular structure; very friable; medium acid; clear smooth boundary. 4 to 8 inches thick.
C_1	8-30"	Reddish-brown (2.5YR 4/4) sandy loam or light sandy clay loam; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary. 8 to 30 inches thick.
C_2	30-40"+	Reddish-brown (2.5YR 5/4) fine sandy loam; structureless; very friable; medium acid.

Range in Characteristics: Texture of the surface soil may be sandy loam, silt loam, clay loam, or loamy sand. Color of the surface soil may be grayish-brown, dark brown, or reddish-brown. Reaction is medium to slightly acid. The subsoil may be silt loam or light silty clay loam; medium acid to neutral; reddish-brown, red, or dusky red in color; with weak or moderate structure. Under intensive cultivation there is usually a massive or platy traffic pan below the A_p horizon, with an abrupt boundary. The C_1 may be absent and the C_2 may consist of thin alternating beds of medium-textured material. Colors given are for moist soil. Color of dry soil may be one or two values lighter.

Topography: Level to undulating, with slopes mostly less than 5 per cent.

Drainage and Permeability: Well drained with medium runoff and moderate permeability.

Vegetation: Presumably bottom land hardwoods.

Use: Practically the total acreage has been cleared. It is used for row crops, hay, and pasture. Row crops are cotton, soybeans, corn, and truck. Hay and pasture crops are alfalfa, annual lespedezas, and tame grasses. Crop yields are high under good management.

Distribution: Arkansas, Louisiana, and eastern Oklahoma.

Page 2--Pulaski Series

Type Location: Two miles south of Scott, Arkansas; along boundary highway between Lonoke and Pulaski Counties.

Series Established: Lonoke County, Arkansas, 1921.

Rev. ML
2-10-59

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USA

Established Series

PURDY SERIES

The Purdy series includes light-colored poorly drained Planosols of the Holston catena. They were formerly included on soil maps with the Tyler soils and are developed on old stratified clay and silt deposits on stream terraces in association with Holston, Monongahela and Tyler soils and adjacent to Muskingum and related soils of the sandstone and shale uplands of the central and southern parts of the Gray-Brown Podzolic soil region.

Soil Profile: Purdy silt loam

Forest litter consisting of partially decomposed roots, leaves and twigs and in places underlain by a very thin mat of raw humus; seldom more than 2 inches thick.

Dark brownish-gray silt loam containing considerable imperfectly decomposed organic matter; medium to strongly acid. Up to 3 inches thick with an average of about 2 inches.

Gray silt loam of weakly phylliform structure, mottled with yellow and rust brown. Strongly acid. Up to 5 inches thick with an average of about 4 inches.

Light gray porous silt loam mottled with rust brown and containing many small dark colored iron and manganese concretional phylliform structure. Very strongly acid reaction. The horizon has an average thickness of about 6 or 7 inches.

Mottled light-gray and brownish-yellow compact heavy silt loam breaking into angular fragments 1/4 to 1/2 inch in diameter. Average thickness about 8 or 9 inches. Very strongly acid.

Mottled light-gray and yellowish-brown compact silty clay loam, breaking into small angular clods 1/2 to 1 inch in diameter. Very strongly acid. Averages about 5 inches thick.

Mottled light gray and yellowish-brown silty clay loam breaking into angular clods 1 or 2 inches in diameter. Strongly acid reaction. This grades into stratified silty and clayey materials of silt stone, shale, and sandstone origin.

Range in Characteristics: Horizons 5 and 6 in many places are dominated by a bluish-gray color. The underlying strata vary from clays to very fine sands. Some of the soil contains small sandstone and shale fragments in lower part and very deep layers in some places contain a few lime concretions.

Topography: Nearly flat or somewhat depressed areas on stream terraces or old hanging valleys (Straths).

Drainage: Poor externally and internally because of flat or depressed surface and impervious subsoil. Soils dry out occasionally during the summer and early autumn.

Vegetation: Hardwoods; mainly oak, beech, hickory, and tulip poplar.

Use: Used for mowing (timothy, red top, and alsike) pasture, and to a limited extent for small grains and corn where drained. Many areas are more or less marshy and have little use.

Distribution: Southeastern Ohio and, as an inclusion with Tyler soils in Pennsylvania, West Virginia, Kentucky, and Tennessee.

Type Location: Scioto County, Ohio.

Series Established: Scioto County, Ohio, 1933.

James Thorp-MB 9-27-38
Mimeo 1957

National Cooperative Soil Survey
USA

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 non-calcareous 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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ROEBUCK SERIES

The Roebuck series comprises poorly-drained, reddish-brown, calcareous Alluvial Soils with mottled clay subsoils. It is largely confined to sloughs, or abandoned stream channels, within the Reddish Prairie and western or drier part of the Red and Yellow Podzolic soil zones. These soils consist of only slightly modified alluvium of rivers that drain prairie and sub-humid grasslands in central and western Oklahoma, Texas, and Kansas, that are underlain by red beds. The principal associated series are Miller, which is better drained and has red unmottled subsoils, and Yahola and Norwood, which have friable permeable subsoils. Roebuch soils are more youthful than Portland, have calcareous less darkened surface soils, and for the most part occur in areas of lower rainfall.

Soil Profile: Roebuck clay

0-10" Reddish-brown (5YR 4/3; 3/4, moist) clay; strong medium granular; crumbly and friable; calcareous. 6 to 15 inches thick.

10-26" Reddish-brown (5YR 5/4; 4/4, moist) clay faintly mottled with other shades of brown; massive; slowly permeable; very sticky and very plastic when wet; weakly stratified with layers of dark material in the lower part; calcareous. 10 to 20 inches thick.

26-45"+ Reddish-brown calcareous clay stratified with grayish-brown clay loam.

Range in Characteristics: The clay is the principal type; color of the surface soil ranges from brown to reddish-brown (hues of 7.5YR to 2.5YR); layer 2 is reddish-brown clay mottled with grayish-brown and brown or weakly stratified reddish-brown clay and grayish-brown clay loam and silt loam over reddish-brown calcareous clay; there are minor areas of Roebuck developed in alkaline but noncalcareous alluvium and in these the soil material is noncalcareous.

Topography: Depressed areas and partly filled abandoned channels in flood plains.

Drainage: Very slow from the surface and internally; inadequate for crop production; during wet seasons water stands on the surface for many weeks.

Vegetation: Forested with elm, hackberry, oak, willow, ash, and cottonwood.

Use: Largely in forest but some areas cleared and drained and used for producing corn, cotton, sorghums; naturally unsuited for cropland but highly productive if drained and protected from overflow.

Distribution: Depressed small areas in flood plains of such rivers as the Brazos, Red, and Canadian Rivers that carry sediments from the western plains; not extensive.

Type Location: Choctaw County, Oklahoma.

Series Established: Choctaw County, Oklahoma, 1940.

Page 2--Roebuck Series

Remarks: In earlier surveys these soils were included in the Portland and Miller series.

Color terms are approximate provisional Soil Survey colors and refer to dry soil.

Rev. HO:EHT 3-12-48
Mimeo 1957

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USA

SOGN SERIES

The Sogn series comprises the dark colored, calcareous to neutral loamy Lithosols very shallow over limestone within the prairies of the central United States north of the Arbuckle uplift in southern Oklahoma. Outcrops of limestone are common in bodies of Sogn soils. The series is darker and more humid than Penrose and Laporte series (light-colored semiarid Lithosols); slightly darker and higher in organic matter than Tarrant series (a more southern, warmer climate counterpart of Sogn series, difficulty distinguishable on profile); less clayey and shallower to limestone than Snead series (clayey regosolic Brunizems developed in humid prairie-forest transition over shale with subordinate interbedded limestone). The comparable series for regosolic Chernozems over highly calcareous friable marine marl or "shale" is Kipson. From Nebraska southward the deeper soils associated with Sogn series are mostly of the Labette, Summit, Newtonia, Florence, Dennis, Irwin, Okemah, and Tully series; to the north the Dodgeville and Ruckton series are the common associates. All of these associated deeper series have distinct B horizons, except the Rockton soils, formed in a shallow mantle of glacial drift over residuum from limestone.

Soil Profile: Sogn rocky clay loam--virgin

A_1	0-7"	Very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; strong medium and fine granular structure; friable; calcareous; abrupt irregular boundary. 2 to 15 inches thick.
D_r	7-60"	Somewhat weathered, level-bedded earthy limestone having clayey partings and interrupted by vertical weathering joints, which average about a foot apart. Extensions of the dark colored A horizon fill crevices in the bedrock to about 15 inches but comprise less than 5 per cent of the volume. A few grass roots penetrate crevices to depths below 6 feet.

Range in Characteristics: The dry color of the A horizon ranges from nearly black to grayish-brown (dry values of 2.5/ to 5/; moist values of 1.5/ to 3.5/; chromas mostly about /2 but locally approaching /1.) Its texture ranges from loam and silt loam to heavy clay loam or silty clay loam with or without limestone fragments. Its reaction ranges from strongly calcareous to noncalcareous but about neutral. The bedrock ranges from earthy or chalky marine limestone generally interbedded with calcareous "clay" or "shale" to dense massive limestone. The change from A horizon to bedrock ranges from gradual and smooth (mostly where the bedrock is more earthy or least consolidated) to quite abrupt and very irregular (mostly on the denser, more resistant limestones). Thickness of the A horizon may range from 2 to 15 inches in an area with a radius of 10 feet.

Topography: Undulating to hilly erosional upland. Mostly convex surfaces of 2 to 15 per cent gradient but ranging up to more than 35%. On the stronger slopes, Sogn soils are generally concentrated toward the crests, the lower halves of the slopes being mostly of deep soils in colluvium or marine "clays" that underlie the limestone.

Drainage and Permeability: Moderate to rapid from the surface; rapid internally. Well drained in the sense of no ground-water table ever within the soil. Moisture-storage capacity is limited by the small volume of soil per unit area. Root distribution and the survival of native vegetation through protracted drouths indicate considerable storage of available moisture in the bedrock.

Vegetation: Originally mostly treeless prairie with little bluestem and side-oats grama as the two dominant grasses. Considerable overstory of sumac, buck brush, or other deciduous woody shrubs in many areas, especially those on strong slopes or underlain by dense limestone. Savannah of scattered deciduous trees surmounting tall grass in most areas within generally forested localities. Some in the most humid localities originally supported an open-canopied, somewhat dwarfed, deciduous forest.

Use: Mostly native range or unimproved pasture. These soils are not tillable with ordinary implements and are generally classed as nonarable.

Distribution: Northeastern Oklahoma to southwestern Wisconsin. Extensive in Kansas and Oklahoma, where the total area is of the order of 1,000,000 acres. Scattered, mostly small areas in Wisconsin, Minnesota, Missouri, Illinois, and eastern Nebraska.

Series Established: Goodhue County, Minnesota, 1913. (Series name is from a hamlet in that county.)

Type Location: Geary County, Kansas; 75 feet east of the northwest corner Section 15, T12S, R7E.

Rev. EHT-AHP-JKA
2-23-60

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USA

Established Series

STEPHENVILLE SERIES

The Stephenville series comprises Red Podzolic Soils with subsoils of yellowish-red or red friable sandy clay loam or sandy clay. The series is developed on noncalcareous sandy formations, mainly of the Cretaceous and Permian, and is related to the Ruston and Hanceville series of more humid regions but is somewhat less acid and less strongly leached. The principal associated series are Windthorst, which has less sandy subsoils, and Nimrod, which has mottled yellow and gray stiff subsoils.

Soil Profile: Stephenville fine sandy loam		Range in Thickness
0-5"	Brown (7.5YR 4/2; dark-brown, 7.5YR 3/2, moist) fine sandy loam; weak fine granular; very friable; slightly acid; grades into horizon below.	3-6"
5-15"	Light-brown (7.5YR 6/3 brown, 7.5YR 4/3, moist) fine sandy loam; massive, porous; very friable; slightly acid; grades into horizon below.	8-12"
15-25"	Yellowish-red (5YR 4/6; 4/8, moist) sandy clay loam; weak medium blocky; friable; plastic when wet; very hard when dry; slightly acid; grades into horizon below.	8-15"
25-36"	Yellowish-red (5YR 5/6; 4/8, moist) light sandy clay loam somewhat more sandy than horizon above; massive to weak medium blocky; very friable; hard when dry; slightly acid; grades into material below.	10-14"
36-50"+	Yellowish-red (5YR 5/8) weakly indurated sandstone banded or laminated with shades of red and yellow; slightly acid.	

