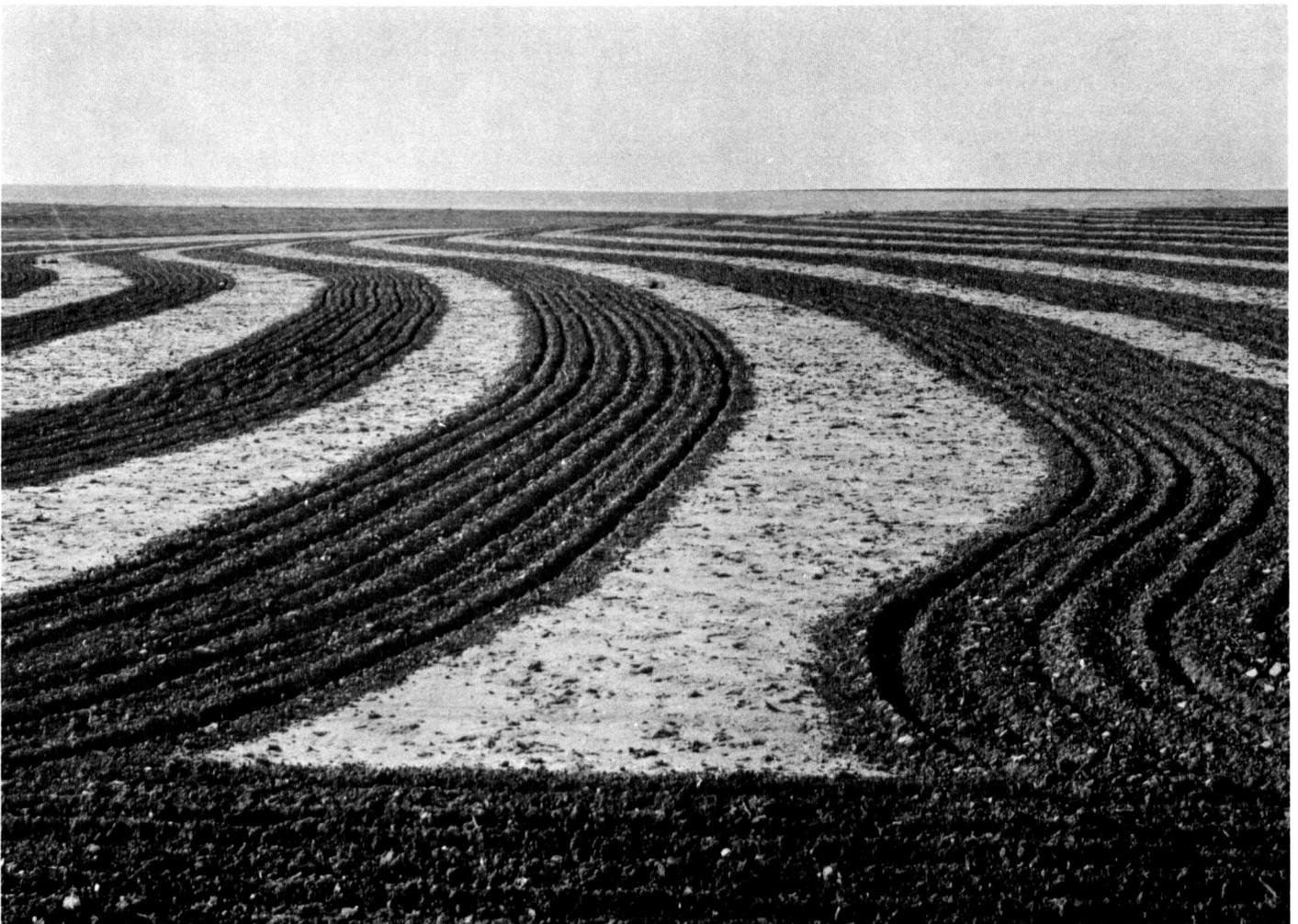


Issued November 1961

SOIL SURVEY
HAMILTON COUNTY
KANSAS



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

HOW TO USE THE SOIL SURVEY REPORT

THIS SURVEY of Hamilton County will help you plan the kind of farming that will protect your soils and produce good yields. It describes the soils, shows their location on a map, and tells what they will do under good management.

Find your farm on the map

In using this survey, start with the soil map, which is in the back of this report. These sheets, if laid together, would make a large photographic map of the county as it looks from an airplane. You can see fields, roads, rivers, towns, and many other landmarks on this map.

To find your farm, use the index to map sheets. This is a small map of the county on which numbered rectangles have been drawn to show the area covered by each sheet of the soil map.

When you have found the map of your farm, you will find that areas of the soils have been outlined and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever the symbol appears on the map.

Suppose you have found on your farm an area marked with the symbol Cb. The map legend identifies this symbol as Colby silt loam, 1 to 3 percent slopes.

Learn about the soils

The Colby soil and all other soils mapped in Hamilton County are described in the section, Descriptions of the Soils. Soil scientists dug holes and examined the surface soil and subsoil; measured slopes with a hand level; noted differences in growth of crops, grass, and weeds; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming.

After they studied and mapped the soils, the scientists talked with farmers and others about the use and management each soil should have and then placed it in a capability unit. A capability unit is a group of similar soils that need and respond to about the same kind of management.

Colby silt loam, 1 to 3 percent slopes, is in capability unit IVe-1 for dryland farming and in unit IIIe-1 for irrigation. Turn to the section, Use and Management of the Soils, and read what is said about the soils of each of these capability units. You will want to study the information given about how these soils can be managed and what to expect from them under good management when they are used as cropland.

The soils are also grouped into range sites, and good management of soils when used for range is discussed in the section on range management.

Finding information

Few readers will be interested in all parts of the soil survey report, for it has special sections for different groups, as well as some sections of value to all. The section, General Facts About the County, points out outstanding features of the survey area and will be of interest mainly to those not familiar with Hamilton County.

Farmers and those who work with farmers will be interested mainly in the sections, General Soil Areas, Descriptions of the Soils, and Use and Management of the Soils. A study of these sections will aid them in identifying soils on a farm, in learning ways the soils can be managed, and in judging what yields can be expected. The guide to mapping units, capability units, and range sites, at the back of the report will simplify use of the map and the report. This guide gives the map symbol for each soil, the name of the soil, the page on which the soil is described, the capability unit and the range site in which the soil has been placed, and the page where each unit and site is described.

Soil scientists and others who want to know about how the soils were formed and how they are classified will be interested in the section, Formation and Classification of the 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.

COVER PICTURE

Surface roughening is used to control wind erosion on this area of Colby silt loam, 1 to 3 percent slopes.

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SOIL SURVEY OF HAMILTON COUNTY, KANSAS

BY CHARLES W. McBEE, EDWARD L. FLEMING, VERNON L. HAMILTON, AND KENNETH H. SALLEE, SOIL CONSERVATION SERVICE,¹ UNITED STATES DEPARTMENT OF AGRICULTURE

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

HAMILTON COUNTY is in the southwestern part of Kansas. It is bordered on the west by Colorado and is in the third tier of counties north of the Oklahoma-Kansas State line (fig. 1). The area of the county is 992 square miles, or 634,880 acres.

Agricultural income in Hamilton County is derived mainly from the sale of wheat, grain sorghum, and cattle. Most of the farmland is cultivated. The rest consists of

known as general soil areas, or as they are sometimes called, soil associations. In Hamilton County the five general soil areas are indicated by the different physiographic divisions (fig. 2).

The map showing general soil areas is useful to those who want a general idea of the soils, who want to compare different parts of a county, or who want to locate large areas suitable for some particular kind of agriculture or other broad land use.

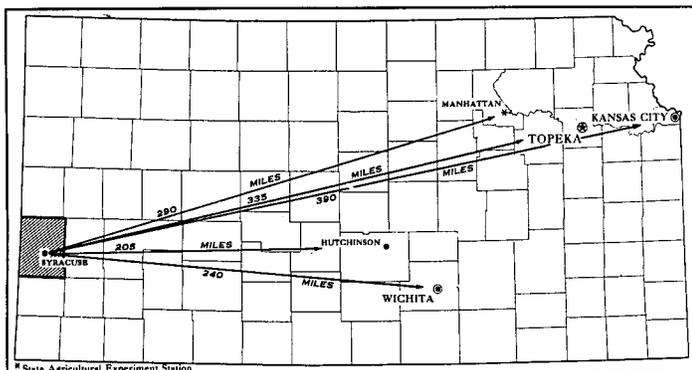


Figure 1.—Location of Hamilton County in Kansas.

Area 1: High Plains Tableland

The soils of this general area have developed in loess or similar silty sediments and are on the nearly level to gently sloping summit of the High Plains. Soils of the Richfield, Ulysses, and Colby series dominate this general area, which occurs in three parts of the county, as shown in figure 2.

The Richfield silt loams comprise the major part of this association. They occupy broad, continuous, nearly level areas that have poorly defined drainageways; within these areas there are a few small, enclosed depressions, or potholes. Lofton clay loam occurs in the depressions.

The Ulysses silt loams occupy the more convex areas on the nearly level parts of the High Plains. These soils occur mainly along the margins of the nearly level tableland where the slope is greater.

Both Ulysses and Colby soils occupy gentle slopes and low ridges. The Ulysses soils are on the smoother, less pronounced slopes, and the Colby soils are on the somewhat steeper, more convex slopes. In the area that lies in the southwestern part of the county, Ulysses and Colby soils occur as a complex, or mixture, of soils. This area has gently undulating topography on which convex and concave slopes are intermingled.

Also within the area in the southwestern part of the county are a few small knolls and ridges occupied by Vona loamy fine sand, Otero fine sandy loam, 1 to 3 percent slopes, and Manter fine sandy loams. Goshen silt loam occurs throughout the three parts of the area. It has developed in colluvial-alluvial sediments on the narrow, nearly level floors of upland swales and intermittent drainageways that have indefinite channels or no channels.

Most of this general soil area is used for cash crops of wheat and grain sorghum. Wind erosion is a hazard on nearly level areas, and both wind and water erosion are hazards on gently sloping areas. Water conservation is necessary on all soils for profitable crop production.

grasslands that occur chiefly on soils in the sandhills and on rough, broken, or shallow soils with steep slopes. Other than agriculture, there are no important industries in the county.

This cooperative soil survey was made by the United States Department of Agriculture and the Kansas Agricultural Experiment Station to provide a basis for managing the soils in farming and other uses. Fieldwork on the survey was completed in 1957, and all statements in the report, unless otherwise specified, refer to conditions in Hamilton County at that time.

General Soil Areas

The soils of Hamilton County occur in several distinctive patterns, each related to the topography, or lay-of-the-land, and to the type of material in which the soils have developed. In each of these patterns, certain soils or associations of soils are dominant. The patterns are

¹ Ernest K. Hogan, Lawrence T. Hanson, and Earl H. Jensen contributed to the fieldwork on this survey.

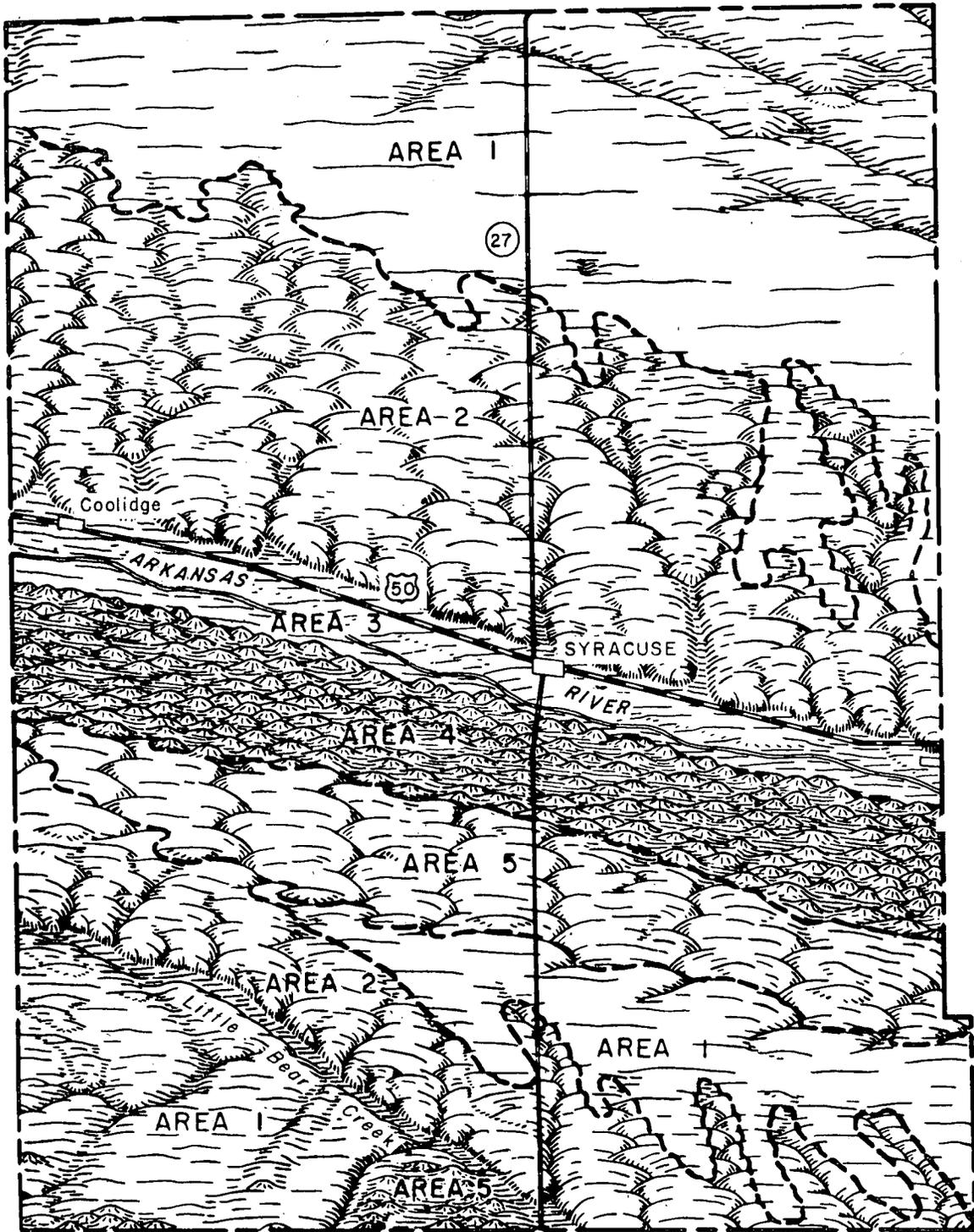


Figure 2.—Physiographic divisions in Hamilton County: (1) High Plains tableland; (2) Sloping High Plains; (3) Valley of the Arkansas River; (4) Sandhills; and (5) Transitional zone between the sandhills and the High Plains tableland.

Area 2: Sloping High Plains

The soils of this general area, like those of area 1, have developed mainly in loess, which mantles most of the slopes. Colby and Ulysses silt loams occupy most of the area; the Colby soils are dominant. The area is dominated by gentle to moderate slopes, but some deeply eroded valleys have steep side slopes. The two bodies of area 2 are shown in figure 2.

Colby silt loams occur on slopes of various gradients, and on some inextensive, nearly level areas. Ulysses silt loams occupy only the more gentle slopes and nearly level areas having gradients ranging from about $\frac{1}{2}$ to 3 percent. Colby silt loam, 5 to 15 percent slopes, occupies all the steep and rough land with the exception of minor areas that are occupied by Potter soils. The Potter soils are shallow over caliche or limestone and are mainly on the more broken slopes. Goshen silt loam is a minor, but important, part of this general area. As in area 1, it occupies the dominantly narrow, nearly level upland swales and drainageways that have indefinite channels or no channels.

Most of the soils that have gentle to moderate slopes are being cultivated. The main crops are wheat and sorghum. Crop failures are common, and profitable yields are obtained only during years of most favorable weather. Both wind and water erosion are serious hazards. Conservation of water is necessary for successful crop production.

The steeper and more broken slopes in this general area remain in native grass and are used for grazing.

Area 3: Valley of the Arkansas River

This general area consists of soils in the valley of the Arkansas River. The river flows eastward through the county, about midway between the northern and southern boundaries. The river valley, which includes the flood plain and the alluvial fans along the northern margin, is uniformly between 2 and 3 miles wide. The area is nearly level, with only a few short, steep slopes along the tributary streams. It is bounded on the north by sloping Colby and Ulysses soils of area 2 and on the south by soils of the sandhills of area 4.

Soils of the Las Animas, Las, Sweetwater, Bowdoin, and Lincoln series occupy the flood plain. The Lincoln soil is on very sandy, recently deposited alluvium adjacent to the river channel. The Sweetwater soil has a high water table that is relatively stable, and it supports good stands of native tall grasses. This soil can be used either as range or meadow, but the Lincoln soil is valuable only for grazing.

The Las Animas, Las, and Bowdoin soils occur throughout the flood plain. They have a moderately high, but fluctuating, water table and the associated slight to moderate salinity. Some areas of Las Animas, Las, and Bowdoin soils are cultivated under irrigation.

The Bridgeport soil occupies the alluvial fans and aprons that are along the northern side of the valley. This friable, well-drained, productive soil constitutes a major part of the irrigated land in the valley of the Arkansas River.



Figure 3.—Area of Tivoli-Dune land complex in the sandhills.

Area 4: Sandhills

The sandhills are south of and adjacent to the valley of the Arkansas River (fig. 3). Near the river the hills are dune shaped, steep, and choppy, but they are more gently undulating or billowy near the southern edge of the area. Intermittent streams and drainageways enter the sandhills from the south but, with few exceptions, are soon indefinable within the maze of hummocks and dunes.

Tivoli soils occupy nearly all the sandhills. Some areas of Active dunes are present, mostly in the rougher areas nearest the river. These actively blowing, nearly barren areas of loose sand have been formed as the result of wind erosion on the Tivoli soils.

All of this area is nonarable and is used exclusively as rangeland. Under good management, mixed stands of tall and mid grasses produce sufficient forage for grazing and protect the soil from wind erosion.

Area 5: Transitional Zone Between the Sandhills and High Plains Tableland

The soils between the sandhills and High Plains tableland occur in two main bodies. The principal soils are Vona loamy fine sand, Manter fine sandy loams, and Ulysses loams.

The larger of the two bodies, as shown in figure 2, lies between the sandhills and the high tableland to the south. This gently sloping area is a zone of transition in which the soil texture grades from the sand of the sandhills to the silt loam of the High Plains upland. The soils contain an appreciable amount of fine sand that decreases as the distance from the sandhills increases.

Vona loamy fine sand occurs on slightly billowy or gentle slopes just south of and adjacent to the sandhills. To the south, this soil grades to Manter fine sandy loams, which in turn grade to Ulysses loams. Both the Manter and Ulysses soils are nearly level to gently sloping. Other soils in the area are the Otero-Vona complex, 5 to 15 percent slopes; the Colby silt loams, which are on moderate to steep slopes along drainageways, and Goshen silt loam, which is in upland swales. This area is drained northward toward the sandhills and the Arkansas River.

Another much smaller body of this general area lies just south of Little Bear Creek. The same soils occur here as in the larger area but in not so orderly a sequence.

Most of the soils in area 5 are cultivated without irrigation. Sorghum is the main crop on the sandy soils, and wheat is predominant on the less sandy ones. Wind erosion is a hazard throughout the area and is particularly serious on the more sandy soils. Erosion by water is an additional hazard on the gently sloping, more silty soils. Careful management is needed on all the soils to control erosion and to conserve water for plant use.

Descriptions of the Soils

This section contains a description of each soil mapping unit in Hamilton County. In the descriptions of the soils, particularly their profiles, some technical terms are used. (See the glossary in the back of the report.) This terminology is explained fully in the Soil Survey Manual.²

Soil scientists dug many holes throughout the county to examine the different layers that make up each soil profile. They measured steepness of slope with a hand level. They observed the lay-of-the-land; the condition of crops and other plants and their habits of growth; the kind of material underlying the soils; and other characteristics of the landscape that indicate the nature and extent of each kind of soil. Then, the scientists used aerial photographs as a base map of the county; on the photographs they drew boundaries to show the extent of the various soil mapping units. The detailed soil map in the back part of the report was prepared from their field maps.

Soil scientists designate main soil layers, or horizons, with letters A, B, and C. The depths of the various horizons, measured from the surface downward, were determined in part by the way the soil material appeared and the way it felt when rubbed between the fingers. The color, texture, structure, and consistence of the soil also were used as a basis for distinguishing different horizons.

The uppermost layer is called the A horizon, or the surface soil. It is usually the darkest layer because it contains the largest amount of organic matter. The subsoil, or B horizon, is below the surface layer. It usually contains enough more clay than the A horizon so that it feels heavier and stickier. Some soils, especially young or weakly developed ones, may not have a B horizon. The underlying or parent material is designated the C horizon. This horizon has been affected very little by weathering, the accumulation of organic matter, and other processes of soil formation. Subdivisions in horizons are designated by numbers or by small letters.

The color of the soil in each horizon is identified precisely through the use of Munsell color notations² that follow the color name. In this report, Munsell color notations refer to the soil when dry, unless otherwise specified.

Soil texture refers to the relative proportions of sand, silt, and clay that make up the soil mass. Sand consists of coarse particles, clay of fine particles, and silt of particles intermediate in size. Soils that are given the textural class names of sand, silt, or clay have physical properties that are influenced mainly by the particles of

the sand, silt, or clay separates, respectively. Soils with textural class names of loam, sandy loam, silt loam, and clay loam have physical properties influenced by mixtures of the sand, silt, and clay separates.

Soil structure refers to the arrangement of the soil particles in natural aggregates. Important characteristics of structure are size, shape, and strength (grade) of the aggregates. Soils without definite structure are described as massive if the material is coherent and as single grain if it is noncoherent. Loose sand is a good example of single-grain material.

Common terms used to describe consistence of the soil are firm, friable, hard, and soft. Consistence is determined by the way the soil feels and is measured by the resistance of the aggregates to pressure.

Most of the mapping units in Hamilton County consist of a single soil. In some places, however, two or more soils are so intermingled that they could not be separated at the scale of mapping used. These soils are mapped together as a complex, such as the Bowdoin-Las Animas complex.

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

Soil	Area	Extent
	Acres	Percent
Active dunes.....	4, 416	0. 7
Alluvial land.....	3, 873	. 6
Bayard fine sandy loam.....	1, 503	. 2
Bowdoin clay loam.....	1, 331	. 2
Bowdoin clay.....	774	. 1
Bowdoin loamy fine sand.....	934	. 2
Bowdoin-Las Animas complex.....	342	. 1
Bridgeport clay loam.....	13, 454	2. 1
Colby silt loam, 0 to 1 percent slopes.....	7, 197	1. 1
Colby silt loam, 1 to 3 percent slopes.....	140, 105	22. 1
Colby silt loam, 3 to 5 percent slopes.....	30, 366	4. 8
Colby silt loam, 5 to 15 percent slopes.....	32, 457	5. 1
Goshen silt loam.....	21, 444	3. 4
Las clay loam, deep.....	1, 572	. 3
Las clay loam, moderately deep.....	2, 129	. 3
Las Animas sandy loam.....	2, 717	. 4
Las Animas loamy sand.....	3, 269	. 5
Lincoln sand.....	4, 782	. 8
Lofton clay loam.....	1, 063	. 2
Manter fine sandy loam, 0 to 1 percent slopes.....	3, 789	. 6
Manter fine sandy loam, 1 to 3 percent slopes.....	7, 866	1. 2
Otero fine sandy loam, 1 to 3 percent slopes.....	793	. 1
Otero-Vona complex, 5 to 15 percent slopes.....	3, 518	. 6
Potter soils.....	2, 512	. 4
Richfield silt loam, 0 to 1 percent slopes.....	177, 700	28. 1
Richfield silt loam; 1 to 3 percent slopes.....	2, 043	. 3
Sweetwater clay loam.....	2, 821	. 4
Tivoli fine sand.....	32, 029	5. 0
Tivoli loamy fine sand.....	17, 900	2. 8
Tivoli-Dune land complex.....	13, 254	2. 1
Ulysses loam, 0 to 1 percent slopes.....	2, 819	. 4
Ulysses loam, 1 to 3 percent slopes.....	19, 877	3. 1
Ulysses silt loam, 0 to 1 percent slopes.....	38, 621	6. 1
Ulysses silt loam, 1 to 3 percent slopes.....	11, 645	1. 8
Ulysses-Colby complex, 1 to 3 percent slopes, eroded.....	14, 003	2. 2
Vona loamy fine sand.....	8, 238	1. 3
Gravel pits.....	45	(¹)
Arkansas River.....	1, 679	. 3
Grand total.....	634, 880	100. 0

¹ Less than 0.1 percent.

² UNITED STATES DEPARTMENT OF AGRICULTURE. SOIL SURVEY MANUAL. U.S. Dept. Agr. Handbook 18. 503 pp., illus. 1951.

Some special soil conditions, such as eroded or sand spots, occur in small areas and are shown on the detailed map by special symbols. These symbols are explained on the legend of the map.

The location and distribution of the soil mapping units in the county are shown on the detailed map in the back part of the report. Their approximate acreage and proportionate extent are given in table 1.

Active dunes (Ad).—This miscellaneous land type consists of actively shifting hills, ridges, and cone-shaped dunes of fine sand. There is no definable soil profile. Soil development is prevented by the continual movement of the sand. Areas of this land type occur throughout the sandhills in association with the Tivoli soils.

Severe erosion on Tivoli soils has furnished the materials for Active dunes. Vegetation is lacking on 80 percent or more of the total acreage. Giant sandreedgrass or blowoutgrass occurs but is too sparse to keep the sand from blowing. The sand tends to spread slowly in a northerly direction, but within areas of Active dunes, it shifts according to the direction of the wind.

Active dunes and blowouts should be fenced to keep out livestock; a protective cover of weeds or sorghum should be established, and then the areas should be seeded to suitable native grasses. *Capability unit VIIe-1 (dryland)*; *Choppy sands range site*.

Alluvial land (An).—This miscellaneous land type consists of loamy alluvial soils and incised, meandering channels of local intermittent streams of the upland. The valley floors included in this mapping unit are at least 200 feet wide and are continuous enough to warrant separate consideration in grazing management. The soils are grayish brown and calcareous and range in texture from loam to sandy loam. Weakly stratified loamy, sandy, and gravelly material commonly occurs below depths of about 2 feet.

Nearly all of this land type is in native grass range. It is well suited to this use. The meandering channels have formed isolated areas that would be suitable for cultivation except for their small size and inaccessibility. Because they are subject to occasional flooding and usually bordered by sloping soils unsuitable for cultivation, areas of Alluvial land generally are considered nonarable. *Capability unit VIw-1 (dryland)*; *Lowland range site*.

Bayard fine sandy loam (Ba).—This is a well-drained, light-colored soil that developed from moderately sandy sediments on alluvial fans and aprons along the northern side of the valley of the Arkansas River. The profile is weakly defined. This soil occupies rather narrow, nearly level areas along present and abandoned channels of upland drainageways that extend across the fans.

Bayard fine sandy loam has a grayish-brown, coarse loam to sandy loam surface layer underlain by somewhat stratified sandy loam and loam. The soil is porous and permeable and has moderate moisture-holding capacity. Depth to sand and gravel is generally more than 3 feet. The water table lies well below the root zone, generally below a depth of 10 feet.

Bayard fine sandy loam is much less extensive than the associated Bridgeport clay loam. It is more sandy throughout the profile, and it is less smooth and more sloping.

Typical profile (800 feet west and 700 feet north of the southeastern corner of sec. 26, T. 23 S., R. 42 W.; about 150 feet north of U.S. Highway 50 in a cultivated field with a convex slope of about 1 percent) :

- A₁ 0 to 10 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3.5/2, moist); weak, granular structure; friable, soft when dry; calcareous; contains an occasional fine, waterworn pebble; gradual boundary.
- AC 10 to 20 inches, light loam that is of an intermediate and mixed color, about grayish brown (10YR 5.5/2.5), dark grayish brown (10YR 4/2, moist); weak, granular structure; friable, soft when dry; calcareous; contains a few small, flattened, waterworn pebbles and an occasional cluster of worm-cast granules; gradual boundary.
- C 20 to 60 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 4/3, moist); almost structureless; very friable, soft when dry; highly calcareous with a few small, soft, lime concretions; contains an insignificant amount of fine gravel; the entire layer is somewhat stratified, containing about equal proportions of light loam and fine sandy loam, which, if mixed, average fine sandy loam.

