Sampling Plan
ESE Alcohol Inc.
Leoti, KS

I. Introduction

ESE Alcohol, Inc. ("ESE Alcohol"), on behalf of itself and Pioneer Hi-Bred International, Inc., has developed this sampling plan per the request of USEPA-7 in order to determine the residual concentration of the seed treatments which were applied to the feedstock grain utilized to produce ethanol. Some residual amounts are known to be present in the agricultural fields where the conditioned mash from the alcohol production was applied for the agronomic value as nitrogen fertilizer and soil conditioner. This will be a tiered sampling plan in relation to the ESE ethanol production facility located 310 East Highway 96, Leoti, Kansas (the "ESE Alcohol Facility"), and nearby agricultural fields where byproducts from the ESE Facility were land applied as fertilizer/soil conditioner and irrigation water since January 1, 2020 (the "Site"). The tiered approach shall afford the refining of the sampling process as worst case fields are sampled first.

The Site is located in located in Eastern Wichita County, Kansas, and comprises approximately __30__ acres at the ESE Alcohol Facility and approximately _2600__ acres of agricultural fields. The sampling is a result of utilizing solid by products from ethanol production for their agronomic value as fertilizer/soil conditioner. ESE Alcohol used treated seed as a feedstock for ethanol production. Liquid byproducts from the ethanol production were utilized at the Site for irrigation and nutrient value. The treated seed used by ESE Alcohol for the time of concern indicated by USEPA-7 was treated with the following six (6) seed treatments: Clothianidin, Thiamethoxam, Tebuconazole, Thiabendazole, Ipconazole, Chlorantranilipole (the "Constituents of Concern" or "COCs").

Two fields which received the higher quantity and mid quantity of mash, most recently applied will be chosen for the initial sampling event along with the facility and the conditioning area. This field type should indicate a worst case scenario as to the residual concentration of the seed treatments. This will also indicate which treatments should be analyzed going forward one duplicate sample will be collected from the initial field sampling. Please see the attached listing (Table 1) the 17 pesticides the laboratory can analyze and as agreed to by EPA for the initial samples. Ten days prior to initial sampling activities the Project Manager will provide oral notification to the assigned EPA contact.

II. Sample Plan Procedure and Media to be sampled.

A. Grain and/or Corn Fields-

The fields chosen for sampling as part of the initial round of sampling from Group 1 and group 2 are identified in Table 3. These agricultural fields are used for production of wheat, corn, and/or milo, on a rotating basis according to good agricultural practices.

Once the results from the initial "worst case" samples are collected the determination for future sampling will be developed. In the event all COC and the list of 17 as approved by EPA are below the levels of ecological concern, i.e. commercial application rates or higher as may be established, no further sampling will be conducted. In the event there are COC's above the levels of ecological concern a representative set of fields from the next tier of application levels will be sampled at the depth where COC's above levels of ecological concern were identified. The analysis will only be conducted for the COC's above the levels of ecological concern. The sampling process will continue until the results indicate all COC's are below the levels of ecological concern. Once the field has an analysis of soil or grain below the levels established that field will be removed from the order.

B. Field Soil Samples-

Soil sampling from representative fields will be undertaken to determine residual levels of COCs in the soil, if any, from land application of ethanol byproducts for irrigation and nutrient value, plus solid by product application for agronomic value and soil conditioning.

Fields to be Sampled. The mash application amounts varied based on the nitrogen fertilizer requirements. The requirements were based on agronomic analysis of the soils in each field. Based on the nitrogen fertilizer analysis, certain fields required 12 tons of mash to be applied. Other fields only required three (3) tons of mash to be applied.

For purposes of the initial field soil sampling, the fields have been segregated into three (3) groups based on historic application levels of mash: Group 1 – ten (10) tons per acre (tpi) and above, Group 2 – less than ten (10) tpi but greater than six (6) tpi, and Group 3 – less than six (6) tpi but greater than three (3) tpi. Within each group, the application date varies based on good farming practices.

Group 1 comprises nine (9) fields, totaling approximately 794 acres. Group 2 comprises five (5) fields, totaling approximately 451 acres. Group 3 comprises seven (7) fields, totaling approximately 786 acres.

For the initial round of field soil sampling, one (1) Group 1 field and one Group (2) field will be sampled. The soil samples will be analyzed for the COCs by LC/MS/MS at Matrix Laboratory.

Due to the fact that Group 3 has a low application rate, none of these will be sampled as part of the initial round of field sampling. Once sample results are received for the initial round of field sampling, we will review the analysis to determine whether Group 3 requires sampling; i.e. in the event that Group 1 and/or Group 2 levels are acceptable levels of seed treatment residue, there is no requirement for sampling the fields with the lower application rate.

Fields chosen for sampling as part of the initial round of sampling from Group 1 and Group 2 are identified in Table 3. All fields where solid ethanol production byproducts were applied since January 1, 2020, and the relevant grouping for such fields, are depicted in Figure 4.

Any and/or all of these fields where crop samples met the FDA clearance levels will not be sampled once a crop analysis passes the FDA clearance level indicating the biological up take availability of each COC is below the level of concern.

Sampling Procedures. Each morning and evening of sampling days, there will be a tailgate safety discussion among all parties. The primary safety items will be rubber gloves (change between each field soil sample) and safety glasses. The rubber gloves will insure worker safety, as well as mitigate the possibility of cross-contamination between field soil samples.

Each field to be sampled will be segmented in such a way as to insure that a representative soil sample is collected. There will be a minimum of fifteen (15) soil sample points in each field sampled. The sample configuration in a circle pivot irrigation system will be via a grid across the area mash was applied for agronomic value. The standard size of the three high rate circle pivot fields is 94 acres, i.e. 4,094,640 square feet. The radius of this circle is approximately 1141.6 feet. The sample grid shall be configured of five line segments equally spaced across the circle, i.e. each approximately 380.5 feet separation. Each line segment will have three sample points. One sample point on each line segment will be in the center of the line segment. The additional two sample points on each line shall be 80% of the distance between the center of the line and the other edge of the circle, i.e. the center line three points shall be located in the approximate center of the pivot circle with the two additional sample points approximately 913 feet from the center.

Each sample point will have one (1) aliquot collected from the biologically active zone. Each aliquot within a field shall be collected with a clean stainless steel scoop or spoon, at a depth of 0” to 6” below the soil surface. Each aliquot will be placed directly into a glass 4oz jar, then placed into a stainless steel bowl in order to assure equal aliquot from each point. Once all aliquots from all soil sample points in a field have been collected into the bowl, the sample will be thoroughly mixed with the stainless steel spoon or scoop. Once the soil sample aliquots are thoroughly mixed, a portion shall be taken from opposite sides of the bowl and placed into a sample jar. The sample jar of soil will then be sealed and labeled with field location. The jar will be placed into a secure container with ice for transport. Each day of sampling will be recorded in a detailed log of the activities. The GPS coordinates will be recorded for each composite location. The agricultural fields identified in Table 3 map (see Table 3) will have a core sample collected. The core shall be collected at the depth of 20” to 30” below grade. The initial 0” to 6” sample will be collected. The area will be cleared of any loose soil then the soil core will be collected. Once the 20” to 30” section of the core is collected the soil will be manually mixed then a 4oz aliquot will be collected then placed into a stainless steel sample bowl. Once all 15-4oz aliquots are placed into the stainless steel sample bowl the aliquots will be thoroughly mixed.

Once thoroughly mixed an aliquot will be removed from opposing sides of the bowl and placed into a glass sample jar. The sample will then be sealed, labeled and placed in a secure container with ice for storage until shipment to the laboratory. A detailed log will be recorded for each sample activity.

Once all samples are collected, they will be shipped 2nd Day Air to Matrix Laboratory for analysis. The soil samples shall be analyzed by LC/MS/MS for the COCs.

Once the results from the initial "worst case" samples are collected the determination for future sampling will be developed. In the event all COC and the list of 17 as approved by EPA are below the levels of ecological concern, i.e. commercial application rates or higher or may be established no further sampling will be conducted. In the event there are COC's above the levels of ecological concern a representative set of fields from the next tier of application levels will be sampled at the depth where COC's above levels of ecological concern were identified. The analysis will only be conducted for the COC's above the levels of ecological concern. The sampling process will continue until the results indicate all COC's are below the levels of ecological concern. Once the field has an analysis of soil or grain below the levels established that field will be removed from the order.

C. Staging and conditioning area-

Sampling from holding pond bottom material at the staging and conditioning area will be undertaken to determine residual levels of COCs in these materials, if any, for purposes of determining the appropriate disposition of these materials.

The staging and conditioning area (Figure 1) currently has approximately _2000_ tons of pond bottom clean out material on site in windrows. The pond bottom clean out material is the only ethanol production byproduct material remaining at the Site. This material was removed from the very bottom of the holding ponds where processed mash was stored prior to drying. The semi-dry mash was removed from the holding pond, transported to the staging and conditioning area for further conditioning and drying prior to application for its agronomic value as fertilizer and soil conditioner. The pond bottoms were then thoroughly cleaned and wheel compacted. The materials are placed in windrows. The windrows are turned and rolled with a front end loader for further drying and conditioning. The material currently is in windrows. Each windrow will be sampled in seven random locations. Each sample location shall have two 4oz aliquots collected; one from 0"-6", then one from 12"-18", the next sample location will be sampled 0"-6" and 18"-24". This process will be repeated for a collection of 14 aliquots along each windrow. All fourteen 4oz aliquots from each windrow will be composited into a stainless steel container thoroughly mixed then 4 opposing aliquots will be removed into the sample for analysis. Once containerized and properly labeled the sample will be placed in a secure container on ice. Once all samples are collected the batch will be shipped 2nd day to the laboratory for analysis.

D. Treated Seed Receiving Area

Soil sampling from the Treated Seed Receiving Area at the ESE Alcohol Facility will be undertaken to determine residual levels of COCs in the soil, if any. The level of concern at the facility shall be based on commercial/workplace levels for human/mammal exposure only. (See Figure 5) Treated seed used as a feedstock for ethanol production at the ESE Alcohol Facility was received at the Treated Seed Receiving Area depicted in Figure 6.

Two composite soil samples will be obtained from the Treated Seed Receiving Area. One duplicate sample will be submitted from this area.

The area where the receiving grid was located will be the center of the sample zone. Six sample locations will be sampled (1)-5' and (1)-10' North of the receiving grid, (1)-5' and (1)-10' South of the receiving grid and (1)-5' and (1)-10' East of the receiving grid. One sample will be comprised of six 4oz aliquots from 0"-6" all combined in a stainless steel vessel mixed thoroughly then two opposing aliquots will be removed into a sample container for analysis. An additional sample shall be collected via a core from 20"-30" depth. Once the 0"-6" aliquot has been removed a core shall be collected. Each 20"-30" core shall be thoroughly mixed then a 4oz aliquot will be placed into a stainless steel container and be thoroughly mixed, aliquots will be removed from opposing sides and placed into sample containers for analysis. Once containerized and properly labeled each sample shall be placed into a secure container with ice. Once all samples are collected the batch will be shipped 2nd day to the laboratory for analysis. The samples will analyzed by LC/MS/MS for the 17 anolytes directed by EPA.

III. Reporting

ESE Alcohol and Pioneer will submit sampling data from the sampling within thirty (30) days of receiving the data. The data shall be tabulated chronologically by media.

IV. Schedule

Once the plan is accepted the sampling will be conducted within two weeks, weather permitting. The following schedule applies to the sampling work detailed in the sampling plan:

Timeframe	**Activity**
Within 30 days after approval of QAPP, DQOs, and HASP	Schedule Field soil sampling, Staging and Conditioning Area, and Treated Seed Receiving Area Sampling
10 days prior to sampling activities	Oral notification of sampling activities to EPA
Within 30 days after receipt of analytical results	Provide analytical results to EPA

Figure 1
E2 5-18-36

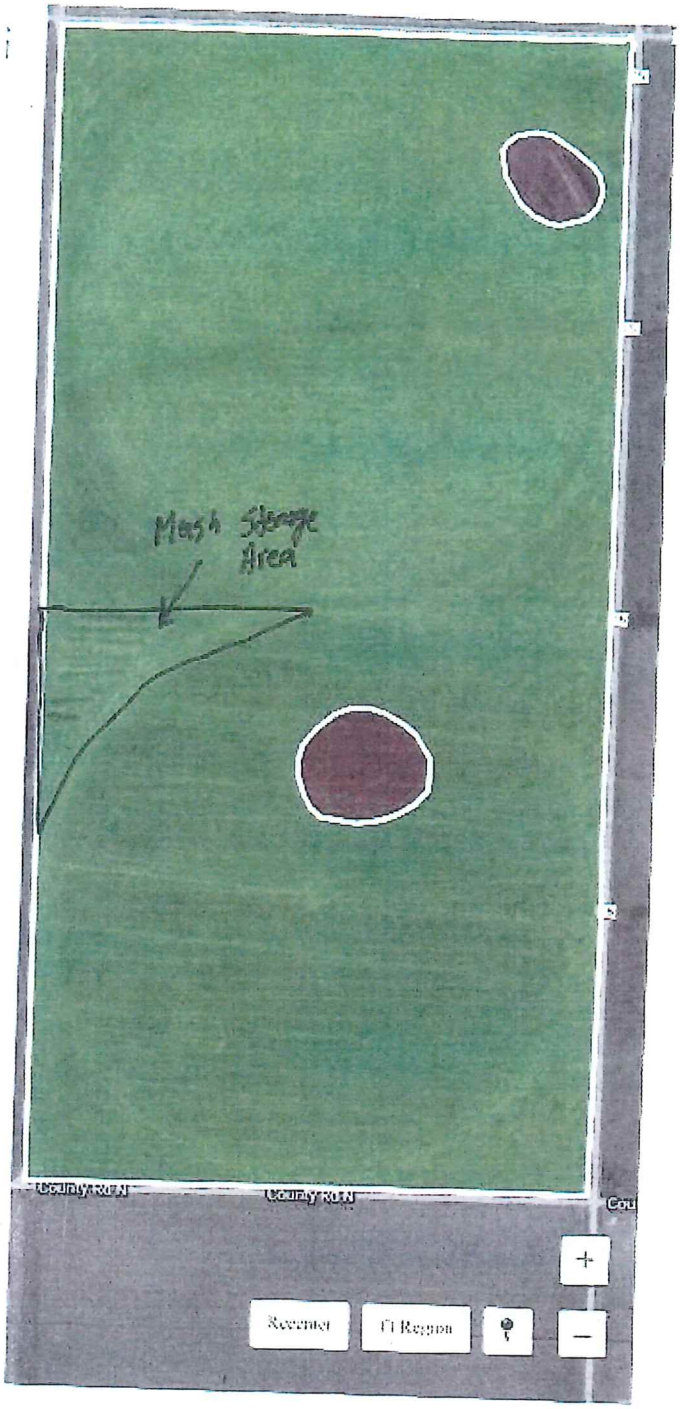


Table 1

Original EPA Laboratory Analysis list of Pesticides:

1. Azoxystrobin
2. Clothianidin
3. Chlorantraniliprole
4. Thiamethoxam
5. Thiabendazole
6. Mefenoxam
7. Ipconazole
8. Ethaboxam *
9. Metalaxyl
10. Tebuconazole
11. Fludioxonil
12. Sedaxane
13. Abamectin
14. Captan ●
15. Carbendazim ●
16. Carboxin ●
17. Fluoxastrobin
18. Imidacloprid
19. Metconazole
20. Penflufen *●
21. Trifloxystrobin
22. Difenconazole
23. Prothioconazole *
24. Desthio-prothioconazole *

*Laboratory Does Not Analyze
●EPA Removed

Table 3

Crop Fields

1.) Circle Pivot Field NW 32-16-37

Mash Applied	**Rate**
Feb. 2020	6.46 Tons/Per Acre
Dec. 2020	12.0 Tons/Per Acre

Crop Grown	**Yield**
2020 Corn	138 Bushels/Per Acre
2021 Corn	216 Bushels/Per Acre
2022 Fallow	

2.) Circle Pivot Field SE 36-17-37

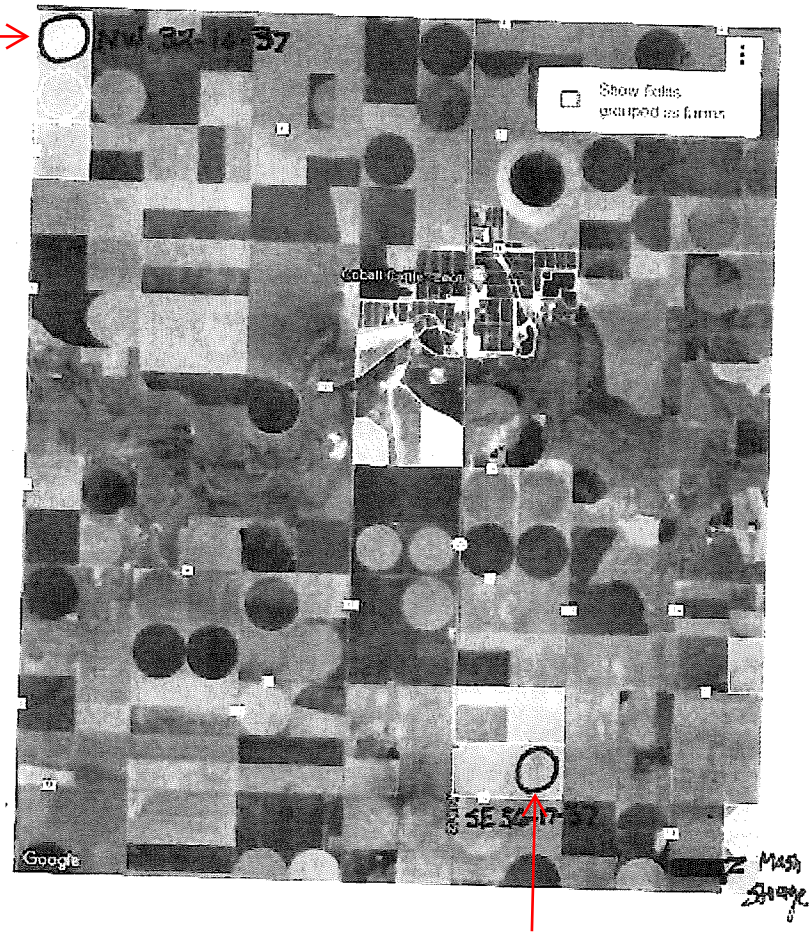
Mash Applied	**Rate**
Jan. 2020	6.35 Tons/Per Acre

Crops Grown	**Yield**
2020 Corn	156 Bushels/Per Acre
2021 Corn	87 Bushels/Per Acre
*2022 Corn	109 Bushels/Per Acre

*Purchased Commercial Fertilizer Due To Lack of Mash To Apply

Table 3 Map

NW 32-16-37



SE 36-17-37

Figure 4

Section 33-17-36 excluding W 2 Cirlces

2020 & 2021 Spreading

	N2 33 Corners	NE 33 Circle	SE 33 Circle	S2 33 Corners	
Acres	90	92	92	93	
		Mash History Tons/A			
2020	7 Ton Dec 20		12 Ton Dec 20	7 Ton July 20	2020
2021		11.96 Ton Aug 21			2021

Crops

	N2 33 Corners	NE 33 Circle	SE 33 Circle	S2 33 Corners	
2020	Corn 104 bu/a	Corn 220 bu/a	Corn 155 bu/a	Wheat 50 bu/a	2020
2021	Fallow	Wheat 66 bu/a	Corn 207 Bu/A	Corn 73.35 bu/a	2021
2022	Wheat	Fallow	Fallow	Fallow	2022

E2 5-18-36

2020 & 2021 Spreading

	NE 5	SE 5	E2 5 Corners	
Acres	120.5	121.5	55	
		Mash History Tons/A		
2020	12.03 Ton July 20			20
2021		11.85 Ton Aug21	3.06 Ton July 21	21

Crops

	NE 5	SE 5	E2 5 Corners	
Crop and Yields				
2020	Wheat 70 bu/a	Silage 261 bu/a	Corn 122 bu/a	20
2021	Corn 207 bu/a	Wheat 91 bu/a	Fallow	21
2022	Wheat	Fallow	Wheat	22

S2 36-17-37

2020 and 2021 Spreading

	SW 36 Circle	SE 36 Circle	SE Corners	
Aces	92	92	70	
		Mash History Tons/A		
2020	10.05 Ton July 20	6.35 Ton Jan 20	6.35 Ton Jan-20	2020
2021				2021

Crops

	SW 36 Circle	SE 36 Circle	SE 36 Corners	
2020	Wheat 28 bu/a	Corn 156 bu/a	Fallow	2020
2021	Corn 174 bu/a	Corn 87 bu/a	Wheat 70 bu/a	2021
2022	Wheat	Corn	Corn	2022

N2 36-17-37

2020 and 2021 Spreading

	SW 105	SE 105	N3 105	
Acres	107.37	106.5	106.5	
		Mash History Tons/A		
2020		3 Ton July 20	6.73 Ton July 20	2020
2021	3.04 Ton July 21			2021

Crops

	SW 105	SE 105	N3 105	
2020	Corn - 121 bu/a	Fallow	Wheat - 43 bu/a	2020
2021	Fallow	Wheat - 82 bu/a	Corn - 79 bu/a	2021
2022	Wheat	Corn	Fallow	2022

E2 36-16-38

	NE 36 Circle	SE 36 Circle	E2 36 Corners	
Acres	92	92	135	

2020 and 2021 Spreading

		Mash History Tons/A		
2020	10.62 Ton Feb 20	12 Ton Dec 20		2020
2021			3.06 Ton July 21	2021

Crops

	NE 36 Circle	SE 36 Circle	E2 36 Corners	
		Crop and Yield		
2020	Corn 222 bu/a	Corn 133 bu/a	Corn 72 bu/a	2020
2021	Wheat 87 bu/a	Corn 199 bu/a	Fallow	2021
2022	Corn	Fallow	Wheat	2022

W 2 32-16-37

	NW 32 Circle	SW 32 Circle	W2 32 Corners	
Acres	92	92	135	

2020 and 2021 Spreading

		Mash History Tons/A		
2020	6.46 Ton Feb 20 & 12 Ton Dec 20	10 Ton Dec 20		2020
2021			3.04 Ton July 21	2021

Crops

	NW 32 Circle	SW 32 Circle	W2 32 Corners	
		Crop and Yield		
2020	Corn 138 bu/a	Corn 200 bu/a	Corn 76 bu/a	2020
2021	Corn 216 bu/a	Corn 137 bu/a	Fallow	2021
2022	Fallow	Fallow	Wheat	2022

NW 5-17-37 Circle

	NW 5 Circle
Acres	92

2020 and 2021 Spreading

	Mash History Tons/A		
2020	3.96 Ton	July 20	2020
2021			2021

Crops

	NW 5 Circle		
2020	Fallow		2020
2021	Wheat	82 bu/a	2021
2022	Corn		2022

S2 N2 13-16-37

	S2 N2 13	
Acres	157	
	Mash History Tons//	
2020	4.03 Ton July 20	2020
2021		2021

Crops

	S2 N2 13	
2020	Fallow	2020
2021	Wheat 89 bu/a	2021
2022	Corn	2022

Figure 5

Risk Exposure Levels for Non Crop-Land

Seed Treatments	LD 50/Acute Dermal Level
*Chlorantraniliprole	> 5000 mg/kg
*Clothianidin	> 4000 mg/kg
*Ipconazole	> 2000 mg/kg
*Tebuconazole	> 2000 mg/kg
*Thiabendazole	> 5000 mg/kg
*Thiamethoxam	> 6000 mg/kg

Any and all soil analysis below these levels will clear and remove non crop-land from the order.

*Information from Office of Pesticide Programs, USEPA, Drill Rear Bldg., 1200 Pennsylvania Ave., Washington, D.C. 20460

Figure 6

N

Treated Seed Receiving Area

Application Equipment

The historical application of the conditioned mash by-product for its agronomic value is via a manure spreader. The equipment for the application of the conditioned mash by-product is very similar to the equipment utilized to apply chicken litter for the fertilizer value. These fields are no-till therefore the mash by-product is not incorporated into the soil. The rate of application varies greatly based upon the agronomic requirements of each field based on agricultural analysis.

Soil Characterization

The fields related to the mash application are all relatively flat well drained quarter sections. Certain fields are managed as a square quarter section and certain fields are managed as a center circle pivot irrigation system with 4 corners managed in a separate way. The soil type is agriculturally similar in each field. There are no major variations in any field.

See attached Soil Survey.

Series 1962, No.

Issued November 1965

SOIL SURVEY

Wichita County, Kansas

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
KANSAS AGRICULTURAL EXPERIMENT STATION

HOW TO USE THIS SOIL SURVEY REPORT

THIS SOIL SURVEY of Wichita County, Kans., will serve several groups of readers. It will help farmers and ranchers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; aid those who wish to plant windbreaks; add to soil scientists' knowledge of soils; and help bankers, prospective buyers, and others in appraising a farm or other tract.

Locating the Soils

At the back of this report is an index map and a soil map consisting of many sheets. On the index map are rectangles numbered to correspond to the sheets of the soil map, so that the sheet showing any area can be located easily. On each map sheet, the soil boundaries are outlined and there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside the area and a pointer shows where it belongs. For example, an area on the map has the symbol Br. The legend for the set of maps shows that this symbol identifies Bridgeport loam. That soil and all others mapped in the county are described in the section "Descriptions of the Soils."

Finding Information

In the "Guide to Mapping Units, Capability Units, and Range Sites" at the back of this report, each soil is listed in alphabetic order of its map symbol. This guide gives the page where each soil is described, and the pages of the capability unit and the range site in which the soil has been placed. It also shows where to find the acreage of each soil, the yields that can be expected, and the information about engineering uses of the soils.

Farmers and those who work with farmers can learn about the soils on a farm by reading the description of each soil and the description of its capability unit and other groupings. A convenient way of doing this is to turn to the soil map and list the soil symbols of a farm and then to use the "Guide to Mapping Units, Capability Units, and Range Sites" in finding the pages where each soil and its groupings are described.

Farmers and others interested in planting windbreaks can refer to the section "Windbreak Management." In that section trees suited to the soils of the county are listed, and management of windbreaks is discussed.

Game managers, sportsmen, and others concerned with wildlife will find information about the main kinds of wildlife and their food and cover in the section "Management for Wildlife."

Ranchers and others interested in range will find the the section "Management of Rangeland" helpful. In that section the soils of the county are placed in groups according to their suitability as rangeland, and the management of each group is discussed.

Engineers and builders will find in the section "Engineering Uses of the Soils" tables that (1) give engineering descriptions of the soils in the county; (2) name soil features that affect engineering practices and structures; and (3) rate the soils according to their suitability for several kinds of work.

Scientists and others who are interested can read about how the soils were formed and how they were classified in the section "Genesis, Classification, and Morphology of Soils."

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers in Wichita County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About the County."

* * * * *

This soil survey was made by the United States Department of Agriculture in cooperation with the Kansas Agricultural Experiment Station to provide a basis for determining the best agricultural uses of the soils. The Soil Conservation Service did the fieldwork for the survey. This work was completed in 1962, and all statements in this report, unless otherwise specified, refer to conditions at that time. The soil survey is part of the technical assistance furnished by the Soil Conservation Service to the Wichita County Soil Conservation District, which was established in 1948. The governing board of that district arranges for technical assistance from the Soil Conservation Service and provides leadership in the countywide program for conserving soil and water. If you want help in planning farm or ranch operations, consult the local representative of the Soil Conservation Service or the county agricultural agent.

Cover picture: Harvesting wheat in Wichita County.

U.S. GOVERNMENT PRINTING OFFICE: 1968

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402

Contents

	Page
How this soil survey was made	1
General soil map	3
1. Richfield-Ulysses association	3
2. Ulysses-Goshen-Potter association	4
3. Ulysses-Mansic association	4
Effects of erosion	5
Descriptions of the soils	6
Alluvial land	7
Bayard series	7
Bridgeport series	8
Colby series	8
Goshen series	8
Humbarger series	9
Lincoln series	9
Lofton series	10
Mansic series	10
Mansker series	12
Manter series	12
Potter series	13
Richfield series	13
Ulysses series	14
Use and management of soils	16
Management of dryland	16
Capability groups of soils	18
Management by capability units (dryland)	19
Predicted yields of crops (dryland)	22
Management of irrigated soils	23
Irrigated capability classes, subclasses, and units	24
Predicted yields of crops (irrigated)	25
Management of rangeland	26
Range sites and condition classes	26
Principles and practices of range management	29
Management for wildlife	30
Windbreak management	30
Engineering uses of the soils	31
Engineering classification systems	31
Engineering interpretations of soils	38
Genesis, classification, and morphology of soils	39
Factors of soil formation	39
Classification and morphology of soils	44
Descriptions of soil series	46
Climate	50
Additional facts about the county	54
Water supply	54
Agriculture	56
Social and industrial development	57
Literature cited	59
Glossary	60
Guide to mapping units, capability units, and range sites	63

Series 1962, No. 7 Issued November 1965

SOIL SURVEY OF WICHITA COUNTY, KANSAS

BY VERNON L. HAMILTON, SOIL SCIENTIST, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH KANSAS AGRICULTURAL EXPERIMENT STATION

WICHITA COUNTY is in the west-central part of Kansas and is the second county east of the Colorado line (fig. 1). The county has an approximate area of 724 square miles, or 463,360 acres. Leoti is the county seat.

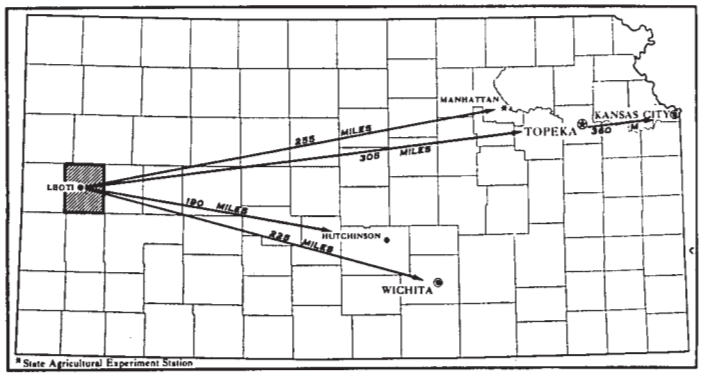


Figure 1.—**Location of Wichita County in Kansas.**

This county has a continental, semiarid type of climate. It is within the High Plains section of the Great Plains physiographic province. The area it occupies is a nearly level to gently rolling part of the High Plains (fig. 2) and lies between the Smoky Hill River to the north and the Arkansas river to the south. In that area the upland plain slopes eastward with a drop of about 15 feet to the mile. It is covered by loess and is dissected by narrow valleys.

The elevation at Leoti is 3,300 feet, and that of the nearly level tableland in the western and northwestern parts of the county is about 3,500 feet. The area that has the lowest elevation, 3,050 feet above sea level, is in the southeastern part of the county along White Woman Creek.

Ladder Creek (locally called Beaver Creek), White Woman Creek, and Sand Creek are streams that flow through this county. Ladder Creek is fed by seep areas in the eastern part of the county, but White Woman Creek and Sand Creek are intermittent streams. Ladder Creek enters the county near the northwestern corner, flows to the south and east through the county, and leaves the county about 9 miles south of the northeastern corner. The valley of Ladder Creek is about one-half mile wide and contains low terraces or benches that are interrupted by the channels of streams. The walls of the valley consist of steep, rough, broken areas where there are outcrops of caliche and gravel.

White Woman Creek rises in the eastern part of Colorado. It enters the county at a point about midway along the Wichita-Greeley County line and leaves the county at a point about 6 miles north of the line between Wichita County and Kearny County.

Sand Creek rises in the southwestern part of the county. It parallels White Woman Creek and joins that creek in Scott County.

White Woman and Sand Creeks have low terraces of sandy alluvium, and high benches of alluvium on either side. The low benches are subject to flooding; the high benches are not flooded when the creeks overflow, but they receive runoff from the uplands. The upland plains are dotted by shallow, undrained depressions, 40 acres or more in size. After severe rains, these depressions are temporarily ponded.

Agriculture is the main occupation in Wichita County, and wheat, grain sorghum, and cattle are the main sources of income. About 75 percent of the acreage is cultivated, and about 15 percent of the cultivated land is irrigated by means of deep-well pumping systems. The slopes adjacent to drainageways, and small areas on the nearly level uplands, are still in native grass.

How This Soil Survey Was Made

Soil scientists made this survey to learn what kind of soils are in Wichita County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform

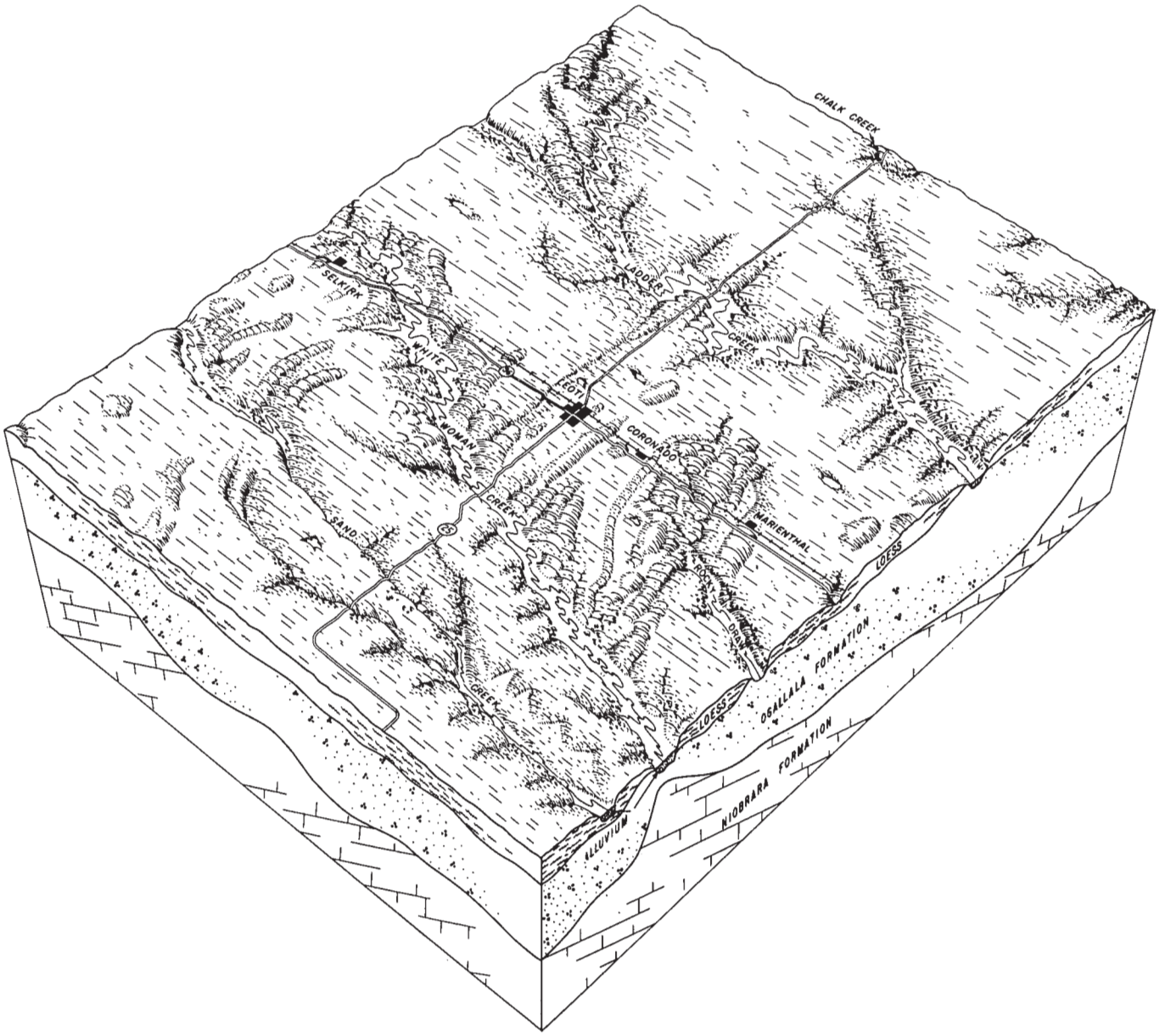


Figure 2.—**Cross section of Wichita County showing the relief and drainage.**

procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Richfield and Ulysses, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those natural characteristics.

Many soil series contain soils that are alike except for the texture of their surface layer. According to this difference in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Mansic clay loam and Manter fine sandy loam, for example, are the names of two soil types. The difference in the texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Ulysses silt loam, 1 to 3 percent slopes, is one of several phases of Ulysses silt loam, a soil type that in this county ranges from nearly level to sloping.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used photos for their base map because they show streams, buildings, field borders, roads, and similar detail that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from these aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed soil maps, the soil scientist has a problem of delineating areas where different kinds of soils are so intricately associated and so small in size, that it is not practical to show them separately on the map. Therefore, he shows these soils as one mapping unit and calls it a soil complex. Ordinarily, a soil complex is named for the major soil series in it, for example, Mansker-Potter complex. Also, in most mapping, there are areas to be shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Alluvial land, and are called land types rather than soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. Based on the yield and practice tables and other data, the soil scientists set up trial groups, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

After study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils, called soil associations. Such a map is the colored general soil map in the back of this report. Each association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic, although not strictly uniform.

The soils within any one association are likely to differ greatly among themselves in some properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general map does not show the kind of soil at any particular place, but patterns of soils.

The soil associations are named for the major soil series in them, but soils of other series may also be present. The major soils of one soil association may also be present in other associations, but in a different pattern.

The general map is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use.

The soils of this county occur on the landscape in patterns that are closely related to the topography of the land surface and to the type of material in which the soils developed. Three such patterns, or soil associations, are in this county. They are described in the following pages.

1. Richfield-Ulysses Association

Deep, nearly level, loamy soils of the High Plains

This association is a part of the High Plains tableland and is in a part of the county that has not been dissected by streams. It consists of broad, continuous flats broken by occasional slight depressions or potholes (fig. 3). The soils are dark colored and silty, and they are deep and well drained. They developed in loess under a cover of native grass. This association occupies about three-fourths of the county.

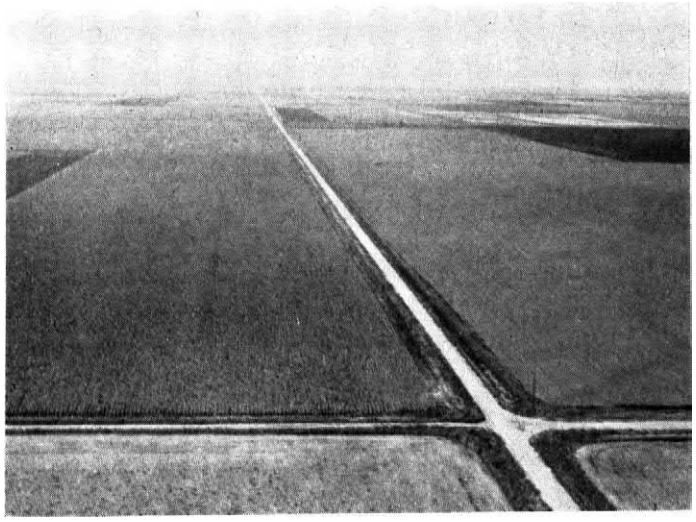


***Figure 3.*—Aerial view of the broad flats typical of association 1.**

Richfield soils occupy about 80 percent of the association. They have a surface layer of dark-colored silt loam that has granular structure and is about 8 inches thick. Their subsoil is dark grayish-brown, firm silty clay loam that has subangular blocky structure.