Range in Characteristics: The fine sandy loam is the principal type but some loams and loamy fine sands occur; color of horizon 1 ranges from very pale brown to grayish-brown; reaction ranges from medium acid to neutral; parent material, horizon 5 is friable sandy loam or soft sandstone interbedded with sandy loam; underlying parent material ranges from soft sandstone to sandy earths and is calcareous in places.

Topography: Undulating to gently rolling upland with gradients of 2 to 10 per cent, dominantly 2 to 5.

Drainage: Moderate to rapid from the surface; moderate internally.

Vegetation: Scrub forest of blackjack and post oak and coarse bunch grasses, mainly little bluestem.

Use: Probably one-half is cleared and cultivated or used for pasture; peanuts, cotton, sorghums, melons, and peaches are the principal cultivated crops; inherent fertility is moderate to low and soil is very susceptible to erosion. A large part of the cleared land is now in pasture of low carrying capacity.

Distribution: Western part of the Red and Yellow Podzolic soils zone in West Cross Timbers areas of North Texas and southern Oklahoma; moderately extensive.

Page 2--Stephenville Series

Remarks: Color terms are provisional Soil Survey color names based on Munsell Color Charts and unless stated otherwise refer to dry soil.

Type Location: Parker County, Texas; 5.2 miles SW of Weatherford on U. S. Highway 80.

Series Established: Eastland County, Texas, 1916.

EGF:MB
10-31-41
Rev. HO:EHT
6-11-46

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Established Series

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 grassland, 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. 2-5" 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. 10-15" 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. 4-12" 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. 15-30" 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 abbut one to four per cent.

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.

Page 2--Stidham Series

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.

3-18-39
WTC:MB
Revised: 3-5-48
HO:EHT

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Established Series

SUMMIT SERIES

The Summit series includes very dark granular soils developed from limestone residuum and soft calcareous shales in the Prairie and Reddish-Prairie soils zones. These soils may be considered to be Rendzinas. They differ from those of the Labette series in having darker surface layers and heavier subsoils which are very dark grayish-brown or almost black in the upper part whereas the corresponding part of the Labette soils is reddish-brown. They differ from Woodson soils in having deeper and more granular surface soils and no claypan.

Soil Profile: Summit silty clay		Range in Thickness
0-2"	Very dark olive-gray 1/ (5.0Y 3/1 dry) to black (5.0Y 2/1 moist) silty clay of fine-crumb structure; slightly acid to neutral.	2-3"
2-10"	Very dark olive-gray (5.0Y 3/1 dry) to black (5.0Y 2/1 moist) granular silty clay, slightly acid.	8-12"
10-16"	Dark grayish-brown (2.5Y 3/2 dry) to a dark-brown (10YR 3/2 moist), coarse granular cloddy silty clay; a few rust-brown pellets in places; slightly acid to neutral.	6-8"
16-22"	Dark grayish-brown (2.5Y 3/2 dry) to dark-brown (10YR 3/2 moist) silty clay or clay with a blocky structure; neutral or slightly alkaline.	4-8"
22-40"	Olive-gray (5.0Y 5/2 dry) to dark grayish-brown (2.5Y 4/2 moist) massive or blocky clay which rests on disintegrated limestone or calcareous shale.	8-20"

Range in Characteristics: Thickness of the dark surface layer and depth to bedrock are variable. A few lime-carbonate nodules may occur below 30 inches.

Topography: Undulating or rolling uplands. Some of these soils occupy colluvial slopes.

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

Vegetation: Prairie grasses, with bluestems dominate.

Use: These soils are very productive and are used for growing all important crops common to the region of their occurrences. Some areas remain in native pastures.

Distribution: Eastern Oklahoma, southeastern Kansas, and southwestern Missouri.

Type Location: Tulsa County, Oklahoma
Series Established: Bates County, Missouri, 1908
1/ Provisional Soil color names proposed by the 1946 committee; color of soil dry unless otherwise stated. Symbols express Munsell notations.

EGF:MB
2-8-40
Rev. FAH:EBE:WHM
7-3-40
Rev. WIW
6-25-46

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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 per cent 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 per cent.

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: Le Flore County, Oklahoma; NW 1/4 Section 22, T8N, R25E.

Series Established: Le Flore County, Oklahoma, 1931.

EGF
2-19-38
Rev. HO:EHT
5-6-48

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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 considerately 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 inch 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

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

Page 2--Teller Series

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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TYLER SERIES

The Tyler series includes imperfectly (somewhat poorly) drained acid soils of the Gray-Brown Podzolic region developed on 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, and 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 portion 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 and grading downward, at depths differing rather widely from place to place, to stratified or laminated silts and clays. Strongly acid.

Range in Characteristics: Chiefly in 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, and 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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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, Talika, 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.

Page 2--Vanoss Series

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 given 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.

Rev. EHT
7-31-57

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USA

WAYNESBORO SERIES

The Waynesboro series consists of well drained Red-Yellow Podzolic soils which intergrade to the Reddish-Brown Lateritic group. These soils occupy old high stream terraces consisting of alluvium washed mainly from acid sandstone, shale, and quartzite. Associated and closely related well-drained soils are the Nolichucky, Holston, and Allegheny series. Nolichucky soils have thicker and yellower A horizons and less red B horizons. Holston and Allegheny soils have B horizons of 7.5YR or 10YR hue rather than 5YR or 2.5YR hue. Other associated soils formed from similar parent materials are the Tyler, Purdy, and Blago series, all of which are more poorly drained and are grayer in color. Additional similar soils are the Allen, Anniston, Cumberland, and Etowah series. Allen soils occupy footslopes and fans and typically have less red B horizons. Anniston soils have darker and redder A horizons as well as redder upper B horizons, Cumberland soils, members of the Reddish-Brown Lateritic group have darker A horizons together with redder and darker B horizons of finer texture. Etowah soils are similar to Waynesboro soils in general morphology but are less sandy throughout the profile, have somewhat less red and less dark B horizons, and are formed in sediments washed mainly from limestones. The Waynesboro series is widely distributed and of considerable extent.

Soil Profile: Waynesboro loam

Ap	0-9"	Brown (10YR 4/3) loam; weak fine granular structure; very friable; many fine roots; strongly acid; clear smooth boundary. 5 to 12 inches thick.
B1	9-14"	Yellowish-red (5YR 4/6-5/6) light clay loam; weak fine and medium subangular blocky structure; friable; few clay films; many fine roots; very strongly acid; clear smooth boundary. 3 to 10 inches thick.
B21	14-23"	Yellowish-red (5YR 4/6) clay loam; moderate medium subangular blocky structure; friable, slightly sticky; common clay films; common fine roots; very strongly acid; gradual smooth boundary. 6 to 14 inches thick.
B22	23-37"	Dark-red (2.5YR 3/6-10YR 3/6) clay loam; moderate medium subangular blocky structure, friable; common to many clay films; few roots; very strongly acid; gradual wavy boundary. 8 to 28 inches thick.
B3	37-45"	Red (2.5YR 4/6) light clay loam with few medium distinct variegations of reddish-yellow (7.5YR 6/6) and yellowish-brown (10YR 5/6); moderate medium subangular blocky structure; friable; common clay films; very strongly acid; gradual wavy boundary. 6 to 20 inches thick.
C	45-70"	Yellowish-red (5YR 4/6) stratified clay loam, fine sandy loam, sandy clay loam, and gravel; common medium distinct variegations of strong brown (7.5YR 5/6) and yellowish-brown (10YR 5/6); very weak medium blocky structure; friable; few clay films on vertical faces of peds; very strongly acid.

Range in Characteristics: Thickness of solum ranges from about 32 to 60 inches, with the lower end of the range found in eroded sites. Thickness of alluvium in which the soil has been formed ranges upward from about three feet and this alluvium may be mantled by loess one foot or less thick. Chief types in the series are loam, fine sandy loam, and silt loam with clay loam occurring in severely eroded areas. Gravel and cobbles may be present in any or all horizons and may be common enough in the A horizon to warrant recognition of phases. The Ap horizon may be brown (10YR 5/3), dark yellowish-brown (10YR 4/4), or strong brown (7.5YR 5/6). If the soil is not plowed, it has an A2 horizon which is brown (10YR 5/3) or yellowish-brown (10YR 5/4) in color. Textures of the A and B horizons commonly parallel one another, with loams and clay loams, fine sandy loams and sandy clay loams, and silt loams and silty clay loams as the associated pairs. The entire B horizon may be yellowish-red in color. The B1 horizon may be sandy clay loam or silty clay loam. The B2 horizon may be silty clay loam or sandy clay loam rather than clay loam and reach light sandy clay in the deeper part. The B22 horizon ranges from dark red through red or yellowish-red in color. The B3 horizon has a similar range in color and texture. The C horizon may have a single color dominant or may have a pattern in which no one color dominates. Colors given above are for moist conditions. When soil is dry, values are one or two units higher.

Topography: Gently sloping to steep, with slopes of about 3 to 25 per cent.

Drainage and Permeability: Well drained with medium runoff and moderate permeability.

Vegetation: Hardwoods, including oaks, hickory, beech, elm, maple, yellow poplar, hornbeam, holly, and in places, loblolly, shortleaf and Virginia pines.

Use: Most areas have been cleared and are used for a wide variety of crops and pasture. Crops include corn, small grains, hay, and in places, tobacco, cotton, truck, and fruits.

Distribution: Arkansas, West Virginia, Tennessee, Kentucky, Virginia, Alabama, Georgia, Missouri, and Oklahoma.

Type Location: Polk County, Tennessee; 200 yards north of US Highway 64 at Cherokee Corners.

Series Established: Pope County, Arkansas, 1913.

Rev. JEW
9-1-62

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USA

Established Series

WINDTHORST SERIES

The Windthorst series includes Red Podzolic soils of the West Cross Timbers areas of Texas and Oklahoma. The soils have developed on sandy clays or interbedded weakly indurated sandstones and clays under open-canopies oak forest or prairie grasses with scattered trees and are confined to the western (less humid) part of the Red and Yellow Podzolic soils zone. The associated series are principally Stephenville, which has a reddish-brown friable subsoil; Nimrod which has a deeper, more sandy A horizon and mottled yellow and gray stiff sandy clay subsoil; May, which is darker, less reddish, and has friable sandy clay loam or light clay subsoil; and Renfrow, which is a Reddish Prairie soil developed on clay. The Windthorst series resembles the Boswell series of more humid areas but is less acid and somewhat darker colored.

Soil Profile: Windthorst fine sandy loam		Range in Thickness
0-4"	Grayish-brown (10YR 4/2; 3/2, moist)[1]/ fine sandy loam; weakly granular; very friable; slightly acid; grades to horizon below.	2-6"
4-10"	Light yellowish-brown (10YR 6/4; 5/4, moist) fine sandy loam; weakly granular; very friable; slightly acid; passes abruptly to horizon below.	6-10"
10-18"	Red (2.5YR 4/6; same color moist) heavy sandy clay; strong fine blocky; very firm; very sticky and stiff; slightly acid to neutral; grades into horizon below.	3-10"
18-38"	Mottled red and yellow (2.5YR 5/6 and 5Y 8/6) heavy sandy clay; strong coarse blocky; very firm; extremely hard; neutral to slightly acid.	15-30"
38"+	Parent material of very firm stratified sandy clay of various colors, mainly light gray and pale yellow with thin strata of weakly indurated reddish-yellow sandstone; neutral to slightly acid.	