Variations in the profile are common. The texture of the surface layer ranges from light loam to light fine sandy loam. In a few places thin strata of loamy fine sand occur below the surface layer. Depth to sand and gravel ranges from 3 to 6 feet.

Included with this soil as mapped are very small areas of shallow, sandy soil. These sandy pockets and bars are too small to be mapped separately and are indicated on the detailed map by a symbol.

Much of Bayard fine sandy loam is cultivated under irrigation. Some of the slightly higher, less smooth areas cannot be reached with irrigation water and remain in native grass. They are small and are generally low, isolated ridges surrounded by large areas of irrigated soils. Wind erosion is a hazard and will occur whenever the soil is dry and inadequately protected. Flash floods that develop in the uplands sometimes damage crops and irrigation installations. *Capability unit IVe-2 (dryland)*; *capability unit IIs-1 (irrigated)*; *Sandy range site*.

Bowdoin clay loam (Bd).—This is a gray to grayish-brown, calcareous, generally saline soil that has formed in the clayey alluvium of the nearly level bottom land of the Arkansas River. The profile is weakly developed. It has a darkened clay loam surface layer. The gray, compact clay subsoil is prominently mottled with strong-brown spots. The soil is somewhat poorly drained; it has a slowly permeable subsoil, and the fluctuating water table is within a depth of 10 feet.

Bowdoin clay loam is similar to the associated Las soils but has a subsoil of clay instead of clay loam.

Typical profile (500 feet south and 200 feet west of the NE corner of sec. 36, T. 23 S., R. 43 W.; in a nearly level, native grass pasture) :

- A₁₁ 0 to 11 inches, grayish-brown (10YR 4.5/2), light clay loam, very dark grayish brown (10YR 3/2, moist); weak, granular structure; friable; calcareous; a few small clusters of worm-cast granules; clear boundary.
- A₁₂ 11 to 20 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2, moist); moderate, medium, granular structure; friable, slightly hard when dry; calcareous; numerous worm casts; abrupt boundary.
- AC 20 to 44 inches, gray (10YR 5/1.5) clay, dark gray (10YR 4/1, moist); many, medium, prominent, strong-brown mottles; moderate, fine, blocky structure; firm, hard

when dry; calcareous, with a few soft to semihard lime concretions; numerous nests and seams of fine, white crystals; roots occur but few are below a depth of 40 inches.

- C₁ 44 to 54 inches, light yellowish-brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4, moist); many, medium, prominent, brownish-yellow and brown mottles; structureless; very friable, soft when dry; calcareous; stratified with thin layers of loamy sand and loam; gradual boundary.
- C₂ 54 to 60 inches +, pale-brown (10YR 6/3) sand; loose and structureless.

Thin strata of soil material ranging in texture from sand to clay may occur in any layer. Depth to sand is usually greater than 40 inches and averages about 50 inches. The darkened surface layer ranges in texture from loam to clay loam and has a very thin (less than 4 inches) covering of sandy loam in some places. The commonly stratified clay subsoil occurs at depths of 10 to 24 inches and ranges from 12 to 24 inches in thickness. The horizons containing the fine, white crystalline material are commonly moderately saline, whereas the horizons above are low in salts. The water table is generally between 6 and 10 feet below ground level but may be higher during seasons when precipitation is above average.

Included with areas of Bowdoin clay loam as mapped are small areas of Las clay loams and Bowdoin clay. Inclusions comprise about 15 percent of this soil mapping unit.

Most of Bowdoin clay loam is in native grass pasture, but a small acreage is cultivated under irrigation. The principal irrigated crops are forage sorghum and wheat. Slow permeability, poor drainage, and the associated salinity combine to limit crop production on this soil. Satisfactory yields are obtained only if the quality of irrigation water is good and if water and fertilizer are applied carefully. The suitable native grasses produce abundant forage under good management. *Capability unit IVw-1 (dryland)*; *capability unit IVw-1 (irrigated)*; *Saline lowland range site*.

Bowdoin clay (Bc).—This soil is like Bowdoin clay loam in all characteristics except for the clay texture of its darkened surface layer. Subsoil permeability and surface drainage are slow. Usually the soil is slightly saline, but it is strongly saline in local areas. It is inextensive.

Typical profile (600 feet east and 600 feet south of quarter-section corner on north side of sec. 17, T. 24 S., R. 40 W.; in a nearly level cultivated field):

- A₁ 0 to 12 inches, grayish-brown (10YR 4.5/2) clay, very dark grayish brown (10YR 3/2, moist); weak, blocky structure; firm, very hard when dry; calcareous; gradual boundary.
- AC 12 to 44 inches, gray (10YR 5/1.5) clay, dark gray (10YR 4/1, moist); common, medium, distinct, yellowish-brown mottles; massive and compact; very hard when dry; calcareous; numerous nests and seams of fine, white crystals below a depth of 24 inches; abrupt boundary.
- C₁ 44 to 56 inches, light yellowish-brown (10YR 6/3.5) sandy loam stratified with clay loam, brown (10YR 5/3, moist); medium, prominent, brownish-yellow and gray mottles; structureless (massive); friable, soft when dry; calcareous; gradual boundary.
- C₂ 56 to 60 inches +, very pale brown (10YR 7/3) coarse sand; loose and structureless.

The clay subsoil ranges from about 15 to 40 inches in thickness, but lenses and thin layers of clay commonly occur in the more loamy horizons below.

Small areas of Bowdoin clay loam and Las clay loams are included with this soil mapping unit.

Because it occurs in areas that can be irrigated from existing canals, most of the Bowdoin clay is cultivated under irrigation. It is unsuited to dryland farming and is only moderately good for crops when irrigated. Preparation of an adequate seedbed is difficult because of the clay texture of the surface soil. Slow permeability, slow surface drainage, and slight to moderate salinity combine to limit crop production on this soil. Satisfactory yields are obtained only when water, fertilizer, and tillage are carefully managed. *Capability unit VIIw-2 (dryland)*; *capability unit IVw-1 (irrigated)*; *Saline lowland range site*.

Bowdoin loamy fine sand (Bf).—This soil is similar to Bowdoin clay loam and Bowdoin clay in characteristics of the subsoil and substratum. It differs in texture of the surface soil and in topography. The surface layer consists of loamy fine sand or light fine sandy loam that ranges from 8 to 20 inches in thickness. This layer is thick on the high areas and thin on the lower ones; it averages about 12 to 14 inches in thickness over the stratified clay subsoil. The topography is nearly level with a general gradient of less than 1 percent, but there are short, low, gentle undulations and small hummocks.

Typical profile (1,100 feet north of the quarter corner on the south side of sec. 1, T. 24 S., R. 42 W.; in a native grass pasture):

- A₁ 0 to 14 inches, brown (10YR 5/3) loamy fine sand, dark grayish brown (10YR 4/2.5, moist); weak, granular structure to structureless; very friable, soft when dry; calcareous below a depth of 4 inches; abrupt boundary.
- AC 14 to 24 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1, moist); common, fine, distinct, brown and yellowish-brown mottles; weak, blocky structure; firm, very hard when dry; calcareous; gradual boundary.
- C₁ 24 to 50 inches, pale-brown (10YR 6/3) erratically stratified clay, clay loam, and sandy loam (averages clay loam), brown (10YR 5/3, moist); common, medium, prominent, yellowish-brown, strong-brown, and gray mottles; structureless (massive); friable, slightly hard when dry; calcareous; a few small, soft to semihard lime concretions; gradual boundary.
- C₂ 50 to 60 inches +, very pale brown (10YR 7/3) sand; loose and structureless.

Surface drainage ranges from moderate to good, but permeability of the subsoil is slow. Mottled colors generally occur at the same depth as the clay subsoil. Depth to the water table ranges from about 6 to 10 feet.

Small areas of Las Animas sandy loam and Las Animas loamy sand are included with this mapping unit.

Bowdoin loamy fine sand is unsuited to dryland and irrigated farming. Most of it remains under native vegetation consisting of sand sagebrush, blue grama, sand dropseed, saltgrass, and some widely scattered switchgrass. Moderate amounts of forage can be produced if good grazing management is practiced. *Capability unit VIIe-2 (dryland)*; *Sands range site*.

Bowdoin-Las Animas complex (Bx).—This soil complex consists of a mixture of alluvial soils in which Bowdoin clay loam and Las clay loam predominate. Other soils in the complex are Las Animas sandy loam, Las Animas loamy sand, and Bowdoin clay. In some areas there are soils that have profiles intermediate in characteristics between the Las Animas and Bowdoin soils.

About 60 percent of the total acreage consists of Bowdoin clay loam and 25 percent, Las clay loam; the remain-

ing 15 percent is occupied by the Las Animas soils, Bowdoin clay, and soils that are intermediate in characteristics. The topography is mainly nearly level, but there are slight undulations in old, partly filled channels. This complex of soils is inextensive.

Most areas of the Bowdoin-Las Animas complex remain in native grass vegetation that consists of saltgrass, switchgrass, alkali sacaton, and, to some extent, blue grama and buffalograss. The areas are generally not suited for use as cropland because of the fluctuating high water table, slow permeability of the subsoil, and slight to moderate salinity. *Capability unit VIw-2 (dryland)*; *Saline lowland range site*.

Bridgeport clay loam (By).—Bridgeport clay loam is a deep, well-drained, light-colored, calcareous soil that has formed in alluvium. Its profile is weakly developed. The soil occupies the nearly level alluvial fans and aprons along the northern margin of the valley of the Arkansas River and, to a less extent, the valley of Little Bear Creek. The alluvium consists of sediments derived from adjacent upland and deposited by local intermittent streams emptying into the valleys.

The soil has a grayish-brown, heavy loam to clay loam surface layer underlain by lighter colored but otherwise similar material. It is porous and permeable and has the capacity to hold a large amount of water available for plant use. Depth to sand and gravel is generally more than 5 feet. The water table lies well below the root zone.

Bridgeport clay loam is deeper and has better drainage than the geographically associated Las soils. It is more porous and permeable, is not so heavy or clayey in the subsoil, and is better drained than the Bowdoin soils.

Typical profile (400 feet west and 50 feet north of the quarter-section corner on the east side of sec. 24, T. 23 S., R. 43 W.; in a nearly level cultivated field on a slope of less than 1 percent):

- A₁ 0 to 10 inches, grayish-brown (10YR 4.5/2) clay loam, very dark grayish brown (10YR 3.5/2, moist); weak, medium, granular structure; friable, hard when dry; calcareous; gradual boundary.
- AC 10 to 18 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2, moist); weak, subangular blocky structure; friable, hard when dry; calcareous; some worm casts; gradual boundary.
- C 18 to 52 inches, pale-brown (10YR 6/3), light clay loam, brown (10YR 5/3, moist); massive but porous; very friable, slightly hard when dry; strongly calcareous with a few small, soft lime concretions; a few small, rounded pieces of gravel; this layer is quite permeable.

Variations in the profile are not common but occur in some places. In areas where the soil has been irrigated for many years with water diverted from the Arkansas River, up to 8 inches of dark grayish-brown (10YR 4/2) clay loam or silty clay loam has been deposited on the surface by irrigation water. In a few places the clay loam and loam subsoil is stratified with layers of fine sandy loam.

Most of this soil is cultivated under irrigation. It is the most extensive and productive of the soils in the valley of the Arkansas River. Hazards and limitations are few. When the soil is cultivated without irrigation, wind erosion becomes a hazard and occurs whenever the surface is dry and unprotected. Infrequently, flash floods from the upland may damage crops and irrigation installations. *Capability unit IIIc-1 (dryland)*; *capability unit I-1 (irrigated)*; *Loamy upland range site*.

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Colby silt loam, 1 to 3 percent slopes (Cb).—This soil has formed in the deep loess or similar silty sediments that mantle much of the High Plains. Its profile is weakly developed. The soil occurs on plane or convex, gentle slopes.

The surface layer is grayish-brown, calcareous, friable silt loam, about 6 inches thick; it is only slightly darker than the underlying parent material. The soil is so young that a clayey subsoil, or B horizon, has not had time to develop. Free lime occurs throughout the profile. The soil is moderately permeable to roots, air, and water. It has the capacity to store a large amount of water that is available for plant use.

The Colby soil has a lighter colored, more calcareous surface layer than the associated Ulysses soils. The associated Richfield soils are darker than the Colby soil, and their subsoil contains more clay.

Typical profile (1,600 feet north of the SW corner of sec. 30, T. 23 S., R. 40 W.; in a native grass pasture on about a 2 percent slope):

- A₁ 0 to 4 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2, moist); weak, thin, platy structure to a depth of 2 inches, weak, granular below; friable, slightly hard when dry; calcareous; gradual boundary.
- AC 4 to 8 inches, an intermediate and mixed color, about grayish-brown (10YR 5.5/2.5), silt loam, dark grayish brown (10YR 4.5/2.5, moist); weak, fine, granular structure; otherwise similar in characteristics to above horizon; gradual boundary.
- C_{ca} 8 to 20 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3, moist); very weak, subangular blocky structure; friable, slightly hard when dry; porous and moderately permeable; a few (less than 5 percent of volume) soft lime concretions; gradual boundary.
- C 20 to 60 inches +, very pale brown (10YR 7/3) silt loam (essentially unaltered loess), brown (10YR 5/3, moist); massive; porous; very friable; strongly calcareous.

Variations in the profile are not common. The thickness of the darkened surface layer ranges from 3 to 8 inches. In a few places, some rounded gravel is scattered over the surface of the soil.

Colby silt loam, 1 to 3 percent slopes, is not well suited for use as cropland, but much of it is being cultivated. Wheat and sorghum are grown under a system of alternate crop and fallow (fig. 4). Because this gently sloping



Figure 4.—Grain sorghum planted on the contour on Colby silt loam, 1 to 3 percent slopes.

soil tends to seal over during rainstorms, runoff and the loss of soil by water erosion are excessive. Wind erosion is also a serious hazard, and soil blowing occurs whenever the soil is not adequately protected by growing vegetation or its residue. *Capability unit IVe-1 (dryland)*; *capability unit IIIe-1 (irrigated)*; *Loamy upland range site*.

Colby silt loam, 0 to 1 percent slopes (Ca).—This nearly level soil has a profile like that of Colby silt loam, 1 to 3 percent slopes. The darkened surface layer averages about 8 inches in thickness. This soil occurs in many small areas.

Small areas of the associated Ulysses silt loams and Goshen silt loam are included with this soil.

Most of Colby silt loam, 0 to 1 percent slopes, is cultivated without irrigation. Because it is nearly level, runoff and erosion by water are not excessive. Most of the rainfall is absorbed by the soil. Wind erosion is a serious hazard, and the soil will blow whenever it is not adequately protected by growing vegetation or its residue. *Capability unit IVe-3 (dryland)*; *capability unit I-1 (irrigated)*; *Loamy upland range site*.

Colby silt loam, 3 to 5 percent slopes (Cc).—This soil has a profile like that of Colby silt loam, 1 to 3 percent slopes. The darkened surface layer, however, is thinner, averaging about 3 to 5 inches in thickness.

Some of this soil is under cultivation, but the soil is not well suited to crops. Runoff is excessive because of the strong slopes and the sealing and slicking of the surface of the soil during rainstorms. As a result, much soil is lost through erosion and plants that do not have well-established root systems are damaged. Wind erosion is a serious hazard. *Capability unit VIe-1 (dryland)*; *Loamy upland range site*.

Colby silt loam, 5 to 15 percent slopes (Cd).—This non-arable soil occupies steeper slopes than the other Colby silt loams. The texture of the darkened surface layer ranges from silt loam to loam. Silt loam is the dominant texture; much of the rest of the surface soil is near the limit between loam and silt loam.

Soils other than the Colby soil make up about 15 percent of this mapping unit. These inclusions consist of (1) grayish-brown, calcareous, loamy alluvial soils on narrow valley floors of minor drainageways and (2) Potter soils that occur on a few small areas, generally less than 20 acres in size. These areas of included soils are too small to have special significance in range planning and management.

Most of Colby silt loam, 5 to 15 percent slopes, is still under native short grass and is used for grazing. A few small areas, occurring as parts of large fields of arable soils, have been cultivated. Most of these areas have been abandoned as cropland because of severe wind and water erosion. These areas and other areas of this soil that are still being cultivated should be seeded to suitable native grasses and used as rangeland. *Capability unit VIe-1 (dryland)*; *Loamy upland range site*.

Goshen silt loam (Go).—This deep, dark-colored, friable, nearly level soil occurs in swales and along narrow intermittent drainageways of the upland. It is associated with Colby, Ulysses, and Richfield soils and occupies the swales that collect and drain away runoff water from these soils. Goshen silt loam has developed in silty material washed down from the soils on higher slopes nearby.

The surface layer is thicker and darker than that of typical upland soils in the county. The dominant slope is less than 1 percent, but this is enough for good surface drainage. The soil is porous and permeable, absorbs water readily, and has good internal drainage.

Typical profile (250 feet north and 350 feet west of the quarter-section corner on the east side of sec. 28, T. 23 S., R. 40 W.; in a nearly level swale that is cultivated):

- A₁ 0 to 19 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown to very dark brown (10YR 2.5/2, moist); moderate, medium, granular structure; friable; noncalcareous; porous and permeable; easily penetrated by plant roots, air, and water; gradual boundary.
- B₂ 19 to 34 inches, brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2, moist); moderate, medium, sub-angular blocky structure; friable, hard when dry; calcareous with lime films visible on surface of aggregates below a depth of 28 inches; moderately permeable to plant roots, air, and water; clear boundary.
- C_{ea} 34 to 42 inches, pale-brown (10YR 6/3), heavy silt loam, brown (10YR 5/3, moist); almost structureless; friable, soft when dry; calcareous with numerous small, soft, white lime concretions; porous and permeable; gradual boundary.
- C 42 to 60 inches +, very pale brown (10YR 7/3), heavy silt loam, brown to pale brown (10YR 5.5/3, moist); structureless; friable, soft when dry; strongly calcareous; porous and permeable.

Significant variations in the profile are not common. The subsoil and substratum, however, range in texture from heavy silt loam to clay loam; the finer textured soil occurs in the broader swales. Depth to calcareous material is variable but usually exceeds 15 inches.

Most of this soil is cultivated along with other cropland soils. Although not extensive, the soil is important to the agriculture of the county because of its high natural productivity. Crops generally benefit from the extra moisture gained through the accumulation of runoff from adjacent areas, and yields on this soil are higher than those on most other cultivated soils. Water erosion is negligible, but wind erosion occurs whenever the soil is barren of growing vegetation or its residue. *Capability unit IIIc-2 (dryland)*; *capability unit I-1 (irrigated)*; *Lowland range site*.

Las clay loam, deep (lb).—This is a grayish-brown, imperfectly drained, calcareous soil that has formed in alluvium. Its profile is weakly developed. The darkened surface soil and the subsoil are dominantly clay loam in texture. This soil occurs on the nearly level flood plains of the Arkansas River, and it is closely associated with soils of the Las Animas and Bowdoin series.

The Las soil has a finer textured, more coherent subsoil than the Las Animas soils. It has a coarser textured, more permeable subsoil than the Bowdoin soils.

Typical profile (1,400 feet east and 100 feet north of the SW corner of sec. 31, T. 23 S., R. 41 W.; in a cultivated field on the flood plain of the Arkansas River):

- A₁ 0 to 12 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2, moist); massive but porous; firm, hard when dry; calcareous; gradual boundary.
- AC 12 to 28 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2, moist); massive and somewhat compact; very hard when dry; calcareous; gradual boundary.
- C₁ 28 to 44 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2, moist); massive and compact; very hard when dry; calcareous; prominently

mottled with many, medium, yellowish-brown and strong-brown spots and streaks; contains some thin strata of sandy loam in lower part of horizon; abrupt boundary.

- C₂ 44 to 60 inches +, very pale brown (10YR 7/3) coarse sand and gravel, mottled with yellowish brown in upper part of horizon.

Variations in profile characteristics are common. Thin layers of sand, silt, or clay may occur in any layer. The texture of the surface layer ranges from loam to clay loam. The texture of the subsoil may be clay loam, sandy clay loam, or heavy loam. Depth to sand ranges from 36 to 60 inches and averages about 45 inches. The subsoil is mottled with brown and gray at depths ranging between 16 and 40 inches. The water table normally fluctuates at depths between 3 and 6 feet, but it may be higher or lower during seasons of extreme variation in the amount of precipitation and streamflow.

Insignificant areas of Las clay loam, moderately deep, Bowdoin clay loam, and Las Animas sandy loam are included in this soil as mapped. These inclusions are small and generally so irregular in shape that it was impractical to map them separately.

Most of this soil is now cultivated under irrigation. Moderately good yields of wheat and sorghum are obtained. The longevity of stands of alfalfa varies because of the fluctuating water table, but yields are good as long as an adequate stand is maintained. Salinity of the soil is slight to moderate, but this has little detrimental effect on the crops commonly grown. *Capability unit IVw-1 (dryland)*; *capability unit IIw-1 (irrigated)*; *Saline lowland range site*.

Las clay loam, moderately deep (ld).—This soil has coarse sand and gravel at shallower depths than Las clay loam, deep. This material occurs at depths ranging between 20 and 36 inches; the average depth to sand is about 28 inches. The subsoil is mottled with gray and brown at depths ranging between 16 and 30 inches. This soil generally occupies parts of the flood plain that are nearer the river than those occupied by Las clay loam, deep.

Las clay loam, moderately deep, is not well suited to the production of cultivated crops under dryland farming. It is moderately good for crops if irrigated. The root zone is limited in depth, and the fluctuating water table is detrimental to some crops. The slight to moderate salinity generally present in the soil decreases yields somewhat, but over any large area the crops commonly irrigated show no general adverse effects from salt. Local areas and small spots within a field may be moderately to strongly saline. When used as rangeland, this soil produces abundant forage from suitable native grasses. *Capability unit IVw-1 (dryland)*; *capability unit IIIw-1 (irrigated)*; *Saline lowland range site*.

Las Animas sandy loam (ld).—This somewhat poorly drained soil has formed in calcareous, sandy alluvium of the nearly level bottom land of the Arkansas River. Its profile is weakly developed. The soil is freely permeable to plant roots, air, and water. It has a limited capacity to store moisture that is available for plant use.

This soil has a coarser textured subsoil than the Las soils, but it has a finer textured, more coherent subsoil than the Lincoln soil. The Las Animas soil has poorer

natural drainage than the Bridgeport soil but better drainage than the Sweetwater soil.

Typical profile (0.25 mile north and 300 feet east of the SW corner of sec. 35, T. 23 S., R. 42 W.; in a nearly level pasture of native grass on the flood plain of the Arkansas River):

- A₁ 0 to 16 inches, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2, moist); weak, fine, granular structure to almost structureless; very friable, soft when dry; moderately calcareous; thin seams of fine, white crystalline substance occur in lower 6 inches; a few clusters of worm-cast granules; gradual boundary.
- AC 16 to 34 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 4/3, moist); common, medium, strong-brown and gray mottles of faint to distinct contrast below a depth of 24 inches; nearly structureless; very friable, soft when dry; calcareous; a few very small nests of fine, white crystalline substance; gradual boundary.
- C 34 to 50 inches +, pale-brown (10YR 6/3) coarse sand and gravel that is weakly stratified; prominently mottled in upper part of horizon with coarse yellowish-brown and strong-brown streaks and splotches.

Variations in the soil profile are common. Thin layers of soil material ranging in texture from sand to clay may occur in any horizon. Depth to coarse sand and gravel ranges from 20 to 40 inches and averages about 28 to 30 inches. The texture of the darkened surface layer ranges from coarse loam to sandy loam. In many places the nearly level flood plain occupied by Las Animas sandy loam is somewhat irregular in relief. Within short distances and with differences in elevation of 12 inches or less, texture of the soil may range from sandy loam to loam. Depth to brown and gray mottling in the subsoil ranges between 16 and 40 inches. The water table is usually between 3 and 6 feet below the surface, but it may be higher or lower during seasons of extreme variations in the amount of precipitation and streamflow. In most places the soil is slightly saline, but in small local areas it may be moderately to strongly saline.

Areas of Las Animas sandy loam include some small areas of Las Animas loamy sand, Las clay loams, and Sweetwater clay loam. These inclusions are too small or irregular in shape to have any practical significance if mapped separately.

This soil is not well suited to use as cropland under dryland farming and is only moderately well suited to irrigation. Some areas with more favorable topography have been broken from native grass sod and brought under irrigation. Wheat and sorghum are the principal irrigated crops. Some alfalfa is grown, but the stand is difficult to maintain because the water table fluctuates near the surface. Abundant forage is produced on this soil when it is used as irrigated pasture or for native grass range or meadow. The soil is susceptible to soil blowing when not adequately protected by growing vegetation or its residue. *Capability unit IVw-1 (dryland)*; *capability unit IIIw-2 (irrigated)*; *Saline lowland range site*.

Las Animas loamy sand (lc).—This soil is closely associated with Las Animas sandy loam. It has formed in the calcareous sandy alluvium of the nearly level bottom land of the Arkansas River. Its profile is weakly developed. The soil is freely permeable to plant roots, air, and water but has low capacity to store moisture that is available for plant use.

Las Animas loamy sand is more sandy throughout than Las Animas sandy loam. It is not so sandy as Lincoln sand.

Typical profile (1,300 feet north and 400 feet west of the quarter-section corner on the south side of sec. 18, T. 24 S., R. 40 W.; in a cultivated field on the flood plain of the Arkansas River):

- A₁ 0 to 8 inches, grayish-brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2, moist); loose and structureless; calcareous; gradual boundary.
- C₁ 8 to 30 inches, pale-brown (10YR 6/3) loamy sand stratified with sandy loam, brown (10YR 4/3, moist); structureless; very friable, soft when dry; calcareous; a few, fine, distinct, yellowish-brown and strong-brown mottles below a depth of 18 inches.
- C₂ 30 to 50 inches +, very pale brown (10YR 7/3), coarse, stratified sand and gravel; prominently mottled with yellowish brown in upper part of horizon.

Depth to coarse sand and gravel ranges between 15 and 40 inches but in most places is less than 30 inches. The water table fluctuates within the coarse substrata and usually is within 3 to 6 feet of the surface. It may be higher or lower during seasons of extreme variation in the amount of precipitation and streamflow. The subsoil averages loamy sand in texture but occurs as stratified sandy loam and loamy sand; occasional strata of finer textured material commonly occur. In an important variation of this soil, the darkened surface layer, 6 to 8 inches thick, is loam or clay loam in texture. The rest of the profile is like the one just described, but in many places depth to sand is only 15 inches.

Small areas of Las Animas sandy loam, Lincoln sand, and Sweetwater clay loam are included within mapped areas of Las Animas loamy sand. These included soils make up about 15 percent of the total area of the mapping unit.

Most of Las Animas loamy sand remains under native vegetation of tall and mid grasses. Some scattered cottonwood and willow trees and thickets of tamarisk seem to thrive in areas of this soil where the water table is highest. The soil is well suited to the common native grasses, and moderate to large amounts of forage are produced during most years. Because of droughtiness, restricted root zone, fluctuating water table, and susceptibility to wind erosion, Las Animas loamy sand is generally unsuitable for use as cropland. *Capability unit VIIw-2 (dryland)*; *Saline lowland range site*.

Lincoln sand (Lf).—This soil consists of slightly altered, very sandy and gravelly alluvium of the nearly level to undulating flood plain of the Arkansas River. It is subject to recurrent flooding and deposition of fresh soil material. The water table underlying this soil is at about the level of water in the river.

Lincoln sand has sandier subsoil and sandier, lighter colored surface soil than the associated Sweetwater clay loam. It lacks the mottled colors in the subsoil that are characteristic of the associated Las Animas soils.

Typical profile (located in the NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 24 S., R. 41 W.):

- A₁ 0 to 4 inches, grayish-brown (10YR 5/2.5) sand, dark grayish brown (10YR 4/2, moist); loose and structureless; calcareous.
- C₁ 4 to 8 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3, moist); loose and structureless; calcareous; abrupt boundary.
- C₂ 8 to 12 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2, moist); moderate, thin,

platy structure; friable, hard when dry; calcareous; abrupt boundary.

