Series 1961, No. 28

Issued September 1965

# SOIL SURVEY

# Seward 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 Seward County will serve several groups of readers, particularly farmers and ranchers who want information to help them plan the kind of management that will protect their soils and provide good yields. The survey describes the soils, shows their location on a map, and tells what they will do under different kinds of management.

## Locating the Soils

Use the *index to the map sheets* to locate areas on the large map. The index is a small map of the county that has numbered rectangles to show where each sheet of the large map is located. When you locate the correct sheet on the large map, you will see that the boundaries of the soils are 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 they appear on the map. The symbol is inside the area if there is enough space; otherwise, it is outside the area, and a pointer shows where the symbol belongs.

Suppose, for example, an area on the map has the symbol Rm. The legend for the detailed map shows that this symbol identifies Richfield silt loam, 0 to 1 percent slopes. This soil and all others mapped in the county are described in the section "Descriptions of the Soils."

## Finding Information

Special sections in the report will interest different groups of readers, and some sections may be of interest to all.

*Farmers and ranchers* can learn about the soils in the section "Descriptions of the Soils," and then they can turn to the section "Use and Management of the Soils." In this way they first identify the soils on their farm, and then they learn how these soils can be managed.

The soils are placed in capability units, which are groups of soils that need similar management and respond to this management in about the same way. For example, in the section "Descriptions of the Soils," Richfield silt loam, 0 to 1 percent slopes, is shown to be in capability unit IIIc-1 for dryland farming and in capability unit I-1 for irrigation farming. The management suitable for this soil, therefore, will be described under the subheadings "Capability Unit IIIc-1 (Dryland)" and "Capability Unit I-1 (Irrigated)" in the section "Use and Management of the Soils."

For the convenience of those who manage rangeland, the soils are placed in range sites. A range site is a group of soils that are similar in their potential production of grasses and in their response to management. Each range site is described in the subsection "Range Management."

The "Guide to Mapping Units" at the back of the report is provided to simplify use of the map and the report. With it, the reader can locate the description of each soil shown on the map, as well as the description of the capability unit and the range site in which the soil has been placed.

*Scientists and others interested in the study of soils* will find information about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

*Engineers and builders* will want to refer to the subsection "Engineering Properties of Soils." Tables in that subsection show the characteristics of the soils that affect engineering.

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

*Newcomers in Seward County* and those who want general information about soils, will be especially interested in the section "General Soil Map," which describes broad patterns of the soils. They may also wish to read the section "General Nature of the County," which gives additional information about the county.

* * * * *

To provide a basis for agricultural and other use of the land, this cooperative soil survey was made by the United States Department of Agriculture and the Kansas Agricultural Experiment Station. Fieldwork was completed in 1961. Unless otherwise mentioned, all statements in this report refer to conditions at the time the survey was in progress.

This survey is a part of the technical assistance that the Soil Conservation Service furnishes the Seward County Soil Conservation District, which was established in 1948. The governing board of that district arranges for technical assistance for farmers and ranchers in the countywide program for conserving soil and water. If you want help in farm or ranch planning, consult a local representative of the Soil Conservation Service.

**_Cover picture._—Combining irrigated grain sorghum. Field averages 80 bushels per acre.**

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# Contents



Series 1961, No. 28

Issued September 1965

# SOIL SURVEY OF SEWARD COUNTY, KANSAS

BY HAROLD P. DICKEY, W. R. SWAFFORD, AND Q. L. MARKLEY, SOIL CONSERVATION SERVICE

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

SEWARD COUNTY is in southwestern Kansas, on the Oklahoma line. The air mileage from Liberal, the county seat, to Topeka, the State capital, and to other towns and cities is shown in figure 1. The total area of the county is 639 square miles, or 408,960 acres.

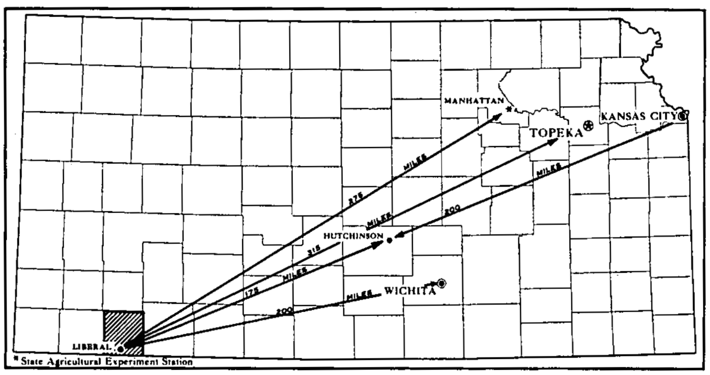


*Figure 1.*—**Location of Seward County in Kansas.**

Seward County is important for the production of grain sorghum and wheat. The county has a semiarid climate, and wind erosion is the chief hazard in farming. The production, collection, and transportation of natural gas and oil are the principal nonagricultural industries.

## *General Soil Map*

As one travels over a county or other large tract, differences in the landscape are fairly easy to see. Some of the obvious differences are in shape, steepness, and length of slopes; in the course, depth, and speed of streams and the width of their bordering valleys; in kinds of wild plants; and in kinds of farming. With these more obvious differences, there are also less easily noticed differences in the patterns of soils. Each kind of soil pattern is called a soil association.

By drawing lines around patterns of soils, or soil associations, one can make a map of general soil areas. On such a map the soil associations are named for the major soil series in them, but soils of other series may be present in any of the associations. Also, the major soil series of one association may occur in others. A map showing soil associations 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 farming or other broad land use. But a general soil map, or map of soil associations, does not show accurately all the kinds of soils on a single farm or a small tract.

The four soil associations in Seward County are shown on the colored map at the back of this report. One contains the flood plains and adjacent slopes along the Cimarron River and its main tributaries. Another is the rolling sandy land on both sides of the river valley. The northeastern part of the county is mainly loamy soils of the upland. The southwestern part contains good-sized areas of moderately sandy soils and smaller blocks of the rolling sandy land and the loamy hardland, all in upland positions. A discussion of each soil association follows.

### 1. Colby-Otero-Lincoln association: Soils on flood plains and adjacent slopes along the Cimarron River

This soil association covers about 19 percent of the county. It occupies the slopes and flood plains along the Cimarron River and its tributaries (fig. 2).

Colby, Otero, and Lincoln soils are dominant in this association, but there are also smaller areas of Las Animas, Likes, and Bayard soils and of Alluvial land, Gravelly broken land, and Rough broken land. The Colby and Otero soils are on moderately steep slopes above the gently sloping Likes and Bayard soils. The Colby soils have a loam surface soil, and the Otero soils have a fine sandy loam surface soil. The surface soil of the Likes soil is loamy sand, and that of the Bayard soil is fine sandy loam. The Lincoln and Las Animas soils and Alluvial land are on bottom lands along the Cimarron River. Gravelly broken land and Rough broken land are on steep slopes.

The soils of this association are best suited to pasture of native grass and are used mainly for this purpose.

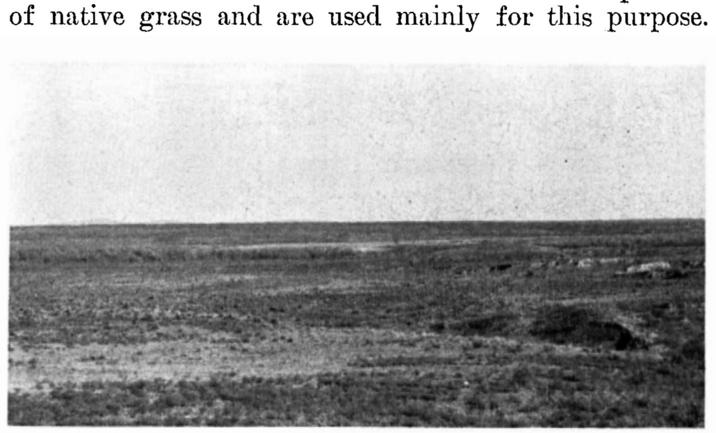

*Figure 2.*—**Cimarron River valley and adjacent slopes. Soil association 1.**

Small acreages of Bayard, Colby, Las Animas, and Likes soils produce wheat and sorghum.

Wind erosion and water erosion are problems on the soils in this association. Flooding is an additional problem on the Lincoln and Las Animas soils.

**2. Vona-Tivoli association: Rolling sandy soils on upland**

This soil association covers about 22 percent of the county. It occurs in all parts of the county except the northeastern. The soils are rolling, hilly, and generally sandy (fig. 3).

The Vona soils are the most extensive in this soil association, but large areas of Tivoli soils also occur. The Vona soils are gently rolling. They have a loamy fine sand surface layer and a fine sandy loam subsoil. The Tivoli soils are hilly. They have a fine sand and loamy fine sand surface layer and a fine sand subsoil. Also in this association are smaller areas of Otero and Mansic soils and of Blown-out land.

These soils are used mainly for pasture of native grass and are best suited to that use. They are not well suited to cultivated crops, but a small acreage is used for crops, mainly sorghum.

The soils of this association are highly susceptible to wind erosion in areas not protected by vegetation. Also, they have a low or moderate moisture-holding capacity.

**3. Richfield-Spearville association: Loamy soils on upland**

This soil association covers about 33 percent of the county. It occurs mostly in the northeastern part of the county and is nearly level and gently sloping (fig. 4).

Dominant in this association are the Richfield and Spearville soils, both of which are nearly level. The more extensive Richfield soils have a silt loam and loam surface layer and a silty clay loam and clay loam subsoil. The Spearville soil has a silty clay loam surface layer and a silty clay subsoil. Also in this association are the Ulysses, Colby, and Randall soils. The Ulysses soils have a silty loam surface layer and a subsoil less clayey than that of the Richfield and Spearville soils. Ulysses soils are nearly level and gently sloping. The Randall soil is a clay, and the Colby soils are loamy.

Most of this association is used for cultivated crops, mainly wheat and grain sorghum, and is well suited to this use. The irrigated acreage is the largest in the county.

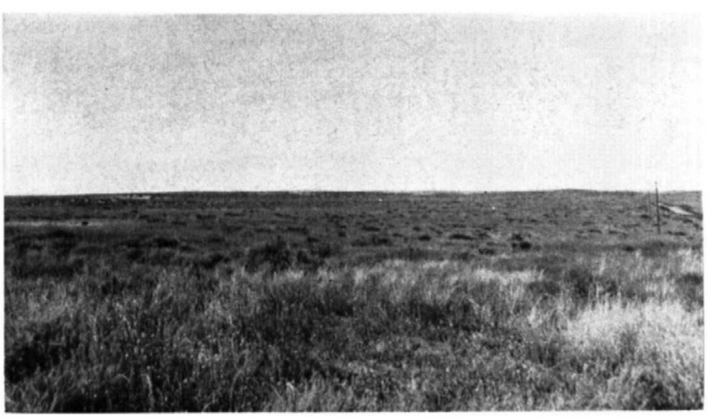

*Figure 3.*—**Rolling soils of the Vona-Tivoli soil association.**

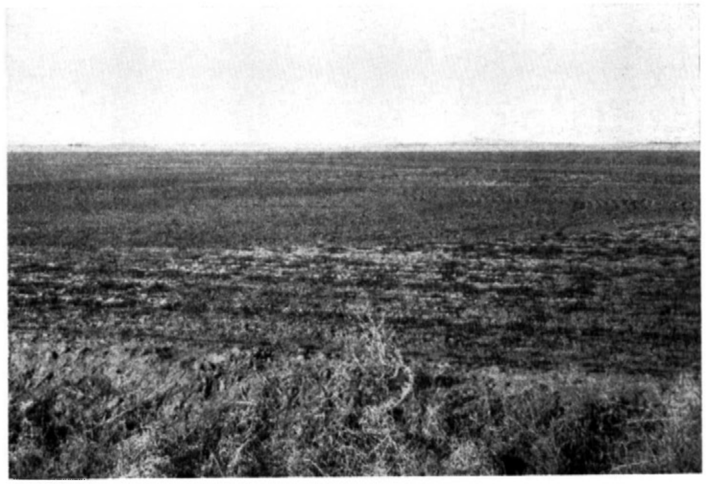

*Figure 4.*—**Nearly level soils of the Richfield-Spearville association.**

Nearly level areas are susceptible to wind erosion, and both wind and water erosion are hazards on gentle slopes. Water should be conserved on all soils if they are to produce crops profitably.

**4. Dalhart-Manter association: Moderately sandy soils on upland**

This soil association covers about 26 percent of the county. It occurs in all parts of the county except the northeastern and is adjacent to the Vona-Tivoli association. The soils range from nearly level to undulating.

Dalhart and Manter soils are dominant in this association, and there are smaller areas of Richfield soils. The Dalhart soils, the most extensive in this association, are nearly level or undulating. They have a fine sandy loam or loamy fine sand surface layer and a sandy clay loam subsoil. The Manter soils are undulating and have a fine sandy loam surface layer and subsoil. The Richfield soils are nearly level and have a fine sandy loam surface layer and a clay loam subsoil.

These soils are used mainly for cultivated crops, particularly wheat and sorghum, and are well suited to that use. Native grass grows on a small acreage, and it is grazed.

The soils of this association are susceptible to wind erosion, but they take in water well and readily supply it to plants.

## *How Soils Are Mapped and Classified*

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

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

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Dalhart and Richfield, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Dalhart fine sandy loam and Dalhart loamy fine sand are two soil types in the Dalhart series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Dalhart fine sandy loam, 0 to 1 percent slopes, is one of several phases of Dalhart fine sandy loam, a soil type that ranges from nearly level to gently sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

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

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Otero-Mansic soils. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Alluvial land or Blown-out land, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

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

## *Effects of Erosion*

Erosion is the wearing away of the earth's surface by water and wind. Accelerated soil erosion is erosion that has had its rate increased because of human activity. Normal, or geologic, erosion is a continuous wearing away and reshaping of the earth's surface. This section discusses some of the effects of accelerated erosion in Seward County.

Wind is the erosive agent that does the most damage to the soils in Seward County. Wind erosion is always a hazard and may become serious if the soil lacks vegetation or a roughened surface. Only dry soils are moved by wind. Soil blowing generally starts on the windward edge of an area and increases progressively toward the leeward edge. Therefore, emergency tillage should begin on the windward edge of an eroding area.

All of the cultivated soils in Seward County have had some soil moved by wind. In comparing cultivated soils with undisturbed soils of the same type, the cultivated soils appear only slightly altered. The alteration is most apparent on a few sandy soils that have been cultivated. These sandy soils, however, have been affected more by wind-deposited sand particles and by winnowing than by removal of the surface soil.

Soil blowing forms small drifts on the nearly level and gently sloping loamy soils (fig. 5). These drifts become larger and more extensive (fig. 6) unless the soil is tilled to provide a roughened surface that resists wind erosion. Many of the loamy soils show no permanent effects of wind erosion. Nevertheless, much of the organic matter and some clay has been removed from their surface layer

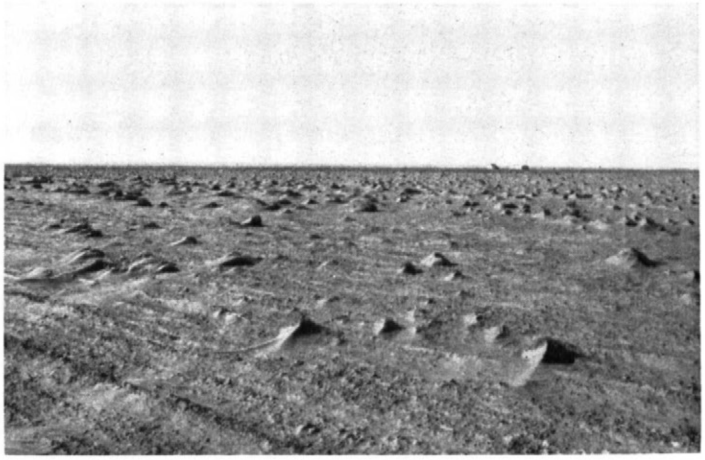

*Figure 5.*—**The beginning stage of soil blowing on a clean-tilled field of Richfield silt loam, 0 to 1 percent slopes.**

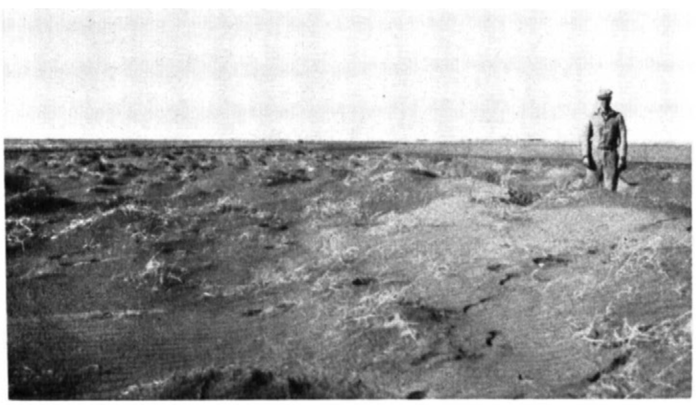

*Figure 6.*—**Richfield and Spearville soils in the 1930's. Some of the drifts were 3 to 4 feet high.**

by the wind. A few areas of loamy soils had been significantly eroded before the survey was made, and these were mapped and described as eroded soils.

In most places the fine sandy loams have a 2- to 4-inch layer of loamy fine sand on the surface, generally because the surface soil has been winnowed.

Soils that ordinarily have a surface layer of loamy fine sand are highly susceptible to wind erosion and, in places, are covered with large drifts as much as 10 feet high. Apparently the most damaging results of wind on the soils are the large drifts and the loss of organic matter, silt, and clay from the plow layer. Because the sand shifts, farmers may have to plant a crop two or three times before a stand is established. As a result of deposition and winnowing, some soils that originally had a fine sandy loam surface layer now have a surface layer of loamy fine sand that is 8 to 12 inches thick.

The effect of wind erosion is apparent, even dramatic, at the time it happens, but it is difficult to identify and record the lasting effect of wind erosion on the soil profile. From field observations the effect of wind erosion on soil productivity appears to be slight.

The best method of controlling and preventing wind erosion is to maintain a cover of crop residue that protects the soil from the wind. Tillage helps to control wind erosion on bare soil but is not so effective as a cover of crop residue. Figure 7 shows that emergency tillage does not always control or stop wind erosion.

Water erosion in Seward County may permanently damage the soil in sloping areas, particularly along the drains. Water causes sheet and rill erosion on a sloping field during an intensive rain (fig. 8). On the nearly level fields water erosion does little permanent damage to the soils, but it is a nuisance to the farmer. A newly planted crop can be washed under by an intensive rain (fig. 9), and replanting will be required. Management that slows down or decreases runoff conserves moisture and helps control water erosion.

Erosion has important short-time effects, even if it does not permanently damage the soil. Replanting of crops, seeding some rangeland, and emergency tillage are needed to correct the effect of erosion, and these operations are time consuming and costly.

For more specific information about erosion control, consult the local representative of the Soil Conservation Service.

Soils in Seward County that have been eroded and can be consistently identified as eroded are shown on the detailed soil map. Spot symbols on the maps show areas that have been eroded but are too small to be mapped separately.

*Figure 7.*—**Wind erosion has occurred on this field despite emergency tillage.**

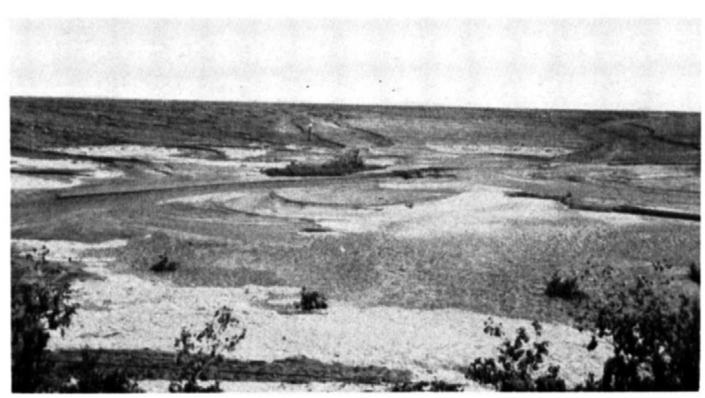

*Figure 8.*—**Water erosion on gently sloping soils.**

*Figure 9.*—**Effects of water erosion on a nearly level field.**

## *Descriptions of the Soils*

This section describes the soil series (groups of soils) and single soils (mapping units) of Seward County. The acreage and proportionate extent of each mapping unit are given in table 1.

The procedure in this section is first to describe the soil series, and then the mapping units in that series. Thus to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. As mentioned in the section "How Soils Are Mapped and Classified," not all mapping units are members of a soil series. Alluvial land and Blown-out land are miscellaneous land types and do not belong to a soil series but, nevertheless, are listed in alphabetic order along with the soil series.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit and the range site in which the mapping unit has been placed. The page on which each capability unit or range site is described can be found readily by referring to the "Guide to Mapping Units" at the back of the report.

Soil scientists, engineers, students, and others who want detailed descriptions of soil series should turn to the section "Formation and Classification of the Soils." Many terms used in the soil descriptions and other sections of the report are defined in the Glossary.

### Alluvial Land (An)

Alluvial land occupies narrow flood plains along the tributaries of the Cimarron River in the northwestern part of the county. It is nearly level but has been dissected by meandering intermittent streams. This land type receives runoff from Colby loam and Otero gravelly complex. Its surface layer is loam or fine sandy loam.

This land type produces native grass for pasture and is best suited to that use. It generally produces a good stand of native grasses, except in the stream channels. Capability unit VIw-1 (dryland); Loamy Lowland range site.

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

| Soil name | Area | Extent |
|---|---|---|
| | *Acres* | *Percent* |
| Alluvial land. | 776 | 0. 2 |
| Bayard fine sandy loam, 1 to 4 percent slopes. | 2, 725 | . 7 |
| Blown-out land. | 1, 927 | . 5 |
| Colby loam, 5 to 12 percent slopes. | 14, 729 | 3. 6 |
| Colby loam, 3 to 5 percent slopes. | 2, 782 | . 7 |
| Dalhart fine sandy loam, 0 to 1 percent slopes. | 29, 299 | 7. 2 |
| Dalhart fine sandy loam, 1 to 3 percent slopes. | 23, 863 | 5. 8 |
| Dalhart loamy fine sand, 0 to 3 percent slopes. | 19, 398 | 4. 7 |
| Gravelly broken land. | 2, 021 | . 5 |
| Las Animas sandy loam. | 3, 326 | . 8 |
| Likes loamy sand. | 12, 843 | 3. 1 |
| Lincoln soils. | 4, 897 | 1. 2 |
| Manter fine sandy loam, hummocky. | 2, 664 | 7 |
| Manter-Dalhart fine sandy loams, undulating. | 28, 214 | 6. 9 |
| Otero gravelly complex. | 23, 838 | 5. 8 |
| Otero-Mansic complex, undulating. | 9, 728 | 2. 4 |
| Randall clay. | 3, 932 | 1. 0 |
| Richfield fine sandy loam, 0 to 1 percent slopes. | 3, 626 | . 9 |
| Richfield loam, thick surface, 0 to 1 percent slopes. | 9, 121 | 2. 2 |
| Richfield silt loam, 0 to 1 percent slopes. | 73, 435 | 18. 0 |
| Richfield and Ulysses complexes, bench leveled. | 5, 736 | 1. 4 |
| Rough broken land. | 6, 393 | 1. 6 |
| Spearville silty clay loam, 0 to 1 percent slopes. | 25, 265 | 6. 2 |
| Tivoli fine sand. | 4, 703 | 1. 1 |
| Ulysses silt loam, 0 to 1 percent slopes. | 11, 680 | 2. 8 |
| Ulysses silt loam, 1 to 3 percent slopes. | 4, 162 | 1. 0 |
| Ulysses-Colby complex, 1 to 3 percent slopes, eroded. | 1, 565 | . 4 |
| Vona loamy fine sand. | 39, 061 | 9. 5 |
| Vona-Tivoli loamy fine sands. | 35, 136 | 8. 6 |
| Cimarron River. | 1, 990 | . 5 |
| Water. | 125 | (1) |
| Total. | 408, 960 | 100. 0 |

[1] Less than 0.1 percent.

### Bayard Series

The Bayard series consists of deep, gently sloping, sandy soils that are calcareous and well drained. These soils occur on alluvial fans below the moderately steep slopes along the Cimarron River. They developed under a cover of mid and tall grasses.

The brown to dark-brown fine sandy loam surface layer is very friable, generally calcareous, and easily tilled. It is moderately to highly susceptible to wind erosion in cultivated areas. The brown, granular fine sandy loam subsoil is easily penetrated by moisture and plant roots. It is calcareous and friable. The underlying material is calcareous sand to sandy loam that washed or rolled from the steeper slopes above these soils.

The Bayard soils have a thicker, darker colored surface layer than the Likes soils and are less sandy throughout the profile. Their substratum is not mottled and contains less sand than that of Las Animas soils. Also, stratification is not so noticeable as it is in the Las Animas soils.

**Bayard fine sandy loam, 1 to 4 percent slopes** (Bb).—This soil has a brown fine sandy loam surface layer about 6 to 12 inches thick. Its slopes are convex. Many intermittent drainageways either cross the soil or end on it. Included in areas mapped as this soil, and totaling as much as 10 percent of these areas, are pockets of gravelly material and small areas of Likes loamy sand and Las Animas sandy loam.

This soil is not well suited to cultivated crops. About 30 percent of its acreage is used for wheat and sorghum, and the rest is in native grass pasture. In cultivated areas wind erosion is a hazard. Capability unit IVe-4 (dryland); Sandy range site.

## Blown-Out Land (Bo)

Blown-out land is severely eroded and almost without vegetation. It consists of sand or loamy sand that is still shifted by the wind. It occurs mainly with Vona and Tivoli soils on complex slopes of 5 to 15 percent. Growing plants are difficult to establish, but a local representative of the Soil Conservation Service can give information about revegetation of this land type. Blown-out land is generally used as pasture, or it is idle. Capability unit VIIe-1 (dryland); Choppy Sands range site.

## Colby Series

Soils of the Colby series are deep, light colored, and loamy. They occur on uplands along drains and in areas that slope to the Cimarron River in the northwestern part of the county. These soils developed under a cover of short and mid grasses.

The brown to grayish-brown surface layer is loam 4 to 8 inches thick. This layer is granular and friable, and it takes in moisture readily. It is calcareous and highly erosive. The pale-brown, granular loam subsoil is easily penetrated by moisture and plant roots. It is calcareous and friable and is underlain by loamy sediments.

The Colby soils contain less sand than the Otero soils and have a thinner, lighter colored surface layer than the Ulysses soils.

**Colby loam, 5 to 12 percent slopes** (Cm).—This soil has a loam surface layer. Many intermittent drainageways begin on its convex slopes. Runoff is medium to rapid. Figure 10 shows a view of this soil. Included in areas mapped as this soil, and totaling as much as 15 percent of these areas, are small areas of Otero fine sandy loam, Ulysses silt loam, and Mansic clay loam.

Most of this soil is used to produce native grass for pasture, which is its best use. The soil is subject to wind and water erosion, particularly water erosion. Capability unit VIe-1 (dryland); Limy Upland range site.

*Figure 10.*—Colby loam, 5 to 12 percent slopes.

**Colby loam, 3 to 5 percent slopes** (Cc).—This soil has a loam surface layer and convex slopes. Areas mapped as this soil may include small areas of Otero fine sandy loam, Ulysses silt loam, and Mansic clay loam that total as much as 10 percent of the mapped areas.

Most of this soil is used to produce native grass for pasture, which is its best use. About 10 percent is used for wheat and grain sorghum. The soil is subject to wind erosion and water erosion, particularly water erosion. Capability unit VIe-1 (dryland); Loamy Upland range site.

## Dalhart Series

The Dalhart series consists of deep, dark-colored, well-drained, sandy soils. These soils are on nearly level and gently sloping uplands in all parts of the county except the northeastern. They developed under a cover of mid and tall grasses.

The brown to dark-brown surface layer is very friable to loose and is easily tilled. It takes in moisture readily. In most plowed fields the surface layer is loamy fine sand. The subsoil is brown to dark-brown, granular sandy clay loam. It is friable, moderately slowly permeable, and easily penetrated by moisture and plant roots. The subsoil is underlain by sandy wind-deposited sediments that extend to a depth of 2 to 6 feet.

Dalhart soils have a sandier, less distinct subsoil than the Richfield soils and have more clay in the subsoil than the Manter and Vona soils. Also, the layers are more distinct than those in the Manter and Vona soils.

**Dalhart fine sandy loam, 0 to 1 percent slopes** (Da).—This soil has a fine sandy loam surface layer that is about 5 to 10 inches thick and is moderately to highly susceptible to wind erosion. It occurs on flats or on slightly convex, nearly level slopes. Included in areas mapped as this soil, and totaling as much as 15 percent of these areas, are small areas of Richfield fine sandy loam, Manter fine sandy loam, and Mansic fine sandy loam.

This soil is desirable for farming. Most of it is used for cultivated crops, mainly wheat and grain sorghum. Wind erosion is the major hazard. Capability unit IIIe-3 (dryland), I-2 (irrigated); Sandy range site.

**Dalhart fine sandy loam, 1 to 3 percent slopes** (Db).—This soil has a fine sandy loam surface layer about 4 to 8 inches thick. It occurs on convex slopes that are single and complex. Depth to calcareous material ranges from 12 to 28 inches. Included in the areas mapped as this soil, and totaling as much as 15 percent of these areas, are smaller areas of Manter fine sandy loam, Ulysses silt loam, Richfield fine sandy loam, and Otero fine sandy loam.