Range in Characteristics: Fine sandy loam is the principal type but loam also occurs; the A horizon in cultivated fields is yellowish-brown or pale brown to a depth of 5 to 12 inches; color of the subsoil, horizon 3, ranges from red to reddish-brown with distinct or faint yellowish-red mottling; reaction of all horizons ranges from neutral to slightly acid; locally the parent material, below a depth of about 3 feet, is calcareous or contains thin seams of limestone. In places sandstone fragments are present on the surface and in the solum.

Topography: Gently to moderately sloping upland; mostly convex slopes, some plane; surface gradients of about 1 to 8 per cent, mostly 1 to 4.

Drainage: Free from the surface, slow internally; very susceptible to sheet erosion.

Vegetation: Open-canopies scrub forest largely of post oak and blackjack oak below which in places there is considerable grass. According to local residents much little bluestem grass originally was present and the forest was very open. Buffalo grama grasses are common in some pastures especially on the loams.

Page 2--Windthorst Series

Use: Exclusive of eroded, sloping phases these soils are largely in cultivation and devoted mainly to peanuts, peaches, sorghums, corn, and cotton; moderately productive; the loam is somewhat droughty. In places considerable areas formerly cultivated have retired; due to lowered productivity induced by exhaustive cropping and erosion. Areas lie in western part of humid region where irregular moisture conditions discourage use of commercial fertilizers. The soil is moderately productive for pasture.

Distribution: West Cross Timbers of Texas and Oklahoma.

Series Established: Archer County, Texas, 1912.

Type Location: Erath County, Texas.

Remarks: The areas mapped as Windthorst in the survey of Archer County, Texas, where the series was established, are mostly complexes of several soils and include little of the Windthorst as now recognized. The Lithosols formerly included in the Windthorst series as stony types are now classed as Darnell.

1/ Provisional soil color names proposed by the 1946 committee; color of soil dry unless otherwise stated. Symbols express Munsell notations.

7-7-38
WTC
Rev. EHT-HO
6-20-46

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Bureau of Plant Industry, Soils,
and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture

Established Series

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.

Page 2--Woodson Series

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

Established Series

WRIGHTSVILLE SERIES

The Wrightsville series consists of poorly drained Planosols developed in old clayey alluvium generally overlain by a silty mantle. The soils are marked by clay pans and characteristically have light colors of low chroma except in the A_1 or A_p horizon. These soils occupy terraces in association with the Acadia, Gore, Hortman, McKamie, and Muskogee series. The Acadia soils are less poorly drained and less gray in color throughout the profile. Gore soils are also less poorly drained, are less gray, and have prominent red mottles in reticulate patterns or as patches in the B horizon. The Hortman soils have thin reddish upper B horizons, whereas the McKamie soils are reddish colored throughout the profile. Muskogee soils are less poorly drained and browner in color or have higher chromas and also have a thicker silty upper part of the profile. Wrightsville soils are of moderate distribution and extent.

Soil Profile: Wrightsville silt loam--forested

A_{oo} & A_o	2-0"	Litter and very dark gray leaf mold that is very soft and very friable; many roots; abrupt smooth boundary. 1 to 4 inches thick.
A_1	0-2"	Dark grayish-brown (10YR 4/2) silt loam; weak fine granular structure; very friable; numerous roots; very porous; strongly acid; clear wavy boundary. 1 to 5 inches thick.
A_2	2-12"	Light gray (2.5Y 7/2) silt loam with few distinct fine and medium mottles of yellowish-brown (10YR 5/6); weak medium platy blocky structure; very friable; common roots; few medium concretions; strongly acid; clear wavy boundary. 4 to 15 inches thick.
B_{2g}	12-35"	Gray (10YR 6/1) silty clay with common coarse and medium mottles of yellowish-brown (10YR 5/4) as patches and in reticulate patterns; moderate medium prismatic structure parting readily to moderate medium subangular blocks; very hard, very firm; very plastic; clay films nearly continuous; few medium concretions; few roots; common tubular pores; common verticle channel or crack fills of gray silt loam; strongly acid; gradual wavy boundary. 20 to 30 inches thick.
C_g	35-50"+	Grayish-brown (10YR 5/2) clay with common medium and coarse mottles of yellowish-brown and reddish-brown moderate medium and coarse angular blocky structure; very hard, very firm, very sticky, very plastic; strongly acid.

Range in Characteristics: Silt loam is dominant, with silty clay as a minor type. The A_o horizon generally occurs as patches and may be lacking. The A_1 horizon may be very dark gray or dark grayish-brown in color, of weak fine blocky structure, and slightly through strong acid in reaction. The A_2 horizon may be light gray through grayish-brown in color, have few or common and fine through coarse mottles, weak fine blocky structure, and an abrupt or irregular boundary. Concretions may be few or common and either fine or medium in size. Where the soil has been cultivated, it has

a grayish-brown, dark gray, or dark grayish-brown A_p horizon. The B_{2g} horizon may be silty clay or clay in texture, strongly or very strongly acid in reaction, lack prismatic structure, have common or many medium or coarse mottles ranging through strong brown, reddish-brown, red, and yellowish-red, and a diffuse boundary. The C_g horizon ranges in texture from clay through silty clay loam and colors have the same range and distribution as in the B_{2g} horizon. Reaction of the C_g horizon ranges from strongly acid through mildly alkaline, with carbonate concretions present in some places. This horizon may be replaced by stratified sands and clays or these may occur beneath the C_g horizon. Colors given are for moist conditions. When soil is dry, colors are one or two units higher in value.

Topography: Level, with slopes less than 1 per cent. Dome shaped mounds up to 50 inches high and 100 feet in diameter are common in places. Some micro-relief is common.

Drainage and Permeability: Poorly drained; permeability very slow; runoff very slow or ponded.

Vegetation: Loblolly and shortleaf pine, willow oak, postoak, hawthorne, sweetgum, blackgum, and hickory.

Use: Principally forest. Some is used for pasture and some for rice. Occasionally used for row crops where water management is feasible.

Distribution: Terraces of Red and Arkansas Rivers in Oklahoma, Arkansas, Louisiana, and possibly east Texas.

Type Location: Pope County, Arkansas; 2 miles east of Atkins, 500 feet south of Missouri-Pacific Railroad and US Highway 64.

Series Established: Pulaski County, Arkansas, 1922.

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National Cooperative Soil Survey
USA

Established Series

YAHOLA SERIES

The Yahola series comprises somewhat reddish calcareous Alluvial soils with moderately sandy subsoils that occur in the Reddish Prairie, Reddish Chestnut and western part of the Red and Yellow Podzolic soils zones. These soils are extensive in the flood plains of such streams as the Red, Canadian, Brazos, and Colorado Rivers which drain prairies and subhumid plains in western and central Oklahoma and Texas that are underlain by red beds. The Yahola soils have sandier subsoils than Miller, Portland, and Norwood. They are redder than Lincoln and more alkaline than Pulaski and occur under more humid climate than Rositas and Largo. Yahola soils occupy situations subject to recurrent flooding and the addition of fresh soil materials to the surface and lack the weakly developed color and reaction profile that is characteristic of the Reinach series.

Soil Profile: Yahola very fine sandy loam

0-18" Light reddish-brown (5YR 6/4; reddish-brown, 5YR 4/4, moist) very fine sandy loam; weakly granular to massive; freely permeable, very friable; calcareous. 6-30" thick.

18-60"+ Light reddish-brown calcareous very fine sandy loam stratified with subsidiary silt, sand, or clay.

Range in Characteristics: Sandy loams are the principal types but at least minor areas of almost every possible texture occur; color of surface soil ranges from light brown and light reddish-brown to reddish-brown, the latter principally in types heavier than sandy loams; degree of stratification of substrata varies widely; locally the soils are noncalcareous but alkaline.

Topography: Level to gently undulating flood plains.

Drainage: Mostly internal which ranges from moderate to rapid; depth to water table is commonly 10 to 30 feet but locally less than 5; all areas save those protected by levees are periodically flooded at average intervals generally ranging from 2 to 10 years.

Vegetation: Flood-plain forest, mainly of cottonwood, ash, oak, elm, and pecan in the most eastern areas; largely tall grasses and scattered cottonwood; mesquite and hackberry trees in the more western.

Use: Largely in cultivation and devoted to general field crops, mainly cotton, corn, small grains, sorghums, and alfalfa; moderately to highly fertile and productive.

Distribution: Oklahoma, Texas, Arkansas, and Louisiana; widely distributed in flood plains of the Red, Canadian, Washita, Brazos, Colorado, and other similar streams.

Type Location: Muskogee County, Oklahoma.

Series Established: Muskogee County, Oklahoma, 1913.

Remarks: Most areas of soils indicated in published soil surveys as clay loam and clay types of the Yahola series and some areas indicated as silt loam and very fine sandy loam would now be correlated as Norwood.

Colors are described with Provisional Soil Survey Color Names (1947) and unless stated otherwise refer to dry soil.

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National Cooperative Soil Survey
USA