- C₃ 12 to 40 inches +, stratified coarse sand and gravel.

Depth to coarse sand ranges from 10 to 20 inches, but generally is less than 15 inches. Thin strata of loam or clay loam may be mottled with brown and gray.

Inclusions of Sweetwater clay loam, Las Animas loamy sand, and Las Animas sandy loam are present in most areas as mapped and constitute about 15 percent of the soil mapping unit.

Lincoln sand is unsuitable for use as cropland and is used mainly as native grass pasture. It supports a sparse growth of tall and mid grasses, groves of cottonwood trees, scattered willow trees, and, where the water table is highest, a dense growth of tamarisk. *Capability unit VIIw-1 (dryland)*.

Lofton clay loam (Lo).—This deep, dark, moderately fine textured soil occupies the generally small upland depressions locally called potholes or buffalo wallows. These enclosed depressions have no surface drainage. Water may stay in them for a period of several days to a week or more, before it drains into the soil or evaporates.

Lofton clay loam is not extensive in Hamilton County. The areas of this soil are associated mainly with broad, nearly level areas of Richfield silt loams that have poorly defined drainage patterns. Lofton clay loam has a darker, more clayey surface soil and subsoil than the Richfield silt loams.

Typical profile (1,200 feet north and 200 feet east of the quarter-section corner on the south side of sec. 31, T. 25 S., R. 40 W.; in a depression in a native grass pasture):

- A₁ 0 to 8 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2, moist); thin, platy structure; friable, slightly hard when dry; noncalcareous; abrupt boundary.
- B₂₁ 8 to 22 inches, very dark grayish-brown (10YR 3/2), light silty clay, very dark brown (10YR 2/2, moist); moderate, fine, blocky structure; firm, very hard when dry; noncalcareous; clay films distinct and continuous; gradual boundary.
- B₂₂ 22 to 36 inches, brown (10YR 4/3), heavy silty clay loam, dark brown (10YR 3/3, moist); strong, medium, subangular blocky structure; firm, very hard when dry; noncalcareous; clay films thick and continuous; gradual boundary.
- B₃ 36 to 50 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2, moist); moderate, medium, subangular blocky structure; friable, hard when dry; clay films thin and continuous; soil mass is noncalcareous but small, soft lime concretions occur throughout the horizon.

The profile varies somewhat in characteristics from one depression to another, depending on the size of the depression and extent of its drainage area. These variations seem to be insignificant, however, to the use of this soil in the county, because of the small size of the depressions. The main profile variations are in the texture of surface soil and subsoil and the depth to calcareous material.

Most of the areas of Lofton clay loam are cultivated along with the associated surrounding soil. At times water is ponded long enough to delay planting or harvesting. Crops are frequently drowned out and are either replanted or lost. Wind erosion is a hazard unless sufficient crop residues are kept on the surface to protect

the soil. *Capability unit IVw-2 (dryland)*; *Loamy upland range site*.

Manter fine sandy loam, 0 to 1 percent slopes (Ma).— This is a deep, moderately dark, well-drained soil on nearly level upland. It has a fine sandy loam surface layer and a loam to light sandy clay loam subsoil. The parent, or underlying, material in which the soil has formed is about loam in texture. This soil is porous and permeable and has good capacity to hold moisture and release it for use by plants.

The soil is intermediate in characteristics between the associated Vona loamy fine sand and the Ulysses loams; it is darker and not so sandy as Vona loamy fine sand but is more sandy throughout than the Ulysses loams.

Typical profile (600 feet west and 300 feet north of the SE corner of sec. 33, T. 24 S., R. 41 W.; in a native grass pasture on a nearly level area) :

- A₁ 0 to 8 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2, moist); weak, granular structure; friable, slightly hard when dry; noncalcareous; clear boundary.
- B₂ 8 to 18 inches, dark grayish-brown (10YR 4/2), heavy fine sandy loam, very dark grayish brown (10YR 3/2, moist); weak, coarse, prismatic structure that breaks to moderate, fine, granular; friable, slightly hard when dry; noncalcareous; numerous clusters of worm-cast granules; sand content decreases with increasing depth; gradual boundary.
- B_{3ca} 18 to 24 inches, grayish-brown (10YR 5/2) loam containing somewhat more silt than horizon above, dark grayish brown (10YR 4/2, moist); moderate, medium, granular structure; friable, slightly hard when dry; abundant worm casts in upper part of horizon; calcareous with a few small, white, soft lime concretions; gradual boundary.
- C_{ca} 24 to 36 inches, light brownish-gray (10YR 6/2) loam, grayish brown (10YR 5/2, moist); massive and porous; very friable, slightly hard when dry; calcareous with a few soft, white lime concretions; gradual boundary.
- C 36 to 50 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3, moist); massive and porous; very friable, soft when dry; calcareous with only a few small, soft lime concretions.

Significant variations in the soil profile are not common. The texture of the B₂ horizon may be sandy loam, loam, or light sandy clay loam. Depth to calcareous material is variable but generally is between 10 and 24 inches from the surface. In areas under cultivation, winnowing by the wind has occurred to the extent that up to 4 inches of loamy fine sand or light fine sandy loam may now cover the surface.

Included with this soil as mapped are areas of Ulysses loam, 0 to 1 percent slopes, that were too small to map separately.

Most of Manter fine sandy loam, 0 to 1 percent slopes, is under cultivation. Sorghum is the main crop, but some wheat is also produced. Soil blowing is a serious hazard, particularly when the soil is summer fallowed without enough protective cover. Crop residues carefully maintained on the surface of the soil will control or minimize soil blowing. *Capability unit IIIe-2 (dryland)*; *capability unit IIs-1 (irrigated)*; *Sandy range site*.

Manter fine sandy loam, 1 to 3 percent slopes (Mb).— This soil has a profile similar to that described for Manter fine sandy loam, 0 to 1 percent slopes. The surface soil, however, is not quite so thick; it ranges from 4 to 8 inches in thickness and averages about 6 inches.

Depth to calcareous material is also somewhat less in this soil; it averages about 12 inches but ranges from 10 to 20 inches.

Some small, insignificant areas of Ulysses loam, 1 to 3 percent slopes, that were impractical to map separately have been included with areas of this mapping unit.

Most of Manter fine sandy loam, 1 to 3 percent slopes, is under cultivation. Sorghum is the main crop, but some wheat is also grown. Soil blowing is a serious hazard and occurs whenever the land is not protected by an adequate vegetative cover. Water erosion is another problem on this soil. Maintaining crop residues on the surface of the soil will conserve moisture and help control wind and water erosion. *Capability unit IIIe-3 (dryland)*; *capability unit IIIe-2 (irrigated)*; *Sandy range site*.

Otero fine sandy loam, 1 to 3 percent slopes (Ot).— This deep, light-colored, calcareous soil has a fine sandy loam surface soil and a sandy loam to sandy clay loam subsoil. It has developed on gently sloping to gently undulating upland.

This soil is inextensive and is confined mostly to the area south of Little Bear Creek in the southwestern part of the county. It occurs in association with Vona loamy fine sand and Ulysses-Colby complex, 1 to 3 percent slopes, eroded. It is more sandy than the Ulysses-Colby soils and is more calcareous at or near the surface than the Vona soil.

The soil is readily penetrated by plant roots, air, and water. It is susceptible to wind erosion and will blow whenever the surface soil is not adequately protected.

Typical profile (600 feet east and 50 feet north of the SW corner of sec. 28, T. 26 S., R. 43 W.; in a cultivated field of about 3 percent slope) :

- A_p 0 to 4 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 3.5/2, moist); weak, fine, granular structure; friable, slightly hard when dry; calcareous; abrupt boundary.
- AC 4 to 12 inches, an intermediately colored, about grayish-brown (10YR 5.5/2.5), fine sandy loam, brown (10YR 4/3, moist); otherwise similar to overlying layer; gradual boundary.
- C 12 to 50 inches, very pale brown (10YR 7/4) sandy loam, yellowish brown (10YR 5/4, moist); structureless; very friable, soft when dry; strongly calcareous with a few small, soft lime concretions.

Variations from the typical profile are common. The texture of the different layers varies considerably from place to place. A 2- to 4-inch surface layer of loamy fine sand is present in many cultivated areas. As a result of winnowing by the wind, the finer particles have been sorted out and carried away, leaving a surface layer that is more sandy than the original. The texture of the soil material at a depth of 2 feet or more ranges from clay loam to loamy sand. In areas under native grass, the surface soil may be brown and free of lime to a depth of about 6 inches.

Included within areas of Otero fine sandy loam, 1 to 3 percent slopes, are small areas of Vona loamy fine sand and of the Ulysses-Colby soils. These inclusions comprise less than 10 percent of the mapping unit. Small blowouts, generally less than 1 acre in size, are also present.

This soil is limited in its suitability for crop production. Much of it is presently cultivated because it occurs

in small spots within larger areas of more desirable soils. Danger of wind erosion is great. Active wind erosion on this soil also is a menace to adjacent soils. *Capability unit IVe-2 (dryland); Sandy range site.*

Otero-Vona complex, 5 to 15 percent slopes (Ox).—This complex consists primarily of a mixture of Otero fine sandy loam and Vona loamy fine sand on strongly sloping to hummocky topography. Slopes are generally greater than 5 percent and are irregular. The soils of this complex occur adjacent to, and on, the more strongly sloping sides of upland drainageways. This complex is inextensive, and the soils are closely associated with the Vona, Otero, Ulysses, and Colby soils south of Little Bear Creek and along the southern margin of the sandhills.

The composition of the complex averages about 60 percent Otero fine sandy loam, 20 percent Vona loamy fine sand, 10 percent Manter fine sandy loam, 5 percent Ulysses loam, and 5 percent Colby silt loam. Each of these soil types is described elsewhere in this section. Variations from the typical profiles of these soils are common. In many places the soil profile is intermediate in characteristics between the Vona and Otero soils and between the Colby and Otero soils.

This soil complex is unsuitable for use as cropland, and most areas remain in native grass. When the soil is cultivated, erosion occurs regardless of precautions taken. Areas now in crops will be better used if they are reseeded to suitable native grasses. *Capability unit VIe-3 (dryland); Sandy range site.*

Potter soils (Po).—These are grayish-brown, calcareous, shallow soils underlain by partly indurated caliche at a depth of 15 inches or less. They occupy the steep slopes and more broken topography well below the summit of the High Plains. Geologic erosion has stripped away the mantle of loamy sediments and exposed the basal caliche and limestone.

Potter soils occupy more broken slopes than do the geographically associated soils of the Colby series.

Typical profile of Potter fine sandy loam (280 feet south and 80 feet east of the center of NW $\frac{1}{4}$ sec. 27, T. 23 S., R. 42 W.; in a native grass pasture):

- A₁ 0 to 10 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2, moist); weak, granular structure; friable, soft when dry; calcareous; a few fine caliche pebbles on the surface and mixed with the soil, and these become more numerous with increasing depth; abrupt boundary.
- C₁ 10 to 20 inches, nearly white, partially weathered caliche that is cracked and broken in upper 6 to 8 inches and moderately dense in lower part of horizon.
- C₂ 20 inches +, white, hard caliche.

Potter soils are as much as 15 inches thick over caliche, but they average about 5 or 6 inches in thickness. Their texture ranges from loam to fine sandy loam and may change from one to the other within a short distance. The amount of gravel in the soil varies greatly, depending on the composition of the underlying caliche. This rock is almost like limestone in places and is moderately indurated, calcareous conglomerate in other places. Slopes range from about 5 to 25 percent.

Included within this mapping unit are small, barren areas that are outcrops of caliche and the associated underlying limestone and shale.

Potter soils are inextensive, nonarable, and valuable only for grazing. They support sparse stands of native grasses, chiefly side-oats grama, blue grama, and little bluestem. Careful grazing management is necessary to keep these soils productive. *Capability unit VIIs-1 (dryland); Breaks range site.*

Richfield silt loam, 0 to 1 percent slopes (Rm).—This is a deep, dark, well-drained soil of the upland. It has developed in deep loess on the high, nearly level tableland north and south of the valley of the Arkansas River. This is the most extensive and agriculturally important soil in the county.

Richfield silt loam, 0 to 1 percent slopes, has a darker surface layer and a darker, more clayey subsoil than the associated Colby soils. Although it resembles the soils of the Ulysses series, it has a more clayey, more strongly developed subsoil and is noncalcareous to a greater depth.

Typical profile (280 feet east and 90 feet north of the SW corner of sec. 14, T. 22 S., R. 40 W.; in a cultivated field of less than 1 percent slope):

- A_{1p} 0 to 4 inches, dark grayish-brown (10YR 4.5/2) silt loam, very dark grayish brown (10YR 3/2, moist); weak, fine, granular structure; friable, slightly hard when dry; noncalcareous; clear, smooth boundary.
- B₂₁ 4 to 8 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2, moist); moderate, medium, subangular blocky structure; firm, hard when dry; weak, continuous clay films on structural aggregates; noncalcareous; gradual boundary.
- B₂₂ 8 to 13 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2.5, moist); compound structure—weak, medium, prismatic and moderate, medium, subangular blocky; firm, hard when dry; distinct, continuous clay films cover structural aggregates; noncalcareous; gradual boundary.
- B_{3ca} 13 to 25 inches, light brownish-gray (10YR 6.5/2) silty clay loam, grayish brown (10YR 5/2.5, moist); compound structure—weak, medium, prismatic and moderate, coarse, subangular blocky; firm, hard when dry; weak, patchy clay films on structural aggregates; calcareous, with about 5 percent of soil mass composed of small, soft lime concretions; gradual boundary.
- C_{oa} 25 to 37 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2.5, moist); compound structure—weak, coarse, prismatic and weak, coarse, subangular blocky; friable, slightly hard when dry; calcareous, with less than 1 percent of soil mass composed of small, soft lime concretions; gradual boundary.
- C 37 to 62 inches, very pale brown (10YR 7/2.5) silt loam, brown (10YR 5/3, moist); massive (structureless); very friable, soft when dry; calcareous.

Variations in the profile are uncommon, but they do occur in some places. The principal variation is the depth at which light-colored, calcareous material occurs; depth to this layer ranges from about 10 to 18 inches. In some places darkened layers, representing remnants of buried soils, occur 24 to 48 inches or more below the surface. The presence of a buried soil is not unusual, but neither is it typical of this mapping unit. The layers of buried soil are not related to the present soil or to any features of the landscape.

Included within large areas of this soil are small areas of Colby and Ulysses soils; it was neither practical nor desirable to map these areas separately. The included

areas usually do not exceed 8 acres in size and comprise less than 5 percent of the mapping unit.

Richfield silt loam, 0 to 1 percent slopes, is well suited to crop production, and most of it is being cultivated. Dryland wheat and sorghum make satisfactory yields in most years if grown on fields that are fallowed in summer. Conservation and storage of moisture in the soil are essential for profitable crop yields. Wind erosion is a hazard on this soil and occurs whenever the soil is dry and not adequately protected by growing vegetation, crop residues, or sufficient cloddiness. *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 similar in most respects to Richfield silt loam, 0 to 1 percent slopes. Depth to calcareous material is somewhat less than in the nearly level Richfield soil and averages about 10 inches. Also, the clay content of the subsoil is slightly lower. This soil is gently sloping and occurs just below and adjacent to Richfield silt loam, 0 to 1 percent slopes. It is much less extensive, however, and has been mapped only in the northeastern quarter of the county. Most areas have slopes of no more than 2 percent.

The problems of controlling wind erosion and conserving moisture on this soil are the same as on Richfield silt loam, 0 to 1 percent slopes. Control of water erosion is an additional problem on this gently sloping soil. *Capability unit IIIe-1 (dryland)*; *capability unit IIIe-1 (irrigated)*; *Loamy upland range site*.

Sweetwater clay loam (Sw).—This nearly level, dark-colored, poorly drained soil has developed in calcareous, sandy alluvium on the flood plain of the Arkansas River. The soil occurs on the lower parts of the flood plain where ground water is within 36 inches of the surface. It is characterized by a strong granular, friable, dark-colored layer, high in organic matter, that is at or near the surface.

The Sweetwater soil is associated with Lincoln sand and with soils of the Las series. It is much darker and wetter and has more coherent subsoil than Lincoln sand. It is darker, somewhat more poorly drained, and less deep over sand than the Las soils.

Typical profile (900 feet north and 550 feet east of the quarter-section corner on the south side of sec. 26, T. 24 S., R. 39 W.; in a nearly level, native grass meadow) :

- A₁₁ 0 to 6 inches, grayish-brown (10YR 5/2), light clay loam, very dark grayish brown (10YR 3/2, moist); moderate, thin, platy structure; friable, slightly hard when dry; weakly calcareous; abrupt boundary.
- A₁₂ 6 to 15 inches, very dark gray (10YR 3.5/1) clay loam, black (10YR 2.5/1, moist); strong, medium, granular structure; very friable, hard when dry; calcareous; numerous small nests and seams of fine, white crystalline substance are profusely scattered throughout the layer; very porous; abrupt boundary.
- C₁ 15 to 25 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3, moist); many, fine, faint, yellowish-brown and dark reddish-brown mottles; massive (structureless) but porous; friable, soft when dry; calcareous; abrupt boundary.
- C₂ 25 to 30 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 4.5/3, moist); many, medium, distinct, dark reddish-brown and gray mottles; massive; compact; calcareous; abrupt boundary.
- C₃ 30 to 40 inches, light yellowish-brown (10YR 5/5, moist) loamy sand; many, medium, prominent, dark reddish-brown mottles; loose and structureless; non-

calcareous; contains a few thin strata or lenses of light-gray clay loam; abrupt boundary.

- C₄ 40 to 50 inches, pale-brown, stratified sand and gravel.

Variations in the profile are common. The texture of the layers to a depth of about 16 inches ranges from loam to clay loam. The alluvium is variable in texture below a depth of about 16 inches and, in most places, consists of stratified sand, loam, and clay. Depth to ground water ranges from about 16 to 36 inches. Included within areas of Sweetwater clay loam as mapped are a few small areas of Lincoln sand, Las Animas loamy sand, Las Animas sandy loam, and Las clay loams.

Most areas of Sweetwater clay loam remain in native grass meadow and pasture. With good grazing management, the native tall and mid grasses produce abundant forage. Slight to moderate salinity, wetness, and a restricted root zone limit the suitability of this soil for crop production. *Capability unit VIw-2 (dryland)*; *Saline lowland range site*.

Tivoli fine sand (Tf).—This soil is light colored and non-calcareous, and it has formed in deep, eolian (wind-deposited) sand. Its profile is weakly developed. It occurs on undulating to steep, sand-dune topography and has slopes of 5 to 20 percent; the sand has been stabilized by the growth of perennial vegetation.

Tivoli fine sand has a thin, grayish-brown surface layer that is only slightly darker than the fine sand beneath. It absorbs water rapidly and has little or no runoff. Because it is low in moisture-holding capacity and excessively permeable, the soil loses some water through internal drainage.

The sandhill area lying south of and adjacent to the valley of the Arkansas River is occupied almost exclusively by Tivoli soils. They give way on the southern edge of the sandhills to the associated less sandy and more gently sloping soils of the Vona series. Some in-extensive, rather isolated areas of Active dunes are associated with Tivoli fine sand within the main body of the sandhills.

Typical profile (0.1 mile south and 100 feet east of the quarter-section corner on the west side of sec. 30, T. 24 S., R. 40 W.; in a native grass pasture on the side of a ridge having about a 15 percent slope) :

- A₁ 0 to 6 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2, moist); weak, granular structure; very friable, soft when dry; noncalcareous; upper 2 inches of layer slightly darker and finer in texture (loamy fine sand) as the result of recent deposition and mixing of material; gradual boundary.
- C 6 to 30 inches +, light yellowish-brown (10YR 6/4) fine sand, brown (10YR 5/3, moist); structureless and loose; noncalcareous.

Significant variations in the profile are not common. Depth of the darkened surface layer ranges from about 2 to 8 inches. In some places finer textured sediments have recently been deposited; here, the uppermost 2 or 3 inches is sandy loam in texture. Blowouts are common on the landscape but make up less than 20 percent of the acreage of this soil.

Nearly all the area occupied by Tivoli fine sand remains under native grasses and sand sagebrush. The soil is not suitable for crops. Important range management practices, such as proper grazing, stabilizing blowouts,

and, in some places, reseeding of native grasses, will protect and improve the grass cover. Soil blowing is always a hazard and occurs whenever the vegetative cover does not provide adequate protection. *Capability unit VIIe-1 (dryland)*; *Choppy sands range site*.

Tivoli loamy fine sand (Ts).—This soil is like the associated Tivoli fine sand in all characteristics except topography and surface soil texture. It occupies smoother, less choppy topography. The texture of the darkened surface layer is loamy fine sand. The slope in most places is between 5 and 15 percent, but on some of the less hummocky topography, it is about 3 percent.

Typical profile (500 feet east and 600 feet north of the SW corner of sec. 36, T. 24 S., R. 41 W.; in a native grass pasture):

- A₁ 0 to 6 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2, moist); weak, granular structure; very friable, soft when dry; noncalcareous; gradual boundary.
- AC 6 to 12 inches, brown (10YR 5.5/3) loamy fine sand, brown (10YR 4.5/3, moist); weak, granular to structureless; soft and fragile when dry; noncalcareous; gradual boundary.
- C 12 to 36 inches +, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3, moist); loose and structureless; noncalcareous.

Included with this soil mapping unit are areas of Vona loamy fine sand and Tivoli fine sand that were too small and insignificant to be mapped separately.

Tivoli loamy fine sand is not suitable for use as cropland. Most of it remains in native range (fig. 5), but a few areas are being cultivated. Since soil blowing cannot be controlled when this soil is cropped, the cultivated areas should be reseeded to suitable native grasses. The few isolated blowouts should also be stabilized by fencing out livestock and reseeding to native grasses. Moderate to large amounts of forage are produced on this soil when good grazing management is practiced. *Capability unit VIIe-2 (dryland)*; *Sands range site*.

Tivoli-Dune land complex (Tx).—This soil complex consists of Active dunes and Tivoli fine sand, each of which is described elsewhere in this section. More than 20 percent of the area consists of blowouts, loose sand, and Active dunes that are almost barren of vegetation. The soils of this complex occupy more extreme dune-type topography than does Tivoli fine sand, as mapped separately. Slope gradient ranges from about 10 to 40 percent.



Figure 5.—Tivoli loamy fine sand covered with sand sagebrush.

The areas are particularly susceptible to damage from soil blowing. They are suitable only for use as rangeland and need careful grazing management to control and reduce soil blowing. The actively blowing areas are a menace to adjacent land and should be stabilized by fencing out livestock and reseeding to suitable native grasses. *Capability unit VIIe-1 (dryland)*; *Choppy sands range site*.

Ulysses loam, 1 to 3 percent slopes (Ub).—This is a deep, moderately dark, gently sloping, well-drained soil of the upland. It has about the same degree of profile development as the Ulysses silt loams, but has formed in coarser loess. This loess is approximately loam in texture and contains less clay and silt than does that in which the Ulysses silt loams have developed.

This Ulysses soil is closely associated with the Manter fine sandy loams, Colby silt loams, and Richfield silt loams and has intermediate characteristics. It contains less sand throughout than the Manter fine sandy loams but has darker, thicker, and more loamy surface layers than the Colby silt loams. Richfield silt loams have a more clayey, less friable subsoil than the Ulysses soil.

Typical profile (1,000 feet east and 200 feet north of the quarter-section corner on the south side of sec. 20, T. 25 S., R. 39 W.; in a cultivated field of about 2 percent slope):

- A_{1p} 0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2, moist); weak, granular structure; friable, slightly hard when dry; noncalcareous; gradual boundary.
- A₁ 6 to 9 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2, moist); moderate, medium, granular structure; friable, hard when dry; noncalcareous; gradual boundary.
- AC 9 to 14 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2, moist); moderate, medium, granular structure; friable, hard when dry; calcareous; gradual boundary.
- C_{1ca} 14 to 23 inches, grayish-brown (10YR 5.5/2) loam, brown (10YR 4.5/2.5, moist); compound structure—weak, prismatic and weak, subangular blocky; friable, hard when dry; calcareous, with a few small, soft lime concretions; gradual boundary.
- C_{2ca} 23 to 32 inches, grayish-brown (10YR 6/3) loam, brown (10YR 4.5/3, moist); structureless (massive); friable, slightly hard when dry; calcareous, with many small, soft lime concretions; gradual boundary.
- C₃ 32 to 60 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3, moist); structureless (massive); very friable, soft when dry; calcareous.

Few significant variations occur in the profile. Depth of the dark-colored surface layers ranges from 6 to about 12 inches. Dark-colored layers representing remnants of buried soils are common, but not always present, below a depth of about 20 inches. A layer of sandy loam, 2 to 4 inches thick, commonly occurs on the surface of the soil in cultivated areas. This is the result of winnowing by the wind; the finer particles were sorted out and carried away, leaving the coarser, sandier particles on the field.

Small, insignificant areas of the associated Manter fine sandy loams and Colby silt loams are included within areas of this mapping unit.

Most of this soil is being cultivated to dryland wheat and sorghum. Erosion by wind and water is a problem. Summer fallowing will build up moisture reserves in the soil, but adequate quantities of crop residues must be maintained on the surface to minimize wind and water

erosion. *Capability unit IIIe-1 (dryland)*; *capability unit IIIe-1 (irrigated)*; *Loamy upland range site*.

Ulysses loam, 0 to 1 percent slopes (Uc).—This nearly level soil has a profile like the one described for Ulysses loam, 1 to 3 percent slopes, but the darkened surface layers are generally 3 to 5 inches thicker over the light-colored calcareous material.

Included within areas of this soil as mapped are minor areas of the associated Manter fine sandy loams.

Nearly all of this soil is under cultivation, chiefly to wheat and sorghum. Wind erosion is a problem. Summer fallowing is successful if adequate quantities of crop residues are carefully maintained on the surface of the soil. This helps control soil blowing and also aids in getting more water into the soil. *Capability unit IIIc-1 (dryland)*; *capability unit I-1 (irrigated)*; *Loamy upland range site*.

Ulysses silt loam, 0 to 1 percent slopes (Uc).—This is a deep, moderately dark, well-drained soil on nearly level upland. It has formed in loess of silt loam texture and has a weakly developed profile. The Ulysses soil is intermediate in characteristics between the associated Richfield silt loams and Colby silt loams. It has a less clayey, more friable subsoil than the Richfield silt loams. It has a thicker, darker surface soil than the Colby silt loams.

Typical profile (1,000 feet east and 50 feet south of the quarter-section corner on the north side of sec. 7, T. 23 S., R. 40 W.; in a cultivated field) :

- A_{1p} 0 to 4 inches, dark grayish-brown (10YR 4.5/2) silt loam, very dark grayish brown (10YR 3/2, moist); weak, granular structure; friable, slightly hard when dry; noncalcareous; abrupt boundary.
- A₁ 4 to 7 inches, dark grayish-brown (10YR 4/2), heavy silt loam, very dark grayish brown (10YR 3/2, moist); moderate, medium, granular structure; friable, hard when dry; noncalcareous; a few clusters of worm-cast granules; clear boundary.
- AC 7 to 16 inches, grayish-brown (10YR 5/2), heavy silt loam, dark grayish brown (10YR 4/2, moist); moderate, medium, granular structure; friable, slightly hard when dry; calcareous; numerous worm casts throughout layer; gradual boundary.
- C_{oa} 16 to 26 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3, moist); massive (structureless) to weak, subangular blocky structure; friable, slightly hard when dry; calcareous, with a few small, soft, white lime concretions; small root holes and pores are open and abundant; indistinct boundary.
- C 26 to 40 inches +, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3, moist); massive and porous; very friable, soft when dry; calcareous.

Significant variations within the soil profile are uncommon. Thickness of the dark-colored surface layers ranges from 6 to about 12 inches. Depth to calcareous material is variable but averages about 7 inches. Some cultivated areas have a calcareous surface soil, while virgin native grasslands may be noncalcareous to a depth of 12 inches. Remnants of dark-colored, buried soils may occur below a depth of about 20 inches.

Small areas of the associated Colby silt loams and, to a lesser extent, Richfield silt loam, 0 to 1 percent slopes, have been included within areas of Ulysses silt loam, 0 to 1 percent slopes.