Most of this soil is used for cultivated crops, mainly wheat and grain sorghum. Both wind erosion and water erosion are hazards. Capability unit IIIe-2 (dryland), IIe-2 (irrigated); Sandy range site.

**Dalhart loamy fine sand, 0 to 3 percent slopes** (Df).—This soil has a loamy fine sand surface layer that is about 6 to 14 inches thick and is highly susceptible to wind erosion. It occurs on nearly level to gently sloping, complex slopes. Areas mapped as this soil include small areas of Vona loamy fine sand, Richfield fine sandy loam, and Dalhart fine sandy loam that total as much as 15 percent of the mapped area.

Most of this soil is used for cultivated crops, mainly grain sorghum. Wind, the main hazard, blows away the soil or shifts the sand particles on the surface. Because of this erosion and shifting, good stands of crops are difficult to obtain. Capability unit IVe–6 (dryland), IIIe–5 (irrigated); Sands range site.

## Gravelly Broken Land (Gr)

Gravelly broken land occurs on slopes of more than 15 percent that have been deeply dissected by many intermittent drainageways. It consists of sandy soils and many pockets and hills of gravelly materials. The surface layer is slightly darker than the underlying material. Runoff is rapid, and geologic erosion is active. Gravelly broken land supports a moderate stand of mid and tall grasses and a few shrubs of sand sagebrush. It is used for pasture and contains many gravel pits. Capability unit VIIs–4 (dryland); Gravelly Hills range site.

## Las Animas Series

Soils of Las Animas series are sandy, slightly saline, and imperfectly drained. They have been developing for only a short time in calcareous sandy sediment that was deposited on nearly level flood plains by the Cimarron River. The native vegetation is salt-tolerant and tall grasses.

The brown surface layer is 12 to 24 inches thick and is sandy loam in most places. It is very friable, and it takes in moisture readily. The pale-brown, sandy subsoil is friable and easily penetrated by moisture and plant roots. Layers of silt and clay are stratified with the sandy material of these soils. The water table is generally within 8 feet of the surface.

Las Animas soils are less sandy than the Lincoln and Likes soils but are more sandy in the substratum than the Bayard soils. Unlike Bayard soils, Las Animas soils are mottled below a depth of 20 inches.

**Las Animas sandy loam** (Ld).—This soil occupies flood plains of the Cimarron River that are seldom flooded. Although these flood plains are nearly level, they have some microrelief. Included in areas mapped as this soil, and totaling as much as 20 percent of these areas, are Lincoln soils, Bayard fine sandy loam, Likes loamy sand, and other soils. These other soils contain more silt and clay than Lincoln, Bayard, and Likes soils and are wet nearer the surface.

This soil is best suited to native grasses grown for pasture and hay, and most of it is used to produce them. In cultivated areas it is highly susceptible to wind erosion. Capability unit IVw–2 (dryland); Saline Subirrigated range site.

## Likes Series

Soils of the Likes series are deep, gently sloping, light colored, calcareous, and sandy. They occur on colluvial-alluvial fans below the moderately steep slopes of the Cimarron River valley. They developed under a cover of mid and tall grasses and sand sagebrush.

The brown to grayish-brown loamy sand surface layer is calcareous and loose. In cultivated areas it is highly susceptible to wind erosion. The pale-brown loamy sand subsoil is calcareous, loose, and low in water-holding capacity. It is underlain by calcareous sand that contains a few strata of loamy and gravelly material. This sandy material washed or rolled from the steeper slopes above these soils.

The Likes soils contain more sand throughout the profile than the Bayard soils. They contain more gravelly material than the Tivoli soils and occur on smoother relief. Unlike Tivoli soils, Likes soils are calcareous.

**Likes loamy sand** (Lk).—This soil has a loamy sand surface layer. Slopes are convex, and they range from 1 to 5 percent. Many intermittent drainageways cross the soil or end on it. Included in the areas mapped as this soil, and totaling as much as 15 percent of these areas, are pockets of gravelly material and small areas of Bayard fine sandy loam, Las Animas fine sandy loam, and Tivoli fine sand.

Most of this soil produces native grass for pasture, which is its best use. Wind erosion is a hazard in cultivated areas. Capability unit VIe–2 (dryland); Sands range site.

## Lincoln Series

The Lincoln series consists of sandy and gravelly soils on the nearly level to undulating flood plains of the Cimarron River. These soils developed under an unstable cover of cottonwood trees, shrubs, and salt-tolerant and tall native grasses. The pale-brown surface layer ranges from sandy loam to sand. Because this layer is loose and highly erosive, maintaining a stable vegetative cover is difficult.

The pale-brown subsoil is loose sand that has a low water-holding capacity. It is underlain by stratified sandy and gravelly sediments that were deposited by the Cimarron River.

The Lincoln soils contain more sand than the Las Animas soils from the surface to a depth of 24 inches.

**Lincoln soils** (Ll).—These soils on the flood plains of the Cimarron River are nearly level to gently undulating and have slopes of 0 to 3 percent. They are subject to recurrent flooding. Soil blowing is likely on these soils. The water table is generally within 6 feet of the surface. Areas mapped as these soils include small areas of Las Animas sandy loam totaling as much as 5 percent of the areas mapped.

These soils are not suitable for cultivated crops, and most areas are used for pasture. Stands of native grass, however, are difficult to maintain because the soils are unstable. Capability unit VIIw–1 (dryland).

## Mansic Series

The Mansic series consists of deep, moderately dark colored soils on gently undulating uplands. These soils developed under a cover of short and mid grasses. In this county they are mapped only in a complex with Otero soils.

The brown to dark-brown surface layer is granular clay loam or fine sandy loam that is friable and absorbs water readill. The light-brown clay loam subsoil is calcareous, friable, and easily penetrated by plant roots and moisture. It is underlain by calcareous clayey sediments.

The Mansic soils contain more clay than the Ulysses soils. They are more calcareous than the Dalhart soils and contain more clay and less sand.

## Manter Series

The deep, dark-colored soils of the Manter series occur on undulating to rolling uplands. They have developed under a cover of mid and tall grasses.

The surface layer is brown to dark grayish-brown, very friable fine sandy loam that absorbs water readily and is easily tilled. It is moderately to highly susceptible to wind erosion. The brown to yellowish-brown fine sandy loam subsoil is granular, friable, and easily penetrated by moisture and plant roots. It is moderately permeable and has water-holding capacity that is adequate for crop production. The subsoil is underlain by wind-deposited sandy sediments. Depth to calcareous material ranges from 15 to 40 inches.

The Manter soils have a darker colored surface layer than the Vona soils and contain a little less sand throughout the profile. They contain less clay in their subsoil than the Dalhart soils.

**Manter fine sandy loam, hummocky** (Mh).—This soil occurs on complex slopes of 3 to 6 percent. Areas mapped as this soil include small areas of Dalhart fine sandy loam and Vona loamy fine sand that total as much as 15 percent of the mapped areas.

Most of this soil produces cultivated crops, mainly wheat and grain sorghum. Both wind and water erosion are hazards. Capability unit IVe–4 (dryland); Sandy range site.

**Manter-Dalhart fine sandy loams, undulating** (Md).—This is a soil complex consisting mainly of Manter and Dalhart soils. Manter fine sandy loam makes up about 60 percent of the complex, and Dalhart fine sandy loam, about 25 percent. This complex occurs on slopes of 1 to 3 percent in undulating areas that are made up of hills and small ridges with flats between the hills. Manter fine sandy loam is on most of the hills and ridges, and Dalhart fine sandy loam is in the flat areas.

The surface layer of this complex is a fine sandy loam, and the subsoil ranges from fine sandy loam to sandy clay loam. Included in areas mapped as this soil, and totaling as much as 15 percent of these areas, are small areas of Otero fine sandy loam, Mansic fine sandy loam, and Vona loamy fine sand.

The soils of this complex are used mostly for cultivated crops, mainly wheat and grain sorghum. Both wind and water erosion are hazards. Capability unit IIIe–2 (dryland), IIe–2 (irrigated); Sandy range site.

## Otero Series

The Otero series consists of light-colored, calcareous, sandy soils. These soils occur on gently sloping and moderately steep uplands. They developed under a cover of short, mid, and tall grasses. In this county they occur only in complexes with other soils.

The brown to grayish-brown surface layer is fine sandy loam in most places and ranges from 5 to 10 inches in thickness. It is generally calcareous, very friable, and highly susceptible to erosion. The subsoil is granular, calcareous fine sandy loam. It is very friable and easily penetrated by plant roots and moisture. The underlying material consists of calcareous sandy sediments.

The Otero soils contain more sand than the Colby soils and have a lighter colored surface layer than the Manter and Bayard soils. They are lighter colored throughout than the Vona soils and are calcareous. In the Vona soils calcareous material is generally at a depth below 24 inches.

**Otero gravelly complex** (Ox).—This complex consists of Otero fine sandy loam, Manter fine sandy loam, Manter sandy loam, and gravelly areas in which many gravel pits occur. Otero fine sandy loam makes up more than 30 percent of the complex; Manter fine sandy loam and sandy loam, about 25 percent; and gravelly areas, about 20 percent. The complex occurs along the Cimarron River on convex slopes of 5 to 15 percent. Many intermittent drainageways begin on these convex slopes. Runoff is medium or rapid.

The surface layer ranges from fine sandy loam to gravelly sandy loam. The subsoil ranges from fine sandy loam to coarse sand and gravel. Included in areas mapped as this complex, and totaling as much as 15 percent of these areas, are small areas of Colby loam, Mansic clay loam, Bayard fine sandy loam, Likes loamy sand, and Vona loamy fine sand.

Most of this complex produces native grass for pasture, which is its best use. Water erosion is the major hazard. Capability unit VIe–6 (dryland); Sandy-Gravelly Hills range site.

**Otero-Mansic complex, undulating** (Oy).—This complex consists of Otero loamy fine sand, Otero fine sandy loam, Mansic clay loam, and Mansic fine sandy loam. Otero soils total more than 50 percent of this complex, and Mansic soils, about 30 percent. This complex occurs on slopes of 1 to 4 percent in undulating areas that are made up of many small hills and ridges with flats between the hills. Otero soils occur on the hills, and the Mansic soils, in the flat areas.

The surface layer of this complex is calcareous and is fine sandy loam in most places, but areas of loamy fine sand and clay loam occur. It is highly susceptible to wind erosion. The subsoil ranges from fine sandy loam to clay loam. Included in areas mapped as this complex, and totaling as much as 15 percent of these areas, are small areas of Vona loamy fine sand, Manter fine sandy loam, and Dalhart soils.

About 40 percent of this complex is used for cultivated crops, mainly grain sorghum, and the rest is in native grass grown for pasture. Because soil blowing is likely, this complex is not well suited to cultivation. Capability unit IVe–1 (dryland); Sandy range site.

## Randall Series

The Randall series consists of deep, dark-colored, poorly drained soils in upland depressions. Runoff from surrounding soils fills these depressions and keeps the soils wet for a long time after rainy periods.

The gray clay surface layer is about 4 to 6 inches thick. When it is dry, it is hard and has many small cracks. The dark-gray subsoil is a dense clay that is more than 20 inches thick and is underlain by clayey and loamy sediments.

The Randall soils occur within areas of Richfield, Spearville, Ulysses, and Dalhart soils.

**Randall clay** (Ra).—This soil is level or is on concave slopes of not more than 1 percent. As much as 10 percent of the area mapped as this soil has a clay loam surface layer.

Much of this soil is cultivated, but crops are successful only occasionally. Some areas are used for pasture. This soil is generally not suitable for cultivation. The main problem is water ponded on the surface. Capability unit VIw-2 (dryland).

## Richfield Series

The soils of the Richfield series are deep, dark colored, and loamy. They are on nearly level uplands and are the most extensive soils in the county. They developed under a cover of short, mid, and tall grasses.

The brown to dark grayish-brown surface layer ranges from fine sandy loam to silt loam. It is friable and easily tilled. The blocky clay loam subsoil is slowly and moderately slowly permeable and can be penetrated easily by plant roots. It is underlain by wind-deposited loamy sediments. Depth to calcareous material ranges from 14 to 40 inches.

The Richfield soils have a less compact, less clayey subsoil than the Spearville soils. They contain less sand and more clay in their subsoil than the Dalhart soils, and their layers are more distinct. Richfield soils are more clayey in the subsoil than the Ulysses soils and are noncalcareous to a greater depth.

**Richfield fine sandy loam, 0 to 1 percent slopes** (Rf).—This soil has a fine sandy loam surface layer that ranges from 6 to 12 inches in thickness and is moderately to highly susceptible to wind erosion. The subsoil is clay loam. Depth to calcareous material ranges from 18 to 40 inches. Areas mapped as this soil include small areas of Dalhart fine sandy loam that total as much as 10 percent of the areas mapped.

This soil is desirable for farming. Most of it is used for cultivated crops, mainly wheat and grain sorghum. Wind erosion is the major hazard. Capability unit IIIe-3 (dryland), I-2 (irrigated); Sandy range site.

**Richfield loam, thick surface, 0 to 1 percent slopes** (Rh).—This soil has a loam surface layer that is more than 10 inches thick in most places and is low to moderate in susceptibility to wind erosion. The subsoil is clay loam. Depth to calcareous material ranges from 18 to 48 inches. Included in areas mapped as this soil, and totaling as much as 15 percent of these areas, are small areas of Dalhart fine sandy loam, Richfield fine sandy loam, and Richfield silt loam.

This soil is desirable for farming. Most of it is used for cultivated crops, mainly wheat and grain sorghum. If yields of wheat are to be profitable, fallowing is needed so that the moisture stored is increased. Wind erosion is the major hazard. Capability unit IIIc-1 (dryland), I-1 (irrigated); Loamy Upland range site.

**Richfield silt loam, 0 to 1 percent slopes** (Rm).—This soil has a silt loam surface layer that ranges from 4 to 10 inches in thickness. The subsoil is silty clay loam. Depth to calcareous material ranges from 14 to 24 inches. Areas mapped as this soil may include small areas of Spearville silty clay loam, Ulysses silt loam, and Dalhart fine sandy loam that total as much as 15 percent of the areas mapped.

This soil is suitable for farming. Most of it is used to produce cultivated crops, principally wheat. Some grain sorghum is grown, particularly in irrigated areas. If crop yields are to be profitable, fallowing is needed so that the moisture stored is increased. Wind erosion is the major hazard. Capability unit IIIc-1 (dryland), I-1 (irrigated); Loamy Upland range site.

**Richfield and Ulysses complexes, bench leveled** (Rb).—This complex consists of Richfield and Ulysses soils that have been leveled for irrigation. Approximately 35 percent of the acreage in this complex has been cut or filled so much that the original soils cannot be recognized. Most of the rest is Richfield silt loam. Included in areas mapped as this complex, and totaling as much as 10 percent of these areas, are small areas of Spearville silty clay loam, Randall clay, and Dalhart fine sandy loam. All crops that are grown locally are suited to these soils. Capability unit I-1 (irrigated); Loamy Upland range site.

## Rough Broken Land (Ro)

Rough broken land occurs in areas with slopes of more than 25 percent in the southeastern part of the county. It has been dissected by many intermittent V-shaped drainageways. This land consists of a layer of soft limestone or caliche, about 2 to 4 feet thick, and of underlying sandy, gravelly, and clayey strata that are interbedded with thin layers of limestone. Broken slopes extend from the top layer of limestone. Runoff is rapid on this land type, and geologic erosion is active. This land supports moderate to sparse stands of mid and tall grasses and a few sand sagebrush and yucca plants. It is used for pasture. Capability unit VIIs-1 (dryland); Rough Breaks range site.

## Spearville Series

The Spearville series consists of deep, well-drained, dark-colored soils on nearly level uplands. These soils are in the northeastern part of the county where they developed under a cover of short and mid grasses.

The surface layer is dark grayish-brown silty clay loam that is friable and normally easy to till. The subsoil is blocky, slowly permeable silty clay through which plant roots penetrate with little difficulty. It is underlain by wind-deposited loamy sediments. Depth to calcareous material ranges from 12 to 24 inches.

The Spearville soils have a more compact, more clayey subsoil than the Richfield soils.

**Spearville silty clay loam, 0 to 1 percent slopes** (Sp).—This soil has a silty clay loam surface layer that ranges from 4 to 12 inches in thickness. Areas mapped as this soil may include small areas of Richfield silt loam that total as much as 10 percent of the areas mapped.

This soil is suitable for farming, and most of it is used for cultivated crops, mainly wheat and grain sorghum. If crop yields are to be profitable, fallowing is needed so that the moisture stored is increased. Wind erosion is the major hazard. Capability unit IIIs-1 (dryland), IIs-2 (irrigated); Clay Upland range site.

## Tivoli Series

The soils of the Tivoli series are deep, light colored, sandy, and excessively drained. These soils occur on dunes and hills of the uplands in all parts of the county except the northeastern. They developed under a cover of tall grasses and sand sagebrush.

The surface layer is fine sand or loamy fine sand that has been slightly darkened by organic matter and recently deposited silty material. It is loose and is highly susceptible to wind erosion. The subsoil is brown to light yellowish-brown, loose fine sand that holds little water and is underlain by wind-deposited sand.

The Tivoli soils contain more sand than the Vona soils and have less horizon development. Also, they are steeper.

**Tivoli fine sand** (Tf).—This soil occurs on hills with slopes of 10 to 25 percent. It has a low water-holding capacity. The surface layer is fine sand that ranges from 3 to 6 inches in thickness. Included in areas mapped as this soil, and totaling as much as 10 percent of these areas, are small areas of Vona loamy fine sand, Tivoli loamy fine sand, and Blown-out land.

Most of this soil produces native grass for pasture, and the soil is best suited to that use. Management that maintains permanent vegetation is desirable because establishing plants on bare soil is difficult. Capability unit VIIe-1 (dryland); Choppy Sands range site.

## Ulysses Series

The soils of the Ulysses series are deep, moderately dark colored, and well drained. They occur on convex upland slopes of 0 to 3 percent. These soils developed under short and mid grasses.

The surface layer is dark-brown to dark grayish-brown silt loam that is friable and easily tilled. The subsoil is grayish-brown to pale-brown, granular silt loam. It is friable, moderately slow in permeability, and easily penetrated by moisture and plant roots. The underlying material consists of loamy sediments, mostly wind deposited. Depth to calcareous material is less than 13 inches in most places.

The Ulysses soils have a less clayey subsoil than the Richfield soils and weaker horizon development. They are less clayey throughout the profile than the Mansic soils and have a thicker, darker colored surface layer than the Colby soils.

**Ulysses silt loam, 0 to 1 percent slopes** (Ua).—This soil has a silt loam surface layer that ranges from 6 to 10 inches in thickness. Areas mapped as this soil may include, amounting to as much as 15 percent of their extent, small areas of Richfield silt loam, Dalhart fine sandy loam, Manter fine sandy loam, Mansic clay loam, and Colby loam.

This soil is suitable for farming. Most of it is used for cultivated crops, mainly wheat, but some grain sorghum is grown, particularly in irrigated areas. If crop yields are to be profitable, fallowing is needed so that the moisture stored is increased. Wind erosion is the major hazard. Capability unit IIIc-1 (dryland), I-1 (irrigated); Loamy Upland range site.

**Ulysses silt loam, 1 to 3 percent slopes** (Ub).—This soil has a silt loam surface layer that ranges from 5 to 9 inches in thickness. Included in areas mapped as this soil, and totaling as much as 10 percent of these areas, are small areas of Colby loam, Otero fine sandy loam, and Dalhart fine sandy loam.

Most of this soil is used for cultivated crops, principally wheat. If crop yields are to be profitable, fallowing is needed so that the moisture stored is increased. Both wind and water erosion are hazards. Capability unit IIIe-1 (dryland), IIe-4 (irrigated); Loamy Upland range site.

**Ulysses-Colby complex, 1 to 3 percent slopes, eroded** (Ue).—This complex consists mainly of Ulysses and Colby soils. Ulysses silt loam makes up more than 50 percent, and the Colby loam, about 30 percent. The Colby loam is eroded and has lost its original surface layer.

Uneroded areas of this complex generally have a surface layer of dark-brown or dark grayish-brown silt loam, and eroded areas have a surface layer of pale-brown, calcareous loam. Areas mapped as this complex may include small areas of Otero fine sandy loam, Manter fine sandy loam, and Dalhart fine sandy loam that total as much as 15 percent of the areas mapped.

About 40 percent of the acreage of this complex is used for cultivated crops, mainly wheat, and the rest produces native grass for pasture. Most of the acreage has been tilled at one time. Both wind and water erosion are hazards. Capability unit IVe-2 (dryland); Limy Upland range site.

## Vona Series

The deep, sandy soils of the Vona series occupy undulating and rolling uplands. They are the second most extensive soils in the county. These well-drained soils occur in all parts of the county except the northeastern. They developed under a cover of mid and tall grasses.

The surface layer is brown loamy fine sand that is loose and absorbs moisture rapidly. It is highly susceptible to wind erosion. The brown fine sandy loam subsoil is granular, very friable, and easily penetrated by moisture and plant roots. It is moderately permeable and holds enough moisture to meet the needs of growing plants. The underlying material is wind-deposited sandy sediments. Depth to calcareous material is generally more than 24 inches.

The Vona soils have a lighter colored, sandier surface layer than the Manter soils, have less clay in the subsoil than the Dalhart soils, and have less sand throughout the profile than the Tivoli soils.

**Vona loamy fine sand** (Vo).—This soil has a loamy fine sand surface layer that ranges from 6 to 16 inches in thickness. It occurs in undulating areas that have slopes of 1 to 5 percent. Included in areas mapped as this soil, and totaling as much as 15 percent of those areas, are small areas of Dalhart loamy fine sand, Tivoli loamy fine sand, Manter fine sandy loam, Blown-out land, and Otero fine sandy loam.

About 15 percent of this soil is used for cultivated crops, mainly sorghum, and the rest produces native grass for pasture. Because this soil is susceptible to wind erosion, it is not well suited to cultivation. Pasture is the best use. Wind erosion, a severe hazard, can be controlled by keeping growing plants and crop residue on the soil all year. Capability unit IVe-1 (dryland), IVe-7 (irrigated); Sands range site.

**Vona-Tivoli loamy fine sands** (Vx).—This is a soil complex consisting of Vona loamy fine sand and Tivoli loamy fine sand. The Vona loamy fine sand makes up more than 50 percent of the complex, and Tivoli loamy fine sand, about 30 percent.

These soils occur in rolling and hilly areas on slopes of 5 to 20 percent. Vona loamy fine sand is in the less sloping, low areas between the hills, and Tivoli loamy fine sand occupies the larger and steeper hills.

The surface layer of this complex is loamy fine sand that is highly susceptible to wind erosion. The subsoil ranges from fine sandy loam to fine sand. Areas mapped as this complex include small areas of Dalhart loamy fine sand, Otero fine sandy loam, and Mansic fine sandy loam that total as much as 15 percent of the areas mapped.

Most of this complex produces native grass for pasture and is best suited to that use. Because wind erosion is a severe hazard, the soils should be kept in native plants at all times. Capability unit VIe-2 (dryland); Sands range site.

# *Use and Management of the Soils*

First described in this section are general practices of dryland management. Then the capability classification used by the Soil Conservation Service is explained, and management of dryland and irrigated capability units is described. In a subsection on productivity, average yields are predicted for nonirrigated soils and yields on irrigated soils are discussed generally. Other subsections discuss management of rangeland and tame pasture, woodland, and wildlife, and there is a subsection dealing with the properties of soils that affect engineering.

## Management of Dryland[1]

In Seward County conserving moisture is most important. Even when the best practices are applied to conserve moisture, crops use only 30 to 35 percent of precipitation that falls during the growing period. During the period that wheatfields are fallow, the efficiency of moisture storage averages only about 17 percent; for example, only about 1 inch of moisture is stored from 6 inches of precipitation.

Controlling wind erosion is also important in managing soils. Preventing wind erosion, by preparing for strong winds before they blow, is cheaper, easier, and more practical than controlling the erosion after it has started. Wind erosion may be controlled by long-range, seasonal, and emergency practices. A long-range practice is seeding soils that are not suitable for cultivation to perennial grasses or other permanent cover. Seasonal practices include stubble mulching and minimum tillage. Roughening the surface soil by tillage is an emergency practice.

Erosion control and water conservation are generally best when a combination of practices is used. Although a single practice may reduce erosion and conserve some moisture, it seldom controls loss of soil and water as well as a combination of practices does. Descriptions of some practices that maintain and improve soil productivity follow.

*Cropping system.*—A cropping system is a sequence of crops grown in an area for a specified period. It may consist of growing one crop year after year on the same soils; of growing more than one crop, but not in a planned sequence; or of growing several crops in a definite, planned sequence. The cropping sequences used in this county are fallow-wheat, sorghum-fallow-wheat, and continuous sorghum.

Fallowing is generally essential for economical production of wheat. Under fallowing, the soils are managed so that soil moisture accumulates for 11 to 14 months before seeding time.

The flexible cropping system in table 2 can be used as a guide in planning more stable production on silt loams, loams, and fine sandy loams that are used principally for wheat. The fine sandy loams may be cultivated continuously to sorghum, and loamy fine sands generally are cultivated continuously to sorghum.

In table 2 the approximate dates June 1, July 15, and September 1 have been selected for measuring the depth of moist soil and for determining the condition of the soil cover. If the depth of moist soil is less than 24 inches at planting time, crops are planted primarily for protective cover. A field has adequate cover if growing plants and residue, together with cloddiness and surface roughness, reduce wind erosion to a minimum.

*Stubble mulching.*—Stubble mulching is a system of managing plant residue so that it protects the soil. Tilling, planting, and harvesting are managed so that the residue is kept on the surface until the next growing crop can protect the soil. Some of the advantages of stubble mulching are—

1. Crop residue on the surface protects the soil against wind erosion practically, effectively, and economically.
2. Water intake is increased because crusting and sealing of the surface is reduced.
3. Water erosion is reduced.
4. Larger crop yields may be expected where residue is managed to protect the soil against wind erosion and water loss and where the residue does not interfere with weed control or with seeding.

Stubble mulching should be practiced on all cultivated soils (fig. 11). The amount of residue needed to protect the soil depends on the kind of residue and the texture of the surface layer. The local representative of the Soil Conservation Service can tell you the minimum amount of crop residue needed to protect any soil in the county.

Residue should not be burned. Grazing of residue is not advisable, particularly on loamy fine sands. If residue is grazed, enough of it should be left on the surface to control wind erosion.

Implements that undercut the stubble and leave most of it on the surface are best suited for stubble mulching harvested wheatfields. Subsequent tillage is performed only to control weeds. In places where grain sorghum is to be grown continuously, undercutting implements are suitable for the first tillage operation. These implements help control wind erosion by leaving the residue of grain sorghum anchored on the surface. On sandy soils seedbed

[1] By Earl Bondy, agronomist, Soil Conservation Service, Garden City, Kansas.

Table 2.—*A flexible cropping system for silt loams, loams, or fine sandy loams on which wheat is the principal crop and needed conservation practices are used* [1]

| Date | Depth of moist soil | Adequate cover on field | Inadequate cover on field |
|---|---|---|---|
| | *Inches* | | |
| June 1. | 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; after Aug. 20, be ready to plant wheat any time the surface layer contains enough moisture. | Plant sorghum for a cover crop, or plant early maturing grain sorghum. |
| | More than 30. | Manage soil for wheat and expect to harvest it. | 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 and expect to harvest it (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 wheat, roughen surface and manage for sorghum or wheat to be grown the next year. |
| | More than 36. | Plant wheat and expect to harvest it; if there is not enough moisture for 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 wheat, roughen surface and manage for sorghum to be grown the next year. |

[1] Prepared by Fred Meyer, Jr., work unit conservationist.

preparation should be delayed until late in spring so that sorghum residue is kept on the surface as long as possible.

Nothing can take the place of a good cover of growing crops or of crop residue to protect the soils against erosion. The soils need a cover throughout the year.

*Tillage.*—Tillage, or the mixing of the surface layer, is used to prepare the seedbed, to control weeds, to manage crop residue, and to maintain good structure in the surface soil. In Seward County, tillage is one of the principal means by which a farmer manages his soils.

In minimum tillage the soil is tilled only when it is necessary to break up a surface crust, to control weeds, or to prepare a seedbed. Too much tillage destroys crop residue, leaves the soil bare and susceptible to erosion,

***Figure 11.*—Wheat has been planted in stubble on Richfield silt loam, 0 to 1 percent slopes. About 1,000 pounds of residue per acre remain on the surface.**

***Figure 12.*—Emergency contour tillage of a silt loam.**

and tends to destroy the desirable soil structure of the surface layer.

In emergency tillage the soil is tilled once or more so that its surface is roughened and made less susceptible to blowing. The time for tillage is before or just after the soils begin to blow. Fields should be tilled across the direction of the wind, starting on the windward edge of an area subject to blowing.

Emergency tillage is most effective on soils in which the texture of the surface layer is loam or finer (fig. 12). If the surface layer is loamy fine sand, emergency tillage is ineffective or, at best, effective for only a short time.

*Terracing.*—In terracing, ridges are constructed across the slope to intercept runoff. The terraces in Seward

County are built without grade and are sometimes called level terraces. These terraces are used mainly to conserve moisture on nearly level fields (fig. 13). On sloping fields they help to control erosion, as well as to conserve moisture.