Ulysses soils occupy most of the rest of the association. Their surface layer is similar to that of the Richfield soils, but it is slightly calcareous in places and is lighter colored in areas that have been cultivated. The subsoil of the Ulysses soils is friable light silty clay loam that is dark grayish brown in the upper part and grayish brown in the lower part.

The soils of this association have moderate to moderately slow permeability. Their surface layer is neutral to mildly alkaline in most places, and their subsoil is neutral

to alkaline. Their substratum is calcareous loess that contains some free lime.

Lofton soils occupy a small acreage on the floors of the depressions in this association. Their surface layer is silty clay loam, and it is underlain by clay.

Wheat and sorghum are grown as cash crops on most of the acreage. Some areas are still in grass, however, and many fields are irrigated and used for growing sugar beets, corn, beans, and truck crops (fig. 4).

Low rainfall tends to limit yields where the soils are not irrigated. Wind erosion is the major hazard in the nearly level areas, but both wind erosion and water erosion are hazards on the sloping soils. Where the soils are dry farmed, practices that conserve moisture are necessary for profitable production of crops.

***Figure 4.*—Corn and sugar beets grown under irrigation on the nearly level Richfield and Ulysses soils of association 1.**

2. Ulysses-Goshen-Potter Association

Deep to shallow, gently sloping to steep, loamy soils in swales and along drainageways

This association occupies the valleys of the major streams in the county (fig. 5). It consists of deep, gently to strongly sloping soils that formed in loess and of steep soils on broken slopes along deeply entrenched drainageways. The steep soils are shallow over caliche or Plains outwash. The soils do not have a well-defined profile. The association occupies about 20 percent of the county.

Gently sloping or moderately sloping Ulysses soils occupy about 50 percent of the acreage in the association. They have a surface layer of moderately dark colored silt loam and a subsoil of dark grayish-brown, friable, calcareous light silty clay loam or silt loam.

Deep, nearly level Goshen soils, in swales and on benches along streams, occupy about 15 percent of the acreage. They have a surface layer of dark-colored silt loam that is 10 to 20 inches thick. The silt loam is noncalcareous and is 18 to 36 inches thick over loess or similar material. The Goshen soils receive extra moisture from the surrounding areas of upland.

Steep, rocky Potter soils that are shallow over caliche occupy a small part of the association. In this county the Potter soils are mapped only in a complex with the Mansker soils. The Mansker-Potter complex occupies about 10 percent of the county. Mansker soils occupy the smoother parts of the complex. Their surface layer is moderately dark colored silt loam, and they are only 12 to 20 inches deep over soft or hard caliche.

The silt loams of this association have moderate permeability. Runoff is medium on the Ulysses and Goshen soils, but it is rapid or very rapid on the shallow, droughty, and stony Potter soils. Wind and water have eroded some areas where the surface layer was formerly silt loam, and calcareous material is at the surface in those areas.

Alluvial land and Colby, Bridgeport, Lincoln, Humbarger, Bayard, and Manter soils occupy about 25 percent of the association. Alluvial land is dark-colored, silty or loamy soil material in areas broken by meandering drainageways or the channels of streams. This land type is useful only for range because the areas are too small and irregular for cropping.

The Colby soils have a surface layer of light-colored silt loam that is about 4 inches thick. Their surface layer has a slightly darker color than the underlying loess. The Colby soils of this association are steep.

The Bridgeport soils are nearly level, moderately dark colored, and calcareous. They are loamy and are on alluvial fans and terraces along creeks.

The Lincoln soils are on the low flood plains of White Woman Creek, and they are subject to damaging floods. They consist of about 8 inches of calcareous sandy loam over loamy sand and gravel.

The Humbarger soils are deep and nearly level, and they are moderately dark colored. They formed in alluvium on flood plains and are subject to occasional flooding.

The Bayard soils are deep, sandy, and calcareous, and they formed in alluvium. They are on benches and alluvial fans along streams.

The Manter soils are deep and sandy. They are on the side slopes of valleys.

Most of the gently to moderately sloping areas of this association are cultivated, but the steep, broken slopes are in native grass. Wheat and sorghum are the principal cultivated crops. Wind erosion and water erosion are serious hazards in the cultivated areas. Where the soils are dry farmed, practices that conserve moisture are necessary for the profitable production of crops.

3. Ulysses-Mansic Association

Deep, gently sloping and undulating, loamy soils of the High Plains

This association is made up mainly of gently sloping and nearly level areas and of undulating soils that have gentle, convex slopes. It occupies an area of about 36 square miles in the east-central part of the county. The southern tip is just north of the main channel of White Woman Creek.

Nearly level and gently sloping Ulysses soils occupy about 60 percent of the association. They have a surface

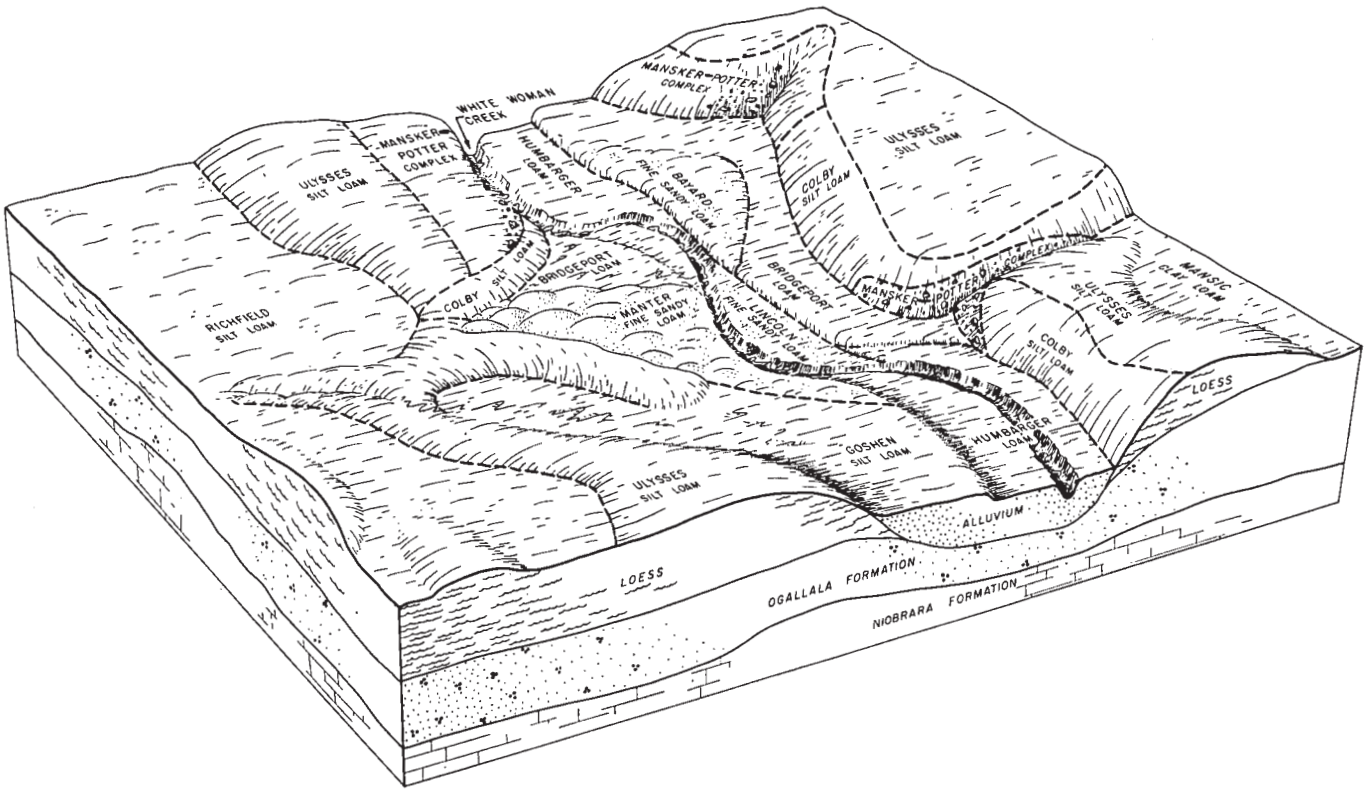


Figure 5.—**Cross section of association 2 along White Woman Creek.**

layer of moderately dark colored silt loam. Below the surface layer is a light-colored, friable, calcareous, loamy layer that is underlain by loess or similar silty sediments.

Deep, nearly level to undulating Mansic soils occupy about 30 percent of the association. In most places their surface layer is calcareous clay loam, but a thin mantle of loam has been deposited over the clay loam in some of the nearly level areas. The Mansic soils have a strongly calcareous layer at a depth of 16 to 28 inches.

Colby soils are on some steep slopes within this association, and they occupy about 10 percent of the acreage. In places the Colby soils are mapped in complexes with eroded Ulysses soils. The Colby soils have a surface layer of light-colored, friable, calcareous silt loam. Where erosion has removed the original dark-colored surface layer of the Ulysses soils, those soils cannot be distinguished from the Colby soils.

Lofton, Mansker, and Potter soils occupy a small acreage in the association. The Lofton soils occupy the floors of the numerous depressions. The Mansker and Potter soils are along entrenched drainageways.

Most of the acreage of nearly level and gently sloping soils is used for cultivated crops, mainly wheat. The steeper areas are in native grass. Conserving moisture and controlling erosion by wind and water are the main problems where cultivated crops are grown.

Effects of Erosion

Erosion is the wearing away of the land surface, mainly by wind, running water, and gravity. Erosion and its effects on the soils of Wichita County are discussed in the following paragraphs. The discussion deals with accelerated soil erosion and not with the gradual, normal process of soil removal, known as geologic erosion, that takes place in an undisturbed environment. Accelerated erosion is the increased rate of soil removal brought about by man through changes in the natural cover or in the condition of the soils.

Wind and water are the main causes of soil erosion in Wichita County. Wind erosion is always a hazard when the soils are dry and unprotected, and it is serious during recurrent droughts (fig. 6). It is serious if the soils are not protected by a cover of growing plants or plant residue, or if the surface layer has not been roughened by tillage. Strong winds and the limited growth of vegetation that are characteristic during periods of drought on the High Plains are conducive to widespread soil blowing. In this county most of the damage from blowing was done in the midthirties and in 1954, but some limy soils still blow and drift during windy periods.

Water erosion is a hazard on all the sloping silty soils that are cultivated. Runoff and erosion occur during the hard, dashing thunderstorms, when rain falls more rapidly than the water can enter the soils. Sheet and rill erosion are serious problems on unprotected, sloping soils after intensive rains (fig. 7). Water erosion normally does little damage in nearly level fields, but rain of high intensity may wash out a newly planted crop or cover it with sediment. Along the drainageways permanent damage may be done by water erosion. Practices that slow or decrease runoff conserve valuable moisture and help to control water erosion.

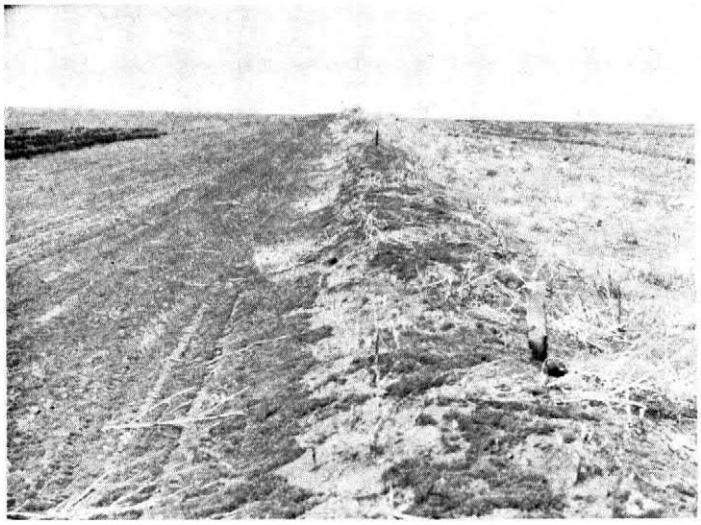


Figure 6.—**A fence row where soil material blown from an unprotected field has accumulated.**

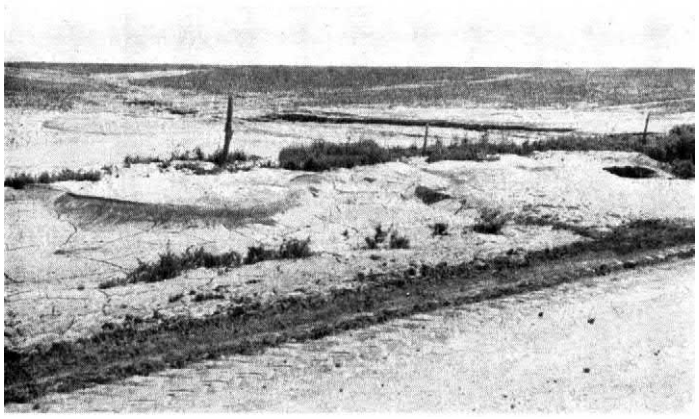


Figure 7.—**Borrow ditch filled with soil material that has washed from the unprotected slopes as a result of water erosion.**

During fieldwork on this soil survey, observations of the effects of erosion were made. Some of the following results of wind erosion were observed:

1. Small, low hummocks and drifts of soil material form in nearly level and smoothly sloping cultivated fields where active soil blowing is in progress. In places along some fence rows, the drifts are as high as 4 feet. These hummocks and drifts will continue to blow unless they are smoothed out and the soils are tilled to provide a roughened surface that resists erosion. If the surface is roughened by tillage, as needed, until vegetation grows, there will be no serious, permanent damage and full use of the soils can be restored.
2. The tops of ridges and knolls in the undulating parts of the Wichita County plains are more exposed to the wind than the adjacent, nearly level areas. Consequently, the soil material in those areas blows more readily than that in the nearly level areas, and much of it has been deposited on the smoother areas nearby. Some of the finer particles have been blown a long distance from the place where they originated. The silty and sandy sediments that remain are generally calcareous. Because calcareous sediments tend to blow more readily than noncalcareous ones, the areas where the surface layer has been removed through erosion are more susceptible to wind erosion than they were originally.
3. Soil material may drift from actively eroding cultivated fields onto adjacent rangeland and may damage or destroy the native vegetation. No permanent damage occurs, but the use of the land is impaired until the grass has become reestablished, either through deferred grazing or by reseeding. Some of the soil material may drift from an actively eroding cultivated field onto another cultivated field that is protected from erosion by weeds or crop residue. This drifting creates problems on the uneroded cultivated field.
4. Sandy and silty sediments deposited on the flood plains damage or destroy the native grass and damage crops. When dry, these sediments blow. They must be cultivated before they are again used for crops or are reseeded to range plants.

In planning erosion control, the climate, crops to be grown, and the characteristics of the soils should all be considered. The farmer must be prepared to change his cropping system and his management if necessary, because the climate of Wichita County is unpredictable. He needs to be prepared for periods of low precipitation and high winds, as well as for rainy periods when severe water erosion is likely to occur. At all times, he needs to keep a protective cover on the soils whenever he can.

Practices that increase erosion by wind and water ought to be avoided. If the fields are tilled too much, the soil is pulverized and is more likely to blow. Also, a loose, powdery soil washes readily during a severe rainstorm. If the pastures are overgrazed, the soils are susceptible to severe erosion. This is particularly true of pastures where the soils are sandy.

In Wichita County eroded phases of the soils are mapped only if erosion has modified some important quality of the soil that is significant to use and management. Examples of eroded phases are Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded, and Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded. Areas that were formerly Ulysses silt loam but that have lost their dark surface layer through erosion have been mapped as Colby silt loam.

Measures needed to control erosion vary according to the kind of soil, the degree of slope, and the land use. A combination of practices that will control erosion at a particular time can generally be chosen. The best defense against erosion is a good cover of vegetation. A protected soil absorbs water, and a soil that has good structure transmits water readily. Practices that will protect the soils from erosion are discussed in the section "Management of Dryland." For additional information, consult a local representative of the Soil Conservation Service.

Descriptions of the Soils

This section is provided for those who want detailed information about the soils of the county. It describes the single soils, or mapping units; that is, the areas on the

detailed soil map that are bounded by lines and identified by a symbol. For more general information about the soils, the reader can refer to the section "General Soil Map" in which broad patterns of soils in the county are described. The acreage and proportionate extent of each soil mapped in the county are given in table 1. Their location is shown on the soil map at the back of the report.

In the descriptions that follow, the soils in a series are first discussed as a group by describing important features that apply to all the soils in the series. The location of the soils in the county is given as well as the position of the soils on the landscape. Some of the nearby or similar soils are named and compared with the soils in the series being described. After the general description of the series there is a broad statement that tells how the soils are used.

Following the description of each series are descriptions of each soil in the series. Generally these descriptions tell how the profile of the soil described differs from the one described as representative of the series. They also tell about the use and the suitability of the soil described and something about its management needs.

Block descriptions of profiles, which give details layer by layer, are not given in this section. A profile that is representative of each soil series is described in the section, "Genesis, Classification, and Morphology of Soils." Some of the terms used in the soil descriptions are defined in the section "How This Soil Survey Was Made." Other terms are described in the Glossary at the back of this report.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil name	Acres	Percent
Alluvial land	950	0.2
Bayard fine sandy loam	1,300	.3
Bridgeport loam	4,000	.9
Colby silt loam, 5 to 15 percent slopes	9,450	2.0
Goshen silt loam	14,800	3.2
Humbarger loam	3,500	.8
Lincoln fine sandy loam	650	.1
Lofton silty clay loam	2,970	.6
Mansic clay loam, 0 to 1 percent slopes	2,960	.6
Mansic clay loam, 1 to 3 percent slopes	800	.2
Mansic clay loam, 1 to 3 percent slopes, eroded	470	.1
Mansic clay loam, 3 to 5 percent slopes	530	.1
Mansker-Potter complex	10,140	2.2
Manter fine sandy loam, 0 to 1 percent slopes	700	.1
Manter fine sandy loam, 2 to 5 percent slopes	630	.1
Richfield silt loam, 0 to 1 percent slopes	266,300	58.0
Richfield silt loam, 1 to 3 percent slopes	3,350	.7
Ulysses silt loam, 0 to 1 percent slopes	70,330	15.2
Ulysses silt loam, 1 to 3 percent slopes	47,850	10.0
Ulysses silt loam, 3 to 5 percent slopes	15,650	3.3
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	5,260	1.1
Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded	770	.2
Total	463,360	100.0

Alluvial Land (An)

This land type consists of deep, loamy alluvial material of the uplands. The areas are broken by the incised, meandering channels of intermittent streams that are subject to overflow. They are at least 150 feet wide and are continuous enough that they can be managed separately for grazing. The soil material is grayish brown and calcareous. Its texture ranges from loam to clay loam, but silt loam is the dominant texture. In some places stratified loamy sand and gravel underlie this land type below a depth of 24 inches.

When this land type is flooded, erosion occurs or new alluvial material is deposited. Most of the areas are still in native grass. (Capability unit VIw–1, dryland; not placed in an irrigated capability unit; Loamy Lowland range site)

Bayard Series

The Bayard soils are well drained, deep, and moderately coarse textured. They developed in calcareous alluvium on fans along Ladder and White Woman Creeks.

In most places the surface layer is grayish-brown or dark grayish-brown fine sandy loam that has granular structure and is about 14 inches thick. It is limy and is friable and easily worked.

The subsoil is generally grayish-brown or dark grayish-brown, structureless light fine sandy loam about 10 inches thick. It is soft and porous, and it contains lime. Below the subsoil is very friable, porous sandy alluvium that contains lime. This sandy material is easily penetrated by roots, but the water table is well below the root zone of adapted crops.

The thickness of the surface layer ranges from 10 to 18 inches. The texture of the subsoil ranges from sandy loam to heavy loamy fine sand.

These soils have medium internal drainage and moderate to moderately rapid permeability. Their capacity for holding moisture available for plants is moderately low. The natural fertility is moderately high, but these soils are susceptible to wind erosion.

The Bayard soils are more sandy than the Bridgeport soils. Their surface layer is thicker than that of the Lincoln soils, and their subsoil contains less sand.

Bayard fine sandy loam (0 to 2 percent slopes) (Ba).—This is the only Bayard soil mapped in the county. Its profile is like the one described for the Bayard series, except that sand and gravel are below a depth of 24 inches in some places. Mapped with this soil are areas of Bridgeport loam and of Lincoln fine sandy loam that are too small to be mapped separately. Sand pockets and gravel bars also occupy small areas.

This Bayard soil is fairly good for cultivated crops, and it is suited to wheat and grain sorghum. Much of the acreage, however, is still in native grass. Most cultivated areas are dry farmed, but a small acreage is irrigated. The areas that are irrigated generally occur with Bridgeport loam. Flash floods that develop in the uplands sometimes damage crops and installations used for irrigation.

Where this soil is in range, yields of grass forage are high. Lack of moisture is a problem where cultivated crops are grown, but wind erosion is the main hazard. Wind erosion occurs whenever this soil is dry and not adequately protected. Stubble-mulch farming and wind stripcropping are practices needed to conserve moisture and to control wind erosion. Some fertilizer is needed to help maintain fertility. (Capability unit IIIe–2, dryland; capability unit IIs–1, irrigated; Sandy Terrace range site)

757-856—65——2

Bridgeport Series

The Bridgeport soils are deep, well drained, and moderately dark colored. They are nearly level and formed in recent alluvium, mainly on fans and terraces. The areas are at the base of steep slopes in the uplands and on the floors of broad valleys along Ladder and White Woman Creeks. Free lime is at or near the surface.

In most places the surface layer is grayish-brown or very dark grayish-brown, limy loam to silt loam that has granular structure and is about 9 inches thick. It is easily worked.

The subsoil is generally light brownish-gray or dark grayish-brown heavy loam that has moderate, fine, granular structure. It is more clayey and contains more free lime than the surface layer. Below the subsoil is friable, porous, silty material that is easily penetrated by roots.

The surface layer ranges from 6 to 14 inches in thickness and from loam to silt loam in texture. The subsoil ranges from 12 to 20 inches in thickness, and from loam to light clay loam in texture. In some places strata of sandy loam and caliche pebbles are below a depth of 24 inches.

These soils have moderate permeability. Their natural fertility and moisture-holding capacity are high, but they are susceptible to erosion by wind and water. Surface runoff is medium, and the water table is well below the root zone of most field crops. Runoff from the nearby upland, however, provides additional moisture for crops.

The Bridgeport soils are more calcareous near the surface and have a less clayey subsoil than the Goshen soils. They are less stratified than the Humbarger soils.

Bridgeport loam (0 to 2 percent slopes) (Br).—This is the only Bridgeport soil mapped in the county. Its profile is like the one described for the Bridgeport series. Areas of this soil range from 10 to 80 acres in size, and they are generally continuous along the creeks. Mapped with this soil are small areas of Goshen silt loam, Bayard fine sandy loam, and Humbarger loam.

About half of the acreage is still in native grass that is used for hay and grazing. This soil is well suited, however, to cultivated crops. Wheat and grain sorghum are suitable dry-farmed crops, and wheat, corn, sugar beets, and alfalfa are suitable irrigated crops.

The main problem in managing this soil is the lack of moisture. When the surface is dry and unprotected, wind erosion is also a hazard. In areas that are dry farmed, stubble-mulch farming, contour stripcropping, and summer fallowing help to control wind erosion and to conserve moisture. Land leveling, use of diversions, and careful management of water are needed to control erosion, to prevent flooding, and to conserve water. Fertilizer should be added to maintain fertility. Runoff is medium, but occasionally crops and irrigation installations are damaged by floodwaters from the uplands. (Capability unit IIIc–1, dryland; capability unit I–1, irrigated; Loamy Terrace range site)

Colby Series

Soils of the Colby series are deep, friable, and light colored, and they have a weakly defined profile. They are gently sloping to strongly sloping and formed in deep loess or in similar silty material along upland drainageways. The soil material in which these soils formed has either not been in place long enough for development of a well-defined profile, or the soil material has been removed through erosion before development of a well-defined profile could take place.

The surface layer is grayish-brown or dark grayish-brown, friable, limy silt loam. It is 2 to 6 inches thick over friable, porous loess that is easily penetrated by roots. The surface layer is slightly darker than the loess because it contains some organic matter. Free lime occurs throughout the profile.

The Colby soils are well drained and have moderate permeability. Surface runoff is medium to rapid. The moisture-holding capacity is moderately high, but these soils are highly susceptible to erosion by wind and water.

The Colby soils are lighter colored and are less leached of lime than the Ulysses soils. They lack the distinct layer of lime in the underlying material that is typical of the Mansic soils.

A large part of the acreage of Colby soils is still in native grass. The steep areas are better suited to grass than to field crops, and they are used as range.

Colby silt loam, 5 to 15 percent slopes (Cd).—This soil has a profile like the one described for the Colby series. It lies along upland drainageways in areas generally 20 to 160 acres in size. Where this soil has been cultivated, water erosion has removed much of the dark surface layer. In those areas the exposed underlying material is lighter colored and contains more lime than the original surface layer.

Mapped with this soil is a small acreage of Mansker and Potter soils. Also included are the steeper parts of erosional valley walls, drainageways, and stream channels. In some areas there are outcrops of stony material. In places the substratum contains pockets of sand, and outcrops of sand and gravel are on the steep slopes where geologic erosion has occurred.

This soil is not suited to cultivation. Where it is cultivated, yields of crops are low and the soil is subject to severe erosion by wind and water. Nearly all of the acreage is in native grass and is used for range, but a few small areas are a part of cultivated fields. Areas that have been cultivated are severely eroded and should be seeded to native grass.

Careful management is needed to produce adequate yields of forage for livestock and to provide sufficient cover for this soil. Suitable management practices are proper range use through deferred grazing, or rotation-deferred grazing and maintaining a proper stocking rate. (Capability unit VIe–1, dryland; not placed in an irrigated capability unit; Limy Upland range site)

Goshen Series

The Goshen series consists of deep, friable, silty soils that are dark colored and nearly level. These soils are on benches and on the bottoms of upland swales.

In most places the surface layer is dark grayish-brown or very dark grayish-brown silt loam about 10 inches thick. This layer is friable and has granular structure. Immediately below the surface layer is a layer of dark-colored, light silty clay loam that is about 10 inches thick. This light silty clay loam has granular structure and contains a few worm casts.

Generally the subsoil is silty clay loam that has subangular blocky structure. The upper part of the subsoil is dark grayish brown. The lower part is grayish brown or dark grayish brown and contains some lime.

Below the subsoil are silty colluvial and alluvial sediments washed from the surrounding uplands. The sediments are friable and are easily penetrated by roots.

The layer immediately below the surface layer ranges from silt loam to silty clay loam in texture and from 8 to 12 inches in thickness. The texture of the subsoil ranges from light silty clay loam to silty clay loam, and the thickness of the subsoil ranges from 8 to 12 inches.

The Goshen soils are well drained. They receive additional moisture from runoff from the surrounding uplands. The available moisture holding capacity is high. These soils have high natural fertility, but they are susceptible to wind erosion. Lime is at a depth of 18 to 36 inches.

The Goshen soils are darker than the Bridgeport soils. They also have a B horizon of silty clay loam that is lacking in the Bridgeport soils, and they are leached of lime to a greater depth than those soils. Their profile is similar to that of the Richfield and Ulysses soils. Their surface layer is thicker and darker than that of the Richfield and Ulysses soils, however, and their profile is leached of lime to a greater depth.

Wheat is the crop most commonly grown on these soils, but sorghum is also grown. Part of the acreage is in native grass. Some areas of these soils are irrigated.

Goshen silt loam (0 to 1 percent slopes) (Go).—This is the only Goshen soil mapped in the county, and its profile is like the one described for the Goshen series. The areas range from 20 to 160 acres in size. Runoff is medium.

This soil is fertile, and it is important for agriculture. It generally does not make up a whole field, however, but is farmed with adjacent soils. About half of the acreage is cultivated. Yields are slightly higher on this soil than on the nearly level or gently sloping associated Richfield and Ulysses silt loams.

Where this soil is irrigated, yields are high. Wheat and grain sorghum are the chief dry-farmed crops, and corn, beans, sugar beets, and truck crops are the chief irrigated crops.

The main problem in managing this soil is the lack of moisture, which tends to limit crop production. Wind erosion is also a hazard if the soil is dry and unprotected. If dry-farmed crops are grown, stubble-mulch farming and contour stripcropping are needed to control blowing and to conserve moisture. In most years summer fallowing is also necessary to store moisture. On irrigated land such practices as land leveling, use of underground pipes, and careful management of the irrigation water are necessary to control erosion and evaporation. These practices also insure uniform penetration of water. Fertilizer should be added to maintain fertility. (Capability unit IIIc-2, dryland; capability unit I-1, irrigated; Loamy Terrace range site)

Humbarger Series

In the Humbarger series are deep, moderately dark soils formed in alluvium. The soils are of the flood plains of Ladder and White Woman Creeks.

In most places the surface layer is grayish-brown or dark grayish-brown loam about 12 inches thick. It is limy and has granular structure.

The subsoil is grayish-brown or dark grayish-brown heavy loam or light clay loam. It has moderate, medium, granular structure.

The underlying material is loamy alluvium over stratified loamy and sandy sediments. This material is limy. It is easily penetrated by roots.

The surface layer ranges from loam to light clay loam in texture and from 9 to 15 inches in thickness. The underlying material is generally loam to clay loam, but it contains thin layers of sandy loam.

These soils are well drained. They have high natural fertility and high available moisture holding capacity. Surface runoff is slow and permeability is moderate. The water table is well below the root zone of most crops.

These soils are flooded occasionally by the waters of meandering streams. Fresh soil material is deposited during the more damaging floods. Scouring and deposition of soil material occur along the channels of the streams.

The Humbarger soils are more stratified than the Bridgeport soils, and they are on flood plains rather than on fans and stream terraces. Their subsoil is less clayey than that of the Goshen soils, and they have lime near the surface.

Humbarger loam (0 to 1 percent slopes (Hu).—This is the only Humbarger soil mapped in the county. Its profile is like the one described for the Humbarger series. This soil is on the flood plains of Ladder and White Woman Creeks. The areas are small, but they are generally continuous along the channel of the creeks.

This soil is fertile. About half of the acreage is cultivated, and crops are grown year after year on some fields. Alfalfa, corn, and sudangrass are the best suited crops. Wheat and sorghum are also grown, but wheat may be damaged by flooding in spring, and sorghum may be affected by chlorosis. Where this soil is used for grazing, yields of forage are high.

The chief management problem is the hazard of flooding. Floods are not frequent, but after a large amount of rain has fallen upstream, scouring is to be expected in the channels, and soil material is generally deposited on this soil. Such practices as proper tillage and stubble-mulch farming are needed to conserve moisture and reduce erosion. Some fertilizer is necessary to maintain fertility. (Capability unit IIIw-1, dryland; not placed in an irrigated capability unit; Loamy Lowland range site)

Lincoln Series

The Lincoln soils are calcareous and sandy. They are on the flood plains of Ladder and White Woman Creeks.

In most places the surface layer is calcareous fine sandy loam 4 to 12 inches thick. The substratum is calcareous, stratified alluvial sand and loamy fine sand.

These soils are generally limy to the surface. In some places, however, they are leached to a depth of 8 inches.

These soils are excessively drained. They have very rapid permeability and low natural fertility. The water table is more than 10 feet below the surface. These soils are highly susceptible to wind erosion and are frequently flooded. As a result of the flooding, channel cutting occurs, and sandy material is deposited on these soils.

Gravel and sand bars that are a source of material for roads and for other construction work are at or below the surface.

The Lincoln soils are more frequently flooded than the Bayard soils, and their substratum contains more sand and gravel. They are more sandy than the Humbarger soils.

Lincoln fine sandy loam (0 to 2 percent slopes) (Lf).—This is the only Lincoln soil mapped in the county. Its profile is like the one described for the Lincoln series. This soil is on flood plains. The areas are small but are long and narrow. Small areas of deeply entrenched creek channels and of broken sandy slopes were included in mapping. Surface runoff is slow.

This soil is not suitable for field crops, because the available moisture holding capacity is low and flooding is a hazard. Range is probably the best use; most of the acreage is in native grass used for range. The native vegetation is sparse and consists of mid and short grasses, sand sage, and yucca. Rotation-deferred grazing, control of grazing, and use of a proper stocking rate will help to maintain sufficient forage for grazing and a protective cover for this soil. (Capability unit VIIw–1, dryland; not placed in an irrigated capability unit; Unstable range site)

Lofton Series

In the Lofton series are deep, dark, nearly level soils on the floors of depressions throughout the tableland. The depressions have no surface drainage and are locally called potholes or buffalo wallows. The soils receive runoff from surrounding areas.

The surface layer is dark gray or very dark gray, firm silty clay loam about 6 inches thick. It has granular structure and is leached of lime.

The subsoil is light clay 18 to 30 inches thick. It has prismatic structure that breaks to blocky structure. The upper part of the subsoil is free of lime, but the lower part is limy.

The underlying material is loess. The loess has a texture of silty clay loam and contains much lime.

These soils have very slow permeability and moderate available moisture holding capacity. They are moderately well drained. Water stands on the surface for short periods. In some years wetness ruins crops. Wind erosion is also a hazard when the surface is not protected by a growing crop or by crop residue.

The Lofton soils are darker than the Richfield and Ulysses soils. They also contain more clay.

The Lofton soils are generally used like the surrounding soils. Those in some of the larger depressions, however, are cultivated only in years of lower than average rainfall.

Lofton silty clay loam (0 to 1 percent slopes) (Lo).—This soil has a profile like the one described for the Lofton series. It is the only Lofton soil mapped in the county. The areas range from 3 to 40 acres in size and are on the floors of upland depressions. This soil occurs mainly with nearly level Goshen, Richfield, and Ulysses silt loams.

Wheat and grain sorghum are suitable crops. Where they are grown, the main problems in managing this soil are wind erosion, too much or too little moisture, and the poor tilth. At times, water is ponded on the surface long enough for planting and harvesting to be delayed; crops are frequently ruined by excess water and must be replanted. Terraces constructed on the surrounding uplands can help to prevent excess water from accumulating in the depressions. Stubble mulching is also needed to control blowing, to conserve moisture, and to improve workability. (Capability unit IVw–1, dryland; not placed in an irrigated capability unit; Unstable range site)

Mansic Series

In the Mansic series are moderately dark, calcareous soils that are nearly level to sloping. These soils are in the east-central part of the county.

In most places the surface layer is dark grayish-brown or very dark grayish-brown clay loam that is about 10 inches thick. In areas that have not been disturbed, this layer has granular structure and a texture of light clay loam. In cultivated areas the plow layer is somewhat more sandy.

The subsoil is grayish-brown or dark grayish-brown clay loam that contains more clay than the surface layer. It has medium granular structure and is about 6 inches thick.

Below the subsoil is friable loam to clay loam Plains outwash that contains much lime. A strongly calcareous layer that can be penetrated by roots is at a depth of 24 inches.

The thickness of the surface layer ranges from 8 to 12 inches. The texture of that layer ranges from loam to clay loam.

The Mansic soils are well drained. Surface runoff is medium, and permeability is moderate. The available moisture holding capacity is moderately high in the surface layer and the subsoil. These soils have moderate to high natural fertility but are susceptible to erosion by wind and water.

Below the subsoil, the Mansic soils have a more distinct strongly calcareous layer than the Ulysses soils. They are similar to the Colby soils, but they have a surface layer of clay loam instead of silt loam.

The Mansic soils are better suited to wheat and the native grasses than to grain sorghum (fig. 8). Grain sorghum grown on these soils is likely to be affected by chlorosis because the high content of lime makes iron unavailable to the plants. Irrigation is not practiced intensively on the Mansic soils, because the wells in the part of the county where these soils occur yield only a small amount of water.

Mansic clay loam, 0 to 1 percent slopes (Ma).—This soil is on the upland in the east-central part of the county, below the level of the silty tableland. It has a profile like the one described for the Mansic series. Mapped with it are small areas of Ulysses silt loam, 0 to 1 percent slopes. Small eroded areas are also included.

This Mansic soil is fairly desirable for crops. The areas range from 40 to 160 acres in size, and most of them are cultivated. The soil is suited to wheat and sorghum. Sorghum is likely to be affected by chlorosis, however, because of the high content of lime in the lower part of the profile. The chief management problems are wind erosion and the small amount of rainfall. Water erosion is not a hazard, because the areas are nearly level and most

of the water soaks in. There is only a medium amount of runoff. Nevertheless, this soil will blow if it is not adequately protected by a growing crop or crop residue. Stubble mulching is needed to control or minimize wind erosion. Summer fallowing is necessary to store moisture for crops.

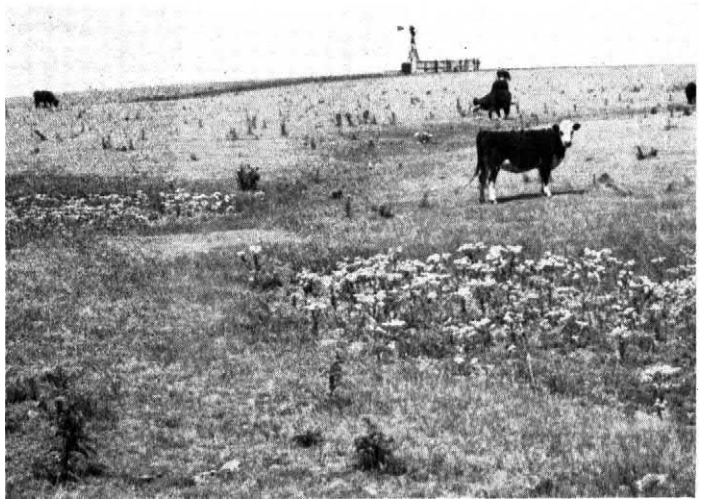


Figure 8.—**Cattle grazing on a Mansic soil of the Limy Upland range site.**

Wheat, grain sorghum, forage sorghum, corn, and alfalfa are suitable irrigated crops. Practices that control water erosion, conserve water, and maintain fertility are needed where this soil is irrigated. Land leveling, use of underground pipes for conducting water, and desirable practices for managing the water are all needed. These practices help to control erosion, conserve water, and distribute water more evenly. Fertilizer is needed to help maintain fertility. (Capability unit IIIc–1, dryland; capability unit I–1, irrigated; Limy Upland range site)

Mansic clay loam, 1 to 3 percent slopes (Mb).—This soil is on the uplands in areas adjacent to Mansic clay loam, 0 to 1 percent slopes. Its profile is like the one described for the Mansic series, except that it is less deep. The surface layer is calcareous light clay loam about 8 inches thick. The layer that is high in lime is at a depth of about 20 inches. Mapped with this soil are small areas of Mansker soils and of eroded Ulysses and Colby silt loams. Also included are small eroded areas less than 3 acres in size.

About half of the acreage is in native grass. Wheat and sorghum are suitable dry-farmed crops; corn, alfalfa, and tame grasses are suitable irrigated crops on the small acreage that is irrigated. Surface runoff is medium, and the moisture intake rate is good.

The main problems in managing this soil are the hazards of erosion by wind and water, and lack of moisture. Another major problem is the decrease in fertility if the soil is cultivated year after year and erosion is allowed to continue. Good management is needed to maintain fertility.