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
ATKINS																		
Haskell																		
A	11	A-4(8)	99	98	97	94	38	8	-	-	-	-	-	No	11		X	
C	17	A-7-6(13)	99	97	96	94	43	21	30	14	1.85	31	-	No	14			X
Pittsburg																		
A	8	A-4(8)	100	99	97	87	29	5	29	19	1.68	16	-	No	11		X	
AC	13	A-6(10)	100	99	97	87	33	16	23	12	1.94	22	-	No	12		X	
C	13	A-6(10)	100	99	95	76	33	16	27	11	1.98	32	-	No	12		X	
Sequoyah																		
A	7	A-4(8)	100	99	98	86	27	3	-	-	-	-	-	No	11		X	
AC	9	A-4(8)	100	99	99	96	30	7	-	-	-	-	-	No	11		X	
C	10	A-4(8)	100	99	99	95	28	10	-	-	-	-	-	No	11		X	
BATES																		
Haskell																		
A	7	A-4(8)	100	99	98	96	28	3	-	-	-	-	-	No	11		X	
B	7	A-4(8)	100	99	99	85	27	5	26	-	-	-	-	No	11		X	
C	8	A-4(8)	99	98	97	87	28	5	-	-	-	-	-	No	11		X	
McIntosh																		
A	6	A-4(8)	100	98	95	77	24	2	-	-	-	-	-	No	11	X		
B	8	A-4(8)	98	96	93	82	28	6	-	-	-	-	-	No	11		X	
C	12	A-6(9)	96	92	90	81	35	12	-	-	-	-	-	No	12		X	
Muskogee																		
A	0	A-4(8)	99	95	93	83	NP	NP	-	-	-	-	-	No	11	X		
B	10	A-4(8)	100	100	99	93	35	8	-	-	-	-	-	No	11		X	
C	13	A-6(9)	96	92	91	83	37	13	-	-	-	-	-	No	12		X	
Okmulgee																		
A	Not	Sampled																
B	6	A-4(8)	99	98	97	79	24	4	-	-	-	-	-	No	11	X		
C	6	A-4(8)	98	97	95	81	26	2	-	-	-	-	-	No	11	X		
Pittsburg																		
A	2	A-4(2)	99	97	86	46	20	2	-	-	-	-	-	5.5	9	X		
B	2	A-4(3)	99	97	86	48	17	1	-	-	-	-	-	6.0	10	X		
C	2	A-4(3)	99	97	87	50	18	2	-	-	-	-	-	6.0	10	X		
Sequoyah																		
A	0	A-4(8)	98	95	94	80	NP	NP	-	-	-	-	-	No	11	X		
B	8	A-4(8)	98	95	94	79	29	4	-	-	-	-	-	No	11		X	
C	0	A-4(4)	97	96	94	56	NP	NP	-	-	-	-	-	6.5	10	X		
Wagoner																		
A	6	A-4(7)	100	99	98	68	26	3	-	-	-	-	-	No	11	X		
B	9	A-4(8)	100	99	98	74	29	9	-	-	-	-	-	No	11		X	
C	9	A-4(7)	100	99	97	72	30	10	-	-	-	-	-	No	11		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
BATES (Shallow Phase)																		
Wagoner																		
A	1	A-4(1)	100	99	98	41	21	1	-	-	-	-	-	5.5	9	X		
C	0	A-2-3(0)	100	99	97	35	NP	NP	-	-	-	-	-	5.0	9	X		
BAXTER																		
Adair																		
A	5	A-4(8)	86	82	79	74	24	2	-	21	1.65	6	-	No	11	X		
B	10	A-4(8)	90	86	86	81	29	9	-	18	1.79	20	-	No	11		X	
C	9	A-4(7)	76	73	73	69	33	9	-	20	1.76	26	-	No	11		X	
BODINE																		
Adair																		
A	0	A-4(5)	71	70	65	62	NP	NP	-	-	-	-	-	No	10	X		
B	2	A-4(2)	54	50	49	47	21	3	-	-	-	-	-	No	9	X		
Cherokee																		
A	0	A-4(8)	79	77	76	73	NP	NP	-	-	-	-	-	No	11	X		
B	6	A-6(2)	42	40	40	38	36	13	34	16	1.80	33	-	No	10	X		
Sequoyah																		
A	0	A-1-6(0)	28	25	25	25	NP	NP	-	-	-	-	-	No	-	X		
BC	0	A-4(1)	47	42	41	40	NP	NP	-	-	-	-	-	No	-	X		
C	1	A-2-4(0)	36	33	33	31	24	1	-	-	-	-	-	No	-	X		
BREWER																		
McIntosh																		
A	8	A-4(8)	100	99	99	96	28	5	-	-	-	-	-	No	11		X	
B	23	A-7-6(19)	100	100	99	97	55	31	39	14	2.00	50	0.63	No	17			X
C	24	A-7-6(19)	100	100	99	98	56	32	41	12	2.00	57	0.70	No	17			X
Muskogee																		
A	7	A-4(8)	100	99	97	91	28	4	-	-	-	-	-	No	11		X	
B	20	A-7-6(16)	100	100	99	96	51	25	44	12	1.99	64	0.36	No	15			X
C	15	A-6(11)	99	96	95	90	39	18	36	14	1.90	41	-	No	12		X	
CANADIAN																		
Haskell																		
A	0	A-4(6)	100	100	98	66	NP	NP	-	-	-	-	-	No	11	X		
C	0	A-4(8)	100	99	97	74	NP	NP	-	-	-	-	-	No	11	X		
Okmulgee																		
A	3	A-4(5)	100	100	99	59	20	1	-	-	-	-	-	6.5	10	X		
C	0	A-4(8)	100	100	100	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)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
Pittsburg																		
A	0	A-2-3(0)	98	96	84	27	NP	NP	-	-	-	-	-	4.5	7	X		
C	3	A-4(1)	100	99	95	41	25	7	-	-	-	-	-	5.5	9	X		
CHEROKEE																		
Adair																		
A	14	A-7-6(11)	100	99	99	96	41	14	-	17	1.81	37	-	No	14		X	
B	20	A-7-6(16)	100	99	99	97	50	26	-	11	1.99	59	0.39	No	15			X
Muskogee																		
A	8	A-4(8)	100	96	95	91	32	4	-	-	-	-	-	No	11		X	
B	21	A-7-5(17)	100	99	98	96	58	22	43	14	1.93	56	0.24	No	14			X
C	24	A-7-6(20)	100	99	98	97	60	31	47	10	2.07	76	0.63	No	17			X
CHOTEAU																		
Cherokee																		
A	8	A-4(8)	100	98	98	95	33	4	34	25	1.48	13	-	No	11		X	
B	10	A-6(8)	99	97	96	93	30	11	26	11	1.76	14	-	No	12		X	
C	11	A-4(8)	99	97	96	93	17	10	30	17	1.77	23	-	No	11		X	
Haskell																		
A	0	A-4(7)	100	100	97	71	NP	NP	-	-	-	-	-	No	11	X		
B	9	A-4(8)	100	100	98	82	29	8	-	-	-	-	-	No	11		X	
C	16	A-6(12)	100	99	98	82	39	21	39	13	1.95	51	0.21	No	13		X	
McIntosh																		
A	0	A-4(8)	100	98	97	91	NP	NP	-	-	-	-	-	No	11	X		
B	19	A-7-6(15)	98	96	94	89	48	24	38	14	1.90	46	0.32	No	15			X
C	21	A-7-6(16)	96	92	91	88	48	27	34	13	1.94	39	0.42	No	15			X
Muskogee																		
A	0	A-4(8)	100	99	99	94	NP	NP	-	-	-	-	-	No	11	X		
B	18	A-7-6(14)	100	99	99	97	46	22	40	12	1.97	54	0.24	No	14			X
C	21	A-7-6(17)	100	99	99	97	51	28	36	12	2.01	49	0.49	No	15			X
Okmulgee																		
A	6	A-4(8)	100	99	99	88	25	3	-	-	-	-	-	No	11	X		
B	19	A-7-6(15)	100	99	97	91	43	27	35	12	1.91	44	0.42	No	15			X
C	Not Sampled																	
Pittsburg																		
A	8	A-4(8)	100	99	97	83	28	6	28	18	1.76	18	-	No	11		X	
B1	14	A-6(10)	100	99	98	87	36	16	23	15	1.85	15	-	No	12		X	
B3	22	A-7-6(18)	100	99	97	84	48	30	32	13	1.92	37	0.58	No	17			X
Sequoyah																		
A	0	A-4(8)	100	99	98	85	NP	NP	43	-	-	-	-	No	11	X		
B	16	A-7-6(12)	100	99	99	89	41	19	32	15	1.86	41	-	No	14		X	
C	25	A-7-6(19)	100	99	99	90	55	35	36	12	1.91	39	-	No	17			X

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
CHOTEAU, Contd.																		
Wagoner																		
A	5	A-4(8)	100	98	97	96	23	2	-	-	-	-	-	No	11	X		
B	18	A-7-6(14)	100	99	99	90	44	22	34	13	1.89	39	0.24	No	14			X
C	12	A-6(10)	100	99	98	89	34	14	31	14	1.85	30	-	No	12		X	
COLLINSVILLE																		
Haskell																		
A	8	A-4(8)	100	89	86	69	31	5	-	-	-	-	-	No	11		X	
C	9	A-4(8)	100	95	93	78	31	7	-	-	-	-	-	No	11		X	
McIntosh																		
A	0	A-4(4)	90	83	82	54	NP	NP	-	-	-	-	-	6.0	10	X		
Muskogee																		
A	4	A-4(6)	97	95	93	65	27	1	-	-	-	-	-	No	11	X		
C	0	A-4(8)	100	99	98	82	NP	NP	-	-	-	-	-	No	11	X		
Okmulgee																		
A	0	A-4(8)	100	99	93	74	NP	NP	-	-	-	-	-	No	11	X		
C	Not	Sampled																
Sequoyah																		
A	7	A-4(8)	96	89	87	79	30	2	-	-	-	-	-	No	11		X	
C	12	A-4(8)	96	93	92	90	40	10	-	-	-	-	-	No	11		X	
Wagoner																		
A	4	A-4(7)	100	97	94	70	21	2	-	-	-	-	-	No	11	X		
CONWAY																		
Pittsburg																		
A	0	A-4(0)	100	99	97	54	NP	NP	-	-	-	-	-	6.0	9	X		
B	16	A-6(11)	100	99	97	71	39	20	33	12	1.93	41	0.20	No	12		X	
C	16	A-6(12)	100	100	97	68	40	22	31	12	1.99	38	0.24	No	13		X	
Sequoyah																		
A	7	A-4(8)	100	98	98	93	29	3	-	-	-	-	-	No	11		X	
B	9	A-4(8)	100	99	99	95	31	6	-	-	-	-	-	No	11		X	
C	17	A-7-5(13)	100	99	99	96	51	17	44	18	1.82	46	-	No	13			X
R	12	A-4(8)	99	97	96	91	38	10	-	-	-	-	-	No	11		X	
CRAIG																		
Adair																		
A	8	A-4(8)	100	98	97	92	29	5	-	-	-	-	-	No	11		X	
B	9	A-4(8)	100	97	96	93	28	8	27	16	1.81	19	-	No	11		X	
C	9	A-4(8)	100	97	96	91	29	8	30	-	-	-	-	No	11		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
DALE																		
Muskogee																		
A	11	A-4(8)	100	100	100	97	35	10	-	-	-	-	-	No	11		X	
C	10	A-4(8)	100	100	100	90	33	9	-	-	-	-	-	No	11		X	
Sequoyah																		
A	14	A-6(9)	100	100	100	98	38	13	-	-	-	-	-	No	12		X	
C	15	A-7-6(10)	100	100	100	99	43	14	-	-	-	-	-	No	14		X	
DARNELL																		
McIntosh																		
A	0	A-2-4(0)	100	99	86	26	NP	NP	-	-	-	-	-	4.5	7	X		
C	0	A-2-4(0)	100	96	82	33	NP	NP	-	-	-	-	-	5.0	9	X		
Muskogee																		
A	0	A-2-4(0)	99	99	93	34	NP	NP	-	-	-	-	-	5.0	9	X		
C	0	A-4(1)	100	100	93	39	NP	NP	-	-	-	-	-	5.5	9	X		
Okmulgee																		
A	0	A-2-4(0)	100	98	86	34	NP	NP	-	-	-	-	-	5.0	9	X		
C	Not	Sampled																
DENNIS																		
Haskell																		
A	5	A-4(7)	100	85	82	71	26	2	-	-	-	-	-	No	11	X		
B	11	A-6(8)	98	96	95	91	37	11	33	20	1.73	24	-	No	12		X	
C	18	A-7-6(14)	100	99	99	98	48	20	34	18	1.84	29	-	No	14			X
McIntosh																		
A	5	A-4(8)	100	98	98	90	20	1	-	-	-	-	-	No	11	X		
B	22	A-7-6(18)	100	100	100	96	50	29	37	12	2.01	52	0.52	No	17			X
C	19	A-7-6(15)	100	100	100	99	44	26	31	11	2.02	39	0.39	No	15			X
R	15	A-6(12)	100	100	99	96	37	19	29	12	1.98	34	0.15	No	13		X	
Muskogee																		
A	6	A-4(8)	98	94	93	86	27	2	-	-	-	-	-	No	11	X		
B	20	A-7-5(16)	99	97	97	93	56	23	40	15	1.90	48	0.28	No	14			X
C	15	A-7-6(11)	100	98	97	91	42	16	35	15	1.92	39	-	No	14		X	
Okmulgee																		
A	11	A-4(8)	99	98	97	91	35	9	-	-	-	-	-	No	11		X	
B	14	A-6(10)	100	99	99	94	39	16	30	14	1.87	31	-	No	12		X	
C	18	A-7-6(14)	100	99	99	95	46	23	35	11	1.96	47	0.28	No	14			X
Pittsburg																		
A	6	A-4(8)	100	97	94	74	23	3	23	18	1.78	8	-	No	11	X		
B2	25	A-7-5(20)	100	98	97	87	63	32	49	11	2.00	76	0.70	No	16			X
B3	23	A-7-6(19)	100	96	95	83	54	31	37	8	2.07	59	0.63	No	17			X