Contour farming and other practices should be used with terracing. Each row that is planted on the contour between terraces acts as a miniature terrace; the row holds back some water until it soaks into the soil. Terracing and contour tillage, used together, increase yields and decrease soil losses.

The horizontal distance needed between terraces depends largely on the slope. Since much of the rainfall in this county is intensive, the terraces insure the effectiveness of contour tillage, stubble mulching, and contour stripcropping.

*Contour farming.*—In contour farming, the soil is tilled parallel to terraces or contour guidelines. As a result, furrows, ridges, and wheel tracks are nearly level. By holding much of the water where it falls, the furrows and ridges decrease runoff and erosion. Yields of crops increase because more water is absorbed by the soil and made available to crops. Contour farming is most effective when used with stubble mulching, terracing, contour stripcropping, and other conservation practices.

*Stripcropping.*—In stripcropping, suitable erosion-resistant crops are grown in narrow strips on the same field. Strips of crops or of their residue are alternated with strips of other crops or with fallowed strips. Good stands of wheat or sorghum, and the thick, heavy stubble that they leave after harvest, resist erosion. Stripcropping helps control wind erosion by shortening the distance that loose soil can move. It provides a barrier of growing crops that reduces water erosion.

Two kinds of stripcropping are contour stripcropping and wind stripcropping. Contour stripcropping is used on sloping fields to help control both wind erosion 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 nearly level fields (fig. 14) on which water erosion is not a problem. It is also used on more sloping fields where the slopes are so complex that farming on the contour is not practical. The strips are uniform in width, are straight in most places, and extend from east to west.

*Figure 13.*—**Water retained by terraces on a nearly level field.**

*Figure 14.*—**Wind stripcropping on Richfield and Ulysses soils.**

The width of the strip necessary to control soil blowing varies according to the texture of the surface layer. Strips are generally wider on silt loams and clay loams than they are on sandy soils.

Stripcropping reduces soil blowing but does not completely control it when used alone. It is most effective when used with good residue management, minimum tillage, and other needed conservation practices.

## Capability Groups of Soils

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

In this system all the kinds of soil are grouped at three levels—the capability class, subclass, and unit. Eight capability classes are in the broadest grouping and are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the remaining classes have progressively greater natural limitations. In class VIII are soils and land types so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, grazing, or wood products. None of the soils in Seward County are in class VIII.

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

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it are susceptible to little or no erosion but have other limitations that limit their use largely to pasture, range, woodland, or wildlife. None of the soils in Seward County are in class V.

Within the subclasses are the capability units, which are groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other response to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally identified by numbers assigned locally, for example, IIIe-2 or IIIc-1. Units are not consecutive in this report, because the soils in the county have not been placed in all the capability units recognized in the State.

### Capability Classification for Dryland Farming

Class III.—Soils that have severe limitations that reduce the choice of plants or require special conservation practices, or both.
- Subclass IIIc: Soils that have moderate climatic limitations.
  - Unit IIIc-1: Deep, dark-colored loamy soils on nearly level upland.
- Subclass IIIe: Soils that are highly susceptible to erosion if used for crops.
  - Unit IIIe-1: Deep, moderately dark colored loamy soils on gently sloping uplands.
  - Unit IIIe-2: Deep, dark-colored fine sandy loams on gently sloping uplands.
  - Unit IIIe-3: Deep, dark-colored fine sandy loams on nearly level uplands.
- Subclass IIIs: Soils that have slow permeability.
  - Unit IIIs-1: Deep, dark-colored silty clay loam on nearly level uplands.

Class IV.—Soils that can be used for crops but that have very severe limitations that restrict the choice of plants, require very careful management, or both.
- Subclass IVe: Soils that have a severe risk of erosion if they are cultivated and not protected.
  - Unit IVe-1: Deep, light-colored loamy fine sands and fine sandy loams on undulating and hummocky uplands.
  - Unit IVe-2: Deep, moderately dark and light-colored loamy soils on gently sloping uplands.
  - Unit IVe-4: Deep, dark-colored fine sandy loams on gently sloping and hummocky uplands.
  - Unit IVe-6: Deep, dark-colored loamy fine sand on nearly level to gently sloping uplands.
- Subclass IVw: Soils that are affected by excess water.
  - Unit IVw-2: Deep, dark-colored sandy loam on nearly level bottom land.

Class VI.—Soils that have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, to woodland, or to wildlife habitats.
- Subclass VIe: Soils that are subject to severe erosion if not protected.
  - Unit VIe-1: Deep, light-colored loams on sloping and moderately steep uplands.
  - Unit VIe-2: Deep, light-colored loamy sand and loamy fine sands on gently sloping and rolling uplands.
  - Unit VIe-6: Deep, light-colored fine sandy loam to gravelly fine sandy loam on moderately steep uplands.
- Subclass VIw: Soils that are severely affected by excess water.
  - Unit VIw-1: Loamy alluvial soils on narrow bottom lands cut by meandering, intermittent streams.
  - Unit VIw-2: Deep, dark-colored clay in upland depressions.

Class VII.—Soils that have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife habitats.
- Subclass VIIe: Soils that are subject to very severe erosion.
  - Unit VIIe-1: Deep, loose sandy soils on hilly uplands and in blown-out areas.
- Subclass VIIw: Soils affected by excess water.
  - Unit VIIw-1: Loose sandy soils on flood plains.
- Subclass VIIs: Steep, broken areas of deep, moderately deep, and shallow soils.
  - Unit VIIs-1: Areas of steep, broken slopes.
  - Unit VIIs-4: Gravelly and sandy soils on steep slopes.

### *Management by capability units (dryland)*

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

#### CAPABILITY UNIT IIIc-1 (DRYLAND)

This unit consists of deep, dark-colored, loamy soils on nearly level uplands. The surface layers are silt loam or loam, and the subsoils are silt loam or clay loam. The soils are—

Richfield loam, thick surface, 0 to 1 percent slopes (Rh).
Richfield silt loam, 0 to 1 percent slopes (Rm).
Ulysses silt loam, 0 to 1 percent slopes (Uo).

These soils have high moisture-holding capacity and are easily penetrated by plant roots. Conserving moisture and controlling wind erosion are problems.

Wheat and grain sorghum are suitable crops. The cropping sequence used is fallow-wheat or sorghum-fallow-wheat.

Storing moisture through fallowing is essential for profitable crop yields. Stubble mulching and minimum tillage are needed to control wind erosion and to help conserve moisture. Contour farming, stripcropping, and terracing may also be used to conserve moisture.

#### CAPABILITY UNIT IIIe-1 (DRYLAND)

Ulysses silt loam, 1 to 3 percent slopes (Ub), is the only soil in this unit. It is on gently sloping uplands and is deep and moderately dark colored. Both the surface layer and subsoil are silt loam.

This soil has a high moisture-holding capacity and is easily penetrated by plant roots. Conserving moisture and controlling wind and water erosion are problems.

Wheat and grain sorghum are suitable crops. The cropping sequence used is fallow-wheat or sorghum-fallow-wheat.

Storing moisture through fallowing is essential for profitable crop yields. Stubble mulching and minimum tillage help to control wind erosion and water erosion and to conserve moisture. Terracing and contour farming are also needed, and contour stripcropping may be used.

### CAPABILITY UNIT IIIe-2 (DRYLAND)

This unit is made up of deep, dark-colored soils on the gently sloping and undulating uplands. These soils have fine sandy loam surface layers and fine sandy loam to sandy clay loam subsoils. They are—

Dalhart fine sandy loam, 1 to 3 percent slopes (Db).
Manter-Dalhart fine sandy loams, undulating (Md).

These soils have moderate to high moisture-holding capacity and are easily penetrated by plant roots. Conserving moisture and controlling wind and water erosion are problems.

Grain sorghum and wheat are suitable crops. The cropping sequence used is fallow-wheat, sorghum-fallow-wheat, or sorghum grown continuously.

If yields of wheat are to be profitable, fallowing is generally needed so that the moisture stored is increased. Stubble mulching and minimum tillage are needed to control water erosion and wind erosion and to help conserve moisture. Contour farming and stripcropping also may be used. In some places terraces are constructed to control water erosion and to help conserve moisture. Adding a nitrogen fertilizer is profitable on fields of sorghum during years when rainfall is above normal or when moisture is in reserve at the beginning of the growing season.

### CAPABILITY UNIT IIIe-3 (DRYLAND)

This unit consists of deep, dark-colored soils on nearly level uplands. These soils have fine sandy loam surface layers and sandy clay loam or clay loam subsoils. They are—

Dalhart fine sandy loam, 0 to 1 percent slopes (Da).
Richfield fine sandy loam, 0 to 1 percent slopes (Rf).

These soils have high moisture-holding capacity and are easily penetrated by plant roots. Conserving moisture and controlling wind erosion are problems.

Wheat and grain sorghum are suitable crops. The cropping sequence used is fallow-wheat or sorghum-fallow-wheat. When rainfall is above normal, grain sorghum is grown for several successive years.

In most places, storing moisture through fallowing is essential for profitable yields of wheat. Stubble mulching and minimum tillage are needed to control wind erosion and to help conserve moisture. Contour farming and stripcropping also may be used. Nitrogen fertilizer applied on fields of sorghum is profitable during years when rainfall is above normal or when moisture is in reserve at the beginning of the growing season.

### CAPABILITY UNIT IIIs-1 (DRYLAND)

Spearville silty clay loam, 0 to 1 percent slopes (Sp), is the only soil in this unit. It is on nearly level uplands, and is deep and dark colored. The surface layer is silty clay loam, and the subsoil is silty clay.

This soil has high moisture-holding capacity and slow permeability. Conserving moisture and controlling wind erosion are problems.

Wheat and grain sorghum are suitable crops. The cropping sequence used is fallow-wheat or sorghum-fallow-wheat.

Storing moisture through fallowing is essential for profitable crop yields. Stubble mulching and minimum tillage are needed to control wind erosion and to help conserve moisture. Contour farming and stripcropping also may be used. Terracing helps to conserve moisture.

### CAPABILITY UNIT IVe-1 (DRYLAND)

This unit consists of deep, light-colored soils on undulating and hummocky uplands. These soils have loamy fine sand or fine sandy loam surface layers and fine sandy loam or clay loam subsoils. They are—

Vona loamy fine sand (Vo).
Otero-Mansic complex, undulating (Oy).

These soils are moderate to low in moisture-holding capacity. Because wind erosion is the major problem, they are poorly suited to crops.

Sorghum can be grown for grain or forage or to produce crop residue that prevents erosion. Generally, the sorghum is grown continuously.

Stubble mulching and minimum tillage are needed to control wind erosion. Adding a nitrogen fertilizer is generally profitable. If crop residue is not grazed but is left on the surface, it protects the soils from wind erosion. Many fields should be seeded to native grasses and used for pasture.

### CAPABILITY UNIT IVe-2 (DRYLAND)

This unit is made up of deep, moderately dark and light-colored soils of the Ulysses-Colby complex, 1 to 3 percent slopes, eroded (Ue). These soils occur on gently sloping uplands. Their surface layers and subsoils are silt loam or loam.

These soils have high moisture-holding capacity. Conserving moisture and controlling wind erosion and water erosion are problems.

Although wheat and grain sorghum are grown, the soils are not well suited to cultivated crops. The cropping sequence used is fallow-wheat or sorghum-fallow-wheat.

Storing moisture through fallowing is essential for profitable crop yields. Stubble mulching and minimum tillage are needed to help control wind erosion and water erosion and to conserve moisture. Terracing, contour farming, and stripcropping are also needed. Some fields should be seeded to native grasses and used for pasture.

### CAPABILITY UNIT IVe-4 (DRYLAND)

This unit consists of deep, dark-colored soils that occur on gently sloping and hummocky uplands. These soils have fine sandy loam surface layers and subsoils. They are—

Bayard fine sandy loam, 1 to 4 percent slopes (Bb).
Manter fine sandy loam, hummocky (Mh).

These soils have adequate moisture-holding capacity for crop production. They are subject to wind erosion and water erosion. Because wind erosion is a major problem, these soils are poorly suited to crops.

Wheat and sorghum are grown. The cropping sequence used is fallow-wheat, sorghum-fallow-wheat, or either wheat or sorghum grown continuously. A cover crop of sorghum or small grain is used to control erosion during droughts. Also needed to control erosion are stubble mulching and minimum tillage. Stripcropping helps to control wind erosion. Adding a nitrogen fertilizer is usually profitable during years when rainfall is above normal. Many fields should be seeded to native grass and used for pasture.

#### CAPABILITY UNIT IVe-6 (DRYLAND)

Dalhart loamy fine sand, 0 to 3 percent slopes (Df), is the only soil in this unit. It is on nearly level to gently sloping uplands and is deep and dark colored. It has a loamy fine sand surface layer and sandy clay loam subsoil.

This soil is high in moisture-holding capacity and is easily penetrated by plant roots. Wind erosion is the major problem.

Sorghum, a suitable crop, is grown continuously in most places.

Stubble mulching and minimum tillage are needed to control wind erosion. In most places the use of nitrogen fertilizer is profitable, particularly during years when rainfall is above normal. If crop residue is not grazed but is left on the surface, it protects the soil from wind erosion.

#### CAPABILITY UNIT IVw-2 (DRYLAND)

Las Animas sandy loam (Ld), is the only soil in this unit. It is deep and occupies the nearly level flood plains of the Cimarron River.

This soil is flooded occasionally and is highly susceptible to wind erosion. It is slightly to moderately saline. Depth to the water table is generally less than 8 feet.

This soil is best suited to native grass used for pasture or meadow. Because wind erosion is a hazard, the soil is not well suited to cultivation. Practices needed in managing grassland are proper range use, deferred grazing, and rotation-deferred grazing.

#### CAPABILITY UNIT VIe-1 (DRYLAND)

This unit is made up of deep, light-colored soils that occur on sloping and moderately steep uplands. These soils have loam surface layers and subsoils. They are—

Colby loam, 5 to 12 percent slopes (Cm).
Colby loam, 3 to 5 percent slopes (Cc).

These soils have high moisture-holding capacity. They are generally calcareous at the surface. Both wind erosion and water erosion are hazards.

Because of the erosion hazard, these soils are best suited to native grass pasture. Practices needed in managing grassland are proper range use, deferred grazing, and rotation-deferred grazing.

#### CAPABILITY UNIT VIe-2 (DRYLAND)

This unit consists of deep, light-colored sandy soils that occur on rolling and gently sloping uplands. These soils have loamy sand surface layers and sandy loam to fine sand subsoils. They are—

Vona-Tivoli loamy fine sands (Vx).
Likes loamy sand (Lk).

These soils have low moisture-holding capacity. Because wind erosion is a serious hazard, native plants should cover the soils to protect them from blowing.

These soils are best suited to native grass pasture. Practices needed in managing grassland are proper range use, deferred grazing, rotation-deferred grazing, and range seeding.

#### CAPABILITY UNIT VIe-6 (DRYLAND)

The Otero gravelly complex (Ox) makes up this capability unit. It occurs on moderately steep uplands. The soils of this complex have fine sandy loam to gravelly sandy loam surface layers and sandy loam to coarse sand and gravel subsoils.

These soils are moderate to low in moisture-holding capacity. In some places they are calcareous at the surface. Both wind erosion and water erosion are hazards.

This complex is best suited to native grass pasture because erosion is a hazard and, in some of the soils, the moisture-holding capacity is low. Fields that are now cultivated should be seeded to suitable native grasses and used for pasture. Practices needed in managing grassland are proper range use, deferred grazing, rotation-deferred grazing, and range seeding where needed.

#### CAPABILITY UNIT VIw-1 (DRYLAND)

This unit consists of Alluvial land (An), which occupies narrow flood plains of upland drains. These flood plains are dissected by meandering, intermittent streams. The surface layer is loam and sandy loam.

This land has adequate moisture-holding capacity, and it receives extra moisture from surrounding areas. Flooding and channel scouring are serious hazards. A cover of native plants should be maintained to protect this land. This land is well suited to native grass pasture. Practices needed in managing grassland are proper range use, deferred grazing, and rotation-deferred grazing.

#### CAPABILITY UNIT VIw-2 (DRYLAND)

Deep, dark-colored Randall clay (Ra), is the only soil in this unit. It is in shallow upland depressions where water is ponded indefinitely after rainstorms.

This soil has high moisture-holding capacity and very slow permeability. Wetness caused by the ponded water is the major problem.

Terraces on surrounding soils will keep some of the excess water from running into the depressions occupied by this soil. Wheat and grain sorghum are grown in areas protected from flooding. Stubble mulching and minimum tillage are needed on Randall clay to control wind erosion.

#### CAPABILITY UNIT VIIe-1 (DRYLAND)

This unit is made up of deep, loose sandy soils that occur on the hilly uplands and in blown-out areas. The soils are—

Blown-out land (Bo).
Tivoli fine sand (Tf).

The soils are suited only to native grass pasture that is grazed sparingly. Replanting is needed on Blown-out land before it can be used for pasture. Unless plant cover is maintained on the Tivoli fine sand by limiting grazing, that soil becomes Blown-out land or active sand dunes. Practices needed in managing grassland are proper range use, deferred grazing, rotation-deferred grazing, and range seeding where needed.

#### CAPABILITY UNIT VIIw-1 (DRYLAND)

This unit consists of Lincoln soils (Ll) on the flood plains of the Cimarron River. These soils consist of sandy alluvium that has been changed little since it was deposited.

Because of flooding and wind erosion, the vegetation on these soils is sparse and unstable. The areas are suited only to native grass pasture that is used sparingly.

#### CAPABILITY UNIT VIIs-1 (DRYLAND)

This unit consists only of Rough broken land (Ro), which occurs on steep, broken slopes that are dissected by V-shaped drainage channels. Strata of sandy, gravelly, and clayey materials are interbedded with strata of limestone.

This land type is suited to native grass pasture that is grazed sparingly. Because geologic erosion is active, little can be done to protect this land type, other than to manage grazing so that the grass cover is maintained or improved. Practices needed in managing grassland are proper range use, deferred grazing, and rotation-deferred grazing.

#### CAPABILITY UNIT VIIs-4 (DRYLAND)

This unit consists only of Gravelly broken land (Gr), which occurs on steep slopes dissected by drainageways. This land type is made up of sandy soils and many pockets and hills of gravelly material.

This land type is suited to native grass pasture that is grazed sparingly. Because geologic erosion is active, little can be done to protect this land type, other than to manage grazing so that the grass cover is maintained or improved. Practices needed in managing grassland are proper range use, deferred grazing, and rotation-deferred grazing.

## Management of Irrigated Soils [2]

In 1960, about 20,670 acres were irrigated in Seward County. The two general methods used to apply water in Seward County are gravity irrigation and sprinkler irrigation. Sprinkler irrigation is used only where it is impractical to use the gravity method.

Irrigation water is obtained from deep wells. The first irrigation well in the county was drilled in 1947. By 1960, there were 65 irrigation wells. More than half of these were drilled between 1953 and 1957. Internal combustion engines supply power for turbine pumps that lift the water from depths ranging from about 200 to 250 feet. Although underlying water-bearing formations are continuous throughout the county, test wells are drilled so that the quantity of water at a particular place can be determined. Excellent water for irrigation is obtained from Pliocene and Pleistocene deposits.

Some of the soils in the county are well suited to irrigation. These soils are deep and have adequate moisture-holding capacity. Their permeability is moderately slow to slow, and internal drainage is good. Before these soils can be irrigated, however, leveling is needed on most of them so that water is distributed uniformly. These soils are fertile, and nitrogen is the only plant nutrient now needed for high yields of crops.

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

The principal crops grown on the irrigated soils are wheat, corn, alfalfa, forage sorghum, and grain sorghum. These crops are generally grown continuously. Growing many other kinds of crops would be profitable if better marketing facilities were available in the county. Potatoes, pintobeans, and castorbeans have been grown on trial plots. Also, a few acres have been used to produce native grass seed.

If a farmer plans to irrigate his land, he should consider the following: (1) The suitability of the soils for irrigation; (2) the adequacy, reliability, and quality of the water supply; (3) the control and conveyance of water; (4) the total water requirements based on amount of water used by crops, amount of effective rainfall, and the efficiency of the irrigation system; (5) the method of applying water; and (6) the drainage facilities needed to remove excess surface and subsurface water. For further information about irrigating a specific farm, consult the local representative of the Soil Conservation Service.

### *General practices used in managing irrigated soils*

The following paragraphs discuss water delivery, land leveling, drainage, cropping systems, fertilization, and efficient use of water.

*Water delivery.*—After a supply of water suitable for irrigation is located, it is necessary to control the water and to transmit it economically from its source to the fields it irrigates. The system used may include storage dams, canals and laterals to carry water to the farm, a farm distribution system, and other structures such as pumping plants, pipelines, and drops to control erosion in ditches.

*Land leveling.*—For all methods of irrigation, leveling is generally needed so that water can be applied efficiently and uniformly. Efficient application insures more uniform distribution and saves soil and water. A soil-improving crop should be the first crop grown on newly leveled areas, and the entire plants of the crop should be worked into the plow layer.

*Drainage.*—A drainage system should be developed along with the irrigation system to obtain efficient and complete control of water distribution and removal of excess water.

*Cropping system.*—By growing crops that add organic material annually, a farmer can maintain and improve his irrigated soils and obtain top yields year after year. A sod crop used in the cropping system once every few years adds organic matter and helps rebuild and stabilize the soil.

*Fertilization.*—The use of commercial fertilizer, particularly nitrogen, has become increasingly important in sound irrigation management. In time additions of other elements, especially phosphorus, may be needed for high crop yields. The Kansas Agricultural Experiment Station at Garden City maintains a laboratory for testing soil to determine fertilizer needs. These services are available to the public. A small charge is made for each sample tested.

*Managing irrigation water.*—The efficiency of the irrigation system is affected by the kind of soil, the relief, and the 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 pumped can be applied efficiently by using present irrigation facilities and practices.

### *Management by capability units (irrigated)*

In this subsection the irrigable soils of Seward 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 irrigation. Management practices suitable for the soils in each unit are discussed.

#### Capability Classification for Irrigation Farming

Class I.—Soils that have few limitations that restrict their use.
- Unit I–1: Loamy soils on nearly level uplands.
- Unit I–2: Fine sandy loams on nearly level uplands.

Class II.—Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe: Soils that have a moderate risk of erosion.
  - Unit IIe–2: Loamy soils on gently sloping or undulating uplands.
  - Unit IIe–4: Silt loam on gently sloping uplands.
- Subclass IIs: Soils that have slow permeability.
  - Unit IIs–2: Clayey soils on nearly level uplands.

Class III.—Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.
- Subclass IIIe: Soils that are highly susceptible to erosion when used for crops.
  - Unit IIIe–5: Loamy fine sand on nearly level to gently sloping and undulating uplands.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.
- Subclass IVe: Soils that have a severe risk of erosion if they are cultivated and not protected.
  - Unit IVe–7: Loamy fine sand on undulating to hummocky uplands.

#### CAPABILITY UNIT I–1 (IRRIGATED)

The soils of this unit occur on nearly level uplands. They have loam to clay loam surface layers and subsoils. These fertile soils are deep and moderately slow in permeability. They are well drained and high in moisture-holding capacity. The soils are—

Richfield loam, thick surface, 0 to 1 percent slopes (Rh).
Richfield silt loam, 0 to 1 percent slopes (Rm).
Richfield and Ulysses complexes, bench leveled (Rb).
Ulysses silt loam, 0 to 1 percent slopes (Ua).

Good management of these soils includes the following practices that maintain or improve fertility and tilth: (1) Using a crop sequence that includes a deep-rooted legume, (2) using green-manure crops and crop residue, and (3) applying commercial fertilizer as needed. In most places land leveling improves irrigation by permitting more efficient use of water. Removing excess irrigation water and runoff is essential.

#### CAPABILITY UNIT I–2 (IRRIGATED)

The soils in this capability unit occur on nearly level uplands. They have fine sandy loam surface layers and sandy clay loam to clay loam subsoils. These deep, fertile soils are well drained, moderately slow in permeability, and high in moisture-holding capacity. They do not have so much moisture-holding capacity in the top foot as the soils in unit I–1. The soils are—

Dalhart fine sandy loam, 0 to 1 percent slopes (Da).
Richfield fine sandy loam, 0 to 1 percent slopes (Rf).

Good management of these soils includes the following practices that maintain or improve fertility and tilth: (1) Using a crop sequence that includes a deep-rooted legume, (2) using green-manure crops and crop residue, and (3) applying commercial fertilizer as needed. In most places land leveling improves irrigation by permitting more efficient use of water. Removing excess irrigation water or runoff is essential.

#### CAPABILITY UNIT IIe–2 (IRRIGATED)

The soils in this unit occur on gently sloping or undulating uplands. They have fine sandy loam surface layers and fine sandy loam to sandy clay loam subsoils. These deep, fertile soils have moderately slow permeability and moderate to high moisture-holding capacity. They are susceptible to water erosion and wind erosion. The soils are—

Dalhart fine sandy loam, 1 to 3 percent slopes (Db).
Manter-Dalhart fine sandy loams, undulating (Md).

Good management of these soils provides erosion control, efficient use of water, and maintenance of fertility and tilth. Land leveling and other suitable practices are needed. Removing excess irrigation water and runoff from rainstorms is essential. Distributing water through pipes prevents the loss of water that occurs in open irrigation ditches.

#### CAPABILITY UNIT IIe–4 (IRRIGATED)

Ulysses silt loam, 1 to 3 percent slopes (Ub), the only soil in this unit, is on gently sloping uplands. It has a silt loam surface layer and subsoil. This soil is fertile, deep, moderately slow in permeability, and high in moisture-holding capacity. It is susceptible to water erosion.

Good management of this soil provides control of erosion, efficient use of water, and maintenance of fertility and tilth. Land leveling, contour-furrow irrigation, and other practices that reduce erosion are needed. In most irrigation ditches drop structures are needed to control erosion. Removing excess water resulting from irrigation and from runoff during rainstorms is essential.

#### CAPABILITY UNIT IIs–2 (IRRIGATED)

Spearville silty clay loam, 0 to 1 percent slopes (Sp), the only soil in this unit, occurs on nearly level uplands. It has a silty clay loam surface layer and a silty clay subsoil. This soil is deep, fertile, and slow in permeability. It has high moisture-holding capacity and is well drained.

Good management of this soil includes the following practices that maintain or improve fertility and tilth: (1) Using a crop rotation that includes a deep-rooted legume, (2) using green-manure crops and crop residue, and (3) applying commercial fertilizer as needed. In most places land leveling improves irrigation by permitting more efficient use of water. Removing excess water resulting from irrigation or from runoff is essential.

#### CAPABILITY UNIT IIIe-5 (IRRIGATED)

Dalhart loamy fine sand, 0 to 3 percent slopes (Df), the only soil in this unit, occurs on nearly level to gently sloping and undulating uplands. It has a loamy fine sand surface layer and a sandy clay loam subsoil. This soil is deep, fertile, moderate in permeability, and high in moisture-holding capacity. It is susceptible to wind and water erosion.

Good management of this soil provides control of erosion, efficient use of water, and maintenance of fertility. In some level or nearly level areas, this soil is suitable for flood irrigation, but in most places sprinkler irrigation is best. Most areas are uneven or undulating.

#### CAPABILITY UNIT IVe-7 (IRRIGATED)

Only one soil, Vona loamy fine sand (Vo), is in this capability unit. It occurs on rolling or hummocky uplands. It has a loamy fine sand surface layer and a fine sandy loam subsoil. This soil is deep, moderately permeable, and moderate to low in moisture-holding capacity. It is highly susceptible to wind erosion.

Good management of this soil provides control of erosion, efficient use of water, and maintenance of fertility. In most places, the only practical irrigation is by sprinklers. Tame grasses probably are the most suitable crops, but other crops are also suitable if they leave enough residue to control wind erosion.

## Productivity of the Soils

This subsection deals mainly with the productivity of the soils used for dryland farming, the dominant agriculture in the county. Some information on productivity of soils used for irrigation farming is also included.

### *Predictions of dryland yields*

Crop yields in Seward County depend largely on the climate. Yields of wheat and grain sorghum range from 0 to 50 bushels per acre and generally depend on the amount and distribution of rainfall. Crop yields are also affected by diseases, insects, fertility of the soil, and differences in soil management.

Because the climate is dry, the wheat abandoned during a long period averages about 30 percent of the acreage planted. Most of the farms in the county are large, and farming costs per acre are low. Consequently, farming can be profitable, though yields per acre are relatively low.

Table 3 lists for the arable soils in the county predicted yields per planted acre of dryland wheat and grain sorghum. In columns A are yields that can be expected under the present, or prevailing, management. In columns B are yields that can be expected under improved management. The yields are averages that may be expected over a period of many years and are considered reliable enough to be of value in farm planning.