Terracing and contouring are needed to conserve moisture and to keep water erosion to a minimum. Stubble mulching is needed to prevent or minimize wind erosion. If satisfactory yields of dry-farmed crops are to be obtained, this soil must be summer fallowed so that moisture will be stored for crops.

Bench leveling is needed, and the irrigation water should be run through underground pipes. These practices reduce erosion and conserve irrigation water, and they require less labor than other practices. They also make it possible to store water in the soil and to distribute water to a uniform depth throughout an entire field. Contour ditch and contour furrow irrigation with terraces will also increase the amount of moisture that can be stored and will reduce runoff and erosion. Fertilizer is needed to maintain fertility. (Capability unit IIIe–1, dryland; capability unit IIe–1, irrigated; Limy Upland range site)

Mansic clay loam, 1 to 3 percent slopes, eroded (Me).—This gently sloping soil is on the upland in the east-central part of the county. Its profile is like the one described for the series, except that a large part of the surface layer has been removed, mainly through water erosion. Because of erosion, much of the organic matter, formerly in the surface layer, has been lost.

The light-colored calcareous layer is about 6 inches thick. In some places this layer is underlain by a layer high in content of lime. Some areas have been eroded to the extent that this limy layer is at the surface. Also, in some areas the plow layer is a mixture of material from the subsoil and the surface layer. The surface layer tends to slick over during heavy rains because it contains slightly more clay than that of the uneroded Mansic soils, and it is low in organic matter. Mapped with this soil are small areas of Mansker soils and of Mansic clay loam, 1 to 3 percent slopes.

All of the acreage has been cultivated, and part of it is still under cultivation. The areas range from 20 to 80 acres in size. Their boundaries are generally along the borders of fields. Wheat is the most suitable crop. Grain sorghum grown on this soil is likely to be affected by chlorosis, a yellowing of the leaves induced by excess lime and lack of available iron in the soil.

Because this soil is eroded and is high in content of lime, it probably should be reseeded to suitable native grasses and used for range. The main problems are past erosion, the small amount of rainfall received each year, susceptibility to further erosion by wind and water, and the need to maintain a balance between the supply of plant nutrients and the supply of moisture. Practices that will conserve moisture and protect this soil from erosion are stubble mulching, terracing, and cultivating on the contour. Commercial fertilizer and manure are needed to improve fertility.

This soil is productive in years when rainfall is above average. If it is not protected, however, and if further erosion is not controlled, the soil will become unproductive. It can be used safely for cultivated crops only if wind and water erosion are controlled by careful management.

This soil is not well suited to irrigated crops unless it is bench leveled and fertilizer and soil amendments are applied. Wheat, corn, alfalfa, and tame grasses are crops suited to irrigation. (Capability unit IVe–1, dryland; capability unit IIe–1, irrigated; Limy Upland range site)

Mansic clay loam, 3 to 5 percent slopes (Mg).—In most places this soil lies below areas of Mansic clay loam, 0 to 1 percent slopes, or below areas of Mansic clay loam, 1 to 3 percent slopes. It is on the uplands, mainly in the east-

central part of the county. The areas are small, generally only 40 to 80 acres in size. The surface layer is thinner than the one in the profile described for the Mansic series.

Where this soil has been cultivated, erosion has thinned the surface layer to some extent. The layer of calcareous clay loam is about 6 inches thick, and the layer that is high in content of lime is about 16 inches below the surface. Mapped with this soil are small areas of soils of the Mansker-Potter complex and small areas of eroded Ulysses and Colby silt loams.

This Mansic soil is fairly desirable for crops. Wheat and grain sorghum are suitable crops, but most of the acreage is still in grass. The main problems where cultivated crops are grown are the moderately rapid runoff, the limited amount of moisture from rainfall, and the need to maintain a balance between the supply of plant nutrients and the supply of moisture.

This soil washes readily. Also, it blows readily if clods are not kept on the surface, or if it is not adequately protected by a cover of growing plants or plant residue. Terraces are needed to control water erosion, and contour farming will also reduce water erosion and conserve moisture. Contour stripcropping is effective if it can be used. Stubble mulching helps to control wind and water erosion. Summer fallowing is necessary so that moisture will be stored for the crop that follows.

Unless management is practiced that will maintain the fertility, control erosion, and conserve moisture, this soil becomes eroded, unproductive, and no longer suitable for crops. It may be used safely for cultivated crops only if intensive management is used that will protect it and conserve moisture. (Capability unit IVe-1, dryland; not placed in an irrigated capability unit; Limy Upland range site)

Mansker Series

Mansker soils are light colored, moderately sloping, and moderately deep over caliche. They are on the smooth sides of entrenched upland drainageways, surrounded by areas of steep soils. They are below the summit of the nearly level tableland.

In most places the surface layer is grayish-brown or dark grayish-brown, calcareous heavy silt loam or loam about 6 inches thick. It has granular structure.

Immediately below the surface layer is a layer of clay loam or light silty clay loam that has granular structure. The upper part of this layer is light brownish gray or pale brown. The lower part is very pale brown or pale brown, and it contains soft lime nodules.

The substratum is at a depth of 18 inches. An abrupt boundary separates it from a layer that contains much lime in the form of hard and soft caliche.

The texture of the surface layer ranges from loam to silt loam, and the thickness of that layer ranges from 4 to 8 inches. The thickness of the layer immediately below the surface layer ranges from 9 inches on the steeper slopes near the Potter soils to 16 inches on the smoother slopes near soils developed in loess.

The Mansker soils are well drained. Internal drainage is medium, and the available moisture holding capacity is moderate. These soils are moderately fertile, but they are susceptible to water erosion.

The Mansker soils have more calcium carbonate in the substratum than the Mansic soils. They are deeper over caliche than the Potter soils.

The Mansker soils are better suited to native grasses for range than to cultivated crops. They are highly susceptible to water erosion if they are cultivated.

Mansker-Potter complex (3 to 25 percent slopes) (Mm).—The soils of this complex are so intermingled that it was not practical to map them separately. The profile of the Mansker soil is like the one described for the Mansker series, and the profile of the Potter soil is like the one described for the Potter series. The areas are small. About 45 percent of the acreage consists of Mansker soils; 35 percent, of Potter soils; 10 percent, of Colby silt loam, 5 to 15 percent slopes; 5 percent, of Mansic clay loam, 3 to 5 percent slopes; and 5 percent, of stony outcrops of caliche. The outcrops of caliche are in the geologically eroded, steep areas along drainageways.

These soils are not suited to cultivation, but are suited only to grazing. They are mainly in pastures consisting of native grass. The rapid runoff from the moderately steep, rugged areas of Potter soils causes some local flooding. Runoff is less rapid from the smoother areas of Mansker soils.

The chief problems in managing these soils are the moderate to steep slopes, the damage caused by severe rainstorms, and the moderate to low available moisture holding capacity. If the native grass is well managed, good yields of forage are obtained. Much of the original cover of grass has been thinned by overgrazing, but the soils support a moderate to good stand of native grass that consists mainly of blue grama, side-oats grama, and little bluestem.

Grazing must be carefully controlled for high production of forage. Rotation grazing should be practiced so that a good cover of grass will be maintained, the intake of water increased, and more moisture conserved. (Capability unit VIe-2, dryland; not placed in an irrigated capability unit; Limy Upland and Breaks range sites)

Manter Series

The Manter soils are deep, friable, and nearly level to moderately sloping. They are on uplands along Ladder and White Woman Creeks.

In most places the surface layer is brown or dark-brown fine sandy loam that has granular structure and is about 16 inches thick. This layer contains a few worm casts and is free of lime. Where cultivated crops have been grown, the plow layer has been winnowed, wind has blown away the fine particles, and the texture is now light fine sandy loam.

The subsoil is generally grayish-brown or dark grayish-brown, calcareous fine sandy loam about 15 inches thick. It has moderate, medium, granular structure. The underlying material is loamy. It is porous and friable, and it contains lime.

The thickness of the surface layer ranges from 8 to 18 inches. Where these soils grade to more silty soils, the subsoil is less sandy than the one in the profile described.

These soils are well drained. They have moderate permeability and moderate available moisture holding capacity. The soil-moisture relationship is good, and natural fertility is moderately high. These soils are more susceptible to wind erosion than to water erosion.

The Manter soils are more sandy than the Ulysses soils. They are leached of lime to a greater depth than are the Colby soils.

Manter fine sandy loam, 0 to 1 percent slopes (Mn).—This soil is on high benches adjacent to Ladder and White Woman Creeks. The areas range from 20 to 40 acres in size. The profile is like the one described for the Manter series. Depth to calcareous material ranges from 12 to 20 inches. Included in the mapping are small areas of Goshen silt loam.

This Manter soil is productive. Some areas are irrigated, but about half the acreage is still in native grass. Wheat, grain sorghum, and forage sorghum are suitable dry-farmed crops, and corn, beans, and alfalfa are suitable irrigated crops.

The main problems in managing this soil are soil blowing, the small amount of rainfall, the hot dry winds, and the need to maintain a balance between the supply of plant nutrients and the supply of moisture. If this soil has been cultivated, it will blow if it is summer fallowed without adequate protective cover. Wind stripcropping and stubble mulching, which keep crop residue on the surface, are practices that control or minimize soil blowing. Runoff is slow, and this soil absorbs water readily; therefore water erosion is not a hazard. (Capability unit IIIe–2, dryland; capability unit IIs–1, irrigated; Sandy range site)

Manter fine sandy loam, 2 to 5 percent slopes (Ms).—This soil occupies small areas along Ladder and White Woman Creeks. Its profile is similar to the one described for the Manter series. The surface layer, however, is only about 12 inches thick. In areas that have been cultivated, the surface layer is lighter colored and contains less organic matter than the one in the typical profile. The subsoil is only about 10 inches thick and ranges from sandy loam to loam in texture. Depth to the subsoil ranges from 8 to 16 inches. Mapped with this soil are small, eroded areas that are light colored and calcareous.

If intensive management is practiced, this soil is suited to cultivation, and grain sorghum and forage sorghum are suitable crops. The lack of moisture, however, tends to limit crop production. Where this soil is used for grazing, native grass is well suited. Sudangrass is also grown and is used for green pasture.

Runoff is medium, and this soil is subject to erosion by wind and water. The soil can be cultivated safely only when erosion is controlled. Contour stripcropping and terracing are practices that control erosion and conserve moisture. Stubble mulching, which keeps crop residue on the surface, is needed to control soil blowing. Some fertilizer is needed to maintain fertility. (Capability unit IVe–2, dryland; not placed in an irrigated capability unit; Sandy range site)

Potter Series

The Potter soils are shallow over caliche. They are steep and stony, and they are light colored. These soils are on the sides of entrenched drainageways in the uplands along Sand, Ladder, and White Woman Creeks.

In most places the surface layer is grayish-brown or dark grayish-brown, calcareous loam to silt loam about 6 inches thick. It has granular structure.

The layer immediately below the surface layer is light brownish-gray or grayish-brown light clay loam about 5 inches thick. It has weak, granular structure. The underlying material is hard, fractured caliche.

The surface layer ranges from loam to silt loam in texture and from 4 to 7 inches in thickness. The layer immediately below the surface layer generally ranges from less than 4 to about 6 inches in thickness.

In many places geologic erosion has removed the mantle of loamy sediments and has exposed the hard underlying caliche. The diameter of the pieces of fractured caliche ranges from 6 inches to 3 feet.

The Potter soils are well drained but are droughty. Internal drainage is moderately rapid, and the available moisture holding capacity is low. The soils have moderate natural fertility and are highly susceptible to water erosion. The caliche limits the penetration of roots.

In this county the Potter soils occur only in a complex with the Mansker soils, but they are thinner over caliche than those soils. They are suited only to range and should be kept in native grass.

Richfield Series

In the Richfield series are deep, friable, dark, silty soils of the loess-mantled tableland. The soils are mainly in wide, nearly level areas of the uplands, but some gently sloping areas are on the nearby slopes. These are the most extensive soils in the county.

In most places the surface layer is dark grayish-brown or very dark grayish-brown heavy silt loam that has weak to moderate, medium, granular structure and is about 8 inches thick. It is free of lime and easily worked.

The subsoil is generally dark grayish-brown or very dark grayish-brown, noncalcareous silty clay loam that has moderate, medium, subangular blocky structure and is about 12 inches thick. It contains more clay than the surface layer.

Below the subsoil is friable, porous, silty loess. The loess is limy and is easily penetrated by roots.

The thickness of the surface layer ranges from 4 to 11 inches, and that of the subsoil ranges from 8 to 15 inches.

These soils are naturally well drained. Internal drainage is medium, and permeability is moderately slow. The available moisture holding capacity is good. These soils have high natural fertility but are susceptible to erosion by wind and water.

The Richfield soils have a thinner surface layer and are less deeply leached of lime than the associated Goshen soils of the swales. They are similar to the Ulysses soils, but their subsoil is noncalcareous silty clay loam.

Most of the acreage of Richfield soils is cultivated. The soils are suited to native grass and to wheat and other dry-farmed crops, but winter wheat and grain sorghum are the crops most commonly grown.

These soils are suited to irrigation, but the irrigated areas are mainly in the northern part of the county. Crops grown under irrigation are wheat, sorghum, corn, beans, alfalfa, sugar beets, and specialty crops.

Richfield silt loam, 0 to 1 percent slopes (Rm).—This is the most extensive soil in the county, and it is on the tableland. Its profile is like the one described for the Richfield series, but depth to limy material ranges from 14 to 24 inches. Mapped with this soil are small areas of Ulysses and Goshen silt loams.

This Richfield soil is well suited to crops, and nearly all the acreage is cultivated. The areas range from 320 to 640 acres in size. Wheat and grain sorghum are the chief dry-farmed crops.

The main problems in managing this soil are the lack of moisture and the hazard of wind erosion when the soil is dry and is not protected. Runoff is slow to medium, and water erosion is not a hazard. Summer fallowing and stubble mulching are practices that will conserve moisture and reduce wind erosion. In most years yields of dry-farmed crops are satisfactory if this soil has been summer-fallowed the previous year.

This soil holds a large amount of water and is well suited to irrigation. Wheat, sorghum, corn, beets, beans, alfalfa, and truck crops are suitable irrigated crops. Land leveling is needed to reduce erosion and to insure the uniform penetration and storage of irrigation water. Using underground pipes for conducting the water also conserves moisture and reduces erosion. The irrigation water should be applied carefully to prevent overirrigating and loss of tail water. Fertilizer is needed to increase yields and to maintain the fertility of the soil. Manure should be added, if available. (Capability unit IIIc–1, dryland; capability unit I–1, irrigated; Loamy Upland range site)

Richfield silt loam, 1 to 3 percent slopes (Rn).—This soil is mainly on uplands in the northern part of the county. Its profile is similar to the one described for the Richfield series, but it is less deep. The subsoil is only 10 inches thick, and limy material is at a depth of 12 to 18 inches. In most places the slope is no greater than 2 percent. Mapped with this soil are areas of Ulysses silt loam, 1 to 3 percent slopes, that are too small to be mapped separately.

This is a fertile soil. About half of the acreage is cultivated, and the rest is in native grass. In areas that are dry farmed, wheat and grain sorghum are suitable crops. Some areas are irrigated and are used mainly for growing corn, wheat, grain sorghum, and sugar beets.

Water erosion is the main hazard on this soil. Runoff is medium; the amount of runoff is slightly greater than on Richfield silt loam, 0 to 1 percent slopes. Controlling wind erosion and conserving moisture are also problems in managing this soil. The lack of moisture tends to limit crop production. Such practices as terracing and contour farming help to control water erosion and conserve moisture. Stubble mulching is needed to control or reduce wind erosion. When the soil is fallowed in summer, it should be tilled only enough to control weeds.

Where this soil is irrigated, contour furrows and contour ditches with terraces will reduce erosion and increase the amount of water stored in the soil. Underground pipes conserve water and prevent erosion in the ditches. Bench leveling requires less labor than other practices, and it also reduces erosion and increases the uniform penetration of water. The irrigation water must be managed carefully to prevent overirrigation and excessive loss of tail water.

This soil needs fertilizer to maintain its fertility and to increase yields. Manure, where available, should be applied. (Capability unit IIIe–1, dryland; capability unit IIe–1, irrigated; Loamy Upland range site)

Ulysses Series

In the Ulysses series are deep, moderately dark, nearly level to moderately sloping, well-drained soils of the uplands. These soils formed in loess or similar silty sediments, and they have a weakly defined profile. They occur with the Richfield and Colby soils.

In most places the surface layer is dark grayish-brown, friable silt loam that has granular structure and is about 9 inches thick. It is easily worked and takes water fairly well. This layer contains a few worm casts.

The subsoil is generally about 10 inches thick and is more clayey than the surface layer. The upper part is light silty clay loam that has medium, granular structure. The lower part is slightly lighter colored silt loam that has fine, granular structure. This layer is easily penetrated by roots and water. It contains numerous worm casts.

Below the subsoil is limy, friable silty loess. The loess is massive. It is easily penetrated by roots and water.

The surface layer ranges from 6 to 12 inches in thickness and from light silty clay loam to loam in texture. In cultivated fields where part of the subsoil has been mixed with the surface layer, the subsoil is as thin as 5 inches in some places.

These soils are well drained, and their available moisture holding capacity is high. Natural fertility is high, but these soils wash and blow if they are not protected.

The Ulysses soils have a lighter colored, less well-defined profile than the Richfield soils, and their subsoil contains less clay. Their surface layer is thicker and darker than that of the Colby soils, and their subsoil is leached of lime to a greater depth.

Most of the nearly level areas of Ulysses soils are used for cultivated crops, mainly wheat. Where the soils are dry farmed, summer fallowing is necessary for favorable yields. Part of the acreage is irrigated, mainly with the Richfield soils. Most of the irrigated areas are in the northern part of the county. The steeper areas are best suited to native grass.

Ulysses silt loam, 0 to 1 percent slopes (Ua).—This soil occurs with Richfield silt loam, 0 to 1 percent slopes, on uplands throughout the county. Its profile is similar to the one described for the Ulysses series. The thickness of the surface layer in cultivated areas, however, ranges from 9 to 10 inches, and it ranges from 10 to 12 inches in areas under grass. The texture of the subsoil ranges from silt loam to light silty clay loam. Free lime is at a depth of about 15 to 20 inches. Small nearly level areas of Richfield and Goshen silt loams were included in the mapping. Areas of this Ulysses soil range from 5 to 160 acres in size. Much of the acreage is cultivated, but some areas are still in native grass.

This is a good soil for agriculture, and winter wheat and grain sorghum are suitable dry-farmed crops. The chief crops grown under irrigation are wheat, sorghum, and corn, but alfalfa, sugar beets, beans, and truck crops also grow well.

Runoff is medium, and this soil has moderate permeability. The chief management problems are the lack of moisture and the slight hazard of wind erosion. If the surface is bare in cultivated areas, the force of raindrops hitting the surface breaks down the clods. Then this soil may blow after severe rains.

In dry-farmed areas stubble mulching reduces wind erosion. Summer fallowing is also necessary to conserve and store moisture for future crops. In irrigated areas such practices as land leveling and use of underground pipes help to reduce erosion, conserve water, and increase the uniform penetration of water. The irrigation water should be carefully managed. Fertilizer is needed to maintain the fertility of this soil. (Capability unit IIIc–1, dryland; capability unit I–1, irrigated; Loamy Upland range site)

Ulysses silt loam, 1 to 3 percent slopes (Ub).—This soil is mainly along upland drainageways. Its profile is similar to the one described for the Ulysses series. Where this soil is cultivated, the surface layer is only about 8 inches thick, but it is about 10 inches thick in areas under grass. Also this soil is calcareous to the surface in some areas that have been cultivated. Depth to free lime in other places ranges from about 12 to 15 inches. Small, eroded areas and small areas of Richfield silt loam, 1 to 3 percent slopes, were included in the mapping.

Areas of this Ulysses soil range from 5 to 80 acres in size. About half of the acreage is cultivated, and the rest is still in native grass.

This is a good soil for agriculture. Wheat and grain sorghum are suitable dry-farmed crops, and wheat, corn, grain sorghum, and sugar beets are suitable irrigated crops. Grain sorghum, however, may be affected by chlorosis in the early stages of its growth if it is planted on eroded or calcareous spots. Runoff is medium, and this soil has moderate permeability. The chief management problems are water erosion and lack of moisture. When the soil is bare, wind erosion is also a hazard. Practices for dryfarming include stubble mulching to control wind erosion and to increase the rate of infiltration, contour tillage and terracing to control water erosion, and summer fallowing to store moisture. Level terraces may also be constructed.

Unless this soil is carefully managed, it is not well suited to irrigation, because it erodes easily. Irrigation water should be carefully managed, and practices that control erosion and conserve water are needed. Contour furrows or bench leveling help to control erosion, conserve water, and insure uniform penetration of moisture. They also require less labor than other practices. Using underground pipes or gated pipes prevents the loss of water by evaporation and deep percolation. If contour ditches are used, care must be taken to use the correct tube size. Fertilizer is needed to maintain fertility. (Capability unit IIIe–1, dryland; capability unit IIe–1, irrigated; Loamy Upland range site)

Ulysses silt loam, 3 to 5 percent slopes (Uc).—This soil lies along large drainageways with Ulysses silt loam, 1 to 3 percent slopes, and Colby silt loam, 5 to 15 percent slopes. Its profile is similar to the one described for the Ulysses series, but it is thinner. In cultivated areas the surface layer is only about 6 inches thick, but it is about 8 inches thick in areas under grass. In some areas that have been cultivated, erosion has removed the surface layer and has exposed the limy subsoil and the underlying material. Small areas of Mansic clay loam, 3 to 5 percent slopes, were included in mapping.

This Ulysses soil is a fairly good soil for agriculture. It is not well suited to cultivation, however, because it is susceptible to erosion by wind and water. Some areas are cultivated, but most of the acreage is still in native grass used for range. Where this soil is cultivated, wheat and grain sorghum are suitable dry-farmed crops.

This soil will wash and blow if it is not protected by a growing crop or by crop residue. Runoff is rapid, and water erosion is a serious hazard. This soil must be protected by vegetation or by such practices as terracing, farming on the contour, contour stripcropping, and stubble mulching. These practices help to control washing, conserve moisture, and prevent wind erosion. Summer fallowing is necessary to store moisture for future crops. (Capability unit IVe–1, dryland; not placed in an irrigated capability unit; Loamy Upland range site)

Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).—The soils of this complex occur on uplands with Ulysses silt loam, 1 to 3 percent slopes. They are so intermingled that mapping them separately was impractical. Erosion has thinned their surface layer, and as a result, much of the organic matter has been lost. In about 40 percent of the acreage, areas that formerly were Ulysses silt loam are eroded to the extent that the soil material has characteristics within the range of Colby silt loam. The profiles are similar to the ones described for the Ulysses and Colby series, but the texture of the surface layer ranges from loam to silt loam. Also, the profile of the Ulysses soil is thinner than the one described for the Ulysses series. Tillage has mixed part of the subsoil with the material in the surface layer. These soils are generally limy to the surface.

Nearly all of the acreage is cultivated, and some areas are irrigated. These soils are productive in years when rainfall is above average. Wheat is the most suitable dry-farmed crop. Grain sorghum is also suited, but it is likely to be affected by chlorosis. Wheat, corn, grain sorghum, and beets are suitable irrigated crops.

These soils have low natural fertility and are not well suited to cultivation. They can be cultivated safely only if measures are taken to control erosion by wind and water. Runoff is rapid, and serious water erosion occurs, unless practices are used to protect these soils. Wind erosion is also a serious hazard and occurs where the soils are not adequately protected by clods, vegetation, or crop residue.

Where dryfarming is practiced, terracing, contouring, stubble mulching, and summer fallowing are methods of controlling soil washing, conserving moisture, preventing wind erosion, and storing moisture. In irrigated areas contour furrows and contour ditch irrigation are practices that reduce erosion and increase the amount of moisture stored for crops. To further reduce erosion and to increase yields, such practices as bench leveling, use of underground pipes and gated pipes, and careful management of irrigation water are needed. These practices reduce the amount of labor required for irrigating. Fertilizer should be added to maintain fertility. (Capability unit IVe–1, dryland; capability unit IIe–1, irrigated; Limy Upland range site)

Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded (Um).—About half of this complex is Ulysses silt loam, and about half is Colby silt loam. Probably some of the areas of Colby silt loam have not been thinned much by erosion, and were originally that soil. In some places, however, erosion has thinned the former Ulysses silt loam

to the extent that the characteristics of the soil are now within the range of Colby silt loam. These areas are indistinguishable from those that were originally Colby silt loam. Some of the remaining acreage of Ulysses silt loam is slightly eroded.

The profiles of the soils of this complex are similar to the ones described for the Ulysses and Colby series. In the Ulysses soil, however, limy material is nearer the surface. In the more eroded areas, the lighter colored subsoil and underlying material are exposed. Where these soils adjoin sandy soils, the surface layer is loam rather than silt loam. Small areas of Mansic clay loam, 3 to 5 percent slopes, and of Manter fine sandy loam, 2 to 5 percent slopes, were included in mapping.

The soils of this complex are not suited to cultivated crops, although most of the acreage has been cultivated. They are best suited to permanent grass for range. The content of lime is high, and the soils blow readily when they are not protected. Erosion has removed much of the original dark surface layer, and the fertility has been reduced. Runoff is excessive, and the surface layer tends to seal or slick over during severe rains. Plants that do not have a well-developed root system are likely to be damaged when erosion occurs.

Some areas that were formerly cultivated have been reseeded to native grass. The remaining areas that are now cultivated should be reseeded and used for range. (Capability unit VIe–1, dryland; not placed in an irrigated capability unit; Limy Upland range site)

Use and Management of Soils

This section discusses the use and management of the soils of Wichita County and explains the system of capability classification used by the Soil Conservation Service. It gives general management and management by capability units for soils under dryland farming, and yields per acre of the principal dryland crops. Then, similar information is given for the soils under irrigation. Finally, the management of soils for range, windbreaks, and wildlife is discussed, and engineering interpretations of the soils are given.

The soils in about 80 percent of the county are on uplands and are nearly level, fertile, and loamy. Most of the irrigation in the county is on these soils. About 15 percent of the county consists of gently sloping to moderately sloping soils that are subject to both water and wind erosion. About half of the acreage of these sloping soils is in native grass, but the soils are suited to wheat and sorghum if they are well managed. The rest of the county is made up mainly of steep soils and of very steep stony soils that are mainly in native grass except where they are eroded. Good yields of grass forage are produced on these steep soils. The eroded areas should be reseeded to grass.

Most of the soils have a surface layer of loam or silt loam; sandy soils make up less than 1 percent of the acreage. The sandy soils are in scattered areas along White Woman and Ladder Creeks. They are mostly in grass, but small areas of the less sandy soils are cultivated to wheat and sorghum.

Management of Dryland [1]

Before the soils of Wichita County were cultivated, they were covered with grass. The vegetation on the surface conserved moisture and gave protection from erosion. Roots could easily penetrate, and rain and wind did little damage. The rainfall was absorbed rapidly, and there was little flash runoff. Only geologic erosion occurred, and that was at a slow, harmless rate. Except in a few areas, erosion and soil formation were in balance.

Cultivation of crops, especially without irrigation, has reduced the content of organic matter in the soils. In many areas the structure and general condition of the soils have deteriorated. This deterioration, and management practices that have left the soils unprotected, have opened the way for erosion by wind and water. As a result, many of the soils are now eroded, and erosion is continuing in many areas. If the cropland is to be conserved, a protective cover must be kept on the surface at all times. It is not necessary to restore the native grass, but some kind of protective cover is necessary.

Practices that conserve moisture and that protect the soils are use of a good cropping system, stubble mulching and other good management of crop residue, and minimum tillage. Additional practices that may be used are summer fallowing, contour farming, terracing, and stripcropping. A combination of these practices is best. A single practice may conserve some moisture or reduce erosion, or it may do both, but it seldom conserves enough moisture or protects the soils adequately. The following describes cropping systems used in the county and management practices that apply to all the soils.

A *cropping system* is a sequence of crops grown on a given area over a period of time. Some cropping systems consist of a rotation of different crops, and the crops follow a definite order of appearance in the field. Other cropping systems consist of only one crop grown year after year in the same field. A flexible cropping system generally consists of different crops, but the crops do not succeed one another in a definite, previously planned order. After the cropping system has been chosen, such practices as summer fallowing, contour farming, stubble mulching, and minimum tillage should be used to conserve moisture, to keep damage by wind and water to a minimum, and to maintain or improve the productivity of the soils.

In this county winter wheat and grain sorghum are the principal dryland crops, and the cropping system most frequently used is summer fallow, winter wheat, and grain sorghum. Most farmers, however, like to keep their cropping system flexible. Where a flexible system is used, the selection of the next crop or fallow period depends on the amount of moisture stored in the soil at the time the winter wheat or sorghum is to be planted. It also depends on the need for a protective cover and on the economic needs of the particular farm.

Residue management consists of using crop residue in a way that will protect the soils from erosion, reduce crusting of the surface soil, and conserve moisture. When the residue is well managed, the soils are tilled and planting and harvesting are done in a way that will keep residue on the surface until the next crop provides protection (fig. 9).

[1] By EARL J. BONDY, agronomist, Soil Conservation Service, Garden City, Kans.

Figure 9.—**Dryland grain sorghum planted in a field where stubble-mulch tillage was used to prepare the seedbed.**

Plant residue, if properly managed, reduces erosion by protecting the surface of the soil from wind and from the impact of raindrops. It increases the amount of moisture that is taken into the soil (fig. 10) by reducing runoff, by increasing the intake of water, and by reducing the splashing effect of rain. It also helps to maintain the content of organic matter in the soils, lessens the effects of extreme temperature, and increases the activity of microorganisms in the soils.

Figure 10.—**Standing stubble holds snow evenly over the field so that moisture is stored at a uniform depth.**

Two kinds of crop residue management are practiced in Wichita County. Management of the usual residue leaves 350 pounds or less of plant residue on the surface at seeding time. The practice of stubble mulching requires 750 pounds per acre or more on the surface at seeding time.

Good residue management should be used on all the cropland in the county. The amount of residue required to protect the soils is determined by the texture of the soils, on the cropping system, and on the kind of farming practices used.

Tillage is used for managing crop residue, for controlling weeds, and for keeping the soils in good tilth. Through tillage the farmer carries out much of his management program. In using tillage equipment to manage crop residue and to kill weeds, he makes the seedbed suitable for seeding and managing the next crop. The residue left on the surface protects the soils from erosion. It also keeps the soil structure from deteriorating as the result of the splashing effect of raindrops. Equipment that undercuts the vegetation kills the weeds, and leaves the residue on the surface (fig. 11).

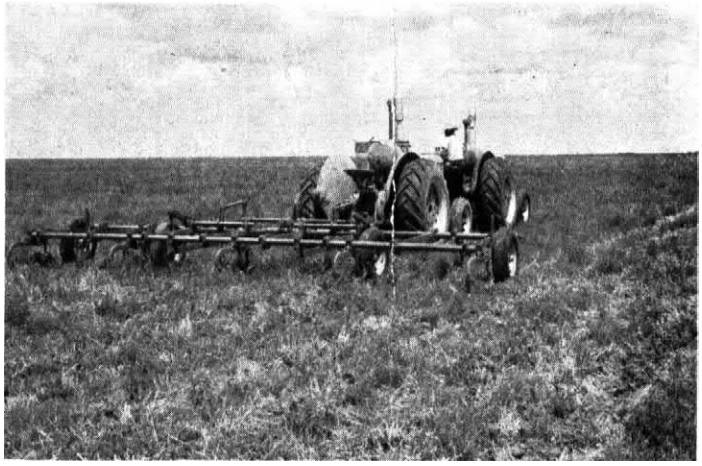


Figure 11.—**Undercutting wheat stubble with sweeps. This method of cultivation, called stubble mulching, controls weeds and keeps the stubble on the surface for a mulch.**

The surface should be roughened by tillage (emergency tillage) when the residue or protective vegetation has decomposed and the soil is left susceptible to wind erosion. Surface roughening minimizes the damage from blowing during the time that the clods are of a size that will resist blowing.

A desirable soil structure is one in which the aggregates are stable. If the aggregates are stable, the soil needs to be worked only to kill weeds and to manage residue. Tillage should be kept to the minimum. Too much tillage breaks down the clods or aggregates and leaves the soils more susceptible to blowing and crusting. Tillage at the proper time is important in maintaining good soil structure. If the soils are tilled when too wet or are always tilled at the same depth, a compact layer, or tillage pan, may form, particularly in soils that have a plow layer of loam or silt loam.

Summer fallowing in dry-farmed areas consists of keeping the soils free of vegetation during one crop season so that moisture will be stored for the crop that follows. Much of the time in this county the total amount of moisture available under a continuous cropping system is too low for the economical production of crops. Therefore, summer fallowing is considered a necessary part of most cropping systems. Summer fallowing is not very efficient in adding to the total amount of moisture stored. However, each additional inch of moisture stored increases the yield of wheat by 2 to 3½ bushels per acre.

In contour farming, tillage and planting operations are performed parallel to terraces or contour guidelines. As a result, furrows, ridges, and wheel tracks are nearly on the level. These furrows and ridges hold much of the moisture from rain or snow where it falls, thus decreasing runoff and erosion. Yields of crops increase when contouring is practiced because more water is absorbed by the

soil and is made available for crops. Also, somewhat less power is required than when farming is done up and down hill.

Contour farming is most effective when used with other practices that conserve moisture and protect the soils. Such practices are stubble mulching, terracing, and contour stripcropping (fig. 12).

Figure 12.—**Contour stripcropping of grain sorghum and wheat. The strip on the left will be planted to wheat.**

Terracing consists of constructing ridges across the slope to intercept runoff. The terraces are constructed with or without a grade. The graded terraces reduce erosion by intercepting runoff and conducting it at a nonerosive velocity to a stable outlet or waterway. The level terraces are constructed to conserve moisture and to help control erosion (fig. 13). Most of the terraces in Wichita County are of the level type because conserving moisture is of primary importance.

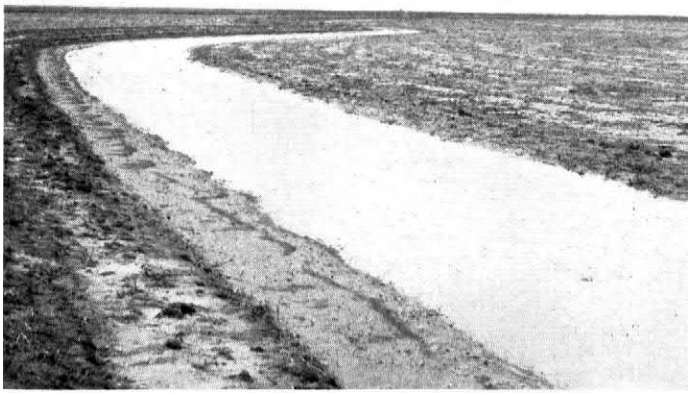


Figure 13.—**A level terrace constructed on an area of Richfield silt loam, 0 to 1 percent slopes. The terrace holds water that fell during a severe rainstorm.**

Contouring and other practices that conserve moisture and protect the soils should be used with the terraces. Each row planted on the contour between terraces acts as a miniature terrace, holding back some water and letting it soak into the soil. When terracing and contour farming are used, yields generally increase and erosion decreases.

The horizontal distance needed between terraces depends on the slope and on the kind of soil. Because much of the precipitation falls during severe storms, a terrace system acts as a safety valve that protects other practices, such as contour farming, stubble mulching, and contour stripcropping.

Stripcropping is a system of growing different adapted crops in narrow strips in the same field. Strips of crops that help to protect the soils from erosion, such as small grains with their residue, are alternated with fallow or with such crops as sorghum that give less protection from erosion. Stripcropping helps control wind erosion by shortening the distance that soil is moved by wind. It reduces water erosion by providing a barrier of growing crops. A good stand of growing wheat or sorghum resists erosion, as does the thick, heavy residue of stubble that remains after harvest.

Two types of stripcropping are (1) contour stripcropping and (2) wind stripcropping. Contour stripcropping is used on sloping fields to help control erosion by both wind and water. The strips are arranged on the contour, and terraces or contour guidelines are used to establish the pattern. Wind stripcropping is used in fields of nearly level or coarse-textured soils where water erosion is not a problem, but where wind erosion is a hazard. It is also used on some sloping fields where the slopes are so complex that farming on the contour is not practical. The strips are uniform in width, are generally straight, and are arranged across the direction of prevailing winds.

The width of the strips necessary to control soil blowing varies according to the kind of soil. On silt loams and clay loams, strips may be wider than on sandy soils.

Stripcropping minimizes soil blowing, but it does not completely control blowing when used alone. It is much more effective when used with good residue management, minimum tillage, and other practices needed to conserve moisture and to protect the soils from erosion.

Capability Groups of Soils

The capability classification is a grouping that shows, in a general way, how suitable soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes, there can be as many as four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited, mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is a climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no susceptibility to erosion but have other limitations that restrict their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally identified by numbers assigned locally, for example, IIIe–1 or IIIe–2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

The eight classes in the capability system, and the subclasses and dryland capability units in this county, are described in the list that follows.

Class I. Soils that have few limitations that restrict their use. (Soils of this county have been placed in class I only when the climatic limitation has been eliminated by irrigation.)

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices. (Soils of this county have been placed in class II only when the climatic limitation has been eliminated by irrigation.)

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.
- Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe–1. Deep, well-drained, gently sloping loamy soils of the uplands.
  - Unit IIIe–2. Nearly level fine sandy loams.
- Subclass IIIw. Soils that have severe limitations because of excess water.
  - Unit IIIw–1. Loamy soils on flood plains.
- Subclass IIIc. Soils that have a severe climatic limitation.
  - Unit IIIc–1. Nearly level loams, silt loams, and clay loams.
  - Unit IIIc–2. Deep, dark-colored, nearly level silt loams in swales and on benches in the uplands.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.
- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe–1. Moderately dark colored and light-colored, gently sloping to moderately sloping silt loams and clay loams.
  - Unit IVe–2. Moderately sloping fine sandy loams.
- Subclass IVw. Soils that have very severe limitations for cultivation because of excess water.
  - Unit IVw–1. Silty clay loams in upland depressions.

Class V. Soils not likely to erode but that have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife food and cover. (None in Wichita County)

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.
- Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.
  - Unit VIe–1. Light-colored, calcareous, moderately sloping to steep silt loams.
  - Unit VIe–2. Light-colored, moderately sloping to steep, droughty and stony soils that are shallow or moderately deep over caliche.
- Subclass VIw. Soils severely limited by excess water and generally unsuitable for cultivation.
  - Unit VIw–1. Loamy soils on narrow bottom lands.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to grazing, woodland, or wildlife.
- Subclass VIIw. Soils very severely limited by excess water.
  - Unit VIIw–1. Nearly level fine sandy loams that have a very sandy subsoil and are on flood plains.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial production of plants; and restrict their use to recreation, wildlife, water supply, or esthetic purposes. (None in Wichita County)

Management by capability units (dryland)

In the following pages the soils of this county are grouped in capability units for dryland farming. The significant features of the soils in each capability unit, together with the hazards and limitations, are described. Suggestions for the use and management of the soils of each unit are also given.