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
DENNIS, Contd.																		
Sequoyah																		
A	5	A-4(8)	98	94	94	77	25	1	-	-	-	-	-	No	11	X		
B2	10	A-4(8)	98	92	91	81	33	9	-	-	-	-	-	No	11		X	
B3	28	A-7-5(20)	100	99	99	96	70	34	40	17	1.85	42	0.83	No	16			X
C	24	A-7-6(19)	97	96	95	90	57	32	44	16	1.89	51	0.70	No	17			X
Wagoner																		
A	7	A-4(8)	99	98	97	83	29	5	-	-	-	-	-	No	11		X	
B	28	A-7-6(20)	100	99	99	94	64	37	43	12	1.95	61	1.06	No	17			X
C	22	A-7-6(19)	98	97	96	87	54	31	40	11	2.00	57	0.63	No	17			X
DICKSON																		
Cherokee																		
A	6	A-4(8)	100	97	96	91	26	3	-	-	-	-	-	No	11	X		
B	17	A-7-6(13)	96	95	95	93	43	22	30	9	1.82	39	0.24	No	14			X
C	11	A-4(8)	86	85	85	82	33	10	35	4	2.22	70	-	No	11		X	
DOUGHERTY																		
Haskell																		
A	0	A-4(1)	100	98	92	37	NP	NP	-	-	-	-	-	5.0	9	X		
B	1	A-4(0)	99	98	86	36	27	7	-	-	-	-	-	5.0	9	X		
C	0	A-2-4(0)	100	100	96	18	NP	NP	-	-	-	-	-	4.0	7	X		
McIntosh																		
A	0	A-4(1)	100	100	97	41	NP	NP	-	-	-	-	-	5.5	9	X		
B	9	A-6(5)	100	100	98	49	37	16	-	-	-	-	-	6.5	11		X	
C	0	A-2-4(0)	100	100	97	32	23	1	-	-	-	-	-	5.0	8	X		
Muskogee																		
A	0	A-4(7)	100	98	93	69	NP	NP	-	-	-	-	-	No	11	X		
B	6	A-4(8)	100	100	96	74	23	3	-	-	-	-	-	No	11	X		
C	5	A-4(6)	100	99	94	64	22	3	-	-	-	-	-	No	11	X		
Okmulgee																		
A	0	A-2-4(0)	100	99	90	26	NP	NP	-	-	-	-	-	4.5	7	X		
B	0	A-4(1)	100	100	93	41	NP	NP	-	-	-	-	-	5.5	9	X		
C	Not	Sampled																
Pittsburg																		
A	0	A-4(1)	100	98	89	41	NP	NP	-	-	-	-	-	5.5	9	X		
B	17	A-7-6(8)	100	99	92	55	41	21	38	14	1.89	45	0.21	6.0	13			X
C	7	A-6(3)	100	99	91	42	33	15	27	16	1.81	19	-	6.0	11		X	
Wagoner																		
A	Not	Sampled																
B	1	A-2-4(0)	98	95	68	25	24	7	-	-	-	-	-	4.5	7	X		
C	0	A-2-3(0)	98	96	80	15	NP	NP	-	-	-	-	-	4.0	8	X		

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
DWIGHT																		
Muskogee																		
A	6	A-4(8)	100	97	96	89	26	3	-	-	-	-	-	No	11	X		
B1	20	A-7-6(16)	100	100	99	95	48	26	35	12	1.98	46	0.39	No	15			X
B2	21	A-7-6(17)	100	98	96	97	48	27	40	12	2.00	56	0.42	No	15			X
C	22	A-7-6(18)	100	100	100	93	49	29	41	11	2.04	62	0.52	No	17			X
Okmulgee																		
A	6	A-4(8)	100	99	98	81	25	2	-	-	-	-	-	No	11	X		
B	17	A-7-6(13)	100	99	98	91	41	22	34	14	1.87	38	0.24	No	14			X
C	Not Sampled																	
ENDERS																		
Muskogee																		
A	0	A-4(8)	99	96	95	76	NP	NP	-	-	-	-	-	No	11	X		
B	26	A-7-5(19)	99	98	98	93	73	28	59	12	1.96	92	0.49	No	16			X
C	28	A-7-5(20)	100	99	99	97	70	36	60	10	2.06	102	0.99	No	16			X
Sequoyah																		
A	0	A-4(5)	85	65	63	59	NP	NP	-	-	-	-	-	6.0	10	X		
B	14	A-6(10)	93	88	87	85	40	15	35	18	1.83	31	-	No	12		X	
C	14	A-7-6(10)	96	92	90	88	43	14	33	18	1.84	28	-	No	14		X	
ELDORADO																		
Cherokee																		
A	5	A-4(3)	61	56	55	51	34	6	-	-	-	-	-	No	10	X		
B	5	A-4(4)	62	58	57	54	26	6	-	-	-	-	-	No	10	X		
ERAM																		
Okmulgee																		
A	11	A-4(8)	99	97	95	88	35	9	31	18	1.79	23	-	No	11		X	
B	20	A-7-6(16)	100	98	98	93	50	24	47	10	1.99	73	0.32	No	15			X
C	23	A-7-6(19)	100	99	92	95	56	30	42	9	2.05	67	0.58	No	17			X
Pittsburg																		
A	10	A-4(7)	96	90	88	72	33	9	25	19	1.76	11	-	No	11		X	
B	25	A-7-5(20)	100	98	98	92	65	30	33	12	1.92	79	0.58	No	16			X
ETOWAH																		
Muskogee																		
A	4	A-4(6)	100	94	82	67	22	1	-	-	-	-	-	No	11	X		
B	12	A-6(9)	100	98	97	92	36	13	34	17	1.83	31	-	No	12		X	
C	12	A-6(9)	100	99	98	93	36	12	32	18	1.81	24	-	No	12		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
ETOWAH, Contd.																		
Sequoyah																		
A	7	A-4(8)	99	97	96	81	26	4	-	-	-	-	-	No	11		X	
B	8	A-4(8)	98	96	95	84	28	7	-	-	-	-	-	No	11		X	
C	17	A-7-6(13)	97	95	94	85	43	22	36	18	1.83	33	0.24	No	14			X
EUFAULA																		
McIntosh																		
A	0	A-2-4(0)	100	88	44	22	NP	NP	-	-	-	-	-	4.0	7	X		
C	0	A-2-4(0)	100	88	42	20	NP	NP	-	-	-	-	-	4.0	7	X		
Okmulgee																		
A	0	A-3(0)	100	100	92	5	NP	NP	-	-	-	-	-	3.5	11	X		
C	Not	Sampled																
Pittsburg																		
A	0	A-2-3(0)	97	93	70	14	NP	NP	-	-	-	-	-	3.5	8	X		
C	0	A-2-3(0)	97	94	70	16	NP	NP	-	-	-	-	-	4.0	8	X		
FITZHUGH																		
Muskogee																		
A	3	A-4(4)	99	99	96	57	20	1	-	-	-	-	-	7.0	10	X		
B	3	A-4(5)	99	98	96	62	20	1	-	-	-	-	-	No	10	X		
C	0	A-4(2)	96	94	93	47	NP	NP	-	-	-	-	-	5.5	9	X		
HARTSELLS																		
Haskell																		
A	0	A-4(1)	100	99	96	40	NP	NP	-	-	-	-	-	5.5	9	X		
B	0	A-4(3)	100	100	97	48	NP	NP	-	-	-	-	-	6.0	10	X		
C	9	A-6(6)	100	100	98	56	31	14	26	15	1.84	20	-	7.0	12		X	
Pittsburg																		
A	0	A-4(1)	100	99	95	38	NP	NP	-	-	-	-	-	5.5	9	X		
B	8	A-4(5)	100	99	97	61	26	7	-	-	-	-	-	No	10		X	
C	9	A-4(4)	100	99	96	53	27	9	23	15	1.86	16	-	6.0	10		X	
Sequoyah																		
A	0	A-4(8)	100	97	96	76	NP	NP	-	-	-	-	-	No	11	X		
B	5	A-4(8)	100	99	98	85	23	1	-	-	-	-	-	No	11	X		
C	7	A-4(8)	100	99	98	87	26	4	-	-	-	-	-	No	11		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
HECTOR																		
Adair																		
A	4	A-4(2)	78	76	72	44	37	7	-	24	1.53	20	-	5.6	9	X		
C	2	A-4(2)	63	61	60	44	22	5	-	17	1.86	11	-	-	9	X		
Cherokee																		
A	0	A-4(3)	100	99	95	49	NP	NP	-	-	-	-	-	5.8	10	X		
C	0	A-2-3(0)	71	69	65	35	NP	NP	-	-	-	-	-	No	9	X		
Haskell																		
A	0	A-4(5)	82	78	77	60	NP	NP	-	-	-	-	-	6.5	10	X		
C	4	A-4(6)	87	83	82	65	23	2	-	-	-	-	-	No	11	X		
Muskogee																		
A	0	A-4(5)	98	96	94	60	NP	NP	-	-	-	-	-	6.5	10	X		
C	0	A-4(0)	97	96	94	37	NP	NP	-	-	-	-	-	5.0	9	X		
Pittsburg																		
A	0	A-2-3(0)	100	99	98	32	NP	NP	-	-	-	-	-	5.0	8	X		
Sequoyah																		
A	0	A-4(3)	95	93	90	51	NP	NP	-	-	-	-	-	6.0	10	X		
C	0	A-2-4(0)	100	99	97	24	NP	NP	-	-	-	-	-	4.5	8	X		
Wagoner																		
A	0	A-2-3(0)	100	99	95	28	NP	NP	-	-	-	-	-	4.5	8	X		
C	1	A-2(0)	100	99	96	31	25	4	-	-	-	-	-	5.0	8	X		
HOLSTON																		
Sequoyah																		
A	0	A-4(8)	100	98	94	85	NP	NP	-	-	-	-	-	No	11	X		
B	7	A-4(8)	100	98	94	85	24	5	-	-	-	-	-	No	11		X	
C	8	A-4(8)	100	99	94	84	26	6	-	-	-	-	-	No	11		X	
HORTMAN																		
Sequoyah																		
A	7	A-4(8)	100	99	99	93	30	2	-	-	-	-	-	No	11		X	
B	22	A-7-5(20)	100	100	100	98	58	26	45	12	2.07	68	0.39	No	16			X
C	31	A-7-6(20)	100	100	100	98	71	42	43	11	2.13	69	1.55	No	17			X
HUNTINGTON																		
Adair																		
A	8	A-4(6)	96	95	92	63	31	9	-	16	1.79	25	-	No	11		X	
C	1	A-2-4(0)	42	40	38	26	27	9	-	16	1.88	16	-	No	9	X		

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
HUNTINGTON, Contd.																		
Cherokee																		
A	9	A-4(8)	100	93	87	75	33	7	-	-	-	-	-	No	11		X	
C	0	A-6(9)	29	20	18	17	34	12	33	17	1.80	29	-	No	12	X		
Sequoyah																		
A	7	A-4(8)	100	100	100	90	28	4	-	-	-	-	-	No	11		X	
AC	9	A-4(8)	100	100	100	94	30	8	-	-	-	-	-	No	11		X	
C	12	A-6(9)	100	100	100	91	34	12	-	-	-	-	-	No	12		X	
LAWRENCE																		
Adair																		
A	6	A-4(8)	100	98	97	93	25	3	-	-	-	-	-	No	11	X		
B	14	A-6(10)	100	98	97	91	39	16	40	13	1.88	52	-	No	12		X	
C	14	A-6(10)	100	99	99	96	40	16	40	15	1.85	45	-	No	12		X	
LIGHTNING																		
Muskogee																		
A	5	A-4(8)	100	99	99	95	24	1	-	-	-	-	-	No	11	X		
B	14	A-6(10)	100	100	99	98	36	16	31	12	1.92	38	-	No	12		X	
C	17	A-7-6(13)	100	100	97	92	43	22	34	11	1.99	46	0.24	No	14			X
Pittsburg																		
A	14	A-7-5(10)	99	98	95	91	44	14	44	18	1.70	43	-	No	13		X	
AC	20	A-7-6(16)	100	99	99	97	52	25	44	10	2.00	68	0.36	No	15			X
C	20	A-7-6(16)	99	98	95	91	52	25	42	19	2.00	47	0.36	No	15			X
Okmulgee																		
A	5	A-4(8)	100	100	98	90	23	2	-	-	-	-	-	No	11	X		
AC	6	A-4(8)	100	99	99	90	23	4	-	-	-	-	-	No	11	X		
C	9	A-4(8)	100	100	99	91	26	9	-	-	-	-	-	No	11		X	
LINCOLN																		
Haskell																		
A	0	A-2-4(0)	100	100	96	32	NP	NP	-	-	-	-	-	5.0	8	X		
C	0	A-2-4(0)	100	100	94	22	NP	NP	-	-	-	-	-	4.5	7	X		
McIntosh																		
A	0	A-4(6)	100	100	99	66	NP	NP	-	-	-	-	-	No	11	X		
C	0	A-4(7)	100	100	100	69	NP	NP	-	-	-	-	-	No	11	X		