Nearly all of this soil is under cultivation. Wheat and sorghum, seeded on summer-fallowed land, yield satisfactorily in most years. Moisture conservation and wind-erosion control are problems. *Capability unit IIIc-1*

(dryland); *capability unit I-1 (irrigated)*; *Loamy upland range site*.

Ulysses silt loam, 1 to 3 percent slopes (Ud).—This soil has a profile similar to the one described for Ulysses silt loam, 0 to 1 percent slopes, but, in general, the dark-colored surface layers are not so thick and the depth to calcareous material is less. The slope gradient is generally less than 2 percent. Small areas of the closely associated Colby silt loams are included in areas of this soil.

Control of wind and water erosion and conservation of moisture are problems when Ulysses silt loam, 1 to 3 percent slopes, is cultivated. Much of this soil is now used for the production of wheat and sorghum. Profitable yields are obtained during most years if crops are seeded in summer-fallowed fields. *Capability unit IIIe-1 (dryland)*; *capability unit IIIe-1 (irrigated)*; *Loamy upland range site*.

Ulysses-Colby complex, 1 to 3 percent slopes, eroded (Ue).—This soil complex, or mixture of soils, consists primarily of Ulysses loam and Colby loam on gently sloping to gently undulating topography. It is relatively inextensive and occurs in association with soils of the Ulysses and Richfield series south of Little Bear Creek in the southwestern part of the county.

The composition of this complex averages about 60 percent Ulysses loam and 25 percent Colby loam; the remaining 15 percent is Richfield silt loam and Otero fine sandy loam. Each of these soils, with the exception of Colby loam, is described elsewhere in this section. Colby loam has a profile like the one described for Colby silt loam, 1 to 3 percent slopes, but has a surface layer of loam instead of silt loam. Some areas of Colby loam were Ulysses loam before most of the darkened surface layer was removed by erosion.

Variations from the typical profiles of soils of this complex are common. In many cultivated fields the texture of the uppermost 2 to 4 inches of the soil is sandy loam. This is a result of winnowing by the wind; the finer soil particles were sorted out and blown away, leaving the coarser, sandier particles on the fields. Another common variation is one in which the soil profile has characteristics intermediate between those of the Colby and Otero soils.

Much of the area occupied by this complex is cultivated to dryland wheat and sorghum. The soil is not well suited to use as cropland, but it can be safely cultivated if carefully managed to control wind and water erosion. *Capability unit IVe-1 (dryland)*; *capability unit IIIe-1 (irrigated)*; *Loamy upland range site*.

Vona loamy fine sand (Vo).—This deep, light-colored, well-drained soil has a loamy fine sand surface layer and a fine sandy loam subsoil. It developed on moderately sandy, gently sloping to gently undulating upland. The slope is generally between 1 and 3 percent but may be as much as 5 percent.

Vona loamy fine sand has profile characteristics similar to those of Otero fine sandy loam, 1 to 3 percent slopes, but is darker colored and is noncalcareous to a greater depth. It is more sandy throughout than the associated Manter fine sandy loams. It is less sandy in the subsoil than the Tivoli soils and generally occurs on smoother, more subdued hummocky topography.

Typical profile (1,400 feet north and 600 feet east of the southwestern corner of sec. 23, T. 25 S., R. 39 W.; in a cultivated field on gently undulating topography):

- A_{1p} 0 to 8 inches, grayish-brown (10YR 5/2.5) loamy fine sand, dark grayish brown (10YR 4/2.5, moist); structureless (single grain); loose; gradual boundary.
- B₂₁ 8 to 14 inches, dark grayish-brown (10YR 4.5/2.5) fine sandy loam, dark brown (10YR 3.5/2.5, moist); weak, coarse, prismatic structure that breaks to weak, fine, granular; friable, hard when dry; noncalcareous; gradual boundary.
- B₂₂ 14 to 26 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/2.5, moist); weak, coarse, prismatic structure that breaks to weak, fine, granular; friable, slightly hard when dry; noncalcareous; a few worm casts; gradual boundary.
- C_{ca} 26 to 36 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3, moist); structureless (massive); friable, slightly hard when dry; highly calcareous with numerous soft, white lime concretions; gradual boundary.
- C 36 to 50 inches, light yellowish-brown (10YR 6/4) loamy fine sand, brown (10YR 5/3.5, moist); structureless (single grain); loose; calcareous.

Variations in the profile are not common. The darkened surface layer ranges in texture from light fine sandy loam to loamy fine sand and is 6 to 14 inches thick. In a few places the upper part of the subsoil is light sandy clay loam. Depth to calcareous material is variable but generally exceeds 15 inches.

Vona loamy fine sand is not well suited to crops, particularly wheat, because of low moisture-holding capacity and high susceptibility to soil blowing. It can be cultivated safely, however, if carefully managed so that soil blowing is controlled. Much of the soil is now being cultivated. The chief crop is sorghum, which is grown continuously. Low moisture-holding capacity and susceptibility to soil blowing limit the effectiveness of summer fallow on this soil. *Capability unit IVe-2 (dryland); Sands range site.*

Climate of Hamilton County ⁴

Hamilton County has a distinctly continental climate with hot summers and moderately cold winters. It is in an area that Thornthwaite ⁵ describes as semiarid with little or no surplus of water in any season of the year. The treeless plains and the vegetation of short grasses indicate that this is a marginal climate. As applied to climate, the term marginal refers to the variations in weather that occasionally result in excellent yields of crops or that may cause a complete failure of crops introduced into the area.

Since favorable weather for agriculture occurs very irregularly in this part of the High Plains, fluctuations in temperature and precipitation are not well indicated by annual averages (means).

The erratic distribution of precipitation is shown in figure 6; in only about one-half of the years of record has the total annual precipitation been either 4 inches

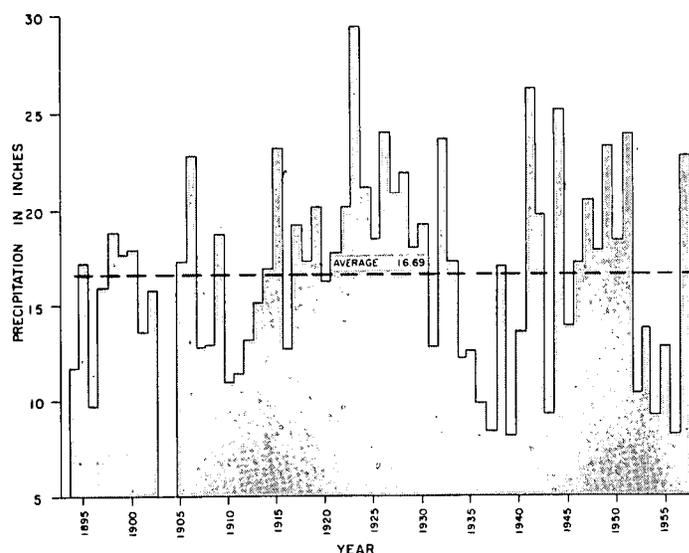


Figure 6.—Variations in annual precipitation, as recorded at the Weather Bureau Station, Syracuse, Kans., from 1894 through 1957. Average precipitation for the period is shown by the horizontal broken line. (No records are available for the years 1903 and 1904.)

more or 4 inches less than 16.69 inches, the average annual amount of precipitation at Syracuse. ⁶ Average annual precipitation has ranged from a low of 8.06 inches in 1956 to a high of 29.50 inches in 1923. About 83 percent of the yearly precipitation falls in the crop-growing season extending from the middle of March to the middle of October.

During three periods the amount of annual precipitation has been below average, as shown in figure 6. These periods were from 1910 through 1913, 1934 through 1937, and 1952 through 1956. The two longest periods in which the amount of annual precipitation was continuously above average were from 1921 through 1930 and from 1946 through 1951. Except in 1920, when the amount of annual precipitation was 0.53 inch below average, the annual precipitation was above average from 1917 through 1930.

During the year, precipitation occurs on an average of about 50 days. More than 0.25 inch of precipitation is received on an average of about 20 days, and more than 1 inch is received on only 5 days; these figures are for a 24-hour period.

Snowfall is erratic in Hamilton County. In 12 seasons the total snowfall was less than 10 inches, while in 5 seasons the total exceeded 40 inches. An average of 24.3 inches of snowfall occurs from September through May.

⁴ Climatic records of three weather stations in Hamilton County are available for the following periods:

Station	Temperature	Precipitation
Coolidge	Jan. 1894—Feb. 1918	Jan. 1894—Feb. 1918
Irene	Mar. 1910—Dec. 1917	Mar. 1910—Apr. 1934
Syracuse	Dec. 1892—Sept. 1893	Dec. 1892—Sept. 1893
	May 1918—Sept. 1920	May 1918—Sept. 1920
	Nov. 1936 to present	Feb. 1921 to present

Unless otherwise stated, statistics in this section are from the Syracuse station.

⁴ This section by A. D. ROBB, climatologist, U.S. Weather Bureau, Topeka, Kans.

⁵ THORNTWHAITE, C. W. AN APPROACH TOWARD A RATIONAL CLASSIFICATION OF CLIMATE. *Geographical Review* 38: 55-94, illus., 1948.

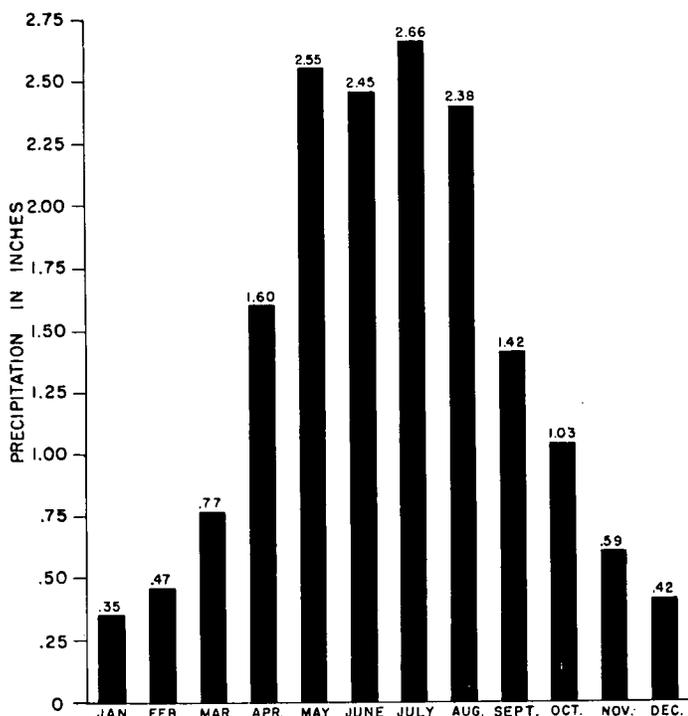


Figure 7.—Average monthly precipitation, as recorded at the Weather Bureau Station, Syracuse, Kans., in the period from 1894 through 1957. (No records are available for the years 1903 and 1904.)

The month of March has the greatest amount of snowfall, an average of about 4.30 inches. Snow is of little benefit to crops, as a rule, because most of it accumulates in drifts. Occasionally, a snow falls without drifting and covers the ground uniformly. During the winter of 1939-40, snow covered the ground for 50 days. A 7-inch snowfall occurred on Dec. 23, 1939; this snow, together with more that fell later in the month and in January and February, remained on the ground until Feb. 10, 1940.

The average monthly precipitation increases from less than 0.50 inch in December, January, and February to more than 2 inches in May, June, and July (fig. 7). Even in 1923, the year of the greatest amount of precipitation, only 0.03 inch of precipitation occurred in January and February combined, whereas more than 5 inches fell in each of the months of May, June, and August. Further evidence of the variability of precipitation is brought out by the fact that in July, the month with the highest average amount of precipitation, less than 0.50 inch of rainfall occurred in 3 Julies but more than 5 inches fell during 7 Julies; these figures are based on a 62-year period.

The greatest and least amount of precipitation that has fallen in each month during the period of record is shown in figure 8. Each month from April through October has had a rainfall of more than 2.40 inches in a 24-hour period. On four occasions a total of 4 inches or more of precipitation has been recorded during 24 hours, but there have been 24 years in which no more than 1.50 inches of rainfall occurred in any 24-hour period.

The sun shines throughout much of the year. Records of the Weather Bureau Station at Dodge City, Kans., show that sunshine occurs 70 percent of the time that the sun is above the horizon.

Pronounced variations in temperature occur in this area of low humidity. Intense solar radiation during the day and back radiation from the earth at night cause a wide daily fluctuation in temperature. This fluctuation averages 32 degrees daily; it is fairly constant throughout the year but is slightly greater during spring and fall. Averages (means) and extremes in temperature are shown on figure 9. The average monthly temperature ranges from 29.7° F. in January to 78.4° F. in July. The average annual temperature is 53.9° F.

Extremes in temperature ranged from 114° F., recorded on July 14, 1913, to -27° F., recorded on Jan. 5, 1942. The range in temperature is somewhat greater in winter than in summer. In February, the extreme range is 107° F., but in July, the maximum range is 72° F. In only 1 year, 1909, has no recording of 100° F. or more been made; in 2 other years a temperature of 100° F. or higher occurred in only 1 month of each year. At the other extreme, in 5 years the temperature has reached 100° F. or higher in each of 5 months.

Every year of record has had a minimum temperature at least as low as -2° F., and this reading was the low mark in 4 years. Minimum temperatures of -20° F. or lower have occurred in 6 years. Although a reading of 0° F. or lower may occur from November 11 through March 27, in 9 years of record the temperature dropped to 0° F. or lower in only 1 month. During 1895 and 1951, 0° F. or below was recorded in each of 4 months.

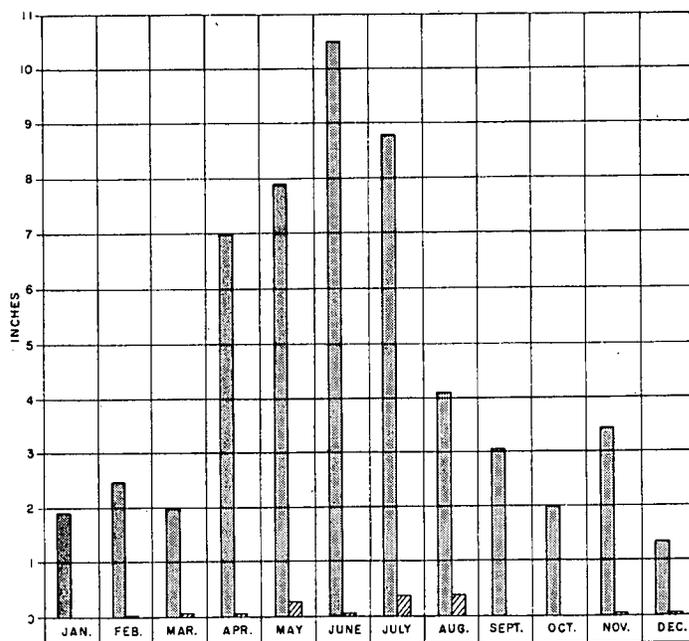


Figure 8.—Greatest and least amount of monthly precipitation, as recorded at the Weather Bureau Station, Syracuse, Kans., in the period from 1894 through 1957. No precipitation occurred during January, September, and October of specific years. (No records are available for the years 1903 and 1904.)

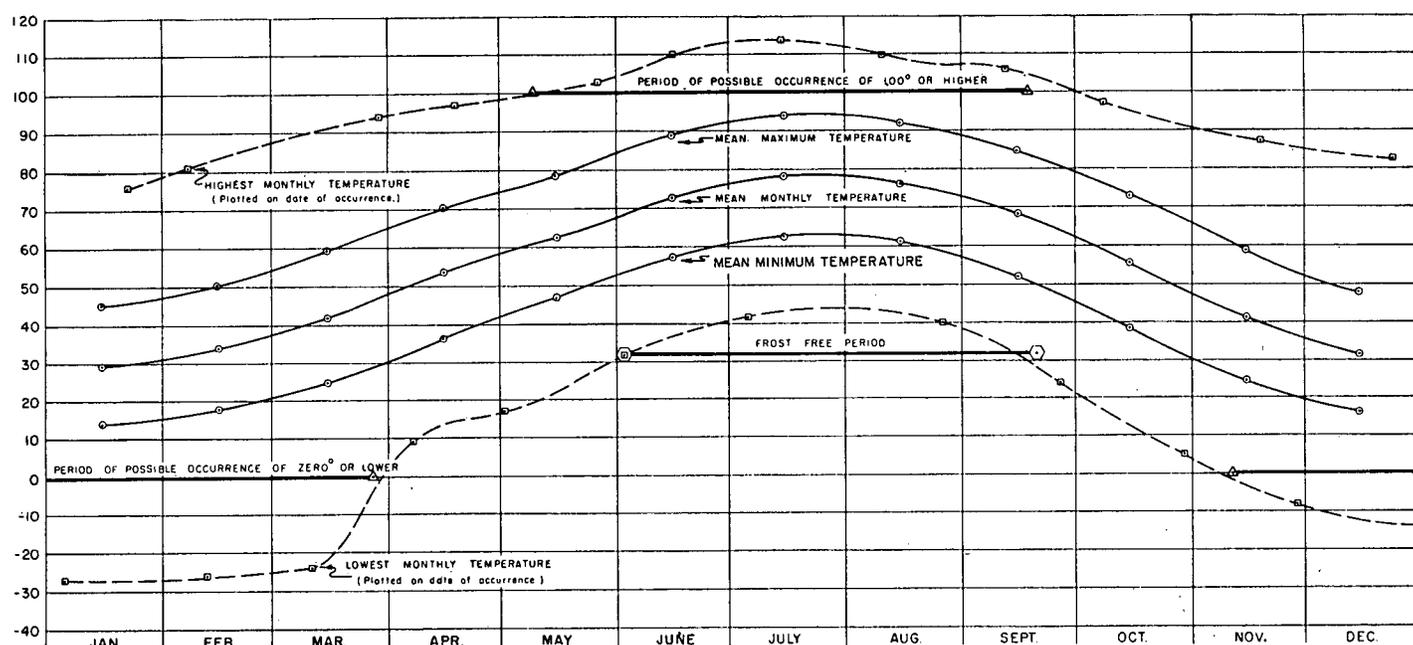


Figure 9.—Averages (means) and extremes in temperature, as recorded at the Weather Bureau Station, Syracuse, Kans., given in degrees Fahrenheit.

Because of the elevation of this region, early fall frosts are a hazard to the sorghum crop. In Hamilton County the average date of the first temperature below 32° F. in fall is October 13, but frost has occurred as early as September 20. (See fig. 9.) On the average, the frost-free period is 169 days.

A newcomer to this area will notice the persistent wind during daylight, especially in spring, and on warm days in other seasons. Because of the constant movement of air and the low humidity, hot, oppressive days are rare in summer. Likewise, calm weather is a rarity. Records of the Dodge City station show that the annual average wind velocity is about 15 miles per hour. Average monthly wind velocity ranges from 17.3 miles per hour in March to 13.6 miles per hour in August. Although the prevailing winds are from the south, most of the high winds come from the northwest and are accompanied by thunderstorms. Winds of 70 to 80 miles per hour have been recorded from February through August.

In addition to the almost perennial hazard of drought, occasional duststorms, hail, lightning, high winds, hot winds, and blizzards occur for short periods or affect a limited area. In some ways they are more hazardous than drought. Duststorms, of course, are more common when the soil is dry, when winds are more persistent, when vegetative cover is lacking, and when the soil is more erodible. Hail, lightning, and high winds are associated with summer thunderstorms, which occasionally are accompanied by tornadoes. In winter, precautions should be taken against severe blizzards, which are likely to sweep suddenly across the plains. Hot, desiccating winds sometimes arrive about heading time for wheat and cause the grain to shrivel. Row crops also may be damaged by these winds.

Effects of Erosion

Erosion is a process in which soil and geologic materials are moved by natural agencies, mainly wind, running water, and gravity. This discussion deals with accelerated soil erosion in Hamilton County. Accelerated erosion should not be confused with the gradual, normal process of soil removal known as geologic erosion. Geologic erosion takes place under natural conditions in an undisturbed environment, whereas accelerated erosion refers to the increased rate of soil erosion that is brought about by changes in the natural cover or soil conditions caused by human activity.

Wind and water are the main active agents that cause soil erosion in Hamilton County. Wind erosion is always a hazard and is serious during recurring periods of drought. High winds and limited vegetative growth that are characteristic of drought on the High Plains are conducive to widespread soil blowing.

Water erosion is a hazard on all the sloping, silty soils that are under cultivation. Runoff occurs during the hard, dashing, thunderstorm-type rains, in which rain falls more rapidly than the water can enter the soil. Practices that slow down or decrease runoff will conserve valuable moisture and help control water erosion.

Some effects of erosion are permanent; the soil is damaged to the extent that it requires a change in its use and management. Other effects of erosion are transitory but may impair the use of the land until restorative measures are taken.

During the course of fieldwork on the soil survey, observations of the effects of erosion were made. Some of the conditions observed as resulting from wind erosion are as follows:

1. Small, low hummocks and drifts of soil form on nearly level and smoothly sloping cultivated fields where active soil blowing is in progress. These hummocks and drifts continue to be a menace and will blow again unless they are smoothed out and unless the soil is tilled to provide a roughened surface that is resistant to erosion. Full use of the area may be restored and no permanent soil damage sustained if the surface is roughened, as needed, through additional tillage.
2. Within the undulating High Plains tableland, the tops of ridges and knolls are more vulnerable to wind action than the adjacent areas of nearly level soils. Soil on these exposed areas tends to blow more often, and, consequently, much of it has been removed and deposited nearby on smoother areas. Some of the finer soil particles are removed from this area and transported long distances by the wind. Much of the silt and sand deposited on the adjacent areas is calcareous. Calcareous silty and sandy soils blow quite readily; wind erosion may occur after this material is deposited in a field that would otherwise be stable.
3. Soil may drift from actively eroding cultivated fields onto adjacent rangeland to the extent that the native vegetation is damaged or destroyed. No permanent damage occurs, but the use of the land is impaired until the grass becomes reestablished either by deferring grazing or by reseeding.
4. During droughts, some of the very sandy, nonarable rangeland may be overused to the extent that the protective vegetation is lost and severe wind erosion occurs. Permanent damage is sustained on these soils and their value for grazing is greatly reduced. Damage to cultivated crops and grass on adjacent areas results from sand drifting. These sandy sediments also increase the wind-erosion hazard to the soils on which they are deposited.

The discussion of the effects of erosion in Hamilton County shows that the seriousness of erosion lies not only in the permanent modification of the soil but also in the short-time damage to crops and forage. Replanting crops, reseeding rangeland, and emergency tillage and smoothing operations may correct most of the temporary effects of erosion and restore full use of the land, but these practices are time-consuming and costly.

In Hamilton County eroded soils are mapped as separate soil units only if erosion has modified some important quality or characteristic of the soil that is significant to its use and management. Many of the soils have been eroded to some degree and are subject to further erosion; the hazard of erosion on all the soils is described in the section, *Use and Management of the Soils*.

An eroded soil is designated as an eroded phase of a soil type if the eroded soil still retains many characteristics of the soil type. Some soils have been altered by erosion to the extent that they now have characteristics similar to those of some associated soil type, and they are mapped as such. For example, if the dark-colored surface layer has been removed from a soil that was once Ulysses silt loam, the soil is now designated as a Colby silt loam. Other soils have been modified extremely through erosion and have

lost their original identity; these soils are now classified as miscellaneous land types. The miscellaneous land type, Active dunes, was presumably Tivoli fine sand before erosion.

Measures needed to control erosion vary according to the kind of soil, the degree of slope, and land use. Some alternatives are generally available from which one can choose a combination of practices that will control erosion on a given soil. These practices are discussed under each capability unit in the section, *Use and Management of the Soils*. For more specific and detailed information on the control of erosion, consult a representative of the Soil Conservation Service.

Use and Management of the Soils

This section deals with the classification and grouping of soils according to their suitability for use as cropland, rangeland, woodland, and wildlife land and the management needs of the soils when they are used for these purposes.

There are six main parts in this section. In the first, the capability classification system used by the Soil Conservation Service is described. The second part consists of a discussion of management of the soils under dryland farming. The principles of dryland management are explained, and then the use and management for soils in the different capability units (dryland) are discussed. Estimated yields of wheat and sorghum are given for the arable soils. In the third main part, management of irrigated land is described. This part contains a description of use and management of soils in capability units (irrigated).

The fourth part of the section discusses principles of range management and groups the soils according to range sites. A description of each range site is given.

In the fifth and sixth parts of the section are brief discussions of the use of the soils as woodland and wildlife land.

Capability Classification

The soils of the county have been grouped to show their suitability for use as cropland and rangeland. This grouping has been done on the basis of their ability to produce, over a long period of time, the common cultivated crops and pasture plants without deterioration of the soil.

There are eight general land capability classes, but all do not necessarily occur in a particular area. Classes I through IV include soils that are suited to cultivation and to other uses.

Soils in class I have the widest range of use and the least risk of damage. They are at least moderately fertile and are not subject to more than slight erosion, droughtiness, or wetness. They can be used as cropland without special practices other than those recognized as needed for good farming. These soils are suited to a wide range of plants and may be used for cropland, rangeland, woodland, or wildlife.

Soils in class II have some limitations that reduce the choice of plants or require moderate conservation prac-

tices. These soils can be used for cropland, rangeland, woodland, or wildlife.

In Hamilton County, low rainfall and recurrent drought, characteristic of semiarid regions, prevent the placing of any soils used as dryland in classes I and II. In irrigated areas soils have been placed in class I or II if the climatic limitation has been removed by relatively permanent systems for supplying water.

Soils in class III have severe limitations that reduce the choice of plants or require special conservation practices, or both. These soils may be used for cropland, rangeland, woodland, or wildlife.

Soils in class IV have very severe limitations that restrict the choice of plants, require very careful management, or both. These soils, with enough care, can be used for cropland, rangeland, woodland, or wildlife.

Classes V through VIII contain soils that are limited in use and are generally not suited to cultivation.

Soils in class V have little or no erosion hazard but have other limitations that are impractical to remove and that limit their use largely to rangeland, woodland, or wildlife. There are no class V soils in Hamilton County.

Soils in class VI have severe limitations that make them generally unsuited to cultivation and limit their use largely to rangeland, woodland, or wildlife habitats. Most of them have some pronounced feature, such as steep slope, severe erosion, wetness, or low moisture-holding capacity, that makes them unsuitable for cultivation. The physical conditions of soils in class VI are generally such that tillage implements can be used to prepare the land for seeding permanent grasses and for renovating and reseeded depleted rangeland.

Soils in class VII have very severe limitations that make them unsuited to cultivation and restrict their use largely to grazing, woodland, or wildlife. Soil restrictions are more severe than those of class VI because of continuing limitations that cannot be corrected, such as steep slopes, serious erosion hazard, shallowness, or other limitations. Soils in class VII in Hamilton County may be used only as rangeland or for wildlife.

Class VIII consists of soils and landforms having such limitations that they produce little useful vegetation. Their use is limited to recreation, to wildlife, or to use as a source of water. There are no soils in class VIII in Hamilton County.

Each of the eight land classes contains soils that have limitations and management problems of about the same degree. The soils within the same class may differ greatly, however, and therefore have different kinds of hazards and limitations. The dominant kind of limitation, except in class I, is indicated by one of four subclasses. The kinds of limitations, and symbols used to denote them, are as follows: (e) Risk of erosion; (w) excess water, either in or on the soil; (s) soil limitations in the root zone; and (c) climatic limitations. All of these subclasses do not usually occur in each capability class in an area the size of a county.

If soils within the same class and subclass require different management or give significantly different response to the same management, they are grouped into capability units. A capability unit, therefore, is a group of soils similar in most of the features that affect management and response to management. Capability units are desig-

nated by numbers within the class and subclass, as IIIe-1 and IIIe-2.

The capability classes, subclasses, and units in Hamilton County are given in the following list. Different groupings are made for dryland farming and for irrigation farming. The names of the soils in each capability unit and a description of each unit are given in the subsection, Management of Dryland, for capability units (dryland), and in the subsection, Management of Irrigated Land, for capability units (irrigated).

CAPABILITY CLASSIFICATION FOR DRYLAND FARMING

Class III.—Soils that can be used as cropland but have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Subclass IIIc: Soils having moderate climatic limitations.