DRYLAND CAPABILITY UNIT IIIe–1

Deep, well-drained, gently sloping loamy soils of the uplands make up this unit. The soils are mainly along the outer edges of the nearly level tableland. They are adjacent to steep upland drainageways. These soils are—

Mansic clay loam, 1 to 3 percent slopes (Mb).
Richfield silt loam, 1 to 3 percent slopes (Rn).
Ulysses silt loam, 1 to 3 percent slopes (Ub).

Runoff is medium on these soils, and permeability is moderate or moderately slow. Water erosion is the main

hazard. When the soils are bare, the surface layer tends to seal over during severe rainstorms, and this sealing causes excessive runoff and erosion. Wind erosion also occurs when these soils are not protected by a growing crop or crop residue, or when the surface is not cloddy. The climatic limitation of low rainfall tends to limit yields.

Good management of these soils consists of growing adapted crops in a suitable cropping system, practicing stubble mulching, and keeping tillage to a minimum. The cropping sequence generally used is sorghum-summer fallow-wheat.

Summer fallowing is considered a necessary practice that allows moisture to be stored in the soils so that crops will make profitable yields. Stubble mulching helps to control erosion by wind and water. Its effectiveness depends on the amount of crop residue left on the surface. Terracing, contouring, or contour stripcropping are other practices needed for controlling erosion and conserving moisture. The amount of crop residue needed at seeding time varies as the result of differences in the cropping sequence and in the kind of tillage.

DRYLAND CAPABILITY UNIT IIIe-2

In this unit are deep, nearly level soils on alluvial fans and benches. The surface layer of these soils is fine sandy loam. The subsoil is sandy loam to loam. These soils are—

Bayard fine sandy loam (Ba).
Manter fine sandy loam, 0 to 1 percent slopes (Mn).

Permeability is moderate to moderately rapid, and runoff is slow. The available moisture holding capacity is moderate to moderately high, and moisture is readily released to plants. These soils are easily penetrated by roots, air, and water. The main problem is their susceptibility to wind erosion. Also the climatic limitation of low rainfall tends to reduce yields in years of low rainfall.

Sorghum and wheat are suitable crops, but practices that control wind erosion are needed on these soils. Sorghum is generally grown year after year, but a cropping sequence of sorghum-summer fallow-wheat can be used if the crop residue is carefully managed.

Good management of these soils consists of growing suitable crops in a flexible cropping system, practicing stubble mulching, and keeping tillage to a minimum. If wheat is to be grown, summer fallowing is needed so that moisture will be stored in the soils. Wind stripcropping is effective for controlling erosion. The width of the strips depends on the amount of residue on the surface at seeding time.

During periods of extended drought, crops may have to be planted solely to provide protection against wind erosion. Grazing of crop residue should be limited so that enough stubble is left on the surface to protect the soils. Terracing and farming on the contour are practices not generally needed on these soils.

DRYLAND CAPABILITY UNIT IIIw-1

Humbarger loam (Hu) is the only soil in this unit. This soil is on flood plains, and it is deep, dark colored, and nearly level. It consists mainly of loam, but the subsoil contains strata of sandy loam.

Permeability is moderate, and the available moisture holding capacity is high. The water table is below the root zone of most crops, but it can be reached by the roots of alfalfa. This soil receives additional moisture from stream overflow, but crops grown on it are sometimes damaged by flooding. Flooding occurs at least once a year, but damaging floods occur about once in 10 years.

Corn, sorghum, and alfalfa are well suited to this soil. Wheat is not suited, because it may be damaged by flooding late in spring. Practices such as keeping crop residue on the surface are needed to give protection from erosion. Because this soil is on flood plains, terraces are not effective. Where this soil is used for range, yields of forage are high.

DRYLAND CAPABILITY UNIT IIIc-1

In this unit are deep, fertile, nearly level, well-drained, loamy soils on uplands and terraces. The surface layer of these soils is loam, silt loam, or clay loam, and their subsoil is silty clay loam, silt loam, or clay loam. These soils are—

Bridgeport loam (Br).
Mansic clay loam, 0 to 1 percent slopes (Ma).
Richfield silt loam, 0 to 1 percent slopes (Rm).
Ulysses silt loam, 0 to 1 percent slopes (Ua).

The available moisture holding capacity is high, and these soils are easily penetrated by roots, air, and water. Low rainfall and recurrent droughts limit crop production. Wind erosion is also a hazard where these soils are not protected by growing vegetation, crop residue, or clods.

Most of the acreage is cultivated, and wheat and grain sorghum are suitable crops. The cropping sequences generally used are wheat-fallow and sorghum-fallow-wheat. Some areas, however, are still in native grass.

Good management of these soils includes growing adapted crops in a flexible cropping system, summer fallowing to store moisture so that crops will make profitable yields, tilling only to control weeds and to conserve moisture, and keeping crop residue on the surface to protect the soils and to hold moisture from snow or rainfall. Contouring, terracing, or wind stripcropping are other effective practices that conserve moisture and reduce erosion.

DRYLAND CAPABILITY UNIT IIIc-2

Goshen silt loam (Go) is the only soil in this unit. This soil is deep, dark colored, and well drained. It is nearly level and occupies swales and benches in the uplands. The texture of the surface layer is silt loam, and that of the subsoil is silty clay loam.

This soil is permeable and has high available moisture holding capacity. It receives some additional moisture as runoff from surrounding areas. The soil is fertile, and yields in most years are generally good. Low rainfall and recurrent drought, however, limit crop production in some years. Wind erosion is also a hazard where this soil is bare and unprotected.

Wheat and grain sorghum are suitable crops. A good cropping sequence is wheat-summer fallow or sorghum-summer fallow-wheat.

Good management of this soil includes growing adapted crops in a flexible cropping system and tilling only to control weeds and wind erosion. Such practices as summer fallowing and stubble mulching are also needed to conserve moisture, stripcropping, contouring, and terracing are other desirable practices.

DRYLAND CAPABILITY UNIT IVe-1

In this unit are deep, moderately dark colored and light-colored, loamy soils that are gently sloping to moderately sloping and are on uplands. The surface layer of these soils is silt loam or light clay loam, and the subsoil is friable, calcareous clay loam or silt loam. These soils are generally calcareous within the plow layer. These soils are—

Mansic clay loam, 1 to 3 percent slopes, eroded (Me).
Mansic clay loam, 3 to 5 percent slopes (Mg).
Ulysses silt loam, 3 to 5 percent slopes (Uc).
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).

These soils have high available moisture holding capacity and are easily penetrated by roots, air, and water. If they are cultivated, however, the content of organic matter decreases. Also the surface layer tends to seal over during heavy rains, and this sealing causes excessive runoff and erosion. When these soils lack a protective cover, wind erosion is also a serious hazard.

These soils are well suited to native grass for range, but cultivated crops can be grown if intensive management is used. The cropping sequence generally used is wheat-summer fallow or sorghum-summer fallow-wheat. Yields of wheat and grain sorghum are generally low, but good yields are obtained in years when precipitation is above average. Because of the serious hazard of wind and water erosion, the soils must be protected by crop residue or by a growing crop if they are cultivated. During periods of drought, crops need to be planted solely for protection against wind erosion.

If these soils are cultivated, growing suitable crops in a flexible cropping system, keeping tillage to a minimum, and stubble mulching are among the practices that should be used. Terracing, contouring, or contour stripcropping are other practices needed to control erosion and to conserve moisture. Storing moisture by summer fallowing also is essential for profitable yields.

DRYLAND CAPABILITY UNIT IVe-2

Manter fine sandy loam, 2 to 5 percent slopes (Ms), is the only soil in this unit. It is a deep, moderately sloping, moderately sandy soil of the uplands. The surface layer is fine sandy loam, and the subsoil is heavy sandy loam or loam.

This soil has moderate available moisture holding capacity and is easily penetrated by roots, air, and water. Wind erosion is the main problem, but water erosion is also a hazard.

This soil is better suited to native grass for range than to cultivated crops. It can be cultivated, however, if intensive management practices are used to control erosion. Suitable crops are grain sorghum and wheat.

If this soil is used for crops, good management consists of stubble mulching and contour stripcropping. Tillage should also be kept to a minimum, and the soil should be summer-fallowed to store moisture. A cropping sequence of wheat-sorghum-summer fallow may be used if stubble mulching is used to protect the soil during the period it is summer-fallowed. Terracing and contour farming are also needed to reduce water erosion and to conserve moisture.

DRYLAND CAPABILITY UNIT IVw-1

Lofton silty clay loam (Lo) is the only soil in this capability unit. It is a deep, dark-colored, nearly level, moderately well drained soil on the floors of small upland depressions. The texture of its surface layer and subsoil ranges from silty clay loam to light clay.

This soil has slow permeability, and runoff from the nearby uplands collects on it after heavy rains. The amount of runoff depends on the size of the drainage area and the management of the nearby soils. Water may be ponded for only a few days or for a longer period. As a result, planting and harvesting are often delayed, and crops are sometimes drowned. Wind erosion is also a hazard, especially if a protective cover is not left on the surface after a crop has been lost.

Where this soil is used for crops, it is generally managed like the surrounding soils in the same field. If such practices as terracing, contouring, and good residue management are used on the adjacent areas, most of the runoff water can be kept out of the depressions where this soil occurs. In some places surface drainage is feasible.

DRYLAND CAPABILITY UNIT VIe-1

Deep, well-drained, light-colored, calcareous loamy soils make up this unit. These soils are moderately sloping to steep and are on uplands. Their surface layer and subsoil are calcareous silt loam. These soils are—

Colby silt loam, 5 to 15 percent slopes (Cd).
Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded (Um).

These soils have moderate permeability and high available moisture holding capacity. They are easily penetrated by roots. Erosion by wind and water, however, is a serious hazard.

These soils are suited only to range. Runoff and erosion are excessive if the soils are cultivated. Areas that are now cultivated should be seeded to suitable native grasses.

Good range management is needed to maintain or improve the stand of range plants. Such practices as proper range use, deferred grazing, or rotation grazing are needed for producing adequate forage for livestock and a protective cover for the soils. Pasture furrowing also may be used for conserving moisture in the gently sloping areas. Located on these soils are good sites where dams can be constructed so that water will be available for livestock. Range management suitable for these soils is described in the section "Management of Rangeland," under the Limy Upland range site.

DRYLAND CAPABILITY UNIT VIe-2

In this unit are the soils of the Mansker-Potter complex (Mm). These soils are on uplands and are moderately sloping to steep. They are moderately deep or shallow over caliche. These soils are light colored and friable, and they are calcareous. Their surface layer is loam to silt loam, and their subsoil is clay loam to loam. Many rocks outcrop on the steeper slopes.

These soils have a limited root zone, and their available moisture holding capacity is moderately low. They are suited only to range, and nearly all the areas are in native grass. Wind and water erosion are hazards if the grass is overgrazed.

Little can be done to protect these soils, except to manage grazing so that the cover of grass is maintained or improved. Good range management suitable for the soils is discussed in the section "Management of Rangeland" under Limy Upland and Breaks range sites.

DRYLAND CAPABILITY UNIT VIw-1

Only Alluvial land (An) is in this unit. This miscellaneous land type occupies narrow strips of bottom land. The areas are small and irregular in shape, and the adjacent steep slopes isolate them in places. They are generally adjacent to or include narrow, meandering upland stream channels. Some areas on the floors of valleys are nearly level, but the areas along streambanks are generally steep and broken. The soil material is friable loam to silt loam to a depth of about 16 inches, and below that is loam to clay loam.

This land type has high available moisture holding capacity. It receives additional water from occasional floods and from side drainage.

This land type is better suited to range than to field crops, and it should be kept in native grass. If the land is well managed and if grazing is controlled, yields of forage are high. Good range management suitable for this land type is given in the section "Management of Rangeland" under the Loamy Lowland range site.

DRYLAND CAPABILITY UNIT VIIw-1

Lincoln fine sandy loam (Lf) is the only soil in this unit. It is shallow over coarse-textured material and is subject to flooding. This nearly level, light-colored, calcareous soil occupies parts of the low flood plains of Ladder and White Woman Creeks. It has a surface layer of fine sandy loam. Sand and gravel are at a depth of only about 8 inches.

This soil has low available moisture holding capacity and a restricted root zone. When it is flooded, additional soil material is deposited, and the soil is subject to channel cutting and scouring. Because of its position on flood plains and its texture of fine sandy loam, this soil and its plant cover are somewhat unstable.

This soil is not suited to cultivation, and it has only limited value for range. The native vegetation is mixed and variable.

Management requirements for this soil vary according to the site. In general, grazing must be controlled to maintain the existing vegetation. Control or eradication of brush is undesirable in some areas, because the vegetation is needed to protect the soil. Further information about the use and management of this soil can be obtained from a local representative of the Soil Conservation Service.

Predicted Yields of Crops (Dryland)

Table 2 gives predicted average yields per seeded acre of wheat and grain sorghum for the arable soils in the county. The yields in columns A are based on the prevailing, or most common, management, and those in columns B are based on improved management. Information on which to base precise estimates is limited, however, because no longtime, accurate records of yields are available. Also, yields fluctuate greatly, mainly as the result of the recurring droughts and the periods of abnormally high precipitation.

Estimates of yields were based on data obtained from farmers, from the county agricultural agent, from members of the Agricultural Stabilization Conservation Committee, and from members of the board of the Soil Conservation District. They were also based on information from the Tribune, Colby, and Garden City branches of the Kansas State Agricultural Experiment Station. Most of the data for wheat were for yields obtained on Ulysses and Richfield silt loams. The estimated yields for wheat grown on other soils were based partly on the records of yields on the Ulysses and Richfield silt loams.

TABLE 2.—*Predicted longtime average acre yields of dryland wheat and grain sorghum grown on the arable soils under two levels of management*

[Yields in columns A are those to be expected under common management, and yields in columns B are those to be expected under improved management]

Soil name	Wheat [1]		Grain sorghum	
	A	B	A	B
	Bu.	*Bu.*	*Bu*	*Bu.*
Bayard fine sandy loam	10	15	16	22
Bridgeport loam	15	19	18	24
Goshen silt loam	18	21	24	28
Humbarger loam	13	15	20	22
Lofton silty clay loam	10	14	12	18
Mansic clay loam, 0 to 1 percent slopes	15	19	16	22
Mansic clay loam, 1 to 3 percent slopes	13	17	14	20
Mansic clay loam, 1 to 3 percent slopes, eroded	11	15	12	18
Mansic clay loam, 3 to 5 percent slopes	11	15	12	18
Manter fine sandy loam, 0 to 1 percent slopes	14	19	22	28
Manter fine sandy loam, 2 to 5 percent slopes	11	16	16	24
Richfield silt loam, 0 to 1 percent slopes	17	21	18	24
Richfield silt loam, 1 to 3 percent slopes	14	18	16	22
Ulysses silt loam, 0 to 1 percent slopes	16	20	18	24
Ulysses silt loam, 1 to 3 percent slopes	14	18	16	22
Ulysses silt loam, 3 to 5 percent slopes	12	16	14	20
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded [2]	13	17	14	20

[1] The yields of wheat reflect the general use of summer fallow.
[2] The yields given are for the complex as a whole. Yields on the Colby soil are 15 to 25 percent less than those on the Ulysses soil.

Prevailing management.—Under the prevailing management for which yields are shown in columns A, suitable crop varieties are used, and seeding is done at the proper time and rate. Methods of planting and harvesting are efficient, and weeds, insects, and plant diseases are controlled to some extent. Some residue management is practiced. The following are the prevailing, or most common, management practices used in producing wheat:

1. Tillage is done in straight lines, generally parallel to the boundaries of the field or around the field, not on the contour.
2. The soils are tilled frequently; equipment is used that soon eliminates the crop residue.
3. The cropping system generally used is alternate wheat and summer fallow, but a cropping system of fallow, wheat, and sorghum is sometimes used. Winter wheat is seeded early in fall on soils that have been left idle and kept free of weeds during one growing season. If the stand of wheat is not satisfactory, or if the wheat is blown out, the soils are planted to sorghum or are again summer-fallowed for wheat.

4. Emergency tillage is used to control blowing soils.
5. Crop residue is grazed if available. Both seeded and volunteer wheat are usually grazed during fall and winter.

The following are the prevailing, or most common, management practices used in producing grain sorghum:

1. Sorghum is seeded on land that was used for wheat the previous season. Before the sorghum is seeded, the soils are plowed with a one-way disk to obtain a stand of volunteer wheat for fall pasture.
2. The soils are generally tilled at least twice in spring before about June 1, when the sorghum is seeded. The first tillage is done to kill volunteer wheat. The subsequent tillage is shallow and is intended to control weeds and to prepare the seedbed.
3. The sorghum is drilled in rows spaced about 20 inches apart. After the plants emerge, the crop is cultivated once with a rotary hoe or with a drag spiketooth harrow. Later, if weeds are numerous, the crop is sometimes sprayed with a chemical weedkiller.
4. If the supply of moisture has been inadequate during the growing season, or if there is an early frost, grain sorghum is not harvested in many of the fields. Livestock are allowed to graze the plants in those fields, as well as the residue in harvested fields.
5. Sorghum is generally grown year after year on the Manter and Bayard soils and on the Humbarger soils along creeks.

The predicted yields given in columns B are based on improved management, which consists of the following practices:

1. Erosion is controlled, and moisture is conserved by using stubble-mulch tillage, cover crops, stripcropping, terracing, contouring, and summer fallowing.
2. Tillage is performed at the proper time, and a suitable tillage implement is used.
3. Adapted crop varieties are grown in a flexible cropping system, and a seeding rate is used that provides the proper number of plants.
4. Only the crop residue that is not needed for protecting the soils is grazed.

Additional information about these improved practices is given in the section "Management of Dryland."

Management of Irrigated Soils [2]

Irrigation was begun in this county when three wells were drilled for irrigation in 1938. In that year about 300 acres was irrigated. In 1962 there were approximately 328 wells in the county, and about 70,000 acres was irrigated. Each year, some land leveling is done and additional underground pipe is laid to reduce erosion and losses from evaporation.

[2] By EARL BONDY, agronomist, Soil Conservation Service, Garden City, Kans.

Much of the irrigation farming in the county is done in conjunction with dryland farming. The farms are large, and only part of a farm is irrigated. Irrigation helps to stabilize the income and to insure that there will be a feed crop for livestock.

Sources of irrigation water.—In this county most of the water for irrigation comes from deposits of Pliocene and Pleistocene age. The water is pumped from wells that are 50 to 210 feet deep. A gas engine that burns natural gas for fuel is the usual source of power, but some engines use liquid gas or diesel fuel, and a few are operated by electricity. The irrigation wells in most parts of the county produce about 900 to 1,000 gallons of water per minute. High-yielding wells are uncommon, however, in the southern part of the county.

Methods of applying water.—The two general methods used for applying water in this county are surface irrigation and sprinkler irrigation. The object of either method is to apply adequate water for crops, to apply water uniformly over the field with no damage to the soil or the crop, and to keep labor to a minimum. In surface irrigation, borders or basins may be used and the water may completely cover the surface of the ground. In some places corrugation irrigation is used and the water flows in furrows.

Planning the irrigation system.—Several points should be considered when planning an irrigation system. Some of these are the characteristics of the soils, the amount and quality of the available water, the control and conveyance of the water, the type of system, how the water is to be applied, the preparation of the land (fig. 14), the drainage, and the overall management. The characteristics of the soils should be considered first. The kind of soil will, in varying degrees, influence all other factors when an irrigation system is planned.

Figure 14.—**Smoothing the surface with a landplane.**

The amount of water available and the reliability of the water supply affect both the type and the extent of the irrigation system, as well as the kind of crops to be grown (fig. 15). The quality of the water is highly important. A large concentration of dissolved salts is objectionable.

Figure 15.—**Irrigated forage sorghum grown for silage, and grain sorghum grown as a cash crop or for livestock feed.**

The soils, climate, cropping system, and irrigation practices to be used must all be considered in appraising the quality of the water.

Various controls are needed after a supply of water suitable for irrigation has been located. It is necessary to control the supply of water and to deliver it economically from the point of origin to the point where the water will be used on the farm. The system may include storage dams, canals, and laterals to carry water to the farm; a farm distribution system; and structures such as a pumping plant, pipelines, and drops to control erosion. Information about planning the irrigation system can be obtained from a local technician of the Soil Conservation Service.

Many areas of irrigated soils that are well managed continue to be highly productive for a long time. If the irrigation system is not carefully planned and if good management is not used, however, high productivity may be short lived.

The design of the irrigation system, the degree of land preparation, and the skill and care of the person doing the irrigating probably have the greatest influence on the total amount of water required. The efficiency of the irrigation system is also affected by the kind of soil, the topography, and the condition of the crop. With present facilities and practices, from 50 to 80 percent efficiency can be obtained in the use of the water applied.

Irrigation practices.—Regardless of the method of irrigation used, it is usually necessary to level the land (fig. 16). Land leveling allows water to be distributed more uniformly with less labor, but it may remove valuable surface soil and part of the subsoil. Where much of the surface soil and subsoil have been removed, commercial fertilizer and manure are needed and deep-rooted legumes must be grown to make the exposed soil material productive.

Figure 16.—**Leveling a field that will be used for irrigated crops.**

Drainage should be considered when an irrigation system is planned. Proper drainage is needed to control the irrigation water and to keep salts from building up in the soils.

Where field crops are grown, the chemical characteristics and tilth of the soils are affected. If high yields are to be obtained year after year on irrigated soils, the farmer must maintain and improve the soils by adding organic matter annually.

The use of commercial fertilizer, particularly nitrogen, is also increasingly important in irrigation farming. On some soils a mineral fertilizer, especially a fertilizer high in phosphorus, may be necessary for high yields. The Kansas Agricultural Experiment Station at Garden City maintains a laboratory for testing soils to determine the needs for fertilizer, and this service is available to the public. A small charge is made for each sample tested.

Irrigated Capability Classes, Subclasses, and Units

The soils of Wichita County that are suitable for irrigation have been grouped in the following capability classes, subclasses, and units.

Class I. Soils that have few limitations that restrict their use. (No subclasses)
- Unit I–1. Deep, well-drained, nearly level loamy soils on uplands.

Class II. Soils that have some limitations that reduce the choice of plants or that require moderate conservation practices.
- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe–1. Deep, well-drained, gently sloping loamy soils on uplands.
- Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.
  - Unit IIs–1. Deep, well-drained, nearly level, moderately sandy soils on fans and benches in the uplands.

IRRIGATED CAPABILITY UNIT I-1

Deep, fertile, well-drained, nearly level loamy soils on smooth areas of uplands make up this unit. The surface layer of these soils is loam, clay loam, or silt loam, and their subsoil is loam to silty clay loam. These soils are—

Bridgeport loam (Br).
Goshen silt loam (Go).
Mansic clay loam, 0 to 1 percent slopes (Ma).
Richfield silt loam, 0 to 1 percent slopes (Rm).
Ulysses silt loam, 0 to 1 percent slopes (Ua).

Most of the irrigated acreage in the county is in this capability unit. Richfield and Ulysses silt loams are the principal irrigated soils (fig. 17).

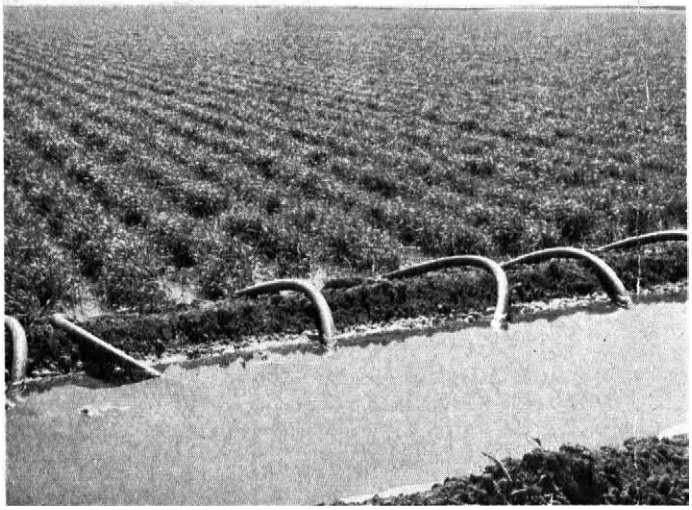


***Figure 17.*—Wheat on Richfield silt loam, 0 to 1 percent slopes. In this field the furrow method of irrigation has been used.**

The soils of this unit have high available water holding capacity. Permeability is moderate.

Crops suited to these soils are wheat, sorghum, alfalfa, sugar beets, corn, pinto beans, tame grasses, and some specialty crops.

The following are among the practices that will maintain or improve the fertility and tilth of the soils. Using a good cropping sequence that may include a deep-rooted legume; properly using crop residue and manure so that the content of organic matter and good tilth will be maintained; applying commercial fertilizer as needed; and managing irrigation water so that the water will be distributed uniformly over the field and will not be wasted.

Land leveling to a uniform grade is generally necessary so that irrigation water will be used efficiently. Also as a result of land leveling, the amount of labor is reduced and yields are increased. Lined ditches or underground pipes will prevent loss of water and erosion of the ditches. A drainage system for removing excess water is essential.

IRRIGATED CAPABILITY UNIT IIe-1

Deep, well-drained, gently sloping loamy soils on uplands make up this unit. The surface layer of these soils is loam, clay loam, or silt loam. These soils are—

Mansic clay loam, 1 to 3 percent slopes (Mb).
Mansic clay loam, 1 to 3 percent slopes, eroded (Me).
Richfield silt loam, 1 to 3 percent slopes (Rn).
Ulysses silt loam, 1 to 3 percent slopes (Ub).
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).

These soils have a moderately permeable subsoil and high available water holding capacity. They are susceptible to water erosion, and it is difficult to use water efficiently on them.

Good management of these soils includes practices that control erosion, that make the use of irrigation water efficient, and that maintain fertility and tilth. To maintain and improve the fertility and tilth, use a cropping system that consists of close-growing crops and deep-rooted legumes, keep crop residues on the surface, and apply commercial fertilizer. Alfalfa, sweetclover, tame grasses, wheat, sorghum, beans, and sugar beets are suitable crops.

Bench leveling, irrigating on the contour, and using sprinkler irrigation for close-growing crops will minimize water erosion. Drop structures may be necessary to control erosion in the irrigation ditches. The use of small tubes helps reduce erosion in the furrows and increases the amount of moisture that can be stored.

IRRIGATED CAPABILITY UNIT IIs-1

In this unit are deep, well-drained, nearly level, moderately sandy soils on fans and benches in the upland. The surface layer of these soils is fine sandy loam, and their subsoil is calcareous fine sandy loam. These soils are—

Bayard fine sandy loam (Ba).
Manter fine sandy loam, 0 to 1 percent slopes (Mn).

These soils are moderately fertile and have moderate to moderately rapid permeability. Wind erosion is a hazard where the surface is unprotected, but the chief limitation is the moderate to moderately low available water holding capacity of the subsoil.

Good management of these irrigated soils includes practices that maintain or improve fertility and tilth and that use water efficiently. Using a cropping system that includes close-growing crops and deep-rooted legumes, keeping crop residue on the surface, and applying commercial fertilizer and manure, where available, will improve fertility and maintain good tilth. Suitable crops are wheat, sorghum, alfalfa, sweetclover, sugar beets, tame grasses, and vegetables.

A properly designed irrigation system is necessary for maximum efficiency in the use of water, and land leveling is generally needed so that the water will be distributed uniformly. There are pockets of sand in some places in the Bayard soil. The soil material should not be removed from those areas when the areas are leveled. The loss of water from a ditch that runs through a sand spot is likely to be excessive, unless that part of the ditch is lined with impervious material.

Care must be taken to avoid overirrigation and leaching of plant nutrients. Use either a lined ditch or underground pipes to prevent excessive loss of water from seepage and evaporation.

Predicted Yields of Crops (Irrigated)

The main crops grown under irrigation in this county are wheat, corn, grain sorghum, forage sorghum, sugar

beets, alfalfa, and pinto beans. However, the soils are also suited to tomatoes, onions, lettuce, and cantaloups. Much of the acreage of irrigated soils is used for crops that are fed to livestock. Some tame grasses are irrigated.

Because irrigation is a recent practice in this county, little information has been recorded on yields of crops grown under irrigation, especially for each soil type. Most of the available information is for crops grown on Richfield silt loam, 0 to 1 percent slopes, and on Ulysses silt loam, 0 to 1 percent slopes. The predicted yields for crops on the other soils were estimated from this information.

Table 3 gives the predicted yields for crops generally grown on the irrigated soils in the county. The estimates of yields were based on information obtained from farmers, from members of the Agricultural Stabilization Conservation Committee, from the Tribune and Garden City branches of the Kansas State Agricultural Experiment Station, and from members of the Soil Conservation Service.

The yields in columns A are based on prevailing management, or the management ordinarily used, and those in columns B are based on improved management. Under the prevailing management suitable varieties of crops are grown and seeding is done at the proper time and rate. Methods of planting and harvesting are efficient, and weeds, insects, and plant diseases are controlled to some extent. Some residue management is also practiced.

Under the prevailing management the land has not been leveled, and the irrigation system used does not insure uniform penetration of water over the field. Therefore plants do not make optimum growth, and their growth is not uniform throughout a field. Also water erosion occurs where downslope irrigation is used in sloping areas that have an excessive grade. In some years maximum yields of wheat and grain sorghum are not obtained, because of insufficient water.

The predicted yields given in columns B are based on improved management, which consists of the following practices:

1. The irrigation system used provides for uniform penetration of water and for control of erosion. Land leveling, contour furrowing, and use of gated pipes and underground pipes are among the practices used in an efficient irrigation system.
2. Tillage is performed at the proper time.
3. An appropriate cropping system is used that includes legumes, close-growing crops, and row crops.
4. Adapted varieties of crops are planted.
5. Seeding is at the proper rate to obtain the maximum plant population.
6. Irrigation water is properly applied.
7. Recommended amounts and kinds of fertilizer are applied, as needed, to provide the optimum level of fertility for the particular crop.
8. Manure, when available, is used to maintain the content of organic matter.

Management of Rangeland [3]

The purpose of this section is to help ranchers plan the management of their range. The section explains how range condition classes are appraised, describes the range sites in Wichita County, gives estimated yields for each range site, and discusses practices that will improve the yields from rangeland.

About 22 percent of the acreage in the county is in range. Most of this acreage is along the breaks of streams and drainageways and is not suited to cultivated crops. Some of the areas have gentle slopes, but others are strongly sloping, rolling, or steep. Outcrops of bedrock occupy part of the steep areas.

The ranches are mainly of the cow-calf type. Beef cattle are the animals generally raised, for they are better suited to the rangeland of this county than other kinds of livestock. They graze over a wide area, make efficient use of the available forage, and protect themselves well against predators. The cattle remain on the range throughout the year. In winter their main source of forage is silage fed on the range (fig. 18). Some ranchers, however, supply the cattle with additional forage by allowing them to graze winter wheat for a short period. In addition, a mineral and protein supplement is fed. Cattle that are wintering on the range need a complete mineral salt. The protein needs are met by feeding a protein concentrate in the form of meal or pellets.

Range sites and condition classes

The rancher can best manage his soils and plant resources if he knows the kinds of soils and plants on his holdings. Soils differ in observable characteristics that

[3] By Glen P. Snell, range conservationist, Soil Conservation Service, Dodge City, Kans.

Table 3.—*Predicted longtime average acre yields of crops on the soils most commonly irrigated*

[Yields in columns A are those to be expected under common management, and yields in columns B are those to be expected under improved management]

Soil name	Wheat		Corn		Grain sorghum		Sugar beets		Alfalfa		Forage sorghum (silage)		Pinto beans	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Cwt.*	*Cwt.*
Goshen silt loam	45	50	85	120	80	115	17.0	21.0	4	6	20	25	17	22
Richfield silt loam, 0 to 1 percent slopes	40	50	80	120	75	115	16.5	20.5	4	6	19	24	16	21
Ulysses silt loam, 0 to 1 percent slopes	35	50	75	120	70	115	16.0	20.0	4	6	18	23	15	19
Ulysses silt loam, 1 to 3 percent slopes	30	45	70	110	65	100	15.5	19.5	3	5	16	21	13	17
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	25	40	65	100	60	90	15.0	19.0	3	5	15	20	11	15

are related to their ability to produce different kinds and amounts of native plants. Range soils that produce essentially the same kinds or amounts of climax vegetation are grouped together in a *range site.*

***Figure 18.*—Harvesting irrigated forage sorghum with an ensilage harvester. The sorghum will be used to feed cattle that are wintering on the range.**

The vegetation that grew originally on a site is called the *climax vegetation.* It is generally the most productive and most suitable kind of vegetation for that particular site. Most of the plants in the climax vegetation are palatable and nutritious for grazing animals. The kind of vegetation on a given site is determined largely by grazing use. It is generally not climax vegetation.

In the descriptions of range sites, the native vegetation is referred to in terms of *decreasers*, *increasers*, and *invaders.* Decreasers and increasers are climax plants. Decreasers are the most heavily grazed and are consequently the first to be injured by overgrazing. Increasers withstand grazing better or are less palatable to livestock than the decreasers. They increase for a while under heavy grazing, but most of them start to decrease if heavy grazing continues. Invaders originally make up a minor part of the vegetation. They become established after the climax vegetation has been reduced by grazing, and they generally continue to increase under heavy grazing.

Grasses, forbs, and shrubs make up the range vegetation. The range grasses are herbaceous plants. They have fibrous roots, hollow stems divided by joints, and leaves that clasp the stems at their base. The forbs are native herbaceous plants other than grasses. Shrubs are low-growing native woody plants; some of them resemble forbs if they have been closely grazed.

The range condition is an estimate of the kind, proportion, and amount of native vegetation on a range site in relation to the highest stage of plant growth the site can support. It is determined by computing the percentage of the present vegetation in relation to the climax vegetation for the site. Changes in range condition are caused primarily by the degree of use or the kind of use of the rangeland. Four range condition classes are defined. A range that has from 76 to 100 percent of its potential composition, that is, the vegetation that is characteristic of the climax vegetation on that site, is in excellent condition; a range that has 51 to 75 percent is in good condition; one that has 26 to 50 percent is in fair condition; and one that has less than 26 percent is in poor condition.

Seven kinds of range sites are recognized in Wichita County. These are the Loamy Lowland, Loamy Terrace, Loamy Upland, Limy Upland, Sandy, Sandy Terrace, and Breaks. In addition there are areas of unstable soils on which a permanent plant community is never developed. The range sites in the county and the dominant vegetation on each site are described in the following pages.

LOAMY LOWLAND SITE

This range site consists of deep, dark, loamy soils that are well drained. The soils occupy lowlands that are flooded frequently during rainy seasons. These soils are—

Alluvial land (An).
Humbarger loam (Hu).

Decreaser grasses make up as much as 55 percent of the potential plant community on this range site, and perennial increaser forbs and grasses make up the rest. Among the principal decreasers are big bluestem, little bluestem, switchgrass, side-oats grama, and Canada wildrye. Important increasers are western wheatgrass, buffalograss, and blue grama. Important invaders are silver bluestem, sand dropseed, western ragweed, sunflower, and cocklebur.

Under present use, this range site is generally in fair condition. Western wheatgrass, buffalograss, and blue grama are the plants grazed most extensively. If moisture is favorable, sunflower, cocklebur, and other annual plants appear to dominate the site. When the site is in excellent condition, the annual yield of air-dry herbage can be 3,000 to 4,000 pounds per acre.

LOAMY TERRACE SITE

Deep, nearly level soils on alluvial fans, benches, and upland swales make up this range site. The surface layer of these soils is loam or silt loam, and the subsoil is loam to silty clay loam. These soils are fertile, and their available moisture holding capacity is high. They receive additional moisture as runoff from the nearby uplands. Overflow from the creeks is rare. The water intake rate is medium, and the water table is below the root zone of most range plants. These soils are—

Bridgeport loam (Br).
Goshen silt loam (Go).

At least 40 percent of the potential plant community on this site consists of decreaser grasses, and perennial increaser forbs and grasses make up the rest. Switchgrass, big bluestem, little bluestem, side-oats grama, and Canada wildrye are the principal decreasers, and western wheatgrass, blue grama, and buffalograss are important increasers. Important invaders are silver bluestem, annual weeds, or other annual plants.

Blue grama is the main increaser under heavy grazing. Under present range conditions, blue grama, western wheatgrass, and buffalograss are the dominant grasses, but in droughty years annuals are the common invaders. When this site is in excellent condition, the annual yield of air-dry herbage can be 2,000 to 3,000 pounds per acre.

LOAMY UPLAND SITE

In this range site are deep soils that have a surface layer of silt loam. These soils are moderately permeable and have high available moisture holding capacity. These soils are—

Richfield silt loam, 0 to 1 percent slopes (Rm).

Richfield silt loam, 1 to 3 percent slopes (Rn).
Ulysses silt loam, 0 to 1 percent slopes (Ua).
Ulysses silt loam, 1 to 3 percent slopes (Ub).
Ulysses silt loam, 3 to 5 percent slopes (Uc).

Decreaser grasses make up at least 25 percent of the potential plant community on this range site, and perennial increaser forbs and grasses make up the rest. Among the principal decreasers are little bluestem, side-oats grama, and western wheatgrass. Important increasers are blue grama, buffalograss, sand dropseed, silver bluestem, and prairie sagewort. Important invaders are pricklypear and annual weeds or other annual plants.

Buffalograss is the main increaser under heavy grazing. The dominant grasses under present conditions are blue grama and buffalograss. In droughty years pricklypear is the common invader. When this site is in excellent condition, the annual yield of air-dry herbage can be 1,250 to 2,000 pounds per acre.

LIMY UPLAND SITE

This range site consists of deep, well-drained soils that have a limy subsoil and are on uplands. These soils are—

Colby silt loam, 5 to 15 percent slopes (Cd).
Mansic clay loam, 0 to 1 percent slopes (Ma).
Mansic clay loam, 1 to 3 percent slopes (Mb).
Mansic clay loam, 1 to 3 percent slopes, eroded (Me).
Mansic clay loam, 3 to 5 percent slopes (Mg).
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).
Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded (Um).
Also the Mansker portion of the Mansker-Potter complex (Mm) is in this site.

Decreaser grasses make up at least 60 percent of the potential plant community on this range site, and other perennial increaser grasses and forbs make up the rest. Among the principal decreasers are little bluestem and side-oats grama. Important increasers are blue grama, hairy grama, sand dropseed, hairy dropseed, buffalograss, and broom snakeweed. Important invaders are ring muhly and pricklypear.

Under present use this site is generally in fair condition. Blue grama and buffalograss are grazed most extensively. Broom snakeweed increases rapidly after a severe drought. When this site is in excellent condition, the annual yield of air-dry herbage can be 1,500 to 2,000 pounds per acre.

SANDY SITE

In this range site are deep fine sandy loams. The water intake rate of these soils is moderately rapid, and the soils are subject to wind erosion if the vegetation is removed. These soils are—

Manter fine sandy loam, 0 to 1 percent slopes (Mn).
Manter fine sandy loam, 2 to 5 percent slopes (Ms).

As much as 55 percent of the potential plant community on this site consists of decreaser grasses, and perennial increaser grasses and forbs make up the rest. Sand bluestem, little bluestem, side-oats grama, and switchgrass are the principal decreasers. Among the important increasers are blue grama, sand dropseed, buffalograss, sand paspalum, sand sagebrush, and small soapweed. Important invaders include three-awn, windmillgrass, sixweeks fescue, and annual eriogonum.