Under the prevailing management (columns A) on the silt loams, loams, and fine sandy loams, where the cropping sequence is fallow-wheat or sorghum-fallow-wheat,

TABLE 3.—*Predicted average yields per acre of wheat and grain sorghum on the arable soils under two levels of dryland management*

[Columns A list yields to be expected under present management, and columns B list yields to be expected under improved management; wheat yields are those expected if a fallow period is used]

| Soil | Wheat | | Grain sorghum | |
|---|---|---|---|---|
| | A | B | A | B |
| | *Bu.* | *Bu.* | *Bu.* | *Bu.* |
| Bayard fine sandy loam, 1 to 4 percent slopes. | (1) | (1) | 16.0 | 20.0 |
| Dalhart fine sandy loam, 0 to 1 percent slopes. | 16.0 | 20.0 | 20.0 | 25.0 |
| Dalhart fine sandy loam, 1 to 3 percent slopes. | 12.0 | 16.0 | 16.0 | 20.0 |
| Dalhart loamy fine sand, 0 to 3 percent slopes. | (1) | (1) | 23.0 | 29.0 |
| Manter fine sandy loam, hummocky. | 11.0 | 14.0 | 14.0 | 18.0 |
| Manter-Dalhart fine sandy loams, undulating. | 12.0 | 16.0 | 16.0 | 20.0 |
| Otero-Mansic complex, undulating. | (1) | (1) | 14.0 | 21.0 |
| Richfield fine sandy loam, 0 to 1 percent slopes. | 16.0 | 20.0 | 20.0 | 25.0 |
| Richfield loam, thick surface, 0 to 1 percent slopes. | 16.0 | 20.0 | 18.0 | 22.0 |
| Richfield silt loam, 0 to 1 percent slopes. | 14.5 | 18.0 | 15.0 | 18.0 |
| Spearville silty clay loam, 0 to 1 percent slopes. | 14.5 | 18.0 | 13.0 | 16.0 |
| 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 | 13.0 |
| Vona loamy fine sand. | (1) | (1) | 13.0 | 20.0 |

[1] Little or no wheat grown on soil.

(1) the soil is tilled several times and is bare when the crop is planted; and (2) the grain sorghum is planted thicker than it should be. These practices are also followed on the loamy fine sands and the fine sandy loams where grain sorghum is grown continuously. In addition, most of the sorghum residue is grazed off.

Under improved management (columns B) on the silt loams, loams, or fine sandy loams, in fields where the cropping sequence is fallow-wheat or sorghum-fallow-wheat, the following practices are used:

1. The soil is tilled only to control weeds and to prepare the seedbed.
2. Terracing, contouring, and stripcropping are used to help control erosion and to conserve moisture.
3. Tillage is with implements that leave residue on the surface of the soil.
4. Wheat and grain sorghum are planted only if the soil is moist to a depth of more than 24 inches.
5. Planting of grain sorghum and wheat is at rates recommended by the Kansas Agricultural Experiment Station. The planting rates currently recommended are (a) not more than 2 pounds of grain sorghum seed per acre and (b) about 30 pounds of wheat seed per acre.

Under improved management on the loamy fine sands and the fine sandy loams, in fields where grain sorghum is grown continuously, the following practices are used:

1. The soil is tilled only to control weeds and to prepare a seedbed.
2. Planting of grain sorghum is at the rate recommended by the Kansas Agricultural Experiment Station. The planting rate currently recommended is about 2½ pounds of seed per acre.
3. Grazing of the residue is limited so that protective amounts are left on the surface.

### *Irrigated yields*

Wheat and grain sorghum are the main crops grown under irrigation. The present management of irrigated soils is considered extensive because as many acres as possible are watered and are not leveled, and small amounts of fertilizer are applied.

Under improved management of irrigated soils, average yields may be increased 100 percent. This management is considered intensive because a few acres are watered thoroughly, the soil is leveled so that water distribution is improved, and adequate amounts of fertilizer are applied.

More land is suitable for irrigation in the county than there is water to irrigate it. Consequently, the individual farmer decides whether prevailing management, improved management, or a combination of these, is the most profitable.

## Range Management [3]

This subsection has five main parts. The first part discusses general practices of range management. The second part tells how to improve livestock. The third part defines a range site and range condition classes. In the fourth part the soils are placed in 11 range sites, and suitable management of these sites is described. In the fifth part are estimated yields of forage for each range site.

In Seward County range that produces native grasses for forage makes up about 32 percent of the total acreage. This range is scattered throughout the county, but the larger areas are along the Cimarron River. Areas of range generally are not suitable for cultivation.

Raising livestock, mainly feeder and stocker cattle, is the second largest agricultural enterprise in Seward County. The success of this enterprise depends on the way ranchers and farmers manage their range and feed for cattle. Breeding herds are few in the county.

### *Management principles and practices*

If the range is kept in good or excellent condition and is improved where it is depleted, large amounts of forage are produced and soil, water, and plants are conserved. The growth of grass and of other forage plants depends on the development of roots, the stalk, leaves, and the flower. Also important are food storage in roots, seed production, and forage regrowth. To permit these natural processes of growth, grazing must be regulated.

If grazing is not carefully regulated, livestock select and eliminate the most palatable plants. Less desirable, or second-choice, plants increase, and if heavy grazing continues, those plants are thinned out or eliminated and undesirable weeds, or invaders, take their place.

[3] By PETER N. JENSEN, range conservationist, Soil Conservation Service.

Research and the experience of ranchers have shown that damage to desirable plants is lessened and the range is improved if not more than half the grass that grows in a year is removed by grazing. Then—

(1) The better grasses maintain or improve their vigor and thus crowd out weeds or prevent them from invading.
(2) Plants store food that is used in quick and vigorous growth after droughts and in spring.
(3) Roots increase in number and in length so that they reach additional moisture and plant nutrients.
(4) Plants, particularly grass, protect the soil from wind and water erosion.
(5) Plants serve as a mulch that allows a rapid intake of water.
(6) Snow is held by plants where it falls, and it later melts and supplies water that soaks into the soil and is available for use.
(7) The feed reserve for dry years is increased, and a forced sale of livestock caused by lack of feed may be prevented.

To insure that not more than half of the yearly volume of grass is grazed, the stocking rate is adjusted from season to season according to forage production. The management should provide reserve pastures or other feed during droughts, or when forage production is low for other reasons. Thus, grazing should be no more than moderate at any time. In addition, it is often desirable to keep stocker steers or other livestock ready for sale so that the rancher can balance the number of his livestock with the forage available and not be forced to sell his breeding animals.

The *proper degree of range use*, therefore, is important on all range. By regulating the rate of grazing, plant vigor, forage reserves, and adequate residues are maintained, and soil and water are conserved. Also, desirable plants that have been eliminated through heavy grazing probably will reappear.

The proper degree of range use may be obtained through *deferred grazing* or through *rotation-deferred* grazing. In deferred grazing a pasture is rested for a definite period during the growing season so that the vigor of the forage is increased or desirable plants are given time enough to produce naturally. Deferred grazing also builds up a reserve of forage.

In rotation-deferred grazing one or more pastures are rested at planned intervals through the growing season. The time for each pasture to rest is changed in successive years so that desirable forage plants can develop and produce seed.

Regardless of whether deferred or rotation-deferred grazing is used, the range can be improved and the movement of animals somewhat controlled by seeding depleted range, establishing watering places, erecting fences, placing salt, and controlling weeds and brush.

*Range seeding.*—Native or improved grasses can be established on range suited to them by seeding or reseeding. The climate and soils should be suitable for supporting, with no care other than management of grazing, the kinds of plants seeded. Suitable grasses are those dominant in the climax vegetation and other plants suited to the soils. If native grass is seeded, the seed should be produced no farther away than 400 miles to the south or 150 miles to the north. Grasses should be seeded in forage or grain stubble, for the stubble protects the soil from erosion, provides a firm seedbed, and helps control weeds. Also, as a mulch, the stubble helps retain moisture in the top layer of soil. Grazing should be delayed on newly seeded fields for at least 2 years to give plants time to become firmly established.

*Watering places.*—If possible, watering places should be distributed through the range so that all parts of the range are grazed uniformly and the animals do not have to go far for water. Wells, ponds, and dugouts supply water in most of this county, but in some parts the water has to be hauled. The nature of each range determines the kind of watering places most practical and their location.

*Fencing.*—Fences are constructed so that grazing can be managed more easily. If the range is large enough, fences separate fairly uniform areas.

*Salting.*—Salt is necessary to supplement native range forage. Salting at different places improves grazing distribution.

*Controlling weeds and brush.*—Undesirable plants can be controlled chemically or mechanically. This control is needed to improve some areas so that the more desirable plants can grow and livestock are not forced to overgraze one or more parts of the range.

### Livestock improvement

To improve the quality of livestock and to increase their number, the rancher needs to plan the feeding and breeding of his animals. Also, the nonproductive animals of poor quality should be culled.

A good program of feeding provides range forage, concentrates, and hay or tame pasture to keep the animals in good condition throughout the year. Use of roughage for feed and deferred grazing of native pasture conserve plant cover. These reserves of feed are kept in winter to add to the feed needed for meeting the normal requirements of the animals.

The breeding program should provide the types of livestock best suited to the range and calving in periods when forage is most nutritious. Also, the animals should be continually improved as much as the range and the climate allow.

### Range sites and condition classes

Different kinds of range produce different kinds and amounts of original vegetation. For proper range management, an operator should know the different kinds of range in his holdings and the plants that will grow on each site. Then management can be used that favors growth of the best forage plants on each kind of range. Managing range can be approached by grouping soils in range sites.

*Range sites* are areas of rangeland that differ in their ability to produce a significantly different kind or amount of climax, or original, vegetation. A significant difference is one that is great enough to require different grazing use or management for maintaining or improving the present vegetation. *Climax vegetation* is the combination of range plants that originally grew on a given site. The most productive combination of range plants on the site is generally the climax type of vegetation.

*Range condition* is the term used to relate the current condition of the range to the potential of which this 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 the result of grazing and drought. Following are the different classes of range condition and the percentage of the climax vegetation present in each:

| *Condition class* | *Percentage of climax vegetation on the site* |
|---|---|
| Excellent | 76–100 |
| Good | 51– 75 |
| Fair | 26– 50 |
| Poor | 0– 25 |

### Range sites in Seward County

In this subsection the soils of Seward County, except Lincoln soils and Randall clay, have been placed in range sites. Described for each range site is the dominant vegetation on the site when it is in excellent condition.

Lincoln soils (Ll) and Randall clay (Ra) have been omitted from range sites because they are unstable and their native vegetation generally is not suitable for grazing. Lincoln soils are very sandy and gravelly. They occur on nearly level to undulating flood plains along the Cimarron River. Because of flooding and wind erosion, these soils have an unstable plant cover that consists of cottonwood trees, tamarisk, sand willow, annual weeds and forbs, and tall and salt-tolerant grasses.

Randall clay occurs in upland depressions in which water stands during rainy periods. Its plant cover varies greatly between wet and dry periods and consists dominantly of Pennsylvania smartweed, bur-ragweed, cocklebur, sedges, and rushes.

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

#### CHOPPY SANDS RANGE SITE

This range site consists of deep fine sands that occur in areas of steep, hummocky, dunelike sandhills in which blowouts are numerous (fig. 15). These soils are very permeable, somewhat excessively drained, and low in moisture-holding capacity. The soils are—

Blown-out land (Bo).
Tivoli fine sand (Tf).

In the climax vegetation are sand bluestem, switchgrass, little bluestem, big sandreed, and other decreasers. These decreasers make up about 60 percent of the climax vegetation, and other perennial grasses and forbs make up the rest. The dominant increasers are sand dropseed and sand paspalum, and the principal woody plant is sand sagebrush. Blowoutgrass and big sandreed are the first perennials to grow in blowouts or on dunes, and to start

*Figure 15.*—**Giant sandreed is beginning to stabilize this Blown-out land.**

stabilizing them. Common invaders are false buffalograss and purple sandgrass.

Under present management the condition of this range site is generally poor, and the site produces approximately one-fourth as much as it would under climax vegetation. The dominant plants in areas under cover are sand dropseed, sand sagebrush, sand paspalum, and blue grama. In other places this site is bare except for widely scattered pigweed, Russian-thistle, and a few other annuals.

Management practices needed to maintain or improve this site are proper range use, deferred grazing, rotation-deferred grazing, brush control, and range seeding where needed. Because livestock might disturb the soils and increase their susceptibility to blowing, watering places and salting grounds should not be made on this site.

#### CLAY UPLAND RANGE SITE

The only soil in this range site is Spearville silty clay loam, 0 to 1 precent slopes (Sp). This soil is on uplands and is deep and nearly level. It has a silty clay loam surface layer and a silty clay subsoil. Permeability is slow.

In the climax plant cover are western wheatgrass, side-oats grama, little bluestem, and other decreasers. The dominant increasers are buffalograss and blue grama. Annuals are the principal invaders.

Under present management the condition of this range site is generally fair.

Management practices needed to maintain or improve the range are proper range use, deferred grazing, and rotation-deferred grazing.

#### GRAVELLY HILLS RANGE SITE

This range site consists of only Gravelly broken land (Gr), which is on steep slopes that are dissected by many intermittent streams. This rough land consists of sandy soils and many pockets and hills of gravelly materials. Runoff is rapid.

In the climax plant cover are little bluestem, side-oats grama, sand bluestem, and other decreasers. Blue grama, hairy grama, and sand dropseed are the dominant grass increasers, and sand sagebrush and small soapweed are the dominant woody increasers. Common invaders are tumblegrass and mat-forming spurges.

Under present management, the condition of this range site is generally fair.

Management practices needed to maintain and improve the range are proper range use, deferred grazing, and rotation-deferred grazing.

#### LIMY UPLAND RANGE SITE

The soils in this unit are on gently sloping to moderately steep uplands and have loam to silt loam surface layers and subsoils. They are calcareous, moderately slow in permeability, well drained, and high in moisture-holding capacity. The soils are—

Colby loam, 5 to 12 percent slopes (Cm).
Ulysses-Colby complex, 1 to 3 percent slopes, eroded (Ue).

The climax plant cover is a mixture of little bluestem, side-oats grama, blue grama, hairy grama, buffalograss, and other plants. The dominant increasers are buffalograss, broom snakeweed, and mat-forming spurges.

Under present management the condition of this range site is generally poor. This site produces approximately one-fourth as much as it would under its climax vegetation.

Management practices needed to maintain or improve the condition of the range are proper range use, deferred grazing, rotation-deferred grazing, and range seeding where needed.

#### LOAMY LOWLAND RANGE SITE

This range consists only of Alluvial land (An), which is on narrow, nearly level flood plains that are dissected by meandering intermittent streams. The soil material is sandy loam to loam that has high moisture-holding capacity. Water other than that from precipitation is received from the occasionally flooded streams and as runoff from adjacent slopes.

The climax plants include switchgrass, big bluestem, Indiangrass, Canada wildrye, little bluestem, and other decreasers. These decreasers make up at least 55 percent of the total cover, and increasers may make up the rest. The increasers are perennial forbs and western wheatgrass, blue grama, and buffalograss.

Under present management the condition of this range site is generally fair to good.

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

#### LOAMY UPLAND RANGE SITE

This range site consists of deep soils on nearly level to sloping uplands. These soils have loam to clay loam surface layers and subsoils. They are slow to moderately slow in permeability and high in water-holding capacity. The soils are—

Colby loam, 3 to 5 percent slopes (Cc).
Richfield loam, thick surface, 0 to 1 percent slopes (Rh).
Richfield silt loam, 0 to 1 percent slopes (Rm).
Richfield and Ulysses complexes, bench leveled (Rb).
Ulysses silt loam, 0 to 1 percent slopes (Ua).
Ulysses silt loam, 1 to 3 percent slopes (Ub).

The climax vegetation is a mixture of blue grama, buffalograss, western wheatgrass, side-oats grama, little bluestem, and other grasses. Buffalograss is the main increaser where the site is heavily grazed, and blue grama and buffalograss are dominant under normal grazing. Annuals are the principal invaders. In droughty years, pricklypear is the most common invader. Figure 16 shows the Loamy Upland range site under contrasting management.

Under present management the condition of the Loamy Upland site is generally fair to good, and the site produces approximately half of its climax vegetation. The dominant grasses are blue grama and buffalograss.

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

#### ROUGH BREAKS RANGE SITE

Only Rough broken land (Ro) is in this range site. It is on steep, broken slopes that are dissected by many intermittent streams. Runoff is rapid. The soils range from loam to gravelly loam.

Grasses in the climax plant cover include little bluestem, side-oats grama, and other decreasers. These decreasers may make up 60 percent of the climax vegetation, and other perennial grasses and forbs account for the rest. The dominant grass increasers are blue grama, hairy grama, and sand dropseed. Sand sagebrush and small soapweed are the dominant woody increasers. A common invader is broom snakeweed.

Under present management the condition of this range site is generally fair.

Management practices needed to maintain or to improve the range are proper range use, deferred grazing, and rotation-deferred grazing.

#### SALINE SUBIRRIGATED RANGE SITE

The only soil in this range site is Las Animas sandy loam (Ld). It is on the flood plains (fig. 17) of the Cimarron River and is nearly level, imperfectly drained, and saline. Although the site is dominantly sandy loam, texture ranges from clay loam to loamy fine sand. The water table and occasional floods add to the soil moisture that is supplied by precipitation.

In the climax vegetation are alkali sacaton, switchgrass, Indiangrass, western wheatgrass, and other decreasers. These decreasers make up about 80 percent of the climax vegetation. The dominant increaser is saltgrass, and common invaders are alkali muhly, western ragweed, and tamarisk.

Under present management the condition of this range site is generally good.

Management practices needed to maintain or improve the range are proper range use, deferred grazing, and rotation-deferred grazing.

#### SANDS RANGE SITE

This range site makes up 67 percent of the range in Seward County. It is made up of deep soils on nearly level to undulating uplands (fig. 18). These soils have loamy fine sand surface layers and loamy fine sand to clay loam subsoils. The moisture-holding capacity ranges from low to high and depends on the texture of the subsoil. The soils are—

Dalhart loamy fine sand, 0 to 3 percent slopes (Df).
Likes loamy sand (Lk).
Vona loamy fine sand (Vo).
Vona-Tivoli loamy fine sands (Vx).

***Figure 16.*—Areas of the Loamy Upland range site, separated by fence, show the effects of differences in management.**

***Figure 17.*—Saline Subirrigated range site.**

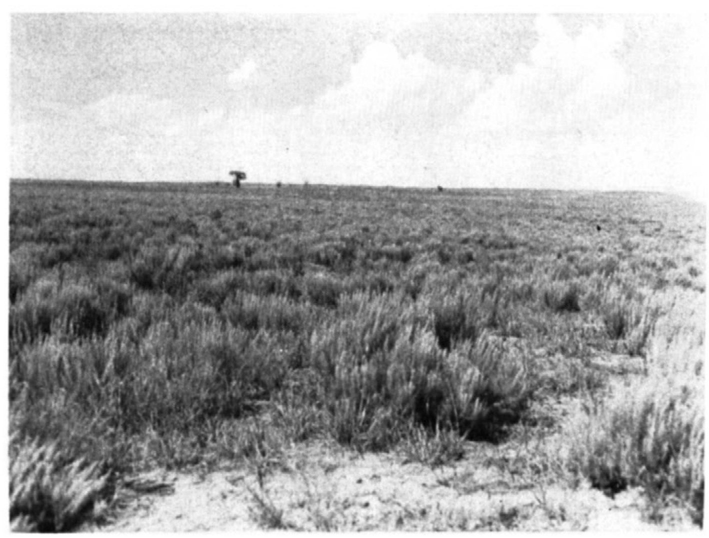

*Figure 18.*—Sands range site.

About 65 percent of the climax vegetation consists of sand bluestem, little bluestem, switchgrass, side-oats grama, big sandreed, and other decreasers. Other perennial grasses and forbs make up the rest. The dominant increaser grasses include blue grama, sand dropseed, and sand paspalum. Sand sagebrush is the principal woody invader. Common invaders are false buffalograss, purple sandgrass, and red lovegrass.

Under present management this range site is in poor condition and produces approximately one-fourth as much as would the climax vegetation. The dominant plants are sand dropseed, sand sagebrush, sand paspalum, and blue grama.

Management practices needed to maintain or improve the site are proper range use, deferred grazing, rotation-deferred grazing, brush control, and range seeding where needed.

#### SANDY RANGE SITE

This range site is made up of deep soils on nearly level to moderately steep uplands (fig. 19). The soils have fine sandy loam surface layers and sandy loam to clay loam subsoils. Permeability is moderate to moderately slow, and moisture-holding capacity is moderate to high. The soils are—

Bayard fine sandy loam, 1 to 4 percent slopes (Bb).
Dalhart fine sandy loam, 0 to 1 percent slopes (Da).
Dalhart fine sandy loam, 1 to 3 percent slopes (Db).
Manter fine sandy loam, hummocky (Mh).
Manter-Dalhart fine sandy loams, undulating (Md).
Otero-Mansic complex, undulating (Oy).
Richfield fine sandy loam, 0 to 1 percent slopes (Rf).

In the climax vegetation are sand bluestem, little bluestem, switchgrass, and side-oats grama and other decreasers. These decreasers make up about 55 percent of the climax vegetation, and increaser grasses and forbs make up the rest. The dominant increasers are blue grama, sand dropseed, buffalograss, and sand paspalum. Sand sagebrush and small soapweed are the dominant woody increasers. Common invaders are three-awn, windmillgrass, and six-weeks fescue.

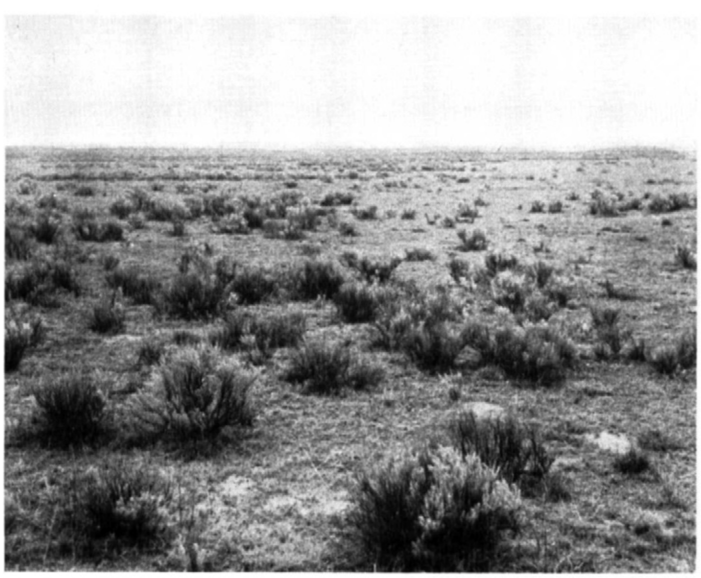

*Figure 19.*—Sandy range site.

Under present management the condition of this range site is generally poor. The site produces approximately one-fourth as much as would the climax vegetation; the main plants are sand dropseed, sand sagebrush, sand paspalum, and blue grama.

Management practices needed to maintain or improve the site are proper range use, deferred grazing, and rotation-deferred grazing, and range seeding.

#### SANDY-GRAVELLY HILLS RANGE SITE

Only Otero gravelly complex (Ox) is in this range site. About 70 percent of this site is the Sandy range site, and 20 percent is the Gravelly Hills range site.

Under present management the condition of this site is generally poor. The site produces approximately one-fourth as much as it would under climax vegetation.

Management practices needed to maintain or improve this site are proper range use, deferred grazing, rotation-deferred grazing, and range seeding.

### *Estimated yields*

Yields on a range site vary according to the amount and distribution of rainfall each year. They are also affected by the degree of grazing in past years. In addition, yields are reduced by trampling and by rodents and insects.

Following is the estimated annual total top growth of forage for each range site, assuming it has received average rain throughout the year and is in excellent condition.

| Range site: | *Air-dry weight (lb. per acre)* |
|---|---|
| Choppy Sands | 1, 250–1, 750 |
| Clay Upland | 750–1, 500 |
| Gravelly Hills | 1, 500–2, 000 |
| Limy Upland | 1, 250–2, 000 |
| Loamy Lowland | 3, 000–4, 000 |
| Loamy Upland | 1, 250–2, 000 |
| Rough Breaks | 1, 250–1, 750 |
| Saline Subirrigated | 4, 000–5, 000 |
| Sands | 2, 000–2, 500 |
| Sandy | 1, 500–2, 000 |
| Sandy-Gravelly Hills | 1, 500–2, 000 |

## Woodland Management

In Seward County there are no native forests or woodland. The flood plains along the Cimarron River support a sparse, mixed stand of cottonwood, tamarisk, and other trees and shrubs. Trees and shrubs grow well only in places that receive additional moisture. The only plantings in the county are farmstead windbreaks and trees grown for shade or ornament.

Windbreak plantings help protect farmsteads and feeding areas for livestock. They can be established successfully if they are well planned and cared for. Tillage is needed to control weeds in windbreaks. Runoff diverted from surrounding areas to the windbreaks provides additional moisture for the trees. Windbreaks that are irrigated provide protection much sooner than those that are not. On uplands a dryland windbreak of conifers and hardwoods that is not irrigated should remain effective for 25 to 35 years.

The soil types and complexes in Seward County that are suitable for windbreak plantings have been arranged in the Silty Upland and the Sandy Upland windbreak sites as follows:

| *Silty Upland* | *Sandy Upland* |
|---|---|
| Colby loam. | Bayard fine sandy loam. |
| Richfield loam. | Dalhart fine sandy loam. |
| Richfield silt loam. | Dalhart loamy fine sand. |
| Spearville silty clay loam. | Likes loamy sand. |
| Ulysses silt loam. | Manter fine sandy loam. |
| Ulysses-Colby complex. | Otero gravelly complex. |
| | Otero-Mansic complex. |
| | Richfield fine sandy loam. |
| | Vona loamy fine sand. |

Not suitable for trees and not listed are Lincoln soils, Las Animas sandy loam, Randall clay, and the miscellaneous land types in the county.

Table 4 shows the trees and shrubs that are suitable for windbreaks, and the approximate height that they will attain in 10 years on the Silty Upland and the Sandy Upland sites under dryland and irrigated management.

The local representative of the Soil Conservation Service or the county extension agent can supply more information on planting trees and on developing farmstead windbreaks.

TABLE 4.—*Trees and shrubs suitable for windbreak sites and approximate height, in feet, attained after 10 years on dryland and irrigated soils*

| Suitable trees and shrubs | Silty Upland | | Sandy Upland | |
|---|---|---|---|---|
| | Dryland | Irrigated | Dryland | Irrigated |
| Eastern redcedar | 5 | 9 | 8 | 11 |
| Honeylocust | 12 | 22 | 14 | 24 |
| Mulberry | 15 | 20 | 17 | 24 |
| Osage-orange | 12 | 22 | 13 | 22 |
| Ponderosa pine | 6 | 9 | 8 | 11 |
| Rocky Mountain juniper | 5 | 9 | 8 | 11 |
| Russian-olive | 12 | 22 | 13 | 22 |
| Siberian elm [1] | 22 | 32 | 25 | 35 |
| Skunkbush sumac | 5 | 9 | 6 | 9 |
| Tamarisk | 10 | 20 | 10 | 15 |

[1] Commonly called Chinese elm.

## Wildlife Management

The most important upland game birds in Seward County are pheasant, bobwhite and blue quail, and doves. If the number of these birds is to be maintained, grasses must be established for nesting, and woody plants for cover.

Doves may nest on the ground, but windbreaks and other tree plantings make better nesting places. To encourage ducks and other waterfowl to stop over during migration, ponds and other open areas of water are needed. Prairie chickens were once abundant in the county, and they can still be found on the sandy ranges. These birds can be increased if watering places are developed and the range is managed so that bluestem and other tall grasses are favored. If food and cover for wildlife are improved, there will be an increase in the number of songbirds and of the birds that are beneficial because they eat harmful insects.

Common in suitable places in the county are cottontail, jackrabbit, ground squirrel, prairie dog, badger, and skunk. A few beavers live along the Cimarron River.

Information on improving land and water for fish and wildlife can be obtained from the Soil Conservation Service, the Agricultural Extension Service, and the Kansas Forestry, Fish, and Game Commission.

## Engineering Properties of Soils [4]

This subsection discusses the main properties of the soils in Seward County that affect highway construction and agricultural engineering. Also, two systems of engineering soil classification are described, and some engineering terms are defined.

Because soils are not completely homogeneous, engineers need a broad understanding of them and experience in observing their behavior before they can evaluate the properties of a particular soil. Engineers are interested in soil properties because many of these properties affect design, construction, and maintenance of structures. The properties most important to the engineer are permeability to water, strength against shearing, consolidation characteristics, texture, plasticity, and pH. Also important are relief and the depth to consolidated material.

The information in this report can be used to—

1. Make soil and land-use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in planning drainage systems, farm ponds, terraces, waterways, dikes, diversions, irrigation canals, and irrigation systems.
3. Make preliminary evaluations of the soil and its site that will aid in selecting locations for highways and airports and in planning detailed surveys at the selected locations.
4. Locate probable sources of gravel, sand, and other construction materials.
5. Correlate performance of structures with soil mapping units and thus obtain information that is useful in designing and maintaining the structures.
6. Determine the suitability of soils for supporting vehicles and construction equipment that move across them.
7. Supplement information from other published maps and reports and from aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
8. Make preliminary evaluation of the suitability of a particular area for construction purposes.

In using this report, the engineer should be sure that he understands the sense in which the terms in this report are used, for some terms used in soil science and agriculture have a different meaning from those used in engineering. Unless otherwise specified, the terms in the Glossary are defined in their agricultural sense. Some engineering terms are defined in this section.

*This report cannot take the place of sampling and testing soils at a site so that specific structures can be properly designed and constructed. The report can be used in planning more detailed field surveys to determine the condition of the soil, in place, at the site of the proposed structure.*

[4] By CARL L. ANDERSON, civil engineer, Soil Conservation Service.