Unit IIIc-1: Nearly level loamy soils.

Unit IIIc-2: Well-drained lowlands.

Subclass IIIe: Soils highly susceptible to erosion when used as cropland.

Unit IIIe-1: Gently sloping loamy soils.

Unit IIIe-2: Nearly level sandy lands.

Unit IIIe-3: Gently sloping sandy lands.

Class IV.—Soils that can be used for cropland but have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe: Soils having severe risk of erosion if they are cultivated and not protected.

Unit IVe-1: Gently sloping, limy loamy soils.

Unit IVe-2: Light-colored sandy lands.

Unit IVe-3: Nearly level, limy loamy soils.

Subclass IVw: Soils affected by excess water.

Unit IVw-1: Moderately wet bottom lands.

Unit IVw-2: Upland depressions.

Class VI.—Soils generally unsuitable for use as cropland that have moderate limitations or hazards under grazing.

Subclass VIe: Soils subject to severe erosion if not protected.

Unit VIe-1: Moderately sloping to steep loamy soils.

Unit VIe-2: Hummocky loamy fine sands.

Unit VIe-3: Steep sandy lands.

Subclass VIw: Soils affected by excess water.

Unit VIw-1: Narrow loamy bottom lands.

Unit VIw-2: Subirrigated saline bottom lands.

Class VII.—Soils unsuitable for use as cropland that have severe limitations or hazards under grazing.

Subclass VIIe: Soils subject to very severe erosion.

Unit VIIe-1: Hummocky fine sands.

Subclass VIIs: Soils extremely limited by shallow depth, steep slope, stoniness, or other factors more important than erosion.

Unit VIIs-1: Shallow, steep upland.

Subclass VIIw: Soils severely affected by excess water.

Unit VIIw-1: Unstable flood plains.

CAPABILITY CLASSIFICATION FOR IRRIGATION FARMING

Class I.—Soils that have few limitations that restrict their use.

Unit I-1: Nearly level loamy soils.

Class II.—Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass II_s: Soils moderately limited by the nature of the root zone.

Unit II_s-1: Nearly level, well-drained fine sandy loams.

Subclass II_w: Soils moderately limited by excess water.

Unit II_w-1: Deep, nearly level clay loam on flood plains.

Class III.—Soils that can be used as cropland but have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Subclass III_e: Soils highly susceptible to erosion when used as cropland.

Unit III_e-1: Gently sloping loamy soils.

Unit III_e-2: Gently sloping fine sandy loam.

Subclass III_w: Soils severely limited by excess water.

Unit III_w-1: Nearly level clay loam, moderately deep over sand and gravel, on flood plains.

Unit III_w-2: Rapidly permeable sandy loam on flood plains.

Class IV.—Soils that can be used for cropland but have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IV_w: Soils very severely limited by excess water.

Unit IV_w-1: Clay loam to clay soils over slowly permeable clay subsoil.

Management of Dryland ⁷

The soils of Hamilton County were covered with grass before they were cultivated. Roots permeated the soil, and living and dead vegetation protected the surface. Rain and wind did little damage to these protected soils. Water was absorbed rapidly, and there was little flash runoff. Erosion was limited to geological erosion, which on grassland occurs at a slow, harmless rate. Except in a few areas of rough broken lands, erosion and soil formation were in balance.

Cultivation of crops, especially without irrigation, has reduced the organic-matter content of the soils and resulted in the deterioration of soil structure and of the physical condition of the soils. This poorer physical condition of the soils, together with management systems that left the land bare and unprotected, opened the way for removal of soil by wind and water. To combat erosion, farmers have had to apply practices that conserve soil and water.

Conservation practices, such as stubble mulching and minimum tillage, apply to all cropland. Terracing, contouring, and stripcropping are other measures that may be effective in controlling wind and water erosion. Soil and water conservation is best obtained through the use of a combination of these practices. Application of a single practice may reduce erosion or conserve some moisture, or may do both, but this is seldom sufficient for complete conservation of cropland. Following is a dis-

cussion of the conservation practices needed in dryland farming in Hamilton County.

Cropping systems.—A cropping system consists of a sequence of crops grown on a given area of cropland over a period of time. It may be made up of a regular rotation of different crops, in which the crops are grown in a definite order, or it may consist of the same crop grown year after year. Some operators grow different crops on a given area but without a definite, planned sequence of crops.

Besides a cropping system, a good system of soil management provides for supporting practices, such as stubble mulching, contour tillage, stripcropping, and terracing. The cropping system and the supporting practices need to be designed to hold damage by wind and water erosion to a minimum and to maintain or increase the productivity of the land.

In many seasons the total amount of moisture that is available under continuous cropping is not enough to produce a worthwhile crop. After harvest, the soil needs to be managed in fallow so that a supply of moisture accumulates before another crop is planted. During this fallow period, wind and water erosion must be controlled.

A flexible cropping system, as shown in table 2, can be used as a guide to plan stable crop production.

June 1, July 15, and September 1 have been selected as the approximate dates when the depth of moist soil should be measured and the condition of the surface cover determined. After this information is known, decisions on the best methods of management can be made.

Crops are planted primarily for protective cover if the depth of moist soil is less than 24 inches at planting time.

The flexible cropping system takes into consideration the cover of the field. A field has adequate cover if erosion can be kept to a minimum by vegetation, crop residue, or both, when combined with the factors of soil texture, cloddiness, and surface roughness. If erosion cannot be kept to a minimum, as judged by these factors, the field has inadequate cover.

Stubble mulching.—This is a system of managing plant residues to conserve soil and water. Tilling, planting, and harvesting are performed in a way that will keep residues on the surface of the soil until the next growing crop provides protection.

Plant residues, if properly managed, will reduce losses of soil and water by protecting the soil surface from the wind and from the impact of raindrops. The moisture intake of the soil will be increased because surface-sealing crusts will be less likely to form.

Stubble mulching should be used on all cropland. The methods used will depend on the kind of soil, the cropping system, the amount of residue, the season of the year, and the physical condition of the soil. The amount of residue required to protect the soil varies; it depends on the kind of residue, the height of the stubble, the texture and cloddiness of the soil, and on the surface roughness. Although stubble mulching is considered a basic factor in a good system of conservation farming, it should be used along with other needed conservation measures.

Tillage.—In this dryland area, tillage has many objectives. Among other things, it is used to manage crop residues, to control weeds, and to maintain desirable

⁷ By EARL J. BONDY, agronomist, Soil Conservation Service, Garden City, Kansas.

TABLE 2.—A flexible cropping system, in which wheat is the principal crop, and needed conservation treatments are applied¹

Date	Depth of moist soil	Adequate cover on field	Inadequate cover on field
June 1.....	<i>Inches</i> Less than 24.....	Manage soil until the depth of moist soil is 24 inches; then plant sorghum or manage until July 15.	Manage soil until the depth of moist soil is 24 inches; then plant sorghum or roughen surface and manage until July 15.
	More than 24.....	Plant sorghum or manage for wheat.....	Plant sorghum or roughen surface and manage for wheat.
July 15.....	Less than 30.....	Manage soil for wheat and expect to seed wheat primarily for a cover crop, but possibly for a grain crop.	Plant sorghum for a cover crop or plant early-maturing grain sorghum.
	More than 30.....	Manage soil for wheat with the expectancy of a grain crop.	Manage soil for wheat and expect to seed wheat primarily for a cover crop, but possibly for a grain crop.
Sept. 1.....	Less than 36.....	Plant wheat with the expectancy of a grain crop (the soil should be moist to a depth of at least 24 inches at seeding time); if there is not enough moisture for seeding of wheat, manage for crop production in the next year.	Plant wheat for a cover crop, but possibly for a grain crop; if there is not enough moisture for seeding of wheat, roughen surface and manage for sorghum or wheat to be grown in the next year.
	More than 36.....	Plant wheat with the expectancy of a grain crop; if there is not enough surface moisture for seeding of wheat, manage for crop production in the next year.	Plant wheat for a cover crop, but possibly for a grain crop; if there is not enough moisture for seeding wheat, roughen surface and manage for sorghum to be grown in the next year.

¹ Prepared by FRED MEYER, JR., work unit conservationist, Syracuse, Kans.

structure and physical condition of the soil. Through tillage the farmer carries out most of his soil management program.

The farmer uses tillage equipment to manage crop residues and kill weeds so as to provide suitable conditions for seeding and managing of the next crop. The residues do the most good when left on the surface to protect the soil from erosion and from deterioration of the structure through the splash of raindrops. Undercutting equipment is used as a method to kill the weeds but still leave the residues on the surface.

The surface must be roughened by tillage whenever the soil becomes devoid of protective vegetation and is susceptible to wind erosion. Surface roughening minimizes the damage from soil blowing for the length of time that the clods of soil are big enough to resist blowing.

A desirable soil structure is one with stable aggregates. If the aggregates are stable, tillage is needed only to eradicate weeds and to manage residues. Tillage should be kept to the minimum that will meet these needs. Excessive tillage breaks down the aggregates and leaves the soil susceptible to crusting and blowing.

Tillage at the optimum time is important in maintaining good soil structure. Compact layers or tillage pans may result if the soils, particularly loams or silt loams, are tilled when too wet.

Contouring.—In contour farming, tillage and planting operations are performed parallel to terraces or contour guidelines (fig. 10). As a result, furrows, ridges, and wheel tracks are nearly level. The furrows and ridges hold much of the rainwater where it falls, thus decreasing runoff and erosion. Yields of crops increase because more water is absorbed by the soil and made available to crops. Also, somewhat less power is required than for up-and-downhill farming.

Contouring is most effective when it is used with other conservation measures, such as stubble mulching, terracing, and stripcropping.

Terracing.—This practice consists of the construction of ridges and channels across the slope to intercept runoff water. On sloping fields, terraces help control erosion and also conserve moisture that otherwise would be lost through runoff. On nearly level fields, terraces are used mainly to conserve moisture.

Contouring and other conservation measures should be used in conjunction with terracing. Each row that is planted on the contour between terraces acts as a miniature terrace, holding back some water and letting it soak into the soil. Increased yields and decreased losses of soil result when terracing and contouring are used together.

The horizontal distance needed between terraces depends on the slope of the land and the kind of soil. Since much of the precipitation falls during severe storms, a terrace system protects other conservation practices, such as contouring, stubble mulching, and contour stripcropping.

Stripcropping.—This is a system of growing suitable crops in narrow strips on the same field. Strips of erosion-resistant crops or their residues are alternated with strips of other crops or fallowed land. Good stands of wheat and sorghum and thick, heavy stubble are considered erosion resistant. Stripcropping helps control wind erosion by shortening the distance that loose soil can move. It reduces water erosion by providing a vegetative barrier of growing crops.

Two types of stripcropping are (1) contour stripcropping and (2) wind stripcropping. Contour stripcropping is used on sloping fields to aid in the control of both wind and water erosion. The strips are arranged on the contour; terraces or contour guidelines are used to establish the pattern. Wind stripcropping is used on fields of nearly level or coarse-textured soils where water erosion is not a problem and 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 usually

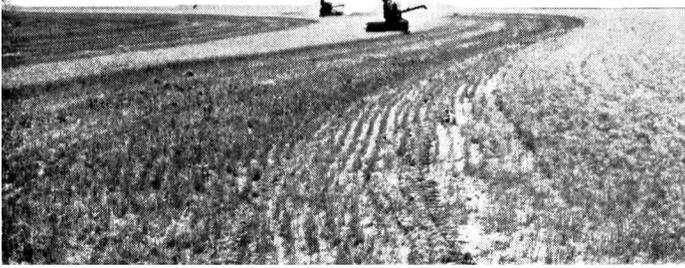


Figure 10.—Combining on the contour on Colby silt loam, 1 to 3 percent slopes. This field is terraced and all operations are performed on the contour.

straight, and are arranged across the direction of the prevailing winds.

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

Stripcropping will reduce soil blowing, but when used alone, it does not completely control blowing. It is much more effective when used along with good management of residues, minimum tillage, and other needed conservation measures.

Establishing native grass seedings.—Seedings of suitable native grasses can be established successfully on cropland and depleted rangeland. The following procedure is necessary to secure and maintain satisfactory stands of native grasses:

1. Select good quality live seed of suitable grasses.
2. Seed in a firm seedbed. Ordinarily, this requires no tillage, since the soil under the cover crop is sufficiently firm.
3. Seed in an erosion-resistant cover. To obtain enough cover in which to seed grass on cropland, plant sorghum in close-drilled rows about July 15 of the year before the year in which the grass is to be seeded.
4. Exclude livestock from the area until after seed matures in the second season of growth. Then, permit only light grazing until the grass is well established.

For further information on seeding native grass, selecting suitable grasses, establishing protective cover, and obtaining seed, see a local technician of the Soil Conservation Service.

Management by capability units (dryland)

In this subsection the soils of Hamilton County are listed 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 use and management of the soils of each unit are also given. The management practices referred to in the descriptions of capability units are described under the heading, Management of Dryland; also under

this heading is a plan of a flexible cropping system (see table 2) that gives the critical dates when decisions must be made as to whether to plant crops for grain or for cover, or to leave the land in fallow.

CAPABILITY UNIT IIIc-1

Nearly level loamy soils: These deep, dark, fertile soils occur on smooth, nearly level areas. The texture of the surface soil and subsoil is loam, silt loam, or clay loam. These soils have high moisture-holding capacity and are easily penetrated by roots, air, and water. The conservation of moisture and the control of wind erosion are problems. The soils in this unit are as follows:

- Bridgeport clay loam.
- Richfield silt loam, 0 to 1 percent slopes.
- Ulysses loam, 0 to 1 percent slopes.
- Ulysses silt loam, 0 to 1 percent slopes.

Wheat and sorghum are suited to these soils. Good management consists of choosing suitable crops in a flexible cropping system and applying stubble mulching and minimum tillage to conserve soil and water. Contouring, terracing, and stripcropping are also effective conservation measures. Grazing of crop residues should be limited so that enough stubble remains to protect the soils.

CAPABILITY UNIT IIIc-2

Well-drained lowlands: Goshen silt loam is the only soil in this capability unit. This deep, fertile soil occupies nearly level swales in the upland. The surface soil is dark silt loam. The subsoil is clay loam; has high moisture-holding capacity; and is easily penetrated by roots, air, and water. This soil receives some extra moisture as runoff from adjacent areas. Nevertheless, moisture conservation and wind-erosion control are problems.

Wheat and sorghum are well suited to this soil. Good management includes the use of suitable crops in a flexible cropping system, designed to help conserve soil and water, and the application of stubble mulching and minimum tillage. Stripcropping may also be used. Contouring and terracing help conserve water and may be applied if the site is determined suitable according to engineering standards.

CAPABILITY UNIT IIIe-1

Gently sloping loamy soils: These deep, dark, fertile soils occupy gently sloping upland. The surface soil is silt loam to loam in texture, and the subsoil is silt loam, loam, or clay loam. The surface tends to seal over during rainstorms. The subsoil is easily penetrated by roots, air, and water and has high moisture-holding capacity. Conservation of moisture and control of wind and water erosion are problems on these soils. The soils in this unit are as follows:

- Richfield silt loam, 1 to 3 percent slopes.
- Ulysses loam, 1 to 3 percent slopes.
- Ulysses silt loam, 1 to 3 percent slopes.

Wheat and sorghum are suited to these soils. Good management consists of using suitable crops in a flexible cropping system and the application and maintenance of needed soil and water conservation measures, such as stubble mulching, minimum tillage, terracing, and contouring. Contour stripcropping also helps control erosion and may be used if needed. Grazing of crop residues

should be limited so that enough stubble is left to protect the soils.

CAPABILITY UNIT IIIe-2

Nearly level sandy lands: Manter fine sandy loam, 0 to 1 percent slopes, is the only soil in this unit. This deep, moderately dark, fertile soil occupies nearly level areas of the upland. The surface soil is fine sandy loam in texture, and the subsoil ranges from loam to sandy loam. The soil is easily penetrated by roots, air, and water and has moderate to high moisture-holding capacity. Because of the semiarid climate, the conservation of moisture and control of wind erosion are problems.

Sorghum is well suited to this soil. Wheat may be grown successfully if crop residues are carefully used to protect against soil blowing. During extended drought, crops must be planted to provide protection against wind erosion, but with no expectation of a harvest. Good management of this soil includes the use of suitable crops in a flexible cropping system and the application of needed soil and water conservation measures, especially stubble mulching and minimum tillage. Contouring, terracing, and stripcropping are effective measures that may also be used. Grazing of crop residues should be limited so as to leave enough stubble to protect the soil.

CAPABILITY UNIT IIIe-3

Gently sloping sandy lands: Manter fine sandy loam, 1 to 3 percent slopes, is the only soil in this unit. This deep, dark, fertile soil occupies gently sloping to gently undulating areas in the upland. The surface soil is fine sandy loam, and the subsoil ranges from loam to sandy loam. The soil is easily penetrated by roots, air, and water and has moderate to high moisture-holding capacity. Controlling wind and water erosion and the conservation of moisture for crops are major problems.

Sorghum is well suited to this soil. Wheat may be grown successfully if crop residues are carefully used to protect against soil blowing. During extended drought, crops must be planted to protect against wind erosion, but with no expectation of a harvest. Good management of this soil includes the use of suitable crops in a flexible cropping system and the application of needed soil and water conservation measures, such as stubble mulching, minimum tillage, and contouring. Terracing and contour stripcropping also help control erosion, and either or both may be used as a supplementary practice. Grazing of crop residues should be limited so as to leave enough stubble to protect the soil.

CAPABILITY UNIT IVe-1

Gently sloping, limy loamy soils: These deep soils occupy gently sloping to gently undulating areas in the upland. The surface soil is light-colored silt loam or loam and is generally calcareous within the plow layer. The subsoil is also friable, calcareous loam or silt loam; it is high in moisture-holding capacity and easily penetrated by roots, air, and water. These soils are low in organic matter. The surface seals over during rainstorms, and excessive runoff and serious erosion result. Wind erosion is also a serious hazard on these soils and occurs whenever the soils lack sufficient protective cover. The soils in this unit are as follows:

Colby silt loam, 1 to 3 percent slopes.

Ulysses-Colby complex, 1 to 3 percent slopes, eroded.

These soils are not well suited to cropland but may be used for crops. They are better kept in suitable native grasses and used as rangeland. Wheat and sorghum yields are usually low, but good yields are obtained during years when precipitation is greater than normal. Because of the serious hazard of wind and water erosion, the soils must be protected at all times. During periods of drought, crops must be planted to protect against wind erosion, but with no expectation of a harvest.

Good management of these soils, when they are used for crops, requires growing suitable crops in a flexible cropping system and the application of needed soil and water conservation measures, such as stubble mulching, minimum tillage, terracing, contouring, and contour stripcropping. If the slopes are so complex that a satisfactory system of terraces or contour lines cannot be laid out, wind stripcropping should be used. All crop residues are needed to protect the soils against erosion; the residues should not be grazed.

CAPABILITY UNIT IVe-2

Light-colored sandy lands: These deep, moderately fertile soils occupy gently undulating to gently sloping topography. The surface soil consists of moderately dark to light colored fine sandy loam and loamy fine sand. The subsoil is sandy loam in texture and has only low to moderate moisture-holding capacity. The soils are easily penetrated by roots, air, and water. Wind-erosion control is the dominant problem. Runoff is slow, and water erosion is insignificant. The soils in this unit are as follows:

Bayard fine sandy loam.

Otero fine sandy loam, 1 to 3 percent slopes.

Vona loamy fine sand.

Because of the wind-erosion hazard, these soils are not well suited to cropland but may be used for crops. They are better kept in suitable native grasses and used as rangeland (fig. 11).

Good management of these soils, when used as cropland, should provide effective wind-erosion control. This can be obtained through the use of stubble mulching and minimum tillage in a cropping system in which sorghum is grown continuously. Crop residues should not be grazed; all residues are needed to protect the soils against wind erosion.



Figure 11.—Seeding native grass in cover crop of sudangrass on Vona loamy fine sand.

Wheat is not well suited to these soils. Summer fallowing is not advisable, because of the severe hazard of wind erosion.

CAPABILITY UNIT IVe-3

Nearly level, limy loamy soils: Colby silt loam, 0 to 1 percent slopes, is the only soil in this unit. This deep, light-colored, calcareous soil occupies nearly level upland. The surface soil and subsoil are silt loam in texture; are easily penetrated by roots, air, and water; and have high moisture-holding capacity. The semiarid climate limits crop production on this soil and imposes problems of moisture conservation and wind-erosion control.

Wheat and sorghum are suitable crops. Good management of this soil should provide for moisture conservation and wind-erosion control through stubble mulching, minimum tillage, terracing, and contouring. Contour stripcropping is another measure that helps control erosion and conserve moisture. Grazing of crop residues should be limited so as to leave enough stubble to protect the soil.

CAPABILITY UNIT IVw-1

Moderately wet bottom lands: This group of mixed alluvial soils occupies nearly level topography on the flood plain of the Arkansas River. The surface soil and subsoil range from sandy loam to clay loam in texture. The productivity of the soils is slightly to moderately affected by a fluctuating high water table and associated slight to moderate salinity. Moisture conservation and wind-erosion control are also problems. The soils in this unit are as follows:

- Bowdoin clay loam.
- Las clay loam, deep.
- Las clay loam, moderately deep.
- Las Animas sandy loam.

These soils are not well suited to cropland. They are better kept in suitable native grasses and used as rangeland. Good management of these soils, when they are used as cropland, consists of growing crops in a flexible cropping system that will aid in controlling wind erosion and help store moisture for succeeding crops. Wheat and sorghum can be grown, but yields are low to moderate. Stubble mulching should be used to protect against wind erosion. If a site is suitable, wind stripcropping will help control wind erosion.

CAPABILITY UNIT IVw-2

Upland depressions: Lofton clay loam is the only soil in this unit. This is a deep, dark, slowly permeable soil of small depressions in the upland. After rainstorms, water is ponded on the surface for as much as several days. Consequently, planting and harvesting are often delayed and growing crops may be drowned out. Wind erosion is a hazard, particularly after crops have been lost and no cover remains on the soil.

When used for crops, this soil is usually managed in the same manner as the surrounding soils in the same fields. If soil and water conservation treatments, such as terracing, contouring, and stubble mulching, are applied on the adjacent soils, some of the runoff water can be kept out of depressions occupied by this soil. In places surface drainage is feasible. For further information on managing the soil in depressions, see a local technician of the Soil Conservation Service.

CAPABILITY UNIT VIe-1

Moderately sloping to steep loamy soils: These deep soils occur in the upland. The surface soil consists of light-colored, calcareous loam and silt loam. The subsoil is made up of friable, calcareous loam and clay loam and has high moisture-holding capacity. These soils are easily penetrated by roots, air, and water. Erosion by wind and water is a serious hazard. The soils in this unit are as follows:

- Colby silt loam, 3 to 5 percent slopes.
- Colby silt loam, 5 to 15 percent slopes.

These soils are suitable only for use as grassland. Runoff and erosion are excessive if the soils are cultivated. Suitable native grasses should be planted in any areas that are still cultivated. To produce adequate forage for livestock and cover for the soils, operators need to apply proper intensity of grazing, deferred grazing, or rotation grazing. More information on good grassland management is given in the section on range management.

CAPABILITY UNIT VIe-2

Hummocky loamy fine sands: These soils occupy moderately undulating to nearly level areas of the upland and the valleys. The surface soil and subsoil are light-colored loamy fine sand. Rainfall is rapidly absorbed, but these sandy soils will not hold large amounts of water. Erosion by water is not a problem, even on the steeper slopes. Wind erosion is a serious hazard and occurs whenever the soils are not adequately protected. The soils in this unit are as follows:

- Bowdoin loamy fine sand.
- Tivoli loamy fine sand.

Because of low moisture-holding capacity and susceptibility to soil drifting, these soils are suitable only for grassland. Blowouts develop quickly in places where grass is destroyed by overgrazing and trampling. Overgrazing of grasslands can be prevented through proper intensity of grazing and deferred grazing. Blowouts and bare spots should not be grazed and should be seeded to suitable native grasses. More information on good management of grassland is given in the section on range management.

CAPABILITY UNIT VIe-3

Steep sandy lands: Otero-Vona complex, 5 to 15 percent slopes, is the only soil mapping unit in this capability unit. These deep soils occur in the upland. They have sandy loam surface soil and friable, calcareous sandy loam or loam subsoil. The soils have good moisture-holding capacity and are easily penetrated by roots, air, and water. Wind and water erosion are hazards and occur whenever the soils are not protected by vegetative cover.

These soils are suitable only for grassland; runoff and erosion are excessive when they are cultivated. Suitable native grasses should be seeded on areas still being cultivated. If proper intensity of grazing and deferred grazing are applied, overgrazing and the resulting damage of the soils by erosion will be prevented. More information on good management of grassland is given in the section on range management.

CAPABILITY UNIT VIw-1

Narrow loamy bottom lands: Alluvial land is the only mapping unit in this capability unit. This miscel-

laneous land type occurs adjacent to and includes the meandering channels of narrow upland drainageways. Soils along the valley floors are nearly level, but those of the streambanks are steep, cut, and broken in some places. The soil is mostly loam or sandy loam, is friable and calcareous, and has good moisture-holding capacity. It receives extra water from occasional floods and from side drainage.

This land type is generally nonarable because the areas where the topography is suitable for cultivation are subject to flooding, are small in size, and are irregular in shape; and also because the areas are generally isolated by adjacent, steep, nonarable slopes. The areas are best kept in suitable native grasses. They produce abundant forage when managed so as to prevent overgrazing. More information on good management of grassland is given in the section on range management.

CAPABILITY UNIT VIw-2

Subirrigated saline bottom lands: These alluvial soils occur on nearly level topography in the valley of the Arkansas River. Texture of the surface soil and subsoil ranges from loamy sand to clay. The soils are shallow to moderately deep over sand. The water table fluctuates between about 2 and 10 feet below the surface. The soils have slight to moderate salinity. Wind erosion is a hazard, and soil blowing occurs whenever the land is not protected by vegetation. The soils in this unit are as follows:

- Bowdoin clay.
- Bowdoin-Las Animas complex.
- Las Animas loamy sand.
- Sweetwater clay loam.

These soils are unsuited to cultivated crops under dryland farming and are best kept in suitable native grasses grown for hay or pasture. Alkali sacaton, switchgrass, vine-mesquite, and other suitable grasses produce abundant forage. Proper intensity of grazing, deferred grazing, and rotation grazing will maintain or improve the productivity of these grassland soils. More information on good grassland management is given in the section on range management.

CAPABILITY UNIT VIIe-1

Hummocky fine sands: These deep, light-colored fine sands occupy most of the sandhill area south of and adjacent to the valley of the Arkansas River. The wind-formed dunes, hills, and ridges have steep, hummocky or choppy slopes. The surface soil and subsoil consist of fine sand that is rapidly permeable and low in moisture-holding capacity. Blowouts and areas of loose sand are common. Drainage channels are few and indistinct. Runoff is negligible because most of the rainfall is absorbed as fast as it falls. These soils are droughty and highly susceptible to wind erosion. The soils in this unit are as follows:

- Active dunes.
- Tivoli fine sand.
- Tivoli-Dune land complex.

These soils are suitable only for grassland. Vegetative cover must be maintained at all times to protect the soils from blowing. Under good range management, these soils produce dependable, but not abundant, yields of forage. Controlling grazing, stabilizing blowouts (fig. 12), con-



Figure 12.—Giant sandreedgrass is beginning to stabilize this blowout. The area should be fenced to keep out livestock.

trolling sagebrush, and reseeding areas where desirable grasses have disappeared are needed management practices. Further information on management of grassland is given in the section on range management.

CAPABILITY UNIT VIIs-1

Shallow, steep upland: This unit consists only of Potter soils. These shallow soils occupy steep, more or less broken slopes along upland drainageways and along the low escarpment that borders the northern side of the valley of the Arkansas River. The surface soil is loam or fine sandy loam that overlies caliche and limestone at a depth ranging from about 6 to 15 inches. Rock outcrops are common. The soils have low moisture-holding capacity and a restricted root zone.

These soils are suitable only for grassland. Runoff is excessive on the steep, shallow areas. Water and wind erosion occur if the grass is overgrazed and good cover is not maintained. Little can be done to protect the soils, except to maintain a good cover of grass through controlled grazing. More information on good management of grassland is given in the section on range management.