Under present use this range site is generally in fair condition. Blue grama and buffalograss are the plants grazed most extensively. If moisture is favorable, sand dropseed and annual eriogonum appear to dominate the site. When this site is in excellent condition, the annual yield of air-dry herbage can be 1,500 to 2,000 pounds per acre.

SANDY TERRACE SITE

Bayard fine sandy loam (Ba) is the only soil in this range site. This deep, well-drained, nearly level to slightly sloping soil is on alluvial fans and terraces. It has a subsoil of calcareous fine sandy loam and a substratum of sandy loam to loamy sand. The moisture-holding capacity is moderate to low, but a large part of the moisture stored is available for plant use. Additional moisture is received as runoff from adjacent soils. Flooding from the creek is infrequent, and the water table is below the root zone of most range plants.

Decreaser grasses make up at least 60 percent of the potential plant community on this range site, and perennial increaser forbs and grasses make up the rest. Among the principal decreasers are sand bluestem, little bluestem, switchgrass, and side-oats grama. The principal woody increasers are sand sagebrush and small soapweed; other important increasers are blue grama, buffalograss, sand dropseed, and sand paspalum. Important invaders include windmillgrass, tumblegrass, annual weeds, and other annual plants.

Blue grama is the main increaser under heavy grazing. The dominant grasses under present grazing conditions are blue grama and sand dropseed. Windmillgrass, tumblegrass, and annuals are common invaders. When this range site is in excellent condition, the annual yield of air-dry herbage can be 1,500 to 2,500 pounds per acre.

BREAKS SITE

This range site consists of the Potter soils of the Mansker-Potter complex; it occurs only in combination with the Limy Upland range site (fig. 19). The soils are steep, stony, and shallow. Their surface layer is loam to silt loam.

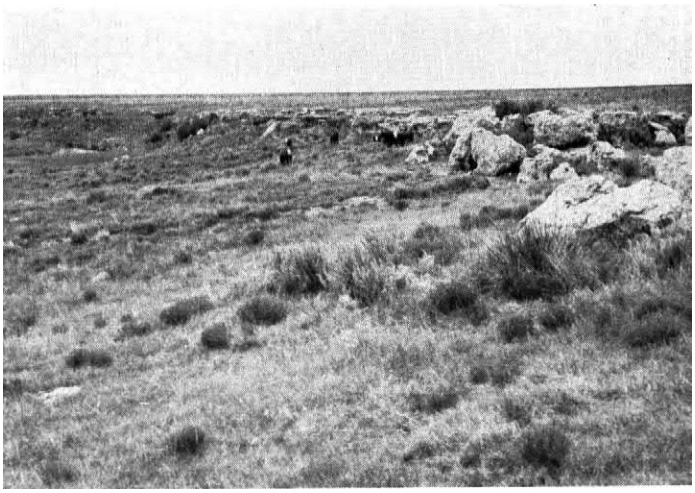


Figure 19.—**Breaks and Limy Upland range sites along White Woman Creek.**

Decreaser grasses make up at least 60 percent of the potential plant community on this range site, and perennial increaser forbs and grasses make up the rest. Little bluestem and side-oats grama are the principal decreasers.

Among the important increasers are blue grama, hairy grama, sand dropseed, and broom snakeweed. Important invaders are ring muhly and three-awn.

Under present use this range site is generally in good condition. Blue grama and hairy grama are the plants grazed most extensively. If this site is overgrazed, perennial three-awn invades rapidly. When this site is in excellent condition, the annual yield of air-dry herbage can be 1,250 to 1,750 pounds per acre.

UNSTABLE SOILS

On some soils a permanent plant community never develops, because the soils are naturally unstable. These soils are—

Lincoln fine sandy loam (Lf).
Lofton silty clay loam (Lo).

Some plants will grow for a time on these sites. Flooding and wind erosion, however, prevent the development of a stable range site. Lincoln fine sandy loam is subject to severe wind erosion if all the vegetation is removed.

Principles and practices of range management

On rangeland, grazing use is the one factor that a range operator can control to maintain or improve his range. Fluctuations in climate are important, but the range operator cannot control the weather. The following are practices that improve the range and that cost little:

Proper range use is the most important practice in good range management. If the range grasses are to remain vigorous, only about half the year's supply of forage should be grazed. By adjusting the grazing load throughout the year, so that at least half the current year's growth of desirable plants remains, the range operator will gradually improve the quality and quantity of the forage and will conserve the soils (fig. 20). If the range is overgrazed, on the other hand, more water runs off the soils and less water is available for the range plants. The production of forage is decreased, the better forage plants are weakened, and erosion by water and wind is increased.

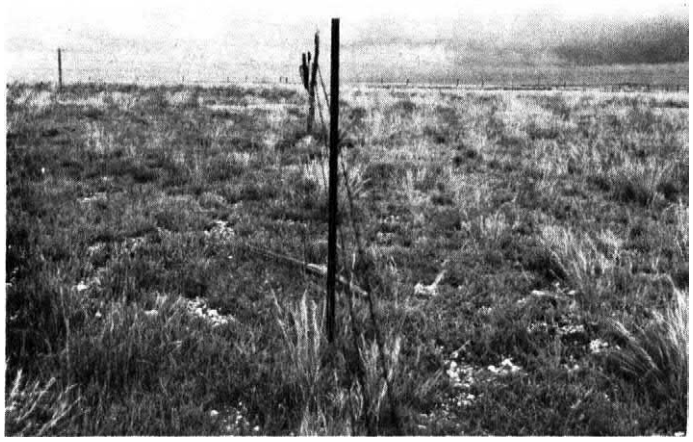


***Figure 20.*—An area of the Limy Upland range site divided by a fence. The range on both sides of the fence is still in good condition, but three-awn is increasing on the right side because that area has been overgrazed.**

Uniform distribution of grazing is important in proper range use. The range must be grazed as evenly as possible so that efficient use will be made of the forage. Properly locating fences, water, salt, and supplemental feed influences the distribution of livestock and thus helps make grazing more uniform. Because fences and watering places are permanent, their proper location should be carefully planned. Livestock tend to graze the forage on some range sites more than others; therefore, adjacent range sites that are grazed differently should be separated by a fence.

The location of salt and feed is more flexible than that of fences and watering places, as the salt and feed can be moved from time to time. Moving salt and feed to areas of pasture that have the least use is the least expensive way of obtaining uniform grazing distribution and is the easiest to control.

Care must be taken so that livestock do not overgraze plants that they prefer. For example, during the warm season of May to October, livestock prefer buffalograss, blue grama, and other grasses that grow in warm seasons to western wheatgrass. In the cool season of October to December, they prefer western wheatgrass, which grows in that season. During the warm season, therefore, the livestock should not be allowed to overgraze sites where buffalograss and blue grama are dominant. During cool seasons, they should not be allowed to overgraze sites where western wheatgrass is dominant.

Deferred grazing consists of resting a pasture or range for a definite period during the growing season, at least for a period of 3 months. This allows the better forage plants to improve in vigor and permits the plants to produce seed. When grazing is deferred throughout the entire spring and summer, a reserve of forage is built up for use in fall and winter, or for use during emergencies.

Rotation-deferred grazing is a practice in which one or more pastures are rested at planned intervals throughout the growing season. Each pasture is given a different rest period each successive year to permit the desirable forage plants to develop and produce seed.

Range seeding is used to establish native grasses by seeding or reseeding land that is suitable for range. If a satisfactory stand of grass is to be obtained, the following practices are necessary:

1. About July 15 of the year prior to the year the grass is to be seeded, plant sorghum in close-drilled rows as a cover crop. While the sorghum is growing, the annual grasses and weeds on the range that is to be reseeded will usually furnish sufficient protective cover.
2. Select good-quality seed of adapted grasses for seeding.
3. Plant the seed in a firm seedbed where the cover crop is growing. Ordinarily, no tillage is needed to prepare the seedbed, as the soil under the cover crop is sufficiently firm.
4. Exclude livestock until the second season, when the grass has matured. Allow livestock to graze only lightly thereafter until the grasses are well established.

For additional information about seeding native grasses and legumes, the adapted species to grow, establishing a protective cover, and the availability of seed, consult a local representative of the Soil Conservation Service.

Management for Wildlife [4]

Soils influence wildlife, primarily through the kind of vegetation they produce. The carrying capacity of an area for wildlife is largely determined by the kind, amount, and distribution of this vegetation.

Topography and such soil characteristics as fertility also affect wildlife. Topography affects wildlife by influencing the way the land is used. Fertile soils are capable of producing greater numbers of wildlife than less fertile soils, and waters that drain from fertile soils generally produce more fish than waters that drain from infertile soils.

Wetness and the water-holding capacity are also important soil features that influence wildlife resources. They affect the construction of ponds for fish and the development and maintenance of habitats for waterfowl.

The characteristics of the soils and the topography were considered in preparing table 4. That table shows the potential of the soil associations in the county for producing habitats for the more important species of wildlife. The column titled "Food" shows, by means of ratings, the capacity of the soil associations to provide the kinds of food plants needed by the kind of wildlife specified. The ratings of *poor*, *fair*, and *good* in the other columns indicate the potential of the soil associations for developing the type of habitat indicated.

The soil associations are described in the section "General Soil Map," and the location of each is shown on the general soil map at the back of the report. A detailed description of the individual soils in each association is given in the section "Descriptions of the Soils." Information about the use and management of the soils and about the kinds of vegetation they are capable of producing is given in the section "Use and Management of Soils."

The soils of this county are capable of producing vegetation that provides suitable habitats for a number of wildlife species. The ringneck pheasant is probably the most important game bird in the county, but doves migrate annually to and from the area. Habitats for fish are limited to a few suitable farm ponds.

Many species of wildlife are beneficial because they help control undersirable insects and rodents. For example, the hawk, which inhabits this county or migrates to the county, helps to control rodents. Recreational opportunities, mainly hunting and fishing, are other important contributions of wildlife resources.

Basic practices used in conserving moisture and protecting the soils from erosion are also important in conserving wildlife resources. For example, stripcropping helps to control wind erosion and also provides a variety of different plants in a specific area. Stubble mulching and keeping crop residue on the surface conserve moisture and protect the soils. They also make waste grain a more accessible source of food for wildlife.

Where conditions are suitable, establishing trees and shrubs in field or farmstead windbreaks also fulfills the requirements for habitats of certain species. Proper grazing of pasture and rangeland results in greater production of livestock and also provides better cover for wildlife.

Some areas are more suitable for wildlife than for use as cropland. Such areas can be improved as habitats for wildlife by protecting the present natural vegetation or by establishing suitable cover.

Developing a specific habitat for wildlife requires that the kind of plant cover the soils are capable of producing be properly located and distributed. Technical assistance in planning developments for wildlife and in determining which species of vegetation to plant can be obtained from the district office of the Soil Conservation Service. Engineering assistance is also provided for designing some developments for wildlife. Additional information and assistance can be obtained from the Extension Service, from the Bureau of Sport Fisheries and Wildlife, and from the Kansas Forestry, Fish and Game Commission.

Windbreak Management [5]

Trees are not native to Wichita County, and there are no large areas of woodland. Late in the 1870's, however, a few cottonwood trees were planted along some of the drainageways. Some of these trees have survived because they received extra moisture when the streams overflowed. Also some trees have been planted in windbreaks.

[4] By CHARLES V. BOHART, conservation biologist, Soil Conservation Service, Lincoln, Nebr.

[5] By ANDREW J. LONGLEY, area conservationist, Soil Conservation Service, Garden City, Kans.

TABLE 4.—*Potential of the soil associations for providing habitats required by some of the more important kinds of wildlife*

Soil association	Species	Potential for producing, for species of wildlife named—			
		Woody cover	Herbaceous cover	Aquatic habitat	Food
Richfield-Ulysses	Pheasant	Poor	Good	Poor	Very good.
	Dove	Poor	Good	Poor	Good.
Ulysses-Goshen-Potter	Deer	Fair	Fair	Fair	Fair.
	Cottontail rabbit	Fair	Fair	Fair	Fair.
	Doves	Fair	Fair	Fair	Fair.
Ulysses-Mansic	Pheasant	Poor	Good	Poor	Fair.
	Doves	Poor	Good	Poor	Good.

Plantings for windbreaks can be successfully established and maintained in this area if proper planning and care are used. Grass and weeds must be controlled carefully to prevent competition for the available moisture. Cultivating the soil controls the weeds. Also, water and air penetrate the soil more readily after tillage. Extra moisture for windbreaks can be obtained by diverting floodwaters or by pumping water from irrigation or domestic wells. Trees grown in irrigated windbreaks grow faster and provide protection much sooner than those grown without irrigation (fig. 21).

***Figure 21.*—An irrigated windbreak on Richfield silt loam, 0 to 1 percent slopes.**

Trees and shrubs suitable for windbreak planting are eastern redcedar, Rocky Mountain juniper, Siberian elm (also called Chinese elm), Osage-orange, mulberry, ponderosa pine, cotoneaster, American plum, and lilac. The eastern redcedar, Rocky Mountain juniper, Siberian elm, and Osage-orange tolerate drought better than the other trees and shrubs.

Some soils are more favorable for trees than others. In this county Alluvial land and the Humbarger, Bayard, and Goshen soils are the most suitable soils for trees because they receive runoff from surrounding areas. The Lofton and Lincoln soils and the soils of the Mansker-Potter complex are not considered suitable for trees. The other soils of the county are deep, silty, and permeable and are on uplands. All of them have about the same potential for growing trees. If the trees and shrubs grown on them are supplied with water and are given proper care, the trees generally grow 2 to 3 feet each year, and the shrubs grow about 1 foot. Growth is somewhat slower where the trees are grown under dryland practices. More information about planting and developing farmstead windbreaks can be obtained from a local representative of the Soil Conservation Service or from the county agricultural agent.

Engineering Uses of the Soils [6]

This section describes the outstanding engineering properties of the soils, particularly in relation to highway construction and conservation engineering. A brief description of the engineering soil classification systems, and definitions of engineering terms used in the tables, are also given.

Soil properties frequently influence design, construction, and maintenance of engineering structures. The properties most important to the engineer are permeability to water, shear strength, compaction characteristics, texture, plasticity, and reaction. However, depth of unconsolidated material, depth to the water table, and topography are also important.

The information in this report can be used to—

1. Make soil and land use studies that will aid in selecting sites for industries, businesses, residences, and recreational purposes.
2. Make preliminary estimates of the engineering properties of the soils for the planning of agricultural drainage systems, farm ponds, terraces, waterways, dikes, diversions, irrigation canals, and irrigation systems.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways and airports and in planning detailed investigations of the selected locations.
4. Locate probable sources of gravel, sand, and other construction material.
5. Correlate performance of engineering structures with soil mapping units and thus develop information that will be useful in maintaining structures. The information may also prove useful as a guide in future planning.
6. Determine the suitability of soil units for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that will be more useful to engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

The engineering interpretations reported here can be used for many purposes. It should be emphasized, however, that these interpretations may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, sand, and aggregate—may have a special meaning in soil science. These terms, as well as other special terms that are used in the soil survey report, are defined in the Glossary at the back of this report.

Engineering classification systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture, color, and structure. This system is useful only as the initial step in making engineering classifications of soils. The engineering properties of a soil must be determined or estimated after the initial classifications have been made.

[6] CARL L. ANDERSON, civil engineer, Soil Conservation Service, assisted in the preparation of this section.

757-856—65——3

TABLE 5.—*Brief description of the soils of*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification USDA
			Inches	
An	Alluvial land.	Nearly level loamy soil subject to flooding; in narrow valleys along channels of intermittent streams.	(3)	(3)
Ba	Bayard fine sandy loam.	Deep soil that has a surface layer and subsoil of fine sandy loam and a sandy substratum at a depth of about 5 feet; formed in alluvium on fans; subject to overflow as the result of runoff from the uplands.	0–24 24–50	Fine sandy loam Loamy fine sand
Br	Bridgeport loam.	Deep, nearly level soil that has a surface layer and subsoil of granular loam to clay loam; on alluvial fans above flood plains; formed in calcareous sediment washed from the adjacent slopes.	0–50	Loam
Cd	Colby silt loam, 5 to 15 percent slopes.	Deep, calcareous, light-colored silt loam that has a weakly developed profile; formed in loess on uplands.	0–50	Silt loam
Go	Goshen silt loam.	Deep, dark-colored silt loam that has a well-developed profile; the subsoil is silty clay loam; in upland swales and on benches along entrenched drainageways.	0–20 20–32 32–50	Silt loam Silty clay loam Light silty clay loam
Hu	Humbarger loam.	Deep, nearly level, moderately dark colored soil formed in alluvium on flood plains; the surface layer is loam; the substratum is loam to a depth of 24 inches, but it has thin layers of sandy loam below that depth.	0–24 24–50	Loam (3)
Lf	Lincoln fine sandy loam.	Sandy soil formed in alluvium; it has a surface layer of fine sandy loam over a sandy and gravelly substratum; on flood plains along intermittent streams, and subject to damaging overflow.	0–7 7–50	Fine sandy loam Sand and gravel
Lo	Lofton silty clay loam.	Deep, dark, noncalcareous soil that has a surface layer of silty clay loam and a clay subsoil; it is in depressions where water is ponded after heavy rains.	0–6 6–24 24–50	Silty clay loam Clay Silty clay loam
Ma Mb Me Mg	Mansic clay loam, 0 to 1 percent slopes. Mansic clay loam, 1 to 3 percent slopes. Mansic clay loam, 1 to 3 percent slopes, eroded. Mansic clay loam, 3 to 5 percent slopes.	Deep, moderately dark colored, nearly level to strongly sloping soils that have a weakly developed profile; the surface layer is light clay loam and the subsoil is clay loam; a strongly calcareous layer is at a depth of 24 inches; formed in Plains outwash.	0–24 24–50	Light clay loam Clay loam
Mm	Mansker-Potter complex:			
	Mansker soil.	A moderately deep soil that has a surface layer of silt loam and a subsoil of clay loam underlain by strongly calcareous caliche; on uplands near breaks.	0–13 13–40 40+	Silt loam or loam Light clay loam Hard caliche
	Potter soil.	A soil that has a loamy surface layer and is shallow over hard caliche; on uplands near breaks or outcrops of sand or caliche.	0–11 11+	Loam Hard caliche
Mn Ms	Manter fine sandy loam, 0 to 1 percent slopes. Manter fine sandy loam, 2 to 5 percent slopes.	Deep, dark-colored, nearly level or gently sloping soils that are well drained; the soils have a surface layer of fine sandy loam and a loamy subsoil; on uplands adjacent to streams.	0–16 16–30 30–50	Fine sandy loam Sandy loam Loam
Rm Rn	Richfield silt loam, 0 to 1 percent slopes. Richfield silt loam, 1 to 3 percent slopes.	Deep, dark-colored, nearly level or gently sloping soils that have a surface layer of silt loam over a well-defined subsoil of silty clay loam; on loess-capped tablelands.	0–8 8–16 16–48	Silt loam Silty clay loam Silt loam
Ua Ub Uc	Ulysses silt loam, 0 to 1 percent slopes. Ulysses silt loam, 1 to 3 percent slopes. Ulysses silt loam, 3 to 5 percent slopes.	Deep, well-drained, nearly level to strongly sloping soils that have a weakly developed profile; the surface layer is silt loam, and the subsoil is light silty clay loam to silt loam; formed in loess on uplands.	0–9 9–15 15–50	Silt loam Light silty clay loam Silt loam

See footnotes at end of table.

Wichita County, Kans., and estimated properties

Classification—Continued		Percentage passing sieve—			Permeability [2]	Available water capacity	Reaction	Shrink-swell potential
Unified [1]	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3).
SM-SC	A-2	100	95-100	25-35	1.0-1.5	0.12	7.4-8.4	Low.
SM	A-2	100	95-100	15-20	2.5-5.0	.10	7.4-8.4	Low.
CL	A-6	95-100	85-95	50-70	0.5-1.0	.18	7.4-7.8	Moderate.
ML-CL	A-6		100	75-95	0.5-1.0	.18	7.4-7.8	Low to moderate.
ML-CL	A-4	100	95-100	75-95	0.5-1.0	.19	6.6-7.3	Low to moderate.
CL	A-6 or A-7	100	95-100	75-90	0.3-0.5	.19	6.6-7.3	Moderate.
CL	A-6	100	95-100	75-90	0.5-1.0	.19	7.4-7.8	Moderate.
CL	A-4 or A-6		95-100	75-90	0.5-1.0	.19	7.4-7.8	Moderate.
(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3).
SM-SC	A-2	100	95-100	25-35	2.0-3.0	.12	7.4-7.8	Low.
SP or SP-SM	A-2 or A-3	95-100	95-100	0-10	5.0-10.0	.06	7.4-7.8	None.
CL	A-7		100	90-100	0.1-0.3	.18	6.6-7.3	Moderate.
CH	A-7		100	90-100	0.1	.15	6.6-7.3	High.
CL	A-7		100	90-100	0.1-0.3	.18	7.4-7.8	Moderate.
CL	A-6	100	90-100	75-85	0.3-0.5	.18	7.4-7.8	Moderate.
CL	A-6	100	90-100	75-85	0.3-0.5	.15	7.0-8.0	Moderate.
CL	A-6	95-100	95-100	75-80	0.5-1.0	.18	7.4-7.8	Moderate.
CL or CH	A-6 or A-7	95-100	70-80	55-65	0.3-0.5	.16	7.4-7.8	Moderate to high.
(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3).
SC or CL	A-6	90-100	85-95	45-60	0.5-1.0	.18	7.4-7.8	Moderate.
(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3).
SM-SC	A-2		100	25-35	1.0-1.5	.14	6.6-7.3	Low.
SM-SC	A-2 or A-4	100	95-100	30-40	1.0-1.5	.14	7.4-7.8	Low.
CL	A-6	100	95-100	70-80	0.5-1.0	.18	7.4-7.8	Moderate.
CL	A-4 or A-6		100	80-90	0.3-0.5	.19	6.6-7.3	Moderate.
CL or CH	A-7		100	85-100	0.1-0.3	.19	6.6-7.3	High.
ML-CL	A-6 or A-7		100	80-90	0.3-0.5	.18	7.4-7.8	Moderate to high.
ML-CL	A-4 or A-6		100	85-95	0.5-1.0	.18	6.6-7.3	Moderate.
CL	A-6		100	75-90	0.3-0.5	.18	7.4-7.8	Moderate.
ML-CL	A-4 or A-6		100	70-85	0.5-1.0	.18	7.4-7.8	Moderate.

TABLE 5.—*Brief description of the soils of*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification
				USDA
			Inches	
Ue	Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded.	Deep, gently sloping to strongly sloping, well-drained soils that have a surface layer and subsoil of calcareous silt loam; the soils are on loess-capped uplands. These are a complex of Ulysses soils, some of which are eroded to the extent that they cannot be distinguished from Colby soils.	0–50	Silt loam or loam
Um	Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded.			

[1] The Soil Conservation Service and the Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are SM–SC and ML–CL.

TABLE 6.—*Interpretations of*

Soil series and map symbol	Suitability as a source of—					Soil features affecting engineering practices	
	Topsoil	Sand	Gravel	Road fill [1]	Subgrade [1]	Highway location [1]	Dikes or levees
Bayard (Ba)	Fair	Surface layer poor; fair below a depth of 14 inches.	Poor	Good	Fair	Well drained; fair stability; low plasticity; medium erodibility; subject to runoff water from uplands.	Well graded; moderate stability and permeability.
Bridgeport (Br)	Good	Poor	Poor	Good	Fair	Well drained; stable material; subject to runoff water from uplands.	Deep; moderate stability; moderate permeability.
Colby (Cd)	Fair	Unsuitable	Unsuitable	Good	Good	Well drained; moderate stability and erodibility.	Moderate erodibility; low to moderate shear strength and plasticity.
Goshen (Go)	Good	Unsuitable	Unsuitable	Good	Fair to good.	Well drained; occasionally runoff from the uplands floods the soils and deposits sediment.	Moderate permeability; fair compaction; moderate erodibility.
Humbarger (Hu)	Surface layer good; poor below a depth of 24 inches.	Poor	Poor	Good	Fair	Subject to stream overflow; water table below a depth of 4 feet.	Moderate permeability; fair to good compaction.

See footnotes at end of table.

Wichita County, Kans., and estimated properties—Continued

Classification—Continued		Percentage passing sieve—			Permeability [2]	Available water capacity	Reaction	Shrink-swell potential
Unified [1]	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
ML–CL	A–6		100	75–95	0. 5–1. 0	0. 18	7. 4–7. 8	Moderate.

[2] Permeability is a measure of the rate of percolation of water through a unit cross section of saturated soil material under gravity with a one-half inch head.
[3] Variable.

engineering properties of soils

Soil features affecting engineering practices—Continued						
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Remarks
Reservoir area	Embankment					
Moderate to rapid permeability; subsoil is sandy.	Well graded; moderate shear strength and stability; medium erodibility.	Well drained; moderate permeability.	Well drained; moderate permeability; limited water-holding capacity.	(2)	Friable; moderate stability and erodibility.	
Moderate permeability.	Moderate shear strength and stability; compaction fair to good; high compressibility.	Well drained; moderate permeability; water table at a depth of 15 feet.	Deep; well drained; moderate permeability; high water-holding capacity.	Deep; friable; moderate permeability; moderate stability.	Deep; friable; fertile; moderate stability and low erodibility.	
Deep; moderate permeability; stream channels may contain rapidly permeable sand.	Moderate shear strength, stability, and plasticity; fair to good compaction.	Well drained; strongly sloping to moderately steep.	Strongly sloping to moderately steep; moderate permeability; high water-holding capacity.	Deep; friable; strongly sloping to moderately steep; moderate to high erodibility.	Deep; friable; strongly sloping to moderately steep; moderate to high erodibility; low to moderate stability.	Sand deposits occur in localized pockets in the substratum, and they outcrop in a few places on steep, eroded slopes.
Deep; moderate to moderately slow permeability; moderate shrink-swell potential	Moderate shear strength and plasticity; moderate to high compressibility.	Deep; well drained; moderate to high erodibility.	Deep and fertile; good structure; moderate permeability; high water-holding capacity.	Deep; friable; nearly level; moderate permeability.	Deep; friable; good structure; fertile; moderate to high erodibility.	
Moderate permeability in uppermost 24 inches; rapid permeability in substratum.	Moderate shear strength and shrink-swell potential; fair to good compaction.	Well drained; water table below a depth of 4 feet.	High water-holding capacity; subject to occasional flooding; water table below a depth of 4 feet.	(2)	Deep; low erodibility; subject to stream overflow.	Sand deposits occur in a few places in the substratum.

TABLE 6.—*Interpretations of*

Soil series and map symbol	Suitability as a source of—					Soil features affecting engineering practices	
	Topsoil	Sand	Gravel	Road fill [1]	Subgrade [1]	Highway location [1]	Dikes or levees
Lincoln (Lf)	Poor	Good	Poor, except for occasional pockets.	Fair	Poor to good.	Hazard of flooding.	(2)
Lofton (Lo)	Poor	Unsuitable	Unsuitable	Poor	Poor	In depressions, which fill with water from runoff after heavy rain.	Deep; slow permeability; high to moderate shrink-swell potential.
Mansic (Ma, Mb, Me, Mg).	Fair	Unsuitable	Unsuitable	Good	Fair	Well drained; moderate stability; high compressibility.	Moderate shrink-swell potential.
Mansker (occurs only in a complex (Mm) with the Potter soils).	Surface layer fair; substratum poor.	Poor, see remarks.	Poor, see remarks.	Good	Poor	Moderate stability; high compressibility.	Moderate shrink-swell potential; moderate plasticity.
Potter (occurs only in a complex (Mm) with the Mansker soils).	Poor	Poor	Poor; localized deposits.	Good	Poor	Steep; hard caliche near surface.	(2)
Manter (Mn, Ms)	Fair	Poor	Unsuitable	Good	Good	Well drained; moderately stable.	Deep; moderate permeability; medium erodibility.
Richfield (Rm, Rn)	Good	Unsuitable	Unsuitable	Fair to good.	Poor to fair.	Well drained; stable material; no detrimental features.	Deep; moderately slow permeability.
Ulysses (Ua, Ub, Uc)	Good	Unsuitable	Unsuitable	Good	Good	Well drained; stable material; no detrimental features.	Low to moderate stability, plasticity, and shrink-swell potential.
Ulysses-Colby complexes (Ue, Um).	Fair	Unsuitable	Unsuitable	Good	Good	Well drained; no detrimental features.	Low to moderate stability, plasticity, and shrink-swell potential.

[1] Prepared with the assistance of C. W. HECKATHORN, field soil engineer, and HERBERT E. WORLEY, soil research engineer, Kansas State Highway Commission. This assistance was performed under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

engineering properties of soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Remarks
Reservoir area	Embankment					
(2)	(2)	Well drained; high permeability; hazard of stream overflow.	(2)	(2)	(2).	
(2)	(2)	In depressions where ponding occurs; outlets remote.	(2)	(2)	(2).	
Moderately slow permeability.	Moderate stability, shear strength, and shrink-swell potential; high compressibility.	Well drained and on uplands.	High water-holding capacity and moderate permeability; well drained; deep; friable.	Deep; friable; low erodibility.	Good structure, stability, and fertility.	Deposits of caliche occur in some places, in most of them below a depth of 36 inches.
Moderately slow permeability.	Moderate shear strength, shrink-swell potential, and permeability; high compressibility.	Well drained	Moderately shallow over caliche; sloping; low water-holding capacity.	Moderately shallow over caliche.	Moderately shallow; low erodibility.	Fair source of caliche; has sand and gravel in the substratum.
Moderate to rapid permeability; pervious caliche and strata of sand.	Moderate permeability; contains caliche and outcrops of sand; variable.	Well drained	(2)	(2)	(2)	Good source of caliche; some deposits of sand and gravel in the substratum.
Moderate permeability.	Well graded; good compaction; slight piping potential.	Well drained	Limited water-holding capacity; moderately rapid permeability.	Deep; friable	Moderate erodibility; deep and friable.	
Moderately slow permeability; low to moderate shrink-swell potential.	Moderate shear strength and stability; low to moderate shrink-swell potential; fair compaction.	Well drained	Deep; moderately slow permeability; high water-holding capacity; nearly level.	Deep; moderately slow permeability; moderate stability; low to moderate erodibility.	Deep; friable; low to moderate erodibility.	
Moderate permeability; low shrink-swell potential.	Moderate permeability; low to moderate shear strength, plasticity, stability, and erodibility; fair to good compaction.	Well drained	Deep; moderate permeability; high water-holding capacity; nearly level to gently sloping.	Deep; low to moderate stability and erodibility.	Deep; friable; low to moderate erodibility.	
Moderate permeability; low to moderate shrink-swell potential.	Moderate permeability; low to moderate shear strength, plasticity, stability, and erodibility; fair to good compaction.	Well drained	Moderate permeability; high water-holding capacity; moderately sloping.	Deep; moderately sloping; moderate to high erodibility.	Deep; friable; moderately sloping; moderate to high erodibility.	

[2] Not applicable.

Two systems are used by engineers for classifying soils. These are the systems used by the American Association of State Highway Officials (AASHO) and the Unified system. These systems are explained briefly in the following paragraphs. The explanations are taken largely from the PCA Soil Primer (*7*).[7]

AASHO Classification System.—The AASHO system is based on actual performance of material used as a base for roads and highways (*1*). In this system all the soils are classified in seven groups. The soils most suitable for road subgrade are classed as A–1, and the soils least suitable are classed as A–7. Within rather broad limits, soils are classified numerically between these two extremes, according to their load-carrying ability.

Three of the seven basic groups may also be divided into subgroups to designate within-group variations. In each group the relative engineering value of the soil material is indicated by a group index number, which is shown in parentheses following the group classification. Group index numbers range from 0 for the best material to 20 for the poorest.

In the AASHO system the soil material may be further divided into the following two major groups: (1) Granular material in which 35 percent or less of the material passes a 200-mesh sieve, and (2) silt-clay material in which more than 35 percent of the material passes a 200-mesh sieve.

The silty part of the silt-clay material has a plasticity index of 10 or less, and the clayey material has a plasticity index greater than 10. The plasticity index refers to the numerical difference between the liquid limit and the plastic limit. The liquid limit is the moisture content, expressed as a percentage of the ovendry weight of the soil, at which the soil material passes from a plastic to a liquid state. The plastic limit is the moisture content, expressed as a percentage of the ovendry weight of the soil, at which the soil material passes from a semisolid to a plastic state.

Unified Classification System.—In the Unified system the soils are grouped on the basis of their texture and plasticity, as well as on their performance when used as material for engineering structures (*14*). The soil materials are identified as coarse grained, which are gravels (G) and sands (S); fine grained, which are silts (M) and clays (C); and highly organic (Pt). No highly organic soils are mapped in Wichita County.

Under the Unified system, clean sands are identified by the symbols SW or SP; sands with fines of silt and clay are identified by the symbols SM or SC; silts and clays that have a low liquid limit are identified by the symbols ML and CL; and silts and clays that have a high liquid limit are identified by the symbols MH and CH.

After an engineer has been trained and has obtained experience, he can make an approximate classification of soils, based on visual field inspection and observation. Exact classification, however, must be based on the review and application of complete laboratory analysis data. Field classifications are useful in determining when and upon which soils laboratory analyses should be made.

Engineering interpretations of soils

Two tables are given in this section. In the first (table 5, p. 32) the soils are briefly described and their properties important to engineering are estimated. In the second (table 6, p. 34) the suitability of the soils for engineering uses is indicated. No test data were available for the soils in Wichita County. The data given in table 5 are based on laboratory testing of soils in Ford, Logan, and Morton Counties; on the results of tests made by the State Highway Commission of Kansas at the sites of construction; on experience with the same kind of soils in other counties; and on information given in other parts of this report.

The properties described in table 5 are for a typical profile, generally a representative one of each soil series. Therefore, some variation from these values should be anticipated. In the column that gives a description of the soil and site, the significant layers in each kind of soil are described. A more complete description of a profile that is typical for each series is given in the section "Genesis, Classification, and Morphology of Soils." Table 5 also gives classifications for each significant layer, according to the textural classes of the U.S. Department of Agriculture, as well as estimates of the Unified and AASHO classifications.

In the columns that show the percentage of material passing sieves of various sizes, the separation between the coarse-textured and fine-textured soils is shown, and the percentages of soil material that is smaller in diameter than the openings in a given screen.

Soil permeability is the ability of the soil to transmit water or air. It is measured in terms of the rate at which water passes through the soil profile or through each major horizon. The column that shows permeability gives the estimated rate of water percolation through a soil that is not compacted, expressed in inches per hour.

The column that shows available water capacity gives the amount of capillary water in inches per inch of soil depth that is held at field capacity over that held at the wilting point of common crops.

The reaction of the soils in the county ranges from neutral to moderately alkaline. Most of the soils are neutral to mildly alkaline, except the Bayard and Mansic soils, which are mildly alkaline to moderately alkaline. The following terms were used to express the ranges in pH: Neutral—6.6 to 7.3; mildly alkaline—7.4 to 7.8; and moderately alkaline—7.9 to 8.4.

Salinity, alkalinity, and dispersion are not rated in table 5. Generally they are not considered to be a problem in this county.

The column that shows shrink-swell potential indicates the volume change in a soil when the content of water changes. It gives estimates of how much a soil shrinks when it is extremely dry and of how much it swells when it is extremely wet. Lofton silty clay loam is an example of a soil that has a high shrink-swell potential at a depth between 6 and 24 inches. The Lofton soil shrinks greatly when dry and swells when wet.

Bayard fine sandy loam and the upper layers (0 to 30 inches) of the Manter fine sandy loams have a low shrink-swell potential. Lincoln fine sandy loam has a rating of "none" below a depth of 7 inches. A knowledge of the shrink-swell potential is important in planning the use of a soil for roads and other engineering structures.

Estimates of the shrink-swell potential are based on the liquid limit of the soil. The shrink-swell potential of the soils of the county is indicated by the relative terms "low,"

[7] Italic numbers in parentheses refer to Literature Cited, p. 59.

"moderate," and "high." The soils that have a liquid limit of 25 or less are given a rating of "low;" those that have a liquid limit of 25 to 40 are given a rating of "moderate;" those that have a liquid limit of 40 to 60 are given a rating of "high;" and those that have a liquid limit of more than 60 are given a rating of "very high."

The suitability of the soils of this county for various engineering uses is indicated in table 6. In that table are also given soil features that affect the use of the soils for highway construction and for agricultural engineering.

In table 6 depth to ground water or to bedrock is mentioned only where the water table or bedrock is within 10 feet of the surface. For more information about the ground water and bedrock in this county the reader can refer to the section "Water Supply" and to State Geological Survey of Kansas Bulletin No. 108 (*8*), which gives facts about the geology and ground water in this county.

The suitability of the soils as a source of topsoil is indicated by the terms "good," "fair," or "poor." This information is important because topsoil is needed for growing vegetation that will control erosion on embankments, shoulders of roads, ditches, and cut slopes. For these estimates, each layer of the soil profile was considered as a possible source of topsoil, although only one rating is shown in the table. The subsoil may have a different rating than the surface layer because of its different characteristics. It may, for example, be more sandy or more clayey than the surface layer, or it may contain caliche. Whether it is still in place or has been moved, some part of the soil material can be used as topsoil in many areas, as on embankments and on cut slopes.

Certain soils have surface water ponded during wet seasons. Roads across these soils must be constructed on embankment sections, or must be provided with a good system of underdrains and surface drains. The Lofton soil occurs in depressions. This soil has slow to very slow permeability and poor surface drainage. It is occasionally ponded when the water from runoff accumulates. The clayey layers in the Lofton soil shrink greatly when this soil dries, and they swell when the soil becomes wet. If a subgrade made of this soil is too wet when the pavement is constructed above it, the soil will shrink as it dries out under the edges of the pavement. This may cause the pavement to crack.

If a subgrade made of the Lofton soil is too dry, the pavement that is laid over it will warp as the soil absorbs moisture and swells. Pavements laid over plastic soils will crack and warp less if a granular base course is used beneath the pavement. Adequate drainage can be provided by extending this foundation course through the shoulder of the road.

"Not applicable" is shown for the Lofton soil as a site for reservoirs or for the embankment of ponds. The Lofton soil is in depressions in the upland where drainage is imperfect and where the topography is such that there are generally no sites for farm ponds. However, dugouts can be constructed in this soil. Sites for farm ponds on the Bayard, Colby, and Ulysses soils and on soils of the Mansker-Potter complex should be checked carefully, since they may contain thin layers of sand and gravel. Sand pockets may also occur in the bottom of drainage channels at any of the pond sites in the county. There are no suitable sites for ponds in the Lincoln soil.

Features that affect the suitability of the soils for irrigation are given in table 6. Additional facts about the suitability of the soils for irrigation are given in the section "Management of Irrigated Soils."

Terraces and diversions are not applicable on nearly level soils such as the Bayard, Humbarger, and Lincoln, which are along White Woman and Ladder Creeks. Terraces also are not applicable on soils such as the Lofton, which are in depressions, and they are not applicable on the steep soils such as the Potter.

Because they are sloping, some soils are not suitable for waterways. Wind erosion is a hazard to the waterways constructed in this county. Windblown materials accumulate in the waterways, smother the vegetation, and hinder the flow of water.