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
LINKER																		
Adair																		
A	1	A-4(3)	100	99	97	48	17	1	-	15	1.84	5	-	5.7	10	X		
B	6	A-4(6)	100	99	98	66	22	6	-	15	1.92	12	-	No	11	X		
C	12	A-6(9)	100	89	88	62	38	17	-	13	1.96	38	-	No	12		X	
Cherokee																		
A	0	A-4(6)	100	98	96	64	NP	NP	-	-	-	-	-	No	11	X		
B	10	A-4(8)	100	97	96	83	30	9	27	14	1.93	26	-	No	11		X	
C	5	A-4(2)	67	60	59	44	30	9	26	13	1.95	26	-	No	9	X		
Muskogee																		
A	0	A-4(8)	100	99	97	76	NP	NP	-	-	-	-	-	No	11	X		
B	12	A-6(8)	100	99	98	85	38	11	37	16	1.91	40	-	No	12		X	
C	11	A-6(9)	100	99	98	84	36	11	31	17	1.86	26	-	No	12		X	
Sequoyah																		
A	0	A-4(5)	99	98	96	59	NP	NP	-	-	-	-	-	6.5	10	X		
B	7	A-4(8)	99	98	97	76	24	5	-	-	-	-	-	No	11		X	
C	6	A-4(6)	93	91	90	67	28	5	-	-	-	-	-	No	11	X		
Wagoner																		
A	5	A-4(7)	100	99	94	70	22	3	-	-	-	-	-	No	11	X		
B	8	A-4(6)	99	97	92	67	29	8	-	-	-	-	-	No	11		X	
C	9	A-4(7)	99	97	92	70	31	10	-	-	-	-	-	No	11		X	
LONOKE																		
Muskogee																		
A	0	A-4(7)	100	100	98	69	NP	NP	-	-	-	-	-	No	11	X		
AC	6	A-4(8)	100	100	98	75	23	3	-	-	-	-	-	No	11	X		
C	5	A-4(8)	100	100	99	78	22	1	-	-	-	-	-	No	11	X		
MASON																		
McIntosh																		
A	15	A-7-6(11)	100	100	100	98	42	16	-	-	-	-	-	No	14		X	
B	23	A-7-5(19)	100	100	100	96	59	28	47	15	1.90	62	0.49	No	16			X
C	16	A-7-6(12)	100	100	100	94	43	19	37	17	1.83	37	0.15	No	14		X	
Muskogee																		
A	5	A-4(8)	100	99	98	85	21	1	-	-	-	-	-	No	11	X		
B	6	A-4(8)	99	99	97	83	24	5	24	15	1.85	18	-	No	11	X		
C	14	A-4(8)	100	99	97	78	27	9	25	15	1.88	19	-	No	11		X	
Pittsburg																		
A	6	A-4(8)	100	100	99	92	25	3	-	-	-	-	-	No	11	X		
B	8	A-4(8)	100	100	99	87	27	7	-	-	-	-	-	No	11		X	
C	10	A-6(8)	100	100	100	82	29	11	-	-	-	-	-	No	12		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
MASON, Contd.																		
Okmulgee																		
A	0	A-4(3)	100	100	71	50	NP	NP	-	-	-	-	-	6.0	10	X		
B	8	A-6(6)	100	100	98	62	29	11	28	12	1.90	30	-	No	12		X	
C	10	A-6(7)	100	100	98	61	33	14	30	12	1.84	34	-	No	12		X	
McLAIN																		
Muskogee																		
A	7	A-4(8)	100	100	100	99	26	2	-	-	-	-	-	No	11		X	
B	14	A-7-6(10)	100	100	100	100	42	15	38	17	1.83	38	-	No	14		X	
C	7	A-4(8)	100	100	100	100	29	3	-	-	-	-	-	No	11		X	
Sequoyah																		
A	17	A-7-6(13)	100	100	100	99	47	19	44	17	1.88	51	0.15	No	14			X
B	28	A-7-5(20)	100	100	100	100	69	36	50	9	2.05	85	0.99	No	16			X
C	23	A-7-6(20)	100	100	100	99	61	32	44	11	2.06	69	0.70	No	17			X
Wagoner																		
A	10	A-4(8)	100	100	100	89	32	9	-	-	-	-	-	No	11		X	
C	10	A-4(8)	100	99	98	92	32	9	-	-	-	-	-	No	11		X	
MILLER																		
Muskogee																		
A	16	A-7-5(12)	100	100	100	99	48	16	39	15	1.96	46	-	No	13		X	
B	20	A-7-6(16)	100	100	100	100	50	25	38	10	2.03	55	0.36	No	15			X
C	22	A-7-6(18)	100	100	100	100	55	28	42	9	2.08	71	0.49	No	17			X
Wagoner																		
A	Not	Sampled																
C	21	A-7-6(17)	100	100	100	99	53	26	47	11	1.99	71	0.39	No	15			X
MUSKOGEE																		
Haskell																		
A	0	A-4(8)	100	98	96	79	NP	NP	-	-	-	-	-	No	11	X		
B	15	A-6(12)	100	99	98	85	38	19	28	11	1.94	33	0.15	No	13		X	
C	17	A-7-6(13)	100	99	97	84	41	23	32	11	2.01	43	0.28	No	14			X
Muskogee																		
A	0	A-4(8)	99	96	94	75	NP	NP	-	-	-	-	-	No	11	X		
B	14	A-6(11)	100	99	98	85	37	17	29	17	1.78	21	-	No	12		X	
C	13	A-6(10)	100	99	98	87	34	16	27	16	1.86	21	-	No	12		X	
Pittsburg																		
A	6	A-4(8)	99	98	96	77	24	2	-	-	-	-	-	No	11	X		
B	16	A-7-6(13)	100	99	99	87	41	21	36	10	2.02	52	0.21	No	14		X	
C	19	A-7-6(14)	100	99	98	89	44	24	38	12	1.95	51	0.32	No	14			X

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						PO TENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
MUSKOGEE, Contd.																		
Sequoyah																		
A	5	A-4(8)	100	99	99	92	23	1	-	-	-	-	-	No	11	X		
B	13	A-6(9)	100	99	98	96	40	12	37	18	1.80	33	-	No	12		X	
C	11	A-6(8)	100	99	99	93	32	11	-	-	-	-	-	No	12		X	
NEWTONIA																		
Wagoner																		
A	Not	Sampled																
B	18	A-7-6(14)	100	100	100	99	48	21	42	12	1.94	59	0.21	No	14			X
C	15	A-7-5(11)	98	96	95	90	51	12	44	12	1.93	62	-	No	13		X	
NORGE																		
Wagoner																		
A	6	A-4(8)	100	99	98	89	27	2	-	-	-	-	-	No	11	X		
B	12	A-6(9)	100	100	100	96	34	12	31	18	1.68	22	-	No	12		X	
C	7	A-4(8)	100	100	100	91	29	4	-	-	-	-	-	No	11		X	
OKEMAH																		
Muskogee																		
A	0	A-4(8)	100	97	97	91	NP	NP	-	-	-	-	-	No	11	X		
B	26	A-7-6(19)	100	96	95	90	56	36	41	12	2.02	58	0.99	No	17			X
C	22	A-7-6(18)	100	95	94	89	51	30	37	12	2.03	52	0.58	No	17			X
Okmulgee																		
A	11	A-6(8)	99	99	97	83	34	11	22	18	1.77	7	-	No	12		X	
B	21	A-7-6(17)	99	99	96	89	50	27	43	11	2.01	65	0.42	No	15			X
C	Not	Sampled																
Wagoner																		
A	8	A-4(8)	100	98	97	88	30	4	-	-	-	-	-	No	11		X	
B	18	A-7-6(14)	100	100	99	96	48	21	36	11	1.99	51	0.21	No	14			X
C	21	A-7-6(18)	100	99	97	91	52	28	38	11	2.03	56	0.49	No	17			X
OSAGE																		
Adair																		
A	18	A-7-5(13)	100	99	97	91	53	17	47	17	1.91	57	-	No	13			X
AC	27	A-7-5(20)	100	97	96	88	71	33	53	11	2.01	85	0.76	No	16			X
C	24	A-7-5(18)	100	98	97	91	69	25	50	9	2.04	83	0.36	No	16			X

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
OSAGE, Contd.																		
Cherokee																		
A	13	A-6(9)	100	99	99	92	37	13	37	17	1.79	37	-	No	12		X	
C	18	A-7-6(14)	100	99	99	95	46	21	34	12	1.95	43	0.21	No	14			X
Wagoner																		
A	23	A-7-6(19)	100	100	98	93	55	32	44	12	1.95	63	0.70	No	17			X
C	27	A-7-6(20)	100	99	98	95	66	34	54	25	2.03	59	0.83	No	17			X
PARSONS																		
Adair																		
A	10	A-4(8)	100	98	97	90	33	9	32	-	-	-	-	No	11		X	
B	16	A-7-6(12)	100	98	95	88	46	18	39	12	1.96	52	-	No	14		X	
C	19	A-7-6(15)	100	99	98	94	49	23	42	11	2.03	63	0.28	No	15			X
Haskell																		
A	7	A-4(8)	100	94	93	89	28	3	-	-	-	-	-	No	11		X	
B	27	A-7-6(20)	100	99	99	98	65	35	51	14	1.93	70	0.90	No	17			X
C	28	A-7-6(20)	100	99	99	96	64	38	44	13	1.98	61	1.14	No	17			X
McIntosh																		
A	5	A-4(8)	100	99	98	94	23	1	-	-	-	-	-	No	11	X		
B	17	A-7-6(13)	100	100	100	97	41	22	30	12	1.87	34	0.24	No	14			X
C	19	A-7-6(15)	100	100	100	98	43	25	30	11	2.01	40	0.36	No	15			X
R	15	A-6(12)	100	99	99	95	35	19	29	13	1.96	31	0.15	No	13		X	
Muskogee																		
A	6	A-4(8)	99	97	95	89	26	2	-	-	-	-	-	No	11	X		
B	20	A-7-6(16)	100	100	99	97	52	25	41	14	1.96	52	0.36	No	15			X
C	28	A-7-6(20)	100	95	91	87	65	37	41	12	2.01	58	1.06	No	17			X
Okmulgee																		
A	0	A-4(8)	99	99	97	75	NP	NP	-	-	-	-	-	No	11	X		
B	16	A-6(13)	100	99	99	88	40	21	-	-	-	-	0.21	No	13		X	
C	18	A-7-6(14)	100	100	97	90	43	23	31	11	1.99	41	0.28	No	14			X
Pittsburg																		
A	7	A-4(8)	99	95	93	79	26	4	-	-	-	-	-	No	11		X	
B	23	A-7-6(19)	100	99	98	91	55	31	38	10	2.08	58	0.63	No	17			X
C	21	A-7-6(17)	100	98	97	87	48	28	43	10	2.06	67	0.49	No	15			X
PHILO																		
Haskell																		
A	10	A-4(8)	99	98	96	82	32	9	-	-	-	-	-	No	11		X	
C	12	A-4(7)	100	99	97	73	31	14	24	12	1.98	25	-	No	11		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
PHILO, Contd.																		
Pittsburg																		
A	6	A-4(8)	100	100	99	85	24	4	21	17	1.82	7	-	No	11	X		
AC	8	A-4(8)	100	100	100	92	26	6	23	15	1.87	15	-	No	11		X	
C	9	A-4(8)	100	100	100	96	28	8	23	15	1.89	15	-	No	11		X	
POPE																		
Haskell																		
A	3	A-4(4)	100	99	99	53	25	2	-	-	-	-	-	6.0	10	X		
C	7	A-4(8)	100	99	99	75	28	3	-	-	-	-	-	No	11		X	
Pittsburg																		
A	3	A-4(4)	100	99	97	54	20	3	-	-	-	-	-	6.0	10	X		
C	3	A-4(5)	100	99	96	62	17	2	-	-	-	-	-	No	10	X		
Sequoyah																		
A	0	A-4(3)	100	100	98	49	NP	NP	-	-	-	-	-	6.0	10	X		
C	0	A-2-4(0)	100	99	90	25	NP	NP	-	-	-	-	-	4.5	8	X		
POTTSVILLE																		
Haskell																		
A	5	A-4(7)	99	97	96	69	21	2	-	-	-	-	-	No	11	X		
C	29	A-7-5(20)	100	99	99	97	73	35	59	16	1.85	81	0.90	No	16			X
Pittsburg																		
A	4	A-4(6)	93	87	84	63	19	2	21	19	1.81	3	-	No	11	X		
B	34	A-7-5(20)	100	100	99	97	85	43	55	13	1.87	79	1.68	No	16			X
C	14	A-6(10)	100	95	93	91	40	16	25	12	1.94	26	-	No	12		X	
PULASKI																		
Okmulgee																		
A	0	A-2-4(0)	100	100	90	11	NP	NP	-	-	-	-	-	3.5	8	X		
C	3	A-4(4)	100	100	92	56	19	2	-	-	-	-	-	6.5	10	X		
PURDY																		
Sequoyah																		
A	0	A-4(7)	100	99	97	68	NP	NP	-	-	-	-	-	No	11	X		
B	0	A-4(7)	100	99	97	68	NP	NP	-	-	-	-	-	No	11	X		
C	8	A-4(8)	100	99	98	76	27	6	-	-	-	-	-	No	11		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
REINACH																		
Sequoyah																		
A	0	A-4(8)	100	100	100	95	NP	NP	-	-	-	-	-	No	11	X		
C	8	A-4(8)	100	100	100	99	30	6	-	-	-	-	-	No	11		X	
Wagoner																		
A	6	A-4(8)	100	100	99	93	25	2	-	-	-	-	-	No	11	X		
C	6	A-4(8)	100	100	100	91	27	3	-	-	-	-	-	No	11	X		
ROEBUCK																		
Haskell																		
A	18	A-7-5(14)	100	100	99	96	52	19	46	19	1.77	47	0.15	No	13			X
AC	24	A-7-5(20)	100	100	100	99	61	30	47	17	1.89	57	0.58	No	16			X
C	23	A-7-6(19)	100	100	100	100	55	29	40	13	1.98	53	0.52	No	17			X
Okmulgee																		
A	18	A-7-6(14)	100	100	99	97	47	21	41	13	1.95	55	0.21	No	14			X
C	16	A-7-6(12)	100	99	98	97	41	19	34	13	1.95	41	0.15	No	14		X	
SHARKEY																		
Sequoyah																		
A	12	A-6(8)	100	100	100	98	38	11	-	-	-	-	-	No	12		X	
AC	17	A-7-6(13)	100	100	100	98	44	20	36	17	1.85	35	0.20	No	14			X
C	18	A-7-6(14)	100	100	100	96	45	22	36	15	1.89	41	0.24	No	14			X
SOGN																		
Adair																		
A	13	A-7-5(9)	100	98	96	83	43	11	-	-	-	-	-	No	13		X	
Cherokee																		
A	16	A-7-6(12)	100	98	95	80	46	17	45	15	1.86	57	-	No	14		X	
Muskogee																		
A	10	A-4(8)	98	95	94	86	36	7	-	-	-	-	-	No	11		X	
Sequoyah																		
A	16	A-7-5(11)	96	94	92	76	51	13	46	16	1.88	56	-	No	13		X	
Wagoner																		
A	25	A-7-5(20)	100	99	98	96	61	31	45	14	1.91	60	0.63	No	16			X