### *Engineering classification*

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture, color, and structure. This system is useful only as the initial step in making engineering classifications of soils. The engineering properties of a soil must be determined or estimated after the initial classifications have been made. The two systems generally used by engineers in classifying soils are the system approved by the American Association of State Highway Officials (AASHO) and the Unified system of the Corps of Engineers, U.S. Army. These systems are explained briefly in the following paragraphs. The explanations are taken largely from the PCA Soil Primer (*7*).[5]

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

Three of the seven basic groups may also be divided into subgroups to designate variations within the groups. Within each group or subgroup, the relative engineering value of the soil material is indicated by a group index number, which is shown in parentheses following the group classification. Group indexes range from 0 for the best material to 20 for the poorest. Increasing values of group indexes denote decreasing load-carrying capacity.

In the AASHO system the soil material may be further divided into the following two major groups: (1) Granular material in which 35 percent or less of the material passes a 200-mesh sieve, and (2) silt-clay material in which more than 35 percent of the material passes a 200-mesh sieve. The silty part of the silt-clay material has a plasticity index of 10 or less, and the clayey material has a plasticity index greater than 10. The plasticity index refers to the numerical difference between the liquid limit and the plastic limit. The liquid limit is the moisture content, expressed as a percentage of the ovendry weight of the soil, at which the soil material passes from a plastic to a liquid state. The plastic limit is the moisture content, expressed as a percentage of the ovendry weight of the soil, at which the soil material passes from a semisolid to a plastic state.

*Unified classification system.*—In the Unified system the soils are grouped on the basis of their texture and plasticity, as well as on their performance when used as material for engineering structures (*9*). The soil materials are identified as coarse grained, which are gravels (G) and sands (S); fine grained, which are silts (M) and clays (C); and highly organic (Pt.). No highly organic soils are mapped in Seward County.

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

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

[5] Italic numbers in parentheses refer to Literature Cited, p 48.

### *Soil engineering interpretations*

The engineer should know the physical properties of the soil material and the condition of the soil in place so that he can make the best use of the soil map and the text of this report. In table 5 are soil classifications and estimated physical and chemical properties that are important in construction. The estimates in table 5 are based (1) on laboratory tests of soils in Morton, Logan, and Ford Counties; (2) on soil tests made by the Kansas State Highway Commission at construction sites; (3) on the behavior of the same kinds of soil in other counties; and (4) on information in other sections of this report. The properties of the soils are given for each layer in a profile typical of the soil series. For soil complexes, reference is made to the major soils in the complexes. For the soil profile, the depth of each significant layer (horizon) is given in inches. More complete descriptions of the profile are in the section "Formation and Classification of the Soils." Also given in table 5 are classifications by textural classes, as used by the U.S. Department of Agriculture, as well as estimates of the Unified and AASHO classifications.

In table 5 the columns under "Percentage passing sieve" list the percentage of soil material that is smaller in diameter than the openings of the given sieve.

Soil permeability is the quality of the soil that enables it to transmit water or air. In table 5 the probable rate that water percolates in soils is estimated in inches per hour. This is the estimated rate that water percolates through a unit cross-section of saturated soil under gravity and a ½-inch head of water.

The column, "Available moisture holding capacity," shows how much more water can be held at field capacity than is held when the soil is air dry.

Shrink-swell potential is an estimated rating of the change in volume that takes place when the water content changes extremely. For example, Randall clay has a very high shrink-swell potential; it shrinks greatly as it dries and swells greatly when it becomes wet. In contrast, Tivoli fine sand has low shrink-swell potential. A knowledge of this potential is valuable in planning roads and other structures.

In table 5 the depth to the water table is given in the soil descriptions of those soils that are affected by a high water table.

The soils in the county range from neutral to moderately alkaline. The pH of the surface layer and subsoil ranges from 7.0 to 8.5. The substratum of most of the soils is moderately alkaline and has a pH of 7.9 to 8.5.

Table 6 rates the suitability of the soils in Seward County for various engineering uses. It also lists the soil features that affect the use of the soil in highways and farm structures.

The suitability of the soil for topsoil is given because vegetation is needed to control erosion on embankments, road shoulders, ditches, and cut slopes. Because each layer of the soil profile is a possible source of topsoil, the rating for the surface layer may differ from that of the subsoil. In most places the loamy soils on cut slopes can be seeded without addition of topsoil. If, however, plants are to grow on the sandier Tivoli and Vona soils, a layer of suitable topsoil is needed on the cut slopes.

Pockets of sand and gravel large enough to be mined occur in local areas of the Lincoln, Las Animas, and Likes soils, and in the Otero gravelly complex, Rough broken land, and Gravelly broken land.

The suitability of the soil materials for road fill and road subgrade depends largely on the texture, the load-carrying capacity, and the natural water content of the soil materials. Highly plastic soil materials are rated "Poor" for road subgrade and "Poor or fair" for road fill, depending on their natural water content and how well they can be handled, dried, and compacted.

# *Formation and Classification of the Soils*

This section consists of two main parts. The first discusses the factors of soil formation and tells how these factors affected the formation of soils in Seward County. In the second part the classification of soils is explained, the soil series of the county are placed in their respective soil orders and great soil groups, and each soil series in the county is described.

## Factors of Soil Formation

Soil is produced when soil-forming processes act on materials deposited or accumulated by geologic agencies. The characteristics of a soil at any given point are determined by (1) the physical and mineralogical composition of the parent materials; (2) the climate under which the soil material has accumulated and has existed since it accumulated; (3) the plants and animals in and on the soil; (4) the relief, or lay of the land; and (5) the length of time that the forces of development acted on the parent material (*8*).

Climate and vegetation are active factors of soil genesis. They act on the parent material and slowly change it into a natural body that has definite genetic horizons. The effects of climate and vegetation upon soil formation are conditioned by relief. The parent material also affects the kind of profile that can be formed and may even determine the profile almost entirely. Finally, time is needed for changing the parent material into a soil with horizons. The length of time may be short or long, but some time is always required for horizons to form. The five factors of soil formation, as they relate to the soils of Seward County, are discussed next.

### *Parent material*

Seward County is a part of the southern High Plains in the Great Plains province. About half of the county lies in the Cimarron bend area of southwestern Kansas. Most of the soils developed from sediments deposited during the Pleistocene and Recent epochs. The parent materials are mainly loess, eolian sand, recent alluvium, and old alluvium laid down in the Pleistocene or late in the Pliocene epoch. Figure 20 shows the parent material underlying the soils of some series in Seward County.

Loamy wind-deposited sediments, or loess, make up the parent material of the soils in about 30 percent of the county. This loess was deposited in a mantle over the area during the Wisconsin stage of the Pleistocene epoch. The loess generally ranges from about 4 to 12 feet in thickness. It is calcareous and pale brown. In most places it is more than 50 percent silt and about 25 percent clay.

Wind-deposited sands make up the parent material of the soils in about 50 percent of the county. In most places deposits of these sands mantle the slightly older and finer

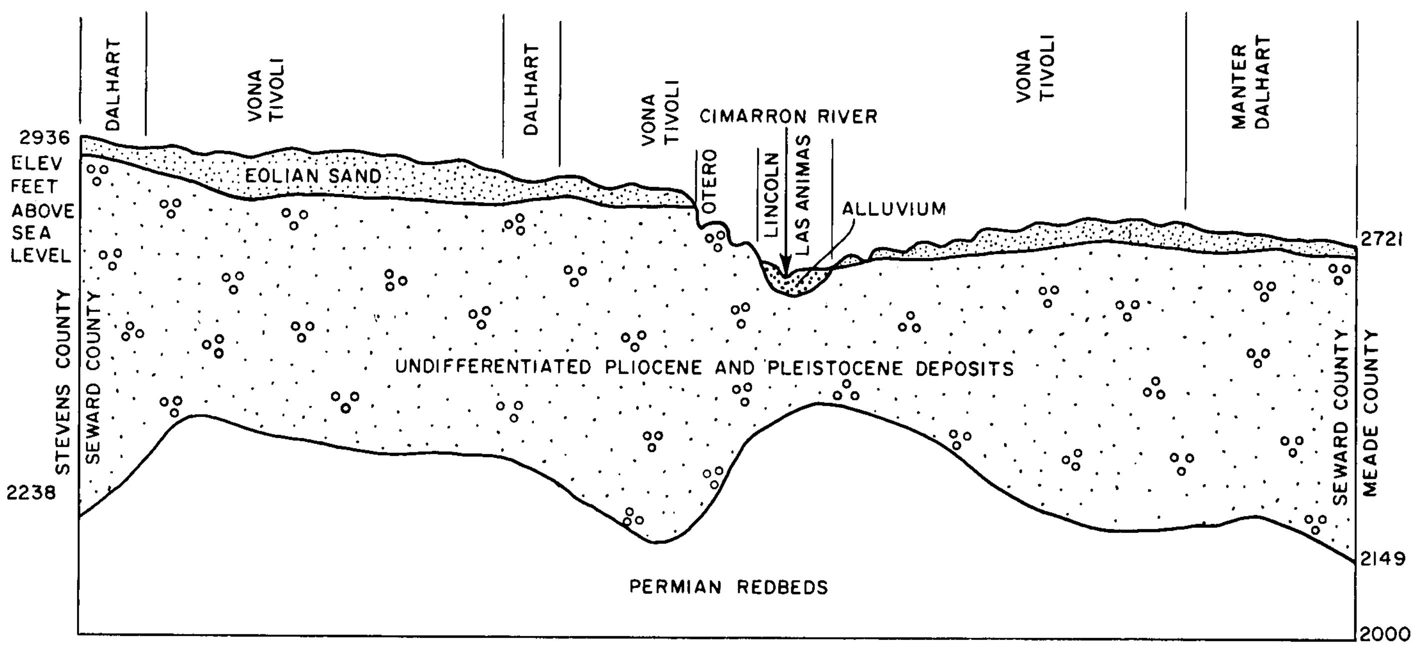


*Figure 20.*—Cross section that extends from west to east across the south-central part of the county and shows soil series and underlying geological materials. Vertical scale greatly exaggerated.

TABLE 5.—*Brief description of soils*

[Absence of data indicates properties vary

| Map symbol | Soil | Soil description | Depth from surface |
|---|---|---|---|
| | | | *Inches* |
| An | Alluvial land. | More than 4 feet of stratified sandy and loamy materials on narrow flood plains of the small tributaries of the Cimarron River; dissected by meandering streams. | ------------ |
| Bb | Bayard fine sandy loam, 1 to 4 percent slopes. | 6 to 12 inches of fine sandy loam underlain by 4 feet or more of colluvial-alluvial fine sandy loam; well drained; few pockets of gravelly material. | 0–10<br>10–48 |
| Bo | Blown-out land. | Actively eroding or blowing sand or loamy sand underlain by loam or clay at a depth of 5 to 20 feet. Refer to Tivoli fine sand and Vona loamy fine sand for estimated properties. | ------------ |
| Cm<br>Cc | Colby loam, 5 to 12 percent slopes.<br>Colby loam, 3 to 5 percent slopes. | 3 to 6 inches of loam underlain by more than 4 feet of calcareous loamy sediments; well-drained uplands with stable convex slopes. | 0–4<br>4–48 |
| Da<br>Db | Dalhart fine sandy loam, 0 to 1 percent slopes.<br>Dalhart fine sandy loam, 1 to 3 percent slopes. | 5 to 10 inches of fine sandy loam on 12 to 24 inches of sandy clay loam underlain by more than 3 feet of loam or clay loam; well-drained soils on uplands; wind deposited; in some places buried soil layers occur below 24 inches and generally are loam or clay loam. | 0–8<br>8–28<br>28–60 |
| Df | Dalhart loamy fine sand, 0 to 3 percent slopes. | 6 to 14 inches of loamy fine sand on 12 to 24 inches of sandy clay loam underlain by more than 3 feet of loam or clay loam; windblown material; well-drained soil; in some places buried soil layers occur below 24 inches and are generally loam or clay; mostly undulating. | 0–12 |
| Gr | Gravelly broken land. | Mainly sandy soils that have many pockets and hills of gravelly materials; on steep slopes that are deeply dissected by many intermittent streams. | ------------ |
| Ld | Las Animas sandy loam. | 12 to 24 inches of sandy loam underlain by more than 3 feet of sand on nearly level plains of the Cimarron River that are occasionally flooded; imperfectly drained; depth to water table is 2 to 8 feet. | 0–20<br>20–48 |
| Lk | Likes loamy sand. | 4 to 10 inches of loamy sand underlain by more than 3 feet of sand that contains strata of loamy and gravelly material and pockets of gravelly material; on gently sloping colluvial-alluvial fans. | 0–8<br>8–48 |
| Ll | Lincoln soils. | 3 to 6 inches of loamy sand to fine sandy loam underlain by more than 4 feet of sand; imperfectly drained; strata of coarse sand and gravel in places; gently undulating flood plain adjacent to channel of the Cimarron River; depth to water table 0 to 6 feet. | 0–6<br>6–48 |
| Mh | Manter fine sandy loam, hummocky. | More than 4 feet of well-drained fine sandy loam; some strata of loam material, generally below 2 feet; complex slopes of 3 to 6 percent; moderate stability; parent material was wind deposited. | 0–48 |
| Md | Manter-Dalhart fine sandy loams, undulating. | About 60 percent Manter fine sandy loam and about 25 percent Dalhart fine sandy loam; on complex slopes of 1 to 3 percent; moderately stable. Refer to Manter fine sandy loam, hummocky, and the Dalhart fine sandy loams for estimated physical properties. | ------------ |
| Ox | Otero gravelly complex. | More than 30 percent Otero fine sandy loam, about 25 percent Manter fine sandy loam, and about 25 percent gravelly areas on old alluvium. Otero fine sandy loam consists of more than 4 feet of calcareous fine sandy loam. Slopes of 5 to 15 percent that are poorly to moderately stable. | 0–48 |

*and estimates of important properties*

and have not been estimated for mapping unit]

| Classification | | | Percentage passing sieve— | | Permeability | Available moisture holding capacity | Shrink-swell potential |
|---|---|---|---|---|---|---|---|
| USDA | Unified | AASHO | No. 10 | No. 200 | | | |
| | | | | | *Inches per hour* | *Inches per inch of depth* | |
| Fine sandy loam. | SM. | A-2-4. | 98 | 20-35 | 1. 0-2. 0 | 0. 10 | Low. |
| Fine sandy loam. | SM. | A-2-4. | 95 | 15-30 | 1. 0-2. 0 | 0. 10 | Low. |
| Loam. | ML-CL. | A-6 or A-4. | 100 | 75-90 | 0. 5-1. 0 | 0. 18 | Low to moderate. |
| Loam. | ML-CL. | A-6 or A-4. | 100 | 70-90 | 0. 5-1. 0 | 0. 18 | Low to moderate. |
| Fine sandy loam. | SM. | A-2-4. | 100 | 20-35 | 1. 0-2. 0 | 0. 10 | Low. |
| Sandy clay loam. | SM-SC or SC. | A-2-4 or A-4. | 100 | 30-45 | 0. 5-1. 0 | 0. 18 | Low. |
| Loam or clay loam. | ML-CL or CL. | A-4 or A-6. | 100 | 75-95 | 0. 2-0. 5 | 0. 19 | Moderate. |
| Loamy fine sand. | SM. | A-2-4. | 100 | 10-25 | 2. 0-5. 0 | 0. 07 | Low. |
| Sandy loam. | SM. | A-2-4. | 98 | 10-30 | 1. 0-2. 0 | 0. 10 | Low. |
| Sand. | SW or SM-SW. | A-1-b or A-3. | 90-95 | 0. 10 | 5. 0+ | 0. 04 | Low. |
| Loamy sand. | SM. | A-2-4. | 95 | 10-25 | 2. 0-5. 0 | 0. 07 | Low. |
| Sand or loamy sand. | SM-SW or SP-SM. | A-3 or A-1-b. | 90-95 | 5-15 | 5. 0+ | 0. 04-0. 07 | Low. |
| Loamy sand. | SM or SM-SW. | A-1-b. | 95 | 5-15 | 2. 0-5. 0 | 0. 07 | Low. |
| Sand. | SW or SM-SW. | A-1-b or A-3. | 90-95 | 0-10 | 5. 0+ | 0. 04 | Low. |
| Fine sandy loam. | SM or SM-SC. | A-2-4. | 100 | 15-35 | 1. 0-2. 0 | 0. 10 | Low. |
| Fine sandy loam. | SM. | A-2-4. | 95 | 15-30 | 1. 0-2. 0 | 0. 10 | Low. |

TABLE 5.—*Brief description of soils and*

| Map symbol | Soil | Soil description | Depth from surface |
|---|---|---|---|
| | | | *Inches* |
| Oy | Otero-Mansic complex, undulating. | More than 50 percent Otero soils and about 30 percent Mansic soils on slopes of 1 to 4 percent that are moderately stable. The Mansic clay loam consists of more than 4 feet of clay loam. | 0–48 |
| Ra | Randall clay. | 24 to 48 inches of clay over more than 2 feet of loam or silt loam; in upland depressions; ponded water after rainstorms. | 0–36<br>36–60 |
| Rf | Richfield fine sandy loam, 0 to 1 percent slopes. | 6 to 12 inches of fine sandy loam on 12 to 20 inches of clay loam underlain by more than 3 feet of loam or clay loam; well drained; long, smooth slopes; parent material was wind deposited. | 0–10<br>10–26<br>26–60 |
| Rh | Richfield loam, thick surface, 0 to 1 percent slopes. | 8 to 14 inches of loam on 12 to 20 inches of clay loam underlain by more than 3 feet of loam or clay loam; well drained; long, smooth slopes; parent material was wind deposited. | 0–11 |
| Rm<br>Rb | Richfield silt loam, 0 to 1 percent slopes.<br>Richfield and Ulysses complexes, bench leveled. | 4 to 10 inches of silt loam on 10 to 18 inches of silty clay loam underlain by more than 4 feet of silt loam or loam (loess); well drained; long, smooth upland slopes. | 0–6<br>6–20<br>20–60 |
| Ro | Rough broken land. | Steeply sloping areas that are deeply dissected by many intermittent drainageways; surface layer of limestone or caliche, about 2 to 4 feet thick, underlain by sandy, gravelly, and clayey strata interbedded with thin layers of limestone; enough gravel to mine in a few places. | ------------ |
| Sp | Spearville silty clay loam, 0 to 1 percent slopes. | 4 to 12 inches of silty clay loam on 10 to 20 inches of silty clay underlain by more than 4 feet of silt loam or loam (loess); well drained; on flat uplands. | 0–6<br>6–24<br>24–60 |
| Tf | Tivoli fine sand. | More than 5 feet of excessively drained fine sand in dune relief; upland slopes of 10 to 25 percent. | 0–60 |
| Ua<br>Ub | Ulysses silt loam, 0 to 1 percent slopes.<br>Ulysses silt loam, 1 to 3 percent slopes. | 6 to 12 inches of silt loam underlain by more than 4 feet of silt loam or loam (loess or old alluvium); well drained on convex upland slopes. | 0–10<br>10–60 |
| Ue | Ulysses-Colby complex, 1 to 3 percent slopes, eroded. | More than 50 percent Ulysses soils and about 30 percent Colby soils. Refer to Ulysses silt loam and Colby loam for estimated properties. | ------------ |
| Vo | Vona loamy fine sand. | 6 to 16 inches of loamy fine sand on 10 to 30 inches of fine sandy loam underlain by 2 feet or more of loamy fine sand to fine sandy loam; well drained; in some places loam or clay loam, which may be buried layers of an old soil, occurs below a depth of 3 feet; low dunes in rolling relief with slopes of 1 to 5 percent. | 0–10<br>10–30<br>30–60 |
| Vx | Vona-Tivoli loamy fine sands. | More than 50 percent Vona loamy fine sand and about 30 percent of Tivoli loamy fine sand on rolling to hilly relief with slopes of 5 to 20 percent. Refer to Tivoli fine sand and Vona loamy fine sand for estimated properties. | ------------ |

[1] Less than 0.05 inch per hour.

*estimates of important properties*—Continued

| Classification | | | Percentage passing sieve— | | Perme-ability | Available moisture holding capacity | Shrink-swell potential |
|---|---|---|---|---|---|---|---|
| USDA | Unified | AASHO | No. 10 | No. 200 | | | |
| | | | | | *Inches per hour* | *Inches per inch of depth* | |
| Clay loam. | ML–CL or CL. | A–6 or A–7–6. | 100 | 80–95 | 0. 2–0. 5 | 0. 20 | Moderate or high. |
| Clay. | CH. | A–7–6. | 100 | 95–100 | (1) | 0. 21 | Very high. |
| Silt loam. | CL. | A–7–6. | 100 | 95–100 | 0. 2–0. 5 | 0. 19 | Moderate or high. |
| Fine sandy loam. | SM or SM–SC. | A–2–4. | 100 | 20–35 | 1. 0–2. 0 | 0. 10 | Low. |
| Clay loam. | CL. | A–6. | 100 | 65–85 | 0. 2–0. 5 | 0. 19 | Moderate. |
| Loam or clay loam. | CL. | A–6 or A–4. | 100 | 75–95 | 0. 2–0. 5 | 0. 19 | Moderate. |
| Loam. | ML–CL or ML. | A–4 or A–6. | 100 | 50–80 | 0. 5–1. 0 | 0. 18 | Low or moderate. |
| Silt loam. | CL or ML–CL. | A–6 or A–4. | 100 | 85–95 | 0. 2–0. 5 | 0. 19 | Moderate. |
| Silty clay loam. | CL. | A–7–6. | 100 | 90–100 | 0. 2–0. 5 | 0. 20 | High. |
| Silt loam. | ML–CL. | A–7–6 or A–6. | 100 | 90–100 | 0. 2–0. 5 | 0. 19 | Moderate or high. |
| ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | |
| Silty clay loam. | CL. | A–7–6. | 100 | 95–100 | 0. 2–0. 5 | 0. 20 | High. |
| Silty clay loam. | CH. | A–7–6. | 100 | 95–100 | 0. 05–0. 2 | 0. 21 | High or very high. |
| Silt loam. | CL or ML–CL. | A–7–6. | 100 | 90–100 | 0. 2–0. 5 | 0. 19 | Moderate or high. |
| Fine sand. | SP–SM. | A–2–4 or A–3. | 100 | 5–10 | 5. 0+ | 0. 04 | Low. |
| Silt loam. | CL or ML–CL. | A–6 or A–7–6. | 100 | 85–95 | 0. 2–0. 5 | 0. 19 | Moderate. |
| Silt loam. | ML–CL or CL. | A–7–6 or A–6. | 100 | 90–100 | 0. 2–0. 5 | 0. 19 | Moderate or high. |
| ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | |
| Loamy fine sand. | SM. | A–2–4. | 100 | 10–25 | 2. 0–5. 0 | 0. 07 | Low. |
| Fine sandy loam. | SM or SM–SC. | A–2–4. | 100 | 15–30 | 1. 0–2. 0 | 0. 10 | Low. |
| Loamy fine sand. | SM. | A–2–4. | 100 | 10–25 | 2. 0–5. 0 | 0. 07 | Low. |
| ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | |

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TABLE 6.—*Interpretation of soil*

| Soil series and map symbol | Suitability as source of— | | | | | Soil features affecting— |
|---|---|---|---|---|---|---|
| | Topsoil | Sand | Gravel | Roadfill [1] | Road subgrade [1] | Highway location |
| Bayard (Bb). | Fair. | Poor. | Poor; local pockets. | Good. | Good. | Good drainage; moderate erodibility. |
| Colby (Cm, Cc). | Good. | Not suitable. | Not suitable. | Good. | Good. | Good drainage; moderate erodibility. |
| Dalhart (Da, Db, Df). | Surface layer, poor to fair; subsoil, good. | Not suitable. | Not suitable. | Good. | Top 2 feet, good; clay loam substrata fair if used alone but poor if mixed. | Good drainage; moderate to high erodibility. |
| Las Animas (Ld). | Fair. | Good below 3 feet; poorly graded; high water table. | Poor; local pockets. | Good. | Poor to good. | High water table; stratified materials in top 2 feet and sand below. |
| Likes (Lk). | Poor. | Fair; local pockets. | Fair; local pockets. | Good. | Good. | Good drainage; high erodibility. |
| Lincoln (Ll). | Not suitable. | Good; poorly graded; high water table. | Poor; local pockets; high water table. | Fair to good. | Poor to good. | High water table; flooding hazard; severe erodibility. |
| Mansic (Oy). | Good. | Not suitable. | Not suitable. | Fair. | Fair. | Good drainage. |
| Manter (Md, Mh). | Fair. | Not suitable. | Not suitable. | Good. | Good. | Good drainage. |
| Otero (Ox, Oy). | Fair. | Fair; local pockets. | Fair; local pockets. | Good. | Good. | Good drainage; unstable slopes. |
| Randall (Ra). | Poor. | Not suitable. | Not suitable. | Poor. | Poor. | Ponding of water. |
| Richfield (Rb, Rf, Rh, Rm). | Generally good but fine sandy loam is only fair. | Not suitable. | Not suitable. | Loam and fine sandy loam, good; silt loam, fair to good. | Poor to fair. | Good drainage. |

*properties important in engineering*

| Soil features affecting—Continued | | | | | |
|---|---|---|---|---|---|
| Farm ponds | | Agricultural drainage | Irrigation | Terraces and diversions | Waterways |
| Reservoir | Embankment | | | | |
| A few sand strata; moderate to rapid permeability. | Fair shear strength and fair to good compaction and stability; moderate erodibility. | Good drainage. | Limited water-holding capacity; sand pockets; good drainage; moderate permeability. | (2). | Moderate erodibility. |
| Deep soil; moderate permeability; stream channels contain rapidly permeable sand in some places. | Fair to poor shear strength, stability, and compaction; moderate compressibility. | Good drainage; sloping. | High water-holding capacity; moderate permeability; deep; sloping. | Sloping; moderate to high erodibility. | Sloping soils; moderate to high erodibility. |
| (2). | (2). | Good drainage. | Deep; moderately slow to moderate permeability; high water-holding capacity. | Moderate to high erodibility; some complex slopes. | Moderate to high erodibility; subject to accumulations from wind erosion. |
| (2). | (2). | Imperfect drainage; seasonally high water table. | Imperfect drainage; local sand pockets; moderate permeability. | (2). | Moderate to high erodibility. |
| (2). | (2). | Good drainage. | (2). | (2). | High erodibility. |
| (2). | (2). | Seasonally high water table. | Low water-holding capacity; rapid permeability; susceptibility to flooding, scouring, and deposition. | (2). | (2). |
| Moderately slow permeability. | Fair shear strength, stability, and compaction; moderate to high shrink-swell potential. | Good drainage. | High water-holding capacity; moderately slow permeability. | (2). | (2). |
| (2). | (2). | Good drainage. | Deep; moderate water-holding capacity; moderate permeability. | Moderate to high erodibility; complex slopes. | (2). |
| Moderate permeability; a few sand strata. | Fair stability and shear strength; fair to good compaction. | Good drainage. | (2). | Complex and moderately steep slopes; moderate to high erodibility. | Moderate to high erodibility. |
| (2). | (2). | Depressions; ponding of water; outlets remote; slow permeability. | (2). | (2). | (2). |
| Moderately slow permeability. | Poor to fair shear strength; fair stability and compaction; moderate to high shrink-swell potential. | Good drainage. | High water-holding capacity; moderately slow permeability; deep, nearly level soils. | Moderately slow permeability; moderate stability; slight or moderate erodibility; deep soils. | Slight or moderate erodibility; deep friable soils. |

TABLE 6.—*Interpretation of soil properties*

| Soil series and map symbol | Suitability as source of— | | | | | Soil features affecting— |
|---|---|---|---|---|---|---|
| | Topsoil | Sand | Gravel | Roadfill [1] | Road subgrade [1] | Highway location |
| Spearville (Sp). | Good. | Not suitable. | Not suitable. | Fair. | Poor. | Good drainage. |
| Tivoli (Tf, Vx). | Not suitable. | Good (fine sand). | Not suitable. | Good, if confined. | Good, if confined. | Good drainage; unstable, highly erodible slopes. |
| Ulysses (Ua, Ub, Ue). | Good. | Not suitable. | Not suitable. | Fair. | Fair. | Good drainage. |
| Vona (Vo, Vx). | Poor. | Poor. | Not suitable. | Good, if confined. | Good, if confined. | Good drainage; unstable, highly erodible slopes. |

[1] Suitability estimated with help from C. W. HECKATHORN, field soils engineer, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission, under a cooperative agreement with U.S. Department of Commerce, Bureau of Public Roads.

textured layers of loess and outwash material in a layer about 2 to 30 feet thick. Deposition started late in the Pleistocene epoch and has continued intermittently until the present time. In Seward County, these sands make up the sandhills and sandy land.

The soils in the remaining 20 percent of the county were formed in recent and old alluvium. The recent alluvium is on the flood plains of the Cimarron River and is sandy and gravelly. The old alluvium lies along the Cimarron River and its tributaries and consists of stratified silty, clayey, and sandy sediments.

### Climate

Seward County has a semiarid climate that is characterized by extreme temperatures in summer and winter and by a deficiency of moisture in all seasons. The average annual velocity of the wind is fairly high. Thornwaite's precipitation effectiveness, or PE(*3*), is 26. Under this climate, soils in the county develop somewhat more slowly than those in areas where rainfall is abundant. Another effect of the semiarid climate is the large amount of bases in the soils; most soils are calcareous at the surface or a few inches below. The calcareous material occurs at about the depth to which moisture normally penetrates.