Genesis, Classification, and Morphology of Soils

Physical and chemical data are limited for the soils of this county. However, this section gives facts that are known about the outstanding characteristics of the soils and relates those characteristics to the factors of soil formation. The first part discusses the environment of the soils in this county; the second shows the classification of the soils; and the third gives some facts about the morphology.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of geologic material or other processes, and they slowly change it to a natural body with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material to a soil profile. The amount of time may be much or little, but some time is always required for horizon differentiation. Usually, a long time is required for the development of distinct horizons.

The amount of time needed for development of a soil profile depends to a great extent upon the amount of precipitation and on the temperature. The greater the amount of precipitation and the higher the temperature, the smaller the amount of time needed for development of a profile. Conversely, the smaller the amount of precipitation, the longer the time needed. This is the reason why the soils in the western part of Kansas do not have the

well-defined B horizon that is typical of the soils in the eastern part.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent Material

Parent material is the unconsolidated material from which a soil develops. It is formed as the result of the weathering of rocks through the processes of freezing and thawing, as the result of wind erosion, and as the result of the grinding away of rocks by rivers and glaciers. It is also formed as the result of chemical processes. Most of the soils in Wichita County were formed in fine-grained, eolian sediments, called loess. Others were formed in eolian sandy sediments, in Plains outwash, rocks, and in alluvial or colluvial sediments. The following paragraphs give some facts about the geologic history of the county and about the various kinds of parent material.

GEOLOGIC HISTORY (*6, 8*).—The area that is now Wichita County was once covered by a shallow sea. During that period, the sediments that form the Niobrara formation were laid down (fig. 22). Near the end of the Cretaceous period, sediments that formed the Pierre shale formation were deposited above the Niobrara formation. Later, however, erosion removed the Pierre shale in the area that is now Wichita County. This erosion took place early in the Tertiary period. In places it cut deep into the Niobrara formation below the Pierre shale.

The Niobrara formation contains the Smoky Hill chalk and Fort Hays limestone members. The Smoky Hill chalk member is made up of interbedded shale and chalk. It is gray until it is exposed, and then it weathers to white, yellow, and orange. This member contains limonitic concretions, massive chalk beds, and many fossils. It is about 100 feet thick in the southeastern part of the county, and 550 to 600 feet in the northwestern part. The Smoky Hill chalk member is the part of the Niobrara formation that confines most of the ground water to the overlying permeable material.

The Fort Hays limestone is 45 to 65 feet thick in this area. In the early days it was used extensively as building material.

The topography of the county developed largely during the Pliocene and Pleistocene epochs. During the Pliocene epoch, swift streams from the Rocky Mountains deposited unsorted calcareous outwash sediments of sand, gravel, silt, and clay over the area that is now the High Plains. These outwash sediments make up the Ogallala formation. They gradually built the High Plains to about their present level. The Ogallala formation is the principal water-bearing formation in this county; high yields of water are obtained from wells located in the thick deposits of gravel of that formation. Caliche of the Ogallala formation outcrops on the sides of deep drainageways, and sand and gravel outcrop on the steep erosional slopes.

After the sediments of the Ogallala formation were deposited, the channels of the streams that flowed from the Rocky Mountains began to fill with sediment. As a result, many fresh water lakes were formed, and the channels began to shift laterally. It is believed that "algal limestone," which occurs in some places in the county, was precipitated in small lakes that formed above the Ogallala formation in many areas.

More recently, during the Pleistocene epoch, a mantle of loess was laid down over the Ogallala formation. Among the deposits of loess, were those of the Sanborn formation, which includes the Bignell silt member, the Peoria silt member, the Loveland silt member, and the Meade or Crete members. The Peoria silt member makes up the major deposit of loess in this county, and the loess in that member extends to a depth of 30 feet in some places. The Bignell and Loveland silt members occur in scattered areas. The Meade and Crete members have not been separated.

During Recent time the area underwent erosion that has changed much of the topography. Streams cut through the loess into the Ogallala formation. Floodwaters deposited unsorted sand, gravel, and silt on the floodplains of White Woman Creek. Runoff from the local uplands deposited similar sediments on the terraces back from White Woman Creek. In the many undefined drainageways throughout the nearly level tableland, many undrained depressions, known locally as buffalo wallows or lagoons, have formed. Water collects in these depressions after severe rainstorms and is held until it evaporates or moves slowly downward to the water table. The depressions in this county have been attributed to differential deposition, erosion by wind, and the action of animals.

PARENT MATERIAL OF THE PRINCIPAL SOILS.—In the following paragraphs, facts are given about the various kinds of parent material of the soils in Wichita County, and as well, a brief discussion of the soils formed in each kind of parent material (fig. 23). A detailed description of a profile that is typical of the soils of each series is given in the section "Descriptions of Soil Series."

Soils formed in loess.—During the Pleistocene epoch, pale-brown windblown material, called loess, was deposited over the area that is now Wichita County. The loess is silty and calcareous. It was laid down over most of the area in a mantle that ranged from a few feet in thickness on the walls of valleys to as much as 30 feet on the high, flat tableland. Analysis of samples of this loess, taken in Hamilton and Logan Counties, shows that the texture is silt loam that is about 65 percent silt and 20 percent clay.

In Wichita County the soils of the Richfield, Colby, Ulysses, and Lofton series formed mainly in this loess. The Richfield soils have a higher degree of profile development than the other soils formed in loess. They are in the Chestnut great soil group. The Richfield soils have well-defined A, B, and C horizons. Their A horizon is dark-colored silt loam that has granular structure. Less than 30 percent of this horizon is clay. The B horizon is also dark colored, but it has subangular blocky structure and is 34 to 38 percent clay. The Richfield soils are nearly level to gently sloping.

The Colby soils have the least profile development of the soils formed in loess. They are in the Regosol great soil group. The Colby soils have no B horizon. Their A horizon is silt loam, only slightly darkened by organic matter, and it is similar to the underlying material. The Colby soils are generally calcareous to the surface. They have slopes of 3 percent or more.

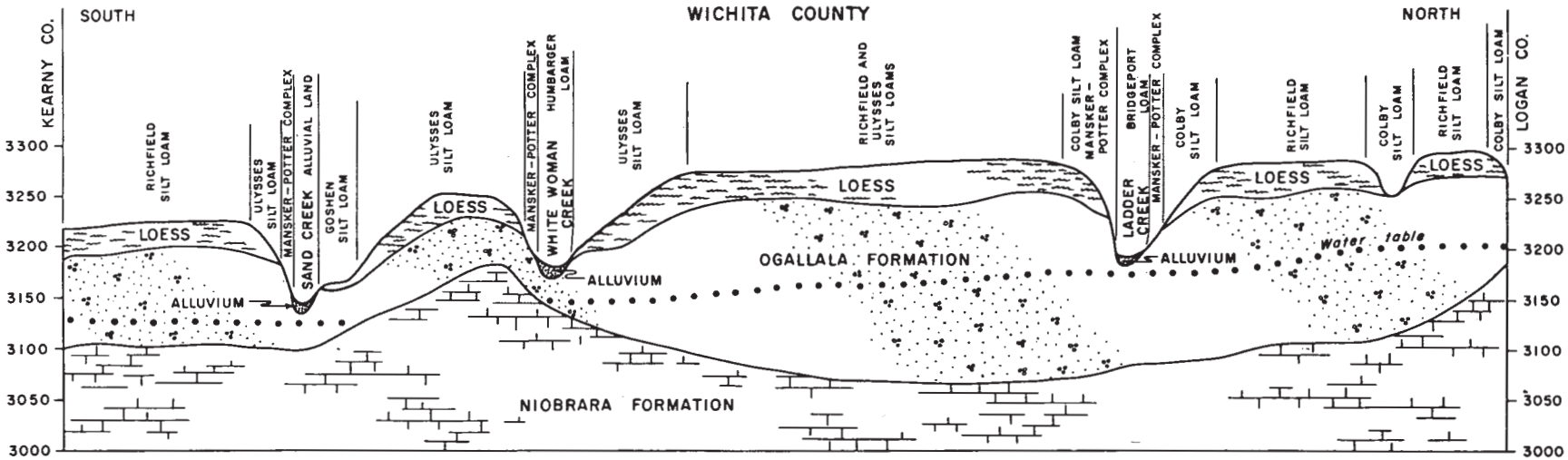


Figure 22.—**An approximate geologic cross section of Wichita County at a point about midway in the county.**

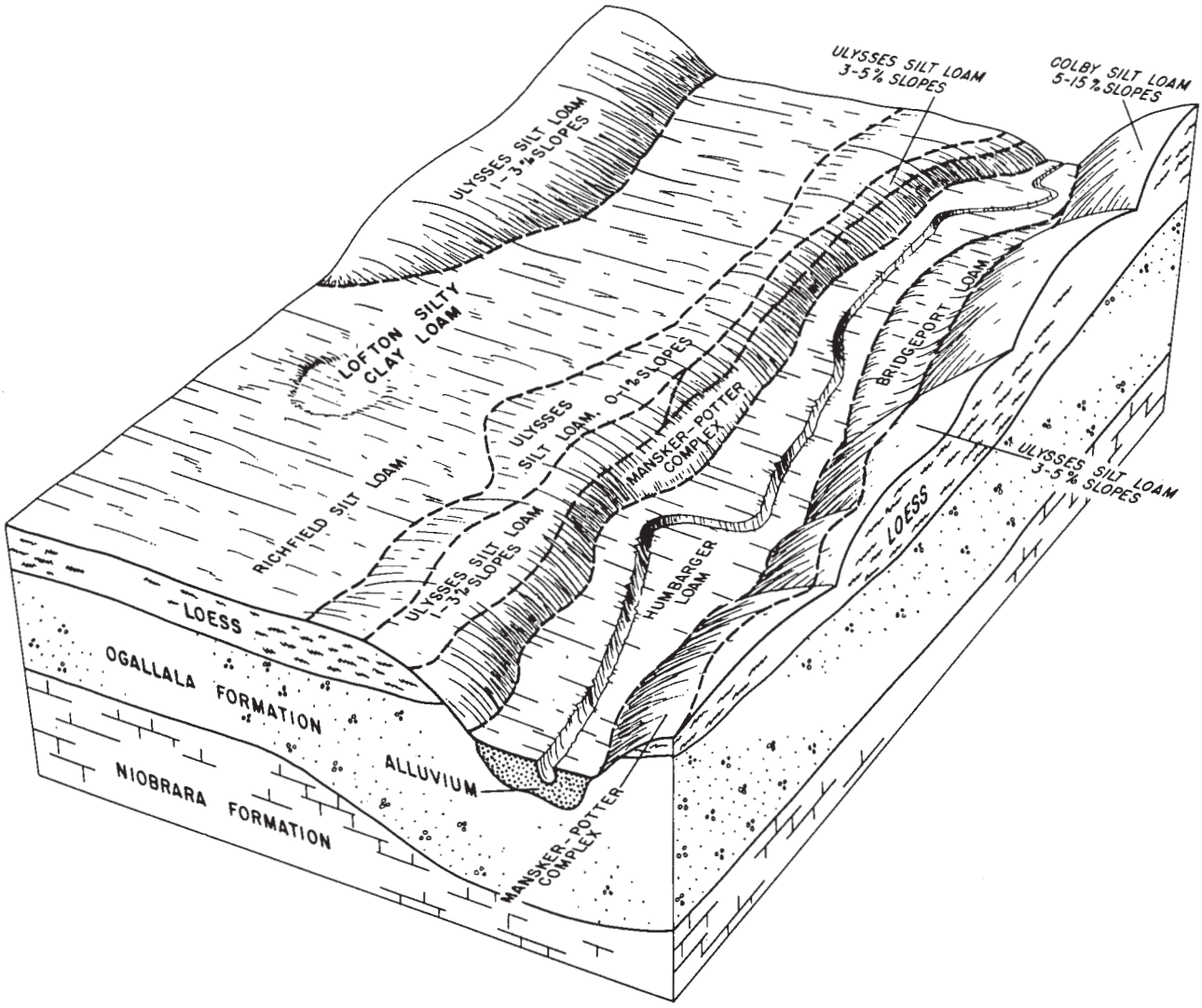


***Figure 23.*—Relationship of soils to the landscape and to the common parent materials of Wichita County.**

The Ulysses silt loams are soils of the uplands. They are intermediate between the Colby and Richfield soils in degree of profile development. Some areas of these soils are nearly level or gently sloping, but the areas along drainageways are moderately sloping.

The Ulysses soils have a moderately dark colored A horizon. They lack a textural B horizon. The nearly level areas of these soils of the tableland are generally calcareous within 10 inches of the surface, but the moderately sloping areas along drainageways are calcareous within 6 to 8 inches of the surface.

The Lofton soils are closely associated with the other soils that formed mainly in loess. They are in the many shallow, undrained depressions throughout the county. Because of their location, water is ponded on the surface for several to many hours after heavy rains. The A horizon of the Lofton soils is dark silty clay loam. The B horizon is heavy silty clay loam or light clay. Unaltered loess is generally below a depth of 4 feet.

Soils formed in eolian sandy sediments.—The sandy sediments were probably deposited after the loess. They consisted of material that is presumably from outcrops of the Ogallala formation and from sandy sediments along creeks. This sandy material was blown about to form knolls and ridges.

The Manter fine sandy loams are the only soils formed in eolian sandy sediments in this county. They are also the only fine sandy loams on the uplands. These soils are nearly level to moderately sloping, and they occur in small areas on benches in the uplands. In most places these soils are bordered on the upland side by Ulysses soils, and on the valley side by Goshen, Bayard, Bridgeport, Humbarger, or Lincoln soils.

These Manter soils are in the Chestnut great soil group. They have a moderately dark colored A horizon of fine sandy loam. Their B horizon is indistinct and consists of fine sandy loam or loam that contains an appreciable amount of silt. The texture of the underlying material ranges from fine sandy loam to loam.

Soils formed in outwash sediments.—Plains outwash of calcareous clay loam is exposed slightly below the summit of the mantle of loess. In it have formed the Mansic soils.

The Mansic soils are classified as Chestnut soils, but they have some characteristics of Regosols. They have a weakly defined profile. The Mansic soils have an A horizon of moderately dark colored, calcareous clay loam that has granular structure. They have no B horizon. The C horizon is highly calcareous clay loam that is 10 to 15 percent segregated lime at a depth of 24 inches.

The Mansker and Potter soils overlie caliche of the Ogallala formation (fig. 24). The Mansker soils are moderately deep Calcisols formed where a thin layer of loess overlies medium-textured, calcareous material weathered from the Ogallala formation. The Mansker soils generally occur at a slightly higher elevation than the Potter soils. Their A horizon is moderately dark, calcareous silt loam. Immediately below the A horizon is a thick layer that is transitional to the highly calcareous material below. This transitional layer is stony in places. The profile of the Mansker soils shows minimal development. The Mansker soils have no B horizon, but they have prominent A and Cca horizons.

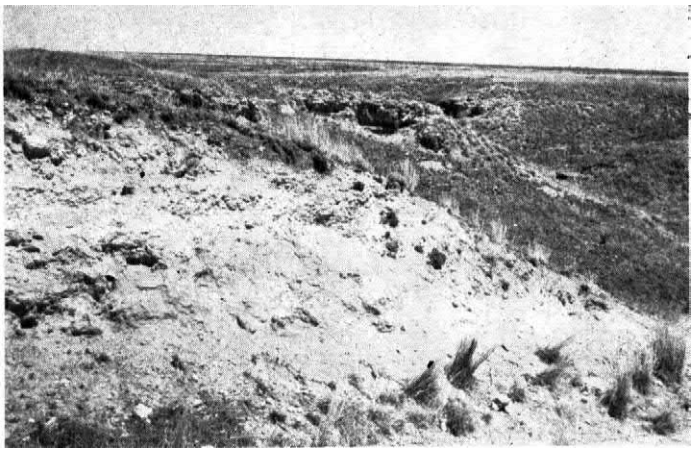


Figure 24.—**An area where the Ogallala formation crops out.**

The Potter soils formed in material weathered from the Ogallala formation. They occur along entrenched drainageways of Sand, Ladder, and White Woman Creeks, where geologic erosion has removed most of the sediments that overlie the caliche of the Ogallala formation. The Potter soils are Lithosols formed in material weathered from outcrops of indurated caliche.

Soils formed in recent alluvial or colluvial sediments.—In this county the soils of the Lincoln, Humbarger, and Bayard series formed in alluvial material; the Bridgeport and Goshen soils formed in a mixture of alluvial and colluvial material. Except for the Goshen soils, which are in the Chestnut great soil group, all of these soils are in the Alluvial great soil group.

The Lincoln and Humbarger soils are on the flood plains of White Woman and Ladder Creeks. The Lincoln soils formed in sandy alluvium, and the Humbarger formed in silty to loamy alluvium. The Lincoln soils are light colored and calcareous, and they have a weakly defined profile. Their A horizon consists of fine sandy loam that contains a slight accumulation of organic matter. It is about 8 inches thick and is underlain by sand and gravel.

The Humbarger soils are moderately dark colored and calcareous, and they have granular structure. Their A horizon is loam about 20 inches thick. Below the A horizon is loam to clay loam, stratified with sandy loam and other sandy material.

The Bridgeport and Bayard soils are on fans and stream terraces, where they receive runoff from the adjacent upland. The Bridgeport soils formed in loamy local colluvial and alluvial sediments high in loess. They have a moderately dark colored loam A horizon that has granular structure. The Bridgeport soils have a weakly defined profile that is calcareous within 8 inches of the surface.

The Bayard soils occur with the Bridgeport soils. They are calcareous and sandy. Their A horizon is moderately dark colored fine sandy loam about 14 inches thick. Below the A horizon is light-colored fine sandy loam.

The Goshen soils are nearly level and are on benches and on the floors of shallow upland swales. They receive considerable runoff from adjacent areas. The sediments in which they formed came mainly from higher lying soils developed in loess. The A horizon of the Goshen soils is dark-colored silt loam that has granular structure and is about 20 inches thick. Goshen soils have a B horizon of dark-colored silty clay loam that has subangular blocky structure. They are leached of lime to a depth of 18 to 36 inches.

Climate

Climate affects the physical, chemical, and biologic relationships in the soil. The amount of water that percolates through the soil depends partly on the amount and intensity of rainfall, on the humidity, and on the length of the frost-free period. The water from rain or melting snow dissolves small amounts of some of the minerals and carries them out of the soil. Such minerals as clay and calcium carbonate, however, are moved downward only a short distance in the soil profile.

Because of the limited amount of precipitation in this county, the minerals in the soils are only slightly weathered. Calcium carbonate has been leached to a depth of 20 to 30 inches in some soils, but it is at or near the surface in other, younger soils.

Temperature influences the growth of organisms and the rate of the chemical reactions involved in the weathering of minerals. The rate at which chemicals react and at which organic material is decomposed increases as the temperature increases.

The strong winds characteristic of this area have influenced the formation of soils by modifying the soil material through sorting action. They have been responsible for recharging the surface layer of some soils with calcium carbonate blown in from eroded areas.

Plant and Animal Life

Plants and animals are indispensable in the development of soils. The type of plants and the amount of plant cover are determined in part by the climate and in part by the kind of geologic material. Plants add organic matter to the soil. They thus influence the structure and tilth of the soil, as well as the chemical characteristics. Plants also affect the climate within the soil by providing shade and by helping the soil retain moisture. In this county they use most of the precipitation that falls. Their roots take up little or no moisture from the material that underlies the soils, because that material is dry.

757-856—65——5

The soils of the county formed under grass, which takes up large amounts of such soluble plant nutrients as calcium and phosphate through its roots and carries them upward to the leaves and stems. When the plant dies and decomposes, these minerals are returned to the surface layer. The leaves of the dead grass fall evenly over the surface and form a mulch.

Grass has small, fibrous rootlets that fill nearly all of the spaces in the upper part of the soil. When these rootlets die and decay, they leave organic matter evenly distributed throughout the surface layer. Because of this organic matter, the upper horizons in the soil profile are generally dark colored.

Relief

Relief, or the lay of the land, influences the formation of soils through its effects on soil and moisture relationships and on erosion, the temperature, and the plant cover. The Goshen soils are examples of soils in which the development of the profile has been affected by the influence of relief on the soil and moisture relationships. These soils are in swales in the upland. They are deep and dark colored, and they have a well-developed profile because they receive runoff water from surrounding areas. The Goshen soils are leached of lime to a depth of 18 to 36 inches.

Richfield soils occur with the Goshen soils, but they occupy nearly level areas of loess-covered upland. The Richfield soils are not leached of lime to so great a depth as the Goshen soils. In most places they are leached to a depth of only about 16 inches. The Richfield soils have a well-developed profile.

Ulysses soils are silty and occupy nearly level, slightly convex to sloping areas of loess-covered upland, mainly along drainageways. They have only a moderately well developed profile because they have absorbed less water than have the Goshen and Richfield soils.

The Lofton soils are in depressions where they receive more moisture than most of the soils of the county. They are deep and are fine textured because the extra moisture has weathered the particles of silt to clay. Also, some particles of clay have been deposited by runoff water that flows into the depressions.

On steep slopes the soil-forming processes are retarded because the soil material does not remain in place long enough for a well-developed profile to form. The Colby soils are examples of soils that have steep areas. The Mansker and Potter soils also occupy steep, stony areas where geologic erosion has removed the loess and has exposed the caliche. Where those soils occur, runoff and erosion remove the soil material before it has remained in place long enough for a well-developed profile to form.

Mansic soils occupy nearly level to sloping areas of upland underlain by calcareous clay loam outwash. They do not have a well-developed profile and are less leached of lime than some soils not subject to erosion. This is because the soil material is removed before there has been much time for leaching and for the development of a soil profile.

The Manter soils have a moderately sandy surface layer and subsoil and a moderately developed profile. The underlying material contains lime that has been leached from the upper part of the profile. This leaching has been possible because of the nearly level relief and the sandy texture of the surface layer and subsoil.

The Humbarger soils formed in alluvium on nearly level flood plains. Because of their nearly level relief, as well as the amount of moisture received through flooding, these soils are deeper and are darker colored to a greater depth than the slightly sloping Bridgeport soils on fans.

Time

The length of time required for development of a soil profile depends largely on the other factors of soil formation. A profile develops slowly in the dry climate and under the sparse vegetation characteristic of Wichita County. It develops more rapidly in areas where the climate is moist and the vegetation is dense.

As water moves downward through the soil profile, lime and fine particles of soil material are gradually leached from the surface layer and are deposited in the subsoil. The amount of this leaching depends primarily on the length of time the soil has been in place, on the permeability of the soil, and on the amount of water available. As the fine particles are deposited, a horizon of clay accumulation forms in the subsoil. In many areas a similar horizon of lime accumulation is formed where calcium carbonate has been deposited after it was leached from the surface soil.

Classification and Morphology of Soils

Soils are placed in narrow classes for the organization and application of knowledge about their behavior within farms, ranches, or counties. They are placed in broad classes for study and comparisons of large areas, such as continents. In the comprehensive system of soil classification followed in the United States (*2*), the soils are placed in six categories.

Beginning at the top, the six categories are order, suborder, great soil group, family, series, and type.

In the highest category, the soils of the whole country are grouped into three orders, whereas thousands of soil types are recognized in the lowest category. The suborder and family categories have never been fully developed and thus have been little used. Attention has been given largely to the classification of soils into soil types and series within counties or comparable areas and to the subsequent grouping of series into great soil groups and orders. The soil series, type, and phase are described briefly in the section "How This Soil Survey Was Made."

Classes in the highest category of the classification scheme are the zonal, intrazonal, and azonal orders (*9*). In the zonal order are soils that contain evident, genetically related horizons that reflect the predominant influence of climate and living organisms in their formation. The intrazonal order is made up of soils with evident, genetically related horizons that reflect the dominant influence of a local factor of topography or parent material over the effects of climate and living organisms. The azonal order consists of soils that lack distinct, genetically related horizons, commonly because of youth, resistant parent material, or steep topography. In table 7 the soil series are classified by higher categories and their important characteristics are given.

The Chestnut soils are in the zonal order. They are a group of soils that have a dark-brown surface horizon that grades to lighter colored horizons. The Chestnut soils have accumulated lime at a depth of 1 to 4 feet. They

TABLE 7.—*Soil series classified by higher categories and some of their important characteristics*

Great soil group and series	Parent material	Relief	Topographic position	Natural drainage	Native vegetation
ZONAL SOILS					
Chestnut soils:					
Goshen	Colluvial-alluvial sediments.	Nearly level	Swales and benches of upland drainage-ways.	Well drained	Short, mid, and some tall grasses.
Lofton	Fine-textured loess and alluvial sediments.	Nearly level	Depressions	Moderately well drained.	Mid grasses.
Mansic [1]	Loamy, calcareous outwash sediments.	Nearly level to moderately sloping.	High Plains uplands	Well drained	Short grasses.
Manter	Partly reworked, moderately sandy sediments.	Nearly level to moderately sloping.	Ridges and knobs of the High Plains uplands.	Well drained	Tall and mid grasses.
Richfield	Loess	Nearly level to gently sloping.	High Plains uplands	Well drained	Short and mid grasses.
Ulysses [1]	Loess	Nearly level to moderately sloping.	High Plains uplands	Well drained	Short and mid grasses.
INTRAZONAL SOILS					
Calcisols:					
Mansker	A thin layer of loess over loamy, calcareous outwash sediments.	Moderately sloping.	High Plains uplands	Well drained	Short and mid grasses.
AZONAL SOILS					
Alluvial soils:					
Bayard	Moderately coarse textured alluvium.	Nearly level	Alluvial fans and terraces.	Well drained	Tall and mid grasses, sagebrush, and yucca.
Bridgeport	Calcareous, loamy local alluvium.	Nearly level	Alluvial benches and terraces.	Well drained	Mid and short grasses, sagebrush, and yucca.
Humbarger	Loamy alluvium over stratified sandy material.	Nearly level	Alluvial flood plains	Well drained	Mid grasses.
Lincoln	Very sandy alluvium	Nearly level to hummocky.	Alluvial flood plains and stream channels.	Excessively drained.	Tall and mid grasses, sagebrush, and yucca.
Lithosols:					
Potter	Weathered caliche	Steep and broken.	High Plains uplands	Excessively drained.	Mid and short grasses.
Regosols:					
Colby	Loess	Moderate to steep.	Sloping uplands of the High Plains.	Well drained	Short grasses.

[1] Intergrading toward Regosols.

formed mainly under mixed tall and short grasses in a subhumid to semiarid, temperate to cool-temperate climate. Typical Chestnut soils of this county are those of the Goshen, Lofton, Manter, and Richfield series. The Mansic and Ulysses soils are also classified as Chestnut soils, but they have some characteristics of Regosols.

The intrazonal soils of this county are in the Calcisol great soil group. Calcisols are a group of soils that have an A horizon variable in thickness and color, a prominent deeper horizon of lime accumulation, and parent material that has a high to very high content of carbonates. In this county only the Mansker soils are Calcisols.

The azonal soils are the Alluvial soils, Lithosols, and Regosols. Alluvial soils are any group of soils without well-developed profile characteristics, because of their youth, or because the nature of the parent material or the relief prevents normal development of such characteristics. In this county the Bayard, Bridgeport, Humbarger, and Lincoln soils are Alluvial soils.

Lithosols are a group of soils having no clearly expressed soil morphology and consisting of a freshly and imperfectly weathered mass of rock fragments. These soils occur mainly on steep slopes. The Lithosols in this county are the Potter soils.

Regosols are a group of soils that lack definite genetic horizons and that develop from deep unconsolidated or soft rocky deposits. The Regosols in this county are the Colby soils.

Descriptions of soil series

This section was prepared for those who need more technical information about the soils in the county than is given elsewhere in the report. Described in alphabetic order are the soil series in the county. The procedure is to name characteristics common to the soils of the series and to describe, by horizons, a profile at a stated location. The profile is representative of the series. After the profile is described, variations from this profile are given. Soil descriptions that are probably easier for the general reader to understand are given in the section "Descriptions of the Soils." They contain some interpretations and other information that is not in this section.

Bayard Series

Well-drained, moderately coarse textured soils make up the Bayard series. These soils have a weakly defined profile and formed in calcareous alluvium. Small water-rounded pebbles are scattered throughout the profile. These soils are on fans and stream terraces along the flood plains of Ladder and White Woman Creeks. They are rarely flooded when the creeks overflow, but they are occasionally flooded by runoff from the nearby uplands.

The Bayard soils are coarser textured than the Bridgeport soils and are deeper over sand and gravel than the Lincoln soils. They are less subject to overflow than the Lincoln soils.

Typical profile of Bayard fine sandy loam in a cultivated area that has been reseeded to grass (about 2,000 feet south and 130 feet west of the northeast corner of sec. 16, T. 17 S., R. 36 W.):

A1–0 to 14 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; slightly hard when dry, very friable when moist; calcareous with few scattered fragments of caliche and caliche pebbles on the surface; diffuse, smooth boundary.

AC—14 to 24 inches, grayish-brown (10YR 5/2) light fine sandy loam, dark grayish brown (10YR 4/2) when moist; structureless; soft when dry, very friable when moist; porous; calcareous; abrupt, smooth boundary.

C—24 to 50 inches, light brownish-gray (10YR 6/2) heavy loamy fine sand, grayish brown (10YR 5/2) when moist; single grain (structureless); soft when dry, very friable when moist; calcareous.

The A horizon ranges from 10 to 18 inches in thickness and from light to heavy fine sandy loam in texture. Depth to coarse sand and gravel ranges from 30 to 60 inches. Some areas of this soil under grass are leached of lime to a depth of 8 inches, but the areas under cultivation are generally calcareous to the surface.

Bridgeport Series

Deep, well-drained, moderately dark colored soils that have a weakly defined profile and are calcareous near the surface make up the Bridgeport series. These soils are at the base of slopes on fans and benches along Ladder and White Woman Creeks. They formed in medium-textured, recent colluvial and alluvial material that contains some silt loam (loess). The loess washed from Mansker, Potter, and Colby soils of the uplands.

The Bridgeport soils are calcareous nearer the surface than the Goshen soils, and they lack a B horizon. Their substratum is less stratified than that of the Humbarger soils of the flood plains.

Typical profile of Bridgeport loam in a pasture of native grass (about 2,200 feet north and 300 feet east of the southwest corner of sec. 15, T. 17 S., R. 36 W.):

A1—0 to 9 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; gradual, smooth boundary.

AC—9 to 24 inches, grayish-brown (10YR 5/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; calcareous and contains a few, small, soft and hard concretions of lime; a few clusters of worm casts; gradual, smooth boundary.

C—24 to 50 inches, grayish-brown (10YR 5/2) light clay loam, dark grayish brown (10YR 4/2) when moist; weak, granular structure; hard when dry, friable when moist; porous; calcareous, with few small, hard lime concretions.

The A horizon ranges from 6 to 14 inches in thickness. In some places texture of that layer is gravelly loam, but it is silt loam in other places. In cultivated areas this soil is generally calcareous to the surface.

Colby Series

In the Colby series are well-drained, light-colored, friable soils. These soils formed in loess or loamy sediments, and they have a weakly developed profile. They are gently sloping to moderately steep and are on the sides of drainageways in the uplands along Ladder and White Woman Creeks.

The Colby soils are lighter colored than the Ulysses soils. They are also calcareous nearer the surface.

Typical profile of Colby silt loam, 5 to 15 percent slopes, in a pasture of native grass (100 feet north and 500 feet west of the southeast corner of sec. 3, T. 16 S., R. 35 W.):

A1—0 to 4 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; weakly calcareous; clear, smooth boundary.

AC—4 to 8 inches, grayish-brown (10YR 5/2) heavy silt loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; calcareous; a few clusters of worm casts; diffuse, smooth boundary.

C1—8 to 20 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; weak, granular structure; slightly hard when dry, friable when moist; porous; calcareous; gradual, smooth boundary.

C2—20 to 48 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; massive (structureless); soft when dry, friable when moist; porous; calcareous.

The A horizon ranges from 2 to 6 inches in thickness and from loam to silt loam in texture. It may be noncalcareous in some places.

Goshen Series

Deep, dark-colored, friable, noncalcareous soils make up the Goshen series. These soils occupy swales and benches along intermittent streams in the uplands. They formed in colluvial and alluvial deposits from associated Ulysses and Richfield soils that occur on higher slopes. Goshen soils also receive runoff from the uplands.

The Goshen soils are darker than the Bridgeport soils. They are noncalcareous to a greater depth than those soils, and they have a B horizon that is lacking in the

Bridgeport soils. The Goshen soils lack the thin layers of sandy material that are typical below a depth of 24 inches in the Humbarger soils. They have a thicker, darker colored A horizon and are deeper over calcareous material than the Richfield soils.

Typical profile of Goshen silt loam in a pasture of native grass (about 1,200 feet south and 100 feet west of the northeast corner of sec. 26, T. 19 S., R. 38 W.):

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; gradual, smooth boundary.

A3—10 to 20 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate to strong, medium, granular structure; hard when dry, friable when moist; a few worm casts; noncalcareous; diffuse, smooth boundary.

B2—20 to 28 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; noncalcareous; gradual, smooth boundary.

B3—28 to 32 inches, grayish-brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; hard when dry, firm when moist; weakly calcareous; diffuse, smooth boundary.

C—32 to 50 inches, light brownish-gray (10YR 6/2) light silty clay loam, grayish brown (10YR 5/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous, with a few streaks of lime.

The thickness of the A horizon ranges from 10 to 20 inches. The texture of that layer is generally silt loam, but it is loam in some places. The A3 horizon is absent in most areas of these soils on benches. Depth to calcareous material ranges from 18 to 36 inches, and it is greatest in the swales.

Humbarger Series

Deep, moderately dark colored, calcareous soils make up the Humbarger series. These soils formed in loamy alluvium on the flood plains of Ladder and White Woman Creeks. They are well drained. The water table is at a depth of 6 feet in some places.

The Humbarger soils are more highly stratified than the Bridgeport soils, and they are on flood plains, rather than on fans and benches. Humbarger soils lack the B horizon that is typical of the Goshen soils, and they are calcareous at a depth of 10 inches or less.

Typical profile of Humbarger loam in a pasture of native grass (about 750 feet north and 250 feet west of the southeast corner of sec. 17, T. 17 S., R. 36 W.):

A11—0 to 12 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate to weak, fine, granular structure; slightly hard when dry, friable when moist; calcareous; diffuse, smooth boundary.

A12—12 to 22 inches, grayish-brown (10YR 5/2) heavy loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous; a few clusters of worm casts; clear, smooth boundary.

AC—22 to 30 inches, grayish-brown (10YR 5/2) light clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous; clear, smooth boundary.

C—30 to 50 inches, light brownish-gray (10YR 6/2) light clay loam, dark grayish brown (10YR 4/2) when moist; weak, granular structure; hard when dry, friable when moist; calcareous, with a few small, soft concretions of calcium carbonate.

The texture of the A horizon ranges from silt loam to light clay loam, but the dominant texture is loam. The texture of the substratum, below a depth of 24 inches, ranges from clay loam to loam. In places the substratum contains thin strata of sandy loam, loamy sand, or sand. These soils are well drained, but in some places the water table is 6 feet below the surface.

Lincoln Series

In the Lincoln series are excessively drained soils that are shallow over sandy and gravelly alluvium. These soils are on low flood plains along White Woman Creek. The water table is well below the root zone of most plants.

The Lincoln soils have a thinner surface layer and a coarser textured substratum than the Bayard soils, and they are more subject to overflow. They are more sandy and occupy lower positions on the flood plains than the Humbarger soils.

Typical profile of Lincoln fine sandy loam in a pasture of native grass (about 500 feet north and 100 feet east of the center of sec. 28, T. 19 S., R. 35 W.):

A1—0 to 7 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, granular structure; soft when dry, very friable when moist; weakly calcareous; a few small pebbles scattered throughout the horizon; gradual, smooth boundary.

AC—7 to 12 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) when moist; contains a few scattered pebbles; structureless; soft when dry, very friable or loose when moist; calcareous; gradual boundary.

IIC—12 to 48 inches, light brownish-gray (10YR 6/2) sand and gravel, dark grayish-brown (10YR 4/2) when moist; single grain (structureless); soft when dry; calcareous.

The combined A and AC horizons range from 4 to 12 inches in thickness over calcareous, stratified sand and gravel. In places these soils are noncalcareous to a depth of 8 inches.

Lofton Series

Deep, dark-colored, noncalcareous soils make up the Lofton series. These soils occupy the floors of depressions, or deflation basins, that have no surface drainage and are locally called potholes or buffalo wallows. They occur with broad areas of nearly level Richfield, Ulysses, and Goshen soils. Within the areas the drainage pattern is poorly defined. The Lofton soils have a more clayey surface layer and subsoil than the Ulysses and Richfield soils.

Typical profile of Lofton silty clay loam in a cultivated field (about 1,500 feet west and 100 feet south of the northeast corner of sec. 11, T. 18 S., R. 37 W.):

Ap—0 to 6 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; moderate, medium, prismatic structure that breaks to weak, blocky structure; very hard when dry, very firm when moist; noncalcareous; clear, smooth boundary.

B2t—6 to 24 inches, gray (10YR 5/1) light clay, dark gray (10YR 4/1) when moist; moderate, medium, prismatic structure that breaks to weak, blocky structure; very hard when dry, very firm when moist; noncalcareous; clear, smooth boundary.

B3—24 to 36 inches, grayish-brown (10YR 5/2) heavy silty clay loam; very dark grayish brown (10YR 3/2) when moist; weak, subangular blocky structure; very hard

when dry, firm when moist; calcareous in the lower 6 inches; gradual, smooth boundary.

Cca—36 to 50 inches, light brownish-gray (10YR 6/2) light silty clay loam, grayish brown (10YR 5/2) when moist; massive (structureless); hard when dry, friable when moist; calcareous, with a few small, soft concretions of calcium carbonate.

The texture of the surface layer ranges from heavy silt loam to light clay. Depth to calcareous material varies with the size of the depression and with the extent of the drainage area. In the larger depressions calcareous material is at a greater depth than in the smaller ones; the average depth is about 30 inches.

Mansic Series

In the Mansic series are deep, well-drained, moderately dark colored loamy soils. These soils are nearly level to moderately sloping. They are on uplands, mainly in the east-central part of the county. They formed in deep, medium-textured, highly calcareous clay loam outwash sediments, well below the level of the loess-capped tableland.

The Mansic soils lack a textural B horizon, and the layer immediately below their surface layer is more calcareous and friable than that in the Richfield soils. The Mansic soils are similar to the Ulysses soils, but they formed in weathered outwash material rather than in loess. The layer where soft calcium carbonate has accumulated is less distinct in the Mansic than in the Mansker soils, and it is at a slightly greater depth.

Typical profile of Mansic clay loam, 0 to 1 percent slopes, in a cultivated field (about 2,100 feet east and 100 feet south of the northwest corner of sec. 11, T. 19 S., R. 36 W.):

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous; diffuse, smooth boundary.

AC1—10 to 16 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous with a few small, hard concretions of calcium carbonate; diffuse, smooth boundary.

AC2—16 to 24 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; moderate, fine, granular structure; porous; hard when dry, friable when moist; calcareous; clear, smooth boundary.

Cca—24 to 50 inches, very pale brown (10YR 8/3) clay loam, very pale brown (10YR 7/3) when moist; massive (structureless); porous; hard when dry, friable when moist; relatively permeable; strongly calcareous and about 15 percent segregated lime. The concentration of segregated lime decreases in the lower part of this horizon.

The A horizon ranges from clay loam to loam in texture and from 8 to 12 inches in thickness. Depth to segregated lime ranges from 14 to 28 inches; the amount of segregated lime in the Cca horizon ranges from 10 to 15 percent.