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
STEPHENVILLE																		
McIntosh																		
A	0	A-4(2)	100	99	88	44	NP	NP	-	-	-	-	-	5.5	9	X		
B	6	A-4(5)	100	99	90	62	26	6	-	-	-	-	-	No	10	X		
C	6	A-4(5)	99	99	90	61	26	7	-	-	-	-	-	No	10	X		
Muskogee																		
A	0	A-4(3)	100	99	90	52	NP	NP	-	-	-	-	-	6.0	10	X		
B	7	A-4(7)	100	100	93	68	28	6	-	-	-	-	-	No	11		X	
C	4	A-4(5)	100	100	87	59	23	3	-	-	-	-	-	6.5	10	X		
Okmulgee																		
A	0	A-4(1)	100	98	89	38	NP	NP	-	-	-	-	-	5.0	9	X		
B	9	A-6(5)	100	99	95	53	33	14	36	15	1.82	39	-	6.5	11		X	
C	8	A-6(5)	100	99	85	52	33	13	31	13	1.93	34	-	6.5	11		X	
STIDHAM																		
Haskell																		
A	0	A-4(8)	100	97	85	48	NP	NP	-	-	-	-	-	6.0	11	X		
B	5	A-4(5)	98	97	88	58	24	5	-	-	-	-	-	6.5	10	X		
C	1	A-4(0)	98	96	79	36	28	8	-	-	-	-	-	5.5	9	X		
McIntosh																		
A	0	A-4(3)	100	98	88	48	NP	NP	-	-	-	-	-	6.0	10	X		
B	5	A-4(4)	100	98	89	56	23	6	-	-	-	-	-	6.5	10	X		
C	1	A-4(1)	100	98	85	40	18	1	-	-	-	-	-	5.5	9	X		
Muskogee																		
A	0	A-2-4(0)	100	80	42	21	NP	NP	-	-	-	-	-	5.0	7	X		
B	2	A-4(1)	100	90	57	40	22	5	-	-	-	-	-	5.5	9	X		
C	0	A-2-4(0)	100	87	66	26	NP	NP	-	-	-	-	-	4.5	7	X		
Okmulgee																		
A	0	A-2-4(0)	100	100	97	35	NP	NP	-	-	-	-	-	5.0	9	X		
B	8	A-4(3)	100	100	98	51	27	11	25	13	1.89	23	-	6.5	10		X	
C	3	A-4(1)	100	100	96	38	25	9	-	-	-	-	-	6.0	9	X		
Pittsburg																		
A	0	A-2-3(0)	98	96	72	21	NP	NP	-	-	-	-	-	4.0	7	X		
B	6	A-6(2)	99	97	80	40	31	13	26	13	1.90	17	-	6.0	10	X		
C	0	A-2-4(0)	98	97	68	21	26	8	-	-	-	-	-	4.0	7	X		
STIDHAM (Coarse Phase)																		
Pittsburg																		
A	0	A-2-3(0)	85	79	61	32	NP	NP	-	-	-	-	-	4.5	8	X		
B	7	A-4(1)	84	79	65	40	22	8	18	10	1.93	15	-	5.0	9		X	
C	0	A-2(0)	75	53	41	23	19	3	-	-	-	-	-	4.0	7	X		

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
SUMMIT																		
Adair																		
A	14	A-7-6(10)	100	99	98	93	43	13	42	18	1.77	42	-	No	14		X	
B	23	A-7-5(20)	100	99	98	96	59	28	48	11	2.00	74	0.49	No	16			X
C	24	A-7-6(19)	100	99	99	95	56	31	43	11	2.04	66	0.63	No	17			X
Cherokee																		
A	13	A-6(10)	100	96	93	80	38	14	36	14	1.88	42	-	No	12		X	
B	28	A-7-5(20)	100	98	97	92	67	36	52	11	1.98	83	0.99	No	16			X
C	18	A-7-5(14)	100	95	91	81	49	19	45	14	1.88	56	0.15	No	13			X
Muskogee																		
A	9	A-4(8)	99	97	96	92	37	4	-	-	-	-	-	No	11		X	
B	11	A-4(8)	98	95	93	91	37	10	35	20	1.75	27	-	No	11		X	
C	14	A-7-6(10)	100	99	99	97	41	15	35	17	1.85	34	-	No	14		X	
Sequoyah																		
A	10	A-4(7)	100	97	93	70	34	9	-	-	-	-	-	No	11		X	
B	15	A-7-6(11)	100	98	95	75	42	17	37	14	1.92	45	-	No	14		X	
C	21	A-7-6(17)	99	98	96	85	50	27	41	15	1.99	52	0.42	No	15			X
Wagoner																		
A	13	A-6(9)	99	97	96	87	39	12	35	16	1.82	36	-	No	12		X	
B	Not	Sampled																
C	21	A-7-6(17)	98	96	95	90	54	25	45	10	2.02	72	0.36	No	15			X
TAFT																		
Adair																		
A	9	A-4(8)	100	99	98	93	32	8	29	21	1.64	13	-	No	11		X	
B	15	A-7-5(11)	100	99	99	96	46	15	43	12	1.88	58	-	No	13		X	
C	13	A-6(10)	100	98	97	88	33	15	28	16	1.81	21	-	No	12		X	
Cherokee																		
A	9	A-4(8)	98	97	96	86	32	7	30	25	1.56	8	-	No	11		X	
B	17	A-7-6(12)	96	95	94	88	45	20	39	14	1.87	46	0.20	No	14			X
C	19	A-7-6(13)	98	98	97	90	46	23	38	13	1.92	47	0.28	No	14			X
TALIHINA																		
Haskell																		
A	12	A-5(8)	100	97	94	87	41	9	-	-	-	-	-	No	11		X	
C	22	A-7-5(18)	100	95	94	91	57	26	50	19	1.81	55	0.39	No	16			X
McIntosh																		
A	21	A-7-5(17)	99	95	95	91	59	22	41	17	1.80	42	0.24	No	14			X
C	26	A-7-5(20)	100	99	98	97	65	32	40	15	1.88	47	0.70	No	16			X
R	15	A-7-6(11)	100	99	99	96	45	16	35	16	1.91	37	-	No	14		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
TALIHINA, Contd.																		
Muskogee																		
A	14	A-7-5(10)	100	97	95	89	48	11	-	-	-	-	-	No	13		X	
C	22	A-7-6(18)	100	99	99	97	59	25	47	16	1.84	56	0.36	No	17			X
Okmulgee																		
A	18	A-7-6(14)	98	97	95	91	48	20	41	14	1.87	51	0.20	No	14			X
C	21	A-7-5(17)	98	96	94	91	55	25	42	14	1.88	54	0.36	No	14			X
Pittsburg																		
A	11	A-4(8)	100	94	92	85	35	9	28	14	1.83	25	-	No	11		X	
AC	20	A-7-5(16)	100	99	98	97	53	23	33	13	1.93	39	0.28	No	14			X
TALOKA																		
Adair																		
A	9	A-4(8)	100	99	98	93	32	8	29	21	1.64	13	-	No	11		X	
B	15	A-7-5(11)	100	99	99	96	46	15	43	12	1.88	58	-	No	13		X	
C	13	A-6(10)	100	98	97	88	33	15	28	16	1.81	21	-	No	12		X	
Cherokee																		
A	9	A-4(8)	99	98	97	96	31	6	31	24	1.60	11	-	No	11		X	
B	15	A-7-6(11)	95	90	89	87	41	17	34	20	1.85	25	-	No	14		X	
C	15	A-6(11)	90	85	84	81	39	18	32	15	1.88	32	-	No	12		X	
Haskell																		
A	0	A-4(6)	100	99	92	67	NP	NP	-	-	-	-	-	No	11	X		
B	16	A-6(12)	100	99	96	78	39	20	34	10	2.03	49	0.20	No	13		X	
C	14	A-6(11)	100	100	96	69	37	20	34	9	2.04	51	0.20	No	12		X	
McIntosh																		
A	0	A-4(8)	100	100	99	95	NP	NP	-	-	-	-	-	No	11	X		
B	21	A-7-6(18)	100	100	100	98	49	29	35	13	1.96	44	0.52	No	17			X
C	20	A-7-6(16)	100	100	99	97	47	27	34	14	1.94	40	0.42	No	15			X
Muskogee																		
A	0	A-4(6)	100	93	80	63	NP	NP	-	-	-	-	-	No	11	X		
B	17	A-7-6(13)	100	95	87	76	42	21	33	19	1.97	29	0.21	No	14			X
C	11	A-6(9)	100	97	95	83	30	13	23	14	1.86	18	-	No	12		X	
Okmulgee																		
A	7	A-4(8)	99	98	98	77	26	4	-	-	-	-	-	No	11		X	
B	20	A-7-6(15)	100	99	98	91	47	26	30	12	1.93	36	0.36	No	15			X
C	Not Sampled																	
Pittsburg																		
A	4	A-4(8)	100	99	98	82	21	1	-	-	-	-	-	No	11	X		
B	19	A-7-6(15)	100	100	99	91	43	25	34	10	2.03	50	0.36	No	15			X
C	21	A-7-6(17)	100	100	99	89	48	29	40	9	2.10	66	0.52	No	15			X