### Plants and animals

The original vegetation consisted primarily of grasses, which remain dominant. Trees grow naturally only along the Cimarron River, mostly in thin stands. Sand bluestem and other tall grasses are dominant on the sandy soils, and mid and short grasses are dominant on loamy soils. For many centuries, the remains of grass roots and leaves accumulated and darkened the surface layer of most of these soils.

Worms and burrowing animals affect soil development in this county more than do other animals. Their activity improves aeration, mixes soil in different horizons, and aids in decomposing plant materials. The grazing of wild animals influences soil formation both physically and chemically.

### Relief

Relief influences soil formation by affecting drainage and runoff. It also affects the amount of moisture and air in the soil. The three main kinds of relief in Seward County are the large smooth plain, the dunelike hills, and the sloping valley walls along the Cimarron River.

The soils developed from loess—Richfield, Spearville, Ulysses, and Randall—occur on a large, fairly smooth plain that has broad, gentle swells and shallow depressions. The horizons of these soils are well expressed and show greater development than those of any other soils in the county.

The soils that developed in the eolian sands are in areas of sand dunes. These dunes range from young to mature. The young dunes are steep and are 20 feet or more high. The Tivoli soils occur in areas of these dunes. The intermediate and mature dunes are lower than the young ones and are a part of undulating and hummocky areas in which Vona and Dalhart soils occur.

*important in engineering*—Continued

| Soil features affecting—Continued | | | | | |
|---|---|---|---|---|---|
| Farm ponds | | Agricultural drainage | Irrigation | Terraces and diversions | Waterways |
| Reservoir | Embankment | | | | |
| Slow permeability; high shrink-swell potential. | Poor to fair shear strength, compaction, and stability; high shrink-swell potential and compressibility. | Good drainage; nearly level slopes. | High water-holding capacity; slow permeability; nearly level soil. | Slow permeability; low erodibility. | ([2]). |
| ([2]). | Poor to fair stability; good to fair shear strength and compaction. | Good drainage. | ([2]). | ([2]). | ([2]). |
| Moderate permeability. | Poor to fair shear strength; fair stability and compaction; moderate to high shrink-swell potential. | Good drainage. | High water-holding capacity; deep, moderately slow permeability; nearly level to gently sloping. | Low to moderate erodibility. | Low to moderate erodibility. |
| ([2]). | Fair stability; fair to good shear strength and compaction. | Good drainage. | Moderate to low water-holding capacity; complex slopes; high erodibility; moderate permeability. | ([2]). | ([2]). |

[2] Not applicable to the soils in this series.

The soils developed in alluvium occupy the walls and the floor of the Cimarron River valley. The valley walls are sloping to steep, and the valley floor is gently undulating to nearly level. Colby loam, 5 to 12 percent slopes, for example, has formed on the valley walls. Its profile has not developed fully, because runoff washed away the soil material before well-developed horizons had time to form.

### *Time*

Because of the semiarid climate, a longer time generally is required for soils in Seward County to develop than is required for soils in humid areas. In most places a long time is required for mature soils to develop, but the length of time required is affected by climate, relief, parent material, and plants and animals in and on the soil. Because of the varying effects of these factors combined, a long time may be required for a young soil to form and a relatively short time for a mature soil. The soils of this county range from very young to mature. The Tivoli soils, for example, are very young, and the Richfield soils are mature.

## Classification of Soils

Soils are placed in narrow classes so that knowledge about their behavior within farms, ranches, or counties can be organized and applied. They are placed in broad classes so that areas as large as continents can be studied and compared. In the comprehensive system of classification followed in the United States (*8*), the soils are placed in six categories that range from broad to narrow. Beginning with the broadest category, the soils are grouped by order, suborder, great soil group, family, series, and type.

The soils of the whole country are grouped into only three classes in the soil order, but thousands of soil types are recognized in the lowest category. The categories of suborder and family are not fully developed and thus are little used. Within counties or comparable areas, soil scientists classify the soils mainly into soil types and series and group the series into great soil groups and orders. Many soil types are subdivided into soil phases so that finer distinctions that are significant to soil use and management can be made.

Classes in the highest category are the zonal, intrazonal, and azonal orders. The zonal order consists of soils with evident, genetically related horizons that reflect in their formation the dominant influence of climate and living organisms. In the intrazonal order, soils have evident, genetically related horizons that reflect the dominant influence of a local factor of topography or parent material over the effects of climate and living things. The azonal order consists of soils that lack distinct, genetically related horizons, commonly because of youth, resistant parent material, or steep topography.

In table 7 the 15 soil series represented in the county are placed in soil orders and great soil groups, and parent material and relief of the soils are given. In the text the soil series are described in the order that they are listed in table 7. For each series a profile is described that is typical of the series.

TABLE 7.—*Soil series classified by soil orders and great soil groups, and parent material and relief of the soils*

ZONAL

| Great soil group and series | Parent material | Relief |
|---|---|---|
| Chestnut soils: | | |
| Dalhart. | Eolian sand. | Undulating upland. |
| Manter. | Eolian sand. | Undulating and hummocky upland. |
| Richfield. | Loess. | Nearly level upland. |
| Chestnut soils (intergrading toward Regosols): | | |
| Mansic. | Loess and old alluvium. | Nearly level to gently sloping upland. |
| Ulysses. | Loess. | Nearly level to gently sloping upland. |
| Chernozems: | | |
| Spearville. | Loess. | Nearly level upland. |
| Brown soils: | | |
| Vona. | Eolian sand. | Hummocky and undulating upland. |
| INTRAZONAL | | |
| Grumusols: | | |
| Randall. | Loess. | Shallow depressions of the upland. |
| AZONAL | | |
| Alluvial soils: | | |
| Bayard. | Sandy alluvium. | Gently sloping alluvial fans. |
| Las Animas. | Sandy alluvium. | Nearly level flood plains |
| Lincoln. | Sandy and gravelly alluvium. | Nearly level to undulating flood plains. |
| Regosols: | | |
| Colby. | Loess and old alluvium. | Moderately steep upland. |
| Likes. | Sandy alluvium. | Gently sloping alluvial fans. |
| Otero. | Old alluvium and eolian sand. | Moderately steep and undulating upland. |
| Tivoli. | Eolian sand. | Hilly upland. |

## *Zonal order*

Soils of the zonal order have well-expressed genetic horizons. The profiles of these soils primarily reflect the effects that climate and living things have had on well-drained parent materials for a period that has been long enough for the soil to develop fully. Zonal soils are sometimes called normal soils or mature soils.

In Seward County, the great soil groups of the zonal order are Chestnut soils, Chernozems, and Brown soils.

### CHESTNUT SOILS

The Chestnut soils in this county are in the Dalhart, Richfield, Manter, Mansic, and Ulysses series. Soils in the Mansic and Ulysses series intergrade toward Regosols.

*Dalhart series.* The Dalhart series consists of deep, brown to dark-brown sandy soils that are on uplands and have a granular, permeable subsoil. They developed in calcareous, moderately sandy material under a cover of mid and tall grasses. In most places the sandy material was deposited by the wind in a mantle that ranges from 2 to 6 feet in thickness. Slopes are single and complex and range from 0 to 3 percent.

Dalhart soils have a more sandy, less well developed subsoil than the Richfield soils. They contain more clay in the subsoil than the Manter and Vona soils.

Typical profile of Dalhart fine sandy loam, 0 to 1 percent slopes (about 300 feet north and 900 feet west of southeast corner, sec. 6, T. 34 S., R. 33 W., in a cultivated field):

A1p—0 to 4 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; very friable when moist, soft when dry; noncalcareous; clear boundary.

A1—4 to 10 inches, dark-brown (10YR 4/3 dry; 3/3 moist) fine sandy loam; moderate, medium and fine, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

B21—10 to 20 inches, dark-brown (10YR 4/3 dry; 3/3 moist) sandy clay loam; moderate, medium and fine, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

B22—20 to 27 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; moderate, medium and fine, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

B21b—27 to 40 inches, brown (10YR 5/3) light clay loam, dark brown (10YR 4/3) when moist; massive (structureless); friable when moist, hard when dry; porous; calcareous; gradual boundary.

B22b—40 to 55 inches, dark-brown (10YR 4/3 dry; 3/3 moist) clay loam; massive (structureless); friable when moist, hard when dry; porous; calcareous; gradual boundary.

Cb—55 to 65 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; massive (structureless); friable when moist, hard when dry; porous; calcareous.

Fine sandy loams and a loamy fine sand are mapped in this county. The A1 horizon ranges from 5 to 16 inches in thickness. In the B2 horizon the content of clay ranges from 17 to 30 percent. Depth to calcareous material ranges from 12 to 40 inches.

*Manter series.* Soils of the Manter series occur on uplands and are deep, brown, and sandy. They developed from calcareous, moderately sandy material under a cover of mid and tall grasses. The sandy material is an eolian mantle in most places. Slopes are complex and range from 1 to 6 percent.

Manter soils contain somewhat less sand throughout the profile than the Vona soils and contain less clay in their subsoil than the Dalhart soils.

Typical profile of Manter fine sandy loam, hummocky (about 1,400 feet south and 800 feet west of northeast corner, sec. 15, T. 33 S., R. 31 W., in a pasture):

A11—0 to 5 inches, dark grayish-brown (10YR 4/2) light fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and fine, granular structure; slightly hard or soft when dry, very friable when moist; noncalcareous; gradual boundary.

A12—5 to 14 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; mostly massive (structureless) but some granular structure; very friable when moist, slightly hard when dry; porous; noncalcareous; gradual boundary.

AC—14 to 28 inches, yellowish-brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4.5/4) when moist; massive (structureless); very friable when moist, slightly hard when dry; porous; noncalcareous; gradual boundary.

Cca—28 to 45 inches, yellowish-brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4/4) when moist; massive (structureless); very friable; porous; calcareous; gradual boundary.

C—45 to 60 inches, light yellowish-brown (10YR 6/4) heavy fine sandy loam, yellowish brown (10YR 5/4) when moist; massive (structureless); friable when moist, slightly hard when dry; porous; calcareous.

Only a fine sandy loam is mapped in this county. The A1 horizon ranges from brown to dark grayish brown. The C horizon is fine sandy loam in most places. It ranges from brown to yellowish brown, with hues of 10YR and 7.5YR. Depth to calcareous material ranges from 15 to 40 inches.

*Richfield series.* The Richfield series consists of deep, dark-colored loamy soils on uplands. These soils developed from Pleistocene loess or other loamy sediments that were calcareous, uncompacted, and permeable. The native vegetation was short, mid, and tall grasses. Slopes are flat and slightly convex and range from 0 to 1 percent.

Richfield soils have a B2 horizon that is slightly less compact than that of the Spearville soils and contains less clay. Their solum is more clayey and less sandy than the Dalhart soils. Richfield soils are more clayey in the B2 horizon than the Ulysses soils and have more strongly developed horizons.

Typical profile of Richfield silt loam, 0 to 1 percent slopes (about 1,075 feet west and 150 feet north of southeast corner, sec. 9, T. 32 S., R. 31 W., in a cultivated field):

A1p—0 to 5 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; friable when moist, slightly hard when dry; noncalcareous; clear boundary.

B2—5 to 14 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium to fine, subangular blocky structure; thin continuous clay films on blocks; firm when moist, hard when dry; noncalcareous; wavy to clear boundary.

B3ca—14 to 20 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; mostly massive (structureless) but some subangular blocky structure; friable or firm when moist, hard when dry; porous; worm casts; calcareous; small, soft concretions of calcium carbonate make up about 2 percent of the soil mass; gradual boundary.

Cca—20 to 33 inches, light brownish-gray (10YR 6/2.5) clay loam, grayish brown (10YR 5/2.5) when moist; massive (structureless); friable when moist, hard when dry; porous; worm casts; calcareous; films of calcium carbonate; gradual boundary.

C1—33 to 55 inches, pale-brown (10YR 6/3) heavy loam, brown (10YR 5/3) when moist; massive (structureless); friable when moist, hard when dry; porous; calcareous; films of calcium carbonate; gradual boundary.

C2—55 to 70 inches, very pale brown (10YR 8/3) heavy loam, pale brown (10YR 6.5/3) when moist; massive (structureless); friable when moist, slightly hard when dry; porous; calcareous; a high percentage of calcium carbonate.

In this county the surface layer ranges from silt loam to fine sandy loam. The B2 horizon ranges from silty clay loam to clay loam and has a content of clay of 30 to 40 percent. Depth to calcareous material ranges from 12 to 40 inches.

#### CHESTNUT SOILS INTERGRADING TOWARD REGOSOLS

Soils of the Mansic and Ulysses series in this county are Chestnut soils that intergrade toward Regosols.

*Mansic series.* This series consists of deep, moderately dark colored soils that occupy upland slopes of 1 to 3 percent. These soils developed from Pleistocene sediments of clay loam that were uncompacted, permeable, and calcareous. The native vegetation was short and mid grasses. These soils occur only in a complex with the Otero soils in this county.

Mansic soils contain more clay than the Ulysses soils and have a more conspicuous Cca horizon. They are more calcareous and contain more clay and less sand than the Dalhart soils.

Typical profile of Mansic clay loam (about 1,000 feet south and 800 feet west of northeast corner, sec. 6, T. 33 S., R. 33 W., in a cultivated field):

A1p—0 to 4 inches, brown (10YR 5/3) light fine sandy loam, dark brown (10YR 4/3) when moist; very friable when moist, soft when dry; noncalcareous; abrupt boundary.

A1—4 to 8 inches, brown (10YR 4.5/3) light clay loam, dark brown (10YR 3/3.5) when moist; moderate, medium and fine, granular structure; friable when moist, slightly hard when dry; noncalcareous; clear boundary.

AC—8 to 30 inches, light-brown (7.5YR 6/4) clay loam, yellowish brown (7.5YR 5/4) when moist; mostly massive (structureless) but some granular structure; friable when moist, hard when dry; porous; calcareous; gradual boundary.

Cca—30 to 55 inches, light-brown (7.5YR 6/4) clay loam, yellowish brown (7.5YR 5/4) when moist; massive (structureless); friable when moist, hard when dry; porous; calcareous; small concretions of calcium carbonate.

In this county the surface layer ranges from clay loam to fine sandy loam. In most places the subsoil is clay loam. These soils are generally calcareous at the surface.

*Ulysses series.* The Ulysses series consists of deep, moderately dark colored loamy soils on upland. These soils developed from Pleistocene loess or from other loamy, calcareous, uncompacted, permeable sediments. The native vegetation was short and mid grasses. Slopes are single and convex, and they range from 0 to 3 percent.

Ulysses soils have a less clayey subsoil than the Richfield soils and more weakly developed horizons. They are less clayey throughout than the Mansic soils and have a weaker Cca horizon. Their surface layer is thicker and darker colored than that of the Colby soils.

Typical profile of the Ulysses silt loam, 0 to 1 percent slopes (about 125 feet south and 225 feet west of northeast corner of the northwest quarter, sec. 18, T. 31 S., R. 34 W., in a cultivated field):

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; upper 4 inches is plow slice; friable when moist, hard when dry; worm casts; weakly calcareous; gradual boundary.

AC—6 to 12 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; moderate, medium and fine, granular structure; friable when moist, hard when dry; many worm casts; calcareous; gradual boundary.

Cca1—12 to 18 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4.5/3) when moist; mostly massive (structureless) but some granular structure; friable when moist, hard when dry; porous; few worm casts; calcareous; gradual boundary.

Cca2—18 to 32 inches, very pale brown (10YR 6.5/3) silt loam, brown (10YR 5/3) when moist; massive (structureless); friable when moist, hard when dry; porous; calcareous; few, small concretions of calcium carbonate; gradual boundary.

C—32 to 62 inches, light yellowish-brown (10YR 6/3.5) heavy silt loam, yellowish brown (10YR 5/3.5) when moist; massive (structureless); friable when moist, slightly hard when dry; porous; calcareous; about 2 percent of horizon consists of very small, soft concretions of calcium carbonate.

The A1 horizon ranges from 6 to 10 inches in thickness, and it is silt loam in most places. The AC (or B2) horizon is generally silt loam or light silty clay loam that is 25 to 32 percent clay. Depth to calcareous material ranges from 0 to 13 inches.

#### CHERNOZEMS

The only Chernozem in the county is in the Spearville series.

*Spearville series.* Soils of the Spearville series are deep and dark colored. They occur on uplands and have a B horizon of firm silty clay. They developed from Pleistocene loess or other loamy, calcareous, permeable sediments under a cover of mid and short grasses. These soils occur on flat slopes of 0 to 1 percent.

Spearville soils have a clayey B horizon that is more compact than that in the Richfield soils.

Typical profile of Spearville silty clay loam, 0 to 1 percent slopes (about 1,000 feet west and 600 feet north of southeast corner, sec. 23, T. 31 S., R. 31 W., in a cultivated field):

A1p—0 to 4 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; friable when moist, slightly hard when dry; noncalcareous; abrupt boundary.

B2—4 to 15 inches, dark-brown (10YR 4/3) silty clay, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure breaking to moderate to strong, medium and fine, subangular and angular blocky structure; continuous clay films on blocks; firm when moist, hard when dry; noncalcareous; gradual boundary.

B2ca—15 to 24 inches, brown (10YR 5/3) silty clay, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure and moderate, medium and fine subangular blocky structure; firm when moist, hard when dry; calcareous; gradual boundary.

C—24 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; massive (structureless); friable when moist, slightly hard when dry; porous; calcareous.

Only a silty clay loam is mapped in this county. The A1 horizon ranges from 4 to 12 inches in thickness. The B2 horizon is 40 to 50 percent clay. Depth to calcareous material ranges from 12 to 24 inches.

#### BROWN SOILS

Soils of the Vona series are the only Brown soils in the county.

*Vona series.* In the Vona series are deep, brown sandy soils that occur on complex slopes of 1 to 5 percent. These soils developed in calcareous sandy material that is an eolian mantle in most places. The native vegetation was mid and tall grasses.

The Vona soils have a lighter colored A horizon than the Manter soils and, in most places, a slightly sandier C horizon. They have a lighter colored A horizon than the Dalhart soils and a less clayey B horizon. These soils contain less sand throughout the profile than the Tivoli soils.

Typical profile of Vona loamy fine sand (800 feet north and 400 feet east of the southwest corner, sec. 22, T. 33 S., R. 34 W., in a cultivated field):

A1—0 to 8 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; single grain (structureless); loose when moist or dry; noncalcareous; clear boundary.

B2—8 to 31 inches, brown (10YR 5/3.5) fine sandy loam, dark brown (10YR 4/3) when moist; weak, medium and fine, granular structure; very friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

C1—31 to 40 inches, brown (10YR 5/3.5) light fine sandy loam, dark brown (10YR 4/3) when moist; weakly massive (structureless); very friable when moist, soft when dry; porous; noncalcareous; gradual boundary.

Cu—40 to 65 inches, brown (10YR 5/3 dry) light sandy clay loam and a few thin strata of loamy fine sand, dark brown (10YR 4/3) when moist; massive (structureless); friable when moist, slightly hard when dry; calcareous; few, very small concretions of calcium carbonate.

Only a loamy fine sand is mapped in the county. The A1 horizon ranges from 6 to 16 inches in thickness. In most places depth to calcareous material is more than 24 inches.

### *Intrazonal order*

Soils of the intrazonal order have well-developed characteristics that reflect the dominating influence of some local factor of relief or of parent material over the normal influences of climate and vegetation.

Grumusols are the only soils in the intrazonal order in this county.

#### GRUMUSOLS

The only Grumusols in this county are in the Randall series.

*Randall series.* The Randall series consists of deep clays on the floors of shallow, enclosed depressions. These soils remain under water for a long time after rainy periods. Randall soils developed in place from loamy calcareous sediments.

Typical profile of Randall clay (about 400 feet south and 200 feet east of the northwest corner of the southwest quarter, sec. 24, T. 31 S., R. 31 W., in a pasture):

A1—0 to 4 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; weak to moderate, fine, granular structure; very firm when moist, very hard when dry; many roots; noncalcareous; gradual boundary.

AC1—4 to 36 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; moderate, very coarse and coarse, mostly prismatic structure but some blocky structure; very firm when moist, very hard when dry; noncalcareous; gradual boundary.

AC2—36 to 48 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; massive (structureless); very firm when moist, very hard when dry; noncalcareous; gradual boundary.

C1—48 to 54 inches, pale-brown (10YR 6/3) silty clay, brown (10YR 5/3) when moist; massive (structureless); firm when moist, very hard when dry; calcareous; few, small, soft concretions of calcium carbonate.

Only a clay is mapped in this county. In most places the clay extends to a depth of more than 24 inches. Depth to calcareous material is generally more than 24 inches.

### *Azonal order*

Soils of the azonal order are young or immature, and they have few characteristics that are the result of genetic factors. They generally lack evidence of horizon differentiation. Their characteristics are similar to those of their parent materials, but their surface layer is darkening slightly because plant material is beginning to accumulate.

The azonal soils in Seward County are Alluvial soils and Regosols.

#### ALLUVIAL SOILS

In this county the soils of the Bayard, Las Animas, and Lincoln series are Alluvial soils.

*Bayard series.* Soils of the Bayard series are deep and moderately sandy. They are developing in colluvial-alluvial deposits at the base of slopes and in sandy loam on alluvial fans. The native vegetation consists of mid and tall grasses. These soils occur on slopes of 1 to 4 percent.

Bayard soils contain less sand throughout than the Likes soils and less sand in the substratum than the Las Animas soils. The substratum is not mottled in Bayard soils but is mottled in Las Animas soils.

Typical profile of Bayard fine sandy loam, 1 to 4 percent slopes (about 1,250 feet west and 600 feet north of southeast corner, sec. 26, T. 32 S., R. 33 W., in a cultivated field):

A1p—0 to 4 inches, dark-brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; very weak, granular structure; friable when moist, slightly hard when dry; calcareous; gradual boundary.

A1—4 to 10 inches, brown (10YR 5/3) heavy fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak to moderate, medium and fine, granular structure; friable when moist, slightly hard when dry; worm casts; calcareous; films of calcium carbonate; gradual boundary.

AC—10 to 22 inches, brown (10YR 5/3) heavy fine sandy loam, dark brown (10YR 4/3) when moist; weak to moderate, medium and fine, granular structure; friable when moist, slightly hard when dry; many worm casts; calcareous; about 1 percent of horizon is small, soft concretions of calcium carbonate; gradual boundary.

C1—22 to 38 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; mostly massive (structureless) but some granular structure; porous; calcareous; about 2 percent of horizon is small, soft concretions of calcium carbonate; gradual boundary.

C2—38 to 48 inches, very pale-brown (10YR 7/4) fine sandy loam, light yellowish brown (10YR 6/4) when moist; massive (structureless); very friable when moist, soft when dry; porous; calcareous; about 3 percent of horizon is very small, soft concretions of calcium carbonate; gradual boundary.

C3—48 to 60 inches, pale-brown (10YR 6/3.5) fine sandy loam, brown (10YR 5/3.5) when moist; massive (structureless); very friable when moist, soft when dry; porous; calcareous; about 1 percent of horizon is small, soft concretions of calcium carbonate.

Only a fine sandy loam is mapped in this county. The A1 horizon ranges from brown to dark grayish brown. In most places the C horizon is fine sandy loam that contains thin silty and sandy strata. These soils generally are calcareous at the surface.

*Las Animas series.* Soils of the Las Animas series occur on the nearly level bottom land along the Cimarron River. These soils developed in sandy alluvium under a cover of tall grasses. In most places they are slightly saline.

Las Animas soils are less sandy than the Lincoln and Likes soils. Their substratum is sandier than that of the Bayard soils and is mottled at a depth of about 20 inches. The substratum of the Bayard soils is not mottled.

Typical profile of Las Animas sandy loam (about 1,200 feet north and 500 feet west of the southeast corner, sec. 20, T. 32 S., R. 33 W., in a pasture):

A1—0 to 9 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) when moist; stratified silty and fine sandy loam layers; some granular structure; very friable when moist, soft to slightly hard when dry; calcareous; clear boundary.

C1—9 to 16 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; mostly massive (structureless) but some granular structure; friable when moist, slightly hard when dry; calcareous; gradual boundary.

C2—16 to 24 inches, pale-brown (10YR 6/3) light fine sandy loam, brown (10YR 5/3) when moist; massive (structureless); very friable when moist, hard when dry; porous; calcareous; gradual boundary.

C3—24 to 34 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; a few, fine, faint mottles; massive (structureless); friable when moist, hard when dry; porous; calcareous; gradual boundary.

C4—34 to 58 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; common, fine and medium, distinct mottles; single grain (structureless); loose when moist or dry; calcareous; diffuse boundary.

C5—58 to 65 inches, pale-brown (10YR 6/3) loamy sand or sand, brown (10YR 5/3) when moist; single grain (structureless); loose when moist or dry; calcareous; water table at about 60 inches.

Only a sandy loam is mapped in this county. Las Animas soils are made up largely of sandy material that contains strata of silty and clayey material. In most places sandy loam extends from the surface to a depth of 12 to 24 inches. These soils are calcareous throughout the profile. Depth to brownish mottling ranges from 15 to 40 inches. Depth to the water table is generally less than 8 feet.

*Lincoln series.* Soils of the Lincoln series consist of slightly altered sandy alluvium. They occupy flood plains of the Cimarron River. The vegetation of tall grasses, annual weeds, cottonwood trees, and tamarisk is unstable because of soil blowing and recurrent flooding.

Lincoln soils are sandier than the Las Animas soils to a depth of 24 inches and, unlike those soils, are not mottled in the subsoil.

Typical profile of Lincoln soils (about 500 feet east and 200 feet south of the northwest corner, sec. 35, T. 31 S., R. 34 W., in a pasture):

A1—0 to 6 inches, pale-brown (10YR 6/3) fine sandy loam made up of thin, stratified layers of very fine sand, fine sand, silt, and clay; dark grayish brown (10YR 4/2) when moist; very friable when moist; calcareous; abrupt textural boundary and gradual color boundary.

C1—6 to 12 inches, pale-brown (10YR 6/3) mostly medium and some very coarse sand, brown (10YR 5/3) when moist; single grain (structureless); loose when moist or dry; calcareous; gradual boundary.

C2—12 to 42 inches, pale-brown (10YR 6/3) medium sand, brown (10YR 5/3) when moist; single grain (structureless); loose when moist or dry; calcareous; abrupt textural boundary and gradual color boundary.

C3—42 to 46 inches, very pale brown (10YR 7/3) very fine sand, brown (10YR 5/3) when moist; single grain (structureless); loose when moist or dry; calcareous; abrupt textural boundary and gradual color boundary.

C4—46 to 64 inches, pale-brown (10YR 6/3) mostly medium and some coarse and very coarse sand, brown (10YR 5/3) when moist; single grain (structureless); loose when both moist or dry; calcareous.

The A1 horizon ranges from fine sandy loam to sand and is generally darker than the lower horizons. The water table is normally within 6 feet of the surface.

#### REGOSOLS

The Regosols in this county are in the Colby, Likes, Otero, and Tivoli series.

*Colby series.* Soils of the Colby series are deep and light colored. They occur on convex slopes of 3 to 12 percent. These soils developed from Pleistocene sediments of loam that were uncompacted, permeable, and calcareous. The native vegetation was short and mid grasses.

Colby soils contain less sand than the Otero soils and have less distinct horizons than the Ulysses soils. Their A horizon is thinner and lighter colored than that in Ulysess soils.

Typical profile of Colby loam, 5 to 12 percent slopes (about 650 feet west and 500 feet south of northeast corner of the southwest quarter, sec. 3, T. 32 S., R. 34 W., in a pasture):

A1—0 to 6 inches, brown (10YR 5/3) light loam, dark brown (10YR 3/3) when moist; weak, medium and fine, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

AC—6 to 12 inches, brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) when moist; moderate, medium and fine, granular structure; friable when moist, hard when dry; worm casts; calcareous; gradual boundary.

Cca—12 to 24 inches, pale-brown (10YR 6/3) heavy loam, brown (10YR 5/3) when moist; moderate, medium and fine, granular structure; friable when moist, hard when dry; worm casts; calcareous; few, small, soft concretions of calcium carbonate; gradual boundary.

C1—24 to 36 inches, pale-brown (10YR 6/3) light clay loam, brown (10YR 5/3) when moist; mostly massive (structureless) but some blocky structure; firm when moist, very hard when dry; porous; calcareous; few, small, soft concretions of calcium carbonate; gradual boundary.

C2—36 to 58 inches, light yellowish-brown (10YR 6/4) light clay loam, yellowish brown (10YR 5/4) when moist; massive (structureless); firm when moist, very hard when dry; porous; calcareous; about 2 percent of horizon is small, soft concretions of calcium carbonate.

Only loams are mapped in the county. The A1 horizon ranges from 3 to 6 inches in thickness. In most places these soils are calcareous at the surface. They are dissected by many intermittent drainageways.

*Likes series.* The deep sandy soils of the Likes series occur on convex alluvial fans that have slopes of 1 to 5 percent. These soils developed in sandy and gravelly colluvial-alluvial material that rolled or washed from nearby slopes. The native vegetation is mid and tall grasses and sand sagebrush.

Likes soils contain more sand than the Bayard soils. Unlike the Tivoli soils, Likes soils are calcareous and contain loamy and gravelly strata.

Typical profile of Likes loamy sand (about 250 feet east and 900 feet south of northwest corner of the southwest quarter, sec. 4, T. 34 S., R. 31 W., in a pasture):

A1—0 to 10 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) when moist; mostly single grain (structureless) but some weak, granular structure; loose or very friable when moist, soft or loose when dry; calcareous; gradual boundary.