Mansker Series

Gently sloping soils that are moderately deep over caliche (fig. 25) make up the Mansker series. These soils formed in strongly calcareous sediments in areas adjacent to upland drainageways. In this county they are mapped only in a complex with the Potter soils.

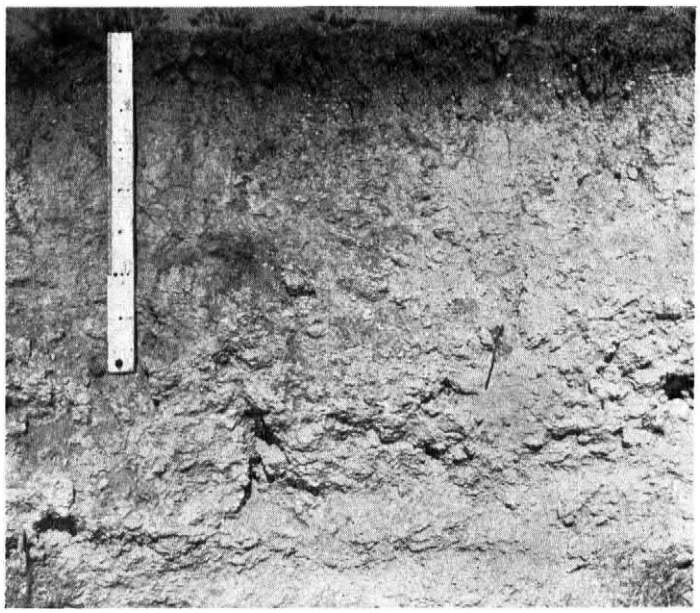


Figure 25.—**A profile of a typical Mansker soil. Caliche underlies the loamy material.**

The Mansker soils are deeper over caliche than the Potter soils. The strongly calcareous layer of soft and hard caliche is nearer the surface in the Mansker soils than in the Mansic soils.

Typical profile of Mansker silt loam in a pasture of native grass (about 2,200 feet north and 50 feet west of the southeast corner of sec. 17, T. 17 S., R. 36 W.):

A1—0 to 6 inches, grayish-brown (10YR 5/2) heavy silt loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; calcareous; gradual, smooth boundary.

AC—6 to 13 inches, light brownish-gray (10YR 6/2) light silty clay loam, brown (10YR 5/3) when moist; moderate, medium, granular structure; hard when dry, friable when moist; numerous worm casts; calcareous; diffuse, smooth boundary.

ACca—13 to 18 inches, very pale brown (10YR 7/3) light clay loam, pale brown (10YR 6/3) when moist; weak granular structure; hard when dry, friable when moist; calcareous and has streaks of lime; clear, smooth boundary.

Cca—18 to 40 inches, white (10YR 8/2) clay loam, light gray (10YR 7/2) when moist; massive (structureless); very hard when dry, friable when moist; strongly calcareous; about 40 percent of soil mass is soft and hard segregated lime.

IIR—40 inches +, white, moderately dense, semihard and hard caliche.

The A horizon ranges from 4 to 8 inches in thickness and from loam or clay loam to light silty clay loam in texture. Depth to the Cca horizon ranges from about 12 to 20 inches, and the content of calcium carbonate in the Cca layer ranges from 30 to 60 percent.

Manter Series

In the Manter series are deep, moderately dark colored, nearly level to moderately sloping soils. These soils are moderately coarse textured and formed in reworked sandy deposits. They occupy small areas in the uplands along Ladder and White Woman Creeks. They are well drained and have moderate moisture-holding capacity.

The Manter soils are more sandy than the Ulysses soils. They are noncalcareous to a greater depth than the Colby soils.

Typical profile of Manter fine sandy loam, 0 to 1 percent slopes, in a pasture of native grass (near the center of sec. 36, T. 19 S., R. 35 W.):

Ap—0 to 8 inches, brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

A1—8 to 16 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; slightly hard when dry, very friable when moist; noncalcareous; a few scattered clusters of worm casts; clear, smooth boundary.

B—16 to 30 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous; diffuse, smooth boundary.

Cca—30 to 50 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, granular structure; hard when dry, friable when moist; calcareous and contains scattered streaks of lime.

The thickness of the A horizon ranges from 8 to 18 inches. The texture of that horizon ranges from light loam to light fine sandy loam, but it is generally fine sandy loam. The A horizon is darker in areas under native grass than in cultivated areas.

Potter Series

The Potter soils are steep and stony, and they are shallow over caliche. They occur along deeply entrenched drainageways in the uplands, below the summit of the High Plains tableland. Some areas are rough and broken, and the slopes range from 5 to 20 percent.

In this county the Potter soils are mapped in a complex with the Mansker soils. They are shallower over a strongly calcareous layer of caliche than the Mansker soils.

Typical profile of Potter soils in a pasture of native grass (about 750 feet north and 100 feet east of the southwest corner of sec. 20, T. 17 S., R. 36 W.):

A1—0 to 6 inches, grayish-brown (10YR 5/2) heavy loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; calcareous, and small pebbles of caliche are scattered throughout the horizon; clear, smooth boundary.

AC—6 to 9 inches, light brownish-gray (10YR 6/2) light clay loam, grayish brown (10YR 5/2) when moist; weak, granular structure; hard when dry, friable when moist; calcareous, and contains small caliche stones; abrupt, smooth boundary.

R—9 inches +, white (10YR 8/2), unweathered, hard caliche, very pale brown (10YR 7/3) when moist; mixed with light-gray (10YR 7/2) clay loam, light brownish gray (10YR 6/2) when moist; massive (structureless); very hard when dry, friable when moist; strongly calcareous.

Significant variations in the profile are not common. However, the texture of the A horizon ranges from sandy loam to clay loam, but loam is the dominant texture. Depth to caliche ranges from 4 to 12 inches.

Richfield Series

Deep, well-drained, dark-colored soils (fig. 26) make up the Richfield series. These soils are nearly level to gently sloping, and they formed in loess. They occur in broad areas throughout the tableland.

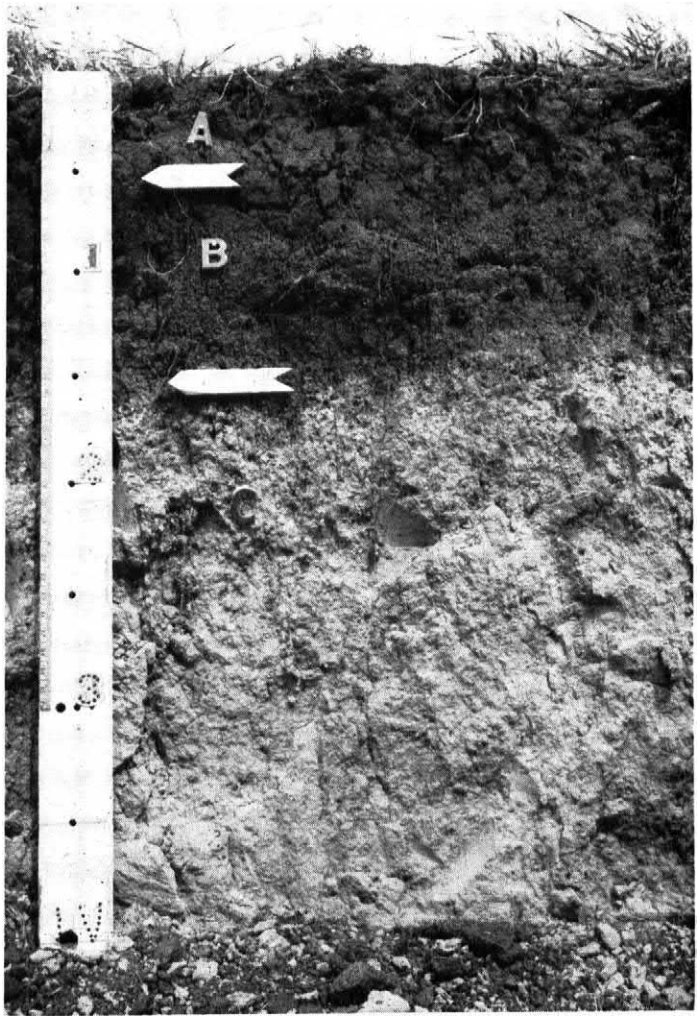


Figure 26.—**A profile of Richfield silt loam showing the horizons, or layers. Richfield soils occupy about 60 percent of Wichita County.**

The Richfield soils are similar to the Ulysses soils, but they have a well-defined B horizon of silty clay loam and are leached of lime to a greater depth than the Ulysses soils. Their A horizon is thinner than that of the Goshen soils.

Typical profile of Richfield silt loam, 0 to 1 percent slopes, in a cultivated field (about 2,300 feet south and 75 feet west of the northeast corner of sec. 20, T. 18 S., R. 36 W.):

Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; weak, granular structure when disturbed; slightly hard when dry, friable when moist; noncalcareous; abrupt, smooth boundary (plow slice).

A1—4 to 8 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; gradual, smooth boundary.

B2t—8 to 16 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; thin, continuous clay films on the surfaces of peds; noncalcareous; gradual, smooth boundary.

B3ca—16 to 20 inches, brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; calcareous, with streaks of lime on the surfaces of peds; clear, smooth boundary.

Cca—20 to 26 inches, very pale brown (10YR 7/3) light silty clay loam, brown (10YR 5/3) when moist; weak, subangular blocky structure; slightly hard when dry, friable when moist; calcareous, with clusters of small, soft concretions of lime; diffuse, smooth boundary.

C—26 to 48 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) when moist; massive to weak, fine, granular structure; slightly hard when dry, friable when moist; porous; calcareous.

Variations in the profile are not common, but they do occur in some places. A dark-colored layer that represents remnants of buried soils occurs in places at a depth ranging from 16 to 48 inches. The buried layer is not typical of this soil and is not related to the present soil or to any features of the present landscape. The thickness of the A horizon ranges from 4 to 11 inches. The content of clay in the B2t horizon ranges from 32 to 38 percent. The moist color of the B horizon ranges from very dark grayish brown (10YR 3/2) to dark brown (10YR 3/3).

Ulysses Series

In the Ulysses series are deep, well-drained, moderately dark colored soils. These soils formed in deep loess or silty deposits, and they have a moderately well defined profile. They are nearly level to moderately sloping and are mainly along upland drainageways. In places in the northeastern part of the county, they contain remnants of a buried soil.

The Ulysses soils are shallower over calcareous material than the Richfield soils, and their B horizon is weakly defined. Their A horizon is thicker and darker than that of the Colby soils.

Typical profile of Ulysses silt loam, 0 to 1 percent slopes, in a cultivated field (about 400 feet north and 80 feet east of the southwest corner of sec. 17, T. 17 S., R. 37 W.):

Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; abrupt, smooth boundary (plow slice).

A1—4 to 9 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; contains a few clusters of worm casts; gradual, smooth boundary.

B—9 to 15 inches, grayish-brown (10YR 5/3) light silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous; contains numerous worm casts; gradual, smooth boundary.

Cca—15 to 24 inches, pale-brown (10YR 6/3) heavy silt loam, brown (10YR 5/3) when moist; weak, granular structure; slightly hard when dry, friable when moist; calcareous and has streaks of free lime; abundant small open root holes and pores; diffuse, smooth boundary.

C—24 to 50 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive to weak, granular structure; porous, soft when dry, friable when moist; calcareous.

The A horizon ranges from 6 to 12 inches in thickness. The texture of the A horizon is generally silt loam, but it is loam and light clay loam in places. The content of clay in the B horizon ranges from 25 to 32 percent. In some places the B horizon is absent. Depth to calcareous material is as much as 15 inches in the nearly level areas, but this soil is calcareous to the surface in some cultivated areas.

Climate[8]

Wichita County has a continental type of climate. The county is on the Great Plains about midway between the Rocky Mountains and the Missouri River. Rainfall is limited because the county lies in the lee of the mountains, which are an effective barrier to the moist air from the Pacific Ocean. Also the county is too far west to be in the path of the moisture-laden air that flows northward from the Gulf of Mexico. The treeless plains and the native vegetation of short grasses identify this region as dry subhumid (*10*).

The many sunny days and the pronounced radiation at night cause the temperature to vary widely over a 24-hour period. Because of the level, open sweep of the plains, cold northern air readily invades the area and causes wide ranges in seasonal and annual temperatures. Also over longer periods there are contrasting periods. For a time there is cooler than normal weather and greater amounts of precipitation, and then periods of more intense heat accompanied by small amounts of rainfall.

Tables 8, 9, 10, and 11 give facts about temperatures and precipitation in the county. The information given was taken from records of the U.S. Weather Bureau at Leoti.

Generally, the seasonal characteristics are well defined. Rain or snow early in spring is usually slow and steady. As the season warms, however, the rains become more sudden and more intense. Winds of increasing velocity from the south accompany the rising temperatures. Occasional sharp relapses toward winter occur with a quick shift of the wind to the north, but these gradually decrease in number and severity as the season progresses.

Thunderstorms that occur late in afternoon and at night are associated with the summer heat. The chance of rain on any 1 day is greater during the early part of the summer than it is during the later part. Later in summer, rains occur less frequently but are of greater intensity. Good wind movement and low humidity temper the summer heat.

Fall brings clear weather, a decrease in rainfall, and mild, pleasant days. The approach of winter is indicated by increasing cloudiness, chillier nights, and snow flurries. Severe cold spells in winter generally are not prolonged. Precipitation is commonly light in winter. It consists mostly of snow, but occasionally there are periods of freezing drizzle or sleet. Strong winds from the northwest often blow the snow from the fields into drifts.

TEMPERATURES.—Figure 27 (p. 53) gives an overall picture of the ranges in temperature, including the mean maximum, the mean minimum, and the mean monthly temperatures, and the approximate season of the year that extremely high or extremely low temperatures may be expected. Extreme variations in temperature are much more likely to occur in winter than in summer.

Table 8 shows the average daily maximum and minimum temperatures for each month and for the year. It

[8] By A. D. ROBB, State climatologist, U.S. Weather Bureau, Topeka, Kans.

also gives the more commonly recorded temperatures and the probable dates of their occurrence. The highest recorded temperature of 111° F. has occurred only once, but a maximum temperature of 102° may be expected at least 4 days in July and August about 2 years in 10. The coldest temperature of −26° was recorded on January 12, 1912. January is likely to have 4 days with a temperature of −4° or lower 2 years in 10. The monthly extremes of temperature and precipitation and the date they occurred are shown in table 9.

The coldest month on record was January 1940, which had an average temperature of 14.6°. The lowest average minimum temperature was 2.0° in January 1930. Monthly average minimum temperatures have been lower than 5° in only four Januarys—in 1925, 1930, 1937, and 1940—and in only one December, in 1924.

TABLE 8.—*Temperature and precipitation data for Wichita County, Kans.*

[From records of the U.S. Weather Bureau station at Leoti]

Month	Temperature				Precipitation				
	Average daily maximum [1]	Average daily minimum [1]	Two years in 10 will have at least 4 days with— Maximum temperature equal to or higher than [2]—	Two years in 10 will have at least 4 days with— Minimum temperature equal to or lower than [2]—	Average total [3]	One year in 10 will have— Totals less than [3]—	One year in 10 will have— Totals more than [3]—	Days with snow cover of 1 inch or more [4]	Average depth of snow on days with snow cover [4]
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Number	Inches
January	43.0	14.2	62	−4	0.37	(5)	1.02	6	5.2
February	47.6	18.4	67	5	.62	0.08	1.53	3	3.9
March	54.8	24.8	74	9	.95	.10	2.02	4	6.2
April	66.2	35.9	83	23	1.77	.30	3.63	(6)	3.2
May	75.6	46.7	91	34	2.59	.82	4.71	0	0
June	85.9	56.6	100	47	2.88	.87	6.27	0	0
July	92.5	62.1	102	56	2.56	.79	4.62	0	0
August	90.8	61.1	102	55	2.33	.70	4.10	0	0
September	82.7	51.6	97	39	1.25	.10	2.54	0	0
October	70.6	38.5	86	27	1.13	.01	2.35	(6)	1.5
November	55.6	24.7	72	11	.59	(5)	1.60	2	3.5
December	45.0	17.0	66	4	2.47	.03	1.24	5	3.9
Year	67.5	37.6	[7] 105	[8] −13	17.51	11.34	26.79	21	3.9

[1] For period 1893–1962.
[2] For period 1938–1962.
[3] For periods 1888–95, 1901–03, and 1911–62, respectively.
[4] For period 1912–50.
[5] Trace.
[6] Less than 1 day.
[7] Average annual highest temperature.
[8] Average annual lowest temperature.

TABLE 9.—*Monthly extremes of temperature and precipitation at Leoti and dates of occurrence*

[Records for temperature are for the periods of 1893–95, 1901–03, and 1911–62, and those for precipitation are for the periods of 1888–95, 1901–03, and 1911–60]

Month	Temperature				Precipitation			
	Maximum		Minimum		Least		Greatest	
	°F.	Day and year	°F.	Day and year	Inches	Year	Inches	Year
January	78	13/53 [1]	−26	12/12	(2)	1961 [1]	1.70	1944
February	80	13/62	−25	9/33	(2)	1923 [1]	2.33	1960
March	89	31/46	−21	11/48	(2)	1890 [1]	3.52	1958
April	94	9/30 [1]	2	2/36	0.04	1893	8.47	1944
May	103	17/27	18	1/93	.11	1927	6.46	1951
June	110	30/33	32	2/17 [1]	.08	1924	8.75	1895
July	111	23/36 [1]	40	8/52	(2)	1935	10.84	1950
August	109	5/34	39	30/15	.29	1944	6.24	1915
September	105	1/39	24	26/42 [1]	0	1892	5.52	1919
October	96	2/54 [1]	2	29/17 [1]	0	1892 [1]	5.58	1946
November	85	5/45 [1]	−10	28/52 [1]	(2)	1924 [1]	3.33	1946
December	80	25/55	−22	20/24	(2)	1949 [1]	2.70	1913
Year	111	7/23/36 [1]	−26	1/12/12	7.05	1956	29.48	1923

[1] Also in earlier years. [2] Trace.

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall, Wichita County, Kans.*

[From records kept at Leoti from 1893–1958]

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 12	April 16	April 21	May 5	May 19
2 years in 10 later than	April 6	April 11	April 16	April 30	May 14
5 years in 10 later than	March 26	April 1	April 7	April 20	May 4
Fall:					
1 year in 10 earlier than	October 27	October 24	October 14	October 5	September 27
2 years in 10 earlier than	November 3	October 29	October 19	October 10	October 1
5 years in 10 earlier than	November 14	November 8	October 29	October 19	October 11

TABLE 11.—*Probabilities of receiving specified amounts of rainfall during stated time intervals at Leoti*

Length of return period, in years [1]	30 min.	1 hr.	2 hr.	3 hr.	6 hr.	12 hr.	24 hr.
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1	0.9	1.1	1.2	1.3	1.5	1.7	1.8
2	1.1	1.4	1.6	1.6	1.8	2.1	2.3
5	1.4	1.9	2.1	2.2	2.5	2.8	3.1
10	1.8	2.3	2.5	2.7	3.0	3.4	3.7
25	2.1	2.7	3.0	3.1	3.5	4.0	4.2
50	2.4	3.1	3.4	3.5	4.0	4.5	5.0
100	2.6	3.4	3.7	4.0	4.5	5.0	5.6

[1] Expresses probability of receiving specified inches of rainfall at given time intervals. For example, 0.9 inch of rain can be expected to fall in 30 minutes once in every year (100 percent probability), but 2.6 inches can be expected to fall in 30 minutes once in 100 years (1 percent probability).

The cold spell lasting from December 25, 1911, through January 13, 1912, was the most intense on record. During that period, the temperature dropped to zero or lower each night, and on only 3 days did it rise above freezing. Several other winter months have had a temperature of zero or below on 10 to 14 nights, but none with as many severely cold nights in sequence. During four winters, a reading of zero or below was recorded in 4 consecutive months. A winter without a reading of zero or below is rare, and only three winters have escaped. These are the winters of 1925–26, 1933–34, and 1960–61.

In nine summers a temperature of 100° or higher has been recorded once or more in 4 consecutive months. This indicates that those summers were rather long and hot. Only July 1934 had a mean maximum temperature of 100° or higher. In that month the temperature rose to 100° or higher on 22 days, 15 of which were consecutive. That month had the greatest number of 100° days of any month on record and the greatest number of consecutive days with a temperature of 100° or higher. August 1913 and August 1937 each had a temperature of 100° on 16 and 14 days, respectively. The temperature failed to rise above 100° in the wet summer of 1915. In that year the highest temperature was 95°.

Figure 28, based on records kept at the U.S. Weather Bureau at Leoti, shows the percentage of years that maximum or minimum temperatures have been reached. In one-fourth of the summers, a temperature of 105° or higher has been recorded, and during one-fourth of the winters the minimum temperature has been −18° or lower.

Freezing temperatures.—A temperature of 32° or lower has occurred as early as September 17 (in 1903) and as late as May 27 (in 1950). The earliest date of the last freezing temperature in spring was April 26, 1913, and the latest date of the first freezing temperature in fall was October 22, 1937. The probabilities that a damaging freeze will occur by the dates indicated in spring or fall are given in table 10 and figure 29 (p. 54).

PRECIPITATION.—The average annual precipitation in this county is 17.51 inches (see table 8), but the amount of precipitation varies greatly from year to year. For example, a total of 29.48 inches was received in 1923, but only 7.05 inches was received in 1956. A total of 25 inches of annual precipitation has been received in 9 years, and less than 10 inches has been received in only 2 years (1956 and 1911).

The amount of monthly precipitation increases and decreases with the rise and fall of the temperature throughout the year. The lowest average precipitation for any 1 month is 0.37 in January, and the greatest is 2.88 inches in June. The average for June is only slightly more than that for May or July (see table 8).

Over the period of record, less than a measurable amount of precipitation has been recorded in all months except April, May, June, and August. In the months from April to October, a total of 5 inches or more of rainfall each month has been received at least once. In the 4 months from May to August in 1915 and again in 1923, 4 inches or more of rainfall was received each month.

The average length of the freeze-free period is 160 days (*3*), and major frost damage to the adapted crops grown in the county is rare. Grain sorghum may occasionally be damaged if planting is delayed because of a wet, cool spring and if a freeze occurs early in fall before the crop is mature. A hard freeze early in spring, when wheat is in the boot to flowering stage, may severely damage this crop.

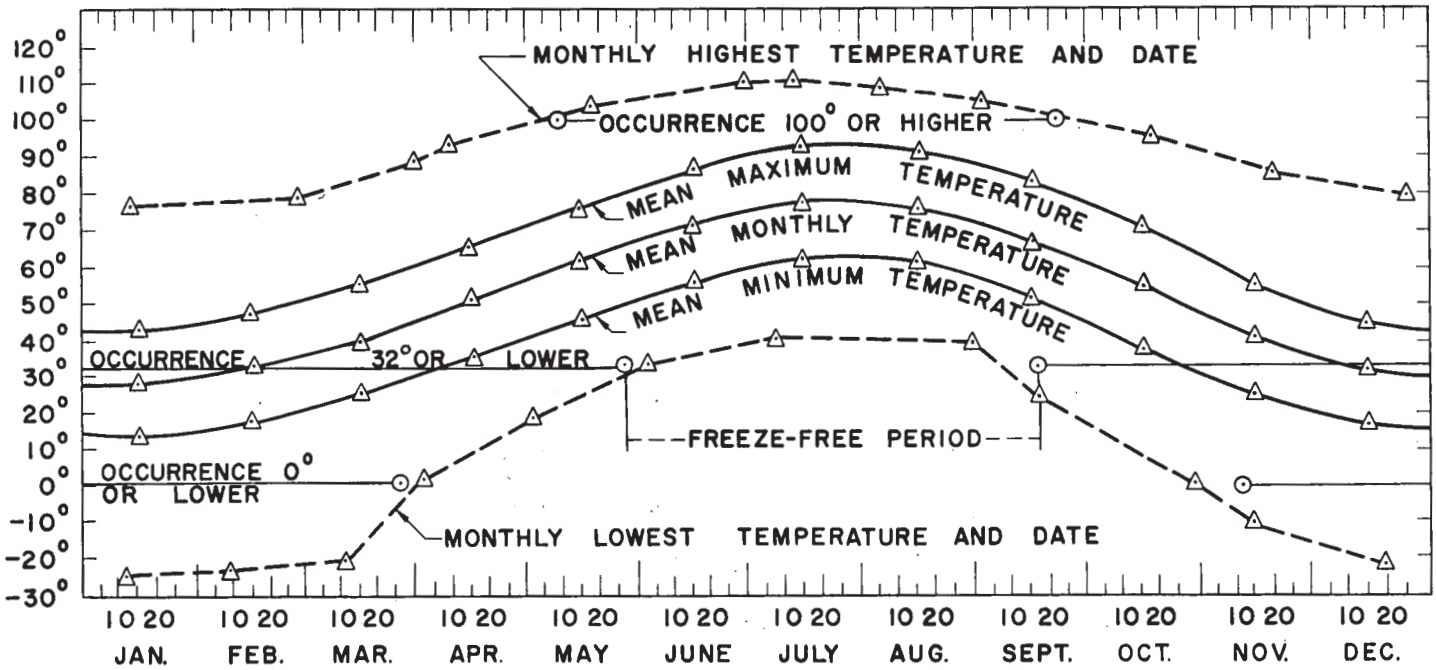


Figure 27.—**Means and extremes of temperature at Leoti, Kans.**

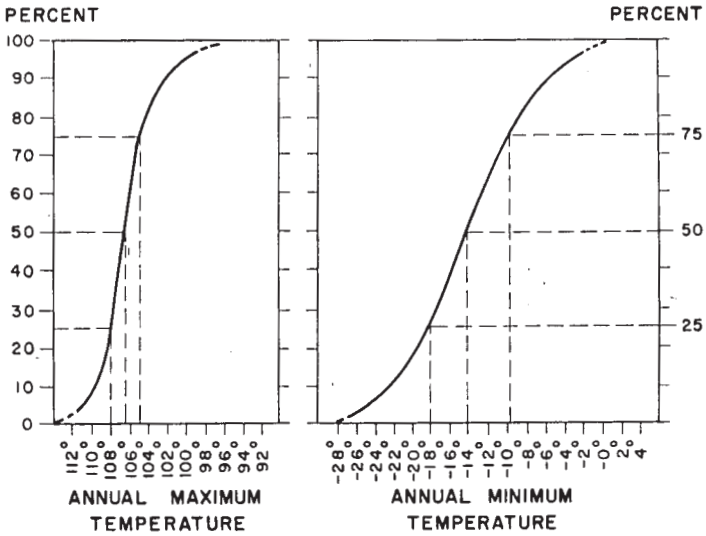


Figure 28.—**Frequency of indicated annual extremes of temperature in Wichita County.**

On approximately 160 days the minimum temperature is freezing or lower, and on about 25 of those days the temperature does not rise above 32°. Consequently, the freeze-thaw effects are pronounced in this county.

A more precise picture of the amount of precipitation received in this county and the time of its occurrence is given in figure 30 (p. 55) (*4*). This chart shows the probability, in percent, of receiving a specified amount of precipitation each week throughout the year. It also shows the normal amount of weekly precipitation for the years indicated. Past records indicate there is less than a 2 percent probability of receiving 1 inch of precipitation in any week from the middle of November until the latter part of February, but there is a 28 percent chance of receiving 1 inch of rain in the last week of May. The probability of receiving 1 inch of rain is almost twice as great for the last part of May as for the first. One characteristic of the rainfall in this region, shown on figure 30, is the rapid decrease in precipitation through June and the leveling off through July and throughout much of August.

Fortunately, most of the year's precipitation comes when it is most needed for crops. Approximately 76 percent of the annual amount falls in the period from April to September. Figure 31 (p. 56) gives the annual total, as well as the total received during the growing season from April to September. It also shows the periods when precipitation was near average or above average and the periods when precipitation was below average, but there is little to indicate a regular occurrence of either. During the period from 1941 to 1951, 20 inches or more of precipitation was received in 8 of the 11 years, but during the two periods of drought from 1929 to 1940 and 1952 to 1956, the summers of nearly normal precipitation hardly offset the lack of rainfall in the drier years. In the summer of 1911, only 3.95 inches of rainfall was received, which is the least amount recorded for any summer. Only 4 years later, in 1915, the wettest such period on record, 24.80 inches fell during the period from April to September. The April-September average is 13.38 inches, but that amount can be expected in only 30 percent of the summers. More information on the monthly extremes of precipitation is given in table 9.

Figure 32 (p. 56) gives as the probabilities of receiving at least a specified amount of percipitation during the period from April to September. It shows that in half the summers 11 inches or more of rainfall was received, and in 25 percent of the summers less than 8.5 inches was received.

Plans for many drainage and construction projects are based on figures that show the frequency with which various amounts of rainfall are received in a relatively short space of time. Table 11 shows the probable frequency of rainfalls of specified duration for return periods of 1 year, 2 years, 5 years, 10 years, 25 years, 50 years, and 100 years (*11*). A 30-minute rain of 0.9 inch or more, for example, may be expected once each year, but a total of 2.6 inches in 30 minutes occurs only once in 100 years. Again, a 6-hour rain may produce 2.5 inches once in 5 years, but a 24-hour rain may be expected to yield 5 inches only once in 50 years.

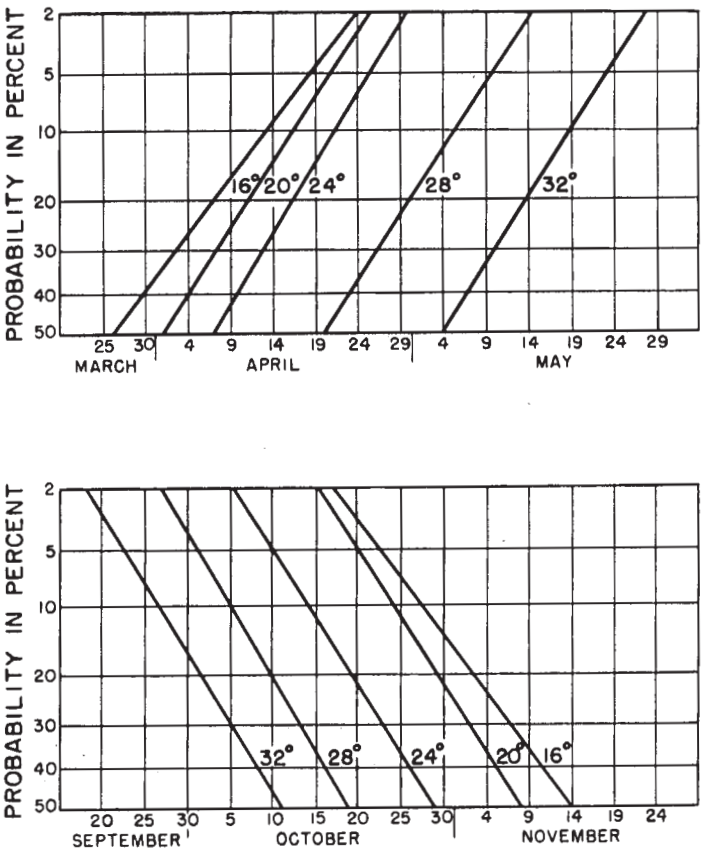


***Figure 29.*—Probabilities that temperatures of 16°, 20°, 24°, 28°, or 32° will occur in spring after the indicated dates or in fall before the indicated dates.**

Snowfall.—In this county snow has fallen as early in fall as September 27 (in 1935) and as late in spring as May 21 (in 1931). The amount of snow varies from year to year, but the average yearly amount is 24 inches, with the greatest accumulation in March. In five winters more than 45 inches was received, and in six winters less than 10 inches was received. Six times since 1893 no measurable snowfall has been received, and four times since that time more than 20 inches has been received. The largest total amount received was 33.0 inches in 1924. A total of 20 inches or more was received twice in February and once in April and December. Because temperatures generally rise above freezing during the day, snow does not remain on the ground very long.

Wind.—The almost constant movement of the wind is another characteristic of the climate in this county. The records of wind kept at the Weather Bureau station in Dodge City, indicate an average hourly speed of 15.0 miles per hour; and a rise from about 12 miles per hour late in summer to 16 or 17 miles per hour in spring (*12*). Southerly winds predominate, especially during the warmer months. Extreme velocities range from 50 to 75 miles per hour. Winds of extreme velocity are generally from the northwest.

Storms.—Damaging storms in this county are relatively infrequent and are of short duration. The most dreaded are the preharvest hailstorms. These seldom last more than a few minutes. In that time, however, the myriads of pea-sized to marble-sized stones driven by high winds mean destruction to a large acreage of crops. Occasionally, the stones are much larger and less numerous, but they damage roofs, windows, and the bodies of automobiles. On an average, hail in some measure may fall four times in one summer at any one place.

Five tornadoes were reported in this county during the period from 1950 to 1962 (*13*). The longest tornado path was from the west-central part of the county almost due east across Scott County, to central Lane County. This tornado occurred on June 20, 1951, and lasted from 9:30 p.m. to 10:30 p.m.

In this county thunderstorm squalls are sometimes accompanied by damaging winds that flatten crops, break trees, or unroof buildings. Sometimes winds of high velocity stir up and blow dust from the fields in times of extremely dry weather, and reduce visibility to only a few yards. Occasional high winds during winter storms leave little snow on the fields to benefit crops. These storms can cause severe damage locally, but they occur infrequently and do not cover a large area. This keeps them from being a dominant factor in the overall climate.

Additional Facts About the County

In this section facts about the water supply are discussed, and information is given about the agriculture and the social and industrial development of the county. Unless otherwise indicated the agricultural statistics are from reports of the U.S. Bureau of the Census.

Water Supply

In Wichita County water for domestic use is obtained from drilled wells. Most of the water for livestock also comes from wells, but part comes from farm ponds. The small dams used to impound water in the ponds have been constructed across intermittent drainageways in the uplands. During extended periods of drought, ponds do not supply enough water for livestock. Water for irrigating field crops is pumped from deep wells drilled in the Ogallala formation (fig. 33, p. 56).

Except in the western part of the county, most of the irrigation wells are north of White Woman Creek. In the southern part of the county, the irrigation wells yield only

a small amount of water. The following shows the number of irrigation wells in the county in specified years:

Year:	Number of wells	Number of acres irrigated
1938	3	300
1948	33	2,980
1956	176	39,000
1957	241	54,000
1958	286	64,000
1959	297	65,900
1960	313	67,210
1961	320	68,500
1962	328	70,000

Ground water.—The Ogallala formation is the principal aquifer in this area. This formation consists of a heterogeneous deposit of sand, gravel, silt, and clay. High yields of water are obtained from the coarse gravel and sand in the lower part of that formation.

The Smoky Hill chalk member of the Niobrara formation is important as an effective aquiclude. It confines most of the ground water to the permeable material overlying it, and it serves as an impervious floor beneath the overlying water-bearing sediments.

The ground water available from wells is derived entirely from precipitation that falls as rain or snow within the county and in areas to the west and north of the county.

One of the principal sources of ground-water recharge in this county is the water lost from streams. The alluvium in the valleys of White Woman, Sand, and Ladder Creeks is permeable, and during periods of streamflow much water probably percolates downward through the alluvium to the water table. Also after a severe rain, a con-

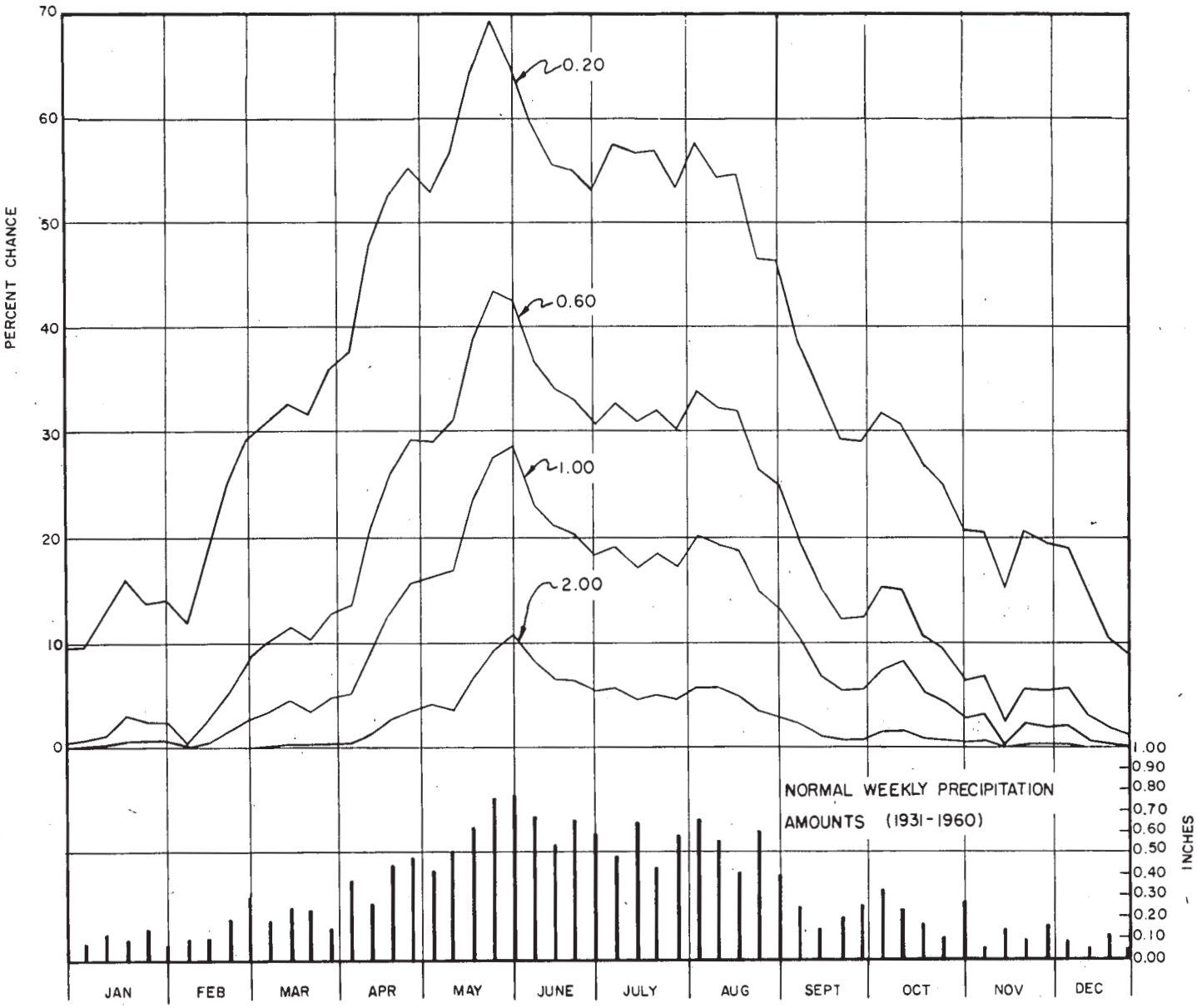


***Figure 30.*—Probabilities of receiving at least the indicated amount of precipitation weekly. The normal amount of weekly precipitation, by weeks, is shown at the bottom.**

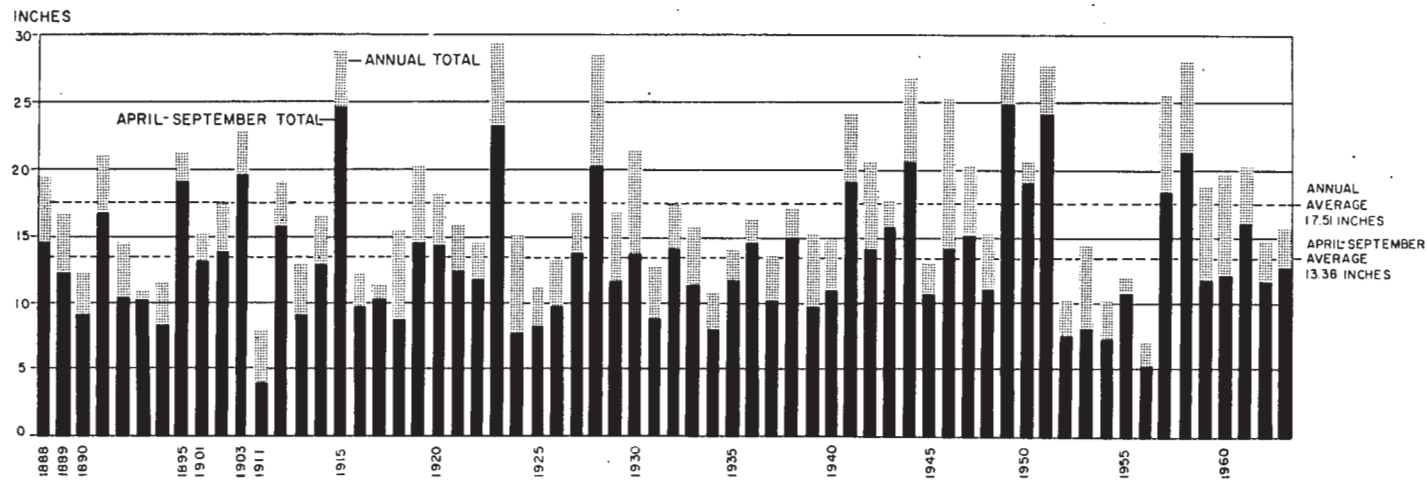


Figure 31.—**Annual and April to September precipitation at Leoti for the periods 1888–95, 1901–03, and 1911–63.**

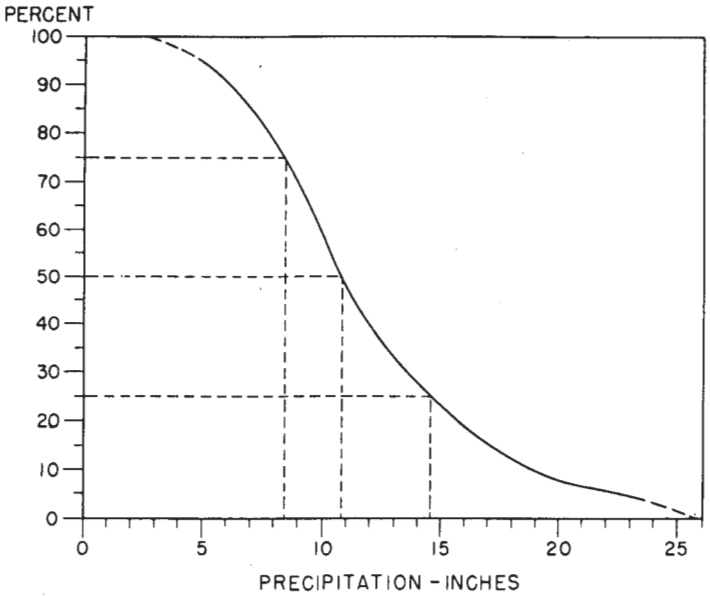


Figure 32.—**Probabilities of receiving at least specified amounts of precipitation from April to September. These figures are based on records kept at Leoti for the periods 1888–95, 1901–03, and 1911–63.**

siderable amount of water is generally ponded in depressions in the uplands, and some of this water may percolate downward to the water table.