CAPABILITY UNIT VIIw-1

Unstable flood plains: Lincoln sand is the only soil in this capability unit. This shallow, light-colored, very sandy soil occurs principally on the low flood plain of the Arkansas River. The surface soil, which is mainly fine sand and loamy fine sand, overlies coarse sand and gravel at depths generally less than 15 inches. Some areas consist of almost barren sand and gravel bars. This soil has a low moisture-holding capacity and a restricted root zone. It is subject to flooding, deposition of sand, shifting of the stream channel, and scouring. Wind erosion is a hazard in unprotected areas.

This soil is nonarable and has only limited value for native grass pastures. Because of the unfavorable characteristics of this soil and its position on the flood plain, the soil and plant cover are somewhat unstable. The native vegetation is variable and mixed. Some areas sup-

port sparse stands of native tall grasses; others have groves of cottonwood trees interspersed with native grasses; and still others support mixed stands of cottonwoods, willows, and tamarisk bushes. Because the vegetation and its condition are variable, management requirements differ from place to place. Generally, grazing must be controlled so that the grasses will survive and maintain their vigor. On some areas, brush control or eradication may be desirable. For further information on the management of this soil, see a local technician of the Soil Conservation Service.

Estimated yields (dryland)

Information is limited on average yields per acre of crops obtained over a long period on the soils of Hamilton County. Records of long-time yields are needed to make fairly precise estimates of expected yields. Yields fluctuate greatly during the recurring and alternating periods of drought and abnormally high precipitation.

On the basis of data obtained from local farmers and from the Tribune and Garden City branches of the Kansas State Agricultural Experiment Station, average yields per acre of wheat and grain sorghum have been estimated. Most of the data obtained were for wheat grown on the Ulysses silt loams and Richfield silt loams and for sorghum grown on Vona loamy fine sand. Using this information, agricultural specialists prepared estimated yields of these crops when grown on all the arable soils.

Estimated yields of wheat and grain sorghum to be expected over a long period under the prevailing, or most common, system of management are shown in columns A of table 3. Yields that may be obtained by use of an improved system of management are shown in columns B.

Prevailing management.—The prevailing, or most common, system of management used in the production of wheat is as follows:

1. Tillage operations are performed in straight lines, generally parallel to field boundaries and not on the contour.
2. Tillage is done with such equipment, in such a manner, and so frequently that protective crop residues are soon destroyed.
3. The cropping system consists of wheat and fallow. Winter wheat is seeded early in autumn on land that was left idle and kept free of weeds during the growing season. If a satisfactory stand of wheat is not obtained or if the wheat blows out during winter or spring, the land is planted to sorghum.
4. Crop residues are grazed whenever available. Growing wheat, both seeded and volunteer, is usually grazed during fall and winter.

The prevailing system of management used in the production of grain sorghum on all soils except the Vona, Otero, and Manter is as follows:

1. Sorghum is seeded on land that was in wheat the previous season. Following the wheat harvest, the soil is plowed to obtain a stand of volunteer wheat that will be used as fall pasture.
2. The soil generally is clean tilled at least twice in the spring before sorghum is planted about June 1.

TABLE 3.—Estimated long-time average acre yields of seeded wheat and grain sorghum grown on the arable soils under two levels of management

[Columns A show yields to be expected under prevailing management, and columns B show yields to be expected under improved management; absence of a yield figure indicates the soil is not suited to the crop specified; wheat yields reflect the general use of summer fallow]

Soil	Wheat		Sorghum	
	A	B	A	B
	Bu.	Bu.	Bu.	Bu.
Bayard fine sandy loam.....	8.5	12.0	14.0	17.5
Bowdoin clay loam.....	8.0	12.0	9.0	11.0
Bridgeport clay loam.....	12.5	15.5	12.0	14.5
Colby silt loam, 0 to 1 percent slopes.....	11.0	15.0	11.0	13.5
Colby silt loam, 1 to 3 percent slopes.....	10.0	14.0	10.0	12.0
Goshen silt loam.....	16.0	20.0	22.0	27.0
Las clay loam, moderately deep.....	10.0	13.0	11.0	13.5
Las clay loam, deep.....	11.0	14.5	12.0	14.5
Las Animas sandy loam.....	8.0	11.0	10.0	12.5
Lofton clay loam.....	9.0	13.0	13.0	15.0
Manter fine sandy loam, 0 to 1 percent slopes.....	12.0	16.0	16.0	20.0
Manter fine sandy loam, 1 to 3 percent slopes.....	10.0	14.0	15.0	19.0
Otero fine sandy loam, 1 to 3 percent slopes.....			13.0	16.5
Richfield silt loam, 0 to 1 percent slopes.....	14.5	18.0	15.0	18.0
Richfield silt loam, 1 to 3 percent slopes.....	11.0	16.0	12.0	14.5
Ulysses loam, 0 to 1 percent slopes.....	13.5	18.0	16.0	19.0
Ulysses loam, 1 to 3 percent slopes.....	11.0	16.0	13.0	15.5
Ulysses silt loam, 0 to 1 percent slopes.....	14.0	18.0	15.0	18.0
Ulysses silt loam, 1 to 3 percent slopes.....	11.5	16.0	12.0	14.5
Ulysses-Colby complex, 1 to 3 percent slopes, eroded.....	10.5	14.5	11.0	13.5
Vona loamy fine sand.....			13.0	16.5

The first tillage is done to kill the volunteer wheat. Subsequent tillage is shallow and is intended for the control of weeds.

3. Sorghum is drilled in rows at about 20-inch spacing. After it emerges, the sorghum is cultivated once with a rotary-hoe type implement and later is sprayed with a chemical weedkiller.
4. Because of inadequate moisture, sorghum in many fields is not harvested for grain. The plants on these fields and the residues remaining on harvested fields are grazed off by sheep and cattle.

Under prevailing management, sorghum generally is grown continuously on Vona loamy fine sand; Otero fine sandy loam, 1 to 3 percent slopes, and on the Manter fine sandy loams. Spring tillage, other cultivation, and spraying are done in about the same way on these soils as on the other arable soils.

Improved management.—The improved system of management for wheat and grain sorghum consists of the use of needed soil and water conservation measures in addition to the cropping sequences given under the prevailing system of management. The practices necessary to conserve soil and water were mentioned for each capability unit in the description of the dryland capability units.

Management of Irrigated Land^a

Irrigation in Hamilton County is not extensive outside of the valley of the Arkansas River. A small acreage in the upland in the southern part of the county is irrigated from deep wells, however. Here, the supply of water appears to be limited. Most of the cultivated soils in the valley of the Arkansas River are irrigated with water diverted from the river; this is supplemented by water pumped from shallow wells. A few areas lying above the river ditches and canals are irrigated only by water from shallow wells. The water from the river and from the shallow wells is only of fair quality but is usable. Water of excellent quality is obtained from the deep wells in the southern part of the county.

The first part of this section describes the principles and practices of irrigation that are referred to under the discussion of each capability unit (irrigated). In the second part of the section the irrigable soils have been grouped into capability units, and a description of each capability unit is given. The soils have been placed in capability units according to their limitations in use and risk of damage that will affect management over a long period when they are used for irrigated cropland.

Planning an irrigation system.—Factors to be considered when planning an irrigation system are the kind of soil, kind and amount of water, control and conveyance of water, type of irrigation system, method of applying water, preparation of the land, drainage, and overall management.

The soil should be considered first. The kind of soil influences to varying degrees all other factors in the development of the irrigation system.

The adequacy and reliability of the water supply influence the type of irrigation system installed, the acreage that can be irrigated, and the crops that can be grown.

The quality of the water is highly important. Heavy concentrations of dissolved salts are harmful. The soils, climate, cropping system, and irrigation practices all must be considered in appraising the quality of the water.

Various physical controls are needed after a water supply suitable for irrigation is located. It is necessary to control the supply of water and to deliver it economically from the point of origin to the point of use on the farm. The system may include storage dams, canals, and laterals to carry water to the farm; the farm distribution system; and other structures, such as pumping plants, pipelines, and drops to control erosion.

In Hamilton County the two general methods used for applying water are surface irrigation and sprinkler, or overhead, irrigation. In the border or basin type of surface irrigation, water may completely cover the surface; otherwise, the water is conveyed through furrows or corrugations.

The efficiency of the irrigation system is affected by the kind of soil, topography, and condition of the crop. However, the design of the system, the degree of land preparation, and the skill and care of the irrigator probably have the greatest influence on the total amount of water required. From 50 to 80 percent of the water can

be applied efficiently with present irrigation facilities and practices.

Before irrigating it usually is necessary to level the land to get efficient, uniform application of water, regardless of the method of irrigation to be used. Land leveling provides greater efficiency in the application of water, insures more uniform distribution of water, and saves soil and water. However, land leveling may remove valuable surface soil and subsoil. It then is necessary to apply fertilizer and manure and to grow deep-rooted legumes to make the exposed soil productive.

The drainage program should be developed along with the irrigation program to obtain efficient overall control of water and salinity.

Organic matter and commercial fertilizer.—The growing of crops affects both the chemical and physical condition of the soil. To obtain top yields year after year from irrigated soils, a farmer must maintain and improve the soils by adding organic material annually. He needs to rotate crops in such a manner as to have a sod crop growing once every few years. The sod crop helps to rebuild and stabilize soil aggregates, besides adding organic matter to the soil.

The use of commercial fertilizer, particularly nitrogen, has become increasingly important in sound irrigation management. On some soils other elements, especially phosphorus, may be necessary for high crop yields. The Kansas Agricultural Experiment Station at Manhattan and the branch station at Garden City maintain laboratories for testing soil to determine fertilizer needs. These services are available to the public. A small charge is made for each sample tested.

Overall irrigation management.—Many people have learned through experience that productivity of irrigated land may be short-lived. On the other hand, many irrigated areas are farmed successfully and continue to be highly productive for a long time. It seems clear that continuous irrigation farming can be practiced for a long time if all factors involved are considered in the development of the irrigation system and if sound management is applied.

Management by capability units (irrigated)

In this subsection the irrigable soils of Hamilton County have been placed in capability units, and a description of each unit is given. The soils in a capability unit have about the same limitations and risk of damage when used for irrigated crops.

CAPABILITY UNIT I-1 (IRRIGATED)

Nearly level loamy soils: The soils of this unit have a loam to clay loam surface soil and subsoil. They are deep, well drained, moderately permeable, and good in moisture-holding capacity. The soils in this unit are as follows:

- Bridgeport clay loam.
- Colby silt loam, 0 to 1 percent slopes.
- Goshen silt loam.
- Richfield silt loam, 0 to 1 percent slopes.
- Ulysses loam, 0 to 1 percent slopes.
- Ulysses silt loam, 0 to 1 percent slopes.

Good management of these soils when irrigated includes the following practices that maintain or improve

^a By EARL BONDY, agronomist, Soil Conservation Service, Garden City, Kans.

fertility and tilth: Use of a cropping system that includes a deep-rooted legume; use of crop residues to maintain organic matter; and the application of commercial fertilizer as needed. Suitable crops on these soils include wheat, sorghum, alfalfa, sugar beets, tame grasses, and vegetables.

Engineering practices or other practices that make for the most efficient use of irrigation water should be used. Land leveling is commonly needed. Managing runoff water from adjacent areas is a problem on some sites. For further information on conservation irrigation and related engineering problems, see a local technician of the Soil Conservation Service.

CAPABILITY UNIT II_s-1 (IRRIGATED)

Nearly level, well-drained fine sandy loams: This unit consists of deep soils that have a fine sandy loam surface soil. The subsoil is generally sandy loam, but in some places it is light loam. The soils are fertile, are moderately to rapidly permeable, and have moderate to good moisture-holding capacity. Wind erosion is a hazard and will occur whenever the surface of the soil is unprotected. The soils in this unit are as follows:

Bayard fine sandy loam.
Manter fine sandy loam, 0 to 1 percent slopes.

Good management of these soils when they are irrigated should include practices that maintain or improve fertility and tilth and that make for the most efficient use of water. Fertility and tilth can be maintained through the use of a cropping system that includes a deep-rooted legume; proper use of crop residues; and applications of manure and commercial fertilizer as needed. Suitable crops are wheat, sorghum, alfalfa, sweetclover, sugar beets, tame grasses, and vegetables.

Proper design of the irrigation system is necessary for maximum efficiency in using water. Land leveling is commonly needed for uniform distribution of water. Sand pockets are present at many places in Bayard fine sandy loam, and soil should not be removed from these areas when leveling. Loss of water in the ditch running through a sand spot is likely to be excessive unless this part of the ditch is lined with impervious material. For further information and help on conservation irrigation practices, see a local technician of the Soil Conservation Service.

CAPABILITY UNIT II_w-1 (IRRIGATED)

Deep, nearly level clay loam on flood plains: This unit contains only one soil—Las clay loam, deep. This is a moderately dark soil that has a clay loam surface soil and subsoil. It is fertile, is moderately to slowly permeable, and has good moisture-holding capacity; the soil, however, is imperfectly drained. This soil occurs on the flood plain of the Arkansas River, and it is underlain by a moderately high, fluctuating water table. Drainage is not feasible. Slight to moderate amounts of toxic salts may accumulate in the soil when the water table is high.

Good management of this soil is needed to maintain and improve fertility and tilth, to control salinity, and to make for the most efficient use of water. A cropping system that includes the growing of legumes, the use of crop residues, and the use of commercial fertilizer will improve the fertility, content of organic matter, and tilth

of the soil. Heavy irrigation before seeding will reduce the salt content. Suitable crops are wheat, sorghum, alfalfa, sugar beets, sweetclover, and tame grasses.

Proper design of the irrigation system and land leveling where needed will help to provide efficient use of water. For further information on the use of this soil under irrigation, see a local technician of the Soil Conservation Service.

CAPABILITY UNIT III_e-1 (IRRIGATED)

Gently sloping loamy soils: This unit contains deep soils of the upland. These soils have silt loam or loam surface soil over silt loam and clay loam subsoil. They are fertile, well drained, moderately permeable, and good in moisture-holding capacity. Water erosion and obtaining efficient use of irrigation water are problems. The soils in this unit are as follows:

Colby silt loam, 1 to 3 percent slopes.
Richfield silt loam, 1 to 3 percent slopes.
Ulysses loam, 1 to 3 percent slopes.
Ulysses silt loam, 1 to 3 percent slopes.
Ulysses-Colby complex, 1 to 3 percent slopes, eroded.

Not much irrigation is done on these soils. Water available for irrigation in the upland is generally used on soil that has a slope of less than 1 percent.

Good management of these soils when irrigated provides for erosion control, efficient use of water, and maintenance of fertility and tilth. A cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residues, and the use of commercial fertilizer will maintain and improve fertility and tilth. Alfalfa, sweetclover, tame grasses, wheat, sorghum, and sugar beets are suitable crops.

Land leveling, irrigation on the contour, and sprinkler irrigation of close-growing crops will minimize the danger of erosion. Drop structures may be necessary to control erosion in irrigation ditches. Other problems in engineering and erosion control may occur on particular sites. A local technician of the Soil Conservation Service can give you help with these problems.

CAPABILITY UNIT III_e-2 (IRRIGATED)

Gently sloping fine sandy loam: This unit contains only one soil—Manter fine sandy loam, 1 to 3 percent slopes. This is a deep upland soil that has moderately dark colored fine sandy loam surface soil and loam to sandy loam subsoil. It is fertile, well drained, moderately permeable, and good in moisture-holding capacity. Problems are the risk of erosion and the difficulty in obtaining efficient use of irrigation water.

Not much of the acreage is irrigated. Water available for irrigation in the upland is generally used on soils that have a slope of less than 1 percent.

Good management of this soil under irrigation provides for control of erosion, efficient use of irrigation water, and maintenance of fertility and tilth. A cropping system that includes close-growing crops and deep-rooted legumes, the use of crop residues, and the use of commercial fertilizer will help maintain and improve soil fertility and tilth. Alfalfa, sweetclover, tame grasses, wheat, sorghum, and sugar beets are suitable crops.

Land leveling, irrigation on the contour, and sprinkler irrigation of close-growing crops will help to control

erosion and to permit the efficient use of water. Other problems in engineering and erosion control may occur on a particular site. See a local technician of the Soil Conservation Service for help with these problems.

CAPABILITY UNIT IIIw-1 (IRRIGATED)

Nearly level clay loam, moderately deep over sand and gravel, on flood plains: This unit consists of only one soil—Las clay loam, moderately deep. This moderately dark soil occurs on the flood plain of the Arkansas River. It is underlain by a moderately high, fluctuating water table, and drainage is not practicable. The soil is moderately fertile, is moderately permeable, and has moderate moisture-holding capacity. Slight to moderate amounts of salts may accumulate in the soil when the water table is high. The soil is low in organic matter and tends to seal over and become hard and cloddy as it dries.

Good management is needed to maintain and improve fertility and tilth and to control salinity. A cropping system that includes legumes, the use of crop residues, and the use of commercial fertilizer are practices needed to improve fertility and tilth of the soil and to increase the content of organic matter. Heavy irrigation in winter and early in spring reduces accumulations of salt and fills the root zone with water that can be used by the crop to be grown. The soil is well suited to irrigated pasture, but profitable yields of wheat, sorghum, and sugar beets can be produced.

Proper design of the irrigation system and land leveling where needed will help promote efficient use of water. For further information on the use and management of this soil under irrigation, see a local technician of the Soil Conservation Service.

CAPABILITY UNIT IIIw-2 (IRRIGATED)

Rapidly permeable sandy loam on flood plains: This unit consists of only one soil—Las Animas sandy loam. This is a moderately deep alluvial soil on the flood plain of the Arkansas River. It is moderately fertile and has low to moderate moisture-holding capacity. A fluctuating, moderately high water table that cannot be lowered by any practicable drainage subjects the soil to slight or moderate salinity. Any accumulation of salt is easily leached, however, when the water table is low.

Good management is needed to maintain and improve soil fertility, to use irrigation water efficiently, and to control salinity. A cropping system that includes legumes, the proper use of crop residues, and the use of commercial fertilizer will help maintain or improve soil fertility. The occasional leaching of the soil by irrigation when the water table is low will control salinity. This soil is well suited to irrigated pasture, but profitable yields of wheat and sorghum can be produced.

The layout of the irrigation system, land leveling, and other engineering practices vary from site to site. For further help with the practices of conservation irrigation, see a local technician of the Soil Conservation Service.

CAPABILITY UNIT IVw-1 (IRRIGATED)

Clay loam to clay soils over slowly permeable clay subsoil: The soils of this unit soak up water slowly, stay wet a long time after irrigation, crust and seal over, and often

become compacted. Timely tillage is necessary in preparing a seedbed; otherwise, the soils become cloddy and difficult to work. Because they are on the flood plain of the Arkansas River, these soils have a fluctuating, moderately high water table that cannot be lowered by any practicable drainage. The soils of this unit are as follows:

- Bowdoin clay.
- Bowdoin clay loam.

These soils are susceptible to accumulations of salt, so irrigation water must be carefully applied. Surface drainage is necessary to carry away excess water and prevent ponding.

Good management of these soils, when they are used for cultivated crops, is needed to control salinity, to maintain and improve soil fertility and tilth, and to make the most efficient use of water. Heavy applications of irrigation water in winter and spring will remove excess salts and leave some water stored for use by the next crop to be grown. To improve the tilth of these soils, farmers need to increase the content of organic matter by plowing under crop residues and by applying barnyard manure. A cropping system that includes legumes and the use of commercial fertilizers will maintain and improve soil fertility. When irrigated, the soils are best suited to tame pasture, but wheat, sorghum, and sugar beets can be grown. Much of the area occupied by these soils is not cultivated but remains under a cover of native tall grasses.

The layout of irrigation and surface drainage systems, the need for leveling, and other practices necessary for efficient use of water and for control of salinity vary from one site to another. For further information and aid on conservation irrigation practices, see a local technician of the Soil Conservation Service.

Range Management ⁹

Rangeland makes up a considerable part of the county. Most of the rangeland is not suitable for cultivation. The principal grazing area is in the sandhills south of the Arkansas River. Next in importance is the sloping High Plains north of the river. Most of the sandhill range is now producing less than one-fourth of the forage that it can produce, while the sloping High Plains is producing about one-half of its potential. Areas of the Saline lowland site adjacent to the Arkansas River are used primarily for native meadow, but some of them are used for grazing. Most of the Saline lowland is highly productive.

The raising of livestock is the second largest agricultural enterprise in the county. Only the raising of wheat and sorghum for grain is more important. The success of the livestock industry depends on the way ranchers manage their range forage.

The section on range management is divided into two main parts. In the first, principles and practices of range management are discussed. The second part consists of a discussion of range sites; except for Lincoln sand, each soil in the county occurs in a specific range site.

⁹ By PETER N. JENSEN, range conservationist, Soil Conservation Service, Dodge City, Kans.

Principles and practices of range management

High production of forage and conservation of soil, water, and plants on rangeland are obtained primarily through the maintenance or improvement of native vegetation. This is accomplished by managing grazing so as to encourage and increase the best native forage plants.

Leaf development, root growth, flower-stalk formation, seed production, forage regrowth, and storage of food in plant roots are essential stages in the development and growth of grass. If maximum yields of forage and peak production of livestock are to be maintained, grazing must be regulated to permit these natural stages of growth. Yields of forage are influenced mainly by the climate, kind of soil, relief, and management practices.

Livestock graze selectively, constantly seeking the more palatable plants. If grazing is not carefully regulated, the better plants are eventually eliminated. Less desirable, or second choice, plants increase. If heavy grazing is continued, even the second choice plants thin out or are eliminated, and undesirable weeds or invaders take their place.

Research by agricultural workers and experience by ranchers have shown that if no more than half the yearly growth of grass is removed, damage to the better plants is minimized and the range will improve. The forage left on the ground does these things—

1. Serves as a mulch that provides rapid intake of water by the soil; the more water stored in the soil, the better the growth of grass for grazing.
2. Enables roots to reach moisture deep in the soil. Overgrazed grass cannot reach deep moisture because not enough green shoots are left to provide the food needed for good growth of roots.
3. Protects the soil from wind and water erosion. Grass is the best kind of cover to prevent erosion.
4. Allows the better grasses to improve in vigor and to crowd out weeds, especially annuals. This means that range of low productivity will improve.
5. Enables plants to store food for rapid, vigorous growth after droughts and in spring.
6. Stops snow where it falls so that it will melt and soak into the soil for use at a later date.
7. Provides for greater feed reserves for use during dry years. Otherwise, livestock must be sold at a loss during droughts.

Sound range management requires that the intensity of grazing be adjusted from season to season according to the amount of forage produced. Reserve pastures or other feed are needed during droughts or other periods when production of forage is below normal. If reserves are available, forage can be grazed moderately at all times. It often is desirable to have part of the livestock herd consist of readily salable stock, such as stocker steers. This allows the rancher to balance his livestock with the amount of forage produced, and without sacrificing breeding animals.

The grazing practices that improve rangeland, that cost little to apply, and that are needed on all rangeland, regardless of other practices used, are defined as follows:

Proper intensity of grazing.—This is the practice of grazing rangeland at a rate that will maintain vigorous plants, food reserves, and enough residues to conserve

soil and water; at the same time this practice maintains the most desirable vegetation or improves the quality of vegetation that has deteriorated. No range practice can be fully effective unless the intensity of grazing is controlled.

Deferred grazing.—This is the practice of postponing grazing on a given range. It allows the forage plants to increase in vigor and permits the desirable plants to produce seed or to increase in quantity; the plants are free from pressure of grazing, and natural revegetation is promoted. In addition to being important in range improvement, deferred grazing helps build up a reserve of forage for later use.

Rotation-deferred grazing.—This is a practice by which one or more range units are rested at planned intervals throughout the growing season. In each successive year, each range unit gets a different rest period than during the previous year. This permits all important forage plants to develop fully and to produce seed every second, third, or fourth year.

Following is a list of practices needed for range improvement. These practices help control grazing on the range and promote better management.

1. Water developments.—These should be distributed over the entire range, if possible, so that livestock do not have to go too far for water. Good distribution of watering places is of great help in getting uniform use of the range. Wells, ponds, and developed springs supply water for livestock; in some places, water must be hauled. The makeup of each range determines what type of water development is most practical.
2. Fencing.—Fences are used to separate ranges to be used during different seasons. In some places different range sites are fenced separately; this is done where the areas differ greatly and are of large enough size.
3. Salting.—Proper distribution of salt will improve distribution of grazing and provide more uniform use of the range.
4. Control of undesirable plants.—On some sites these plants may need to be controlled through chemical or mechanical means. This improves range forage.
5. Range seeding.—This is the establishment of perennial or improved native grasses to prevent losses of soil and water and to improve range in poor condition or improve land converted to range from other uses.

Aspects of livestock management that must be considered in obtaining high production of livestock and conservation of range resources are listed next.

1. A feed and forage program is needed that will keep livestock in a productive or desirable condition throughout the year. This program should include the use of range forage, concentrates, and hay or tame grass pastures, or both.
2. Prolonged drought is always a threat in Hamilton County. For this reason, a livestock enterprise needs a reserve supply of feed, stored in stacks (fig. 13), pits, or silos, that will carry animals at least 2 years. The importance of a reserve supply of feed needs to be emphasized.

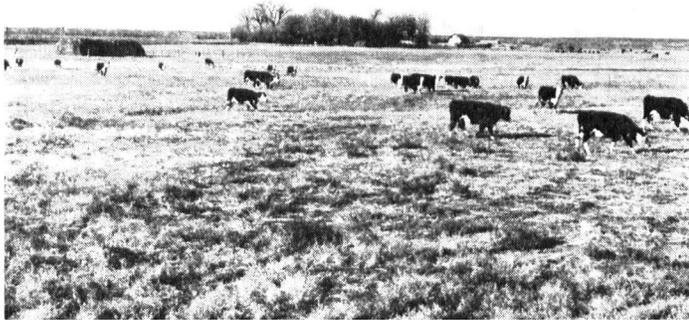


Figure 13.—Meadow of native grass, on Sweetwater clay loam, from which hay was cut and stacked. Haystacks are in background.

3. A breeding program should provide for the type of livestock fitted to the range, seasonal arrival of calves to take advantage of forage when it is most nutritious, and continual improvement of livestock according to the type of range and the climate of the area.
4. Culling of nonproductive animals from range herds can increase production of livestock and contribute greatly to successful range management.

Range sites

Different kinds of range produce different kinds and amounts of grass. To manage rangeland properly, an operator needs to recognize the different kinds of land (range sites) in his holdings and to know the range plants and their response to use. He will then be able to use the management needed to produce the best forage plants on each site.

Climax vegetation refers to the combination of plants that grew originally on a given site. The most productive combination of range plants on a site is generally the climax type of vegetation.

Range condition is a term used to relate the current condition of range to the potential of which the site is capable. It is expressed as the percentage of the climax, or natural, vegetation that is present on the site. Changes in range condition are primarily due to the intensity of grazing and to drought. Following are the different classes of range condition and the percentage of the climax vegetation present in each:

Condition class	Percentage of present vegetation that is climax for the site
Excellent	76 to 100
Good	51 to 75
Fair	26 to 50
Poor	0 to 25

Range sites differ from each other in their ability to produce significantly different kinds or amounts of climax vegetation. A significant difference in vegetation is one that is great enough to require different grazing or other management practices to maintain and improve the present vegetation.

The range sites in Hamilton County are described next. The description of each site includes (1) the name and map symbol of each soil; (2) the dominant vegetation on the site when in excellent condition; (3) the estimated yields of forage on the site when in excellent condition; and (4) the management practices needed to maintain or improve range condition.

Because the soil and vegetation are unstable, Lincoln sand is not considered as occurring in a range site. This soil is in capability unit VIIw-1 (dryland).

In the descriptions of range sites, native vegetation is referred to in terms of *increasers*, *decreasers*, and *invaders*. Decreasers and increasers are climax plants. Decreasers are the most heavily grazed and are consequently the first to be destroyed by overgrazing. Increasers withstand grazing better or are less palatable to the livestock; they increase under grazing and replace the decreasers. Invaders are plants that become established after the climax vegetation has been reduced by grazing.