C1—10 to 31 inches, pale-brown (10YR 6/3) loamy sand, brown (10YR 5/3) when moist; single grain (structureless); loose when moist, soft or loose when dry; calcareous; clear boundary.

C2—31 to 38 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; massive (structureless); very friable when moist, slightly hard or soft when dry; porous; calcareous; clear boundary.

C3—38 to 60 inches, light yellowish-brown (10YR 6/4) sand and some fine gravel, yellowish brown (10YR 5/4) when moist; single grain (structureless); loose when moist or dry; calcareous.

The A1 horizon is slightly darkened and, in most places, is less than 12 inches thick. The C horizon consists of stratified sands that contain some gravel, and there are thin strata of loamy and clayey materials.

*Otero series.* The Otero series consists of deep, light-colored sandy soils on upland. Slopes range from 1 to 15 percent. These soils developed in sandy sediments deposited by wind and water. The native vegetation is short, mid, and tall grasses. In this county these soils are mapped only in complexes with other soils.

Otero soils occur with Colby, Vona, Manter, Likes, and Bayard soils. They are sandier than Colby soils, and their surface layer is lighter colored than that in the Manter and Bayard soils. Otero soils are lighter colored throughout the profile than the Vona soils and, unlike those soils, are calcareous.

Typical profile of Otero fine sandy loam (about 600 feet north and 300 feet west of southeast corner of the northwest quarter, sec. 17, T. 31 S., R. 34 W., in a pasture):

A1—0 to 8 inches, brown (10YR 5/3) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium and fine, granular structure; very friable when moist, slightly hard when dry; calcareous; few, small, soft concretions of calcium carbonate; gradual boundary.

AC—8 to 20 inches, light brownish-gray (10YR 6/2.5) fine sandy loam, brown (10YR 5/3) when moist; weak, medium and fine, granular structure; friable when moist, slightly hard when dry; worm casts; calcareous; gradual boundary.

Cca—20 to 32 inches, pale-brown (10YR 6/3) light sandy loam, brown (10YR 5/3) when moist; some weak, granular structure to single grain (structureless); very friable when moist, loose to slightly hard when dry; calcareous; about 1 percent of horizon is small, soft concretions of calcium carbonate; gradual boundary.

C—32 to 52 inches, pale-brown (10YR 6/3) loamy sand or sand, brown (10YR 5/3) when moist; single grain (structureless); loose when moist or dry; calcareous; few, small, soft concretions of calcium carbonate.

In most places the A1 horizon is fine sandy loam. The thickness of A1 horizon ranges from 6 to 12 inches. The C horizon ranges from fine sandy loam to sand. These soils are generally calcareous at the surface.

*Tivoli series.* Soils of the Tivoli series are light colored and very sandy. They developed in wind-deposited sands under a cover of tall grasses and sand sagebrush. The only indication of soil development is in the upper few inches that have been darkened by accumulation of a small amount of organic matter. These soils occur in duned or hilly areas.

Tivoli soils contain more sand and are steeper than the Vona soils.

Typical profile of Tivoli fine sand (about 900 feet east and 125 feet south of the northwest corner, sec. 26, T. 34 S., R. 33 W., in a pasture):

A1—0 to 6 inches, brown (10YR 5/3) fine sand, dark grayish brown (10YR 4/2.5) when moist; some weak, granular structure but mostly single grain (structureless); very friable or loose when moist, soft or loose when dry; noncalcareous; clear boundary.

C1—6 to 18 inches, brown (10YR 5/3) fine sand, dark brown (10YR 4/3) when moist; single grain (structureless); loose when moist or dry; noncalcareous; gradual boundary.

C2—18 to 60 inches, light yellowish-brown (10YR 6/4) fine sand, light yellowish brown (10YR 6/4) when moist; single grain (structureless); loose when moist or dry; noncalcareous.

Only a fine sand is mapped separately in this county, but a loamy fine sand occurs in a complex with Vona soils. The A1 horizon ranges from 3 to 10 inches in thickness. The C horizon is brown to light yellowish brown.

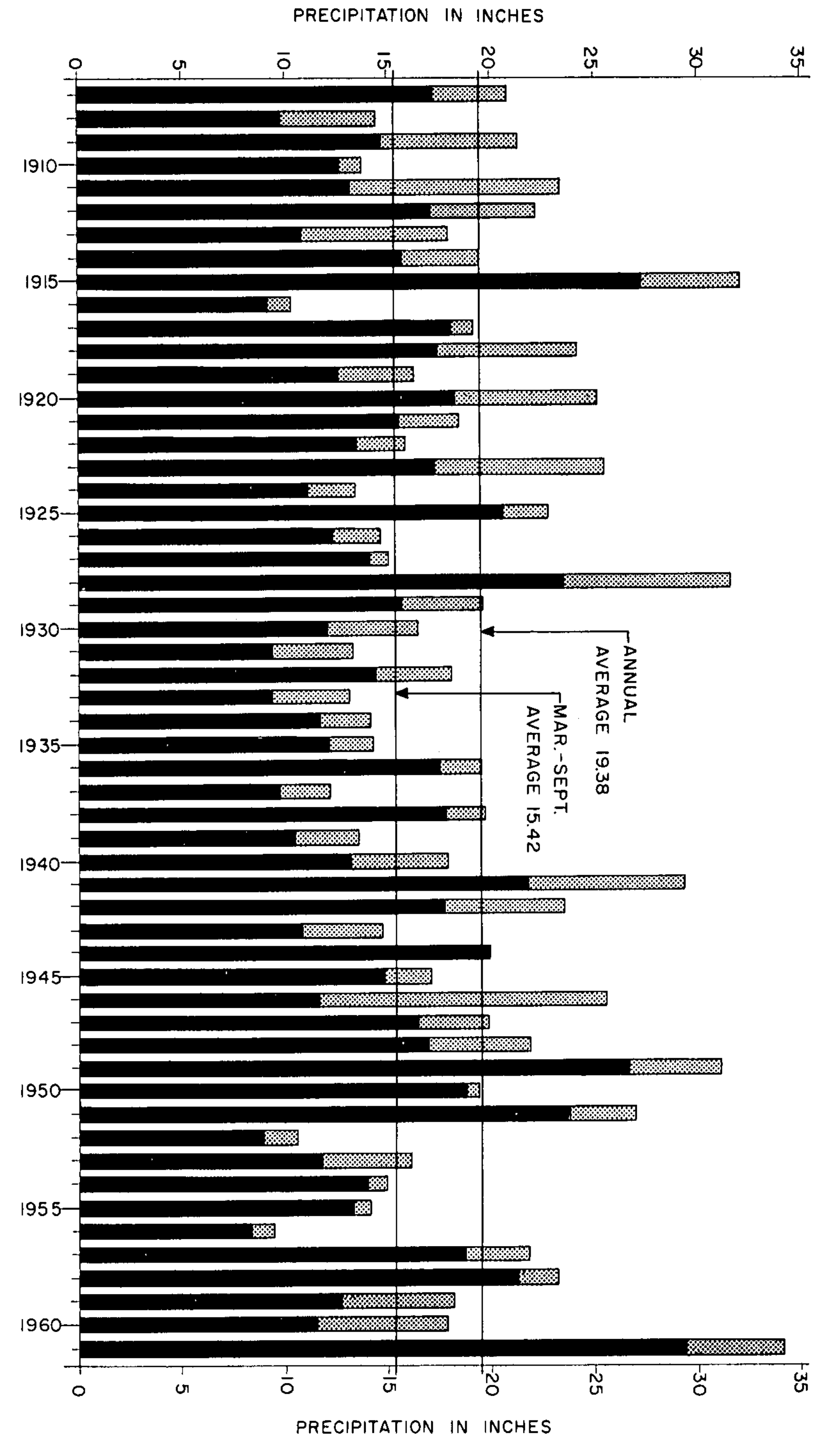


***Figure 21.*—Annual precipitation and precipitation from March through September at Liberal, Kans., 1907–61. Black part of bar represents precipitation from March through September. Black parts plus shaded part represent annual precipitation.**

## Climate [6]

Seward County, in southwestern Kansas, has a semiarid, continental climate that results from the location of the county far inland on the lee side, or in the rain shadow, of the Rocky Mountains. Because there are no effective barriers north or south of the county, the wind sweeps from those directions and causes wide seasonal changes of temperature that are sometimes sudden. Daily ranges in temperature are also high because most days are sunny.

Periods lasting several years have temperature and rainfall favorable for crop production, but these periods alternate irregularly with periods in which precipitation is deficient, heat is excessive, and droughts are serious. Seldom is there more precipitation than is needed.

The lack of moisture in Seward County is indicated by short grasses and treeless plains. Because moisture is insufficient, crops that can withstand drought are most suitable. The temperature, though sometimes extreme, is not too cold or too hot for man or for his domesticated animals.

### Precipitation

Listed in table 8 are temperature and precipitation data rom the records at Liberal, Kans. Precipitation is less in winter than it is in any other season. Table 8 shows that the average monthly precipitation is 3.12 inches for May and, after that month, generally falls gradually through the rest of the year. In long periods, however, the annual total rainfall varies greatly. Figure 21 shows that 1961 had an annual total rainfall of almost 35 inches and was the wettest year on record from 1907 through 1961. In 1916, rainfall totaled only about 10 inches, or less than one-third of that in 1961. Figure 21 also shows that the variations between wet and dry periods are noticeable. In the 11 years extending from 1930 through 1940, rainfall was below average (19.38 inches) in almost every year, but during the next 11 years, from 1941 through 1951, only 2 years had much less precipitation than average.

On the average, almost 80 percent of the annual precipitation falls from March through September. This is fortunate because the precipitation supports the growth of row crops and of grasses, and much of it is stored for use by wheat seeded in fall. But in dry years and in periods of dry years, crops are damaged because there is not enough precipitation. Figure 21 shows that during the summers of the period 1907–61 less than 10 inches of rain fell in seven of the years, and in three of the years more than 25 inches fell. From 1947 to 1951, the rainfall was above average for five consecutive summers, but this hardly makes up for the three periods ranging from four to six consecutive summers in which rainfall was below average.

The curve in figure 22 shows the probability, in percent, that specified amounts of precipitation, or more, will fall from March through September.

In three-fourths of the years (75 percent) precipitation is more than 13 inches. In half of the years (50 percent) precipitation is almost 16 inches or more, and in one-fourth of the years (25 percent) precipitation is more than 19 inches. Since 1902, the driest year on record was 1956, when precipitation totaled only 8.45 inches. Figure 21 shows that the wettest seasonal total was in 1961, when the precipitation from March through September amounted to almost 30 inches.

Between April 1 and September 30, there is generally one period of 30 days in which not more than 0.25 inch

[6] Written by A. D. Robb, State climatologist, U.S. Weather Bureau, Topeka, Kans.

TABLE 8.—*Temperature and precipitation at Liberal, Kans.*

| Month | Temperature | | | | Precipitation | | |
|---|---|---|---|---|---|---|---|
| | Average daily maximum [1] | Average daily minimum [1] | Two years in 10 will have at least 4 days with [2]— | | Average monthly total [1] | One year in 10 will have [2]— | |
| | | | Maximum temperature equal to or higher than— | Minimum temperature equal to or lower than— | | Monthly total less than— | Monthly total more than— |
| | °F. | °F. | °F. | °F. | Inches | Inches | Inches |
| January | 47.9 | 20.1 | 65 | 3 | 0.39 | (3) | 0.87 |
| February | 52.8 | 23.6 | 73 | 10 | .69 | 0.04 | 1.80 |
| March | 60.7 | 30.1 | 80 | 15 | 1.00 | .02 | 2.32 |
| April | 70.3 | 40.6 | 89 | 29 | 1.46 | .30 | 2.41 |
| May | 78.7 | 50.8 | 95 | 38 | 3.12 | .79 | 6.32 |
| June | 89.6 | 61.3 | 102 | 52 | 2.77 | .98 | 4.79 |
| July | 94.5 | 66.4 | 104 | 60 | 3.02 | .82 | 5.20 |
| August | 93.3 | 64.9 | 104 | 58 | 2.45 | .73 | 5.03 |
| September | 86.0 | 56.5 | 99 | 44 | 1.60 | .29 | 3.46 |
| October | 74.3 | 44.1 | 90 | 32 | 1.55 | .11 | 3.21 |
| November | 60.0 | 30.3 | 75 | 15 | .76 | .02 | 1.73 |
| December | 49.5 | 22.3 | 67 | 11 | .57 | (3) | 1.13 |
| Year | 71.5 | 42.6 | [4] 106 | [4] −6 | 19.38 | [5] 13.37 | [6] 26.26 |

[1] Period 1907–61.
[2] Period 1937–61.
[3] Trace.
[4] Average of annual extremes.
[5] In 1 year in 10, total precipitation will be less than 13.37 inches.
[6] In 1 year in 10, total precipitation will be more than 26.26 inches.

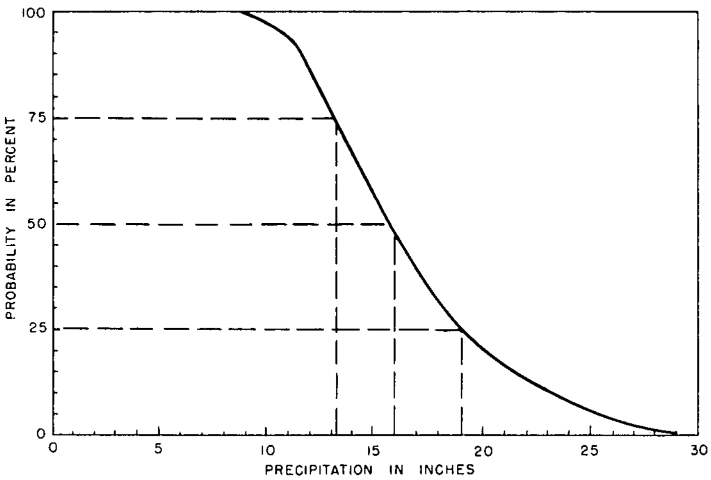


***Figure 22.*—Probability, in percent, of receiving specified amount of precipitation from March through September. Probability calculated from records at Liberal, Kans., for period 1907–61.**

of rain falls in any day. A period so dry can be serious, as it was at Liberal in 1934, when not a day had more than 0.20 inch of rain from April 1 until the afternoon of June 4 (*4*).

Planning construction, especially of roads and drains, is affected by the frequency of various precipitation intensities. For that reason, the frequencies of rainfall of various intensity are given in table 9. About once each year, 0.9 inch of rain may be expected in 30 minutes and 2.0 inches may be expected in 24 hours (*5*). The nearest approach to a 6-inch rainfall in 24 hours listed was on May 23, 1941, when there was 5.50 inches of rain.

Table 8 shows that for 1 year in 10 the total precipitation in January will probably be less than a trace, and for the same frequency, total precipitation in January probably will be more than 0.87 inch. In May, however, 1 year in 10 probably will have 0.79 inch or less of total precipitation, and 1 year in 10 probably will have 6.32 inches or more.

Snowfall is not of great consequence in Seward County. Seasonal totals have varied at Liberal from as little as a trace in the winter of 1922–23 to 53 inches in 1911–12. Because the fallen snow often drifts, much moisture and protective cover are lost. The ground seldom remains covered by snow, because the abundant sunshine melts the snow. For two periods, however, the ground did remain covered for almost 1½ months. One period began December 19, 1911, and ended late in January 1912; the other began December 23, 1943, and ended January 25, 1944. The greatest recorded depth of snow on the ground at Liberal was 18 inches on December 20, 1911.

TABLE 9.—*Frequency of rains of stated duration and intensity at Liberal, Kans.*

| Frequency | Duration of— | | | | | | |
|---|---|---|---|---|---|---|---|
| | ½ hour | 1 hour | 2 hours | 3 hours | 6 hours | 12 hours | 24 hours |
| Once in— | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| 1 year. | 0. 9 | 1. 2 | 1. 3 | 1. 4 | 1. 6 | 1. 8 | 2. 0 |
| 2 years. | 1. 2 | 1. 5 | 1. 7 | 1. 8 | 2. 0 | 2. 3 | 2. 5 |
| 5 years. | 1. 6 | 2. 0 | 2. 3 | 2. 4 | 2. 7 | 3. 1 | 3. 5 |
| 10 years. | 1. 9 | 2. 4 | 2. 7 | 2. 8 | 3. 3 | 3. 7 | 4. 1 |
| 25 years. | 2. 2 | 2. 8 | 3. 2 | 3. 3 | 3. 8 | 4. 5 | 4. 9 |
| 50 years. | 2. 5 | 3. 2 | 3. 6 | 3. 8 | 4. 2 | 5. 0 | 5. 6 |
| 100 years. | 2. 8 | 3. 6 | 4. 0 | 4. 2 | 4. 7 | 5. 6 | 6. 0 |

Factors other than the seasonal total of precipitation need to be considered before selecting crops, determining the kind of tillage, and deciding whether or not to irrigate. Among these factors are the timeliness of rain, the moisture content of the soil at the beginning of the growing season, and the probable amount of evaporation during the growing season. Figure 23 shows, in percent, the probability of receiving specified amounts of rainfall each week of the year. The 52 weeks of the year are numbered at the bottom of the figure. The 14th week, which is the last week in May, appears to have the best chance of receiving some rainfall because during that week there will be at least 0.02 inch of rain 80 percent of the time. Probability is also high the last week in May for other amounts of rain. Following this peak in rainfall there is a definite decline for almost all amounts shown in figure 23. Rainfall is least about the middle of June; then it increases and continues higher than average through most of July, although it does not amount to the May peak. In the latter part of July a decline begins that continues until the lowest probability percentage is reached in January.

On the average, measurable precipitation falls on about 60 days per year; ¼ inch or more falls on 22 days, and 1 inch or more falls on 5 days. Although precipitation is fairly well distributed through the day in fall, winter, and spring, the amount is greater in the afternoon than it is in the morning. Because most rain falls at night during summer, farm operations have few interruptions.

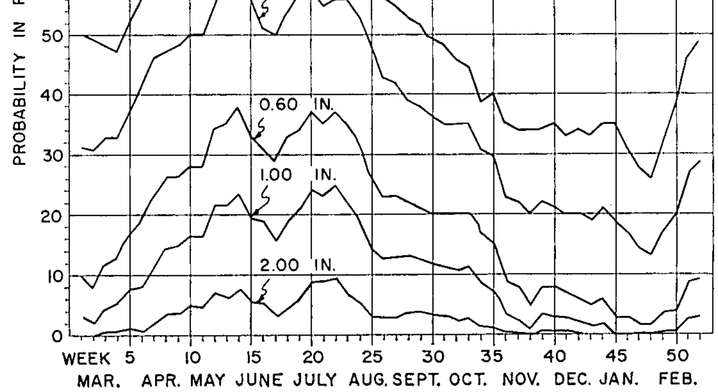


***Figure 23.*—Probability, in percent, of receiving specified amounts of precipitation in each week of the year. Probability calculated from precipitation data in records at Elkhart, Kans.**

## Temperature

Every summer of record has had a maximum temperature of 100°F. or above, and no winter has had, during the day, a maximum temperature of 0° or below. The curves in figure 24 summarize the temperatures that occurred from 1907 through 1961. The curves show the monthly extremes and dates of these extremes, the mean monthly temperature, and the periods of each year when 0°, 32°, and 100° readings are possible. The range of extreme temperatures is much greater in winter than it is in summer. Especially in the spring, the possible occurrence of a temperature of 100° or higher overlaps the possible freeze-free period. The first temperature of 100° in spring occurred 57 days after the last temperature of 0° occurred in winter. The last temperature of 100° in summer came 72 days before the first temperature of 0° in fall.

The following lists the earliest and latest temperature of 100° or higher, 32° or lower, and 0° or lower, and the dates that these temperatures occurred.

| | *Earliest* | *Latest* |
|---|---|---|
| 100° or higher | May 8, 1961 | Sept. 23, 1936 |
| 32° or lower | Sept. 20, 1924 | May 27, 1907 |
| 0° or lower | Dec. 4, 1909 | Mar. 12, 1948 |

A minimum temperature of 0° occurs about 4 years in every 5. Three winters in the period 1907–61 have had at least one minimum temperature of 0° in December, in January, and in February.

These 4 months have had mean maximum temperature of 100° or higher: July 1934 (103°), August 1936 (100.3°), July 1940 (101.3°), and July 1954 (100°). The greatest number of days in any summer that had a temperature of 100° or above was in 1934, when 49 such days occurred. In July of that year 15 consecutive days had readings of 100° or above. During the summer of 1936 there were 48 days on which the maximum temperatures rose to 100° or above, and 16 of these, from August 6 to 21, were consecutive.

The monthly mean minimum temperature has averaged 10° or lower in only the January of 1912 (8.6°), of 1930 (7.1°), and of 1940 (9.1°). In the 2-month period of December 1911 through January 1912, the temperature fell to 0° on 17 days. In that cold spell, the ground was covered with 10 to 15 inches of snow, and 12 nights (December 29 through January 9) had a temperature of 0° or lower.

Extremes of temperature that are more likely to occur are listed in table 8. Table 8 shows that in January a maximum temperature of 65° or higher is probable on at least 4 days in 2 years out of 10, and for that same probability, a temperature of 104° is likely in both July and August. Table 10 lists extremes of monthly temperature, and of precipitation as well.

Table 11 gives probability of the last freezing temperature of 16°, 20°, 24°, 28°, and 32° in spring and the first in fall, at Liberal. From figure 25, a farmer can determine the probability that freezing temperatures of these intensities will occur on any date(*2*). To determine from figure 25 the probability that there will be a temperature at Liberal of 28° or lower after April 20, look up to the point where the vertical line from April 20 intersects the 28° line, and then read the percentage to the left. For this example, the probability is about 28 percent. In the same way you can determine from figure 26 the probability that the temperatures listed will occur before any date in fall.

### *Freezing temperature*

Crops acclimated to the county are damaged very little by freezing temperature. Garden crops occasionally may be nipped by frost, but wheat is seldom damaged late in spring. Because grain sorghum is sometimes planted late and therefore matures late in fall, it may be slightly dam-

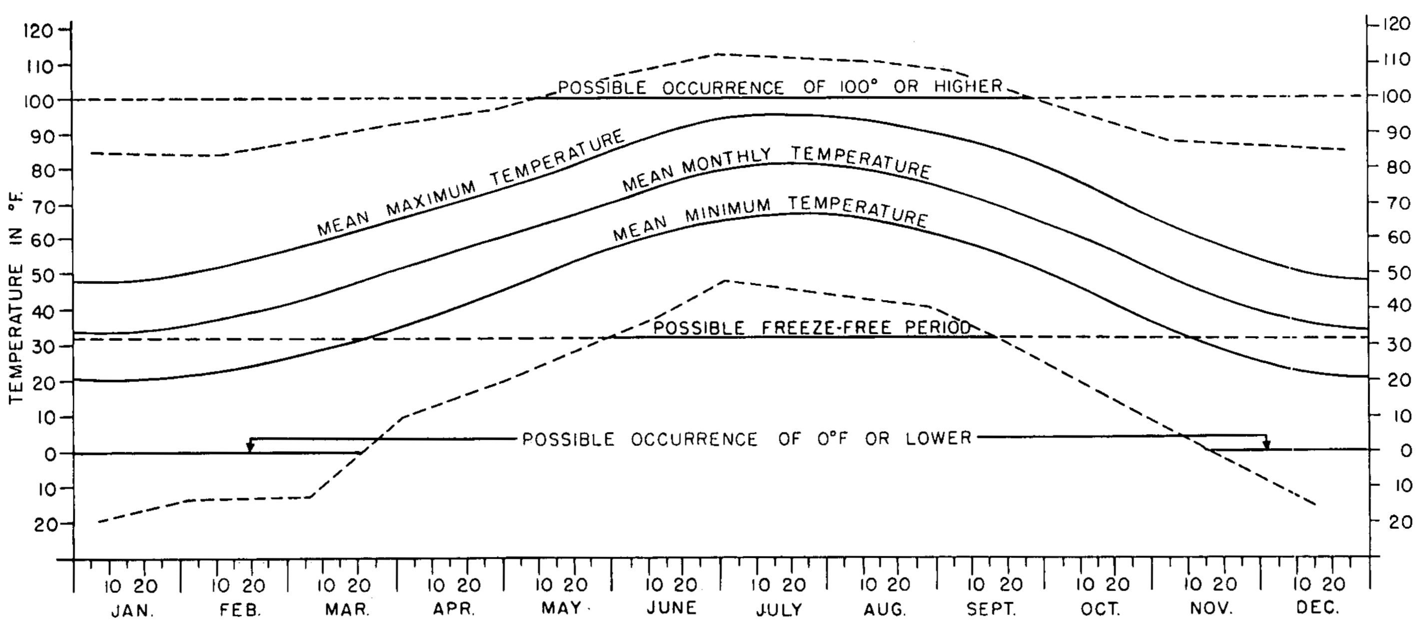


*Figure 24.*—**Summary of temperatures at Liberal, Kans., 1907–61.**

TABLE 10.—*Monthly extremes of temperature and precipitation, at Liberal, 1892–1961, and dates the extremes occurred*

| Month | Temperature | | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|
| | Maximum | Day/Year | Minimum | Day/Year | Least | Year | Greatest | Year |
| | °F. | | °F. | | Inches | | Inches | |
| January. | 85 | 5/27 | −19 | 7/12 | 0 | [1] 1938 | 1.65 | 1944 |
| February. | 84 | 11/51 | −13 | 1/51 | 0 | 1930 | 3.96 | 1911 |
| March. | 92 | [1] 31/46 | −12 | 7/20 | ([2]) | [1] 1954 | 4.90 | 1957 |
| April. | 97 | 28/10 | 10 | 2/36 | 0 | 1935 | 7.96 | 1915 |
| May. | 106 | 29/09 | 20 | 1/09 | .12 | 1916 | 9.30 | 1941 |
| June. | 113 | 30/33 | 38 | [1] 13/47 | ([2]) | 1933 | 7.52 | 1951 |
| July. | 113 | 1/33 | 48 | 3/24 | .41 | 1955 | 11.84 | 1961 |
| August. | 111 | 13/36 | 41 | 29/17 | .38 | 1938 | 6.17 | 1912 |
| September. | 108 | 4/45 | 31 | 20/42 | 0 | 1956 | 5.57 | 1925 |
| October. | 99 | 1/17 | 10 | 29/17 | .01 | 1950 | 8.44 | 1946 |
| November. | 88 | 5/16 | 2 | [1] 14/16 | 0 | [1] 1954 | 4.49 | 1909 |
| December. | 85 | 24/55 | −15 | 16/32 | 0 | [1] 1957 | 3.93 | 1918 |
| Year. | 113 | [3] 6/30/33 | −19 | 1/7/12 | 8.50 | 1893 | 34.14 | 1961 |

[1] Also in earlier years. [2] Trace. [3] Also on July 1, 1933.

aged by freezing temperature, but this damage is infrequent.

The last 32° temperature in spring has occurred as early as March 25 (1943) and as late as May 27 (1907). September 20, 1942, is the date of the earliest 32° temperature in fall, but in 1907 the first freezing temperature was as late as November 11. It is interesting and significant that the latest freezing temperature in spring (May 27, 1907) was compensated by the latest freezing temperature in fall (November 11, 1907). Also, the earliest freeze in fall (September 20, 1942) was followed the next spring by the earliest date on record for the last freezing temperature (March 25, 1943).

In Seward County the average length of the growing season, or the time between the last 32° freeze in spring and the first in fall, ranges in different parts of the county from 180 to 185 days.

## Winds and Storms

Almost always the wind blows noticeably on the plains. The average speed of the wind increases at daybreak as the temperature begins to rise. This increase continues as long as the temperature rises, but in the afternoon when the temperature begins to fall, the speed of the wind decreases. The highest average speed of wind, 17 miles per hour, is in March and April. The lowest average speed, 13 or 14 miles per hour, is in July and August.

Seward County is susceptible to damaging gusts of winds, to tornadoes, to blizzards, to hailstorms, and to duststorms. Occasionally when the winds shift or thunderstorms occur early in spring or in summer, the damaging gusts reach a speed of 70 or 80 miles per hour. Tornadoes do not occur frequently, and even when they do occur, the loss of life or property is not great, because the population is scattered.

Hailstorms probably damage crops and property more than other storms. A grain crop can be mutilated in a few minutes by wind-driven hail of pea-to-marble size. Hail as large as walnuts or even baseballs has fallen and damaged livestock and property.

Duststorms, or "black blizzards," vary in number and severity according to the amount of precipitation and of crop cover and according to the kind of farming. Even the most severe duststorms last only a few hours. The control of duststorms has improved in recent years.