Most of the water from precipitation that falls on the surface never reaches the water table, because it is lost through plant use (transpiration), runoff, and evaporation. The period when the amount of rainfall is the greatest is April to September, which is the growing season. During that period, plants use a large amount of moisture. Also, the rate of evaporation is high because of the high temperature, the low humidity, and the extensive movement of the wind.

Some water may reach the ground-water zone during fall and winter when evaporation and transpiration are low. This occurs only when there is a large amount of precipitation and the soil conditions are favorable.

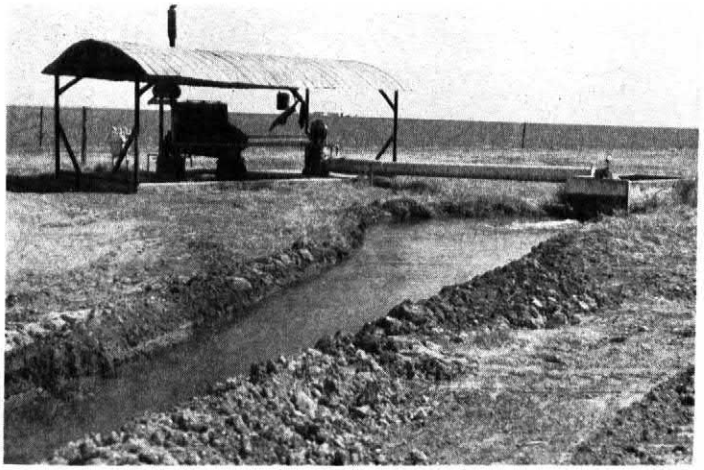


Figure 33.—**A deep well from which water is pumped for irrigation. Power is supplied by a gas engine.**

Agriculture

Before 1900, native grass covered most of the county, and there were many large ranches. Until World War I, wheat, sorghum, corn, and similar crops were grown mainly for use on the farms and ranches. Then farmers began to use tractors extensively for farm power, wheat became a more important crop, and more of the farm produce was sold off the farm. As the demand for wheat increased, a larger and larger acreage of grassland was plowed and large cash-grain farms replaced much of the rangeland. By the late 1920's a large acreage of native grass had been plowed. More of the grassland was plowed in the 1940's and 1950's. In 1938 a total of 151,000 acres was in native grass, but this had decreased to 125,000 acres by 1952. The acreage in native grass has continued to decrease, and in 1962 only about 100,900 acres was still unplowed.

During the period when drought and duststorms occurred in the 1930's, farmers became concerned about soil erosion and the deterioration of the soils. In the 1940's, as the amount of rainfall increased, the farmers also noted that water erosion had occurred on sloping soils that had been cultivated. In 1948 the farmers and landowners or-

ganized the Wichita County Soil Conservation District. Its purpose was to encourage proper use of the soils and to conserve the soil and water resources of the county. Since the district was formed, conservation practices, including contouring, stubble mulching, stripcropping, land leveling, and proper management of water or irrigated land, have been used on a large acreage of cropland. Also suitable native grasses have been reseeded on some nonarable soils, and practices to improve the range have been used on a large acreage of pastures of native grass.

The economy of the county is now based mainly on dryland and irrigated farming, but there are still a few cattle ranches along the creeks. About 80 percent of the acreage in the county consists of nearly level, fertile, loamy soils of the uplands. Most of the acreage already irrigated consists of these nearly level soils. About 83 percent of the farms now in the county are of the cash-grain type.

Since the Rural Electrification Administration was organized, all rural areas of the county have been served by electricity. In 1959 about 69 percent of the farms had telephones.

Land use.—In 1962 approximately 272,660 acres in this county was used for dryland crops, 70,000 acres was used for irrigated crops, 100,900 acres was native grassland, 6,000 acres was land that was formerly cultivated but that had been reseeded to grass, and 13,800 acres was land in towns, railroads, cemeteries, and other nonagricultural uses (fig. 34).

Cultivated crops are grown on most nearly level areas of the uplands, and irrigation is increasing on the nearly level areas of uplands in the northern half of the county. Most of the acreage of steep, stony soils along streams and entrenched drainageways is still in native grass, and the less sloping areas are used partly for native-grass pasture and partly for field crops.

Crops.—Wheat and grain sorghum are the only important crops climatically suited to dryland farming in this part to the High Plains, but rye and barley are also grown. Table 12 gives the acreage of various crops harvested in the county.

On the clayey soils wheat and sorghum are usually grown in a cropping system in which the soils are fallowed every other year. During the period of fallow, weeds are controlled to conserve moisture for the crop that follows.

Wheat, sorghum grown for grain and silage, corn, beans, sugar beets, alfalfa, and garden crops are grown under irrigation. These crops are well suited to the climate and to the soils that are generally irrigated.

Crops are grown year after year on some of the bottomland soils and on most of the sandy soils in the county. Corn, forage sorghum, and alfalfa are usually grown on the bottom lands, and sorghum is usually grown year after year on the sandy soils.

Special crops grown in the county are sugar beets, onions, and garden crops. These crops are grown under irrigation.

Livestock.—The raising of livestock is another important enterprise in this county, and beef cattle usually outnumber other types. Table 13 shows the number of animals on farms in the county. The number of beef cattle varies from year to year and from season to season. The number of cattle, as well as sheep, is usually high in fall and winter, particularly following a favorable growing season. In addition to the cattle raised in the county, animals are brought in from range areas in other parts of the State and from other States. They graze wheat, pasture, or sorghum stubble where available. Farmers who have a summer range keep a few milk cows.

Pasture.—Approximately 11 percent of the farms in the county are classified as livestock farms, and in 1962, about 100,900 acres, or 22 percent of the total acreage in the county was in range. In addition, 6,000 acres of former cropland had been reseeded to grass. Most of the steep, rocky slopes along drainageways are in native grass, and there are some nearly level areas of tableland that have not been plowed. As irrigation developments continue to expand, more of these nearly level areas are used for cultivated crops. Most of the rangeland is nonarable or marginal for cultivation. It supports the mid grasses and short grasses native to the High Plains. A few areas of sandy soils and of areas of bottom land support taller grasses.

Size and tenure of farms.—In Wichita County the average-size farm in 1959 was 1,138 acres. There were 392 farms of which 62 were operated by full owners, 182 by part owners, and 148 by tenants.

Equipment and farm labor.—In the early twenties, most of the farm power was supplied by horses and mules. The Kansas State Board of Agriculture reported only 25 tractors in the county in 1921. In contrast, there were 799 in 1959.

Now, power equipment is used for all tillage, seeding, and harvesting operations. Large, wheel-type tractors are generally used on dryland farms, but a few operators use the track type. On irrigated land, general-purpose, or row-crop, tractors are used. Self-propelled combines are used for harvesting wheat and grain sorghum. In 1959 there were 349 combines in the county.

Most farmers own enough equipment for tillage and planting, but many hire part or all of their grain combined. Custom operators from outside the area commonly furnish much of the labor and equipment for harvest.

The demand for labor is seasonal. The local labor supply is usually adequate for planting and tillage, but additional help is generally needed for harvest. Development of irrigation has increased the demand for labor the year round, and it is stabilizing the income of the farmer by assuring him of employment throughout the year.

Social and Industrial Development

The boundaries of Wichita County were defined in 1873, and the county was organized December 24, 1886. The county was named for the Wichita Indians.

An election to decide the location of the county seat was held in a sod shanty outside Leoti on February 8, 1887. The choice of a county seat was between Leoti, the largest town in the county and Coronado, a new, growing town. Voting took 3 weeks because each side insisted on a thorough canvass. The quarrel between Leoti and Coronado that followed the voting resulted in a bitter battle in which two men from Leoti were killed and five were wounded (*5*). After considerable dispute, Leoti was declared the county seat.

In 1887 settlers were living on nearly every quarter section of land in the county, and the population of the county was 2,607. Just 3 years later, however, the boom had subsided, and hard times began. By 1890 the population

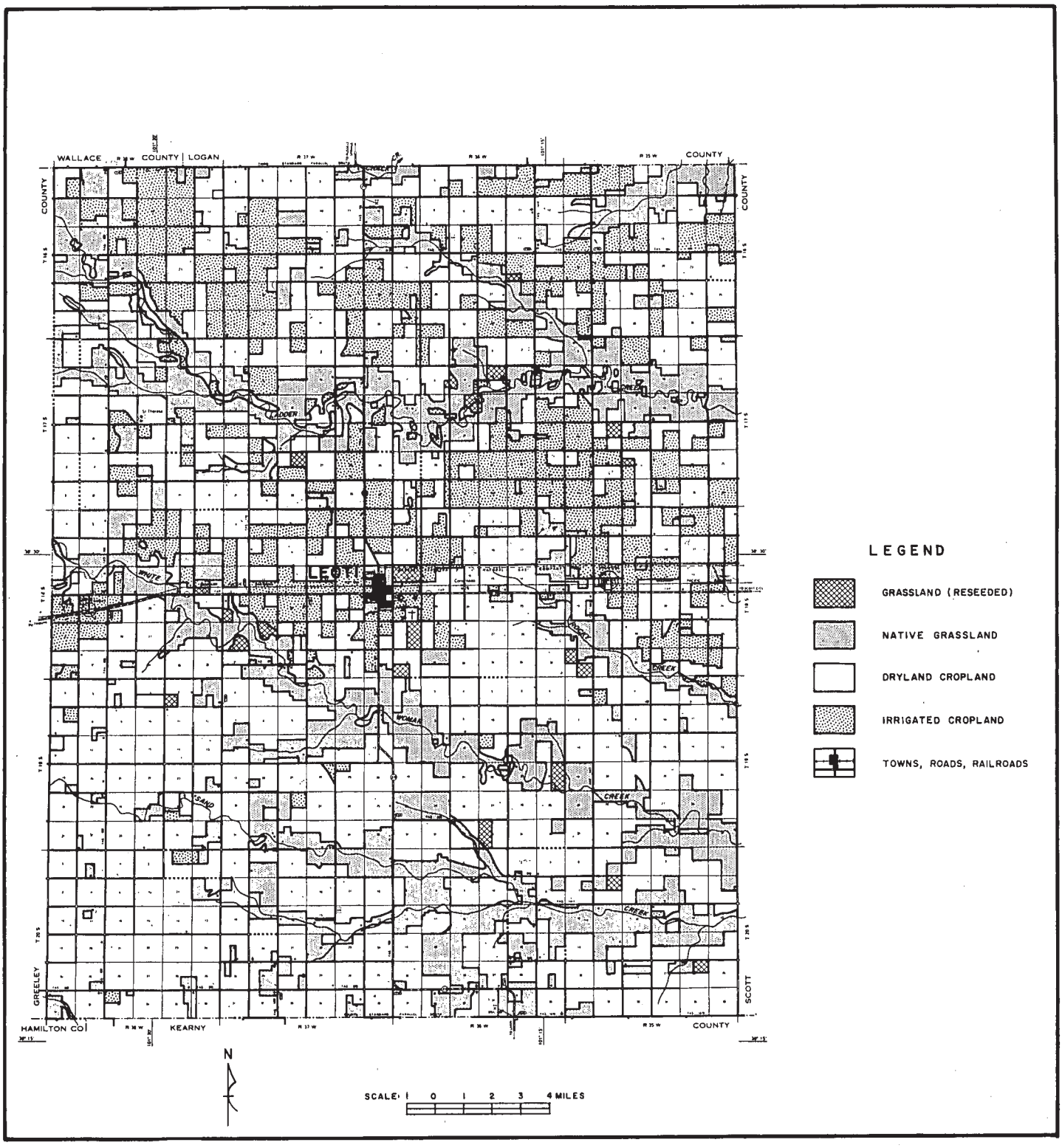


Figure 34.—Map showing land use in Wichita County in July 1962.

had dropped to 1,827, and by 1894 the farmers who remained were faced with a severe drought. The population continued to decline until 1902, but after that, it increased slightly. In 1960 the population was 2,820.

Transportation, markets, and industries.—Two State highways serve the county. Leoti is at the intersection of State Highway No. 96, which crosses the county from east to west, and State Highway No. 25, which crosses the county from north to south. Most of the roads that are used extensively have sand surfaces and are generally passable throughout the year. Some of the county roads, however, and those along section lines are impassable at times, because of mud or drifting snow.

All the towns and communities in the county—Marienthal, Coronado, Leoti, and Selkirk—are served by a railroad. They also have facilities for handling and storing grain. The railroad provides transportation to terminal elevators and markets to the east.

This county is basically agricultural, and there are no large industries. However, sand and gravel, used locally in concrete mixtures and as material for road surfacing, are taken from the channels of streams and from the Ogallala formation. In some places hard caliche, which outcrops along some of the drainageways, also provides material for road surfacing.

TABLE 12.—*Acreage of the principal crops in stated years*

[Based on biennial reports of the Kansas State Board of Agriculture]

Crop	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Wheat	121,000	46,000	176,000	127,000	121,000	100,000	73,000	[1]15,000	141,000	119,000	126,000
Sorghum:											
Grain	20,170	83,280	16,900	23,400	59,700	13,500	12,300	118,000	45,000	68,000	59,000
Forage	9,580	11,310	6,700	7,500	3,900	29,700	15,600	23,000	6,000	1,000	4,000
Silage	3,310	8,230	3,200	1,600	2,000	1,800	2,100	3,000	4,000	2,000	2,000
Corn	480	2,700	2,600	2,900	1,500	1,900	4,500	4,000	4,000	2,500	5,700
Barley	870	2,370	1,900	850	5,300	5,400	4,000	3,800	6,800	6,900	7,600
Rye	60	100	1,100	(2)	(2)	900	300	20	360	280	580
Alfalfa	1,470	1,990	2,960	2,150	1,720	3,160	1,700	2,200	1,800	1,600	1,200
Sugar beets	250	600	250	(2)	(2)	1,630	1,620	2,950	2,020	2,090	2,320
Pinto beans	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	6,500

[1] Probably all irrigated.
[2] Information not available.

TABLE 13.—*Number of livestock on farms in stated years*

[Based on biennial reports of the Kansas State Board of Agriculture]

Livestock	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Horses and mules	550	470	440	380	350	340	290	310	300	310	270
Milk cows	1,030	1,100	1,040	990	1,050	950	900	950	800	700	600
Other cattle	17,370	17,500	24,660	22,510	21,950	24,150	22,400	14,050	16,200	17,300	23,400
Hogs	2,550	3,300	3,810	2,580	1,500	1,300	1,500	1,250	1,800	2,800	3,500
Sheep and lambs	7,610	9,210	9,580	8,210	16,920	7,660	4,910	5,090	6,020	11,010	2,470
Chickens	30,100	25,600	25,900	20,200	20,400	23,000	21,800	21,000	15,000	13,000	10,000
Turkeys	1,300	1,600	960	(1)	(1)	2,200	(1)	4,500	3,000	2,500	2,400

[1] Information not available.

Literature Cited

(1) AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS.
1961. STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING. Ed. 8, 2 pts., illus.

(2) BALDWIN, MARK, KELLOGG, CHARLES E., and THORP, JAMES.
1938. SOIL CLASSIFICATION. U.S. Dept. Agr. Ybk.: 979–1001

(3) BARK, L. DEAN.
1959. WHEN TO EXPECT LATE-SPRING AND EARLY-FALL FREEZES IN KANSAS. Agr. Expt. Sta. and Kans. State Univ. Agr. and Applied Sci. Bul. 415, 23 pp., illus.

(4) ———
1963. CHANCES FOR PRECIPITATION IN KANSAS. Agr. Expt. Sta. and Kans. State Univ. Agr. and Applied Sci. Bul. 461, 83 pp., illus.

(5) BLOCKMAN, FRANK W.
[n.d.] CYCLOPEDIA OF KANSAS. v. 8

(6) BRADLEY, EDWARD, and JOHNSON, CARLTON R.
1957. GROUND-WATER RESOURCES OF THE LADDER CREEK AREA IN KANSAS. Univ. of Kans. Pub., State Geol. Survey of Kans. Bul. 126. 194 pp., illus.

(7) PORTLAND CEMENT ASSOCIATION.
1956. PCA SOIL PRIMER. 86 pp., illus. Chicago.

(8) PRESCOTT, GLENN C., JR., BRANCH, JOHN R., and WILSON, WOODROW W.
1954. GEOLOGY AND GROUND-WATER RESOURCES OF WICHITA AND GREELEY COUNTIES, KANSAS. Univ. of Kans. Pub., State Geol. Survey of Kans. Bul. 108. 134 pp., illus.

(9) THORP, JAMES, and SMITH, GUY D.
1949. HIGHER CATEGORIES OF SOIL CLASSIFICATIONS ORDER, SUBORDER, AND GREAT SOIL GROUPS. Soil Sci. 67: 117–126.

(10) UNITED STATES DEPARTMENT OF COMMERCE, WEATHER BUREAU.
1959. CLIMATE OF THE STATES, KANSAS. Climatography of the U.S. No. 60–14, 16 pp., illus.

(11) UNITED STATES DEPARTMENT OF COMMERCE, WEATHER BUREAU. 1961. RAINFALL FREQUENCY ATLAS OF THE UNITED STATES FOR DURATIONS FROM 30 MINUTES TO 24 HOURS AND RETURN PERIODS FROM 1 TO 100 YEARS. Tech. Paper No. 40, 115 pp., illus.

(12) ——— 1963. LOCAL CLIMATOLOGICAL DATA. 4 pp. Dodge City, Kans.

(13) ——— 1963. LETTER SUPPLEMENT 6308. 4 pp., illus.

(14) WATERWAY EXPERIMENT STATION, CORPS OF ENGINEERS. 1953. THE UNIFIED SOIL CLASSIFICATION SYSTEM. Tech. Memo. 3-357. v. 1.

Glossary

A horizon. The mineral horizon at the surface. It has an accumulation of organic matter, has been leached of soluble minerals and clay, or shows the effects of both. See also Horizon, soil.

Aggregate, soil. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

B horizon. The horizon in which clay minerals or other material has accumulated, that has developed a characteristic blocky or prismatic structure, or that shows the effects of both processes. See also Horizon, soil.

Blocky structure. See Structure, soil.

Blowout. An area from which soil material has been removed by wind.

C horizon. The unconsolidated material immediately below the true soil. In chemical, physical, and mineral composition, it is presumed to be similar to the material from which at least part of the overlying solum has developed. See also Horizon, soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. (Called also *limy soil.*)

Caliche. A more or less cemented deposit of calcium carbonate in many soils of a warm-temperate area, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum; or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. (See also Texture, soil.)

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: Clay coat, clay skin.

Clay loam. Soil textural class that contains 27 to 40 percent clay and 20 to 45 percent sand. (See also Texture, soil.)

Climax vegetation. The combination of plants that originally grew on a given site.

Coarse-textured soils. A broad group of textural classes, including sands and loamy sands.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors, consisting of a concentration of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour. An imaginary line connecting points of equal elevation of the surface of the soil.

Deep soil. Generally, a soil deeper than 40 inches to rock or other strongly contrasting material. Also, a soil that has a thick, black surface layer; or a soil in which the total depth of unconsolidated material, whether true soil or not, is about 40 inches or more.

Erosion. The wearing away of the land surface by wind, running water, and other geological agents.

Fine-textured soil. A broad group of textural classes that include sandy clay, silty clay, and clay; contains 35 percent or more clay. (Also called a clayey soil.)

Ground water. Water that fills all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Loam. A textural class name for soil that contains a moderate amount of sand, silt, and clay. Loam contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. (See also Texture, soil.)

Loess. Geological deposits of relatively uniform, fine material, mostly silt, usually transported by wind.

Mineral soil. Soil composed mainly of inorganic (mineral) material and low in content of organic material. Its bulk density is greater than that of an organic soil.

Parent material. The unconsolidated mass from which the soil profile develops.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity. (See also Reaction, soil.)

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Sand. Individual rock or mineral fragments in soils having a diameter ranging from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay. (See also Texture, soil.)

Sandy clay. Soils of this textural class contain 35 percent or more clay and 45 percent or more sand. (See also Texture, soil.)

Sandy clay loam. Generally, soil material having 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand. (See also Texture, soil.)

Sandy loam. As used in this report, a soil that contains 50 percent sand and less than 20 percent clay. Also used as a general term for a small group of textural classes of soils, including sandy loam and fine sandy loam. (See also Texture, soil.)

Sedimentary rock. A rock composed of particles deposited from suspension in water. The chief sedimentary rocks are conglomerate, from gravel; sandstone, from sand; shale, from clay; and limestone, from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sands have been consolidated into sandstone.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower

limit of very fine sand (0.05 millimeter). Soil material of the silt textural class is 80 percent or more silt and less than 12 percent clay. (See also Texture, soil.)

Silt loam. Soil material having 50 percent or more silt and 12 to 27 percent clay, or 50 to 80 percent silt and less than 12 percent clay. (See also Texture, soil.)

Silty clay. Soil material having 40 percent or more clay and 40 percent or more silt. (See also Texture, soil.)

Silty clay loam. Soil of this textural class contains 27 to 40 percent clay and less than 20 percent sand. (See also Texture, soil.)

Soil. A natural, three-dimensional body on the earth's surface. It supports plants and has properties resulting from the integrated effects of climate and living matter acting upon parent material, as conditioned by relief, over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soils includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumably fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

[See table 1, p. 7, for the approximate acreage and proportionate extent of the soils, table 2, p. 22, for the estimated yields under dryland farming, and table 3, p. 26, for the estimated yields under irrigated farming. To find the engineering properties of the soils, see the section beginning on p. 31]

Map symbol	Mapping unit	Page	Capability unit: Dryland	Page	Capability unit: Irrigated	Page	Range site: Name	Page
An	Alluvial land	7	VIw-1	22	(1/)		Loamy Lowland	27
Ba	Bayard fine sandy loam	7	IIIe-2	20	IIs-1	25	Sandy Terrace	28
Br	Bridgeport loam	8	IIIc-1	20	I-1	25	Loamy Terrace	27
Cd	Colby silt loam, 5 to 15 percent slopes	8	VIe-1	21	(1/)		Limy Upland	28
Go	Goshen silt loam	9	IIIc-2	20	I-1	25	Loamy Terrace	27
Hu	Humbarger loam	9	IIIw-1	20	(1/)		Loamy Lowland	27
Lf	Lincoln fine sandy loam	10	VIIw-1	22	(1/)		Unstable 2/	29
Lo	Lofton silty clay loam	10	IVw-1	21	(1/)		Unstable 2/	29
Ma	Mansic clay loam, 0 to 1 percent slopes	10	IIIc-1	20	I-1	25	Limy Upland	28
Mb	Mansic clay loam, 1 to 3 percent slopes	11	IIIe-1	19	IIe-1	25	Limy Upland	28
Me	Mansic clay loam, 1 to 3 percent slopes, eroded	11	IVe-1	21	IIe-1	25	Limy Upland	28
Mg	Mansic clay loam, 3 to 5 percent slopes	11	IVe-1	21	(1/)		Limy Upland	28
Mm	Mansker-Potter complex	12	VIe-2	21	(1/)		Limy Upland 3/ and Breaks. 4/	28 28
Mn	Manter fine sandy loam, 0 to 1 percent slopes	13	IIIe-2	20	IIs-1	25	Sandy	28
Ms	Manter fine sandy loam, 2 to 5 percent slopes	13	IVe-2	21	(1/)		Sandy	28
Rm	Richfield silt loam, 0 to 1 percent slopes	13	IIIc-1	20	I-1	25	Loamy Upland	27
Rn	Richfield silt loam, 1 to 3 percent slopes	14	IIIe-1	19	IIe-1	25	Loamy Upland	27
Ua	Ulysses silt loam, 0 to 1 percent slopes	14	IIIc-1	20	I-1	25	Loamy Upland	27
Ub	Ulysses silt loam, 1 to 3 percent slopes	15	IIIe-1	19	IIe-1	25	Loamy Upland	27
Uc	Ulysses silt loam, 3 to 5 percent slopes	15	IVe-1	21	(1/)		Loamy Upland	27
Ue	Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	15	IVe-1	21	IIe-1	25	Limy Upland	28
Um	Ulysses-Colby silt loams, 3 to 5 percent slopes, eroded	15	VIe-1	21	(1/)		Limy Upland	28

1/ Not placed in an irrigated capability unit.

2/ Because the soil and vegetation are unstable, this soil is not considered a true range site.

3/ The Mansker soils are in Limy Upland range site.

4/ The Potter soils are in Breaks range site.

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

Nondiscrimination Statement

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).

(j) References. The following references should be consulted for additional information on this sample plan.

(1) Mastradone, P.J., J. Breithaupt, P.J. Hannan, J.A. Hetrick, A.W. Jones, R.D. Jones, R.J. Mahler, S. Syslo, and J.K. Wolf. 1995. Critical assessment of terrestrial field dissipation guidelines. In M.L. Leng, E.M.K. Leovey and P.J. Zubkoff (eds.). Agrochemical Environmental Fate Studies: State of the Art. Lewis Publishers, Boca Raton, FL. p. 93–98.

(2) U.S. Environmental Protection Agency, (2008). OPPTS 850.6100 Independent Laboratory Validation of Environmental Chemistry Methods.

(3) Marlow, D.A., D.D. McDaniel, A.E. Dupuy, Jr., and E.M. Leovey. 1995. Data Reporting Guideline for Environmental Chemistry Methods. Subdivisions N, E, and K. EPA Office of Pesticide Programs, Washington, DC.

(4) Flury, M. 1996. Experimental evidence of transport of pesticides through field soils - a review. J. Environ. Qual. 25: 25–45.

(5) Ghodrati, M., and W.A. Jury. 1992. A field study of the effects of soil structure and irrigation method on preferential flow of pesticides in unsaturated soil. J. Contam. Hydro. 11:101–125.

(6) Hurto, K., and M. Prinster. 1993. Dissipation of turfgrass foliar dislodgeable residues of chlorpyrifos, DCPA, diazinon, isofenphos, and pendimethalin. In: K. Racke and A. Leslie (eds.). Pesticides in urban environments: fate and significance. American Chemical Society, Washington, DC. pp. 86–99.

(7) Wauchope, R. 1987. Tilted-bed simulation of erosion and chemical runoff from agricultural fields: II. Effects of formulation on atrazine runoff. J. Environ. Qual. 16(3):212–216.

(8) Furmidge, C. 1984. Formulation and application factors involved in the performance of soil applied pesticides. In: R. Hance (ed.). Soils and crop protection chemicals. Monogr. 27. British Crop Protection Council, Croydon, UK. p. 49–64.

(9) Kenimer, A., J. Mitchell, A. Felsot, and M. Hirschi. 1997. Pesticide formulation and application technique effects on surface pesticide losses. Trans. of American Society of Agricultural Engineers 40(6):1617–1622. 45

(10) Cheng, H.H. 1990. Pesticides in the Soil Environment: Processes, Impacts, and Modeling. Soil Sci. Soc. Amer. Book Series #2, Madison, WI.

(11) Steel, R.G.D., and J.H. Torrie. 1980. Principles and Procedures of Statistics: A BiometricalApproach. McGraw-Hill Book Company, New York, NY.

(12) Birk, L.A., and F.E.B. Roadhouse. 1964. Penetration and persistence in soil of the herbicide atrazine. Can. J. Plant Sci. 44: 21–27.

(13) Hunter, J.H., and E.H. Stobbe. 1972. Movement and persistence of picloram in soil. Weed Sci. 20: 486–489.

(14) Khan, S.U., H.A. Hamilton, and J.E Hogue. 1976. Fonofos residues in an organic soil and vegetable crops following treatment of the soil with the insecticide.

(15) Chapman, R.A., and C.R. Harris. 1982. Persistence of isofenphos and isazophos in a mineral and an organic soil. J. Environ. Sci. Health. B17: 355–361.

(16) Harris, C.R., H.J. Svec, and W.W. Sans. 1971. Toxicological studies on cutworms. VII. Microplot field experiments on the effectiveness of four experimental insecticides applied as rye cover crop and soil treatments for control of the dark-sided cutworm. J. Econ. Entomol. 64: 493–496.

(17) Harvey, J., Jr. 1983. A simple method of evaluating soil breakdown of 14C-pesticides under field conditions. Residue Rev. 85: 149–158.

(18) Hill, B.D. 1981. Persistence and distribution of fenvalerate residues in soil under field and laboratory conditions. J. Agric. Food Chem. 29: 107–110.

(19) Walker, A., and P.A. Brown. 1985. The relative persistence in soil of five acetanilide herbicides. Bull. Environ. Contam. Toxicol. 34: 143–149.

(20) Kroetsch, D., R. Gangaraju, W. Effland, I. Nicholson, N. Thurman, and D. Pagurek. 1998. A spatial decision support system for the selection of target areas for pesticide field dissipation studies. Paper presented at First International Conference on Geospatial Information in Agriculture and Forestry, 1–3 June 1998, Lake Buena Vista, FL.

(21) Soil Survey and Land Research Centre (SSLRC), Cranfield University (1998). SEISMIC, A unique national spatial information system for environmental modelling. SSLRC, Cranfield University, Silsoe, Bedford, UK. Internet WWW page.

(22) Klute, A. 1986. Methods of Soil Analysis - Part 1: Second Edition, Physical and Mineralogical Methods, American Society of Agronomy, Madison, WI, ASA Monograph.

(23) Page, A.L. 1982. Methods of Soil Analysis - Part 2: Chemical and Microbiological 46 Properties, American Society of Agronomy, Madison, WI, ASA Monograph No. 9.

(24) Roadhouse, F.E.B., and L.A. Birk. 1961. Penetration and persistence in soil of the herbicide 2-chloro-4,6-bis(ethylamino)-s-triazine (simazine). Can. J. Plant Sci. 41: 252–260.

(25) United States Environmental Protection Agency. 1975. Field dissipation studies. Guidelines for registering pesticides in the United States. 40 FR (123): 26894–26896. (26) Smith, A.E. 1971. Disappearance of triallate from field soils. Weed Sci. 19(5): 536– 537. (27) Gilbert, R.O. 1987. Statistical Methods for Environmental Protection Monitoring. Van Nostrand Reinhold, pp. 30–34.

(28) Keith, L.H, G.L. Patton, and P.G. Edwards. Radian International LLC, Austin TX. DQO-PRO 2.0: Calculator for estimating numbers of environmental samples and associated QC samples. Public domain software available at American Chemical Society Division of Environmental Chemistry website http://www.acs-envchem.duq.edu/env-chem.htm

(29) Jones, R.L., et.al. 2004. Suitability of field data for determining degradation rates in environmental risk assessments. Presented at the 227th American Chemical Society National Meeting, Anaheim, CA, March 2004.

(30) van Wessenbeck, I. 2004. Comparison of lab and field DT50 PDFs and PRZM-3 soil and water concentration predictions. Presented at the 227th American Chemical Society National Meeting, Anaheim, CA, March 2004.

(31) Chapman, R.A., and C.R. Harris. 1980. Insecticidal activity and persistence of terbufos, terbufos sulfoxide, and terbufos sulfone in soil. J. Econ. Entomol. 73(4): 536–543.

(32) Chapman, R.A., and C.R. Harris. 1980b. Persistence of chlorpyrifos in a mineral and an organic soil. J. Environ. Sci. Health B15(l): 39–46.

(33) Taylor, A.W., and W.F. Spencer. 1990. Volatilization and Vapor Transport Processes. In H.H. Cheng (ed.). Pesticides in the Soil Environment: Processes, Impacts, and Modeling. Soil Sci. Soc. Amer. Book Series #2, Madison, WI. pp. 213–270.

(34) Smith, C.N., D.S. Brown, J.D. Dean, R.S. Parrish, R.F. Carsel, and A.S. Donigan, Jr. 1985. Field Agricultural Runoff Monitoring (FARM) Manual. EPA 600/3-85/043. United States Environmental Protection Agency, Athens, GA.

(35) Kennedy, J.M., and R.E. Talbert. 1977. Comparative persistence of dinitroaniline type herbicides on the soil surface. Weed Sci. 25(5): 373-381.

(36) Burkhard, N., and J.A. Guth. 1981. Rate of volatilization of pesticides from soil 47 surface; comparison of calculated results with those determined in a laboratory model system. Pestic. Sci. 12(1): 37-44.

(37) United States Environmental Protection Agency. 1975. Volatilization studies. Guidelines for registering pesticides in the United States. 40 FR (123): 26889–26891.

(38) Guth, J.A., and W. D. Hörmann. 1987. Problematik und Relevanz von Pflanzenschutzmittel-Spuren in Grund(Trink-)Wasser. Schr.-Reihe Verein WaBoLu, 68: 91–106.

(39) McCall, P.J., R.L. Swann, and D.A. Laskowski. 1983. Partition Models for Equilibrium Distribution of Chemicals in Environmental Compartments. In R.L. Swann and A. Eschenroder (eds.). Fate of Chemicals in the Environment. American Chemical Society. pp. 105–123.

(40) Tinsley, I.J. 1979. Chemical concepts in pollutant behaviour. John Wiley and Sons, New York.

(41) Cohen, S.Z., S.M. Creeger, R.F. Carsel, and C.G. Enfield. 1984. Potential for pesticide contamination of groundwater resulting from agricultural uses. In R.F. Krugger and J.N. Seiber, (eds.). Treatment and Disposal of Pesticide Wastes. ACS Symposium Series No. 259. American Chemical Society, Washington, DC. pp. 297–325.

(42) Gustafson, D.I. 1989. Groundwater ubiquity score: A simple method for assessing pesticide leachability. Environ. Toxicol. Chem. 8: 339–357.

(43) Fletcher, C., S. Hong, C. Eiden, and M. Barrett. 1989. Standard Evaluation Procedure: Terrestrial Field Dissipation Studies. EPA-540/09-90-073. EPA, Office of Pesticide Programs, Washington, DC.

(44) Agriculture Canada, Environment Canada, and Department of Fisheries and Oceans. 1987. Environmental Chemistry and Fate Guidelines for Registration of Pesticides in Canada. Trade Memorandum T-1-255. Ottawa, Canada.

(45) Organisation for Economic Co-operation and Development. 1993. OECD Guidelines for theTesting of Chemicals. OECD, Paris.

(46) United States Environmental Protection Agency. 1988. Pesticide Assessment Guidelines.Subdivision D: Product Chemistry. EPA-540/09-82-018. EPA, Office of Pesticide Programs, Washington, DC.

(47) Creeger, S.M. 1985. Standard Evaluation Procedure: Hydrolysis Studies. EPA540/9-85-013.EPA Office of Pesticide Programs, Washington, DC.

(48) SETAC-Europe. 1995. Procedures for Assessing the Environmental Fate and Ecotoxicity of Pesticides. Society of Environmental Toxicology and Chemistry. 48

(49) Whetzel, N.K., and S.M. Creeger. 1985. Standard Evaluation Procedure: Soil Photolysis Studies. EPA-540/9-85-016. EPA Office of Pesticide Programs, Washington, DC.

(50) Fletcher, C.L., and S.M. Creeger. 1985. Standard Evaluation Procedure: Aerobic Soil Metabolism Studies. EPA-540/9-85-015. EPA Office of Pesticide Programs, Washington, DC.

(51) Fate Transport and Transformation Test Guidelines OPPTS 835.6100

(52) Standard Methods SW846

(53) Final Bee Risk Assessment to support registration review of Clothianidin and Thiamethoxan. Jan., 14, 2020.

(54) Data Quality Objectives Process for Hazardous waste with Investigations. EPA QA/G-HW.

(55) Superfund Program Representative Sampling Guidance. Volume 4

(56) Sampling and Analysis Plan Guidance and Template. Version 4, General Projects, R9 QA/009.1, May 2014.