LOWLAND SITE

This range site is made up of nearly level soils that are deep and moderately permeable. They are sandy loam to clay loam in texture and have high moisture-holding capacity. The soils receive extra moisture from occasional floods and runoff from adjacent soils. The following soils are in this range site; the map symbol is given for each soil.

Alluvial land (An).
Goshen silt loam (Go).

The climax plant cover is a mixture of such decreasers as switchgrass, big bluestem, Indiangrass, Canada wildrye, little bluestem, and side-oats grama. These grasses make up at least 55 percent of the total cover, and perennial forbs and grasses make up the rest. Up to 45 percent of the climax vegetation may be made up of such increasers as western wheatgrass, blue grama, and buffalograss.

When the site is in excellent condition, the estimated yield of forage is 3,000 to 4,000 air-dry pounds per acre.

Management practices needed to maintain or improve the condition of the site are proper intensity of grazing, deferred grazing, and rotation-deferred grazing.

SALINE LOWLAND SITE

This range site consists of nearly level, somewhat poorly drained saline and saline-alkali soils on the bottom lands of the Arkansas River. The texture of the soils ranges from clay to loamy sand. The soils receive additional moisture from flooding and as the result of a high water table. The following soils are in this range site; the map symbol is given for each soil.

Bowdoin clay (Bc).
Bowdoin clay loam (Bd).
Bowdoin-Las Animas complex (Bx).
Las clay loam, moderately deep (La).
Las clay loam, deep (Lb).
Las Animas loamy sand (Lc).
Las Animas sandy loam (Ld).
Sweetwater clay loam (Sw).

The climax plant cover is a mixture of such decreasers as alkali sacaton, switchgrass, Indiangrass, and western wheatgrass, which make up at least 80 percent of the vegetation; other perennial grasses and forbs compose the rest. Alkali sacaton and switchgrass are the dominant

decreasers. Saltgrass, an increaser, may make up 20 percent of the climax vegetation. Common invaders on this site are alkali muhly, western ragweed, foxtail barley, and tamarisk.

When the site is in excellent condition, the estimated yield of forage is 3,000 to 4,000 air-dry pounds per acre.

Management practices needed to maintain or improve the condition of the site are proper intensity of grazing, deferred grazing, and rotation-deferred grazing.

LOAMY UPLAND SITE

This range site is made up of nearly level to steeply sloping soils of the upland. The soils have surface soil and subsoil that range from loam to clay. They are moderately permeable, well drained, and high in moisture-holding capacity. The following soils are in this range site; the map symbol is given for each soil.

- Bridgeport clay loam (By).
- Colby silt loam, 0 to 1 percent slopes (Ca).
- Colby silt loam, 1 to 3 percent slopes (Cb).
- Colby silt loam, 3 to 5 percent slopes (Cc).
- Colby silt loam, 5 to 15 percent slopes (Cd).
- Lofton clay loam (Lo).
- Richfield silt loam, 0 to 1 percent slopes (Rm).
- Richfield silt loam, 1 to 3 percent slopes (Rn).
- Ulysses loam, 0 to 1 percent slopes (Ua).
- Ulysses loam, 1 to 3 percent slopes (Ub).
- Ulysses silt loam, 0 to 1 percent slopes (Uc).
- Ulysses silt loam, 1 to 3 percent slopes (Ud).
- Ulysses-Colby complex, 1 to 3 percent slopes, eroded (Ue).

The climax plant cover is a mixture of such decreasers as blue grama, buffalograss, western wheatgrass, side-oats grama, and little bluestem. Buffalograss is the main increaser if the site is overgrazed. Blue grama and buffalograss are the dominant grasses at present. Annuals are the principal invaders. In droughty years, pricklypear is a common invader.

When the site is in excellent condition, the estimated yield of forage is 1,250 to 2,000 air-dry pounds per acre.

Management practices needed to maintain or improve the condition of the site are proper intensity of grazing, deferred grazing, and rotation-deferred grazing.

SANDY SITE

This range site is made up of deep, nearly level to steeply sloping soils. The soils have sandy loam surface soil and sandy loam to sandy clay loam subsoil. They are moderately to rapidly permeable and well drained. Moisture-holding capacity ranges from moderate to low. The following soils are in this range site; the map symbol is given for each soil.

- Bayard fine sandy loam (Ba).
- Manter fine sandy loam, 0 to 1 percent slopes (Ma).
- Manter fine sandy loam, 1 to 3 percent slopes (Mb).
- Otero fine sandy loam, 1 to 3 percent slopes (Or).
- Otero-Vona complex, 5 to 15 percent slopes (Ox).

The climax plant cover is a mixture of such decreasers as sand bluestem, little bluestem, side-oats grama, and switchgrass. These climax grasses may make up 55 percent of the vegetation, and perennial forbs and grasses compose the rest. The dominant increasers include such grasses as blue grama, sand dropseed, and buffalograss. Sand sagebrush and small soapweed are the dominant woody increasers. Common invaders are windmillgrass, six-weeks fescue, and three-awn.

When the site is in excellent condition, estimated yields of forage are 1,500 to 2,000 air-dry pounds per acre.

Management practices needed to maintain or improve the condition of the site are proper intensity of grazing, deferred grazing, and rotation-deferred grazing.

SANDS SITE

This range site consists of deep, nearly level to hummocky soils. The texture of the surface layer is loamy fine sand, and that of the subsoil ranges from loamy sand to clay. The soils are well drained and rapidly permeable. Moisture-holding capacity ranges from moderate to low. The following soils are in this range site; the map symbol is given for each soil.

- Bowdoin loamy fine sand (Bf).
- Tivoli loamy fine sand (Ts).
- Vona loamy fine sand (Vo).

The climax plant cover is a mixture of such decreasers as sand bluestem, little bluestem, switchgrass, side-oats grama, and big sandreed. These climax grasses may make up 65 percent of the plant cover, and perennial forbs and grasses compose the rest. The dominant increasers are such grasses as blue grama, sand dropseed, and sand paspalum. Sand sagebrush is the principal woody increaser. Common invaders are false buffalograss, purple sandgrass, and red lovegrass.

When the site is in excellent condition, the estimated yield of forage is 2,000 to 2,500 air-dry pounds per acre.

Management practices needed to maintain and improve the condition of the site are proper intensity of grazing, deferred grazing, rotation-deferred grazing, and brush control.

CHOPPY SANDS SITE

This range site is made up of deep fine sands that occupy hummocks and dunes in the sandhills. Blowouts are numerous throughout the area. The soils are rapidly permeable, somewhat excessively drained, and low in moisture-holding capacity. The following soils are in this range site; the map symbol is given for each soil.

- Active dunes (Ad).
- Tivoli fine sand (Tf).
- Tivoli-Dune land complex (Tx).

The climax plant cover is a mixture of such decreasers as sand bluestem, switchgrass, little bluestem, and big sandreed. These dominant climax grasses may make up 60 percent of the vegetation, and other perennial grasses and forbs compose the rest. The dominant increasers include such grasses as sand dropseed and sand paspalum. The principal woody plant is sand sagebrush. Blowoutgrass and big sandreed are the first perennial plants to stabilize blowouts or dunes. Common invaders are false buffalograss and purple sandgrass.

When the site is in excellent condition, estimated yields of forage are 1,250 to 1,750 air-dry pounds per acre.

Management practices needed to maintain or improve the condition of the site are proper intensity of grazing, deferred grazing, rotation-deferred grazing, and brush control.

BREAKS SITE

This range site is made up of Potter soils (Po). These soils have steep, somewhat broken slopes. They are shallow over caliche and limestone. Texture of the soils ranges

from loam to sandy loam. The soils are permeable and well drained but have low moisture-holding capacity.

The climax plant cover is a mixture of such decreasers as little bluestem and side-oats grama. These climax grasses may make up 60 percent of the vegetation, and other perennial grasses and forbs make up the rest. The dominant increasers are blue grama, hairy grama, sand dropseed, and hairy dropseed. Common invaders are broom snake-weed and ring muhly.

When the site is in excellent condition, estimated yields of forage are 1,500 to 2,000 air-dry pounds per acre.

Management practices needed to maintain or improve the condition of the site are proper intensity of grazing, deferred grazing, and rotation-deferred grazing.

Woodland Management

There are no native forests or woodlands of any consequence in Hamilton County. Small local areas of the flood plain adjacent to the Arkansas River support scattered, mixed stands of cottonwood, tamarisk, and Russian-olive. Since trees and shrubs survive only if they grow in a place that receives extra moisture, plantings in the county have been limited to farmstead windbreaks and trees grown for shade or ornament.

Windbreak plantings are desirable as protection for farmsteads and livestock (fig. 14). They can be successfully established if they are properly planned and cared for. Dryland windbreaks, made up of a combination of conifers and hardwoods, should remain effective between 25 and 35 years on upland sites and between 40 and 60 years on lowland sites. Competition by grass and weeds for available moisture must be eliminated before trees and shrubs will grow well. Cultivation keeps weeds under control and makes the soil favorable for the penetration of water and air. Irrigation and the diversion of runoff water from other areas to the windbreak site provide extra moisture needed by trees. Irrigated windbreaks furnish protection much sooner than those grown on dryland areas.

The trees most tolerant of drought and suitable for planting are eastern redcedar, Rocky Mountain juniper, Siberian elm (Chinese elm), and Osage-orange. In table 4 the soil types suitable for growing trees and shrubs have been placed in planting sites. Trees and shrubs that are suitable for use in windbreaks and that can be grown

TABLE 4.—Soil types grouped into tree (windbreak) planting sites, suitable trees and shrubs on soils of each site, and average height attained by trees after 10 years of growth on irrigated and dryland soils

Tree planting site and soil types	Suitable trees and shrubs	Dry-	Irri-
		land	gated land
		<i>Feet</i>	<i>Feet</i>
Silty upland:			
Bridgeport clay loam;	Tamarisk.....	10	20
Colby silt loam; Rich-	Russian-olive.....	12	22
field silt loam; Ulysses	Osage-orange.....	12	22
loam; Ulysses silt loam;	Mulberry.....	15	20
and Ulysses-Colby com-	Siberian elm.....	22	32
plex.	Honeylocust.....	12	22
	Eastern redcedar....	5	9
	Rocky Mountain	5	9
	juniper.	.	.
	Ponderosa pine.....	6	9
	Skunkbush sumac....	5	9
Sandy upland:			
Bayard fine sandy loam;	Tamarisk.....	10	15
Manter fine sandy	Russian-olive.....	13	22
loam; Otero fine sandy	Osage-orange.....	13	22
loam; Otero-Vona com-	Mulberry.....	17	24
plex; Tivoli loamy fine	Siberian elm.....	25	35
sand; Vona loamy fine	Honeylocust.....	14	24
sand.	Eastern redcedar....	8	11
	Rocky Mountain	8	11
	juniper.	.	.
	Ponderosa pine.....	8	11
	Skunkbush sumac....	6	9
Saline lowland:			
Bowdoin clay loam; Bow-	Tamarisk.....	18	20
doin clay; Bowdoin	Russian-olive.....	18	24
loamy fine sand; Bow-	Cottonwood.....	25	30
doin-Las Animas com-	Willow.....	18	24
plex; Las clay loam; Las	Siberian elm.....	22	30
Animas sandy loam;			
Las Animas loamy sand;			
Sweetwater clay loam.			
Lowland:			
Alluvial land; Goshen silt	Tamarisk.....	12	20
loam.	Russian-olive.....	15	22
	Osage-orange.....	15	22
	Mulberry.....	18	24
	Siberian elm.....	26	32
	Honeylocust.....	15	22
	Eastern redcedar....	8	9
	Rocky Mountain	8	9
	juniper.	.	.
	Ponderosa pine.....	8	9
	Skunkbush sumac....	6	9

best on each site are given along with the approximate average height of each tree after 10 years of growth. Lincoln sand, Tivoli fine sand, Lofton clay loam, and Potter soils are not considered suitable sites for planting trees.

Additional information on planting trees and developing farmstead windbreaks can be obtained from a local technician of the Soil Conservation Service and the county agricultural agent.

Wildlife Management

The ring-necked pheasant is perhaps the best known kind of wildlife throughout the county. Bobwhite and blue quail inhabit the valley of the Arkansas River and the sandhill area. A few prairie chickens still survive in the sandhills. Jackrabbits are numerous all over the



Figure 14.—Young windbreak planted on Ulysses loam, 1 to 3 percent slopes.

county, and cottontails abound in the river valley. A few prairie-dog towns may be seen in native pastures. Doves and migratory waterfowl often stop over in the county during their seasonal migrations.

Areas that are unproductive can be improved to provide food, cover, and water for wildlife. These include ditchbanks, fence rows, ponds and the adjacent areas, and farmstead windbreaks. Practices needed for improving these areas are the planting of trees and food-bearing shrubs, construction of ponds, control of grazing, and protection of vegetation from fires.

Additional information on the development and improvement of areas for wildlife can be obtained from a local technician of the Soil Conservation Service or from a member of the staff of the State Forestry, Fish, and Game Commission.

General Facts About the County

This section tells something about the agriculture of Hamilton County. It also discusses its physiography, topography, and drainage; history; and other subjects of general interest.

Agriculture

Before the first World War, most of the land in Hamilton County was covered by native grass. Only a small acreage was used for cultivated crops, mainly grains and forage used as feed for domestic livestock. Increasingly large acreages of sod were plowed as wheat became more important as a cash crop and as tractor power became available. A large acreage was plowed up in the late 1920's, and another, as recently as the middle 1940's. In 1935, approximately 400,000 acres were in grass, but by 1944 only 280,000 acres remained in grass and this has since declined to approximately 180,000 acres.

Most of the arable land is now cultivated, mainly to wheat and sorghum that are sold and shipped out of the county. Farming operations are on a large scale and highly mechanized. The raising of livestock is mainly confined to ranches in the sandhills south of the Arkansas River and along the breaks north of the river.

Crops

Wheat and sorghum are the only important crops climatically suited to dryland farming in this part of the High Plains. On the more silty soils, these crops are usually grown in a cropping system in which the land is left fallow every other year. During the fallow period, weeds are controlled so that moisture is conserved for use by the next crop. Sorghum is generally grown continuously on the sandy soil because of the difficulty in controlling soil blowing during periods of fallow. Table 5 shows the acreage of principal crops grown in Hamilton County in stated years.

In the early years, a considerable acreage in the county was used to grow corn, broomcorn, and barley. The importance of these crops has declined, and at present they occupy very little acreage. A limited acreage of alfalfa is grown under irrigation.

Livestock

The raising of livestock is important in Hamilton County. Table 6 shows the number of livestock on farms and ranches during stated years.

Cattle usually outnumber other kinds of livestock. The ranches in the sandhills and the breaks maintain breeding herds, predominantly of Herefords. The number of cattle on ranches is relatively stable but decreases during periods of continued drought. Large numbers of sheep and cattle are brought into the county during years when sorghum stubble and pastures of wheat are available for grazing. The number of cattle and sheep is much greater during fall and winter than during the rest of the year. Through the years the number of dairy cattle has remained consistently low. Many farmers do not keep a milk cow. A few small dairy herds are maintained on irrigated farms in the valley of the Arkansas River. Hogs and poultry are not of commercial importance.

Pasture

About 28 percent of the total area of Hamilton County is in native grass and is used as rangeland. Most of the pasture or rangeland is nonarable, or lies adjacent to or within nonarable areas, and therefore cannot be cultivated conveniently. The sandhills south of the Arkansas River constitute a large area used exclusively for grazing.

TABLE 5.—Acreage of principal crops in stated years ¹

Crop	1921	1925	1930	1935	1940	1945	1950	1955
Wheat.....	2, 360	6, 589	37, 582	2, 562	40, 150	127, 000	125, 000	90, 000
Sorghum:								
Grain.....	8, 585	11, 272	11, 686	19, 329	48, 830	15, 580	39, 450	71, 900
Forage.....	3, 445	5, 495	3, 600	32, 005	18, 390	19, 570	11, 780	66, 300
Corn.....	4, 573	5, 527	10, 431	7, 991	1, 000	560	100	90
Barley.....	1, 494	2, 513	3, 420	4, 798	8, 070	3, 380	420	520
Alfalfa.....	2, 014	1, 260	2, 247	2, 034	6, 550	1, 000	1, 100	1, 850
Rye.....	1, 139	304	80	70	380	380	120	(²)
Prairie hay.....	3, 858	3, 121	2, 756	1, 188	2, 710	1, 580	740	600
Broomcorn.....	1, 255	2, 430	11, 599	13, 297	3, 040	2, 070	750	(²)
Sugar beets.....	10	200	260	520	253	470	560	0
Total.....	28, 733	38, 711	83, 661	83, 794	129, 373	171, 590	171, 790	231, 260

¹ Statistics taken from Biennial Reports of the Kansas State Board of Agriculture.

² Not reported.

TABLE 6.—Livestock on farms in stated years ¹

Livestock	1921	1925	1930	1935	1940	1945	1950	1955
Horses and mules.....	5, 138	4, 310	2, 317	1, 434	800	670	520	380
Milk cows.....	603	687	478	1, 147	1, 500	1, 300	640	600
Other cattle.....	18, 500	11, 854	10, 294	8, 457	3, 350	14, 700	13, 960	15, 800
Sheep.....	5, 089	4, 146	3, 935	6, 365	10, 210	45, 300	76, 570	15, 000
Hogs.....	1, 338	762	1, 109	603	1, 680	1, 760	2, 340	850
Chickens.....					22, 040	30, 300	19, 700	11, 000

¹ Statistics taken from Biennial Reports of the Kansas State Board of Agriculture.

They support a mixture of native tall and mid grasses along with sand sagebrush. When overgrazed, the grasses disappear and only the invading sagebrush and annual grasses and weeds are left. The breaks and silty uplands that are used for range support native short and mid grasses. The Arkansas River bottom lands that have a high water table support an abundant growth of the

salt-tolerant native tall and mid grasses. Some of these bottom-land pastures also support scattered cottonwood trees and tamarisk bushes.

Size and tenure of farms

The 1954 Federal census lists 406 farms in Hamilton County. Of these, 326 are dryland farms and average

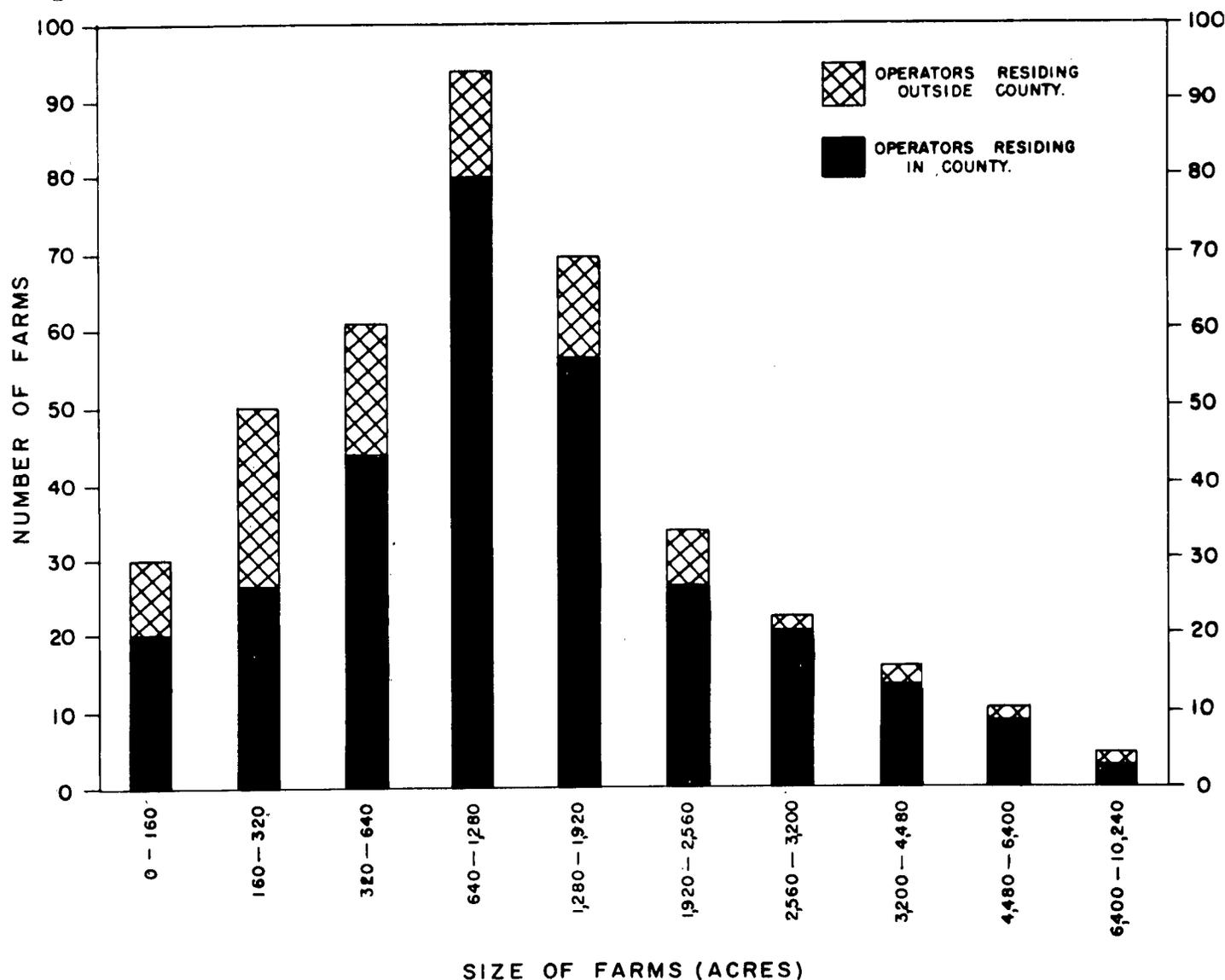


Figure 15.—Number of farms in Hamilton County in 1957 according to various size groups.

1,525 acres per farm. On 80 farms, averaging 1,460 acres per farm, all or part of the cropland is irrigated. Of these, 33 have all the cropland, about 150 acres per farm, under irrigation. The other 47 irrigated farms have an average of 110 acres of irrigated cropland. The number of farms in various size groups is shown in figure 15. Most of the farms of less than 10 acres in size are adjacent to or near towns, and the operators work at least part time at some occupation other than farming.

Comparatively few dryland farmers own all the land they operate. It is not uncommon for an operator to rent land from four or five landowners. The 1954 census lists 76 operators as full owners, 184 as part owners, 143 as tenants, and 3 as managers. Farms are usually leased on a crop-share basis, with the landlord receiving one-fourth to one-third of the crop, and the tenant, the rest. A considerable acreage is farmed by operators who live outside the county. (See fig. 15.) In 1957 about 20 percent of all operators lived outside of the county and farmed about 15 percent of the land, according to records of the Agricultural Stabilization and Conservation Committee.

Farm equipment and labor

All tillage and harvesting are done with mechanically powered equipment. Most tractors used on dryland farms are the large, standard wheel type, but most of those used on irrigated farms are the general purpose type. The number of tractors increased from 38 in 1921 to 735 in 1954. Harvesting of wheat and grain sorghum is done with large, self-propelled combines. Most farmers own enough equipment for tillage and planting operations, but many must pay to have part or all of their grain combined. Custom operators from outside the area commonly furnish much of the labor and equipment necessary for the harvest. The demand for farm labor is seasonal. The local labor supply is about adequate for planting and tilling of crops, but transient labor is generally needed for harvesting.

Physiography, Topography, and Drainage

Hamilton County lies within the central High Plains section of the Great Plains physiographic province. It is entirely within the watershed of the Arkansas River, which crosses the county from west to east about midway between the northern and southern boundaries. Little Bear Creek, an intermittently flowing tributary of the Arkansas River, marks a fault line across the southwestern corner of the county and drains southeastward into Stanton county. Here, it joins Bear Creek, which flows intermittently eastward into Grant county and then northward toward the Arkansas River in Kearny County. There is no defined drainage channel through the sandhills adjacent to the Arkansas River.

Most of the county has topography typical of the High Plains. The high, treeless divides on both sides of the Arkansas River are nearly level plains having poorly defined drainage patterns. These tablelands slope east and southeast at a rate of about 10 to 20 feet a mile. More steeply sloping land lies between these divides and the valleys of the Arkansas River and Little Bear Creek. These areas have a more dissected surface with stronger slopes and fewer nearly level areas. The strongest slopes

occur adjacent to the intermittent drainageways in the upland, and the more gentle slopes are on the rounded crests and sides of the ridges between these streams.

An area of undulating to hummocky sandhills and dunes lies south of and adjacent to the valley of the Arkansas River. It extends in a continuous, narrow belt, ranging from 3 to 5 miles wide, across the county. The area is characterized by a succession of cone-shaped hills or dunes and intervening small, irregular depressions. Within the main body of sandhills are relatively flat local areas with broad, low mounds and wide, shallow depressions. Blowouts are common in areas where the dunes are highest and steepest. The sandhill area is only a few tens of feet higher than the valley of the Arkansas River. Maximum local relief within the area is about 70 feet; this occurs near the river west of Syracuse.

In Hamilton County the valley of the Arkansas River ranges from 2 to 3 miles in width. It is a nearly level plain bordered on the north by a more or less continuous line of low bluffs and on the south by the sandhills. Little, if any, surface drainage gets into the valley from the south, but numerous, intermittently flowing drainageways in the upland empty into the valley from the north. Most of these streams have deposited silty sediments to form alluvial fans where they enter the valley. This series of fans is more or less connected and forms an apron above the flood plains, about 1 mile wide along the northern margin of the valley. The flood plain of the valley of the Arkansas River is only a few feet higher than the riverbed. A high, fluctuating water table occurs just below the land surface. Tamarisk bushes and cottonwood trees grow near the river, but farther from it they quickly give way to native grass.

Elevations in Hamilton County range from about 3,100 feet above sea level, where the Arkansas River leaves the county near Kendall, to 3,850 feet, on the high tableland in the northwestern corner of the county. Other approximate elevations are 3,360 feet at Coolidge near the Colorado State line, 3,220 feet at Syracuse, and 3,130 feet at Kendall.

Water Supply

In Hamilton County water for domestic use is obtained from drilled wells. Most of the water for livestock also comes from wells, but many small dams that impound water for livestock have been constructed across intermittently flowing streams in the upland. These small reservoirs furnish enough water for livestock most of the time. During extended drought, water in these ponds is not replenished often enough and water for livestock must then be supplied from other sources.

Wells that will supply sufficient water for domestic and livestock use can be drilled almost anywhere in the county, except in an area in the northwestern part of the county that covers about three townships.

Water in sufficient quantity to irrigate field crops is pumped from shallow wells drilled in alluvium in the valley of the Arkansas River and from deep wells drilled in the Ogallala, Dakota, and Cheyenne formations south of Little Bear Creek. Water is also diverted from the Arkansas River for irrigation of crops in the valley.

There are no natural lakes in the county. An artificial lake, covering about 90 acres, is located about 3 miles west and 1 mile north of Syracuse.

History

Hamilton County was organized in 1886. Construction of the Santa Fe Railroad in the early 1870's had opened the area to settlement. In July 1876, the first train passed through Syracuse. Up to the time of the first World War, the agriculture of the area consisted of subsistence-type farming, with livestock raising an important part of the farm program. There were some large ranches, and a few of them are still in operation. No industries other than agriculture have been developed in the county. The population of the county has fluctuated over the years, decreasing rapidly during prolonged droughts but surging upward again as new settlers arrived during periods when rainfall was sufficient to produce crops. As the tractor became a practical source of farm power, more and more land was plowed and the large-scale cash grain farms of the present came into being.

After the drought and duststorms of the 1930's, people in the county began to be concerned about soil erosion and land deterioration. In 1946, the farmers and land-owners organized the county into a soil conservation district to promote proper land use and the conservation of soil and water. Since the formation of the district, many acres of nonarable land have been reseeded to native grasses. Soil- and water-conservation practices, such as terracing, contouring, stubble mulching, and supplemental irrigation, have been applied on many acres of cropland.

Markets and Transportation

Syracuse, Coolidge, and Kendall are the three towns in Hamilton County. They are in the valley of the Arkansas River. Coolidge is near the Colorado State line, Syracuse is about midway across the county, and Kendall is near the Kearny County line on the east. These towns are along U.S. Highway 50 and the Santa Fe Railroad, both of which extend in an east-west direction through the middle of the county. Syracuse, the county seat, is at the intersection of Kansas 27 and U.S. 50. Syracuse, Coolidge, and Kendall have facilities to handle and store grain, and the railroad provides adequate transportation to terminal elevators and markets to the east and west.