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
TALOKA, Contd.																		
Sequoyah																		
A	6	A-4(8)	100	99	98	92	26	1	-	-	-	-	-	No	11	X		
B	16	A-7-6(13)	100	100	100	96	46	18	40	17	1.83	43	-	No	14		X	
C	12	A-6(10)	100	99	99	95	33	14	28	17	1.82	21	-	No	12		X	
Wagoner																		
A	Not	Sampled																
B	21	A-7-6(17)	100	98	98	95	51	27	41	11	2.02	62	0.42	No	15			X
C	22	A-7-6(18)	100	98	97	92	53	29	36	24	1.99	24	0.52	No	17			X
TELLER																		
Pittsburg																		
A	0	A-4(6)	99	97	92	66	NP	NP	-	-	-	-	-	No	11	X		
B	7	A-4(8)	99	98	94	79	23	7	-	-	-	-	-	No	11		X	
C	6	A-4(8)	100	100	93	77	23	3	-	-	-	-	-	No	11	X		
Wagoner																		
A	6	A-4(8)	100	99	98	89	27	2	-	-	-	-	-	No	11	X		
B	12	A-6(9)	100	100	99	96	34	12	31	18	1.68	22	0.83	No	12		X	
C	7	A-4(8)	100	100	99	91	29	4	-	-	-	-	-	No	11		X	
TYLER																		
Sequoyah																		
A	8	A-4(8)	100	100	99	97	30	4	-	-	-	-	-	No	11		X	
B	15	A-7-6(11)	100	100	100	98	42	17	36	15	1.85	38	-	No	14		X	
C	15	A-7-6(11)	100	100	99	97	42	17	38	15	1.85	44	-	No	14		X	
VANOSS																		
Okmulgee																		
A	4	A-4(4)	100	99	98	57	23	3	-	-	-	-	-	6.5	10	X		
B	8	A-4(7)	100	98	97	73	27	7	23	16	1.82	12	-	No	11		X	
C	7	A-4(7)	100	98	97	70	26	5	24	16	1.81	15	-	No	11		X	
Pittsburg																		
A	4	A-4(6)	100	98	92	66	19	2	-	-	-	-	-	No	11	X		
B	9	A-4(7)	100	99	94	71	28	9	-	-	-	-	-	No	11		X	
C	4	A-4(4)	99	98	91	54	23	4	-	-	-	-	-	6.0	10	X		
Wagoner																		
A	0	A-4(6)	97	95	86	63	NP	NP	-	-	-	-	-	No	11	X		
B	7	A-4(8)	100	99	97	88	27	5	-	-	-	-	-	No	11		X	
C	9	A-4(8)	100	99	97	85	28	7	-	-	-	-	-	No	11		X	

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
VERDIGRIS																		
Muskogee																		
A	10	A-4(8)	100	100	100	91	35	7	-	-	-	-	-	No	11		X	
C	9	A-4(8)	100	99	99	87	32	7	-	-	-	-	-	No	11		X	
Okmulgee																		
A	10	A-4(8)	100	100	98	92	30	9	29	16	1.82	24	-	No	11		X	
C	13	A-4(8)	100	100	95	93	35	15	30	13	1.90	33	-	No	11		X	
Pittsburg																		
A	8	A-4(8)	100	99	98	95	30	5	-	-	-	-	-	No	11		X	
AC	10	A-4(8)	100	99	98	94	30	9	-	-	-	-	-	No	11		X	
C	9	A-4(8)	100	100	99	94	35	6	-	-	-	-	-	No	11		X	
Wagoner																		
A	18	A-7-5(14)	100	100	99	96	51	20	43	13	1.90	56	0.20	No	13			X
C	11	A-6(9)	100	100	98	71	33	12	-	-	-	-	-	No	12		X	
WAYNESBORO																		
Pittsburg																		
A	4	A-4(6)	99	98	94	66	21	3	-	-	-	-	-	No	11	X		
B	5	A-4(4)	86	84	80	53	21	5	-	-	-	-	-	6.0	10	X		
Sequoyah																		
A	0	A-4(8)	99	98	97	75	NP	NP	-	-	-	-	-	No	11	X		
B	9	A-4(8)	99	98	97	82	28	8	-	-	-	-	-	No	11		X	
C	0	A-4(5)	90	85	82	58	NP	NP	-	-	-	-	-	6.0	10	X		
WINDTHORST																		
McIntosh																		
A	0	A-4(8)	98	94	92	78	NP	NP	-	-	-	-	-	No	11	X		
B	32	A-7-6(20)	100	99	98	93	65	48	37	12	1.96	49	2.29	No	17			X
C	31	A-7-6(20)	99	98	98	93	67	43	39	9	2.05	62	1.68	No	17			X
WRIGHTSVILLE																		
Pittsburg																		
A	0	A-4(8)	100	99	98	97	NP	NP	-	-	-	-	-	No	11	X		
B	18	A-7-6(14)	100	100	99	91	42	23	32	10	2.02	44	0.28	No	14			X
C	18	A-7-6(14)	100	100	99	91	42	23	36	10	2.07	54	0.28	No	14			X

HIGHWAY ENGINEERING CHARACTERISTICS OF SOIL SERIES

SOIL SERIES & HORIZONS BY COUNTY	O.S.I.	AASHO CLASSIFICATION	SIEVE ANALYSIS (% PASSING)				SOIL CONSTANTS						POTENTIAL VERTICAL RISE INCHES	SUITABILITY				
														STABILIZATION		SUBGRADE		
			NO.10	NO.40	NO.60	NO.200	LIQUID LIMIT	PLASTIC INDEX	FIELD MOISTURE EQUIVALENT	SHRINKAGE LIMIT	SHRINKAGE RATIO	VOLUMETRIC CHANGE		% ASPHALT	% CEMENT	GOOD	FAIR	POOR
WOODSON																		
Cherokee																		
A	18	A-7-5(14)	100	100	99	91	51	19	41	15	1.77	46	-	No	13			X
B	25	A-7-6(20)	100	100	99	97	60	33	46	12	2.00	69	0.76	No	17			X
C	26	A-7-6(20)	100	100	99	98	62	35	50	10	2.02	81	0.90	No	17			X
Muskogee																		
A	11	A-4(8)	100	99	98	94	35	9	-	-	-	-	-	No	11		X	
B	19	A-7-6(15)	100	98	97	94	45	24	35	17	1.86	35	0.32	No	15			X
C	23	A-7-6(19)	99	97	96	94	54	29	37	12	2.04	52	0.52	No	17			X
Okmulgee																		
A	10	A-4(8)	100	99	98	82	33	10	32	16	1.76	29	-	No	11		X	
B	17	A-7-6(13)	100	99	98	86	43	21	37	11	1.95	50	0.21	No	14			X
C	19	A-7-6(15)	100	99	99	92	47	24	39	12	2.01	58	0.32	No	15			X
Pittsburg																		
A	9	A-5(8)	100	99	97	89	42	2	-	-	-	-	-	No	11		X	
B	22	A-7-6(18)	100	99	99	95	52	29	43	10	2.00	66	0.52	No	17			X
C	23	A-7-6(19)	100	99	98	93	54	30	43	10	2.05	68	0.58	No	17			X
YAHOLA																		
Haskell																		
A	6	A-4(8)	100	100	100	91	27	2	-	-	-	-	-	No	11	X		
C	0	A-4(6)	100	100	100	66	NP	NP	-	-	-	-	-	No	11	X		
McIntosh																		
A	0	A-4(4)	100	100	98	55	NP	NP	-	-	-	-	-	6.5	10	X		
C	0	A-4(6)	100	100	98	63	NP	NP	-	-	-	-	-	No	11	X		
Muskogee																		
A	0	A-4(7)	100	100	99	72	NP	NP	-	-	-	-	-	No	11	X		
C	8	A-4(8)	100	100	100	99	31	5	-	-	-	-	-	No	11		X	
Pittsburg																		
A	0	A-4(8)	98	96	84	27	NP	NP	-	-	-	-	-	4.5	11	X		
C	0	A-2-3(0)	98	97	82	10	NP	NP	-	-	-	-	-	3.5	8	X		
Wagoner																		
A	Not	Sampled																
C	0	A-4(8)	100	100	100	80	NP	NP	-	-	-	-	-	No	11	X		

TABLE OF TERMS

A HORIZON--See HORIZON, SOIL.

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 per cent 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.

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 HORIZON--See HORIZON, SOIL.

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.

CLAY, CLASS--See CLASS, SOIL TEXTURAL.

CLAY SEPARATE--See SEPARATE, SOIL.

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 2 ft. 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 or 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 of 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.

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 cemented (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.

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 or 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 MONTMORILLONITE).

..g--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.

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, TEXTURAL.

LOESS--Soil material consisting primarily of uniform silt that was transported and deposited by wind.

LOOSE--See CONSISTENCE WHEN DRY.

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 silican 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.

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 "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.

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.

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.

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

as 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.

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 SEPARATE, SOIL.

SEPARATE, SOIL--A group of mineral particles of a specific size range. A soil sample will always contain more than one separate.

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.

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.

SILT SEPARATE--See SEPARATE, SOIL.

SINGLE-GRAIN STRUCTURE--See STRUCTURE, SOIL.

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 per cent 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 in. in diameter, if rounded, and longer than 15 in. 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.

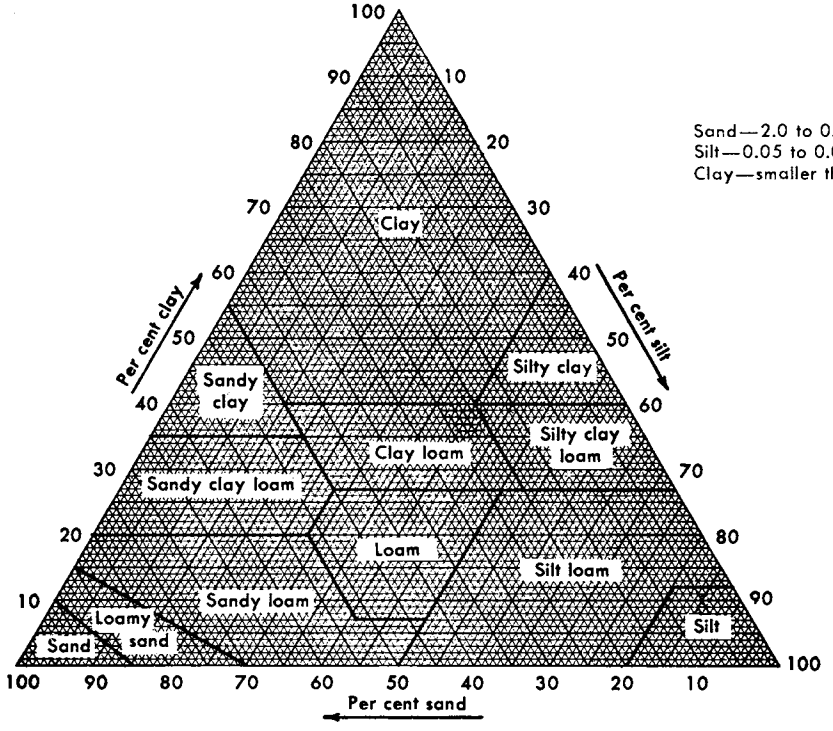
SUBSOIL--Refers to the B horizon of soils with distinct profiles. In soils with weak profiles, it is the soil below the surface soil. It is a poor term.

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.



U.S. Department of Agriculture textural classification chart

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.

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.

The descriptions for the table of terms was taken from the "Highway Research Board Special Report 25, Glossary of Pedological (Soils) and Landform Terminology".

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