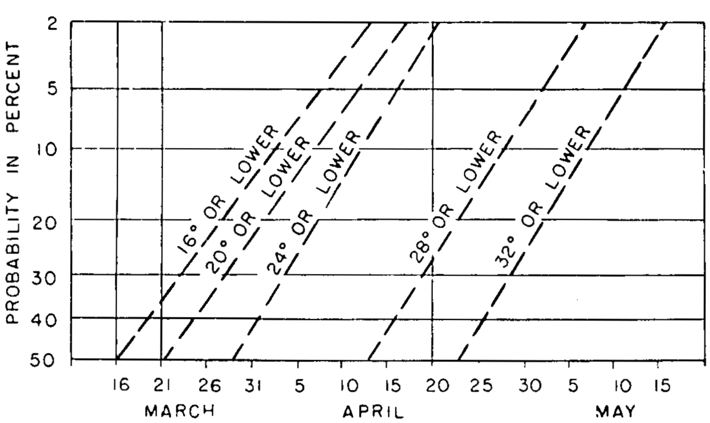


*Figure 25.*—**Probability that temperatures at Liberal will be 16°, 20°, 24°, 28°, 32°, or lower than each of these temperatures, after any date in spring.**

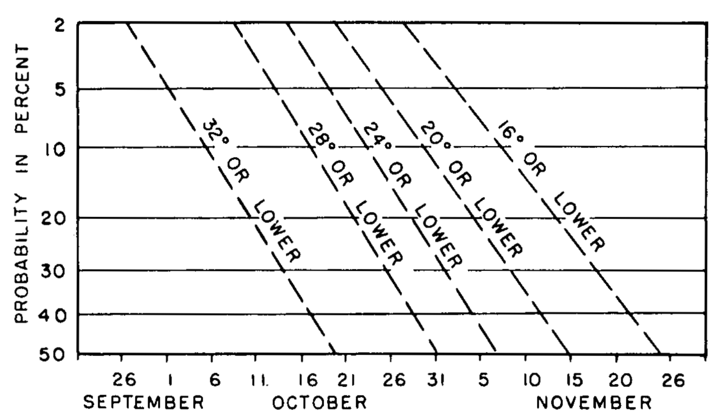


*Figure 26.*—**Probability that temperatures at Liberal will be 15°, 20°, 24°, 28°, 32°, or lower than each of these temperatures, before any date in fall.**

TABLE 11.—*Probabilities of last freezing temperatures in spring and first in fall at Liberal* [1]

| Probability | 16° F. or lower after— | 20° F. or lower after— | 24° F. or lower after— | 28° F. or lower after— | 32° F. or lower after— | 16° F. or lower before— | 20° F. or lower before— | 24° F. or lower before— | 28° F. or lower before— | 32° F. or lower before— |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 year in 10. | Apr. 3 | Apr. 7 | Apr. 12 | Apr. 28 | May 7 | Nov. 7 | Oct. 30 | Oct. 24 | Oct. 17 | Oct. 6 |
| 2 years in 10. | Mar. 28 | Apr. 1 | Apr. 7 | Apr. 23 | May 2 | Nov. 13 | Nov. 4 | Oct. 28 | Oct. 22 | Oct. 10 |
| 5 years in 10. | Mar. 16 | Mar. 22 | Mar. 29 | Apr. 13 | Apr. 23 | Nov. 25 | Nov. 15 | Nov. 7 | Oct. 31 | Oct. 20 |

[1] From record of period 1907–58.

# General Nature of the County

Some of the general characteristics of the county are discussed in this section. These are physiography, relief, and drainage; history and population; water supply; industries; transportation and markets; community facilities; and agriculture.

## Physiography, Relief, and Drainage

Seward County is a part of the southern High Plains in the Great Plains province. About 80 percent of the county consists of upland plains and sandhills, and the rest of flood plains and of slopes between the flood plains and the uplands. Large areas of the uplands are comparatively flat and featureless. In the sandhills are hilly to rolling areas that consist of sand dunes differing in age and size. The larger dunes are 20 feet or more high.

In this county the upland ranges from about 2,970 feet above sea level in the western part to about 2,660 feet in the southeastern part. The lowest point in the county is in the southeastern corner. The general slope is in an east-southeast direction, and its fall is about 11 feet per mile. In most places the Cimarron River is more than 100 feet below the adjacent upland.

The Cimarron River flows across the county from the northwestern to the southeastern corner. It flows continuously in the southeastern part of the county, but in the central part it may stop flowing in summer. Upstream, in the northwestern part of the county, the river is an intermittent stream.

About 20 percent of the county is drained by the Cimarron River and its tributaries, but the rest is not drained by streams that flow out of the county. The rain that falls on the flat uplands and on the sandhills drains into temporary ponds or small, shallow lakes, where it evaporates or percolates downward in the soil. Figure 27 shows a view of the landscape of the county.

## History and Population

In 1873, Seward County was established as an unorganized county and named in the honor of William H. Seward, Secretary of State under President Lincoln. In 1883, the Kansas Legislature temporarily enlarged the county and made its western boundary the Colorado-Kansas line. At that time the county measured 90 miles from east to west and 27 miles from north to south. Within its present boundaries, Seward County was formally organized in June 1886. The county seat was first at Fargo Springs, but 2 years later it was moved to Springfield and remained there until 1896, when it was moved to Liberal, its present site. Both Fargo Springs and Springfield have been abandoned.

Settlement of this county began in 1870, when cattlemen arrived. Although the population of the county increased almost continuously after 1900, the increase has been greatest since 1940. The population reached 16,023 in 1960, when Liberal, the largest city in southwestern Kansas, had 13,813 people. In that year Kismet, the only other town in the county, had 169 people. The following lists the population of the county in stated years, according to biennial reports of the Kansas State Board of Agriculture (*6*).

| *Year* | *Population* |
|---|---|
| 1890 | 1, 575 |
| 1900 | 804 |
| 1910 | 3, 858 |
| 1920 | 6, 327 |
| 1930 | 6, 954 |
| 1940 | 6, 593 |
| 1950 | 11, 051 |
| 1960 | 16, 023 |

## Water Supply

Seward County obtains its water from wells drilled into the huge reservoir of ground water. In the upland the depth to the water table ranges from about 75 to 250 feet. The water-bearing material ranges from about 175 to 400 feet in thickness. Wells that supply enough water for domestic use and for livestock can be drilled almost anywhere in the county, but irrigation wells are harder to locate because test holes must be drilled to find coarse sands and gravels that yield 1,000 to 2,000 gallons of water per minute. In 1960, there were 65 irrigation wells in the county. The water is hard because it contains dissolved salts of calcium, magnesium, sodium, and potassium, but it is suitable for most uses.

## Industries

The most important nonagricultural industry is drilling and servicing oil and gas wells and producing, collecting, and transporting natural gas and oil. About 50 percent of the industrial workers in the county are employed in this industry. Thirty-five companies produce oil and gas in the county, and at the end of 1960, 377 wells were operating.

## Transportation and Markets

The main line of the Chicago, Rock Island and Pacific Railroad crosses the southern part of Seward County, and

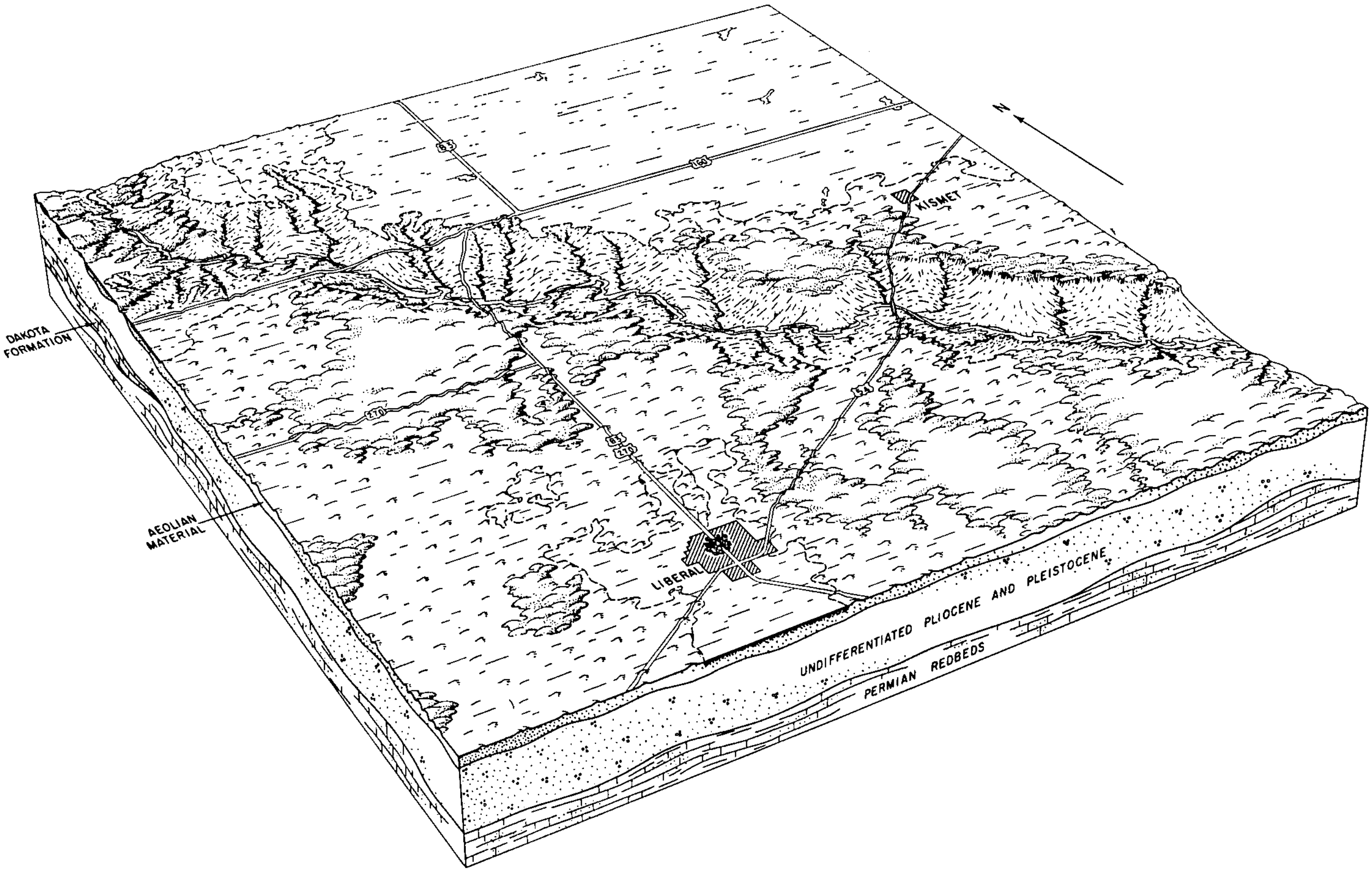


*Figure 27.*—**Landscape of Seward County.**

the Amarillo branch of that line joins the main line in Liberal. The county is crossed by U.S. Highways Nos. 54, 83, 160, and 270. State Route 190 is in the northwestern part of the county, and improved roads run throughout.

Most of the farm products, chiefly wheat and grain sorghum, are sold locally. Liberal, Kismet, and Hayne have facilities for handling and storing grain, most of which is shipped eastward by railroad to terminal elevators and markets. Most beef cattle are shipped to markets outside the county. Many farmers in the northern part of the county sell their products in adjoining counties.

## Community Facilities

The county has 10 elementary schools, 3 of which are in rural areas. High schools are in Liberal and Kismet.

The existing hospital and the new one that is planned will be able to handle the medical needs of the county. Liberal maintains a public library, a swimming pool, and other recreational facilities. The 34 churches in the county are of various denominations; 2 are in rural areas.

Most of the farm dwellings are well kept and have natural gas, electricity, and telephones. All parts of the county have mail service.

## Agriculture [7]

The agriculture of Seward County is based on growing grain sorghum and wheat as cash crops and on raising beef cattle.

Raising cattle was most important before 1910. At that time a small acreage of sandy soils was cultivated to provide grain and forage for cattle. From 1898 to 1959, the acreage of cropland increased from about 1½ percent of the county to about 63 percent. Most of this increase occured between 1905 and 1930. The first large acreage of wheat was sown in 1910.

Farming operations are on a large scale and are highly mechanized. In 1960, about 20,670 acres were irrigated. Wheat, corn, and sorghum were the principal irrigated crops.

### *Crops*

Wheat and grain sorghum, the main crops, are best suited to dryland farming in Seward County. On the silty and loamy soils, these crops are generally grown in a crop-fallow system. During the fallow period, weeds

[7] Unless otherwise stated, the statistics in this subsection are taken from the biennial reports of the Kansas State Board of Agriculture.

are controlled so that they do not use the moisture that is needed by the crops planted after the fallow period. Sorghums are grown continuously on the sandy soils.

Table 12 gives the acreage of the main crops grown in Seward County in stated years.

### Pasture

Pasture or range was the major use on about 130,000 acres in Seward County during 1960. These grazing lands are in rolling, sandy areas or in the valley of the Cimarron River on the moderately steep and steep slopes. The dominant plants in sandy areas are native tall grasses, sand sagebrush, and annual weeds. Loamy soils support native mid and short grasses and make up about 14 percent of the grazing land.

### Livestock

Cattle are the principal livestock in the county. The number of beef cattle varies according to the local supply of feed. Generally, 3,000 or 4,000 head of cattle are raised. In fall and winter, however, many cattle are brought into the county to graze wheat pasture and sorghum stubble. Most of the beef cattle are good in quality. The dairy herds in the county are few.

Horses and mules have gradually decreased in number as tractors have been improved and made available. Most horses are used for riding. A small number of poultry is kept on a few farms. A few farmers raise swine, which are generally good in quality. Only a few sheep are raised in the county, but many sheep may be brought in during fall and winter to graze wheat pasture and sorghum stubble.

Table 13 lists the number of livestock on farms and ranches of Seward County in stated years.

### Size, type, and tenure of farms

Seward County had a total of 538 farms in 1930, according to the Federal census. Since that time, farms have decreased in number and increased in size. By 1959, there were only 314 farms in the county. Most of these, however, were large and highly mechanized.

The average-sized farm is 1,289 acres. The 1959 Federal census reported the number of farms in various size groups as follows:

| *Size of farms in acres* | *Number* |
|---|---|
| Under 99 | 10 |
| 100 to 219 | 23 |
| 220 to 499 | 45 |
| 500 to 999 | 106 |
| 1,000 and over | 130 |

Of these 314 farms, 186 were operated by farmers who lived on them. The rest of the farms were operated by farmers who lived in towns and in other counties.

Most of the farms are of the cash-grain type. The 1959 Federal census shows that 45, or about 14 percent of the farms, are miscellaneous and unclassified. The rest of the farms are classified by type as follows:

| | *Number* |
|---|---|
| Cash grain | 176 |
| General | 18 |
| Livestock | 68 |
| Dairy | 3 |

A few farmers own all the land they farm. Commonly, a farmer rents land from two or more owners. The land is usually leased on a crop-share basis, and the owner gets from one-fourth to one-third of the crop. According to the 1959 Federal census, 61 farmers farmed only land that they owned, 155 farmers farmed some land that they owned and some that they rented, and 93 farmers were tenants. Only one farm was operated by a manager.

TABLE 12.—*Harvested acres of principal crops in stated years*

| Crops | 1925 | 1930 | 1940 | 1950 | 1959 |
|---|---|---|---|---|---|
| Wheat. | [1] 102, 852 | [1] 152, 089 | [1] 115, 000 | [1] 143, 000 | [1] 104, 000 |
| Sorghum for grain. | 33, 918 | 21, 332 | 35, 530 | 42, 360 | 51, 000 |
| Sorghum for forage. | 6, 242 | 5, 470 | 12, 600 | 16, 470 | 4, 000 |
| Corn. | 10, 051 | 19, 674 | 700 | 20 | 1, 500 |
| Barley. | 3, 429 | 1, 662 | 8, 210 | 140 | 1, 400 |
| Broomcorn. | 1, 761 | 4, 167 | 1, 490 | 310 | 340 |
| All hay. | 4, 144 | 1, 767 | 4, 700 | 1, 800 | 2, 200 |

[1] Planted acres.

TABLE 13.—*Number of livestock on farms and ranches in stated years*

| Livestock | 1925 | 1930 | 1940 | 1950 | 1959 |
|---|---|---|---|---|---|
| All cattle. | 8, 726 | 8, 257 | 8, 480 | 14, 000 | 18, 000 |
| Horses and mules. | 5, 370 | 2, 722 | 810 | 490 | 180 |
| Swine, including pigs. | 2, 044 | 1, 512 | 1, 500 | 1, 260 | 800 |
| Sheep and lambs. | 19 | 4 | 1, 720 | 2, 090 | 2, 760 |
| Chickens over 3 months old. | (1) | (1) | 38, 920 | 21, 800 | 10, 000 |

[1] Not reported.

### Farm equipment and labor

All tillage and harvesting are done with mechanically powered equipment. Generally, wheel tractors are used. Large, self-propelled combines harvest the wheat and grain sorghum. Most farmers own enough equipment for tillage and planting, but some of them must hire part or all of the machinery for harvesting. Custom operators from outside the county furnish much of the labor and equipment necessary for harvesting grain crops.

The demand for labor is seasonal. The local labor supply is about adequate for planting and tillage, but transient labor is generally needed for harvesting. Only a few farmers hire help the year round. A total of 68 farmers worked 100 days or more at outside jobs, according to the 1959 Federal census.

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## Glossary

**Alluvial soils.** A group of soils that consists of transported and recently deposited material (alluvium) that has been modified by soil-forming processes only slightly if at all. The soils in alluvium that have well-developed profiles are grouped with other soils that have well-developed profiles, not with the Alluvial soils.

**Association, soil.** A group of soils geographically associated in a characteristic repeating pattern.

**Azonal soils.** A general group of soils without well-developed profile characteristics because they are young, or because the nature of the parent material or the relief prevents normal development of such characteristics.

**Brown soils.** A group of soils having a brown A horizon of moderate thickness and a lighter colored B or C horizon. Commonly these soils have an accumulation of lime at a depth of 1 to 3 feet. They formed under short grasses, bunch grasses, and shrubs in a semiarid, temperate to cool-temperate climate.

**Calcareous soils.** A soil containing enough calcium carbonate to effervesce (fizz) when treated with cold, dilute hydrochloric acid.

**Chernozems.** A group of soils that have a deep, dark to nearly black A horizon rich in organic matter; a brown transitional B horizon that may contain more clay than the A horizon; and a light-colored C horizon with an accumulation of lime at a depth of 1½ to 4 feet. These soils formed under tall grasses or a mixture of tall and short grasses in a subhumid, temperate to cool-temperate climate.

**Chestnut soils.** A group of soils that have a dark-brown surface horizon that grades to lighter colored horizons. These soils have accumulated lime at a depth of 1 to 4 feet. They formed under mixed tall and short grasses in a subhumid to semiarid, temperate to cool-temperate climate.

**Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter (0.000079 inch) in diameter. As a soil textural class, soil material that contains 40 percent or more of clay, less than 45 percent of sand, and less than 40 percent of silt.

**Clayey soils.** As used in this report, soils that contain more than 30 percent of clay.

**Consistence, soil.** Characteristic of soil material that is reflected by the resistence of the individual particles to separating from one another (cohesion) or by the ability of a soil mass to undergo a change in shape without breaking (plasticity). Consistence varies with the moisture content. Thus, a soil aggregate or clod may be hard when dry and plastic when wet. Terms used to describe consistence are—

*Loose.* When moist or dry, soil material is noncoherent.

*Very friable.* When moist, soil material crushes under very gentle pressure and coheres when pressed together.

*Friable.* When moist, soil material crushes easily under gentle to moderate pressure between thumb and forefinger and coheres when pressed together.

*Firm.* When moist, soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

*Soft.* When dry, soil material is very weakly coherent; breaks to powder or individual grains under very slight pressure.

*Slightly hard.* When dry, soil material is weakly resistant to pressure; easily broken between thumb and forefinger.

*Hard.* When dry, soil material is moderately resistant to pressure; can be broken in the hands without difficulty but is barely breakable between the thumb and forefinger.

*Very hard.* When dry, soil material is very resistant to pressure; can be broken in the hands only with difficulty; not breakable between thumb and forefinger.

**Flood plain.** Nearly level land, consisting of stream sediments, subject to frequent or occasional flooding.

**Genesis, soil.** The origin, or formation, of the soil. Referred to particularly in the study of soil genesis are the processes responsible for the development of the solum (horizons A and B) from the unconsolidated parent material.

**Great soil group.** A broad group of soils that have fundamental soil characteristics in common.

**Grumusols.** A group of soils having profiles rather high in content of clay, relatively uniform in texture, and marked by signs of local soil movement resulting from shrinking and swelling as the soils wet and dry. Many of these soils have a thick, dark A horizon over a limy C horizon; others are uniform in general appearance except for the signs of churning. These soils formed in parent material having a high content of clay or of alkaline earth elements, or from rocks that provided abundant clay and alkaline earths upon weathering. Soils of this group occur chiefly in a tropical or subtropical climate where wet and dry seasons alternate.

**Horizon, soil.** A layer of soil that is approximately parallel to the surface and has well-defined characteristics produced by soil-forming processes.

*Horizon A.* The upper mineral horizons in which maximum biological activity is greatest. It contains an accumulation of organic matter, has been leached of soluble minerals, or both.

*Horizon B.* A soil horizon, normally beneath an A horizon, or surface soil, in which (1) clay, iron or aluminum, and accessory organic matter have accumulated from suspended material in the A horizon above, or from clay that developed in place; (2) the soil has a blocky or prismatic structure; or (3) the soil has some combination of these features. In soils that have distinct profiles, the B horizon is roughly equivalent to the general term "subsoil."

*Horizon C.* The layer of partly weathered material underlying the B horizon; the substratum; normally part of the parent material.

**Intrazonal soils.** Any of the great groups of soils that have more or less well-developed characteristics that reflect the dominating influence of some local factor of relief or parent material over the normal influences of climate or vegetation.

**Loamy soil.** As used in this report, soil that contains 30 to 80 percent of silt, 10 to 50 percent of sand, and 10 to 27 percent of clay.

**Loess.** Geological deposit of fine material, mostly silt, transported by wind.

**Morphology, soil.** The physical, mineralogical, and biological constitution of the soil expressed in the kinds of horizons, the thickness of horizons, the profile arrangement, and the texture, structure, consistence, porosity, and color of each horizon.

**Normal soil.** A soil having a profile in near equilibrium with its environment. A normal soil developed under good but not excessive drainage from parent material of mixed mineral, physical, and chemical composition. Its characteristics show the full effects of climate and living matter.

**Parent material.** The unconsolidated mass from which the soil profile develops.

**Permeability, soil.** The quality of a soil that enables water or air to move through it. The permeability of a soil may be limited by the presence of one nearly impermeable horizon, though the other horizons are permeable.

**Phase, soil.** A subdivision of a soil type, series, or other unit in the classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, erosion, or some other characteristics that affects management.

**Profile, soil.** A vertical section of the soil extending from the surface into the parent material.

**Regosols.** A group of soils lacking definite genetic horizons and developing from deep unconsolidated or soft rocky deposits.

**Relief.** The elevation or inequalities of a land surface, considered collectively.

**Sand.** Individual rock or mineral fragments in soils having diameters ranging from 0.05 millimeter (0.002 inch) to 2.0 millimeters (0.079 inch). Sand grains generally consist chiefly of quartz, but they may be of any mineral composition. The textural class name of any soil that is 85 percent or more sand and not more than 10 percent clay.

**Sandy soil.** As used in this report, a soil that is more than 55 percent sand and less than 20 percent clay.

**Series, soil.** A group of soils that have soil horizons similar in their differentiating characteristics and arrangement in the soil profile, except for the texture of the surface soil, and formed in a particular type of parent material. Individual series are given proper names from place names near their first recorded occurrence.

**Silt.** Small mineral soil grains ranging from 0.002 millimeter (0.000079 inch) to 0.05 millimeter (0.002 inch) in diameter. Soils of the textural class silt contain 80 percent or more of silt and less than 12 percent of clay.

**Slope.** The incline of the soil surface. It is generally expressed in percentage, which equals the number of feet of fall per 100 feet of horizontal distance. The slope classes used in this report are as follows: 0 to 1 percent (nearly level); 1 to 3 percent (single slopes, gently sloping); 3 to 5 percent (single slopes, sloping; complex slopes, rolling); 5 to 12 percent (single slopes, moderately steep; complex slopes, hilly).

**Soil.** A natural, three-dimensional body on the earth's surface that supports plants and has properties resulting from the integrated effect of climate and living matter acting on parent material, as conditioned by relief through periods of time.

**Soil separates.** The individual size groups of soil particles, such as sand, silt, and clay.

**Soil textural class.** A classification based on the relative proportion of soil separates. The principal classes, in increasing order of the content of the finer separates, are as follows: Sand, loamy sand, sandy loam, loam, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay.

**Structure, soil.** The arrangement of primary soil particles into compound particles that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering without any regular cleavage, as in many claypans and hardpans).

**Subsoil.** That part of the soil profile commonly below plow depth and above the parent material. The subsoil may be the B horizon in soils that have distinct profiles.

**Substratum.** Any layer lying beneath the solum, or true soil. A term applied to the parent material, or to other layers unlike the parent material that lie below the B horizon or subsoil.

**Surface soil.** Technically, the A horizon; commonly, the part of profile generally stirred by tilling.

**Texture, soil.** The relative proportions of the various size groups of individual soil grains.

**Type, soil.** A subdivision of the soil series that is made on the basis of differences in the texture of the surface layer.

**Zonal soil.** Any one of the great groups of soils having well-developed soil characteristics that reflect the influence of the active factors of soil genesis—climate and living organisms, chiefly vegetation.

## GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

[See table 1, p. 5, for approximate acreage and proportionate extent of the soils; see table 3, p. 19, for predicted average yields per acre on arable soils under dryland farming; see list on p. 25, for windbreak sites according to soil type; and see table 4, p. 25, for suitable trees on Silty Upland and Sandy Upland windbreak sites]

| Map symbol | Mapping unit | Page | Capability unit | | | | Range site | |
|---|---|---|---|---|---|---|---|---|
| | | | Dryland | Page | Irrigated | Page | Name | Page |
| An | Alluvial land | 5 | VIw-1 | 16 | None | -- | Loamy Lowland | 22 |
| Bb | Bayard fine sandy loam, 1 to 4 percent slopes | 5 | IVe-4 | 15 | None | -- | Sandy | 24 |
| Bo | Blown-out land | 6 | VIIe-1 | 16 | None | -- | Choppy Sands | 21 |
| Cc | Colby loam, 3 to 5 percent slopes | 6 | VIe-1 | 16 | None | -- | Loamy Upland | 22 |
| Cm | Colby loam, 5 to 12 percent slopes | 6 | VIe-1 | 16 | None | -- | Limy Upland | 22 |
| Da | Dalhart fine sandy loam, 0 to 1 percent slopes | 6 | IIIe-3 | 15 | I-2 | 18 | Sandy | 24 |
| Db | Dalhart fine sandy loam, 1 to 3 percent slopes | 6 | IIIe-2 | 15 | IIe-2 | 18 | Sandy | 24 |
| Df | Dalhart loamy fine sand, 0 to 3 percent slopes | 6 | IVe-6 | 16 | IIIe-5 | 19 | Sands | 23 |
| Gr | Gravelly broken land | 7 | VIIs-4 | 17 | None | -- | Gravelly Hills | 22 |
| Ld | Las Animas sandy loam | 7 | IVw-2 | 16 | None | -- | Saline Subirrigated | 23 |
| Lk | Likes loamy sand | 7 | VIe-2 | 16 | None | -- | Sands | 23 |
| Ll | Lincoln soils | 7 | VIIw-1 | 17 | None | -- | None | -- |
| Md | Manter-Dalhart fine sandy loams, undulating | 8 | IIIe-2 | 15 | IIe-2 | 18 | Sandy | 24 |
| Mh | Manter fine sandy loam, hummocky | 8 | IVe-4 | 15 | None | -- | Sandy | 24 |
| Ox | Otero gravelly complex | 8 | VIe-6 | 16 | None | -- | Sandy-Gravelly Hills | 24 |
| Oy | Otero-Mansic complex, undulating | 8 | IVe-1 | 15 | None | -- | Sandy | 24 |
| Ra | Randall clay | 9 | VIw-2 | 16 | None | -- | None | -- |
| Rb | Richfield and Ulysses complexes, bench leveled | 9 | None | -- | I-1 | 18 | Loamy Upland | 22 |
| Rf | Richfield fine sandy loam, 0 to 1 percent slopes | 9 | IIIe-3 | 15 | I-2 | 18 | Sandy | 24 |
| Rh | Richfield loam, thick surface, 0 to 1 percent slopes | 9 | IIIc-1 | 14 | I-1 | 18 | Loamy Upland | 22 |
| Rm | Richfield silt loam, 0 to 1 percent slopes | 9 | IIIc-1 | 14 | I-1 | 18 | Loamy Upland | 22 |
| Ro | Rough broken land | 9 | VIIs-1 | 17 | None | -- | Rough Breaks | 23 |
| Sp | Spearville silty clay loam, 0 to 1 percent slopes | 9 | IIIs-1 | 15 | IIs-2 | 18 | Clay Upland | 22 |
| Tf | Tivoli fine sand | 10 | VIIe-1 | 16 | None | -- | Choppy Sands | 21 |
| Ua | Ulysses silt loam, 0 to 1 percent slopes | 10 | IIIc-1 | 14 | I-1 | 18 | Loamy Upland | 22 |
| Ub | Ulysses silt loam, 1 to 3 percent slopes | 10 | IIIe-1 | 14 | IIe-4 | 18 | Loamy Upland | 22 |
| Ue | Ulysses-Colby complex, 1 to 3 percent slopes | 10 | IVe-2 | 15 | None | -- | Limy Upland | 22 |
| Vo | Vona loamy fine sand, eroded | 10 | IVe-1 | 15 | IVe-7 | 19 | Sands | 23 |
| Vx | Vona-Tivoli loamy fine sands | 11 | VIe-2 | 16 | None | 18 | Sands | 23 |

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**All Other Inquiries**

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