Community Facilities

The county is divided into five school districts. High schools are maintained in Syracuse, Coolidge, and Kendall. Bear Creek School in the southwestern part of the county and C-4 District School in the northwestern part are consolidated rural grade schools. Transportation by bus is provided in all the school districts.

Donahue Memorial Hospital is located in Syracuse. All the towns support one or more churches; in Syracuse there are churches of six denominations.

In 1956, the State Forestry, Fish, and Game Commission constructed a lake and park just northwest of Syra-

cuse. This 440-acre park and 90-acre lake offer excellent facilities for fishing, picnicking, and camping.

Formation and Classification of the Soils

This section presents a discussion of the major soils in Hamilton County, tells how the soils were formed, and describes their relationships. Laboratory data on three soils are given in table 7.

The soil series of Hamilton County are classified in great soil groups, as follows:

- Alluvial soils—
 - Bayard.
 - Bowdoin.
 - Bridgeport.
 - Las.
 - Las Animas.
 - Lincoln.
- Brown soils—
 - Vona.
- Chestnut soils—
 - Goshen.
 - Lofton.
 - Manter.
 - Richfield.
- Chestnut soils, intergrading to Regosols—
 - Ulysses.
- Humic Gley soils—
 - Sweetwater.
- Regosols—
 - Colby.
 - Otero.
 - Tivoli.
- Lithosols—
 - Potter.

The soils of Hamilton County that show zonal development are members of the Chestnut and Brown great soil groups. The other soils belong to the Regosols, Lithosols, Humic Gley, and Alluvial groups. All the soils have developed under grass. The climate is temperate and semiarid; the average annual temperature is about 54° F., and the average annual precipitation is about 16.7 inches.

Most of the soils have developed in silty and sandy sediments of Pleistocene age and Recent age. Some minor outcroppings of formations older than Pleistocene, notably the Ogallala formation of Pliocene time, occur in the deeper erosional valleys, but they are of little importance in the study of the soils in the county. Figure 16 shows the approximate position of geologic formations, their relation to each other, and the soils that developed in the exposed areas. The vertical scale has been exaggerated in relation to the horizontal scale so that the proper soil-topography relations can be shown.

The predominantly silty sediments, or loess, range from a few feet to many feet in thickness. They were deposited as a mantle over the area in the Wisconsin stage of Pleistocene time. Over 50 percent of the loess is silt that is pale brown, calcareous, friable, and porous. The sandy sediments appear to have been deposited after

TABLE 7.—Chemical and mechanical analyses of three soils¹

Soil, location, and sample number	Depth	Organic matter		CaCO ₃ equivalent	Cation exchange capacity	Extractable cations			Volume weight	pH 1.1	Particle size distribution			Moisture tensions		
		Organic carbon	Nitrogen			H	Na	Clay (0.002 mm.)			Silt (0.05-0.002 mm.)	Sand (0.05 mm.)	1/10 atmosphere	1/3 atmosphere	15 atmospheres	
Richfield silt loam (located in cultivated field in the SW ¹ / ₄ SW ¹ / ₄ SE ¹ / ₄ sec. 36, T. 21 S., R. 41 W.):																
S-57-Kan-38-3-1	0-4	1.17	0.109	(²)	22.8	1.6	(²)	(³)	7.5	29.0	53.9	17.1	42.7	30.5	12.8	
S-57-Kan-38-3-2	4-8	1.02	.101	1	29.4	2.0	0.1	1.26	7.1	37.4	52.3	10.3	46.3	32.5	16.7	
S-57-Kan-38-3-3	8-11	.94	.105	1	28.9	(³)	.1	(³)	7.8	38.1	49.7	12.2	47.1	33.0	17.3	
S-57-Kan-38-3-4	11-24	.55	.064	18	21.7	(³)	.1	1.14	8.2	33.9	58.9	7.2	43.1	31.2	15.3	
S-57-Kan-38-3-5	24-36	.31	(³)	10	22.5	(³)	.8	(³)	8.3	26.8	66.4	6.8	46.5	31.0	13.1	
S-57-Kan-38-3-6	36-50	.23	(³)	8	22.9	(³)	1.7	(³)	8.6	24.6	67.7	7.7	41.0	27.6	12.3	
S-57-Kan-38-3-7	50-72+	.23	(³)	8	22.8	(³)	2.0	(³)	8.5	24.6	67.6	7.8	40.7	27.6	12.0	
Colby silt loam (located in a virgin area in the SW ¹ / ₄ SW ¹ / ₄ NW ¹ / ₄ sec. 12, T. 23 S., R. 43 W.):																
S-57-Kan-38-2-1	0-2	1.20	.097	(²)	18.5	(²)	(²)	(³)	8.1	18.0	50.6	31.4	37.1	17.4	8.4	
S-57-Kan-38-2-2	2-7	1.23	.128	14	20.9	(³)	.1	1.20	8.2	27.4	49.9	22.7	38.3	22.7	12.0	
S-57-Kan-38-2-3	7-18	.71	.075	12	19.9	(³)	.1	(³)	8.1	28.0	57.1	14.9	39.1	25.6	12.9	
S-57-Kan-38-2-4	18-30	.28	.030	10	20.0	(³)	.9	1.16	8.5	22.3	64.2	13.5	42.2	26.4	11.3	
S-57-Kan-38-2-5	30-44	.20	(³)	9	18.5	(³)	1.7	(³)	8.8	18.7	64.3	17.0	43.1	25.8	10.1	
S-57-Kan-38-2-6	44-65+	.14	(³)	9	17.0	(³)	2.0	1.16	8.8	14.2	66.7	19.1	42.7	22.2	9.6	
Ulysses loam (located in a cultivated field in the SE ¹ / ₄ SW ¹ / ₄ SE ¹ / ₄ sec. 20, T. 25 S., R. 39 W.):																
S-57-Kan-38-6-1	0-4	.43	.041	1	10.2	.4	(²)	(³)	8.0	11.6	21.7	66.7	18.2	10.1	5.0	
S-57-Kan-38-6-2	4-6	.58	.061	(²)	14.5	.4	(²)	(³)	7.9	19.1	34.4	46.5	30.6	18.2	7.9	
S-57-Kan-38-6-3	6-9	.56	.059	1	15.6	(³)	(²)	(³)	7.9	20.4	36.3	43.3	31.5	19.4	8.9	
S-57-Kan-38-6-4	9-14	.49	.054	4	14.9	(³)	(²)	(³)	8.0	23.9	35.7	40.4	32.6	20.4	10.2	
S-57-Kan-38-6-5	14-23	.43	.046	11	16.2	(³)	(²)	(³)	8.1	27.0	39.1	33.9	35.3	23.5	11.4	
S-57-Kan-38-6-6	23-32	.31	.034	11	15.8	(³)	(²)	(³)	8.1	25.9	44.4	29.7	36.4	24.3	10.7	
S-57-Kan-38-6-7	32-49	.26	(³)	7	16.0	(³)	.1	(³)	8.3	22.1	44.7	33.2	37.1	22.5	10.0	
S-57-Kan-38-6-8	49-66+	.16	(³)	7	14.2	(³)	.3	(³)	8.4	16.7	46.8	36.5	36.0	19.2	7.8	

¹ Samples analyzed by the Soil Survey Laboratory, Lincoln, Nebr.
² Below minimum reportable.
³ Not determined.

the loess was deposited. Most of the sands in the county lie south of and adjacent to the valley of the Arkansas River. Steep, choppy dunes and hummocks occur near the river, but they gradually become more subdued farther to the south. According to Thad G. McLaughlin,¹⁰ the formation of the sand dunes lying south of the Arkansas River probably began in late Pleistocene time and continued into Recent time.

Soils Developed in Loess

The Richfield, Colby, and Ulysses silt loams have developed in loess but differ from each other because of differences in relief or drainage and in age. Internal drainage is good in all these soils, but the more sloping soils have a greater amount of runoff. Time, perhaps, is also a factor that is expressed in the different degrees

of development of these soils. The age of the loess is probably the same in all three soils, but the apparent age, as indicated by their soil profiles, is different. This difference in apparent age is a reflection of geologic erosion, which has kept pace with soil development on the steeper slopes. Therefore, the time that soil-forming processes have acted on soil material has been much more limited on steeper slopes than on nearly level areas. The Richfield silt loams normally have slopes of less than 1/2 percent, Ulysses silt loams generally have slopes of 1/2 to 2 percent, and Colby silt loams generally have slopes of 1 to 15 percent. Small areas of Colby silt loams have slopes of less than 1 percent; these slopes and those of less than 2 percent are generally convex in shape.

The Richfield silt loams are dark grayish-brown soils typical of the Chestnut great soil group. The profile has good differentiation between the A, B, and C horizons. The soil is generally noncalcareous to a depth of 12 or 14 inches.

¹⁰ McLAUGHLIN, THAD G. GEOLOGY AND GROUND-WATER RESOURCES OF HAMILTON AND KEARNY COUNTIES, KANSAS. Kans. Geol. Sur. Bul. 49, 220 pp., illus. 1943.

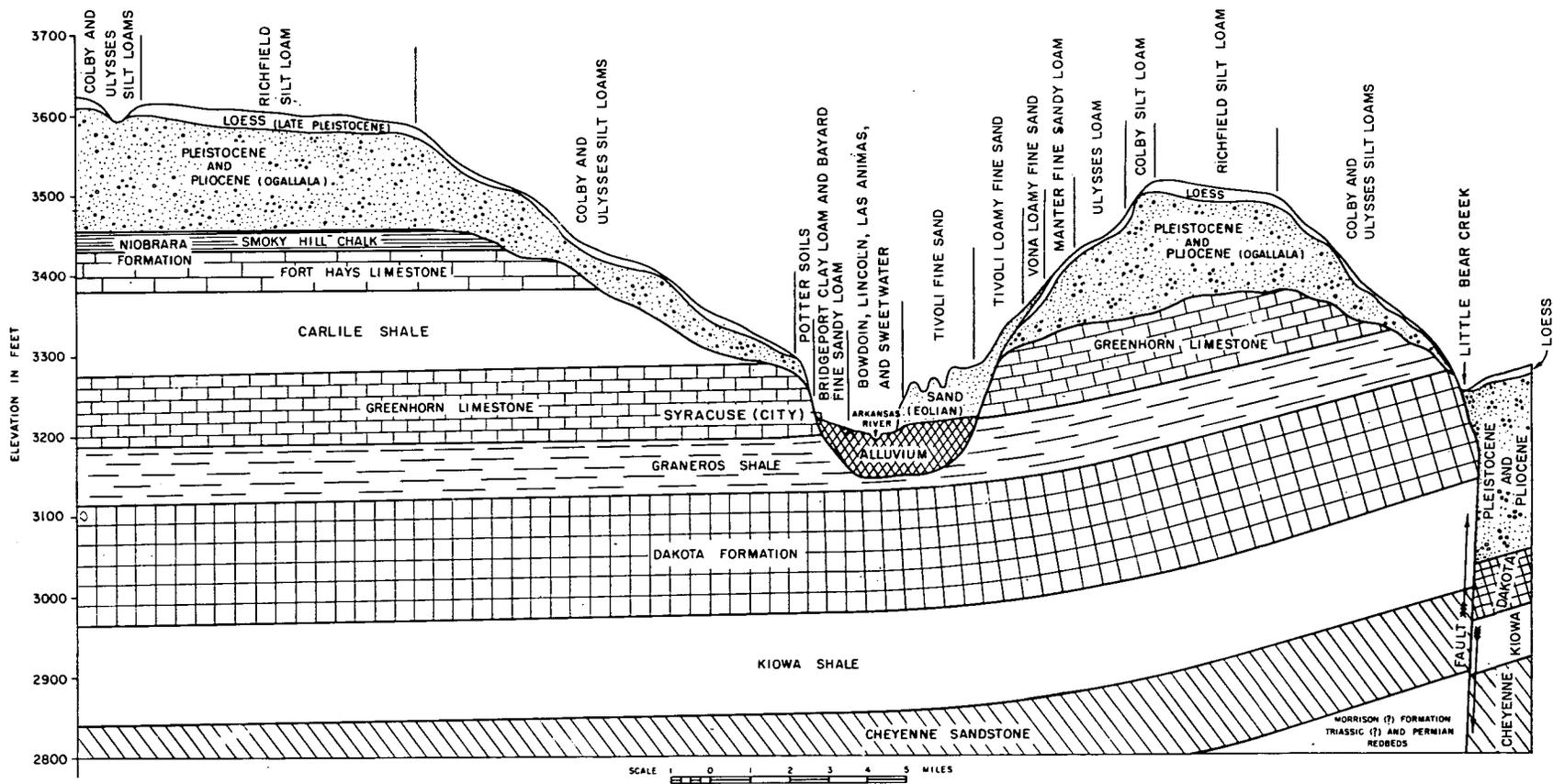


Figure 16.—Geologic profile extending in a north-south direction through the central part of Hamilton County.

In contrast to the Richfield soils, the Colby silt loams are grayish-brown, calcareous Regosols. They have a weakly developed profile with only A and C horizons; the A horizon consists of only slightly altered, somewhat darkened parent material.

The Ulysses silt loams are intermediate between the Colby and Richfield soils. They are dark grayish brown, but the B horizon, if present, is only weakly developed. Under native grass, the soil may be noncalcareous to depths of 6 to 8 inches, but in cultivated areas, it is commonly calcareous to the surface. Where they occur in close association with the Colby soils, the Ulysses silt loams occupy the more gentle, mainly concave slopes.

Representative profiles of the Richfield, Ulysses, and Colby silt loams are described in the section, Descriptions of the Soils.

Soils Developed in Sandy Sediments

A sequence of soils has developed in sandy sediments in a band south of the valley of the Arkansas River. Near the river the soil parent material consists of fine sand that is many feet thick. To the south the parent material becomes thinner and contains increasing amounts of silt and clay.

Soils of the Tivoli series have formed in fine sand on stabilized dunes and occur closest to the river. They have an A horizon of grayish-brown fine sand that is underlain by parent material consisting of pale-brown, noncalcareous, eolian fine sand. The Tivoli soils are members of the Regosol great soil group.

Next in the sequence of soils, and to the south of the Tivoli soils, is the grayish-brown Vona loamy fine sand. This soil is a member of the Brown great soil group. It occupies more subdued but still slightly hummocky topography of generally less than 5 percent slope. The parent material is moderately calcareous sandy loam and loamy fine sand that appear to have been reworked somewhat by the wind. It is reasonable to assume that some of the eolian fine sand, like that in which the Tivoli soils have formed, has drifted and contributed to the development of the Vona soils and its associates in this sequence. Vona loamy fine sand has a weakly developed B₂ horizon of noncalcareous sandy loam over sandy, but somewhat variably textured, calcareous parent material of the C horizon. The soil becomes somewhat calcareous at depths ranging from 15 to 30 inches.

Adjacent and to the south of Vona loamy fine sand are the Manter fine sandy loams. These soils are darker colored than the Vona soil and have developed in somewhat finer textured material that also seems to have been reworked to a degree. They have an A horizon of dark grayish-brown sandy loam over a noncalcareous, weak textural B₂ horizon that is about loam to sandy loam in texture. Calcareous loam underlies the B₂ horizon at depths ranging from about 12 to 24 inches below the surface.

The Manter soils gradually give way on the south to the Ulysses loams. The Ulysses loams have most of the characteristics of the Ulysses silt loams, but they contain more fine sand and less silt and clay; as a result, they are loam in texture throughout the solum and well into the underlying material. The fact that this area

contains more sand than the area in which Ulysses silt loams developed can be attributed to the movement of the coarser local loess out of the valley of the Arkansas River. Some fine eolian sand has also moved onto the area and has subsequently mixed with the siltier material.

Representative profiles of Tivoli, Vona, and Manter soils and Ulysses loam are described in the section, Descriptions of the Soils.

Soils Developed in Alluvium

The Las Animas, Las, Lincoln, Bowdoin, and Sweetwater are calcareous, young soils that have developed in alluvium on the flood plain of the Arkansas River. All except the Sweetwater are members of the Alluvial great soil group.

Bridgeport clay loam occupies alluvial fans and aprons along the northern margin of the valley. This soil is also young, weakly developed, and calcareous. The relatively recent alluvial deposits in which the soil has formed have not been in place long enough for soil-forming influences to be definitely expressed in the profile. A slight accumulation of organic matter and the darkening of the surface soil represent the extent of soil development.

Goshen silt loam is a noncalcareous, dark-colored soil that has a moderately well developed profile. It has formed in local alluvium in upland swales that collect and drain water from Richfield, Ulysses, and Colby soils. The Goshen soil has benefited from extra moisture and, consequently, has developed into a thicker, darker soil than is normal in the area.

Representative profiles of the Las Animas, Las, Lincoln, Bowdoin, Sweetwater, Bridgeport, and Goshen soils are described in the section, Descriptions of the Soils.

Glossary

- Aggregate.** A single mass or cluster of soil consisting of many soil particles held together.
- Alluvium.** Sand, silt, mud, or other sediments deposited by running water.
- Buried soil.** Soil covered by more recently deposited materials in which the present soil has formed.
- Calcareous soil or soil material.** Soil containing sufficient free calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with hydrochloric acid.
- Caliche.** A more or less cemented deposit of calcium carbonate or of mixed calcium and magnesium carbonates, characteristic of warm desert and semiarid regions.
- Classification, soil.** Soils are arranged into groups in several categories, on the basis of their characteristics. Beginning with the lowest category, the soil type, soils are classified on the basis of progressively fewer characteristics into the groups of more inclusive categories; namely, series, family, great soil group, suborder, and order.
- Clay.** Small mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that contains 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.
- Clay films.** A coating or film of clay that has been deposited on the surface of a soil aggregate.
- Clay loam.** Soil material containing 27 to 40 percent clay and 20 to 45 percent sand.
- Colluvium.** Soil material or mixtures of soil material and rock fragments that have moved downslope and accumulated through the influence of gravity, including creep and local wash.

- Complex, soil.** A soil mapping unit consisting of two or more soil types or phases so intermingled that they cannot be separated on the scale of mapping used.
- Concretions.** Local concentration of certain chemical compounds, such as calcium carbonate or compounds of iron, that form nodules of mixed composition and of various sizes, shapes, and coloring.
- Consistence, soil.** The attributes of soil material that are expressed by the degree and kind of cohesion and adhesion or by the resistance to deformation or rupture. Terms commonly used to describe consistence are *loose, soft, hard* (dry); *friable, firm, loose* (moist); and *sticky* or *plastic* (wet). *Friable* soil, for example, is easily crumbled by the fingers.
- Deep soil.** Terms that relate to depth of soil need to be defined in relation to the purpose for which they will be used. In this report, a soil described as deep has an effective root zone of 36 inches or more, over rock or other strongly contrasting material.
- Gravel.** Rounded or angular fragments of stone from 2 millimeters to 3 inches in diameter.
- Horizon, soil.** A layer of soil, approximately parallel to the soil surface, that has characteristics produced by soil-forming processes. The relative positions of the several soil horizons in the soil profile and their nomenclature are given below:
- A horizon.* The surface horizon of a mineral soil having maximum biological activity, or eluviation (movement of soil materials from one place to another within the soil), or both.
- B horizon.* A layer of soil, usually beneath the A horizon, in which clay, iron, and aluminum compounds, and accessory organic matter have accumulated. It has well-defined characteristics, in contrast to horizons above and below, of texture, structure, and usually color.
- C horizon.* A layer of unconsolidated material, relatively little affected by the influence of organisms and presumed to be similar in physical, chemical, and mineralogical composition to the material from which at least part of the overlying solum has developed.
- Loam.** Soil material containing 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.
- Loamy sand.** Soil material containing at the upper limit 85 to 90 percent sand and in which the percentage of silt plus 1½ times the percentage of clay is not less than 15; at the lower limit it contains not less than 70 to 85 percent sand and the percentage of silt plus twice the percentage of clay does not exceed 30.
- Loamy soils.** A general expression for soils with textures intermediate between clay and sand.
- Loess.** Geologic, wind-transported deposit of relatively uniform fine sediments, high in silt content.
- Mechanical analysis.** A physical analysis of soil materials to determine the percentage amounts of the various soil separates, such as sand, silt, and clay.
- Outwash sediments.** Old alluvial sediments, generally now in upland positions, that consist of more or less sorted gravel, sand, silt, or clay.
- Phase, soil.** The subdivision of a soil type or other soil classification unit on the basis of variations in characteristics that are not significant to the classification of the soil in its natural landscape but are significant to the use and management of the soil. Differences in slope and degree of erosion account for the main variations of this kind in western Kansas.
- Profile, soil.** A vertical section of the soil through all its horizons and extending into the underlying or parent material.
- Relief.** The differences in altitude of a land surface, considered collectively.
- Sand.** Individual mineral particles having diameters of 0.05 to 2.0 millimeters. The textural class name for soil material that contains 85 percent or more of sand and in which the percentage of silt, plus 1½ times the percentage of clay, does not exceed 15.
- Sandy clay.** Soil material containing 35 percent or more of clay and 45 percent or more of sand.
- Sandy clay loam.** Soil material that contains 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand.
- Sandy loam.** Soil material that contains either 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30, and 52 percent or more sand; or less than 7 percent clay, less than 50 percent silt, and between 43 and 52 percent sand.
- Series, soil.** A group of soils that have horizons similar in their differentiating characteristics and arrangement within the profile, except for texture of the surface soil, and are formed from similar parent materials. Each soil series is given the name of a town or other geographic feature, generally one near the place where it was first identified, such as Colby, Richfield, or Ulysses.
- Silt.** Individual mineral particles having diameters of 0.002 to 0.05 millimeter. The textural class name for soil material containing 80 percent or more silt and less than 12 percent clay. Locally, the term silt is also used to refer to loamy sediments of any size class that were deposited by floodwaters.
- Silt loam.** Soil material that contains 50 percent or more silt and 12 to 27 percent clay, or 50 to 80 percent silt and less than 12 percent clay.
- Silty clay.** Soil material that contains 40 percent or more clay and 40 percent or more silt.
- Silty clay loam.** Soil material that contains 27 to 40 percent clay and less than 20 percent sand.
- Solum.** The upper part of the soil profile, above the parent material, in which the processes of soil formation are active. This includes the A and B horizons in mature soils.
- Structure, soil.** The aggregation of primary soil particles into compound particles that are separated from adjoining aggregates by surfaces of weakness. An individual soil aggregate is called a ped.
- Subsoil.** Generally, that part of the soil below the plow layer in which plant roots grow. The B horizon in soils with distinct profiles.
- Texture, soil.** Refers to the relative proportions of clay, silt, and sand in soil material. It is indicated by the textural class name—such as silt loam or sandy clay—of the soil. (See **Clay; Loam; Sand; Silt**; and also the definitions of the following textural classes: **Clay loam; Loamy sand; Sandy clay; Sandy clay loam; Sandy loam; Silt loam; Silty clay; Silty clay loam.**)
- Coarse-textured soil.* Soil material of textural classes of sands and loamy sands. (Also known as "light texture.")
- Fine-textured soil.* Soil material of textural classes of sandy clay, silty clay, and clay. (Also known as "heavy texture.")
- Tilth.** The physical condition of a soil in respect to its fitness for growth of specified plants.
- Topsoil.** A general term used in at least four different senses: (1) Surface soil layer or plow layer; (2) the original or present dark-colored upper soil; (3) the A horizon; (4) presumed fertile soil material used to spread on lawns, gardens, and roadbanks.
- Type, soil.** A subdivision of a soil series based on the texture of the A horizon. The name of a soil type consists of the series name plus the textural class name of the A horizon; examples are Colby silt loam and Ulysses loam.

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

[See table 1, p. 4, for approximate acreage and proportionate extent of the soils, and table 3, p. 27, for estimated average yields per acre on arable soils under dryland farming]

Map symbol	Mapping unit	Capability unit		Capability unit		Range site	Page
		Dryland	Irrigated	Dryland	Irrigated		
Ad	Active dunes.....	5	VIIe-1	26	(¹)	Choppy sands.....	33
An	Alluvial land.....	5	VIw-1	25	(¹)	Lowland.....	32
Ba	Bayard fine sandy loam.....	5	IVe-2	24	IIs-1	Sandy.....	33
Bc	Bowdoin clay.....	6	VIw-2	26	IVw-1	Saline lowland.....	32
Bd	Bowdoin clay loam.....	5	IVw-1	25	IVw-1	Saline lowland.....	32
Bf	Bowdoin loamy fine sand.....	6	VIe-2	25	(¹)	Sands.....	33
Bx	Bowdoin-Las Animas complex.....	6	VIw-2	26	(¹)	Saline lowland.....	32
By	Bridgeport clay loam.....	7	IIIe-1	23	I-1	Loamy upland.....	33
Ca	Colby silt loam, 0 to 1 percent slopes.....	8	IVe-3	25	I-1	Loamy upland.....	33
Cb	Colby silt loam, 1 to 3 percent slopes.....	7	IVe-1	24	IIIe-1	Loamy upland.....	33
Cc	Colby silt loam, 3 to 5 percent slopes.....	8	VIe-1	25	(¹)	Loamy upland.....	33
Cd	Colby silt loam, 5 to 15 percent slopes.....	8	VIe-1	25	(¹)	Loamy upland.....	33
Go	Goshen silt loam.....	8	IIIc-2	23	I-1	Lowland.....	32
La	Las clay loam, moderately deep.....	9	IVw-1	25	IIIw-1	Saline lowland.....	32
Lb	Las clay loam, deep.....	8	IVw-1	25	IIw-1	Saline lowland.....	32
Lc	Las Animas loamy sand.....	9	VIw-2	26	(¹)	Saline lowland.....	32
Ld	Las Animas sandy loam.....	9	IVw-1	25	IIIw-2	Saline lowland.....	32
Lf	Lincoln sand.....	10	VIIw-1	26	(¹)	(²).....	
Lo	Lofton clay loam.....	10	IVw-2	25	(¹)	Loamy upland.....	33
Ma	Manter fine sandy loam, 0 to 1 percent slopes.....	11	IIIe-2	24	IIs-1	Sandy.....	33
Mb	Manter fine sandy loam, 1 to 3 percent slopes.....	11	IIIe-3	24	IIIe-2	Sandy.....	33
Ot	Otero fine sandy loam, 1 to 3 percent slopes.....	11	IVe-2	24	(¹)	Sandy.....	33
Ox	Otero-Vona complex, 5 to 15 percent slopes.....	12	VIe-3	25	(¹)	Sandy.....	33
Po	Potter soils.....	12	VIIIs-1	26	(¹)	Breaks.....	33
Rm	Richfield silt loam, 0 to 1 percent slopes.....	12	IIIc-1	23	I-1	Loamy upland.....	33
Rn	Richfield silt loam, 1 to 3 percent slopes.....	13	IIIe-1	23	IIIe-1	Loamy upland.....	33
Sw	Sweetwater clay loam.....	13	VIw-2	26	(¹)	Saline lowland.....	32
Tf	Tivoli fine sand.....	13	VIIe-1	26	(¹)	Choppy sands.....	33
Ts	Tivoli loamy fine sand.....	14	VIe-2	25	(¹)	Sands.....	33
Tx	Tivoli-Dune land complex.....	14	VIIe-1	26	(¹)	Choppy sands.....	33
Ua	Ulysses loam, 0 to 1 percent slopes.....	15	IIIc-1	23	I-1	Loamy upland.....	33
Ub	Ulysses loam, 1 to 3 percent slopes.....	14	IIIe-1	23	IIIe-1	Loamy upland.....	33
Uc	Ulysses silt loam, 0 to 1 percent slopes.....	15	IIIc-1	23	I-1	Loamy upland.....	33
Ud	Ulysses silt loam, 1 to 3 percent slopes.....	15	IIIe-1	23	IIIe-1	Loamy upland.....	33
Ue	Ulysses-Colby complex, 1 to 3 percent slopes, eroded.....	15	IVe-1	24	IIIe-1	Loamy upland.....	33
Vo	Vona loamy fine sand.....	15	IVe-2	24	(¹)	Sands.....	33

¹ Considered unsuitable for irrigation.

² Because the soil and vegetation are unstable, this soil is not considered a true range site.



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